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# **kwcoco**

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If you are new, please see our getting started document: [getting\\_started](#)

Please also see information in the repo [README](#), which contains similar but complementary information.

For notes about warping and spaces see [warping\\_and\\_spaces](#). The Kitware COCO module defines a variant of the Microsoft COCO format, originally developed for the “collected images in context” object detection challenge. We are backwards compatible with the original module, but we also have improved implementations in several places, including segmentations, keypoints, annotation tracks, multi-spectral images, and videos (which represents a generic sequence of images).

A kwcoco file is a “manifest” that serves as a single reference that points to all images, categories, and annotations in a computer vision dataset. Thus, when applying an algorithm to a dataset, it is sufficient to have the algorithm take one dataset parameter: the path to the kwcoco file. Generally a kwcoco file will live in a “bundle” directory along with the data that it references, and paths in the kwcoco file will be relative to the location of the kwcoco file itself.

The main data structure in this model is largely based on the implementation in <https://github.com/cocodataset/cocoapi>. It uses the same efficient core indexing data structures, but in our implementation the indexing can be optionally turned off, functions are silent by default (with the exception of long running processes, which optionally show progress by default). We support helper functions that add and remove images, categories, and annotations.

The `kwcoco.CocoDataset` class is capable of dynamic addition and removal of categories, images, and annotations. Has better support for keypoints and segmentation formats than the original COCO format. Despite being written in Python, this data structure is reasonably efficient.

```
>>> import kwcoco
>>> import json
>>> # Create demo data
>>> demo = kwcoco.CocoDataset.demo()
>>> # Reroot can switch between absolute / relative-paths
>>> demo.reroot(absolute=True)
>>> # could also use demo.dump / demo.dumps, but this is more explicit
>>> text = json.dumps(demo.dataset)
>>> with open('demo.json', 'w') as file:
>>>     file.write(text)

>>> # Read from disk
>>> self = kwcoco.CocoDataset('demo.json')

>>> # Add data
>>> cid = self.add_category('Cat')
>>> gid = self.add_image('new-img.jpg')
>>> aid = self.add_annotation(image_id=gid, category_id=cid, bbox=[0, 0, 100, 100])

>>> # Remove data
>>> self.remove_annotations([aid])
>>> self.remove_images([gid])
>>> self.remove_categories([cid])

>>> # Look at data
>>> import ubelt as ub
>>> print(ub.repr2(self.basic_stats(), nl=1))
>>> print(ub.repr2(self.extended_stats(), nl=2))
>>> print(ub.repr2(self.bboxsize_stats(), nl=3))
>>> print(ub.repr2(self.category_annotation_frequency()))
```

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```

>>> # Inspect data
>>> # xdoctest: +REQUIRES(module:kwplot)
>>> import kwplot
>>> kwplot.autompl()
>>> self.show_image(gid=1)

>>> # Access single-item data via imgs, cats, anns
>>> cid = 1
>>> self.cats[cid]
{'id': 1, 'name': 'astronaut', 'supercategory': 'human'}

>>> gid = 1
>>> self.imgs[gid]
{'id': 1, 'file_name': 'astro.png', 'url': 'https://i.imgur.com/KXhKM72.png'}

>>> aid = 3
>>> self.anns[aid]
{'id': 3, 'image_id': 1, 'category_id': 3, 'line': [326, 369, 500, 500]}

>>> # Access multi-item data via the annots and images helper objects
>>> aids = self.index.gid_to_aids[2]
>>> annots = self.annots(aids)

>>> print('annots = {}'.format(ub.repr2(annots, nl=1, sv=1)))
annots = <Annots(num=2)>

>>> annots.lookup('category_id')
[6, 4]

>>> annots.lookup('bbox')
[[37, 6, 230, 240], [124, 96, 45, 18]]

>>> # built in conversions to efficient kwimage array DataStructures
>>> print(ub.repr2(annots.detections.data, sv=1))
{
  'boxes': <Boxes(xywh,
                  array([[ 37.,   6., 230., 240.],
                        [124.,  96.,  45.,  18.]], dtype=float32))>,
  'class_idxs': [5, 3],
  'keypoints': <PointsList(n=2)>,
  'segmentations': <PolygonList(n=2)>,
}

>>> gids = list(self.imgs.keys())
>>> images = self.images(gids)
>>> print('images = {}'.format(ub.repr2(images, nl=1, sv=1)))
images = <Images(num=3)>

>>> images.lookup('file_name')
['astro.png', 'carl.png', 'stars.png']

>>> print('images.annots = {}'.format(images.annots))

```

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```
images.anns = <AnnotGroups(n=3, m=3.7, s=3.9)>  
  
>>> print('images.anns.cids = {!r}'.format(images.anns.cids))  
images.anns.cids = [[1, 2, 3, 4, 5, 5, 5, 5, 5], [6, 4], []]
```





## COCODATASET API

The following is a logical grouping of the public `kwcoco.CocoDataset` API attributes and methods. See the in-code documentation for further details.

### 1.1 CocoDataset classmethods (via MixinCocoExtras)

- `kwcoco.CocoDataset.coerce` - Attempt to transform the input into the intended `CocoDataset`.
- `kwcoco.CocoDataset.demo` - Create a toy coco dataset for testing and demo puposes
- `kwcoco.CocoDataset.random` - Creates a random `CocoDataset` according to distribution parameters

### 1.2 CocoDataset classmethods (via CocoDataset)

- `kwcoco.CocoDataset.from_coco_paths` - Constructor from multiple coco file paths.
- `kwcoco.CocoDataset.from_data` - Constructor from a json dictionary
- `kwcoco.CocoDataset.from_image_paths` - Constructor from a list of images paths.

### 1.3 CocoDataset slots

- `kwcoco.CocoDataset.index` - an efficient lookup index into the coco data structure. The index defines its own attributes like `anns`, `cats`, `imgs`, `gid_to_aids`, `file_name_to_img`, etc. See `CocoIndex` for more details on which attributes are available.
- `kwcoco.CocoDataset.hashid` - If computed, this will be a hash uniquely identifying the dataset. To ensure this is computed see `kwcoco.coco_dataset.MixinCocoExtras._build_hashid()`.
- `kwcoco.CocoDataset.hashid_parts` -
- `kwcoco.CocoDataset.tag` - A tag indicating the name of the dataset.
- `kwcoco.CocoDataset.dataset` - raw json data structure. This is the base dictionary that contains { 'annotations': List, 'images': List, 'categories': List }
- `kwcoco.CocoDataset.bundle_dpath` - If known, this is the root path that all image file names are relative to. This can also be manually overwritten by the user.
- `kwcoco.CocoDataset.assets_dpath` -
- `kwcoco.CocoDataset.cache_dpath` -

## 1.4 CocoDataset properties

- `kwcoco.CocoDataset.anns` -
- `kwcoco.CocoDataset.cats` -
- `kwcoco.CocoDataset.cid_to_aids` -
- `kwcoco.CocoDataset.data_fpath` -
- `kwcoco.CocoDataset.data_root` -
- `kwcoco.CocoDataset.fpath` - if known, this stores the filepath the dataset was loaded from
- `kwcoco.CocoDataset.gid_to_aids` -
- `kwcoco.CocoDataset.img_root` -
- `kwcoco.CocoDataset.imgs` -
- `kwcoco.CocoDataset.n_annots` -
- `kwcoco.CocoDataset.n_cats` -
- `kwcoco.CocoDataset.n_images` -
- `kwcoco.CocoDataset.n_videos` -
- `kwcoco.CocoDataset.name_to_cat` -

## 1.5 CocoDataset methods (via MixinCocoAddRemove)

- `kwcoco.CocoDataset.add_annotation` - Add an annotation to the dataset (dynamically updates the index)
- `kwcoco.CocoDataset.add_annotations` - Faster less-safe multi-item alternative to `add_annotation`.
- `kwcoco.CocoDataset.add_category` - Adds a category
- `kwcoco.CocoDataset.add_image` - Add an image to the dataset (dynamically updates the index)
- `kwcoco.CocoDataset.add_images` - Faster less-safe multi-item alternative
- `kwcoco.CocoDataset.add_video` - Add a video to the dataset (dynamically updates the index)
- `kwcoco.CocoDataset.clear_annotations` - Removes all annotations (but not images and categories)
- `kwcoco.CocoDataset.clear_images` - Removes all images and annotations (but not categories)
- `kwcoco.CocoDataset.ensure_category` - Like `add_category()`, but returns the existing category id if it already exists instead of failing. In this case all metadata is ignored.
- `kwcoco.CocoDataset.ensure_image` - Like `add_image()`, but returns the existing image id if it already exists instead of failing. In this case all metadata is ignored.
- `kwcoco.CocoDataset.remove_annotation` - Remove a single annotation from the dataset
- `kwcoco.CocoDataset.remove_annotation_keypoints` - Removes all keypoints with a particular category
- `kwcoco.CocoDataset.remove_annotations` - Remove multiple annotations from the dataset.
- `kwcoco.CocoDataset.remove_categories` - Remove categories and all annotations in those categories. Currently does not change any hierarchy information
- `kwcoco.CocoDataset.remove_images` - Remove images and any annotations contained by them

- `kwcoco.CocoDataset.remove_keypoint_categories` - Removes all keypoints of a particular category as well as all annotation keypoints with those ids.
- `kwcoco.CocoDataset.remove_videos` - Remove videos and any images / annotations contained by them
- `kwcoco.CocoDataset.set_annotation_category` - Sets the category of a single annotation

## 1.6 CocoDataset methods (via MixinCocoObjects)

- `kwcoco.CocoDataset.anns` - Return vectorized annotation objects
- `kwcoco.CocoDataset.categories` - Return vectorized category objects
- `kwcoco.CocoDataset.images` - Return vectorized image objects
- `kwcoco.CocoDataset.videos` - Return vectorized video objects

## 1.7 CocoDataset methods (via MixinCocoStats)

- `kwcoco.CocoDataset.basic_stats` - Reports number of images, annotations, and categories.
- `kwcoco.CocoDataset.bboxsize_stats` - Compute statistics about bounding box sizes.
- `kwcoco.CocoDataset.category_annotation_frequency` - Reports the number of annotations of each category
- `kwcoco.CocoDataset.category_annotation_type_frequency` - Reports the number of annotations of each type for each category
- `kwcoco.CocoDataset.conform` - Make the COCO file conform a stricter spec, infers attributes where possible.
- `kwcoco.CocoDataset.extended_stats` - Reports number of images, annotations, and categories.
- `kwcoco.CocoDataset.find_representative_images` - Find images that have a wide array of categories. Attempt to find the fewest images that cover all categories using images that contain both a large and small number of annotations.
- `kwcoco.CocoDataset.keypoint_annotation_frequency` -
- `kwcoco.CocoDataset.stats` - This function corresponds to `kwcoco.cli.coco_stats`.
- `kwcoco.CocoDataset.validate` - Performs checks on this coco dataset.

## 1.8 CocoDataset methods (via MixinCocoAccessors)

- `kwcoco.CocoDataset.category_graph` - Construct a networkx category hierarchy
- `kwcoco.CocoDataset.delayed_load` - Experimental method
- `kwcoco.CocoDataset.get_auxiliary_fpath` - Returns the full path to auxiliary data for an image
- `kwcoco.CocoDataset.get_image_fpath` - Returns the full path to the image
- `kwcoco.CocoDataset.keypoint_categories` - Construct a consistent CategoryTree representation of keypoint classes
- `kwcoco.CocoDataset.load_annot_sample` - Reads the chip of an annotation. Note this is much less efficient than using a sampler, but it doesn't require disk cache.

- `kwcoco.CocoDataset.load_image` - Reads an image from disk and
- `kwcoco.CocoDataset.object_categories` - Construct a consistent CategoryTree representation of object classes

## 1.9 CocoDataset methods (via CocoDataset)

- `kwcoco.CocoDataset.copy` - Deep copies this object
- `kwcoco.CocoDataset.dump` - Writes the dataset out to the json format
- `kwcoco.CocoDataset.dumps` - Writes the dataset out to the json format
- `kwcoco.CocoDataset.subset` - Return a subset of the larger coco dataset by specifying which images to port. All annotations in those images will be taken.
- `kwcoco.CocoDataset.union` - Merges multiple CocoDataset items into one. Names and associations are retained, but ids may be different.
- `kwcoco.CocoDataset.view_sql` - Create a cached SQL interface to this dataset suitable for large scale multiprocessing use cases.

## 1.10 CocoDataset methods (via MixinCocoExtras)

- `kwcoco.CocoDataset.corrupted_images` - Check for images that don't exist or can't be opened
- `kwcoco.CocoDataset.missing_images` - Check for images that don't exist
- `kwcoco.CocoDataset.rename_categories` - Rename categories with a potentially coarser categorization.
- `kwcoco.CocoDataset.reroot` - Rebase image/data paths onto a new image/data root.

## 1.11 CocoDataset methods (via MixinCocoDraw)

- `kwcoco.CocoDataset.draw_image` - Use kwimage to draw all annotations on an image and return the pixels as a numpy array.
- `kwcoco.CocoDataset.imread` - Loads a particular image
- `kwcoco.CocoDataset.show_image` - Use matplotlib to show an image with annotations overlaid

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The main data structure in this model is largely based on the implementation in <https://github.com/cocodataset/cocoapi>. It uses the same efficient core indexing data structures, but in our implementation the indexing can be optionally turned off, functions are silent by default (with the exception of long running processes, which optionally show progress by default). We support helper functions that add and remove images, categories, and annotations.

The `kwcoco.CocoDataset` class is capable of dynamic addition and removal of categories, images, and annotations. Has better support for keypoints and segmentation formats than the original COCO format. Despite being written in Python, this data structure is reasonably efficient.

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>>> import kwcoco
>>> import json
>>> # Create demo data
>>> demo = kwcoco.CocoDataset.demo()
>>> # Reroot can switch between absolute / relative-paths
>>> demo.reroot(absolute=True)
>>> # could also use demo.dump / demo.dumps, but this is more explicit
>>> text = json.dumps(demo.dataset)
>>> with open('demo.json', 'w') as file:
>>>     file.write(text)

>>> # Read from disk
>>> self = kwcoco.CocoDataset('demo.json')

>>> # Add data
>>> cid = self.add_category('Cat')
>>> gid = self.add_image('new-img.jpg')
>>> aid = self.add_annotation(image_id=gid, category_id=cid, bbox=[0, 0, 100, 100])

>>> # Remove data
>>> self.remove_annotations([aid])
>>> self.remove_images([gid])
>>> self.remove_categories([cid])
```

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```

>>> # Look at data
>>> import ubelt as ub
>>> print(ub.repr2(self.basic_stats(), nl=1))
>>> print(ub.repr2(self.extended_stats(), nl=2))
>>> print(ub.repr2(self.boxesize_stats(), nl=3))
>>> print(ub.repr2(self.category_annotation_frequency()))

>>> # Inspect data
>>> # xdoctest: +REQUIRES(module:kwplot)
>>> import kwplot
>>> kwplot.autompl()
>>> self.show_image(gid=1)

>>> # Access single-item data via imgs, cats, anns
>>> cid = 1
>>> self.cats[cid]
{'id': 1, 'name': 'astronaut', 'supercategory': 'human'}

>>> gid = 1
>>> self.imgs[gid]
{'id': 1, 'file_name': 'astro.png', 'url': 'https://i.imgur.com/KXhKM72.png'}

>>> aid = 3
>>> self.anns[aid]
{'id': 3, 'image_id': 1, 'category_id': 3, 'line': [326, 369, 500, 500]}

>>> # Access multi-item data via the annots and images helper objects
>>> aids = self.index.gid_to_aids[2]
>>> annots = self.annots(aids)

>>> print('annots = {}'.format(ub.repr2(annots, nl=1, sv=1)))
annots = <Annots(num=2)>

>>> annots.lookup('category_id')
[6, 4]

>>> annots.lookup('bbox')
[[37, 6, 230, 240], [124, 96, 45, 18]]

>>> # built in conversions to efficient kwimage array DataStructures
>>> print(ub.repr2(annots.detections.data, sv=1))
{
  'boxes': <Boxes(xywh,
                  array([[ 37.,   6., 230., 240.],
                        [124.,  96.,  45.,  18.]], dtype=float32))>,
  'class_idxs': [5, 3],
  'keypoints': <PointsList(n=2)>,
  'segmentations': <PolygonList(n=2)>,
}

```

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```

>>> gids = list(self.imgs.keys())
>>> images = self.images(gids)
>>> print('images = {}'.format(ub.repr2(images, nl=1, sv=1)))
images = <Images(num=3)>

>>> images.lookup('file_name')
['astro.png', 'carl.png', 'stars.png']

>>> print('images.anns = {}'.format(images.anns))
images.anns = <AnnotGroups(n=3, m=3.7, s=3.9)>

>>> print('images.anns.cids = {}'.format(images.anns.cids))
images.anns.cids = [[1, 2, 3, 4, 5, 5, 5, 5, 5], [6, 4], []]

```

## 2.1 CocoDataset API

The following is a logical grouping of the public `kwcoco.CocoDataset` API attributes and methods. See the in-code documentation for further details.

### 2.1.1 CocoDataset classmethods (via MixinCocoExtras)

- `kwcoco.CocoDataset.coerce` - Attempt to transform the input into the intended `CocoDataset`.
- `kwcoco.CocoDataset.demo` - Create a toy coco dataset for testing and demo puposes
- `kwcoco.CocoDataset.random` - Creates a random `CocoDataset` according to distribution parameters

### 2.1.2 CocoDataset classmethods (via CocoDataset)

- `kwcoco.CocoDataset.from_coco_paths` - Constructor from multiple coco file paths.
- `kwcoco.CocoDataset.from_data` - Constructor from a json dictionary
- `kwcoco.CocoDataset.from_image_paths` - Constructor from a list of images paths.

### 2.1.3 CocoDataset slots

- `kwcoco.CocoDataset.index` - an efficient lookup index into the coco data structure. The index defines its own attributes like `anns`, `cats`, `imgs`, `gid_to_aids`, `file_name_to_img`, etc. See `CocoIndex` for more details on which attributes are available.
- `kwcoco.CocoDataset.hashid` - If computed, this will be a hash uniquely identifying the dataset. To ensure this is computed see `kwcoco.coco_dataset.MixinCocoExtras._build_hashid()`.
- `kwcoco.CocoDataset.hashid_parts` -
- `kwcoco.CocoDataset.tag` - A tag indicating the name of the dataset.
- `kwcoco.CocoDataset.dataset` - raw json data structure. This is the base dictionary that contains { 'annotations': List, 'images': List, 'categories': List }

- `kwcoco.CocoDataset.bundle_dpath` - If known, this is the root path that all image file names are relative to. This can also be manually overwritten by the user.
- `kwcoco.CocoDataset.assets_dpath` -
- `kwcoco.CocoDataset.cache_dpath` -

### 2.1.4 CocoDataset properties

- `kwcoco.CocoDataset.anns` -
- `kwcoco.CocoDataset.cats` -
- `kwcoco.CocoDataset.cid_to_aids` -
- `kwcoco.CocoDataset.data_fpath` -
- `kwcoco.CocoDataset.data_root` -
- `kwcoco.CocoDataset.fpath` - if known, this stores the filepath the dataset was loaded from
- `kwcoco.CocoDataset.gid_to_aids` -
- `kwcoco.CocoDataset.img_root` -
- `kwcoco.CocoDataset.imgs` -
- `kwcoco.CocoDataset.n_annots` -
- `kwcoco.CocoDataset.n_cats` -
- `kwcoco.CocoDataset.n_images` -
- `kwcoco.CocoDataset.n_videos` -
- `kwcoco.CocoDataset.name_to_cat` -

### 2.1.5 CocoDataset methods (via MixinCocoAddRemove)

- `kwcoco.CocoDataset.add_annotation` - Add an annotation to the dataset (dynamically updates the index)
- `kwcoco.CocoDataset.add_annotations` - Faster less-safe multi-item alternative to `add_annotation`.
- `kwcoco.CocoDataset.add_category` - Adds a category
- `kwcoco.CocoDataset.add_image` - Add an image to the dataset (dynamically updates the index)
- `kwcoco.CocoDataset.add_images` - Faster less-safe multi-item alternative
- `kwcoco.CocoDataset.add_video` - Add a video to the dataset (dynamically updates the index)
- `kwcoco.CocoDataset.clear_annotations` - Removes all annotations (but not images and categories)
- `kwcoco.CocoDataset.clear_images` - Removes all images and annotations (but not categories)
- `kwcoco.CocoDataset.ensure_category` - Like `add_category()`, but returns the existing category id if it already exists instead of failing. In this case all metadata is ignored.
- `kwcoco.CocoDataset.ensure_image` - Like `add_image()`, but returns the existing image id if it already exists instead of failing. In this case all metadata is ignored.
- `kwcoco.CocoDataset.remove_annotation` - Remove a single annotation from the dataset
- `kwcoco.CocoDataset.remove_annotation_keypoints` - Removes all keypoints with a particular category
- `kwcoco.CocoDataset.remove_annotations` - Remove multiple annotations from the dataset.



- `kwcoco.CocoDataset.remove_categories` - Remove categories and all annotations in those categories. Currently does not change any hierarchy information
- `kwcoco.CocoDataset.remove_images` - Remove images and any annotations contained by them
- `kwcoco.CocoDataset.remove_keypoint_categories` - Removes all keypoints of a particular category as well as all annotation keypoints with those ids.
- `kwcoco.CocoDataset.remove_videos` - Remove videos and any images / annotations contained by them
- `kwcoco.CocoDataset.set_annotation_category` - Sets the category of a single annotation

### 2.1.6 CocoDataset methods (via MixinCocoObjects)

- `kwcoco.CocoDataset.anns` - Return vectorized annotation objects
- `kwcoco.CocoDataset.categories` - Return vectorized category objects
- `kwcoco.CocoDataset.images` - Return vectorized image objects
- `kwcoco.CocoDataset.videos` - Return vectorized video objects

### 2.1.7 CocoDataset methods (via MixinCocoStats)

- `kwcoco.CocoDataset.basic_stats` - Reports number of images, annotations, and categories.
- `kwcoco.CocoDataset.bboxsize_stats` - Compute statistics about bounding box sizes.
- `kwcoco.CocoDataset.category_annotation_frequency` - Reports the number of annotations of each category
- `kwcoco.CocoDataset.category_annotation_type_frequency` - Reports the number of annotations of each type for each category
- `kwcoco.CocoDataset.conform` - Make the COCO file conform a stricter spec, infers attributes where possible.
- `kwcoco.CocoDataset.extended_stats` - Reports number of images, annotations, and categories.
- `kwcoco.CocoDataset.find_representative_images` - Find images that have a wide array of categories. Attempt to find the fewest images that cover all categories using images that contain both a large and small number of annotations.
- `kwcoco.CocoDataset.keypoint_annotation_frequency` -
- `kwcoco.CocoDataset.stats` - This function corresponds to `kwcoco.cli.coco_stats`.
- `kwcoco.CocoDataset.validate` - Performs checks on this coco dataset.

### 2.1.8 CocoDataset methods (via MixinCocoAccessors)

- `kwcoco.CocoDataset.category_graph` - Construct a networkx category hierarchy
- `kwcoco.CocoDataset.delayed_load` - Experimental method
- `kwcoco.CocoDataset.get_auxiliary_fpath` - Returns the full path to auxiliary data for an image
- `kwcoco.CocoDataset.get_image_fpath` - Returns the full path to the image
- `kwcoco.CocoDataset.keypoint_categories` - Construct a consistent CategoryTree representation of keypoint classes

- `kwcoco.CocoDataset.load_annot_sample` - Reads the chip of an annotation. Note this is much less efficient than using a sampler, but it doesn't require disk cache.
- `kwcoco.CocoDataset.load_image` - Reads an image from disk and
- `kwcoco.CocoDataset.object_categories` - Construct a consistent CategoryTree representation of object classes

### 2.1.9 CocoDataset methods (via CocoDataset)

- `kwcoco.CocoDataset.copy` - Deep copies this object
- `kwcoco.CocoDataset.dump` - Writes the dataset out to the json format
- `kwcoco.CocoDataset.dumps` - Writes the dataset out to the json format
- `kwcoco.CocoDataset.subset` - Return a subset of the larger coco dataset by specifying which images to port. All annotations in those images will be taken.
- `kwcoco.CocoDataset.union` - Merges multiple `CocoDataset` items into one. Names and associations are retained, but ids may be different.
- `kwcoco.CocoDataset.view_sql` - Create a cached SQL interface to this dataset suitable for large scale multiprocessing use cases.

### 2.1.10 CocoDataset methods (via MixinCocoExtras)

- `kwcoco.CocoDataset.corrupted_images` - Check for images that don't exist or can't be opened
- `kwcoco.CocoDataset.missing_images` - Check for images that don't exist
- `kwcoco.CocoDataset.rename_categories` - Rename categories with a potentially coarser categorization.
- `kwcoco.CocoDataset.reroot` - Rebase image/data paths onto a new image/data root.

### 2.1.11 CocoDataset methods (via MixinCocoDraw)

- `kwcoco.CocoDataset.draw_image` - Use `kwimage` to draw all annotations on an image and return the pixels as a numpy array.
- `kwcoco.CocoDataset.imread` - Loads a particular image
- `kwcoco.CocoDataset.show_image` - Use `matplotlib` to show an image with annotations overlaid

## 2.2 Subpackages

### 2.2.1 kwcoco.cli

#### Submodules

`kwcoco.cli.__main__`

#### Module Contents

## Functions

---

<code>main(cmdline=True, **kw)</code>	<code>kw = dict(command='stats')</code>
---------------------------------------	---

---

```
kwcoco.cli.__main__.main(cmdline=True, **kw)
    kw = dict(command='stats') cmdline = False
```

```
kwcoco.cli.coco_conform
```

## Module Contents

## Classes

---

*CocoConformCLI*

---

## Attributes

---

*\_CLI*

---

```
class kwcoco.cli.coco_conform.CocoConformCLI
```

```
    class CLIConfig(data=None, default=None, cmdline=False)
```

```
        Bases: scriptconfig.Config
```

```
        Make the COCO file conform to the spec.
```

```
        Populates inferable information such as image size, annotation area, etc.
```

```
        epilog = Multiline-String
```

<pre> 1         Example Usage: 2         kwcoco conform --help 3         kwcoco conform --src=special:shapes8 --dst conformed.json </pre>
---

```
        default
```

```
name = conform
```

```
classmethod main(cls, cmdline=True, **kw)
```

### Example

```
>>> # xdoctest: +SKIP
>>> kw = {'src': 'special:shapes8'}
>>> cmdline = False
>>> cls = CocoConformCLI
>>> cls.main(cmdline, **kw)
```

`kwcoco.cli.coco_conform._CLI`

`kwcoco.cli.coco_eval`

Wraps the logic in `kwcoco/coco_evaluator.py` with a command line script

## Module Contents

### Classes

---

<code>CocoEvalCLIConfig</code>	Base class for custom configuration objects
<code>CocoEvalCLI</code>	

---

### Functions

---

<code>main(cmdline=True, **kw)</code>	
	<b>Todo:</b> <ul style="list-style-type: none"><li>• [X] should live in <code>kwcoco.cli.coco_eval</code></li></ul>

---

### Attributes

---

<code>_CLI</code>
-------------------

---

**class** `kwcoco.cli.coco_eval.CocoEvalCLIConfig`(*data=None, default=None, cmdline=False*)

Bases: `scriptconfig.Config`

Base class for custom configuration objects

A configuration that can be specified by commandline args, a yaml config file, and / or a in-code dictionary. To use, define a class variable named “default” and assing it to a dict of default values. You can also use special *Value* classes to denote types. You can also define a method *normalize*, to postprocess the arguments after this class receives them.

**Usage:** Create a class that herits from this class.

Assign the “default” class-level variable as a dictionary of options

The keys of this dictionary must be command line friendly strings.

The values of the “defaults dictionary” can be literal values or instances of the `scriptconfig.Value` class, which allows for specification of default values, type information, help strings, and aliases.

You may also implement `normalize` (function with that takes no args and has no return) to postprocess your results after initialization.

When creating an instance of the class the defaults variable is used to make a dictionary-like object. You can override defaults by specifying the `data` keyword argument to either a file path or another dictionary. You can also specify `cmdline=True` to allow the contents of `sys.argv` to influence the values of the new object.

An instance of the config class behaves like a dictionary, except that you cannot set keys that do not already exist (as specified in the defaults dict).

Key Methods:

- `dump` - dump a json representation to a file
- `dumps` - dump a json representation to a string
- `argparse` - create the argparse object associated with this config
- **`argparse` - create an `argparse.ArgumentParser` object that** is defined by the defaults of this config.
- **`load` - rewrite the values based on a filepath, dictionary, or** command line contents.

**Variables**

- **`_data`** – this protected variable holds the raw state of the config object and is accessed by the dict-like
- **`_default`** – this protected variable maintains the default values for this config.

## Example

```
>>> # Inherit from `Config` and assign `default`
>>> import scriptconfig as scfg
>>> class MyConfig(scfg.Config):
>>>     default = {
>>>         'option1': scfg.Value((1, 2, 3), tuple),
>>>         'option2': 'bar',
>>>         'option3': None,
>>>     }
>>> # You can now make instances of this class
>>> config1 = MyConfig()
>>> config2 = MyConfig(default=dict(option1='baz'))
```

`__doc__`

`default`

```
class kwcoco.cli.coco_eval.CocoEvalCLI
```

```
name = eval

CLIConfig

classmethod main(cls, cmdline=True, **kw)
```

### Example

```
>>> # xdoctest: +REQUIRES(module:kwplot)
>>> import ubelt as ub
>>> from kwcoco.cli.coco_eval import * # NOQA
>>> from os.path import join
>>> import kwcoco
>>> dpath = ub.ensure_app_cache_dir('kwcoco/tests/eval')
>>> true_dset = kwcoco.CocoDataset.demo('shapes8')
>>> from kwcoco.demo.perterb import perterb_coco
>>> kwargs = {
>>>     'box_noise': 0.5,
>>>     'n_fp': (0, 10),
>>>     'n_fn': (0, 10),
>>> }
>>> pred_dset = perterb_coco(true_dset, **kwargs)
>>> true_dset.fpath = join(dpath, 'true.mscoco.json')
>>> pred_dset.fpath = join(dpath, 'pred.mscoco.json')
>>> true_dset.dump(true_dset.fpath)
>>> pred_dset.dump(pred_dset.fpath)
>>> draw = False # set to false for faster tests
>>> CocoEvalCLI.main(
>>>     true_dataset=true_dset.fpath,
>>>     pred_dataset=pred_dset.fpath,
>>>     draw=draw)
```

```
kwcoco.cli.coco_eval.main(cmdline=True, **kw)
```

---

### Todo:

- [X] should live in kwcoco.cli.coco\_eval
- 

### CommandLine

```
# Generate test data
xdoctest -m kwcoco.cli.coco_eval CocoEvalCLI.main

kwcoco eval \
  --true_dataset=$HOME/.cache/kwcoco/tests/eval/true.mscoco.json \
  --pred_dataset=$HOME/.cache/kwcoco/tests/eval/pred.mscoco.json \
  --out_dpath=$HOME/.cache/kwcoco/tests/eval/out \
  --force_pycocoutils=False \
  --area_range=all,0-4096,4096-inf

nautilus $HOME/.cache/kwcoco/tests/eval/out
```

`kwcoco.cli.coco_eval._CLI`

`kwcoco.cli.coco_grab`

## Module Contents

### Classes

---

*CocoGrabCLI*

---

### Attributes

---

*\_CLI*

---

**class** `kwcoco.cli.coco_grab.CocoGrabCLI`

**class** `CLIConfig(data=None, default=None, cmdline=False)`

        Bases: `scriptconfig.Config`

        Grab standard datasets.

#### Example

`kwcoco grab cifar10 camvid`

**default**

**name** = `grab`

**classmethod** `main(cls, cmdline=True, **kw)`

`kwcoco.cli.coco_grab._CLI`

`kwcoco.cli.coco_modify_categories`

## Module Contents

### Classes

---

*CocoModifyCatsCLI*

---

Remove, rename, or coarsen categories.

---

## Attributes

---

`_CLI`

---

**class** kwcoco.cli.coco\_modify\_categories.CocoModifyCatsCLI

Remove, rename, or coarsen categories.

**class** CLIConfig(*data=None, default=None, cmdline=False*)

Bases: `scriptconfig.Config`

Rename or remove categories

**epilog** = **Multiline-String**

```
1      Example Usage:
2          kwcoco modify_categories --help
3          kwcoco modify_categories --src=special:shapes8 --dst_
↳modcats.json
4          kwcoco modify_categories --src=special:shapes8 --dst_
↳modcats.json --rename eff:F,star:sun
5          kwcoco modify_categories --src=special:shapes8 --dst_
↳modcats.json --remove eff,star
6          kwcoco modify_categories --src=special:shapes8 --dst_
↳modcats.json --keep eff,
7
8          kwcoco modify_categories --src=special:shapes8 --dst_
↳modcats.json --keep=[] --keep_annots=True
```

**default**

**name** = **modify\_categories**

**classmethod** **main**(*cls, cmdline=True, \*\*kw*)

## Example

```
>>> # xdoctest: +SKIP
>>> kw = {'src': 'special:shapes8'}
>>> cmdline = False
>>> cls = CocoModifyCatsCLI
>>> cls.main(cmdline, **kw)
```

kwcoco.cli.coco\_modify\_categories.\_CLI



`kwcoco.cli.coco_reroot`

## Module Contents

### Classes

*CocoRerootCLI*

### Attributes

*\_CLI***class** `kwcoco.cli.coco_reroot.CocoRerootCLI`**class** `CLIConfig`(*data=None, default=None, cmdline=False*)Bases: `scriptconfig.Config`

Reroot image paths onto a new image root.

Modify the root of a coco dataset such to either make paths relative to a new root or make paths absolute.

**Todo:**

- [ ] Evaluate that all tests cases work

**epilog = Multiline-String**

```

1      Example Usage:
2      kwcoco reroot --help
3      kwcoco reroot --src=special:shapes8 --dst rerooted.json
4      kwcoco reroot --src=special:shapes8 --new_prefix=foo --
    ↪ check=True --dst rerooted.json

```

**default****name = reroot****classmethod** `main`(*cls, cmdline=True, \*\*kw*)

## Example

```
>>> # xdoctest: +SKIP
>>> kw = {'src': 'special:shapes8'}
>>> cmdline = False
>>> cls = CocoRerootCLI
>>> cls.main(cmdline, **kw)
```

`kwcoco.cli.coco_reroot._CLI`

`kwcoco.cli.coco_show`

## Module Contents

### Classes

---

*CocoShowCLI*

---

### Attributes

---

*\_CLI*

---

**class** `kwcoco.cli.coco_show.CocoShowCLI`

**class** `CLIConfig`(*data=None, default=None, cmdline=False*)

Bases: `scriptconfig.Config`

Visualize a COCO image using matplotlib or opencv, optionally writing it to disk

**epilog** = **Multiline-String**

```
1      Example Usage:
2      kwcoco show --help
3      kwcoco show --src=special:shapes8 --gid=1
4      kwcoco show --src=special:shapes8 --gid=1 --dst out.png
```

**default**

**name** = **show**

**classmethod** **main**(*cls, cmdline=True, \*\*kw*)

---

#### Todo:

- [ ] Visualize auxiliary data
-

## Example

```
>>> # xdoctest: +SKIP
>>> kw = {'src': 'special:shapes8'}
>>> cmdline = False
>>> cls = CocoShowCLI
>>> cls.main(cmdline, **kw)
```

kwcoco.cli.coco\_show.\_CLI

kwcoco.cli.coco\_split

## Module Contents

### Classes

---

*CocoSplitCLI*

---

### Attributes

---

*\_CLI*

---

**class** kwcoco.cli.coco\_split.CocoSplitCLI

Bases: `object`

**class** CLIConfig(*data=None, default=None, cmdline=False*)

Bases: `scriptconfig.Config`

Split a single COCO dataset into two sub-datasets.

**default**

**epilog** = `Multiline-String`

```
1      Example Usage:
2      kwcoco split --src special:shapes8 --dst1=learn.msccoco.
      ↪ json --dst2=test.msccoco.json --factor=3 --rng=42
```

**name** = `split`

**classmethod** `main(cls, cmdline=True, **kw)`

### Example

```
>>> kw = {'src': 'special:shapes8',  
>>>        'dst1': 'train.json', 'dst2': 'test.json'}  
>>> cmdline = False  
>>> cls = CocoSplitCLI  
>>> cls.main(cmdline, **kw)
```

`kwcoco.cli.coco_split._CLI`

`kwcoco.cli.coco_stats`

## Module Contents

### Classes

---

*CocoStatsCLI*

---

### Attributes

---

*\_CLI*

---

**class** `kwcoco.cli.coco_stats.CocoStatsCLI`

**class** `CLIConfig`(*data=None, default=None, cmdline=False*)

Bases: `scriptconfig.Config`

Compute summary statistics about a COCO dataset

**default**

**epilog** = **Multiline-String**

```
1      Example Usage:  
2      kwcoco stats --src=special:shapes8  
3      kwcoco stats --src=special:shapes8 --boxes=True
```

**name** = `stats`

**classmethod** `main`(*cls, cmdline=True, \*\*kw*)

### Example

```
>>> kw = {'src': 'special:shapes8'}
>>> cmdline = False
>>> cls = CocoStatsCLI
>>> cls.main(cmdline, **kw)
```

kwcoco.cli.coco\_stats.\_CLI

kwcoco.cli.coco\_subset

## Module Contents

### Classes

---

*CocoSubsetCLI*

---

### Functions

---

*query\_subset*(dset, config)

---

### Example

### Attributes

---

*\_CLI*

---

**class** kwcoco.cli.coco\_subset.CocoSubsetCLI

Bases: *object*

**class** CLIConfig(data=None, default=None, cmdline=False)

Bases: *scriptconfig.Config*

Take a subset of this dataset and write it to a new file

**default**

**epilog** = *Multiline-String*

```
1      Example Usage:
2      kwcoco subset --src special:shapes8 --dst=foo.kwcoco.json
3
4      # Take only the even image-ids
5      kwcoco subset --src special:shapes8 --dst=foo-even.kwcoco.
  json --select_images '.id % 2 == 0'
```

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```

6
7         # Take only the videos where the name ends with 2
8         kwcoco subset --src special:vidshapes8 --dst=vidsub.
    ↪ kwcoco.json --select_videos '.name | endswith("2")'
```

`name = subset`

`classmethod main(cls, cmdline=True, **kw)`

### Example

```

>>> kw = {'src': 'special:shapes8',
>>>        'dst': 'subset.json', 'include_categories': 'superstar'}
>>> cmdline = False
>>> cls = CocoSubsetCLI
>>> cls.main(cmdline, **kw)
```

`kwcoco.cli.coco_subset.query_subset(dset, config)`

### Example

```

>>> # xdoctest: +REQUIRES(module:jq)
>>> from kwcoco.cli.coco_subset import * # NOQA
>>> import kwcoco
>>> dset = kwcoco.CocoDataset.demo()
>>> assert dset.n_images == 3
>>> #
>>> config = CocoSubsetCLI.CLIFConfig({'select_images': '.id < 3'})
>>> new_dset = query_subset(dset, config)
>>> assert new_dset.n_images == 2
>>> #
>>> config = CocoSubsetCLI.CLIFConfig({'select_images': '.file_name | test("*.png")'
    ↪'})
>>> new_dset = query_subset(dset, config)
>>> assert all(n.endswith('.png') for n in new_dset.images().lookup('file_name'))
>>> assert new_dset.n_images == 2
>>> #
>>> config = CocoSubsetCLI.CLIFConfig({'select_images': '.file_name | test("*.png")'
    ↪| not'})
>>> new_dset = query_subset(dset, config)
>>> assert not any(n.endswith('.png') for n in new_dset.images().lookup('file_name'
    ↪'))
>>> assert new_dset.n_images == 1
>>> #
>>> config = CocoSubsetCLI.CLIFConfig({'select_images': '.id < 3 and (.file_name |'
    ↪test("*.png"))'})
>>> new_dset = query_subset(dset, config)
>>> assert new_dset.n_images == 1
>>> #
>>> config = CocoSubsetCLI.CLIFConfig({'select_images': '.id < 3 or (.file_name |'
    ↪test("*.png"))'})
```

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```
>>> new_dset = query_subset(dset, config)
>>> assert new_dset.n_images == 3
```

### Example

```
>>> # xdoctest: +REQUIRES(module:jq)
>>> from kwcoco.cli.coco_subset import * # NOQA
>>> import kwcoco
>>> dset = kwcoco.CocoDataset.demo('vidshapes8')
>>> assert dset.n_videos == 8
>>> assert dset.n_images == 16
>>> config = CocoSubsetCLI.CLIFConfig({'select_videos': '.name == "toy_video_3"'})
>>> new_dset = query_subset(dset, config)
>>> assert new_dset.n_images == 2
>>> assert new_dset.n_videos == 1
```

kwcoco.cli.coco\_subset.\_CLI

kwcoco.cli.coco\_toydata

## Module Contents

### Classes

---

*CocoToyDataCLI*

---

### Attributes

---

*\_CLI*

---

**class** kwcoco.cli.coco\_toydata.CocoToyDataCLI

Bases: `object`

**class** CLIFConfig(data=None, default=None, cmdline=False)

Bases: `scriptconfig.Config`

Create COCO toydata for demo and testing purposes.

**default**

**epilog** = `Multiline-String`

```
1      Example Usage:
2      kwcoco toydata --key=shapes8 --dst=toydata.kwcoco.json
3
4      kwcoco toydata --key=shapes8 --bundle_dpath=my_test_
5      ↪ bundle_v1 kwcoco toydata --key=shapes8 --bundle_dpath=my_test_
6      ↪ bundle_v1
7      kwcoco toydata --key=shapes8
8      ↪ --dst=./shapes8.kwcoco/dataset.kwcoco.json
9
10     TODO:
11     - [ ] allow specification of images directory
```

```
name = toydata
```

```
classmethod main(cls, cmdline=True, **kw)
```

### Example

```
>>> kw = {'key': 'shapes8', 'dst': 'test.json'}
>>> cmdline = False
>>> cls = CocoToyDataCLI
>>> cls.main(cmdline, **kw)
```

```
kwcoco.cli.coco_toydata._CLI
```

```
kwcoco.cli.coco_union
```

## Module Contents

### Classes

---

*CocoUnionCLI*

---

### Attributes

---

*\_CLI*

---

```
class kwcoco.cli.coco_union.CocoUnionCLI
```

```
    Bases: object
```

```
    class CLIConfig(data=None, default=None, cmdline=False)
```

```
        Bases: scriptconfig.Config
```

```
        Combine multiple COCO datasets into a single merged dataset.
```



**default**

**epilog = Multiline-String**

```

1      Example Usage:
2      kwcoco union --src special:shapes8 special:shapes1 --
      ↪dst=combo.mscoco.json

```

**name = union**

**classmethod main(cls, cmdline=True, \*\*kw)**

### Example

```

>>> kw = {'src': ['special:shapes8', 'special:shapes1']}
>>> cmdline = False
>>> cls = CocoUnionCLI
>>> cls.main(cmdline, **kw)

```

kwcoco.cli.coco\_union.\_CLI

kwcoco.cli.coco\_validate

## Module Contents

### Classes

---

*CocoValidateCLI*

---

### Attributes

---

*\_CLI*

---

**class kwcoco.cli.coco\_validate.CocoValidateCLI**

**class CLIConfig(data=None, default=None, cmdline=False)**

Bases: `scriptconfig.Config`

Validate that a coco file conforms to the json schema, that assets exist, and potentially fix corrupted assets by removing them.

**default**

**epilog = Multiline-String**

```

1      Example Usage:
2      kwcoco toydata --dst foo.json --key=special:shapes8
3      kwcoco validate --src=foo.json --corrupted=True

```

```
name = validate
classmethod main(cls, cmdline=True, **kw)
```

### Example

```
>>> from kwcoco.cli.coco_validate import * # NOQA
>>> kw = {'src': 'special:shapes8'}
>>> cmdline = False
>>> cls = CocoValidateCLI
>>> cls.main(cmdline, **kw)
```

```
kwcoco.cli.coco_validate._CLI
```

## 2.2.2 kwcoco.data

### Submodules

`kwcoco.data.grab_camvid`

Downloads the CamVid data if necessary, and converts it to COCO.

### Module Contents

#### Functions

<code>_devcheck_sample_full_image()</code>	
<code>_devcheck_load_sub_image()</code>	
<code>grab_camvid_train_test_val_splits(coco_dset, mode='segnet')</code>	
<code>grab_camvid_sampler()</code>	Grab a <code>kwcoco.CocoSampler</code> object for the CamVid dataset.
<code>grab_coco_camvid()</code>	
<b>Example</b>	
<code>grab_raw_camvid()</code>	Grab the raw camvid data.
<code>rgb_to_cid(r, g, b)</code>	
<code>cid_to_rgb(cid)</code>	
<code>convert_camvid_raw_to_coco(camvid_raw_info)</code>	Converts the raw camvid format to an MSCOCO based format, ( which lets use
<code>_define_camvid_class_hierarchy(dset)</code>	
<code>main()</code>	Dump the paths to the coco file to stdout

`kwcoco.data.grab_camvid._devcheck_sample_full_image()`

`kwcoco.data.grab_camvid._devcheck_load_sub_image()`

`kwcoco.data.grab_camvid.grab_camvid_train_test_val_splits(coco_dset, mode='segnet')`

`kwcoco.data.grab_camvid.grab_camvid_sampler()`

Grab a `kwcoco.CocoSampler` object for the CamVid dataset.

**Returns** sampler

**Return type** `kwcoco.CocoSampler`

### Example

```
>>> # xdoctest: +REQUIRES(--download)
>>> sampler = grab_camvid_sampler()
>>> print('sampler = {!r}'.format(sampler))
>>> # sampler.load_sample()
>>> for gid in ub.ProgIter(sampler.image_ids, desc='load image'):
>>>     img = sampler.load_image(gid)
```

`kwcoco.data.grab_camvid.grab_coco_camvid()`

### Example

```
>>> # xdoctest: +REQUIRES(--download)
>>> dset = grab_coco_camvid()
>>> print('dset = {!r}'.format(dset))
>>> # xdoctest: +REQUIRES(--show)
>>> import kwplot
>>> plt = kwplot.autoplt()
>>> plt.clf()
>>> dset.show_image(gid=1)
```

`kwcoco.data.grab_camvid.grab_raw_camvid()`

Grab the raw camvid data.

`kwcoco.data.grab_camvid.rgb_to_cid(r, g, b)`

`kwcoco.data.grab_camvid.cid_to_rgb(cid)`

`kwcoco.data.grab_camvid.convert_camvid_raw_to_coco(camvid_raw_info)`

Converts the raw camvid format to an MSCOCO based format, ( which lets use use kwcoco's COCO backend).

## Example

```
>>> # xdoctest: +REQUIRES(--download)
>>> camvid_raw_info = grab_raw_camvid()
>>> # test with a reduced set of data
>>> del camvid_raw_info['img_paths'][2:]
>>> del camvid_raw_info['mask_paths'][2:]
>>> dset = convert_camvid_raw_to_coco(camvid_raw_info)
>>> # xdoctest: +REQUIRES(--show)
>>> import kwplot
>>> plt = kwplot.autoplt()
>>> kwplot.figure(fnum=1, pnum=(1, 2, 1))
>>> dset.show_image(gid=1)
>>> kwplot.figure(fnum=1, pnum=(1, 2, 2))
>>> dset.show_image(gid=2)
```

```
kwcoco.data.grab_camvid._define_camvid_class_hierarchy(dset)
```

```
kwcoco.data.grab_camvid.main()
```

Dump the paths to the coco file to stdout

**By default these will go to in the path:** `~/.cache/kwcoco/camvid/camvid-master`

**The four files will be:** `~/.cache/kwcoco/camvid/camvid-master/camvid-full.mscoco.json`

`~/.cache/kwcoco/camvid/camvid-master/camvid-train.mscoco.json`    `~/.cache/kwcoco/camvid/camvid-master/camvid-vali.mscoco.json`    `~/.cache/kwcoco/camvid/camvid-master/camvid-test.mscoco.json`

```
kwcoco.data.grab_cifar
```

Downloads and converts CIFAR 10 and CIFAR 100 to kwcoco format

## Module Contents

### Functions

---

```
_convert_cifar_x(dpath, cifar_dset, cifar_name,
classes)
```

---

```
convert_cifar10(dpath=None)
```

---

```
convert_cifar100(dpath=None)
```

---

```
main()
```

---

```
kwcoco.data.grab_cifar._convert_cifar_x(dpath, cifar_dset, cifar_name, classes)
```

```
kwcoco.data.grab_cifar.convert_cifar10(dpath=None)
```

```
kwcoco.data.grab_cifar.convert_cifar100(dpath=None)
```

```
kwcoco.data.grab_cifar.main()
```

## `kwcoco.data.grab_datasets`

---

[ ] HMDB: a large human motion database - <https://serre-lab.clps.brown.edu/resource/hmdb-a-large-human-motion-database/>

[ ] <https://paperswithcode.com/dataset/imagenet>

[ ] <https://paperswithcode.com/dataset/coco>

[ ] <https://paperswithcode.com/dataset/fashion-mnist>

[ ] <https://paperswithcode.com/dataset/visual-question-answering>

[ ] <https://paperswithcode.com/dataset/lfw>

[ ] <https://paperswithcode.com/dataset/lsun>

[ ] <https://paperswithcode.com/dataset/ava>

[ ] <https://paperswithcode.com/dataset/activitynet>

[ ] <https://paperswithcode.com/dataset/clevr>

---

## `kwcoco.data.grab_domainnet`

### References

<http://ai.bu.edu/M3SDA/#dataset>

### Module Contents

### Functions

---

*`grab_domain_net()`*

---

`kwcoco.data.grab_domainnet.grab_domain_net()`

---

#### Todo:

- [ ] Allow the user to specify the download directory, generalize this pattern across the data grab scripts.
-

`kwcoco.data.grab_spacenet`

## References

<https://medium.com/the-downlinq/the-spacenet-7-multi-temporal-urban-development-challenge-algorithmic-baseline-4515ec9bd9fe>  
<https://arxiv.org/pdf/2102.11958.pdf> <https://spacenet.ai/sn7-challenge/>

## Module Contents

## Functions

---

`grab_spacenet7(data_dpath)`

### References

---

<code>convert_spacenet_to_kwcoco(extract_dpath, coco_fpath)</code>	Converts the raw SpaceNet7 dataset to kwcoco
--	--

---

`main()`

---

`kwcoco.data.grab_spacenet.grab_spacenet7(data_dpath)`

## References

<https://spacenet.ai/sn7-challenge/>

**Requires:** awscli

`kwcoco.data.grab_spacenet.convert_spacenet_to_kwcoco(extract_dpath, coco_fpath)`  
Converts the raw SpaceNet7 dataset to kwcoco

---

### Note:

- The “train” directory contains 60 “videos” representing a region over time.
- Each “video” directory contains :
  - images - unmasked images
  - images\_masked - images with masks applied
  - labels - geojson polys in wgs84?
  - labels\_match - geojson polys in wgs84 with track ids?
  - labels\_match\_pix - geojson polys in pixels with track ids?
  - UDM\_masks - unusable data masks (binary data corresponding with an image, may not exist)

**File names appear like:** “global\_monthly\_2018\_01\_mosaic\_L15-1538E-1163N\_6154\_3539\_13”

---

`kwcoco.data.grab_spacenet.main()`

`kwcoco.data.grab_voc`

## Module Contents

### Functions

<code>__torrent_voc()</code>	Requires:
<code>convert_voc_to_coco(dpath=None)</code>	
<code>_convert_voc_split(devkit_dpath, classes, split, year, root)</code>	<code>split, year = 'train', 2012</code>
<code>_read_split_paths(devkit_dpath, split, year)</code>	<code>split = 'train'</code>
<code>ensure_voc_data(dpath=None, force=False, years=[2007, 2012])</code>	Download the Pascal VOC data if it does not already exist.
<code>ensure_voc_coco(dpath=None)</code>	Download the Pascal VOC data and convert it to coco, if it does exist.
<code>main()</code>	

`kwcoco.data.grab_voc.__torrent_voc()`**Requires:** pip install deluge pip install python-libtorrent-bin

### References

<https://academictorrents.com/details/f6ddac36ac7ae2ef79dc72a26a065b803c9c7230>

### Todo:

- [ ] Is there a pythonic way to download a torrent programatically?

`kwcoco.data.grab_voc.convert_voc_to_coco(dpath=None)``kwcoco.data.grab_voc._convert_voc_split(devkit_dpath, classes, split, year, root)`  
`split, year = 'train', 2012 split, year = 'train', 2007``kwcoco.data.grab_voc._read_split_paths(devkit_dpath, split, year)`  
`split = 'train' self = VOCDataset('test') year = 2007 year = 2012``kwcoco.data.grab_voc.ensure_voc_data(dpath=None, force=False, years=[2007, 2012])`  
Download the Pascal VOC data if it does not already exist.

### Note:

- [ ] These URLs seem to be dead

### Example

```
>>> # xdoctest: +REQUIRES(--download)
>>> devkit_dpath = ensure_voc_data()
```

`kwcoco.data.grab_voc.ensure_voc_coco(dpath=None)`

Download the Pascal VOC data and convert it to coco, if it does exit.

**Parameters** `dpath` (*str*) – download directory. Defaults to “~/data/VOC”.

**Returns**

**mapping from dataset tags to coco file paths.** The original datasets have keys prefixed with underscores. The standard splits keys are train, vali, and test.

**Return type** `Dict[str, str]`

`kwcoco.data.grab_voc.main()`

## 2.2.3 kwcoco.demo

### Submodules

`kwcoco.demo.boids`

### Module Contents

#### Classes

---

<i>Boids</i>	Efficient numpy based backend for generating boid positions.
--------------	--

---

#### Functions

---

<i>clamp_mag</i> (vec, mag, axis=None)	<code>vec = np.random.rand(10, 2)</code>
<i>triu_condense_multi_index</i> (multi_index, dims, symetric=False)	Like <code>np.ravel_multi_index</code> but returns positions in an upper triangular
<i>_spatial_index_scratch</i> ()	
<i>closest_point_on_line_segment</i> (pts, e1, e2)	Finds the closet point from p on line segment (e1, e2)
<i>_pygame_render_boids</i> ()	Fast and responsive BOID rendering. This is an easter egg.
<i>_yeah_boid</i> ()	

---

**class** `kwcoco.demo.boids.Boids`(num, dims=2, rng=None, \*\*kwargs)

Bases: `ubelt.NiceRepr`

Efficient numpy based backend for generating boid positions.

BOID = bird-oid object



## References

<https://www.youtube.com/watch?v=mhjuuHl6qHM> <https://medium.com/better-programming/boids-simulating-birds-flock-behavior-in-python-9ff993751118> <https://en.wikipedia.org/wiki/Boids>

## Example

```
>>> from kwcoco.demo.boids import * # NOQA
>>> num_frames = 10
>>> num_objects = 3
>>> rng = None
>>> self = Boids(num=num_objects, rng=rng).initialize()
>>> paths = self.paths(num_frames)
>>> #
>>> # xdoctest: +REQUIRES(--show)
>>> import kwplot
>>> plt = kwplot.autoplt()
>>> from mpl_toolkits.mplot3d import Axes3D # NOQA
>>> ax = plt.gca(projection='3d')
>>> ax.cla()
>>> #
>>> for path in paths:
>>>     time = np.arange(len(path))
>>>     ax.plot(time, path.T[0] * 1, path.T[1] * 1, '-')
>>> ax.set_xlim(0, num_frames)
>>> ax.set_ylim(-.01, 1.01)
>>> ax.set_zlim(-.01, 1.01)
>>> ax.set_xlabel('time')
>>> ax.set_ylabel('u-pos')
>>> ax.set_zlabel('v-pos')
>>> kwplot.show_if_requested()
```

```
import xdev _ = xdev.profile_now(self.compute_forces)() _ = xdev.profile_now(self.update_neighbors)()
```

## Example

```
>>> # Test determenism
>>> from kwcoco.demo.boids import * # NOQA
>>> num_frames = 2
>>> num_objects = 1
>>> rng = 4532
>>> self = Boids(num=num_objects, rng=rng).initialize()
>>> #print(ub.hash_data(self.pos))
>>> #print(ub.hash_data(self.vel))
>>> #print(ub.hash_data(self.acc))
>>> tocheck = []
>>> for i in range(100):
>>>     self = Boids(num=num_objects, rng=rng).initialize()
>>>     self.step()
>>>     self.step()
>>>     self.step()
```

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```
>>> tocheck.append(self.pos.copy())
>>> assert ub.allsame(list(map(ub.hash_data, tocheck)))
```

```
__nice__(self)
```

```
initialize(self)
```

```
update_neighbors(self)
```

```
compute_forces(self)
```

```
boundary_conditions(self)
```

```
step(self)
```

Update positions, velocities, and accelerations

```
paths(self, num_steps)
```

```
kwcoco.demo.boids.clamp_mag(vec, mag, axis=None)
```

```
vec = np.random.rand(10, 2) mag = 1.0 axis = 1 new_vec = clamp_mag(vec, mag, axis) np.linalg.norm(new_vec,
axis=axis)
```

```
kwcoco.demo.boids.triu_condense_multi_index(multi_index, dims, symetric=False)
```

Like np.ravel\_multi\_index but returns positions in an upper triangular condensed square matrix

## Examples

**multi\_index (Tuple[ArrayLike]):** indexes for each dimension into the square matrix

**dims (Tuple[int]):** shape of each dimension in the square matrix (should all be the same)

**symetric (bool):** if True, converts lower triangular indices to their upper triangular location. This may cause a copy to occur.

## References

<https://stackoverflow.com/a/36867493/887074> [https://numpy.org/doc/stable/reference/generated/numpy.ravel\\_multi\\_index.html#numpy.ravel\\_multi\\_index](https://numpy.org/doc/stable/reference/generated/numpy.ravel_multi_index.html#numpy.ravel_multi_index)

## Examples

```
>>> dims = (3, 3)
>>> symetric = True
>>> multi_index = (np.array([0, 0, 1]), np.array([1, 2, 2]))
>>> condensed_idx = triu_condense_multi_index(multi_index, dims, symetric=symetric)
>>> assert condensed_idx.tolist() == [0, 1, 2]
```

```
>>> n = 7
>>> symetric = True
>>> multi_index = np.triu_indices(n=n, k=1)
>>> condensed_idx = triu_condense_multi_index(multi_index, [n] * 2,
↪symetric=symetric)
```

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```

>>> assert condensed_idx.tolist() == list(range(n * (n - 1) // 2))
>>> from scipy.spatial.distance import pdist, squareform
>>> square_mat = np.zeros((n, n))
>>> conden_mat = squareform(square_mat)
>>> conden_mat[condensed_idx] = np.arange(len(condensed_idx)) + 1
>>> square_mat = squareform(conden_mat)
>>> print('square_mat =\n{}'.format(ub.repr2(square_mat, nl=1)))

```

```

>>> n = 7
>>> symetric = True
>>> multi_index = np.tril_indices(n=n, k=-1)
>>> condensed_idx = triu_condense_multi_index(multi_index, [n] * 2,
↳symetric=symetric)
>>> assert sorted(condensed_idx.tolist()) == list(range(n * (n - 1) // 2))
>>> from scipy.spatial.distance import pdist, squareform
>>> square_mat = np.zeros((n, n))
>>> conden_mat = squareform(square_mat, checks=False)
>>> conden_mat[condensed_idx] = np.arange(len(condensed_idx)) + 1
>>> square_mat = squareform(conden_mat)
>>> print('square_mat =\n{}'.format(ub.repr2(square_mat, nl=1)))

```

kwcoco.demo.boids.\_spatial\_index\_scratch()

kwcoco.demo.boids.closest\_point\_on\_line\_segment(*pts, e1, e2*)

Finds the closet point from *p* on line segment (*e1, e2*)

#### Parameters

- **pts** (*ndarray*) – xy points [Nx2]
- **e1** (*ndarray*) – the first xy endpoint of the segment
- **e2** (*ndarray*) – the second xy endpoint of the segment

**Returns** *pt\_on\_seg* - the closest xy point on (*e1, e2*) from *ptp*

**Return type** *ndarray*

#### References

[http://en.wikipedia.org/wiki/Distance\\_from\\_a\\_point\\_to\\_a\\_line](http://en.wikipedia.org/wiki/Distance_from_a_point_to_a_line)    <http://stackoverflow.com/questions/849211/shortest-distance-between-a-point-and-a-line-segment>

#### Example

```

>>> # ENABLE_DOCTEST
>>> from kwcoco.demo.boids import * # NOQA
>>> verts = np.array([[ 21.83012702,  13.16987298],
>>>                    [ 16.83012702,  21.83012702],
>>>                    [  8.16987298,  16.83012702],
>>>                    [ 13.16987298,   8.16987298],
>>>                    [ 21.83012702,  13.16987298]])
>>> rng = np.random.RandomState(0)

```

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```
>>> pts = rng.rand(64, 2) * 20 + 5
>>> e1, e2 = verts[0:2]
>>> closest_point_on_line_segment(pts, e1, e2)
```

`kwcoco.demo.boids._pygame_render_boids()`

Fast and responsive BOID rendering. This is an easter egg.

**Requirements:** `pip install pygame`

### CommandLine

```
python -m kwcoco.demo.boids
pip install pygame kwcoco -U && python -m kwcoco.demo.boids
```

`kwcoco.demo.boids._yeah_boid()``kwcoco.demo.perterb`

## Module Contents

### Functions

<code>perterb_coco(coco_dset, **kwargs)</code>	Perterbs a coco dataset
<code>_demo_construct_probs(pred_cxs, pred_scores, classes, rng, hacked=1)</code>	Constructs random probabilities for demo data

`kwcoco.demo.perterb.perterb_coco(coco_dset, **kwargs)`

Perterbs a coco dataset

#### Parameters

- `rng` (*int*, *default=0*)
- `box_noise` (*int*, *default=0*)
- `cls_noise` (*int*, *default=0*)
- `null_pred` (*bool*, *default=False*)
- `with_probs` (*bool*, *default=False*)
- `score_noise` (*float*, *default=0.2*)
- `hacked` (*int*, *default=1*)

### Example

```

>>> from kwcoco.demo.perterb import * # NOQA
>>> from kwcoco.demo.perterb import _demo_construct_probs
>>> import kwcoco
>>> coco_dset = true_dset = kwcoco.CocoDataset.demo('shapes8')
>>> kwargs = {
>>>     'box_noise': 0.5,
>>>     'n_fp': 3,
>>>     'with_probs': 1,
>>>     'with_heatmaps': 1,
>>> }
>>> pred_dset = perterb_coco(true_dset, **kwargs)
>>> pred_dset._check_json_serializable()
>>> # xdoctest: +REQUIRES(--show)
>>> import kwplot
>>> kwplot.autompl()
>>> gid = 1
>>> canvas = true_dset.delayed_load(gid).finalize()
>>> canvas = true_dset.annots(gid=gid).detections.draw_on(canvas, color='green')
>>> canvas = pred_dset.annots(gid=gid).detections.draw_on(canvas, color='blue')
>>> kwplot.imshow(canvas)

```

`kwcoco.demo.perterb._demo_construct_probs(pred_cxs, pred_scores, classes, rng, hacked=1)`  
 Constructs random probabilities for demo data

### Example

```

>>> import kwcoco
>>> import kwarray
>>> rng = kwarray.ensure_rng(0)
>>> classes = kwcoco.CategoryTree.coerce(10)
>>> hacked = 1
>>> pred_cxs = rng.randint(0, 10, 10)
>>> pred_scores = rng.rand(10)
>>> probs = _demo_construct_probs(pred_cxs, pred_scores, classes, rng, hacked)
>>> probs.sum(axis=1)

```

### `kwcoco.demo.toydata`

Generates “toydata” for demo and testing purposes.

---

**Note:** The implementation of `demodata_toy_img` and `demodata_toy_dset` should be redone using the tools built for `random_video_dset`, which have more extensible implementations.

---

## Module Contents

### Functions

<code>random_single_video_dset</code> ( <code>image_size=(600, 600)</code> , <code>num_frames=5</code> , <code>num_tracks=3</code> , <code>tid_start=1</code> , <code>gid_start=1</code> , <code>video_id=1</code> , <code>anchors=None</code> , <code>rng=None</code> , <code>render=False</code> , <code>dpath=None</code> , <code>autobuild=True</code> , <code>verbose=3</code> , <code>aux=None</code> , <code>multispectral=False</code> , <code>max_speed=0.01</code> , <code>channels=None</code> , <code>multisensor=False</code> , <code>**kwargs</code> )	Create the video scene layout of object positions.
<code>random_video_dset</code> ( <code>num_videos=1</code> , <code>num_frames=2</code> , <code>num_tracks=2</code> , <code>anchors=None</code> , <code>image_size=(600, 600)</code> , <code>verbose=3</code> , <code>render=False</code> , <code>aux=None</code> , <code>multispectral=False</code> , <code>multisensor=False</code> , <code>rng=None</code> , <code>dpath=None</code> , <code>max_speed=0.01</code> , <code>channels=None</code> , <code>**kwargs</code> )	Create a toy Coco Video Dataset
<code>demodata_toy_dset</code> ( <code>image_size=(600, 600)</code> , <code>n_imgs=5</code> , <code>verbose=3</code> , <code>rng=0</code> , <code>newstyle=True</code> , <code>dpath=None</code> , <code>bundle_dpath=None</code> , <code>aux=None</code> , <code>use_cache=True</code> , <code>**kwargs</code> )	Create a toy detection problem
<code>demodata_toy_img</code> ( <code>anchors=None</code> , <code>image_size=(104, 104)</code> , <code>categories=None</code> , <code>n_annots=(0, 50)</code> , <code>fg_scale=0.5</code> , <code>bg_scale=0.8</code> , <code>bg_intensity=0.1</code> , <code>fg_intensity=0.9</code> , <code>gray=True</code> , <code>centerobj=None</code> , <code>exact=False</code> , <code>newstyle=True</code> , <code>rng=None</code> , <code>aux=None</code> , <code>**kwargs</code> )	Generate a single image with non-overlapping toy objects of available

```
kwcoco.demo.toydata.random_single_video_dset(image_size=(600, 600), num_frames=5, num_tracks=3,
tid_start=1, gid_start=1, video_id=1, anchors=None,
rng=None, render=False, dpath=None, autobuild=True,
verbose=3, aux=None, multispectral=False,
max_speed=0.01, channels=None, multisensor=False,
**kwargs)
```

Create the video scene layout of object positions.

---

**Note:** Does not render the data unless specified.

---

#### Parameters

- **image\_size** (*Tuple[int, int]*) – size of the images
- **num\_frames** (*int*) – number of frames in this video
- **num\_tracks** (*int*) – number of tracks in this video
- **tid\_start** (*int, default=1*) – track-id start index
- **gid\_start** (*int, default=1*) – image-id start index
- **video\_id** (*int, default=1*) – video-id of this video
- **anchors** (*ndarray | None*) – base anchor sizes of the object boxes we will generate.
- **rng** (*RandomState*) – random state / seed
- **render** (*bool | dict*) – if truthy, does the rendering according to provided params in the case of dict input.

- **autobuild** (*bool*, *default=True*) – prebuild coco lookup indexes
- **verbose** (*int*) – verbosity level
- **aux** (*bool* | *List[str]*) – if specified generates auxiliary channels
- **multispectral** (*bool*) – if specified simulates multispectral imagery This is similar to aux, but has no “main” file.
- **max\_speed** (*float*) – max speed of movers
- **channels** (*str* | *None* | *ChannelSpec*) – if specified generates multispectral images with dummy channels
- **multisensor** (*bool*) –  
 if **True**, generates demodata from “multiple sensors”, in other words, observations may have different “bands”.
- **\*\*kwargs** – used for old backwards compatible argument names gsize - alias for image\_size

---

**Todo:**

- [ ] Need maximum allowed object overlap measure
  - [ ] Need better parameterized path generation
- 

**Example**

```
>>> from kwcoco.demo.toydata_video import * # NOQA
>>> anchors = np.array([ [0.3, 0.3], [0.1, 0.1]])
>>> dset = random_single_video_dset(render=True, num_frames=10, num_tracks=10,
↳ anchors=anchors, max_speed=0.2)
>>> # xdoctest: +REQUIRES(--show)
>>> # Show the tracks in a single image
>>> import kwplot
>>> kwplot.autompl()
>>> annots = dset.annots()
>>> tids = annots.lookup('track_id')
>>> tid_to_aids = ub.group_items(annots.aids, tids)
>>> paths = []
>>> track_boxes = []
>>> for tid, aids in tid_to_aids.items():
>>>     boxes = dset.annots(aids).boxes.to_cxywh()
>>>     path = boxes.data[:, 0:2]
>>>     paths.append(path)
>>>     track_boxes.append(boxes)
>>> import kwplot
>>> plt = kwplot.autoplt()
>>> ax = plt.gca()
>>> ax.cla()
>>> #
>>> import kwimage
>>> colors = kwimage.Color.distinct(len(track_boxes))
>>> for i, boxes in enumerate(track_boxes):
```

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```

>>> color = colors[i]
>>> path = boxes.data[:, 0:2]
>>> boxes.draw(color=color, centers={'radius': 0.01}, alpha=0.5)
>>> ax.plot(path.T[0], path.T[1], 'x-', color=color)

```

### Example

```

>>> from kwcoco.demo.toydata_video import * # NOQA
>>> anchors = np.array([[0.2, 0.2], [0.1, 0.1]])
>>> gsize = np.array([(600, 600)])
>>> print(anchors * gsize)
>>> dset = random_single_video_dset(render=True, num_frames=10,
>>>                                anchors=anchors, num_tracks=10,
>>>                                image_size='random')
>>> # xdoctest: +REQUIRES(--show)
>>> import kwplot
>>> plt = kwplot.autoplt()
>>> plt.clf()
>>> gids = list(dset.imgs.keys())
>>> pnums = kwplot.PlotNums(nSubplots=len(gids))
>>> for gid in gids:
>>>     dset.show_image(gid, pnum=pnums(), fnum=1, title=False)
>>> pnums = kwplot.PlotNums(nSubplots=len(gids))

```

### Example

```

>>> from kwcoco.demo.toydata_video import * # NOQA
>>> dset = random_single_video_dset(num_frames=10, num_tracks=10, aux=True)
>>> assert 'auxiliary' in dset.imgs[1]
>>> assert dset.imgs[1]['auxiliary'][0]['channels']
>>> assert dset.imgs[1]['auxiliary'][1]['channels']

```

### Example

```

>>> from kwcoco.demo.toydata_video import * # NOQA
>>> multispectral = True
>>> dset = random_single_video_dset(num_frames=1, num_tracks=1, multispectral=True)
>>> dset._check_json_serializable()
>>> dset.dataset['images']
>>> assert dset.imgs[1]['auxiliary'][1]['channels']
>>> # test that we can render
>>> render_toy_dataset(dset, rng=0, dpath=None, renderkw={})

```



## Example

```
>>> from kwcoco.demo.toydata_video import * # NOQA
>>> dset = random_single_video_dset(num_frames=4, num_tracks=1, multispectral=True,
↳ multisensor=True, image_size='random', rng=2338)
>>> dset._check_json_serializable()
>>> assert dset.imgs[1]['auxiliary'][1]['channels']
>>> # Print before and after render
>>> #print('multisensor-images = {}'.format(ub.repr2(dset.dataset['images'], nl=-2)))
>>> #print('multisensor-images = {}'.format(ub.repr2(dset.dataset, nl=-2)))
>>> print(ub.hash_data(dset.dataset))
>>> # test that we can render
>>> render_toy_dataset(dset, rng=0, dpath=None, renderkw={})
>>> #print('multisensor-images = {}'.format(ub.repr2(dset.dataset['images'], nl=-2)))
>>> # xdoctest: +REQUIRES(--show)
>>> import kwplot
>>> kwplot.autompl()
>>> from kwcoco.demo.toydata_video import _draw_video_sequence # NOQA
>>> gids = [1, 2, 3, 4]
>>> final = _draw_video_sequence(dset, gids)
>>> print('dset.fpath = {!r}'.format(dset.fpath))
>>> kwplot.imshow(final)
```

```
kwcoco.demo.toydata.random_video_dset(num_videos=1, num_frames=2, num_tracks=2, anchors=None,
image_size=(600, 600), verbose=3, render=False, aux=None,
multispectral=False, multisensor=False, rng=None, dpath=None,
max_speed=0.01, channels=None, **kwargs)
```

Create a toy Coco Video Dataset

### Parameters

- **num\_videos** (*int*) – number of videos
- **num\_frames** (*int*) – number of images per video
- **num\_tracks** (*int*) – number of tracks per video
- **image\_size** (*Tuple[int, int]*) – The width and height of the generated images
- **render** (*bool | dict*) – if truthy the toy annotations are synthetically rendered. See `render_toy_image()` for details.
- **rng** (*int | None | RandomState*) – random seed / state
- **dpath** (*str*) – only used if render is truthy, place to write rendered images.
- **verbose** (*int, default=3*) – verbosity mode
- **aux** (*bool*) – if True generates dummy auxiliary channels
- **multispectral** (*bool*) – similar to aux, but does not have the concept of a “main” image.
- **max\_speed** (*float*) – max speed of movers
- **channels** (*str*) – experimental new way to get MSI with specific band distributions.
- **\*\*kwargs** – used for old backwards compatible argument names gsize - alias for `image_size`

**SeeAlso:** `random_single_video_dset`

## Example

```
>>> from kwcoco.demo.toydata_video import * # NOQA
>>> dset = random_video_dset(render=True, num_videos=3, num_frames=2,
>>>                          num_tracks=5, image_size=(128, 128))
>>> # xdoctest: +REQUIRES(--show)
>>> dset.show_image(1, doclf=True)
>>> dset.show_image(2, doclf=True)
```

```
>>> from kwcoco.demo.toydata_video import * # NOQA
dset = random_video_dset(render=False, num_videos=3, num_frames=2,
    num_tracks=10)
dset._tree()
dset.imgs[1]
```

```
dset = random_single_video_dset() dset._tree() dset.imgs[1]
```

```
from kwcoco.demo.toydata_video import * # NOQA dset = random_video_dset(render=True, num_videos=3,
num_frames=2,
```

```
    num_tracks=10)
```

```
print(dset.imgs[1]) print('dset.bundle_dpath = {}'.format(dset.bundle_dpath)) dset._tree()
```

```
import xdev globals().update(xdev.get_func_kwargs(random_video_dset)) num_videos = 2
```

```
kwcoco.demo.toydata.demodata_toy_dset(image_size=(600, 600), n_imgs=5, verbose=3, rng=0,
    newstyle=True, dpath=None, bundle_dpath=None, aux=None,
    use_cache=True, **kwargs)
```

Create a toy detection problem

### Parameters

- **image\_size** (*Tuple[int, int]*) – The width and height of the generated images
- **n\_imgs** (*int*) – number of images to generate
- **rng** (*int | RandomState, default=0*) – random number generator or seed
- **newstyle** (*bool, default=True*) – create newstyle kwcoco data
- **dpath** (*str*) – path to the directory that will contain the bundle, (defaults to a kwcoco cache dir). Ignored if *bundle\_dpath* is given.
- **bundle\_dpath** (*str*) – path to the directory that will store images. If specified, dpath is ignored. If unspecified, a bundle will be written inside *dpath*.
- **aux** (*bool*) – if True generates dummy auxiliary channels
- **verbose** (*int, default=3*) – verbosity mode
- **use\_cache** (*bool, default=True*) – if True caches the generated json in the *dpath*.
- **\*\*kwargs** – used for old backwards compatible argument names gsize - alias for image\_size

**Return type** *kwcoco.CocoDataset*

**SeeAlso:** `random_video_dset`

## CommandLine

```
xdoctest -m kwcoco.demo.toydata_image demodata_toy_dset --show
```

### Todo:

- [ ] Non-homogeneous images sizes

## Example

```
>>> from kwcoco.demo.toydata_image import *
>>> import kwcoco
>>> dset = demodata_toy_dset(image_size=(300, 300), aux=True, use_cache=False)
>>> # xdoctest: +REQUIRES(--show)
>>> print(ub.repr2(dset.dataset, nl=2))
>>> import kwplot
>>> kwplot.autompl()
>>> dset.show_image(gid=1)
>>> ub.startfile(dset.bundle_dpath)
```

```
dset._tree()
```

```
>>> from kwcoco.demo.toydata_image import *
>>> import kwcoco
```

```
dset = demodata_toy_dset(image_size=(300, 300), aux=True, use_cache=False) print(dset.imgs[1]) dset._tree()
```

```
dset = demodata_toy_dset(image_size=(300, 300), aux=True, use_cache=False, bundle_dpath='test_bundle')
```

```
print(dset.imgs[1]) dset._tree()
```

```
dset = demodata_toy_dset( image_size=(300, 300), aux=True, use_cache=False, dpath='test_cache_dpath')
```

```
kwcoco.demo.toydata.demodata_toy_img(anchors=None, image_size=(104, 104), categories=None,
                                     n_annots=(0, 50), fg_scale=0.5, bg_scale=0.8, bg_intensity=0.1,
                                     fg_intensity=0.9, gray=True, centerobj=None, exact=False,
                                     newstyle=True, rng=None, aux=None, **kwargs)
```

Generate a single image with non-overlapping toy objects of available categories.

### Todo:

**DEPRECATE IN FAVOR OF** `random_single_video_dset + render_toy_image`

### Parameters

- **anchors** (*ndarray*) – Nx2 base width / height of boxes
- **gsize** (*Tuple[int, int]*) – width / height of the image
- **categories** (*List[str]*) – list of category names
- **n\_annots** (*Tuple | int*) – controls how many annotations are in the image. if it is a tuple, then it is interpreted as uniform random bounds

- **fg\_scale** (*float*) – standard deviation of foreground intensity
- **bg\_scale** (*float*) – standard deviation of background intensity
- **bg\_intensity** (*float*) – mean of background intensity
- **fg\_intensity** (*float*) – mean of foreground intensity
- **centerobj** (*bool*) – if 'pos', then the first annotation will be in the center of the image, if 'neg', then no annotations will be in the center.
- **exact** (*bool*) – if True, ensures that exactly the number of specified annots are generated.
- **newstyle** (*bool*) – use new-style kwcoco format
- **rng** (*RandomState*) – the random state used to seed the process
- **aux** – if specified builds auxiliary channels
- **\*\*kwargs** – used for old backwards compatible argument names. *gsize* - alias for *image\_size*

### CommandLine

```
xdoctest -m kwcoco.demo.toydata_image demodata_toy_img:0 --profile
xdoctest -m kwcoco.demo.toydata_image demodata_toy_img:1 --show
```

### Example

```
>>> from kwcoco.demo.toydata_image import * # NOQA
>>> img, anns = demodata_toy_img(image_size=(32, 32), anchors=[[.3, .3]], rng=0)
>>> img['imdata'] = '<ndarray shape={}>'.format(img['imdata'].shape)
>>> print('img = {}'.format(ub.repr2(img)))
>>> print('anns = {}'.format(ub.repr2(anns, nl=2, cbr=True)))
>>> # xdoctest: +IGNORE_WANT
img = {
    'height': 32,
    'imdata': '<ndarray shape=(32, 32, 3)>',
    'width': 32,
}
anns = [{ 'bbox': [15, 10, 9, 8],
  'category_name': 'star',
  'keypoints': [],
  'segmentation': { 'counts': '['\06j0000020N1000e8', 'size': [32, 32] }, },
{ 'bbox': [11, 20, 7, 7],
  'category_name': 'star',
  'keypoints': [],
  'segmentation': { 'counts': 'g;1m04N0020N102L[=', 'size': [32, 32] }, },
{ 'bbox': [4, 4, 8, 6],
  'category_name': 'superstar',
  'keypoints': [{ 'keypoint_category': 'left_eye', 'xy': [7.25, 6.8125] }, { 'keypoint_
→ category': 'right_eye', 'xy': [8.75, 6.8125] }, },
  'segmentation': { 'counts': 'U4210j0300001010000MV00ed0', 'size': [32, 32] }, },
{ 'bbox': [3, 20, 6, 7],
  'category_name': 'star',
  'keypoints': [],
  'segmentation': { 'counts': 'g31m04N000002L[f0', 'size': [32, 32] }, }, ]
```

### Example

```
>>> # xdoctest: +REQUIRES(--show)
>>> img, anns = demodata_toy_img(image_size=(172, 172), rng=None, aux=True)
>>> print('anns = {}'.format(ub.repr2(anns, nl=1)))
>>> import kwplot
>>> kwplot.autompl()
>>> kwplot.imshow(img['imdata'], pnum=(1, 2, 1), fnum=1)
>>> auxdata = img['auxiliary'][0]['imdata']
>>> kwplot.imshow(auxdata, pnum=(1, 2, 2), fnum=1)
>>> kwplot.show_if_requested()
```

### Example

```
>>> # xdoctest: +REQUIRES(--show)
>>> img, anns = demodata_toy_img(image_size=(172, 172), rng=None, aux=True)
>>> print('anns = {}'.format(ub.repr2(anns, nl=1)))
>>> import kwplot
>>> kwplot.autompl()
>>> kwplot.imshow(img['imdata'], pnum=(1, 2, 1), fnum=1)
>>> auxdata = img['auxiliary'][0]['imdata']
>>> kwplot.imshow(auxdata, pnum=(1, 2, 2), fnum=1)
>>> kwplot.show_if_requested()
```

#### kwcoco.demo.toydata\_image

Generates “toydata” for demo and testing purposes.

Loose image version of the toydata generators.

---

**Note:** The implementation of *demodata\_toy\_img* and *demodata\_toy\_dset* should be redone using the tools built for *random\_video\_dset*, which have more extensible implementations.

---

## Module Contents

### Functions

---

<code>demodata_toy_dset(image_size=(600, 600), n_imgs=5, verbose=3, rng=0, newstyle=True, dpath=None, bundle_dpath=None, aux=None, use_cache=True, **kwargs)</code>	Create a toy detection problem
<code>demodata_toy_img(anchors=None, image_size=(104, 104), categories=None, n_annot=(0, 50), fg_scale=0.5, bg_scale=0.8, bg_intensity=0.1, fg_intensity=0.9, gray=True, centerobj=None, exact=False, newstyle=True, rng=None, aux=None, **kwargs)</code>	Generate a single image with non-overlapping toy objects of available

---

## Attributes

---

*profile*

---

*TOYDATA\_IMAGE\_VERSION*

---

`kwcoco.demo.toydata_image.profile`

`kwcoco.demo.toydata_image.TOYDATA_IMAGE_VERSION = 20`

`kwcoco.demo.toydata_image.demodata_toy_dset(image_size=(600, 600), n_imgs=5, verbose=3, rng=0, newstyle=True, dpath=None, bundle_dpath=None, aux=None, use_cache=True, **kwargs)`

Create a toy detection problem

### Parameters

- **image\_size** (*Tuple[int, int]*) – The width and height of the generated images
- **n\_imgs** (*int*) – number of images to generate
- **rng** (*int | RandomState, default=0*) – random number generator or seed
- **newstyle** (*bool, default=True*) – create newstyle kwcoco data
- **dpath** (*str*) – path to the directory that will contain the bundle, (defaults to a kwcoco cache dir). Ignored if *bundle\_dpath* is given.
- **bundle\_dpath** (*str*) – path to the directory that will store images. If specified, *dpath* is ignored. If unspecified, a bundle will be written inside *dpath*.
- **aux** (*bool*) – if True generates dummy auxiliary channels
- **verbose** (*int, default=3*) – verbosity mode
- **use\_cache** (*bool, default=True*) – if True caches the generated json in the *dpath*.
- **\*\*kwargs** – used for old backwards compatible argument names *gsize* - alias for *image\_size*

**Return type** *kwcoco.CocoDataset*

**SeeAlso:** `random_video_dset`

## CommandLine

```
xdoctest -m kwcoco.demo.toydata_image demodata_toy_dset --show
```

---

### Todo:

- [ ] Non-homogeneous images sizes
-

## Example

```
>>> from kwcoco.demo.toydata_image import *
>>> import kwcoco
>>> dset = demodata_toy_dset(image_size=(300, 300), aux=True, use_cache=False)
>>> # xdoctest: +REQUIRES(--show)
>>> print(ub.repr2(dset.dataset, nl=2))
>>> import kwplot
>>> kwplot.autompl()
>>> dset.show_image(gid=1)
>>> ub.startfile(dset.bundle_dpath)
```

dset.\_tree()

```
>>> from kwcoco.demo.toydata_image import *
>>> import kwcoco
```

```
dset = demodata_toy_dset(image_size=(300, 300), aux=True, use_cache=False) print(dset.imgs[1]) dset._tree()
```

```
dset = demodata_toy_dset(image_size=(300, 300), aux=True, use_cache=False, bundle_dpath='test_bundle')
```

```
print(dset.imgs[1]) dset._tree()
```

```
dset = demodata_toy_dset( image_size=(300, 300), aux=True, use_cache=False, dpath='test_cache_dpath')
```

```
kwcoco.demo.toydata_image.demodata_toy_img(anchors=None, image_size=(104, 104), categories=None,
                                             n_annots=(0, 50), fg_scale=0.5, bg_scale=0.8,
                                             bg_intensity=0.1, fg_intensity=0.9, gray=True,
                                             centerobj=None, exact=False, newstyle=True, rng=None,
                                             aux=None, **kwargs)
```

Generate a single image with non-overlapping toy objects of available categories.

---

### Todo:

**DEPRECATE IN FAVOR OF** random\_single\_video\_dset + render\_toy\_image

---

### Parameters

- **anchors** (*ndarray*) – Nx2 base width / height of boxes
- **gsize** (*Tuple[int, int]*) – width / height of the image
- **categories** (*List[str]*) – list of category names
- **n\_annots** (*Tuple | int*) – controls how many annotations are in the image. if it is a tuple, then it is interpreted as uniform random bounds
- **fg\_scale** (*float*) – standard deviation of foreground intensity
- **bg\_scale** (*float*) – standard deviation of background intensity
- **bg\_intensity** (*float*) – mean of background intensity
- **fg\_intensity** (*float*) – mean of foreground intensity
- **centerobj** (*bool*) – if ‘pos’, then the first annotation will be in the center of the image, if ‘neg’, then no annotations will be in the center.

- **exact** (*bool*) – if True, ensures that exactly the number of specified annots are generated.
- **newstyle** (*bool*) – use new-style kwcoco format
- **rng** (*RandomState*) – the random state used to seed the process
- **aux** – if specified builds auxiliary channels
- **\*\*kwargs** – used for old backwards compatible argument names. `gsize` - alias for `image_size`

## CommandLine

```
xdoctest -m kwcoco.demo.toydata_image demodata_toy_img:0 --profile
xdoctest -m kwcoco.demo.toydata_image demodata_toy_img:1 --show
```

## Example

```
>>> from kwcoco.demo.toydata_image import * # NOQA
>>> img, anns = demodata_toy_img(image_size=(32, 32), anchors=[[.3, .3]], rng=0)
>>> img['imdata'] = '<ndarray shape={}>'.format(img['imdata'].shape)
>>> print('img = {}'.format(ub.repr2(img)))
>>> print('anns = {}'.format(ub.repr2(anns, nl=2, cbr=True)))
>>> # xdoctest: +IGNORE_WANT
img = {
    'height': 32,
    'imdata': '<ndarray shape=(32, 32, 3)>',
    'width': 32,
}
anns = [{ 'bbox': [15, 10, 9, 8],
    'category_name': 'star',
    'keypoints': [],
    'segmentation': { 'counts': '['06j0000020N1000e8', 'size': [32, 32] }, },
  { 'bbox': [11, 20, 7, 7],
    'category_name': 'star',
    'keypoints': [],
    'segmentation': { 'counts': 'g;1m04N0020N102L[=', 'size': [32, 32] }, },
  { 'bbox': [4, 4, 8, 6],
    'category_name': 'superstar',
    'keypoints': [{ 'keypoint_category': 'left_eye', 'xy': [7.25, 6.8125] }, { 'keypoint_
→ category': 'right_eye', 'xy': [8.75, 6.8125] }, },
    'segmentation': { 'counts': 'U4210j0300001010000MVO0ed0', 'size': [32, 32] }, },
  { 'bbox': [3, 20, 6, 7],
    'category_name': 'star',
    'keypoints': [],
    'segmentation': { 'counts': 'g31m04N000002L[f0', 'size': [32, 32] }, }, ]
```



### Example

```

>>> # xdoctest: +REQUIRES(--show)
>>> img, anns = demodata_toy_img(image_size=(172, 172), rng=None, aux=True)
>>> print('anns = {}'.format(ub.repr2(anns, nl=1)))
>>> import kwplot
>>> kwplot.autompl()
>>> kwplot.imshow(img['imdata'], pnum=(1, 2, 1), fnum=1)
>>> auxdata = img['auxiliary'][0]['imdata']
>>> kwplot.imshow(auxdata, pnum=(1, 2, 2), fnum=1)
>>> kwplot.show_if_requested()

```

### Example

```

>>> # xdoctest: +REQUIRES(--show)
>>> img, anns = demodata_toy_img(image_size=(172, 172), rng=None, aux=True)
>>> print('anns = {}'.format(ub.repr2(anns, nl=1)))
>>> import kwplot
>>> kwplot.autompl()
>>> kwplot.imshow(img['imdata'], pnum=(1, 2, 1), fnum=1)
>>> auxdata = img['auxiliary'][0]['imdata']
>>> kwplot.imshow(auxdata, pnum=(1, 2, 2), fnum=1)
>>> kwplot.show_if_requested()

```

### kwcoco.demo.toydata\_video

Generates “toydata” for demo and testing purposes.

This is the video version of the toydata generator and should be preferred to the loose image version in `toydata_image`.

### Module Contents

## Functions

<code>random_video_dset(num_videos=1, num_frames=2, num_tracks=2, anchors=None, image_size=(600, 600), verbose=3, render=False, aux=None, multispectral=False, multisensor=False, rng=None, dpath=None, max_speed=0.01, channels=None, **kwargs)</code>	Create a toy Coco Video Dataset
<code>random_single_video_dset(image_size=(600, 600), num_frames=5, num_tracks=3, tid_start=1, gid_start=1, video_id=1, anchors=None, rng=None, render=False, dpath=None, autobuild=True, verbose=3, aux=None, multispectral=False, max_speed=0.01, channels=None, multisensor=False, **kwargs)</code>	Create the video scene layout of object positions.
<code>_draw_video_sequence(dset, gids)</code>	Helper to draw a multi-sensor sequence
<code>render_toy_dataset(dset, rng, dpath=None, renderkw=None, verbose=0)</code>	Create toydata_video renderings for a preconstructed coco dataset.
<code>render_toy_image(dset, gid, rng=None, renderkw=None)</code>	Modifies dataset inplace, rendering synthetic annotations.
<code>render_foreground(imdata, chan_to_auxinfo, dset, annots, catpats, with_sseg, with_kpts, dims, newstyle, gray, rng)</code>	Renders demo annotations on top of a demo background
<code>render_background(img, rng, gray, bg_intensity, bg_scale)</code>	
<code>false_color(twochan)</code>	TODO: the function ensure_false_color will eventually be ported to kwimage
<code>random_multi_object_path(num_objects, num_frames, rng=None, max_speed=0.01)</code>	
<code>random_path(num, degree=1, dimension=2, rng=None, mode='boid')</code>	Create a random path using a somem ethod curve.

## Attributes

<code>profile</code>
<code>TOYDATA_VIDEO_VERSION</code>

`kwcoco.demo.toydata_video.profile`

`kwcoco.demo.toydata_video.TOYDATA_VIDEO_VERSION = 21`

`kwcoco.demo.toydata_video.random_video_dset(num_videos=1, num_frames=2, num_tracks=2, anchors=None, image_size=(600, 600), verbose=3, render=False, aux=None, multispectral=False, multisensor=False, rng=None, dpath=None, max_speed=0.01, channels=None, **kwargs)`

Create a toy Coco Video Dataset

### Parameters

- **num\_videos** (*int*) – number of videos

- **num\_frames** (*int*) – number of images per video
- **num\_tracks** (*int*) – number of tracks per video
- **image\_size** (*Tuple[int, int]*) – The width and height of the generated images
- **render** (*bool | dict*) – if truthy the toy annotations are synthetically rendered. See [render\\_toy\\_image\(\)](#) for details.
- **rng** (*int | None | RandomState*) – random seed / state
- **dpath** (*str*) – only used if render is truthy, place to write rendered images.
- **verbose** (*int, default=3*) – verbosity mode
- **aux** (*bool*) – if True generates dummy auxiliary channels
- **multispectral** (*bool*) – similar to aux, but does not have the concept of a “main” image.
- **max\_speed** (*float*) – max speed of movers
- **channels** (*str*) – experimental new way to get MSI with specific band distributions.
- **\*\*kwargs** – used for old backwards compatible argument names gsize - alias for image\_size

**SeeAlso:** random\_single\_video\_dset

### Example

```
>>> from kw Coco.demo.toydata_video import * # NOQA
>>> dset = random_video_dset(render=True, num_videos=3, num_frames=2,
>>>                          num_tracks=5, image_size=(128, 128))
>>> # xdoctest: +REQUIRES(--show)
>>> dset.show_image(1, doclf=True)
>>> dset.show_image(2, doclf=True)
```

```
>>> from kw Coco.demo.toydata_video import * # NOQA
dset = random_video_dset(render=False, num_videos=3, num_frames=2,
    num_tracks=10)
dset._tree()
dset.imgs[1]
```

```
dset = random_single_video_dset() dset._tree() dset.imgs[1]
```

```
from kw Coco.demo.toydata_video import * # NOQA dset = random_video_dset(render=True, num_videos=3,
num_frames=2,
```

```
    num_tracks=10)
```

```
print(dset.imgs[1]) print('dset.bundle_dpath = {!r}'.format(dset.bundle_dpath)) dset._tree()
```

```
import xdev globals().update(xdev.get_func_kwargs(random_video_dset)) num_videos = 2
```

```
kw Coco.demo.toydata_video.random_single_video_dset(image_size=(600, 600), num_frames=5,
    num_tracks=3, tid_start=1, gid_start=1,
    video_id=1, anchors=None, rng=None,
    render=False, dpath=None, autobuild=True,
    verbose=3, aux=None, multispectral=False,
    max_speed=0.01, channels=None,
    multisensor=False, **kwargs)
```

Create the video scene layout of object positions.

---

**Note:** Does not render the data unless specified.

---

### Parameters

- **image\_size** (*Tuple[int, int]*) – size of the images
- **num\_frames** (*int*) – number of frames in this video
- **num\_tracks** (*int*) – number of tracks in this video
- **tid\_start** (*int, default=1*) – track-id start index
- **gid\_start** (*int, default=1*) – image-id start index
- **video\_id** (*int, default=1*) – video-id of this video
- **anchors** (*ndarray | None*) – base anchor sizes of the object boxes we will generate.
- **rng** (*RandomState*) – random state / seed
- **render** (*bool | dict*) – if truthy, does the rendering according to provided params in the case of dict input.
- **autobuild** (*bool, default=True*) – prebuild coco lookup indexes
- **verbose** (*int*) – verbosity level
- **aux** (*bool | List[str]*) – if specified generates auxiliary channels
- **multispectral** (*bool*) – if specified simulates multispectral imagery This is similar to aux, but has no “main” file.
- **max\_speed** (*float*) – max speed of movers
- **channels** (*str | None | ChannelSpec*) – if specified generates multispectral images with dummy channels
- **multisensor** (*bool*) –  
    **if True, generates demodata from “multiple sensors”, in** other words, observations may have different “bands”.
- **\*\*kwargs** – used for old backwards compatible argument names gsize - alias for image\_size

---

### Todo:

- [ ] Need maximum allowed object overlap measure
  - [ ] Need better parameterized path generation
-

### Example

```
>>> from kwcoco.demo.toydata_video import * # NOQA
>>> anchors = np.array([[0.3, 0.3], [0.1, 0.1]])
>>> dset = random_single_video_dset(render=True, num_frames=10, num_tracks=10,
↳ anchors=anchors, max_speed=0.2)
>>> # xdoctest: +REQUIRES(--show)
>>> # Show the tracks in a single image
>>> import kwplot
>>> kwplot.autompl()
>>> annots = dset.annots()
>>> tids = annots.lookup('track_id')
>>> tid_to_aids = ub.group_items(annots.aids, tids)
>>> paths = []
>>> track_boxes = []
>>> for tid, aids in tid_to_aids.items():
>>>     boxes = dset.annots(aids).boxes.to_cxywh()
>>>     path = boxes.data[:, 0:2]
>>>     paths.append(path)
>>>     track_boxes.append(boxes)
>>> import kwplot
>>> plt = kwplot.autoplt()
>>> ax = plt.gca()
>>> ax.cla()
>>> #
>>> import kwimage
>>> colors = kwimage.Color.distinct(len(track_boxes))
>>> for i, boxes in enumerate(track_boxes):
>>>     color = colors[i]
>>>     path = boxes.data[:, 0:2]
>>>     boxes.draw(color=color, centers={'radius': 0.01}, alpha=0.5)
>>>     ax.plot(path.T[0], path.T[1], 'x-', color=color)
```

### Example

```
>>> from kwcoco.demo.toydata_video import * # NOQA
>>> anchors = np.array([[0.2, 0.2], [0.1, 0.1]])
>>> gsize = np.array([(600, 600)])
>>> print(anchors * gsize)
>>> dset = random_single_video_dset(render=True, num_frames=10,
>>>                                anchors=anchors, num_tracks=10,
>>>                                image_size='random')
>>> # xdoctest: +REQUIRES(--show)
>>> import kwplot
>>> plt = kwplot.autoplt()
>>> plt.clf()
>>> gids = list(dset.imgs.keys())
>>> pnums = kwplot.PlotNums(nSubplots=len(gids))
>>> for gid in gids:
>>>     dset.show_image(gid, pnum=pnums(), fnum=1, title=False)
>>> pnums = kwplot.PlotNums(nSubplots=len(gids))
```

### Example

```
>>> from kwcoco.demo.toydata_video import * # NOQA
>>> dset = random_single_video_dset(num_frames=10, num_tracks=10, aux=True)
>>> assert 'auxiliary' in dset.imgs[1]
>>> assert dset.imgs[1]['auxiliary'][0]['channels']
>>> assert dset.imgs[1]['auxiliary'][1]['channels']
```

### Example

```
>>> from kwcoco.demo.toydata_video import * # NOQA
>>> multispectral = True
>>> dset = random_single_video_dset(num_frames=1, num_tracks=1, multispectral=True)
>>> dset._check_json_serializable()
>>> dset.dataset['images']
>>> assert dset.imgs[1]['auxiliary'][1]['channels']
>>> # test that we can render
>>> render_toy_dataset(dset, rng=0, dpath=None, renderkw={})
```

### Example

```
>>> from kwcoco.demo.toydata_video import * # NOQA
>>> dset = random_single_video_dset(num_frames=4, num_tracks=1, multispectral=True,
↳ multisensor=True, image_size='random', rng=2338)
>>> dset._check_json_serializable()
>>> assert dset.imgs[1]['auxiliary'][1]['channels']
>>> # Print before and after render
>>> #print('multisensor-images = {}'.format(ub.repr2(dset.dataset['images'], nl=-2)))
>>> #print('multisensor-images = {}'.format(ub.repr2(dset.dataset, nl=-2)))
>>> print(ub.hash_data(dset.dataset))
>>> # test that we can render
>>> render_toy_dataset(dset, rng=0, dpath=None, renderkw={})
>>> #print('multisensor-images = {}'.format(ub.repr2(dset.dataset['images'], nl=-2)))
>>> # xdoctest: +REQUIRES(--show)
>>> import kwplot
>>> kwplot.autompl()
>>> from kwcoco.demo.toydata_video import _draw_video_sequence # NOQA
>>> gids = [1, 2, 3, 4]
>>> final = _draw_video_sequence(dset, gids)
>>> print('dset.fpath = {!r}'.format(dset.fpath))
>>> kwplot.imshow(final)
```

`kwcoco.demo.toydata_video._draw_video_sequence(dset, gids)`

Helper to draw a multi-sensor sequence

`kwcoco.demo.toydata_video.render_toy_dataset(dset, rng, dpath=None, renderkw=None, verbose=0)`

Create toydata\_video renderings for a preconstructed coco dataset.

#### Parameters

- **dset** (*CocoDataset*) – A dataset that contains special “renderable” annotations. (e.g. the demo shapes). Each image can contain special fields that influence how an image will be rendered.

Currently this process is simple, it just creates a noisy image with the shapes superimposed over where they should exist as indicated by the annotations. In the future this may become more sophisticated.

Each item in `dset.dataset['images']` will be modified to add the “file\_name” field indicating where the rendered data is written.

- **rng** (*int* | *None* | *RandomState*) – random state
- **dpath** (*str*) – The location to write the images to. If unspecified, it is written to the rendered folder inside the kwcoco cache directory.
- **renderkw** (*dict*) – See `render_toy_image()` for details. Also takes imwrite keywords args only handled in this function. TODO better docs.

### Example

```
>>> from kwcoco.demo.toydata_video import * # NOQA
>>> import kwarray
>>> rng = None
>>> rng = kwarray.ensure_rng(rng)
>>> num_tracks = 3
>>> dset = random_video_dset(rng=rng, num_videos=3, num_frames=5,
>>>                          num_tracks=num_tracks, image_size=(128, 128))
>>> dset = render_toy_dataset(dset, rng)
>>> # xdoctest: +REQUIRES(--show)
>>> import kwplot
>>> plt = kwplot.autoplt()
>>> plt.clf()
>>> gids = list(dset.imgs.keys())
>>> pnums = kwplot.PlotNums(nSubplots=len(gids), nRows=num_tracks)
>>> for gid in gids:
>>>     dset.show_image(gid, pnum=pnums(), fnum=1, title=False)
>>> pnums = kwplot.PlotNums(nSubplots=len(gids))
```

`kwcoco.demo.toydata_video.render_toy_image(dset, gid, rng=None, renderkw=None)`

Modifies dataset inplace, rendering synthetic annotations.

This does not write to disk. Instead this writes to placeholder values in the image dictionary.

#### Parameters

- **dset** (*CocoDataset*) – coco dataset with renderable anotations / images
- **gid** (*int*) – image to render
- **rng** (*int* | *None* | *RandomState*) – random state
- **renderkw** (*dict*) – rendering config gray (boo): gray or color images fg\_scale (float): foreground noisyness (gauss std) bg\_scale (float): background noisyness (gauss std) fg\_intensity (float): foreground brightness (gauss mean) bg\_intensity (float): background brightness (gauss mean) newstyle (bool): use new kwcoco datastructure formats with\_kpts (bool): include keypoint info with\_sseg (bool): include segmentation info

**Returns** the inplace-modified image dictionary

Return type Dict

### Example

```
>>> from kwcoco.demo.toydata_video import * # NOQA
>>> image_size=(600, 600)
>>> num_frames=5
>>> verbose=3
>>> rng = None
>>> import kwarray
>>> rng = kwarray.ensure_rng(rng)
>>> aux = 'mx'
>>> dset = random_single_video_dset(
>>>     image_size=image_size, num_frames=num_frames, verbose=verbose, aux=aux,
↪ rng=rng)
>>> print('dset.dataset = {}'.format(ub.repr2(dset.dataset, nl=2)))
>>> gid = 1
>>> renderkw = {}
>>> render_toy_image(dset, gid, rng, renderkw=renderkw)
>>> img = dset.imgs[gid]
>>> canvas = img['imdata']
>>> # xdoctest: +REQUIRES(--show)
>>> import kwplot
>>> kwplot.autompl()
>>> kwplot.imshow(canvas, doclf=True, pnum=(1, 2, 1))
>>> dets = dset.anns(gid=gid).detections
>>> dets.draw()
```

```
>>> auxdata = img['auxiliary'][0]['imdata']
>>> aux_canvas = false_color(auxdata)
>>> kwplot.imshow(aux_canvas, pnum=(1, 2, 2))
>>> _ = dets.draw()
```

```
>>> # xdoctest: +REQUIRES(--show)
>>> img, anns = demodata_toy_img(image_size=(172, 172), rng=None, aux=True)
>>> print('anns = {}'.format(ub.repr2(anns, nl=1)))
>>> import kwplot
>>> kwplot.autompl()
>>> kwplot.imshow(img['imdata'], pnum=(1, 2, 1), fnum=1)
>>> auxdata = img['auxiliary'][0]['imdata']
>>> kwplot.imshow(auxdata, pnum=(1, 2, 2), fnum=1)
>>> kwplot.show_if_requested()
```



## Example

```
>>> from kwcoco.demo.toydata_video import * # NOQA
>>> multispectral = True
>>> dset = random_single_video_dset(num_frames=1, num_tracks=1, multispectral=True)
>>> gid = 1
>>> dset.imgs[gid]
>>> rng = kwarrray.ensure_rng(0)
>>> renderkw = {'with_sseg': True}
>>> img = render_toy_image(dset, gid, rng=rng, renderkw=renderkw)
```

`kwcoco.demo.toydata_video.render_foreground(imdata, chan_to_auxinfo, dset, annots, catpats, with_sseg, with_kpts, dims, newstyle, gray, rng)`

Renders demo annoations on top of a demo background

`kwcoco.demo.toydata_video.render_background(img, rng, gray, bg_intensity, bg_scale)`

`kwcoco.demo.toydata_video.false_color(twochan)`

TODO: the function `ensure_false_color` will eventually be ported to `kwimage` use that instead.

`kwcoco.demo.toydata_video.random_multi_object_path(num_objects, num_frames, rng=None, max_speed=0.01)`

`kwcoco.demo.toydata_video.random_path(num, degree=1, dimension=2, rng=None, mode='boid')`

Create a random path using a somem ethod curve.

### Parameters

- **num** (*int*) – number of points in the path
- **degree** (*int*, *default=1*) – degree of curviness of the path
- **dimension** (*int*, *default=2*) – number of spatial dimensions
- **mode** (*str*) – can be boid, walk, or bezier
- **rng** (*RandomState*, *default=None*) – seed

## References

<https://github.com/dhermes/bezier>

## Example

```
>>> from kwcoco.demo.toydata_video import * # NOQA
>>> num = 10
>>> dimension = 2
>>> degree = 3
>>> rng = None
>>> path = random_path(num, degree, dimension, rng, mode='boid')
>>> # xdoctest: +REQUIRES(--show)
>>> import kwplot
>>> plt = kwplot.autoplt()
```

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```
>>> kwplot.multi_plot(xdata=path[:, 0], ydata=path[:, 1], fnum=1, doclf=1, xlim=(0, 1),  
→ ylim=(0, 1))  
>>> kwplot.show_if_requested()
```

### Example

```
>>> # xdoctest: +REQUIRES(--3d)  
>>> # xdoctest: +REQUIRES(module:bezier)  
>>> import kwarray  
>>> import kwplot  
>>> plt = kwplot.autoplt()  
>>> #  
>>> num= num_frames = 100  
>>> rng = kwarray.ensure_rng(0)  
>>> #  
>>> from kwcoco.demo.toydata_video import * # NOQA  
>>> paths = []  
>>> paths.append(random_path(num, degree=3, dimension=3, mode='bezier'))  
>>> paths.append(random_path(num, degree=2, dimension=3, mode='bezier'))  
>>> paths.append(random_path(num, degree=4, dimension=3, mode='bezier'))  
>>> #  
>>> from mpl_toolkits.mplot3d import Axes3D # NOQA  
>>> ax = plt.gca(projection='3d')  
>>> ax.cla()  
>>> #  
>>> for path in paths:  
>>>     time = np.arange(len(path))  
>>>     ax.plot(time, path.T[0] * 1, path.T[1] * 1, 'o-')  
>>> ax.set_xlim(0, num_frames)  
>>> ax.set_ylim(-.01, 1.01)  
>>> ax.set_zlim(-.01, 1.01)  
>>> ax.set_xlabel('x')  
>>> ax.set_ylabel('y')  
>>> ax.set_zlabel('z')
```

**kwcoco.demo.toypatterns**

## Module Contents

### Classes

---

*CategoryPatterns*

### Example

---

*Rasters*

---

## Functions

---

<code>star(a, dtype=np.uint8)</code>	Generates a star shaped structuring element.
--------------------------------------	--

---

## Attributes

---

`profile`

---

`kwcoco.demo.toypatterns.profile`

**class** `kwcoco.demo.toypatterns.CategoryPatterns`(*categories=None, fg\_scale=0.5, fg\_intensity=0.9, rng=None*)

Bases: `object`

## Example

```
>>> from kwcoco.demo.toypatterns import * # NOQA
>>> self = CategoryPatterns.coerce()
>>> chip = np.zeros((100, 100, 3))
>>> offset = (20, 10)
>>> dims = (160, 140)
>>> info = self.random_category(chip, offset, dims)
>>> print('info = {}'.format(ub.repr2(info, nl=1)))
>>> # xdoctest: +REQUIRES(--show)
>>> import kwplot
>>> kwplot.autompl()
>>> kwplot.imshow(info['data'], pnum=(1, 2, 1), fnum=1, title='chip-space')
>>> kpts = kwimage.Points._from_coco(info['keypoints'])
>>> kpts.translate(-np.array(offset)).draw(radius=3)
>>> #####
>>> mask = kwimage.Mask.coerce(info['segmentation'])
>>> kwplot.imshow(mask.to_c_mask().data, pnum=(1, 2, 2), fnum=1, title='img-space')
>>> kpts.draw(radius=3)
>>> kwplot.show_if_requested()
```

`_default_categories`

`_default_keypoint_categories`

`_default_catnames = ['star', 'eff', 'superstar']`

**classmethod** `coerce`(*CategoryPatterns, data=None, \*\*kwargs*)

Construct category patterns from either defaults or only with specific categories. Can accept either an existig category pattern object, a list of known catnames, or mscoco category dictionaries.

### Example

```
>>> data = ['superstar']
>>> self = CategoryPatterns.coerce(data)
```

`__len__(self)`

`__getitem__(self, index)`

`__iter__(self)`

`index(self, name)`

`get(self, index, default=ub.NoParam)`

`random_category(self, chip, xy_offset=None, dims=None, newstyle=True, size=None)`

### Example

```
>>> from kwcoco.demo.toypatterns import * # NOQA
>>> self = CategoryPatterns.coerce(['superstar'])
>>> chip = np.random.rand(64, 64)
>>> info = self.random_category(chip)
```

`render_category(self, cname, chip, xy_offset=None, dims=None, newstyle=True, size=None)`

### Example

```
>>> from kwcoco.demo.toypatterns import * # NOQA
>>> self = CategoryPatterns.coerce(['superstar'])
>>> chip = np.random.rand(64, 64)
>>> info = self.render_category('superstar', chip, newstyle=True)
>>> print('info = {}'.format(ub.repr2(info, nl=-1)))
>>> info = self.render_category('superstar', chip, newstyle=False)
>>> print('info = {}'.format(ub.repr2(info, nl=-1)))
```

### Example

```
>>> from kwcoco.demo.toypatterns import * # NOQA
>>> self = CategoryPatterns.coerce(['superstar'])
>>> chip = None
>>> dims = (64, 64)
>>> info = self.render_category('superstar', chip, newstyle=True, dims=dims,
↳ size=dims)
>>> print('info = {}'.format(ub.repr2(info, nl=-1)))
```

`_todo_refactor_geometric_info(self, cname, xy_offset, dims)`

This function is used to populate kpts and sseg information in the autogenerated coco dataset before rendering. It is redundant with other functionality.

TODO: rectify with `_from_elem`

### Example

```
>>> self = CategoryPatterns.coerce(['superstar'])
>>> dims = (64, 64)
>>> cname = 'superstar'
>>> xy_offset = None
>>> self._todo_refactor_geometric_info(cname, xy_offset, dims)
```

**`_package_info(self, cname, data, mask, kpts, xy_offset, dims, newstyle)`**

packages data from `_from_elem` into coco-like annotation

**`_from_elem(self, cname, chip, size=None)`**

### Example

```
>>> # hack to allow chip to be None
>>> chip = None
>>> size = (32, 32)
>>> cname = 'superstar'
>>> self = CategoryPatterns.coerce()
>>> self._from_elem(cname, chip, size)
```

`kwcoco.demo.toypatterns.star(a, dtype=np.uint8)`

Generates a star shaped structuring element.

Much faster than `skimage.morphology` version

**`class kwcoco.demo.toypatterns.Rasters`**

**`static superstar()`**

test data patch

**`static eff()`**

test data patch

## 2.2.4 kwcoco.examples

### Submodules

`kwcoco.examples.bench_large_hyperspectral`

### Module Contents

### Functions

---

`benchmark_large_hyperspectral()`

---

`kwcoco.examples.bench_large_hyperspectral.benchmark_large_hyperspectral()`

`kwcoco.examples.draw_gt_and_predicted_boxes`

## Module Contents

### Functions

---

<code>draw_true_and_pred_boxes(true_fpath, pred_fpath, gid, viz_fpath)</code>	How do you generally visualize gt and predicted bounding boxes together?
---	--

---

`kwcoco.examples.draw_gt_and_predicted_boxes.draw_true_and_pred_boxes(true_fpath, pred_fpath, gid, viz_fpath)`

How do you generally visualize gt and predicted bounding boxes together?

### Example

```
>>> import kwcoco
>>> import ubelt as ub
>>> from os.path import join
>>> from kwcoco.demo.perterb import perterb_coco
>>> # Create a working directory
>>> dpath = ub.ensure_app_cache_dir('kwcoco/examples/draw_true_and_pred_boxes')
>>> # Lets setup some dummy true data
>>> true_dset = kwcoco.CocoDataset.demo('shapes2')
>>> true_dset.fpath = join(dpath, 'true_dset.kwcoco.json')
>>> true_dset.dump(true_dset.fpath, newlines=True)
>>> # Lets setup some dummy predicted data
>>> pred_dset = perterb_coco(true_dset, box_noise=100, rng=421)
>>> pred_dset.fpath = join(dpath, 'pred_dset.kwcoco.json')
>>> pred_dset.dump(pred_dset.fpath, newlines=True)
>>> #
>>> # We now have our true and predicted data, lets visualize
>>> true_fpath = true_dset.fpath
>>> pred_fpath = pred_dset.fpath
>>> print('dpath = {!r}'.format(dpath))
>>> print('true_fpath = {!r}'.format(true_fpath))
>>> print('pred_fpath = {!r}'.format(pred_fpath))
>>> # Lets choose an image id to visualize and a path to write to
>>> gid = 1
>>> viz_fpath = join(dpath, 'viz_{}.jpg'.format(gid))
>>> # The answer to the question is in the logic of this function
>>> draw_true_and_pred_boxes(true_fpath, pred_fpath, gid, viz_fpath)
```

## kwcoco.examples.faq

These are answers to the questions: How do I?

### Module Contents

#### Functions

---

*get\_images\_with\_video\_id()*

Q: How would you recommend querying a kwcoco file to get all of the images

---

kwcoco.examples.faq.get\_images\_with\_video\_id()

Q: How would you recommend querying a kwcoco file to get all of the images associated with a video id?

## kwcoco.examples.getting\_started\_existing\_dataset

### Module Contents

#### Functions

---

*getting\_started\_existing\_dataset()*

If you want to start using the Python API. Just open IPython and try:

---

*the\_core\_dataset\_backend()*

---

*demo\_vectorize\_interface()*

```
>>> import kwcoco
```

---

kwcoco.examples.getting\_started\_existing\_dataset.getting\_started\_existing\_dataset()

If you want to start using the Python API. Just open IPython and try:

kwcoco.examples.getting\_started\_existing\_dataset.the\_core\_dataset\_backend()

kwcoco.examples.getting\_started\_existing\_dataset.demo\_vectorize\_interface()

```
>>> import kwcoco
>>> dset = kwcoco.CocoDataset.demo('vidshapes2')
>>> #
>>> aids = [1, 2, 3, 4]
>>> annots = dset.annots(aids)
...
>>> print('annots = {!r}'.format(annots))
annots = <Annots(num=4) at ...>
```

```
>>> annots.lookup('bbox')
[[346.5, 335.2, 33.2, 99.4],
 [344.5, 327.7, 48.8, 111.1],
```

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```
[548.0, 154.4, 57.2, 62.1],  
[548.7, 151.0, 59.4, 80.5]]
```

```
>>> gids = annots.lookup('image_id')  
>>> print('gids = {!r}'.format(gids))  
gids = [1, 2, 1, 2]
```

```
>>> images = dset.images(gids)  
>>> list(zip(images.lookup('width'), images.lookup('height')))  
[(600, 600), (600, 600), (600, 600), (600, 600)]
```

## kwcoco.examples.loading\_multispectral\_data

### Module Contents

#### Functions

---

```
demo_load_msi_data()
```

---

kwcoco.examples.loading\_multispectral\_data.**demo\_load\_msi\_data()**

## kwcoco.examples.modification\_example

### Module Contents

#### Functions

---

<pre>dataset_modification_example_via_copy()</pre>	Say you are given a dataset as input and you need to add your own
<pre>dataset_modification_example_via_construction()</pre>	Alternatively you can make a new dataset and copy over categories / images

---

kwcoco.examples.modification\_example.**dataset\_modification\_example\_via\_copy()**

Say you are given a dataset as input and you need to add your own annotation “predictions” to it. You could copy the existing dataset, remove all the annotations, and then add your new annotations.

kwcoco.examples.modification\_example.**dataset\_modification\_example\_via\_construction()**

Alternatively you can make a new dataset and copy over categories / images as needed



## kwcoco.examples.simple\_kwcoco\_torch\_dataset

This example demonstrates how to use kwcoco to write a very simple torch dataset. This assumes the dataset will be single-image RGB inputs. This file is intended to talk the reader through what we are doing and why.

This example aims for clarity over being concise. There are APIs exposed by kwcoco (and its sister module ndsampler) that can perform the same tasks more efficiently and with fewer lines of code.

If you run the doctest, it will produce a visualization that shows the images with boxes drawn on it, running it multiple times will let you see the augmentations. This can be done with the following command:

```
xdoctest -m kwcoco.examples.simple_kwcoco_torch_dataset KWCocoSimpleTorchDataset --show
```

Or just copy the doctest into IPython and run it.

## Module Contents

### Classes

---

<i>KWCocoSimpleTorchDataset</i>	A simple torch dataloader where each image is considered a single item.
---------------------------------	---

---

### Attributes

---

*DatasetBase*

---

kwcoco.examples.simple\_kwcoco\_torch\_dataset.**DatasetBase**

```
class kwcoco.examples.simple_kwcoco_torch_dataset.KWCocoSimpleTorchDataset(coco_dset,
                                                                              input_dims=None,
                                                                              antialias=False,
                                                                              rng=None)
```

Bases: *DatasetBase*

A simple torch dataloader where each image is considered a single item.

#### Parameters

- **coco\_dset** (*kwcoco.CocoDataset* | *str*) – something coercable to a kwcoco dataset, this could either be a *kwcoco.CocoDataset* object, a path to a kwcoco manifest on disk, or a special toydata code. See *kwcoco.CocoDataset.coerce()* for more details.
- **input\_dims** (*Tuple[int, int]*) – These are the (height, width) dimensions that the image will be resized to.
- **antialias** (*bool*, *default=False*) – If true, we will antialias before downsampling.
- **rng** (*RandomState* | *int* | *None*) – an existing random number generator or a random seed to produce deterministic augmentations.

## Example

```

>>> # xdoctest: +REQUIRES(module:torch)
>>> from kwcoco.examples.simple_kwcoco_torch_dataset import * # NOQA
>>> import kwcoco
>>> coco_dset = kwcoco.CocoDataset.demo('shapes8')
>>> input_dims = (384, 384)
>>> self = torch_dset = KWCocoSimpleTorchDataset(coco_dset, input_dims=input_dims)
>>> index = len(self) // 2
>>> item = self[index]
>>> # xdoctest: +REQUIRES(--show)
>>> import kwplot
>>> kwplot.figure(doclf=True, fnum=1)
>>> kwplot.autompl()
>>> canvas = item['inputs']['rgb'].numpy().transpose(1, 2, 0)
>>> # Construct kwimage objects for batch item visualization
>>> dets = kwimage.Detections(
>>>     boxes=kwimage.Boxes(item['labels']['cxywh'], 'cxywh'),
>>>     class_idxs=item['labels']['class_idxs'],
>>>     classes=self.classes,
>>> ).numpy()
>>> # Overlay annotations on the image
>>> canvas = dets.draw_on(canvas)
>>> kwplot.imshow(canvas)
>>> kwplot.show_if_requested()

```

`__len__(self)`

Return the number of items in the Dataset

`__getitem__(self, index)`

Construct a batch item to be used in training

## kwcoco.examples.vectorized\_interface

### Module Contents

### Functions

---

`demo_vectorized_interface()`

This demonstrates how to use the kwcoco vectorized interface for images /

---

`kwcoco.examples.vectorized_interface.demo_vectorized_interface()`

This demonstrates how to use the kwcoco vectorized interface for images / categories / annotations.

## 2.2.5 kwcoco.metrics

mkinit kwcoco.metrics -w --relative

### Submodules

#### kwcoco.metrics.assignment

when deciding whether to go up or down in the tree.

[ ] medschool applications true-pred matching (applicant proposing) fast algorithm.

[ ] Maybe looping over truth rather than pred is faster? but it makes you have to combine pred score / ious, which is weird.

[x] preallocate ndarray and use hstack to build confusion vectors?

doesn't help

[ ] relevant classes / classes / classes-of-interest we care about needs

to be a first class member of detection metrics.

[ ] Add parameter that allows one prediction to “match” to more than one

truth object. (example: we have a duck detector problem and all the ducks in a row are annotated as separate object, and we only care about getting the group):

### Module Contents

#### Functions

<code>_assign_confusion_vectors</code> (true_dets, pred_dets, bg_weight=1.0, iou_thresh=0.5, bg_cidx=-1, bias=0.0, classes=None, compat='all', prioritize='iou', ignore_classes='ignore', max_dets=None)	Create confusion vectors for detections by assigning to ground true boxes
<code>_critical_loop</code> (true_dets, pred_dets, iou_lookup, is-valid_lookup, cx_to_matchable_txs, bg_weight, prioritize, iou_thresh_, pdist_priority, cx_to_ancestors, bg_cidx, ignore_classes, max_dets)	
<code>_fast_pdist_priority</code> (classes, prioritize, _cache={})	Custom priority computation. Needs some vetting.
<code>_filter_ignore_regions</code> (true_dets, pred_dets, ioaa_thresh=0.5, ignore_classes='ignore')	Determine which true and predicted detections should be ignored.

## Attributes

---

### *USE\_NEG\_INF*

---

`kwcoco.metrics.assignment.USE_NEG_INF = True`

`kwcoco.metrics.assignment._assign_confusion_vectors(true_dets, pred_dets, bg_weight=1.0,  
iou_thresh=0.5, bg_cidx=-1, bias=0.0,  
classes=None, compat='all', prioritize='iou',  
ignore_classes='ignore', max_dets=None)`

Create confusion vectors for detections by assigning to ground true boxes

Given predictions and truth for an image return (y\_pred, y\_true, y\_score), which is suitable for sklearn classification metrics

#### Parameters

- **true\_dets** (*Detections*) – groundtruth with boxes, classes, and weights
- **pred\_dets** (*Detections*) – predictions with boxes, classes, and scores
- **iou\_thresh** (*float, default=0.5*) – bounding box overlap iou threshold required for assignment
- **bias** (*float, default=0.0*) – for computing bounding box overlap, either 1 or 0
- **gids** (*List[int], default=None*) – which subset of images ids to compute confusion metrics on. If not specified all images are used.
- **compat** (*str, default='all'*) – can be ('ancestors' | 'mutex' | 'all'). determines which pred boxes are allowed to match which true boxes. If 'mutex', then pred boxes can only match true boxes of the same class. If 'ancestors', then pred boxes can match true boxes that match or have a coarser label. If 'all', then any pred can match any true, regardless of its category label.
- **prioritize** (*str, default='iou'*) – can be ('iou' | 'class' | 'correct') determines which box to assign to if multiple true boxes overlap a predicted box. if prioritize is iou, then the true box with maximum iou (above iou\_thresh) will be chosen. If prioritize is class, then it will prefer matching a compatible class above a higher iou. If prioritize is correct, then ancestors of the true class are preferred over descendents of the true class, over unrelated classes.
- **bg\_cidx** (*int, default=-1*) – The index of the background class. The index used in the truth column when a predicted bounding box does not match any true bounding box.
- **classes** (*List[str] | kwcoco.CategoryTree*) – mapping from class indices to class names. Can also contain class heirarchy information.
- **ignore\_classes** (*str | List[str]*) – class name(s) indicating ignore regions
- **max\_dets** (*int*) – maximum number of detections to consider

---

#### Todo:

- [ ] This is a bottleneck function. An implementation in C / C++ /

Cython would likely improve the overall system.

- [ ] **Implement crowd truth. Allow multiple predictions to match any** truth object marked as "iscrowd".
-

**Returns**

with relevant confusion vectors. This keys of this dict can be interpreted as columns of a data frame. The *txs* / *pxs* columns represent the indexes of the true / predicted annotations that were assigned as matching. Additionally each row also contains the true and predicted class index, the predicted score, the true weight and the iou of the true and predicted boxes. A *txs* value of -1 means that the predicted box was not assigned to a true annotation and a *pxs* value of -1 means that the true annotation was not assigned to any predicted annotation.

Return type `dict`

**Example**

```
>>> # xdoctest: +REQUIRES(module:pandas)
>>> import pandas as pd
>>> import kwimage
>>> # Given a raw numpy representation construct Detection wrappers
>>> true_dets = kwimage.Detections(
>>>     boxes=kwimage.Boxes(np.array([
>>>         [ 0,  0, 10, 10], [10,  0, 20, 10],
>>>         [10,  0, 20, 10], [20,  0, 30, 10]]), 'tlbr'),
>>>     weights=np.array([1, 0, .9, 1]),
>>>     class_idxs=np.array([0, 0, 1, 2]))
>>> pred_dets = kwimage.Detections(
>>>     boxes=kwimage.Boxes(np.array([
>>>         [6, 2, 20, 10], [3,  2,  9,  7],
>>>         [3,  9,  9,  7], [3,  2,  9,  7],
>>>         [2,  6,  7,  7], [20,  0, 30, 10]]), 'tlbr'),
>>>     scores=np.array([.5, .5, .5, .5, .5, .5]),
>>>     class_idxs=np.array([0, 0, 1, 2, 0, 1]))
>>> bg_weight = 1.0
>>> compat = 'all'
>>> iou_thresh = 0.5
>>> bias = 0.0
>>> import kwcoco
>>> classes = kwcoco.CategoryTree.from_mutex(list(range(3)))
>>> bg_cidx = -1
>>> y = _assign_confusion_vectors(true_dets, pred_dets, bias=bias,
>>>                               bg_weight=bg_weight, iou_thresh=iou_thresh,
>>>                               compat=compat)
>>> y = pd.DataFrame(y)
>>> print(y) # xdoc: +IGNORE_WANT
```

	pred	true	score	weight	iou	txs	pxs
0	1	2	0.5000	1.0000	1.0000	3	5
1	0	-1	0.5000	1.0000	-1.0000	-1	4
2	2	-1	0.5000	1.0000	-1.0000	-1	3
3	1	-1	0.5000	1.0000	-1.0000	-1	2
4	0	-1	0.5000	1.0000	-1.0000	-1	1
5	0	0	0.5000	0.0000	0.6061	1	0
6	-1	0	0.0000	1.0000	-1.0000	0	-1
7	-1	1	0.0000	0.9000	-1.0000	2	-1

### Example

```
>>> # xdoctest: +REQUIRES(module:pandas)
>>> import pandas as pd
>>> from kwcoco.metrics import DetectionMetrics
>>> dmet = DetectionMetrics.demo(nimgs=1, nclasses=8,
>>>                             nboxes=(0, 20), n_fp=20,
>>>                             box_noise=.2, cls_noise=.3)
>>> classes = dmet.classes
>>> gid = 0
>>> true_dets = dmet.true_detections(gid)
>>> pred_dets = dmet.pred_detections(gid)
>>> y = _assign_confusion_vectors(true_dets, pred_dets,
>>>                             classes=dmet.classes,
>>>                             compat='all', prioritize='class')
>>> y = pd.DataFrame(y)
>>> print(y) # xdoc: +IGNORE_WANT
>>> y = _assign_confusion_vectors(true_dets, pred_dets,
>>>                             classes=dmet.classes,
>>>                             compat='ancestors', iou_thresh=.5)
>>> y = pd.DataFrame(y)
>>> print(y) # xdoc: +IGNORE_WANT
```

```
kwcoco.metrics.assignment._critical_loop(true_dets, pred_dets, iou_lookup, invalid_lookup,
                                         cx_to_matchable_txs, bg_weight, prioritize, iou_thresh_,
                                         pdist_priority, cx_to_ancestors, bg_cidx, ignore_classes,
                                         max_dets)
```

```
kwcoco.metrics.assignment._fast_pdist_priority(classes, prioritize, _cache={})
```

Custom priority computation. Needs some vetting.

This is the priority used when deciding which prediction to assign to which truth.

---

#### Todo:

- [ ] Look at absolute difference in sibling entropy when deciding whether to go up or down in the tree.
- 

```
kwcoco.metrics.assignment._filter_ignore_regions(true_dets, pred_dets, ioaa_thresh=0.5,
                                                  ignore_classes='ignore')
```

Determine which true and predicted detections should be ignored.

#### Parameters

- **true\_dets** (*Detections*)
- **pred\_dets** (*Detections*)
- **ioaa\_thresh** (*float*) – intersection over other area thresh for ignoring a region.

#### Returns

flags indicating which true and predicted detections should be ignored.

**Return type** Tuple[ndarray, ndarray]

## Example

```
>>> from kwcoco.metrics.assignment import * # NOQA
>>> from kwcoco.metrics.assignment import _filter_ignore_regions
>>> import kwimage
>>> pred_dets = kwimage.Detections.random(classes=['a', 'b', 'c'])
>>> true_dets = kwimage.Detections.random(
>>>     segmentations=True, classes=['a', 'b', 'c', 'ignore'])
>>> ignore_classes = {'ignore', 'b'}
>>> ioaa_thresh = 0.5
>>> print('true_dets = {!r}'.format(true_dets))
>>> print('pred_dets = {!r}'.format(pred_dets))
>>> flags1, flags2 = _filter_ignore_regions(
>>>     true_dets, pred_dets, ioaa_thresh=ioaa_thresh, ignore_classes=ignore_
    ↪ classes)
>>> print('flags1 = {!r}'.format(flags1))
>>> print('flags2 = {!r}'.format(flags2))
```

```
>>> flags3, flags4 = _filter_ignore_regions(
>>>     true_dets, pred_dets, ioaa_thresh=ioaa_thresh,
>>>     ignore_classes={c.upper() for c in ignore_classes})
>>> assert np.all(flags1 == flags3)
>>> assert np.all(flags2 == flags4)
```

`kwcoco.metrics.clf_report`

## Module Contents

### Functions

<code>classification_report</code> (y_true, y_pred, target_names=None, sample_weight=None, verbose=False, remove_unsupported=False, log=None, ascii_only=False)	Computes a classification report which is a collection of various metrics
<code>ovr_classification_report</code> (mc_y_true, mc_probs, target_names=None, sample_weight=None, metrics=None, verbose=0, remove_unsupported=False, log=None)	One-vs-rest classification report

### Attributes

`ASCII_ONLY`

`kwcoco.metrics.clf_report.ASCII_ONLY`

```
kwcoco.metrics.clf_report.classification_report(y_true, y_pred, target_names=None,
                                              sample_weight=None, verbose=False,
                                              remove_unsupported=False, log=None,
                                              ascii_only=False)
```

Computes a classification report which is a collection of various metrics commonly used to evaluate classification quality. This can handle binary and multiclass settings.

Note that this function does not accept probabilities or scores and must instead act on final decisions. See `ovr_classification_report` for a probability based report function using a one-vs-rest strategy.

This emulates the `bm(cm)` Matlab script written by David Powers that is used for computing bookmaker, markedness, and various other scores.

**References:** <https://csem.flinders.edu.au/research/techreps/SIE07001.pdf> <https://www.mathworks.com/matlabcentral/fileexchange/5648-bm-cm-?requestedDomain=www.mathworks.com> Jurman, Riccadonna, Furlanello, (2012). A Comparison of MCC and CEN

Error Measures in MultiClass Prediction

**Args:** `y_true` (array): true labels for each item `y_pred` (array): predicted labels for each item `target_names` (List): mapping from label to category name `sample_weight` (ndarray): weight for each item `verbose` (False): print if True `log` (callable): print or logging function `remove_unsupported` (bool, default=False): removes categories that have

no support.

**ascii\_only** (bool, default=False): if True dont use unicode characters. if the environ `ASCII_ONLY` is present this is forced to True and cannot be undone.

**Example:**

```
>>> # xdoctest: +IGNORE_WANT
>>> # xdoctest: +REQUIRES(module:sklearn)
>>> # xdoctest: +REQUIRES(module:pandas)
>>> y_true = [1, 1, 1, 1, 1, 2, 2, 2, 2, 2, 3, 3, 3, 3, 3, 3, 3, 3]
>>> y_pred = [1, 2, 1, 3, 1, 2, 2, 3, 2, 2, 3, 3, 2, 3, 3, 3, 1, 3]
>>> target_names = None
>>> sample_weight = None
>>> report = classification_report(y_true, y_pred, verbose=0, ascii_
↳ only=1)
>>> print(report['confusion'])
pred 1 2 3 r
real
1      3 1 1 5
2      0 4 1 5
3      1 1 6 8
p      4 6 8 18
>>> print(report['metrics'])
metric precision recall fpr markedness bookmaker mcc
↳ support
class
1      0.7500 0.6000 0.0769      0.6071      0.5231 0.5635
↳ 5
2      0.6667 0.8000 0.1538      0.5833      0.6462 0.6139
↳ 5
```

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(continued from previous page)

3	0.7500	0.7500	0.2000	0.5500	0.5500	0.5500	└
↪8							
combined	0.7269	0.7222	0.1530	0.5751	0.5761	0.5758	└
↪18							

**Example:**

```
>>> # xdoctest: +IGNORE_WANT
>>> # xdoctest: +REQUIRES(module:sklearn)
>>> # xdoctest: +REQUIRES(module:pandas)
>>> from kwcoco.metrics.clf_report import * # NOQA
>>> y_true = [1, 1, 1, 1, 1, 2, 2, 2, 2, 2, 3, 3, 3, 3, 3, 3, 3, 3]
>>> y_pred = [1, 2, 1, 3, 1, 2, 2, 3, 2, 2, 3, 3, 2, 3, 3, 3, 1, 3]
>>> target_names = None
>>> sample_weight = None
>>> logs = []
>>> report = classification_report(y_true, y_pred, verbose=1, ascii_
↪only=True, log=logs.append)
>>> print('
```

```
'.join(logs))
```

**Ignore:**

```
>>> size = 100
>>> rng = np.random.RandomState(0)
>>> p_classes = np.array([.90, .05, .05][0:2])
>>> p_classes = p_classes / p_classes.sum()
>>> p_wrong = np.array([.03, .01, .02][0:2])
>>> y_true = testdata_ytrue(p_classes, p_wrong, size, rng)
>>> rs = []
>>> for x in range(17):
>>>     p_wrong += .05
>>>     y_pred = testdata_ypred(y_true, p_wrong, rng)
>>>     report = classification_report(y_true, y_pred, verbose='hack')
>>>     rs.append(report)
>>> # xdoctest: +REQUIRES(--show)
>>> import kwplot
>>> kwplot.autompl()
>>> import pandas as pd
>>> df = pd.DataFrame(rs).drop(['raw'], axis=1)
>>> delta = df.subtract(df['target'], axis=0)
>>> sqrd_error = np.sqrt((delta ** 2).sum(axis=0))
>>> print('Error')
>>> print(sqrd_error.sort_values())
>>> ys = df.to_dict(orient='list')
>>> kwplot.multi_plot(ydata_list=ys)
```

```
kwcoco.metrics.clf_report.ovr_classification_report(mc_y_true, mc_probs, target_names=None,
                                                    sample_weight=None, metrics=None,
                                                    verbose=0, remove_unsupported=False,
                                                    log=None)
```

One-vs-rest classification report

**Parameters**

- **mc\_y\_true** (*ndarray[int]*) – multiclass truth labels (integer label format). Shape [N].
- **mc\_probs** (*ndarray*) – multiclass probabilities for each class. Shape [N x C].
- **target\_names** (**Dict[int, str]**) – mapping from int label to string name
- **sample\_weight** (*ndarray*) – weight for each item. Shape [N].
- **metrics** (*List[str]*) – names of metrics to compute

**Example**

```
>>> # xdoctest: +IGNORE_WANT
>>> # xdoctest: +REQUIRES(module:sklearn)
>>> # xdoctest: +REQUIRES(module:pandas)
>>> from kwcoco.metrics.clf_report import * # NOQA
>>> y_true = [1, 1, 1, 1, 1, 2, 2, 2, 2, 2, 0, 0, 0, 0, 0, 0, 0]
>>> y_probs = np.random.rand(len(y_true), max(y_true) + 1)
>>> target_names = None
>>> sample_weight = None
>>> verbose = True
>>> report = ovr_classification_report(y_true, y_probs)
>>> print(report['ave'])
auc      0.6541
ap       0.6824
kappa    0.0963
mcc      0.1002
brier    0.2214
dtype: float64
>>> print(report['ovr'])
      auc      ap      kappa      mcc      brier      support      weight
0  0.6062  0.6161  0.0526  0.0598  0.2608         8  0.4444
1  0.5846  0.6014  0.0000  0.0000  0.2195         5  0.2778
2  0.8000  0.8693  0.2623  0.2652  0.1602         5  0.2778
```

**kwcoco.metrics.confusion\_measures**

Classes that store accumulated confusion measures (usually derived from confusion vectors).

**For each chosen threshold value:**

- **thresholds[i]** - the i-th threshold value

The primary data we manipulate are arrays of “confusion” counts, i.e.

- **tp\_count[i]** - true positives at the i-th threshold
- **fp\_count[i]** - false positives at the i-th threshold
- **fn\_count[i]** - false negatives at the i-th threshold
- **tn\_count[i]** - true negatives at the i-th threshold

## Module Contents

### Classes

<i>Measures</i>	Holds accumulated confusion counts, and derived measures
<i>PerClass_Measures</i>	
<i>MeasureCombiner</i>	Helper to iteratively combine binary measures generated by some process
<i>OneVersusRestMeasureCombiner</i>	Helper to iteratively combine ovr measures generated by some process

### Functions

<i>_combine_threshold</i> (tocombine_thresh, thresh_bins, growth, precision)	Logic to take care of combining thresholds in the case bins are not given
<i>reversible_diff</i> (arr, assume_sorted=1, reverse=False)	Does a reversible array difference operation.
<i>populate_info</i> (info)	Given raw accumulated confusion counts, populated secondary measures like

### Attributes

<i>profile</i>	
----------------	--

kwcoco.metrics.confusion\_measures.**profile**

**class** kwcoco.metrics.confusion\_measures.**Measures**(*info*)  
 Bases: `ubelt.NiceRepr`, `kwcoco.metrics.util.DictProxy`

Holds accumulated confusion counts, and derived measures

### Example

```
>>> from kwcoco.metrics.confusion_vectors import BinaryConfusionVectors # NOQA
>>> binvecs = BinaryConfusionVectors.demo(n=100, p_error=0.5)
>>> self = binvecs.measures()
>>> print('self = {!r}'.format(self))
>>> # xdoctest: +REQUIRES(--show)
>>> import kwplot
>>> kwplot.autompl()
>>> self.draw(doclrf=True)
>>> self.draw(key='pr', pnum=(1, 2, 1))
>>> self.draw(key='roc', pnum=(1, 2, 2))
>>> kwplot.show_if_requested()
```

```
property catname(self)
__nice__(self)
reconstruct(self)
classmethod from_json(cls, state)
__json__(self)
```

### Example

```
>>> from kwcoco.metrics.confusion_vectors import BinaryConfusionVectors # NOQA
>>> from kwcoco.metrics.confusion_measures import * # NOQA
>>> binvecs = BinaryConfusionVectors.demo(n=10, p_error=0.5)
>>> self = binvecs.measures()
>>> info = self.__json__()
>>> print('info = {}'.format(ub.repr2(info, nl=1)))
>>> populate_info(info)
>>> print('info = {}'.format(ub.repr2(info, nl=1)))
>>> recon = Measures.from_json(info)
```

```
summary(self)
maximized_thresholds(self)
    Returns thresholds that maximize metrics.
counts(self)
draw(self, key=None, prefix="", **kw)
```

### Example

```
>>> # xdoctest: +REQUIRES(module:kwplot)
>>> # xdoctest: +REQUIRES(module:pandas)
>>> from kwcoco.metrics.confusion_vectors import ConfusionVectors # NOQA
>>> cfsn_vecs = ConfusionVectors.demo()
>>> ovr_cfsn = cfsn_vecs.binarize_ovr(keyby='name')
>>> self = ovr_cfsn.measures()['perclass']
>>> self.draw('mcc', doclf=True, fnum=1)
>>> self.draw('pr', doclf=1, fnum=2)
>>> self.draw('roc', doclf=1, fnum=3)
```

```
summary_plot(self, fnum=1, title="", subplots='auto')
```

## Example

```
>>> from kwcoco.metrics.confusion_measures import * # NOQA
>>> from kwcoco.metrics.confusion_vectors import ConfusionVectors # NOQA
>>> cfsn_vecs = ConfusionVectors.demo(n=3, p_error=0.5)
>>> binvecs = cfsn_vecs.binarize_classless()
>>> self = binvecs.measures()
>>> # xdoctest: +REQUIRES(--show)
>>> import kwplot
>>> kwplot.autompl()
>>> self.summary_plot()
>>> kwplot.show_if_requested()
```

**classmethod demo**(cls, \*\*kwargs)

Create a demo Measures object for testing / demos

**Parameters** **\*\*kwargs** – passed to BinaryConfusionVectors.demo(). some valid keys are:  
n, rng, p\_rue, p\_error, p\_miss.

**classmethod combine**(cls, tocombine, precision=None, growth=None, thresh\_bins=None)

Combine binary confusion metrics

**Parameters**

- **tocombine** (*List[Measures]*) – a list of measures to combine into one
- **precision** (*int | None*) – If specified rounds thresholds to this precision which can prevent a RAM explosion when combining a large number of measures. However, this is a lossy operation and will impact the underlying scores. NOTE: use **growth** instead.
- **growth** (*int | None*) – if specified this limits how much the resulting measures are allowed to grow by. If None, growth is unlimited. Otherwise, if growth is ‘max’, the growth is limited to the maximum length of an input. We might make this more numerical in the future.
- **thresh\_bins** (*int*) – Force this many threshold bins.

**Returns** Measures

## Example

```
>>> from kwcoco.metrics.confusion_measures import * # NOQA
>>> measures1 = Measures.demo(n=15)
>>> measures2 = measures1
>>> tocombine = [measures1, measures2]
>>> new_measures = Measures.combine(tocombine)
>>> new_measures.reconstruct()
>>> print('new_measures = {!r}'.format(new_measures))
>>> print('measures1 = {!r}'.format(measures1))
>>> print('measures2 = {!r}'.format(measures2))
>>> print(ub.repr2(measures1.__json__(), nl=1, sort=0))
>>> print(ub.repr2(measures2.__json__(), nl=1, sort=0))
>>> print(ub.repr2(new_measures.__json__(), nl=1, sort=0))
>>> # xdoctest: +REQUIRES(--show)
>>> import kwplot
```

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```

>>> kwplot.autompl()
>>> kwplot.figure(fnum=1)
>>> new_measures.summary_plot()
>>> measures1.summary_plot()
>>> measures1.draw('roc')
>>> measures2.draw('roc')
>>> new_measures.draw('roc')

```

### Example

```

>>> # Demonstrate issues that can arise from choosing a precision
>>> # that is too low when combining metrics. Breakpoints
>>> # between different metrics can get muddled, but choosing a
>>> # precision that is too high can overwhelm memory.
>>> from kwcoco.metrics.confusion_measures import * # NOQA
>>> base = ub.map_vals(np.asarray, {
>>>     'tp_count': [ 1, 1, 2, 2, 2, 2, 3],
>>>     'fp_count': [ 0, 1, 1, 2, 3, 4, 5],
>>>     'fn_count': [ 1, 1, 0, 0, 0, 0, 0],
>>>     'tn_count': [ 5, 4, 4, 3, 2, 1, 0],
>>>     'thresholds': [.0, .0, .0, .0, .0, .0, .0],
>>> })
>>> # Make tiny offsets to thresholds
>>> rng = kwarray.ensure_rng(0)
>>> n = len(base['thresholds'])
>>> offsets = [
>>>     sorted(rng.rand(n) * 10 ** -rng.randint(4, 7))[:-1]
>>>     for _ in range(20)
>>> ]
>>> tocombine = []
>>> for offset in offsets:
>>>     base_n = base.copy()
>>>     base_n['thresholds'] += offset
>>>     measures_n = Measures(base_n).reconstruct()
>>>     tocombine.append(measures_n)
>>> for precision in [6, 5, 2]:
>>>     combo = Measures.combine(tocombine, precision=precision).reconstruct()
>>>     print('precision = {!r}'.format(precision))
>>>     print('combo = {}'.format(ub.repr2(combo, nl=1)))
>>>     print('num_thresholds = {}'.format(len(combo['thresholds'])))
>>> for growth in [None, 'max', 'log', 'root', 'half']:
>>>     combo = Measures.combine(tocombine, growth=growth).reconstruct()
>>>     print('growth = {!r}'.format(growth))
>>>     print('combo = {}'.format(ub.repr2(combo, nl=1)))
>>>     print('num_thresholds = {}'.format(len(combo['thresholds'])))
>>>     #print(combo.counts().pandas())

```

### Example

```
>>> # Test case: combining a single measures should leave it unchanged
>>> from kwcoco.metrics.confusion_measures import * # NOQA
>>> measures = Measures.demo(n=40, p_true=0.2, p_error=0.4, p_miss=0.6)
>>> df1 = measures.counts().pandas().fillna(0)
>>> print(df1)
>>> tocombine = [measures]
>>> combo = Measures.combine(tocombine)
>>> df2 = combo.counts().pandas().fillna(0)
>>> print(df2)
>>> assert np.allclose(df1, df2)
```

```
>>> combo = Measures.combine(tocombine, thresh_bins=2)
>>> df3 = combo.counts().pandas().fillna(0)
>>> print(df3)
```

```
>>> # I am NOT sure if this is correct or not
>>> thresh_bins = 20
>>> combo = Measures.combine(tocombine, thresh_bins=thresh_bins)
>>> df4 = combo.counts().pandas().fillna(0)
>>> print(df4)
```

```
>>> combo = Measures.combine(tocombine, thresh_bins=np.linspace(0, 1, 20))
>>> df4 = combo.counts().pandas().fillna(0)
>>> print(df4)
```

```
assert np.allclose(combo['thresholds'], measures['thresholds']) assert np.allclose(combo['fp_count'],
measures['fp_count']) assert np.allclose(combo['tp_count'], measures['tp_count']) assert
np.allclose(combo['tp_count'], measures['tp_count'])
```

```
globals().update(xdev.get_func_kwargs(Measures.combine))
```

### Example

```
>>> # Test degenerate case
>>> from kwcoco.metrics.confusion_measures import * # NOQA
>>> tocombine = [
>>>     {'fn_count': [0.0], 'fp_count': [359980.0], 'thresholds': [0.0], 'tn_
↳count': [0.0], 'tp_count': [7747.0]},
>>>     {'fn_count': [0.0], 'fp_count': [360849.0], 'thresholds': [0.0], 'tn_
↳count': [0.0], 'tp_count': [424.0]},
>>>     {'fn_count': [0.0], 'fp_count': [367003.0], 'thresholds': [0.0], 'tn_
↳count': [0.0], 'tp_count': [991.0]},
>>>     {'fn_count': [0.0], 'fp_count': [367976.0], 'thresholds': [0.0], 'tn_
↳count': [0.0], 'tp_count': [1017.0]},
>>>     {'fn_count': [0.0], 'fp_count': [676338.0], 'thresholds': [0.0], 'tn_
↳count': [0.0], 'tp_count': [7067.0]},
>>>     {'fn_count': [0.0], 'fp_count': [676348.0], 'thresholds': [0.0], 'tn_
↳count': [0.0], 'tp_count': [7406.0]},
>>>     {'fn_count': [0.0], 'fp_count': [676626.0], 'thresholds': [0.0], 'tn_
↳count': [0.0], 'tp_count': [7858.0]},
```

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```

>>> {'fn_count': [0.0], 'fp_count': [676693.0], 'thresholds': [0.0], 'tn_
↳count': [0.0], 'tp_count': [10969.0]},
>>> {'fn_count': [0.0], 'fp_count': [677269.0], 'thresholds': [0.0], 'tn_
↳count': [0.0], 'tp_count': [11188.0]},
>>> {'fn_count': [0.0], 'fp_count': [677331.0], 'thresholds': [0.0], 'tn_
↳count': [0.0], 'tp_count': [11734.0]},
>>> {'fn_count': [0.0], 'fp_count': [677395.0], 'thresholds': [0.0], 'tn_
↳count': [0.0], 'tp_count': [11556.0]},
>>> {'fn_count': [0.0], 'fp_count': [677418.0], 'thresholds': [0.0], 'tn_
↳count': [0.0], 'tp_count': [11621.0]},
>>> {'fn_count': [0.0], 'fp_count': [677422.0], 'thresholds': [0.0], 'tn_
↳count': [0.0], 'tp_count': [11424.0]},
>>> {'fn_count': [0.0], 'fp_count': [677648.0], 'thresholds': [0.0], 'tn_
↳count': [0.0], 'tp_count': [9804.0]},
>>> {'fn_count': [0.0], 'fp_count': [677826.0], 'thresholds': [0.0], 'tn_
↳count': [0.0], 'tp_count': [2470.0]},
>>> {'fn_count': [0.0], 'fp_count': [677834.0], 'thresholds': [0.0], 'tn_
↳count': [0.0], 'tp_count': [2470.0]},
>>> {'fn_count': [0.0], 'fp_count': [677835.0], 'thresholds': [0.0], 'tn_
↳count': [0.0], 'tp_count': [2470.0]},
>>> {'fn_count': [11123.0, 0.0], 'fp_count': [0.0, 676754.0], 'thresholds': 0.0,
↳[0.0002442002442002442, 0.0], 'tn_count': [676754.0, 0.0], 'tp_count': [2.0, 0.0],
↳11125.0]},
>>> {'fn_count': [7738.0, 0.0], 'fp_count': [0.0, 676466.0], 'thresholds': 0.0,
↳[0.0002442002442002442, 0.0], 'tn_count': [676466.0, 0.0], 'tp_count': [0.0, 0.0],
↳7738.0]},
>>> {'fn_count': [8653.0, 0.0], 'fp_count': [0.0, 676341.0], 'thresholds': 0.0,
↳[0.0002442002442002442, 0.0], 'tn_count': [676341.0, 0.0], 'tp_count': [0.0, 0.0],
↳8653.0]},
>>> ]
>>> thresh_bins = np.linspace(0, 1, 4)
>>> combo = Measures.combine(tocombine, thresh_bins=thresh_bins).reconstruct()
>>> print('tocombine = {}'.format(ub.repr2(tocombine, nl=2)))
>>> print('thresh_bins = {!r}'.format(thresh_bins))
>>> print(ub.repr2(combo.__json__(), nl=1))
>>> for thresh_bins in [4096, 1]:
>>>     combo = Measures.combine(tocombine, thresh_bins=thresh_bins).reconstruct()
>>>     print('thresh_bins = {!r}'.format(thresh_bins))
>>>     print('combo = {}'.format(ub.repr2(combo, nl=1)))
>>>     print('num_thresholds = {}'.format(len(combo['thresholds'])))
>>> for precision in [6, 5, 2]:
>>>     combo = Measures.combine(tocombine, precision=precision).reconstruct()
>>>     print('precision = {!r}'.format(precision))
>>>     print('combo = {}'.format(ub.repr2(combo, nl=1)))
>>>     print('num_thresholds = {}'.format(len(combo['thresholds'])))
>>> for growth in [None, 'max', 'log', 'root', 'half']:
>>>     combo = Measures.combine(tocombine, growth=growth).reconstruct()
>>>     print('growth = {!r}'.format(growth))
>>>     print('combo = {}'.format(ub.repr2(combo, nl=1)))
>>>     print('num_thresholds = {}'.format(len(combo['thresholds'])))

```



`kwcoco.metrics.confusion_measures._combine_threshold(tocombine_thresh, thresh_bins, growth, precision)`

Logic to take care of combining thresholds in the case bins are not given

This can be fairly slow and lead to unnecessary memory usage

`kwcoco.metrics.confusion_measures.reversible_diff(arr, assume_sorted=1, reverse=False)`

Does a reversible array difference operation.

This will be used to find positions where accumulation happened in confusion count array.

**class** `kwcoco.metrics.confusion_measures.PerClass_Measures(cx_to_info)`

Bases: `ubelt.NiceRepr`, `kwcoco.metrics.util.DictProxy`

`__nice__`(*self*)

`summary`(*self*)

`classmethod from_json`(*cls, state*)

`__json__`(*self*)

`draw`(*self, key='mcc', prefix='', \*\*kw*)

### Example

```
>>> # xdoctest: +REQUIRES(module:kwplot)
>>> from kwcoco.metrics.confusion_vectors import ConfusionVectors # NOQA
>>> cfsn_vecs = ConfusionVectors.demo()
>>> ovr_cfsn = cfsn_vecs.binarize_ovr(keyby='name')
>>> self = ovr_cfsn.measures()['perclass']
>>> self.draw('mcc', doclf=True, fnum=1)
>>> self.draw('pr', doclf=1, fnum=2)
>>> self.draw('roc', doclf=1, fnum=3)
```

`draw_roc`(*self, prefix='', \*\*kw*)

`draw_pr`(*self, prefix='', \*\*kw*)

`summary_plot`(*self, fnum=1, title='', subplots='auto'*)

### CommandLine

```
python ~/code/kwcoco/kwcoco/metrics/confusion_measures.py PerClass_Measures.
  summary_plot --show
```

### Example

```

>>> from kwcoco.metrics.confusion_measures import * # NOQA
>>> from kwcoco.metrics.detect_metrics import DetectionMetrics
>>> dmet = DetectionMetrics.demo(
>>>     n_fp=(0, 1), n_fn=(0, 3), nimgs=32, nboxes=(0, 32),
>>>     classes=3, rng=0, newstyle=1, box_noise=0.7, cls_noise=0.2, score_
↳ noise=0.3, with_probs=False)
>>> cfsn_vecs = dmet.confusion_vectors()
>>> ovr_cfsn = cfsn_vecs.binarize_ovr(keyby='name', ignore_classes=['vector',
↳ 'raster'])
>>> self = ovr_cfsn.measures()['perclass']
>>> # xdoctest: +REQUIRES(--show)
>>> import kwplot
>>> kwplot.autompl()
>>> import seaborn as sns
>>> sns.set()
>>> self.summary_plot(title='demo summary_plot ovr', subplots=['pr', 'roc'])
>>> kwplot.show_if_requested()
>>> self.summary_plot(title='demo summary_plot ovr', subplots=['mcc', 'acc'],
↳ fnum=2)

```

```

class kwcoco.metrics.confusion_measures.MeasureCombiner(precision=None, growth=None,
                                                         thresh_bins=None)

```

Helper to iteratively combine binary measures generated by some process

### Example

```

>>> from kwcoco.metrics.confusion_measures import * # NOQA
>>> from kwcoco.metrics.confusion_vectors import BinaryConfusionVectors
>>> rng = kwarrray.ensure_rng(0)
>>> bin_combiner = MeasureCombiner(growth='max')
>>> for _ in range(80):
>>>     bin_cfsn_vecs = BinaryConfusionVectors.demo(n=rng.randint(40, 50), rng=rng,
↳ p_true=0.2, p_error=0.4, p_miss=0.6)
>>>     bin_measures = bin_cfsn_vecs.measures()
>>>     bin_combiner.submit(bin_measures)
>>> combined = bin_combiner.finalize()
>>> print('combined = {!r}'.format(combined))

```

```
property queue_size(self)
```

```
submit(self, other)
```

```
combine(self)
```

```
finalize(self)
```

```

class kwcoco.metrics.confusion_measures.OneVersusRestMeasureCombiner(precision=None,
                                                                        growth=None,
                                                                        thresh_bins=None)

```

Helper to iteratively combine ovr measures generated by some process

## Example

```
>>> from kwcoco.metrics.confusion_measures import * # NOQA
>>> from kwcoco.metrics.confusion_vectors import OneVsRestConfusionVectors
>>> rng = kwarrray.ensure_rng(0)
>>> ovr_combiner = OneVersusRestMeasureCombiner(growth='max')
>>> for _ in range(80):
>>>     ovr_cfsn_vecs = OneVsRestConfusionVectors.demo()
>>>     ovr_measures = ovr_cfsn_vecs.measures()
>>>     ovr_combiner.submit(ovr_measures)
>>> combined = ovr_combiner.finalize()
>>> print('combined = {!r}'.format(combined))
```

**submit**(*self*, *other*)

**\_summary**(*self*)

**combine**(*self*)

**finalize**(*self*)

kwcoco.metrics.confusion\_measures.**populate\_info**(*info*)

Given raw accumulated confusion counts, populated secondary measures like AP, AUC, F1, MCC, etc..

## kwcoco.metrics.confusion\_vectors

Classes that store raw confusion vectors, which can be accumulated into confusion measures.

## Module Contents

### Classes

<i>ConfusionVectors</i>	Stores information used to construct a confusion matrix. This includes
<i>OneVsRestConfusionVectors</i>	Container for multiple one-vs-rest binary confusion vectors
<i>BinaryConfusionVectors</i>	Stores information about a binary classification problem.

### Functions

<i>_stabilize_data</i> ( <i>y_true</i> , <i>y_score</i> , <i>sample_weight</i> , <i>npad</i> =7)	Adds ideally calibrated dummy values to curves with few positive examples.
--	--

## Attributes

*profile*

kwcoco.metrics.confusion\_vectors.**profile**

**class** kwcoco.metrics.confusion\_vectors.**ConfusionVectors**(cfsn\_vecs, data, classes, probs=None)

Bases: `ubelt.NiceRepr`

Stores information used to construct a confusion matrix. This includes corresponding vectors of predicted labels, true labels, sample weights, etc...

### Variables

- **data** (`kwarrray.DataFrameArray`) – should at least have keys true, pred, weight
- **classes** (`Sequence` | `CategoryTree`) – list of category names or category graph
- **probs** (`ndarray`, *optional*) – probabilities for each class

### Example

```
>>> # xdoctest: IGNORE_WANT
>>> # xdoctest: +REQUIRES(module:pandas)
>>> from kwcoco.metrics import DetectionMetrics
>>> dmet = DetectionMetrics.demo(
>>>     nimgs=10, nboxes=(0, 10), n_fp=(0, 1), classes=3)
>>> cfsn_vecs = dmet.confusion_vectors()
>>> print(cfsn_vecs.data._pandas())
```

	pred	true	score	weight	iou	txs	pxs	gid
0	2	2	10.0000	1.0000	1.0000	0	4	0
1	2	2	7.5025	1.0000	1.0000	1	3	0
2	1	1	5.0050	1.0000	1.0000	2	2	0
3	3	-1	2.5075	1.0000	-1.0000	-1	1	0
4	2	-1	0.0100	1.0000	-1.0000	-1	0	0
5	-1	2	0.0000	1.0000	-1.0000	3	-1	0
6	-1	2	0.0000	1.0000	-1.0000	4	-1	0
7	2	2	10.0000	1.0000	1.0000	0	5	1
8	2	2	8.0020	1.0000	1.0000	1	4	1
9	1	1	6.0040	1.0000	1.0000	2	3	1
..	...	...	...	...	...	...	...	...
62	-1	2	0.0000	1.0000	-1.0000	7	-1	7
63	-1	3	0.0000	1.0000	-1.0000	8	-1	7
64	-1	1	0.0000	1.0000	-1.0000	9	-1	7
65	1	-1	10.0000	1.0000	-1.0000	-1	0	8
66	1	1	0.0100	1.0000	1.0000	0	1	8
67	3	-1	10.0000	1.0000	-1.0000	-1	3	9
68	2	2	6.6700	1.0000	1.0000	0	2	9
69	2	2	3.3400	1.0000	1.0000	1	1	9
70	3	-1	0.0100	1.0000	-1.0000	-1	0	9
71	-1	2	0.0000	1.0000	-1.0000	2	-1	9

```

>>> # xdoctest: +REQUIRES(--show)
>>> # xdoctest: +REQUIRES(module:pandas)
>>> import kwplot
>>> kwplot.autompl()
>>> from kwcoco.metrics.confusion_vectors import ConfusionVectors
>>> cfsn_vecs = ConfusionVectors.demo(
>>>     nimgs=128, nboxes=(0, 10), n_fp=(0, 3), n_fn=(0, 3), classes=3)
>>> cx_to_binvecs = cfsn_vecs.binarize_ovr()
>>> measures = cx_to_binvecs.measures()['perclass']
>>> print('measures = {!r}'.format(measures))
measures = <PerClass_Measures({
    'cat_1': <Measures({'ap': 0.227, 'auc': 0.507, 'catname': cat_1, 'max_f1': f1=0.
→45@0.47, 'nsupport': 788.000})>,
    'cat_2': <Measures({'ap': 0.288, 'auc': 0.572, 'catname': cat_2, 'max_f1': f1=0.
→51@0.43, 'nsupport': 788.000})>,
    'cat_3': <Measures({'ap': 0.225, 'auc': 0.484, 'catname': cat_3, 'max_f1': f1=0.
→46@0.40, 'nsupport': 788.000})>,
}) at 0x7facf77bdfd0>
>>> kwplot.figure(fnum=1, doclf=True)
>>> measures.draw(key='pr', fnum=1, pnum=(1, 3, 1))
>>> measures.draw(key='roc', fnum=1, pnum=(1, 3, 2))
>>> measures.draw(key='mcc', fnum=1, pnum=(1, 3, 3))
...

```

`__nice__`(*cfsn\_vecs*)

`__json__`(*self*)

Serialize to json

### Example

```

>>> # xdoctest: +REQUIRES(module:pandas)
>>> from kwcoco.metrics import ConfusionVectors
>>> self = ConfusionVectors.demo(n_imgs=1, classes=2, n_fp=0, nboxes=1)
>>> state = self.__json__()
>>> print('state = {}'.format(ub.repr2(state, nl=2, precision=2, align=1)))
>>> recon = ConfusionVectors.from_json(state)

```

**classmethod** `from_json`(*cls*, *state*)

**classmethod** `demo`(*cfsn\_vecs*, *\*\*kw*)

**Parameters** *\*\*kwargs* – See [kwcoco.metrics.DetectionMetrics.demo\(\)](#)

**Returns** `ConfusionVectors`

### Example

```
>>> cfsn_vecs = ConfusionVectors.demo()
>>> print('cfsn_vecs = {!r}'.format(cfsn_vecs))
>>> cx_to_binvecs = cfsn_vecs.binarize_ovr()
>>> print('cx_to_binvecs = {!r}'.format(cx_to_binvecs))
```

**classmethod** `from_arrays`(*ConfusionVectors*, *true*, *pred=None*, *score=None*, *weight=None*, *probs=None*, *classes=None*)

Construct confusion vector data structure from component arrays

### Example

```
>>> # xdoctest: +REQUIRES(module:pandas)
>>> import karray
>>> classes = ['person', 'vehicle', 'object']
>>> rng = karray.ensure_rng(0)
>>> true = (rng.rand(10) * len(classes)).astype(int)
>>> probs = rng.rand(len(true), len(classes))
>>> cfsn_vecs = ConfusionVectors.from_arrays(true=true, probs=probs,
↳ classes=classes)
>>> cfsn_vecs.confusion_matrix()
pred    person  vehicle  object
real
person      0         0         0
vehicle      2         4         1
object       2         1         0
```

**confusion\_matrix**(*cfsn\_vecs*, *compress=False*)

Builds a confusion matrix from the confusion vectors.

**Parameters** `compress` (*bool*, *default=False*) – if True removes rows / columns with no entries

**Returns**

**cm** [the labeled confusion matrix]

(**Note:** we should write a efficient replacement for this use case. #remove\_pandas)

**Return type** `pd.DataFrame`

### CommandLine

```
xdoctest -m kwcoco.metrics.confusion_vectors ConfusionVectors.confusion_matrix
```

### Example

```

>>> # xdoctest: +REQUIRES(module:pandas)
>>> from kwcoco.metrics import DetectionMetrics
>>> dmet = DetectionMetrics.demo(
>>>     nimgs=10, nboxes=(0, 10), n_fp=(0, 1), n_fn=(0, 1), classes=3, cls_
↳noise=.2)
>>> cfsn_vecs = dmet.confusion_vectors()
>>> cm = cfsn_vecs.confusion_matrix()
...
>>> print(cm.to_string(float_format=lambda x: '%.2f' % x))
pred      background  cat_1  cat_2  cat_3
real
background      0.00   1.00   2.00   3.00
cat_1            3.00  12.00   0.00   0.00
cat_2            3.00   0.00  14.00   0.00
cat_3            2.00   0.00   0.00  17.00

```

**coarsen**(*cfsn\_vecs*, *cxs*)

Creates a coarsened set of vectors

**Returns** ConfusionVectors

**binarize\_classless**(*cfsn\_vecs*, *negative\_classes=None*)

Creates a binary representation useful for measuring the performance of detectors. It is assumed that scores of “positive” classes should be high and “negative” classes should be low.

**Parameters** **negative\_classes** (*List[str | int]*) – list of negative class names or idxs, by default chooses any class with a true class index of -1. These classes should ideally have low scores.

**Returns** BinaryConfusionVectors

---

**Note:** The “classlessness” of this depends on the `compat=“all”` argument being used when constructing confusion vectors, otherwise it becomes something like a macro-average because the class information was used in deciding which true and predicted boxes were allowed to match.

---

### Example

```

>>> from kwcoco.metrics import DetectionMetrics
>>> dmet = DetectionMetrics.demo(
>>>     nimgs=10, nboxes=(0, 10), n_fp=(0, 1), n_fn=(0, 1), classes=3)
>>> cfsn_vecs = dmet.confusion_vectors()
>>> class_idxes = list(dmet.classes.node_to_idx.values())
>>> binvecs = cfsn_vecs.binarize_classless()

```

**binarize\_ovr**(*cfsn\_vecs*, *mode=1*, *keyby='name'*, *ignore\_classes={'ignore'}*, *approx=0*)

Transforms *cfsn\_vecs* into one-vs-rest BinaryConfusionVectors for each category.

**Parameters**

- **mode** (*int*, *default=1*) – 0 for heirarchy aware or 1 for voc like. MODE 0 IS PROBABLY BROKEN
- **keyby** (*int | str*) – can be cx or name

- **ignore\_classes** (*Set[str]*) – category names to ignore
- **approx** (*bool, default=0*) – if True try and approximate missing scores otherwise assume they are irrecoverable and use -inf

**Returns**

**which behaves like** Dict[int, BinaryConfusionVectors]: cx\_to\_binvecs

**Return type** *OneVsRestConfusionVectors*

**Example**

```
>>> from kwcoco.metrics.confusion_vectors import * # NOQA
>>> cfsn_vecs = ConfusionVectors.demo()
>>> print('cfsn_vecs = {!r}'.format(cfsn_vecs))
>>> catname_to_binvecs = cfsn_vecs.binarize_ovr(keyby='name')
>>> print('catname_to_binvecs = {!r}'.format(catname_to_binvecs))
```

cfsn\_vecs.data.pandas() catname\_to\_binvecs.cx\_to\_binvecs['class\_1'].data.pandas()

---

**Note:**

---

**classification\_report**(*cfsn\_vecs, verbose=0*)

Build a classification report with various metrics.

**Example**

```
>>> # xdoctest: +REQUIRES(module:pandas)
>>> from kwcoco.metrics.confusion_vectors import * # NOQA
>>> cfsn_vecs = ConfusionVectors.demo()
>>> report = cfsn_vecs.classification_report(verbose=1)
```

**class** kwcoco.metrics.confusion\_vectors.**OneVsRestConfusionVectors**(*cx\_to\_binvecs, classes*)

Bases: *ubelt.NiceRepr*

Container for multiple one-vs-rest binary confusion vectors

**Variables**

- **cx\_to\_binvecs** –
- **classes** –

**Example**

```
>>> from kwcoco.metrics import DetectionMetrics
>>> dmet = DetectionMetrics.demo(
>>>     nimgs=10, nboxes=(0, 10), n_fp=(0, 1), classes=3)
>>> cfsn_vecs = dmet.confusion_vectors()
>>> self = cfsn_vecs.binarize_ovr(keyby='name')
>>> print('self = {!r}'.format(self))
```



`__nice__(self)`

**classmethod** `demo(cls)`

**Parameters** `**kwargs` – See [kwcoco.metrics.DetectionMetrics.demo\(\)](#)

**Returns** `ConfusionVectors`

**keys**(`self`)

`__getitem__(self, cx)`

**measures**(`self, stabilize_thresh=7, fp_cutoff=None, monotonic_ppv=True, ap_method='pycocotools'`)

Creates binary confusion measures for every one-versus-rest category.

**Parameters**

- **stabilize\_thresh** (*int, default=7*) – if fewer than this many data points inserts dummy stabilization data so curves can still be drawn.
- **fp\_cutoff** (*int, default=None*) – maximum number of false positives in the truncated roc curves. None is equivalent to `float('inf')`
- **monotonic\_ppv** (*bool, default=True*) – if True ensures that precision is always increasing as recall decreases. This is done in pycocotools scoring, but I'm not sure its a good idea.

**SeeAlso:** [BinaryConfusionVectors.measures\(\)](#)

### Example

```
>>> self = OneVsRestConfusionVectors.demo()
>>> thresh_result = self.measures()['perclass']
```

**abstract** `ovr_classification_report(self)`

**class** `kwcoco.metrics.confusion_vectors.BinaryConfusionVectors(data, cx=None, classes=None)`

Bases: `ubelt.NiceRepr`

Stores information about a binary classification problem. This is always with respect to a specific class, which is given by `cx` and `classes`.

**The data DataFrameArray must contain** `is_true` - if the row is an instance of class `classes[cx]` `pred_score` - the predicted probability of class `classes[cx]`, and `weight` - sample weight of the example

### Example

```
>>> from kwcoco.metrics.confusion_vectors import * # NOQA
>>> self = BinaryConfusionVectors.demo(n=10)
>>> print('self = {!r}'.format(self))
>>> print('measures = {}'.format(ub.repr2(self.measures())))
```

```
>>> self = BinaryConfusionVectors.demo(n=0)
>>> print('measures = {}'.format(ub.repr2(self.measures())))
```

```
>>> self = BinaryConfusionVectors.demo(n=1)
>>> print('measures = {}'.format(ub.repr2(self.measures())))
```

```
>>> self = BinaryConfusionVectors.demo(n=2)
>>> print('measures = {}'.format(ub.repr2(self.measures())))
```

**classmethod demo**(cls, n=10, p\_true=0.5, p\_error=0.2, p\_miss=0.0, rng=None)

Create random data for tests

#### Parameters

- **n** (int) – number of rows
- **p\_true** (int) – fraction of real positive cases
- **p\_error** (int) – probability of making a recoverable mistake
- **p\_miss** (int) – probability of making an unrecoverable mistake
- **rng** (int | RandomState) – random seed / state

**Returns** BinaryConfusionVectors

#### Example

```
>>> from kwcoco.metrics.confusion_vectors import * # NOQA
>>> cfsn = BinaryConfusionVectors.demo(n=1000, p_error=0.1, p_miss=0.1)
>>> measures = cfsn.measures()
>>> print('measures = {}'.format(ub.repr2(measures, nl=1)))
>>> # xdoctest: +REQUIRES(--show)
>>> import kwplot
>>> kwplot.autompl()
>>> kwplot.figure(fnum=1, pnum=(1, 2, 1))
>>> measures.draw('pr')
>>> kwplot.figure(fnum=1, pnum=(1, 2, 2))
>>> measures.draw('roc')
```

**property catname**(self)

**\_\_nice\_\_**(self)

**\_\_len\_\_**(self)

**measures**(self, stabilize\_thresh=7, fp\_cutoff=None, monotonic\_ppv=True, ap\_method='pycocotools')

Get statistics (F1, G1, MCC) versus thresholds

#### Parameters

- **stabilize\_thresh** (int, default=7) – if fewer than this many data points inserts dummy stabilization data so curves can still be drawn.
- **fp\_cutoff** (int, default=None) – maximum number of false positives in the truncated roc curves. None is equivalent to float('inf')
- **monotonic\_ppv** (bool, default=True) – if True ensures that precision is always increasing as recall decreases. This is done in pycocotools scoring, but I'm not sure its a good idea.

## Example

```
>>> from kwcoco.metrics.confusion_vectors import * # NOQA
>>> self = BinaryConfusionVectors.demo(n=0)
>>> print('measures = {}'.format(ub.repr2(self.measures())))
>>> self = BinaryConfusionVectors.demo(n=1, p_true=0.5, p_error=0.5)
>>> print('measures = {}'.format(ub.repr2(self.measures())))
>>> self = BinaryConfusionVectors.demo(n=3, p_true=0.5, p_error=0.5)
>>> print('measures = {}'.format(ub.repr2(self.measures())))
```

```
>>> self = BinaryConfusionVectors.demo(n=100, p_true=0.5, p_error=0.5, p_miss=0.
↳ 3)
>>> print('measures = {}'.format(ub.repr2(self.measures())))
>>> print('measures = {}'.format(ub.repr2(ub.odict(self.measures()))))
```

## References

[https://en.wikipedia.org/wiki/Confusion\\_matrix](https://en.wikipedia.org/wiki/Confusion_matrix) [https://en.wikipedia.org/wiki/Precision\\_and\\_recall](https://en.wikipedia.org/wiki/Precision_and_recall) [https://en.wikipedia.org/wiki/Matthews\\_correlation\\_coefficient](https://en.wikipedia.org/wiki/Matthews_correlation_coefficient)

**\_binary\_clf\_curves**(*self*, *stabalize\_thresh*=7, *fp\_cutoff*=None)

Compute TP, FP, TN, and FN counts for this binary confusion vector.

Code common to ROC, PR, and threshold measures, computes the elements of the binary confusion matrix at all relevant operating point thresholds.

### Parameters

- **stabalize\_thresh** (*int*) – if fewer than this many data points insert stabalization data.
- **fp\_cutoff** (*int*) – maximum number of false positives

## Example

```
>>> from kwcoco.metrics.confusion_vectors import * # NOQA
>>> self = BinaryConfusionVectors.demo(n=1, p_true=0.5, p_error=0.5)
>>> self._binary_clf_curves()
```

```
>>> self = BinaryConfusionVectors.demo(n=0, p_true=0.5, p_error=0.5)
>>> self._binary_clf_curves()
```

```
>>> self = BinaryConfusionVectors.demo(n=100, p_true=0.5, p_error=0.5)
>>> self._binary_clf_curves()
```

**draw\_distribution**(*self*)

**\_3dplot**(*self*)

### Example

```
>>> # xdoctest: +REQUIRES(module:kwplot)
>>> # xdoctest: +REQUIRES(module:pandas)
>>> from kwcoco.metrics.confusion_vectors import * # NOQA
>>> from kwcoco.metrics.detect_metrics import DetectionMetrics
>>> dmet = DetectionMetrics.demo(
>>>     n_fp=(0, 1), n_fn=(0, 2), nimgs=256, nboxes=(0, 10),
>>>     bbox_noise=10,
>>>     classes=1)
>>> cfsn_vecs = dmet.confusion_vectors()
>>> self = bin_cfsn = cfsn_vecs.binarize_classless()
>>> #dmet.summarize(plot=True)
>>> import kwplot
>>> kwplot.autompl()
>>> kwplot.figure(fnum=3)
>>> self._3dplot()
```

`kwcoco.metrics.confusion_vectors._stabalize_data(y_true, y_score, sample_weight, npad=7)`

Adds ideally calibrated dummy values to curves with few positive examples. This acts somewhat like a Bayesian prior and smooths out the curve.

### Example

```
y_score = np.array([0.5, 0.6]) y_true = np.array([1, 1]) sample_weight = np.array([1, 1]) npad = 7
_stabalize_data(y_true, y_score, sample_weight, npad=npad)
```

`kwcoco.metrics.detect_metrics`

## Module Contents

### Classes

---

<i>DetectionMetrics</i>	Object that computes associations between detections and can convert them
-------------------------	---

---

## Functions

---

`_demo_construct_probs(pred_cxs, pred_scores, classes, rng, hacked=1)` Constructs random probabilities for demo data

---

`pycocotools_confusion_vectors(dmet, evaler, iou_thresh=0.5, verbose=0)`

---

### Example

---

`eval_detections_cli(**kw)` DEPRECATED USE *kwcoco eval* instead

---

`_summarize(self, ap=1, iouThr=None, areaRngLbl='all', maxDets=100)`

---

`pct_summarize2(self)`

---

**class** `kwcoco.metrics.detect_metrics.DetectionMetrics(dmet, classes=None)`

Bases: `ubelt.NiceRepr`

Object that computes associations between detections and can convert them into sklearn-compatible representations for scoring.

### Variables

- **gid\_to\_true\_dets** (*Dict*) – maps image ids to truth
- **gid\_to\_pred\_dets** (*Dict*) – maps image ids to predictions
- **classes** (*CategoryTree*) – category coder

### Example

```
>>> dmet = DetectionMetrics.demo(
>>>     nimgs=100, nboxes=(0, 3), n_fp=(0, 1), classes=8, score_noise=0.9,
>>>     hacked=False)
>>> print(dmet.score_kwcoco(bias=0, compat='mutex', prioritize='iou')['mAP'])
...
>>> # NOTE: IN GENERAL NETHARN AND VOC ARE NOT THE SAME
>>> print(dmet.score_voc(bias=0)['mAP'])
0.8582...
>>> #print(dmet.score_coco()['mAP'])
```

**score\_coco**

**clear**(*dmet*)

**\_\_nice\_\_**(*dmet*)

**classmethod from\_coco**(*DetectionMetrics, true\_coco, pred\_coco, gids=None, verbose=0*)

Create detection metrics from two coco files representing the truth and predictions.

### Parameters

- **true\_coco** (*kwcoco.CocoDataset*)
- **pred\_coco** (*kwcoco.CocoDataset*)

### Example

```
>>> import kwcoco
>>> from kwcoco.demo.perterb import perterb_coco
>>> true_coco = kwcoco.CocoDataset.demo('shapes')
>>> perterbkw = dict(box_noise=0.5, cls_noise=0.5, score_noise=0.5)
>>> pred_coco = perterb_coco(true_coco, **perterbkw)
>>> self = DetectionMetrics.from_coco(true_coco, pred_coco)
>>> self.score_voc()
```

**\_register\_imagename**(*dmet, imgname, gid=None*)

**add\_predictions**(*dmet, pred\_dets, imgname=None, gid=None*)

Register/Add predicted detections for an image

#### Parameters

- **pred\_dets** (*Detections*) – predicted detections
- **imgname** (*str*) – a unique string to identify the image
- **gid** (*int, optional*) – the integer image id if known

**add\_truth**(*dmet, true\_dets, imgname=None, gid=None*)

Register/Add groundtruth detections for an image

#### Parameters

- **true\_dets** (*Detections*) – groundtruth
- **imgname** (*str*) – a unique string to identify the image
- **gid** (*int, optional*) – the integer image id if known

**true\_detections**(*dmet, gid*)

gets Detections representation for groundtruth in an image

**pred\_detections**(*dmet, gid*)

gets Detections representation for predictions in an image

**confusion\_vectors**(*dmet, iou\_thresh=0.5, bias=0, gids=None, compat='mutex', prioritize='iou', ignore\_classes='ignore', background\_class=ub.NoParam, verbose='auto', workers=0, track\_probs='try', max\_dets=None*)

Assigns predicted boxes to the true boxes so we can transform the detection problem into a classification problem for scoring.

#### Parameters

- **iou\_thresh** (*float | List[float], default=0.5*) – bounding box overlap iou threshold required for assignment if a list, then return type is a dict
- **bias** (*float, default=0.0*) – for computing bounding box overlap, either 1 or 0
- **gids** (*List[int], default=None*) – which subset of images ids to compute confusion metrics on. If not specified all images are used.
- **compat** (*str, default='all'*) – can be ('ancestors' | 'mutex' | 'all'). determines which pred boxes are allowed to match which true boxes. If 'mutex', then pred boxes can only match true boxes of the same class. If 'ancestors', then pred boxes can match true boxes that match or have a coarser label. If 'all', then any pred can match any true, regardless of its category label.

- **prioritize** (*str*, *default='iou'*) – can be ('iou' | 'class' | 'correct') determines which box to assign to if mutiple true boxes overlap a predicted box. if prioritize is iou, then the true box with maximum iou (above iou\_thresh) will be chosen. If prioritize is class, then it will prefer matching a compatible class above a higher iou. If prioritize is correct, then ancestors of the true class are preferred over descendents of the true class, over unreleated classes.
- **ignore\_classes** (*set*, *default={'ignore'}*) – class names indicating ignore regions
- **background\_class** (*str*, *default=ub.NoParam*) – Name of the background class. If unspecified we try to determine it with heuristics. A value of None means there is no background class.
- **verbose** (*int*, *default='auto'*) – verbosity flag. In auto mode, verbose=1 if len(gids) > 1000.
- **workers** (*int*, *default=0*) – number of parallel assignment processes
- **track\_probs** (*str*, *default='try'*) – can be 'try', 'force', or False. if truthy, we assume probabilities for multiple classes are available.

**Returns** ConfusionVectors | Dict[float, ConfusionVectors]

### Example

```
>>> dmet = DetectionMetrics.demo(nimgs=30, classes=3,
>>>                               nboxes=10, n_fp=3, box_noise=10,
>>>                               with_probs=False)
>>> iou_to_cfsn = dmet.confusion_vectors(iou_thresh=[0.3, 0.5, 0.9])
>>> for t, cfsn in iou_to_cfsn.items():
>>>     print('t = {!r}'.format(t))
...     print(cfsn.binarize_ovr().measures())
...     print(cfsn.binarize_classless().measures())
```

**score\_kwant** (*dmet*, *iou\_thresh=0.5*)

Scores the detections using kwant

**score\_kwcoco** (*dmet*, *iou\_thresh=0.5*, *bias=0*, *gids=None*, *compat='all'*, *prioritize='iou'*)

our scoring method

**score\_voc** (*dmet*, *iou\_thresh=0.5*, *bias=1*, *method='voc2012'*, *gids=None*, *ignore\_classes='ignore'*)

score using voc method

### Example

```
>>> dmet = DetectionMetrics.demo(
>>>     nimgs=100, nboxes=(0, 3), n_fp=(0, 1), classes=8,
>>>     score_noise=.5)
>>> print(dmet.score_voc()['mAP'])
0.9399...
```

**\_to\_coco** (*dmet*)

Convert to a coco representation of truth and predictions

with inverse aid mappings

**score\_pycocotools**(*dmet*, *with\_evaler=False*, *with\_confusion=False*, *verbose=0*, *iou\_thresholds=None*)

score using ms-coco method

**Returns** dictionary with pct info

**Return type** Dict

### Example

```
>>> # xdoctest: +REQUIRES(module:pycocotools)
>>> from kwcoco.metrics.detect_metrics import *
>>> dmet = DetectionMetrics.demo(
>>>     nimgs=10, nboxes=(0, 3), n_fn=(0, 1), n_fp=(0, 1), classes=8, with_
↪probs=False)
>>> pct_info = dmet.score_pycocotools(verbose=1,
>>>                                     with_evaler=True,
>>>                                     with_confusion=True,
>>>                                     iou_thresholds=[0.5, 0.9])
>>> evaler = pct_info['evaler']
>>> iou_to_cfsn_vecs = pct_info['iou_to_cfsn_vecs']
>>> for iou_thresh in iou_to_cfsn_vecs.keys():
>>>     print('iou_thresh = {!r}'.format(iou_thresh))
>>>     cfsn_vecs = iou_to_cfsn_vecs[iou_thresh]
>>>     ovr_measures = cfsn_vecs.binarize_ovr().measures()
>>>     print('ovr_measures = {}'.format(ub.repr2(ovr_measures, nl=1,
↪precision=4)))
```

---

**Note:** by default pycocotools computes average precision as the literal average of computed precisions at 101 uniformly spaced recall thresholds.

pycocotools seems to only allow predictions with the same category as the truth to match those truth objects. This should be the same as calling `dmet.confusion_vectors` with `compat = mutex`

pycocotools does not take into account the fact that each box often has a score for each category.

pycocotools will be incorrect if any annotation has an id of 0

a major difference in the way kwcoco scores versus pycocotools is the calculation of AP. The assignment between truth and predicted detections produces similar enough results. Given our confusion vectors we use the scikit-learn definition of AP, whereas pycocotools seems to compute precision and recall — more or less correctly — but then it resamples the precision at various specified recall thresholds (in the *accumulate* function, specifically how *pr* is resampled into the *q* array). This can lead to a large difference in reported scores.

pycocotools also smooths out the precision such that it is monotonic decreasing, which might not be the best idea.

pycocotools area ranges are inclusive on both ends, that means the “small” and “medium” truth selections do overlap somewhat.

---

**classmethod demo**(*cls*, *\*\*kwargs*)

Creates random true boxes and predicted boxes that have some noisy offset from the truth.

**Kwargs:**

**classes** (int, default=1): class list or the number of foreground classes.



nimgs (int, default=1): number of images in the coco datasets. nboxes (int, default=1): boxes per image. n\_fp (int, default=0): number of false positives. n\_fn (int, default=0): number of false negatives. box\_noise (float, default=0): std of a normal distribution used to

perterb both box location and box size.

**cls\_noise (float, default=0): probability that a class label will** change. Must be within 0 and 1.

anchors (ndarray, default=None): used to create random boxes null\_pred (bool, default=0):

if True, predicted classes are returned as null, which means only localization scoring is suitable.

**with\_probs (bool, default=1):** if True, includes per-class probabilities with predictions

## CommandLine

```
xdoctest -m kw coco.metrics.detect_metrics DetectionMetrics.demo:2 --show
```

## Example

```
>>> kwargs = {}
>>> # Seed the RNG
>>> kwargs['rng'] = 0
>>> # Size parameters determine how big the data is
>>> kwargs['nimgs'] = 5
>>> kwargs['nboxes'] = 7
>>> kwargs['classes'] = 11
>>> # Noise parameters perterb predictions further from the truth
>>> kwargs['n_fp'] = 3
>>> kwargs['box_noise'] = 0.1
>>> kwargs['cls_noise'] = 0.5
>>> dmet = DetectionMetrics.demo(**kwargs)
>>> print('dmet.classes = {}'.format(dmet.classes))
dmet.classes = <CategoryTree(nNodes=12, maxDepth=3, maxBreadth=4...)>
>>> # Can grab kwimage.Detection object for any image
>>> print(dmet.true_detections(gid=0))
<Detections(4)>
>>> print(dmet.pred_detections(gid=0))
<Detections(7)>
```

## Example

```
>>> # Test case with null predicted categories
>>> dmet = DetectionMetrics.demo(nimgs=30, null_pred=1, classes=3,
>>>                               nboxes=10, n_fp=3, box_noise=0.1,
>>>                               with_probs=False)
>>> dmet.gid_to_pred_dets[0].data
>>> dmet.gid_to_true_dets[0].data
>>> cfsn_vecs = dmet.confusion_vectors()
```

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```

>>> binvecs_ovr = cfsn_vecs.binarize_ovr()
>>> binvecs_per = cfsn_vecs.binarize_classless()
>>> measures_per = binvecs_per.measures()
>>> measures_ovr = binvecs_ovr.measures()
>>> print('measures_per = {!r}'.format(measures_per))
>>> print('measures_ovr = {!r}'.format(measures_ovr))
>>> # xdoctest: +REQUIRES(--show)
>>> import kwplot
>>> kwplot.autompl()
>>> measures_ovr['perclass'].draw(key='pr', fnum=2)

```

### Example

```

>>> from kwcoco.metrics.confusion_vectors import * # NOQA
>>> from kwcoco.metrics.detect_metrics import DetectionMetrics
>>> dmet = DetectionMetrics.demo(
>>>     n_fp=(0, 1), n_fn=(0, 1), nimgs=32, nboxes=(0, 16),
>>>     classes=3, rng=0, newstyle=1, box_noise=0.5, cls_noise=0.0, score_
    noise=0.3, with_probs=False)
>>> # xdoctest: +REQUIRES(--show)
>>> import kwplot
>>> kwplot.autompl()
>>> summary = dmet.summarize(plot=True, title='DetectionMetrics summary demo',
    with_ovr=True, with_bin=False)
>>> summary['bin_measures']
>>> kwplot.show_if_requested()

```

`summarize(dmet, out_dpath=None, plot=False, title="", with_bin='auto', with_ovr='auto')`

### Example

```

>>> from kwcoco.metrics.confusion_vectors import * # NOQA
>>> from kwcoco.metrics.detect_metrics import DetectionMetrics
>>> dmet = DetectionMetrics.demo(
>>>     n_fp=(0, 128), n_fn=(0, 4), nimgs=512, nboxes=(0, 32),
>>>     classes=3, rng=0)
>>> # xdoctest: +REQUIRES(--show)
>>> import kwplot
>>> kwplot.autompl()
>>> dmet.summarize(plot=True, title='DetectionMetrics summary demo')
>>> kwplot.show_if_requested()

```

`kwcoco.metrics.detect_metrics._demo_construct_probs(pred_cxs, pred_scores, classes, rng, hacked=1)`

Constructs random probabilities for demo data

`kwcoco.metrics.detect_metrics.pycocotools_confusion_vectors(dmet, evaler, iou_thresh=0.5, verbose=0)`

## Example

```

>>> # xdoctest: +REQUIRES(module:pycocotools)
>>> from kwcoco.metrics.detect_metrics import *
>>> dmet = DetectionMetrics.demo(
>>>     nimgs=10, nboxes=(0, 3), n_fn=(0, 1), n_fp=(0, 1), classes=8, with_
↪probs=False)
>>> coco_scores = dmet.score_pycocotools(with_evaler=True)
>>> evaler = coco_scores['evaler']
>>> cfsn_vecs = pycocotools_confusion_vectors(dmet, evaler, verbose=1)

```

`kwcoco.metrics.detect_metrics.eval_detections_cli(**kw)`  
 DEPRECATED USE *kwcoco eval* instead

## CommandLine

```
xdoctest -m ~/code/kwcoco/kwcoco/metrics/detect_metrics.py eval_detections_cli
```

`kwcoco.metrics.detect_metrics._summarize(self, ap=1, iouThr=None, areaRngLbl='all', maxDets=100)`

`kwcoco.metrics.detect_metrics.pct_summarize2(self)`

`kwcoco.metrics.drawing`

## Module Contents

## Functions

<code>draw_perclass_roc(cx_to_info, classes=None, prefix="", fnum=1, fp_axis='count', **kw)</code>	<b>Parameters</b> <ul style="list-style-type: none"><li>• <b>cx_to_info</b> (<i>PerClass_Measures</i>   <i>Dict</i>)</li></ul>
<code>demo_format_options()</code>	
<code>concice_si_display(val, eps=1e-08, precision=2, si_thresh=4)</code>	Display numbers in scientific notation if above a threshold
<code>_realpos_label_suffix(info)</code>	Creates a label suffix that indicates the number of real positive cases
<code>draw_perclass_prcurve(cx_to_info, classes=None, prefix="", fnum=1, **kw)</code>	<b>Parameters</b> <b>cx_to_info</b> ( <i>PerClass_Measures</i>   <i>Dict</i> )
<code>draw_perclass_thresholds(cx_to_info, key='mcc', classes=None, prefix="", fnum=1, **kw)</code>	<b>Parameters</b> <b>cx_to_info</b> ( <i>PerClass_Measures</i>   <i>Dict</i> )
<code>draw_roc(info, prefix="", fnum=1, **kw)</code>	<b>Parameters</b> <b>info</b> ( <i>Measures</i>   <i>Dict</i> )
<code>draw_prcurve(info, prefix="", fnum=1, **kw)</code>	Draws a single pr curve.
<code>draw_threshold_curves(info, keys=None, prefix="", fnum=1, **kw)</code>	<b>Parameters</b> <b>info</b> ( <i>Measures</i>   <i>Dict</i> )

`kwcoco.metrics.drawing.draw_perclass_roc(cx_to_info, classes=None, prefix="", fnum=1, fp_axis='count', **kw)`

### Parameters

- **cx\_to\_info** (*PerClass\_Measures* | *Dict*)
- **fp\_axis** (*str*) – can be count or rate

`kwcoco.metrics.drawing.demo_format_options()`

`kwcoco.metrics.drawing.concice_si_display(val, eps=1e-08, precision=2, si_thresh=4)`

Display numbers in scientific notation if above a threshold

### Parameters

- **eps** (*float*) – threshold to be formatted as an integer if other integer conditions hold.
- **precision** (*int*) – maximum significant digits (might print less)
- **si\_thresh** (*int*) – If the number is less than  $10^{\{si\_thresh\}}$ , then it will be printed as an integer if it is within eps of an integer.

## References

<https://docs.python.org/2/library/stdtypes.html#string-formatting-operations>

## Example

```
>>> grid = {
>>>     'sign': [1, -1],
>>>     'exp': [1, -1],
>>>     'big_part': [0, 32132e3, 40000000032],
>>>     'med_part': [0, 0.5, 0.9432, 0.000043, 0.01, 1, 2],
>>>     'small_part': [0, 1321e-3, 43242e-11],
>>> }
>>> for kw in ub.named_product(grid):
>>>     sign = kw.pop('sign')
>>>     exp = kw.pop('exp')
>>>     raw = (sum(map(float, kw.values()))))
>>>     val = sign * raw ** exp if raw != 0 else sign * raw
>>>     print('{:>20} - {}'.format(concice_si_display(val), val))
>>> from kwcoco.metrics.drawing import * # NOQA
>>> print(concice_si_display(40000000432432))
>>> print(concice_si_display(473243280432890))
>>> print(concice_si_display(473243284289))
>>> print(concice_si_display(473243289))
>>> print(concice_si_display(4739))
>>> print(concice_si_display(473))
>>> print(concice_si_display(0.432432))
>>> print(concice_si_display(0.132432))
>>> print(concice_si_display(1.0000043))
>>> print(concice_si_display(01.0000000000000000000000000000043))
```

`kwcoco.metrics.drawing._realpos_label_suffix(info)`

Creates a label suffix that indicates the number of real positive cases versus the total amount of cases considered for an evaluation curve.

**Parameters** *info* (*Dict*) – with keys, nsupport, realpos\_total

## Example

```
>>> from kwcoco.metrics.drawing import * # NOQA
>>> info = {'nsupport': 10, 'realpos_total': 10}
>>> _realpos_label_suffix(info)
10/10
>>> info = {'nsupport': 10.0, 'realpos_total': 10.0}
>>> _realpos_label_suffix(info)
10/10
>>> info = {'nsupport': 10.3333, 'realpos_total': 10.2222}
>>> _realpos_label_suffix(info)
10.22/10.33
>>> info = {'nsupport': 10.000000001, 'realpos_total': None}
>>> _realpos_label_suffix(info)
```

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```

10
>>> info = {'nsupport': 10.009}
>>> _realpos_label_suffix(info)
10.01
>>> info = {'nsupport': 3331033334342.432, 'realpos_total': 1033334342.432}
>>> _realpos_label_suffix(info)
1e9/3.3e12
>>> info = {'nsupport': 0.007, 'realpos_total': 0.0000893}
>>> _realpos_label_suffix(info)
8.9e-5/0.007

```

kwcoco.metrics.drawing.draw\_perclass\_prcurve(cx\_to\_info, classes=None, prefix="", fnum=1, \*\*kw)

**Parameters** cx\_to\_info (PerClass\_Measures | Dict)

### Example

```

>>> # xdoctest: +REQUIRES(module:kwplot)
>>> from kwcoco.metrics.drawing import * # NOQA
>>> from kwcoco.metrics import DetectionMetrics
>>> dmet = DetectionMetrics.demo(
>>>     nimgs=3, nboxes=(0, 10), n_fp=(0, 3), n_fn=(0, 2), classes=3, score_noise=0.
→ 1, box_noise=0.1, with_probs=False)
>>> cfsn_vecs = dmet.confusion_vectors()
>>> print(cfsn_vecs.data.pandas())
>>> classes = cfsn_vecs.classes
>>> cx_to_info = cfsn_vecs.binarize_ovr().measures()['perclass']
>>> print('cx_to_info = {}'.format(ub.repr2(cx_to_info, nl=1)))
>>> import kwplot
>>> kwplot.autompl()
>>> draw_perclass_prcurve(cx_to_info, classes)
>>> # xdoctest: +REQUIRES(--show)
>>> kwplot.show_if_requested()

```

kwcoco.metrics.drawing.draw\_perclass\_thresholds(cx\_to\_info, key='mcc', classes=None, prefix="", fnum=1, \*\*kw)

**Parameters** cx\_to\_info (PerClass\_Measures | Dict)

---

**Note:** Each category is inspected independently of one another, there is no notion of confusion.

---

### Example

```

>>> # xdoctest: +REQUIRES(module:kwplot)
>>> from kwcoco.metrics.drawing import * # NOQA
>>> from kwcoco.metrics import ConfusionVectors
>>> cfsn_vecs = ConfusionVectors.demo()
>>> classes = cfsn_vecs.classes
>>> ovr_cfsn = cfsn_vecs.binarize_ovr(keyby='name')
>>> cx_to_info = ovr_cfsn.measures()['perclass']
>>> import kwplot
>>> kwplot.autompl()
>>> key = 'mcc'
>>> draw_perclass_thresholds(cx_to_info, key, classes)
>>> # xdoctest: +REQUIRES(--show)
>>> kwplot.show_if_requested()

```

`kwcoco.metrics.drawing.draw_roc`(*info*, *prefix*="", *fnum*=1, *\*\*kw*)

**Parameters** *info* (*Measures* | *Dict*)

---

**Note:** There needs to be enough negative examples for using ROC to make any sense!

---

### Example

```

>>> # xdoctest: +REQUIRES(module:kwplot, module:seaborn)
>>> from kwcoco.metrics.drawing import * # NOQA
>>> from kwcoco.metrics import DetectionMetrics
>>> dmet = DetectionMetrics.demo(nimgs=30, null_pred=1, classes=3,
>>>                               nboxes=10, n_fp=10, box_noise=0.3,
>>>                               with_probs=False)
>>> dmet.true_detections(0).data
>>> cfsn_vecs = dmet.confusion_vectors(compat='mutex', prioritize='iou', bias=0)
>>> print(cfsn_vecs.data._pandas().sort_values('score'))
>>> classes = cfsn_vecs.classes
>>> info = ub.peek(cfsn_vecs.binarize_ovr().measures()['perclass'].values())
>>> # xdoctest: +REQUIRES(--show)
>>> import kwplot
>>> kwplot.autompl()
>>> draw_roc(info)
>>> kwplot.show_if_requested()

```

`kwcoco.metrics.drawing.draw_prcurve`(*info*, *prefix*="", *fnum*=1, *\*\*kw*)

Draws a single pr curve.

**Parameters** *info* (*Measures* | *Dict*)

### Example

```
>>> # xdoctest: +REQUIRES(module:kwplot)
>>> from kwcoco.metrics import DetectionMetrics
>>> dmet = DetectionMetrics.demo(
>>>     nimgs=10, nboxes=(0, 10), n_fp=(0, 1), classes=3)
>>> cfsn_vecs = dmet.confusion_vectors()
```

```
>>> classes = cfsn_vecs.classes
>>> info = cfsn_vecs.binarize_classless().measures()
>>> import kwplot
>>> kwplot.autompl()
>>> draw_prcurve(info)
>>> # xdoctest: +REQUIRES(--show)
>>> kwplot.show_if_requested()
```

kwcoco.metrics.drawing.draw\_threshold\_curves(info, keys=None, prefix="", fnum=1, \*\*kw)

**Parameters** info (Measures | Dict)

### Example

```
>>> # xdoctest: +REQUIRES(module:kwplot)
>>> import sys, ubelt
>>> sys.path.append(ubelt.expandpath('~/.code/kwcoco'))
>>> from kwcoco.metrics.drawing import * # NOQA
>>> from kwcoco.metrics import DetectionMetrics
>>> dmet = DetectionMetrics.demo(
>>>     nimgs=10, nboxes=(0, 10), n_fp=(0, 1), classes=3)
>>> cfsn_vecs = dmet.confusion_vectors()
>>> info = cfsn_vecs.binarize_classless().measures()
>>> keys = None
>>> import kwplot
>>> kwplot.autompl()
>>> draw_threshold_curves(info, keys)
>>> # xdoctest: +REQUIRES(--show)
>>> kwplot.show_if_requested()
```

kwcoco.metrics.functional

## Module Contents

### Functions

<code>fast_confusion_matrix(y_true, y_pred, n_labels, sample_weight=None)</code>	faster version of sklearn confusion matrix that avoids the
<code>_truncated_roc(y_df, bg_idx=-1, fp_cutoff=None)</code>	Computes truncated ROC info
<code>_pr_curves(y)</code>	Compute a PR curve from a method
<code>_average_precision(tp, ppv)</code>	Compute average precision of a binary PR curve. This is simply the area



`kw coco.metrics.functional.fast_confusion_matrix(y_true, y_pred, n_labels, sample_weight=None)`

faster version of sklearn confusion matrix that avoids the expensive checks and label rectification

#### Parameters

- **y\_true** (*ndarray[int]*) – ground truth class label for each sample
- **y\_pred** (*ndarray[int]*) – predicted class label for each sample
- **n\_labels** (*int*) – number of labels
- **sample\_weight** (*ndarray[int|float]*) – weight of each sample

**Returns** matrix where rows represent real and cols represent pred and the value at each cell is the total amount of weight

**Return type** `ndarray[int64|float64, dim=2]`

#### Example

```
>>> y_true = np.array([0, 0, 0, 0, 1, 1, 1, 0, 0, 1])
>>> y_pred = np.array([0, 0, 0, 0, 0, 0, 0, 0, 1, 1])
>>> fast_confusion_matrix(y_true, y_pred, 2)
array([[4, 2],
       [3, 1]])
>>> fast_confusion_matrix(y_true, y_pred, 2).ravel()
array([4, 2, 3, 1])
```

`kw coco.metrics.functional._truncated_roc(y_df, bg_idx=-1, fp_cutoff=None)`

Computes truncated ROC info

`kw coco.metrics.functional._pr_curves(y)`

Compute a PR curve from a method

**Parameters** **y** (*pd.DataFrame | DataFrameArray*) – output of detection\_confusions

**Returns** `Tuple[float, ndarray, ndarray]`

#### Example

```
>>> # xdoctest: +REQUIRES(module:sklearn)
>>> import pandas as pd
>>> y1 = pd.DataFrame.from_records([
>>>     {'pred': 0, 'score': 10.00, 'true': -1, 'weight': 1.00},
>>>     {'pred': 0, 'score': 1.65, 'true': 0, 'weight': 1.00},
>>>     {'pred': 0, 'score': 8.64, 'true': -1, 'weight': 1.00},
>>>     {'pred': 0, 'score': 3.97, 'true': 0, 'weight': 1.00},
>>>     {'pred': 0, 'score': 1.68, 'true': 0, 'weight': 1.00},
>>>     {'pred': 0, 'score': 5.06, 'true': 0, 'weight': 1.00},
>>>     {'pred': 0, 'score': 0.25, 'true': 0, 'weight': 1.00},
>>>     {'pred': 0, 'score': 1.75, 'true': 0, 'weight': 1.00},
>>>     {'pred': 0, 'score': 8.52, 'true': 0, 'weight': 1.00},
>>>     {'pred': 0, 'score': 5.20, 'true': 0, 'weight': 1.00},
>>> ])
>>> import kw coco as nh
```

(continues on next page)

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```
>>> import kwarrray
>>> y2 = kwarrray.DataFrameArray(y1)
>>> _pr_curves(y2)
>>> _pr_curves(y1)
```

`kwcoco.metrics.functional._average_precision(tpr, ppv)`

Compute average precision of a binary PR curve. This is simply the area under the curve.

**Parameters**

- **tpr** (*ndarray*) – true positive rate - aka recall
- **ppv** (*ndarray*) – positive predictive value - aka precision

**kwcoco.metrics.sklearn\_alts**

Faster pure-python versions of sklearn functions that avoid expensive checks and label rectifications. It is assumed that all labels are consecutive non-negative integers.

## Module Contents

### Functions

---

`confusion_matrix(y_true, y_pred, n_labels=None, labels=None, sample_weight=None)` faster version of sklearn confusion matrix that avoids the

---

`global_accuracy_from_confusion(cfsn)`

---

`class_accuracy_from_confusion(cfsn)`

---

`_binary_clf_curve2(y_true, y_score, pos_label=None, sample_weight=None)` MODIFIED VERSION OF SCIKIT-LEARN API

---

### Attributes

---

`profile`

---

`kwcoco.metrics.sklearn_alts.profile`

`kwcoco.metrics.sklearn_alts.confusion_matrix(y_true, y_pred, n_labels=None, labels=None, sample_weight=None)`

faster version of sklearn confusion matrix that avoids the expensive checks and label rectification

Runs in about 0.7ms

**Returns** matrix where rows represent real and cols represent pred

**Return type** ndarray

### Example

```

>>> y_true = np.array([0, 0, 0, 0, 1, 1, 1, 0, 0, 1])
>>> y_pred = np.array([0, 0, 0, 0, 0, 0, 0, 1, 1, 1])
>>> confusion_matrix(y_true, y_pred, 2)
array([[4, 2],
       [3, 1]])
>>> confusion_matrix(y_true, y_pred, 2).ravel()
array([4, 2, 3, 1])

```

**Benchmarks:** import ubelt as ub y\_true = np.random.randint(0, 2, 10000) y\_pred = np.random.randint(0, 2, 10000)

n = 1000 for timer in ub.Timerit(n, bestof=10, label='py-time'):

```

    sample_weight = [1] * len(y_true)
    confusion_matrix(y_true, y_pred, 2, sample_weight=sample_weight)

```

**for timer in ub.Timerit(n, bestof=10, label='np-time'):** sample\_weight = np.ones(len(y\_true), dtype=int) confusion\_matrix(y\_true, y\_pred, 2, sample\_weight=sample\_weight)

kwcoco.metrics.sklearn\_alts.global\_accuracy\_from\_confusion(cfsn)

kwcoco.metrics.sklearn\_alts.class\_accuracy\_from\_confusion(cfsn)

kwcoco.metrics.sklearn\_alts.\_binary\_clf\_curve2(y\_true, y\_score, pos\_label=None, sample\_weight=None)

### MODIFIED VERSION OF SCIKIT-LEARN API

Calculate true and false positives per binary classification threshold.

#### Parameters

- **y\_true** (array, shape = [n\_samples]) – True targets of binary classification
- **y\_score** (array, shape = [n\_samples]) – Estimated probabilities or decision function
- **pos\_label** (int or str, default=None) – The label of the positive class
- **sample\_weight** (array-like of shape (n\_samples,), default=None) – Sample weights.

#### Returns

- **fps** (array, shape = [n\_thresholds]) – A count of false positives, at index i being the number of negative samples assigned a score  $\geq$  thresholds[i]. The total number of negative samples is equal to fps[-1] (thus true negatives are given by fps[-1] - fps).
- **tps** (array, shape = [n\_thresholds <= len(np.unique(y\_score))]) – An increasing count of true positives, at index i being the number of positive samples assigned a score  $\geq$  thresholds[i]. The total number of positive samples is equal to tps[-1] (thus false negatives are given by tps[-1] - tps).
- **thresholds** (array, shape = [n\_thresholds]) – Decreasing score values.

### Example

```
>>> y_true = [ 1, 1, 1, 1, 1, 1, 0]
>>> y_score = [ np.nan, 0.2, 0.3, 0.4, 0.5, 0.6, 0.3]
>>> sample_weight = None
>>> pos_label = None
>>> fps, tps, thresholds = _binary_clf_curve2(y_true, y_score)
```

## kwcoco.metrics.util

### Module Contents

#### Classes

---

<i>DictProxy</i>	Allows an object to proxy the behavior of a dict attribute
------------------	--

---

#### class kwcoco.metrics.util.DictProxy

Bases: `scriptconfig.dict_like.DictLike`

Allows an object to proxy the behavior of a dict attribute

`__getitem__(self, key)`

`__setitem__(self, key, value)`

`keys(self)`

`__json__(self)`

## kwcoco.metrics.voc\_metrics

### Module Contents

#### Classes

---

<i>VOC_Metrics</i>	API to compute object detection scores using Pascal VOC evaluation method.
--------------------	--

---

#### Functions

---

<code>_pr_curves(y, method='voc2012')</code>	Compute a PR curve from a method
<code>_voc_eval(lines, recs, classname, iou_thresh=0.5, method='voc2012', bias=1.0)</code>	VOC AP evaluation for a single category.
<code>_voc_ave_precision(rec, prec, method='voc2012')</code>	Compute AP from precision and recall

---

**class** kwcoco.metrics.voc\_metrics.VOC\_Metrics(classes=None)

Bases: `ubelt.NiceRepr`

API to compute object detection scores using Pascal VOC evaluation method.

To use, add true and predicted detections for each image and then run the `VOC_Metrics.score()` function.

#### Variables

- **recs** (*Dict[int, List[dict]]*) – true boxes for each image. maps image ids to a list of records within that image. Each record is a tlbr bbox, a difficult flag, and a class name.
- **cx\_to\_lines** (*Dict[int, List]*) – VOC formatted prediction predictions. mapping from class index to all predictions for that category. Each “line” is a list of [  
[<imgid>, <score>, <tl\_x>, <tl\_y>, <br\_x>, <br\_y>]].

`__nice__(self)`

`add_truth(self, true_dets, gid)`

`add_predictions(self, pred_dets, gid)`

`score(self, iou_thresh=0.5, bias=1, method='voc2012')`

Compute VOC scores for every category

#### Example

```
>>> from kwcoco.metrics.detect_metrics import DetectionMetrics
>>> from kwcoco.metrics.voc_metrics import * # NOQA
>>> dmet = DetectionMetrics.demo(
>>>     nimgs=1, nboxes=(0, 100), n_fp=(0, 30), n_fn=(0, 30), classes=2, score_
↳ noise=0.9)
>>> self = VOC_Metrics(classes=dmet.classes)
>>> self.add_truth(dmet.true_detections(0), 0)
>>> self.add_predictions(dmet.pred_detections(0), 0)
>>> voc_scores = self.score()
>>> # xdoctest: +REQUIRES(--show)
>>> import kwplot
>>> kwplot.autompl()
>>> kwplot.figure(fnum=1, doclf=True)
>>> voc_scores['perclass'].draw()
```

```
kwplot.figure(fnum=2)          dmet.true_detections(0).draw(color='green',          labels=None)
dmet.pred_detections(0).draw(color='blue', labels=None) kwplot.autoplt().gca().set_xlim(0, 100)
kwplot.autoplt().gca().set_ylim(0, 100)
```

`kwcoco.metrics.voc_metrics._pr_curves(y, method='voc2012')`

Compute a PR curve from a method

**Parameters** *y* (*pd.DataFrame* | *DataFrameArray*) – output of `detection_confusions`

**Returns** `Tuple[float, ndarray, ndarray]`

### Example

```

>>> import pandas as pd
>>> y1 = pd.DataFrame.from_records([
>>>     {'pred': 0, 'score': 10.00, 'true': -1, 'weight': 1.00},
>>>     {'pred': 0, 'score': 1.65, 'true': 0, 'weight': 1.00},
>>>     {'pred': 0, 'score': 8.64, 'true': -1, 'weight': 1.00},
>>>     {'pred': 0, 'score': 3.97, 'true': 0, 'weight': 1.00},
>>>     {'pred': 0, 'score': 1.68, 'true': 0, 'weight': 1.00},
>>>     {'pred': 0, 'score': 5.06, 'true': 0, 'weight': 1.00},
>>>     {'pred': 0, 'score': 0.25, 'true': 0, 'weight': 1.00},
>>>     {'pred': 0, 'score': 1.75, 'true': 0, 'weight': 1.00},
>>>     {'pred': 0, 'score': 8.52, 'true': 0, 'weight': 1.00},
>>>     {'pred': 0, 'score': 5.20, 'true': 0, 'weight': 1.00},
>>> ])
>>> import kwarray
>>> y2 = kwarray.DataFrameArray(y1)
>>> _pr_curves(y2)
>>> _pr_curves(y1)

```

```
kwcoco.metrics.voc_metrics._voc_eval(lines, recs, classname, iou_thresh=0.5, method='voc2012',
                                     bias=1.0)
```

VOC AP evaluation for a single category.

#### Parameters

- **lines** (*List[list]*) – VOC formatted predictions. Each “line” is a list of [*<imgid>*, *<score>*, *<tl\_x>*, *<tl\_y>*, *<br\_x>*, *<br\_y>*].
- **recs** (*Dict[int, List[dict]]*) – true boxes for each image. maps image ids to a list of records within that image. Each record is a tlbr bbox, a difficult flag, and a class name.
- **classname** (*str*) – the category to evaluate.
- **method** (*str*) – code for how the AP is computed.
- **bias** (*float*) – either 1.0 or 0.0.

**Returns** info about the evaluation containing AP. Contains fp, tp, prec, rec,

**Return type** Dict

---

**Note:** Raw replication of matlab implementation of creating assignments and the resulting PR-curves and AP. Based on MATLAB code [1].

---

### References

[1] [http://host.robots.ox.ac.uk/pascal/VOC/voc2012/VOCdevkit\\_18-May-2011.tar](http://host.robots.ox.ac.uk/pascal/VOC/voc2012/VOCdevkit_18-May-2011.tar)

kwcoco.metrics.voc\_metrics.\_voc\_ave\_precision(*rec*, *prec*, *method*='voc2012')

Compute AP from precision and recall Based on MATLAB code in<sup>1,2</sup>, and<sup>3</sup>.

#### Parameters

<sup>1</sup> [http://host.robots.ox.ac.uk/pascal/VOC/voc2012/VOCdevkit\\_18-May-2011.tar](http://host.robots.ox.ac.uk/pascal/VOC/voc2012/VOCdevkit_18-May-2011.tar)

<sup>2</sup> [https://github.com/rbgirshick/voc-dpm/blob/master/test/pascal\\_eval.m](https://github.com/rbgirshick/voc-dpm/blob/master/test/pascal_eval.m)

<sup>3</sup> [https://github.com/rbgirshick/voc-dpm/blob/c0b88564bd668bcc6216bbffe96cb061613be768/utis/bootstrap/VOCevaldet\\_bootstrap.m](https://github.com/rbgirshick/voc-dpm/blob/c0b88564bd668bcc6216bbffe96cb061613be768/utis/bootstrap/VOCevaldet_bootstrap.m)

- **rec** (*ndarray*) – recall
- **prec** (*ndarray*) – precision
- **method** (*str*) – either voc2012 or voc2007

**Returns** ap: average precision

**Return type** float

## References

## Package Contents

## Classes

<i>DetectionMetrics</i>	Object that computes associations between detections and can convert them
<i>BinaryConfusionVectors</i>	Stores information about a binary classification problem.
<i>ConfusionVectors</i>	Stores information used to construct a confusion matrix. This includes
<i>Measures</i>	Holds accumulated confusion counts, and derived measures
<i>OneVsRestConfusionVectors</i>	Container for multiple one-vs-rest binary confusion vectors
<i>PerClass_Measures</i>	

## Functions

<i>eval_detections_cli</i> (**kw)	DEPRECATED USE <i>kwcoco eval</i> instead
-----------------------------------	---

**class** kwcoco.metrics.DetectionMetrics(*dmet*, *classes=None*)

Bases: `ubelt.NiceRepr`

Object that computes associations between detections and can convert them into sklearn-compatible representations for scoring.

### Variables

- **gid\_to\_true\_dets** (*Dict*) – maps image ids to truth
- **gid\_to\_pred\_dets** (*Dict*) – maps image ids to predictions
- **classes** (*CategoryTree*) – category coder

### Example

```
>>> dmet = DetectionMetrics.demo(
>>>     nimgs=100, nboxes=(0, 3), n_fp=(0, 1), classes=8, score_noise=0.9,
>>>     hacked=False)
>>> print(dmet.score_kwcoco(bias=0, compat='mutex', prioritize='iou')['mAP'])
...
>>> # NOTE: IN GENERAL NETHARN AND VOC ARE NOT THE SAME
>>> print(dmet.score_voc(bias=0)['mAP'])
0.8582...
>>> #print(dmet.score_coco()['mAP'])
```

**score\_coco**

**clear**(*dmet*)

**\_\_nice\_\_**(*dmet*)

**classmethod from\_coco**(*DetectionMetrics*, *true\_coco*, *pred\_coco*, *gids=None*, *verbose=0*)

Create detection metrics from two coco files representing the truth and predictions.

#### Parameters

- **true\_coco** (*kwcoco.CocoDataset*)
- **pred\_coco** (*kwcoco.CocoDataset*)

### Example

```
>>> import kwcoco
>>> from kwcoco.demo.perterb import perterb_coco
>>> true_coco = kwcoco.CocoDataset.demo('shapes')
>>> perterbkw = dict(box_noise=0.5, cls_noise=0.5, score_noise=0.5)
>>> pred_coco = perterb_coco(true_coco, **perterbkw)
>>> self = DetectionMetrics.from_coco(true_coco, pred_coco)
>>> self.score_voc()
```

**\_register\_imagename**(*dmet*, *imgname*, *gid=None*)

**add\_predictions**(*dmet*, *pred\_dets*, *imgname=None*, *gid=None*)

Register/Add predicted detections for an image

#### Parameters

- **pred\_dets** (*Detections*) – predicted detections
- **imgname** (*str*) – a unique string to identify the image
- **gid** (*int*, *optional*) – the integer image id if known

**add\_truth**(*dmet*, *true\_dets*, *imgname=None*, *gid=None*)

Register/Add groundtruth detections for an image

#### Parameters

- **true\_dets** (*Detections*) – groundtruth
- **imgname** (*str*) – a unique string to identify the image



- **gid** (*int, optional*) – the integer image id if known

**true\_detections**(*dmet, gid*)

gets Detections representation for groundtruth in an image

**pred\_detections**(*dmet, gid*)

gets Detections representation for predictions in an image

**confusion\_vectors**(*dmet, iou\_thresh=0.5, bias=0, gids=None, compat='mutex', prioritize='iou', ignore\_classes='ignore', background\_class=ub.NoParam, verbose='auto', workers=0, track\_probs='try', max\_dets=None*)

Assigns predicted boxes to the true boxes so we can transform the detection problem into a classification problem for scoring.

#### Parameters

- **iou\_thresh** (*float | List[float], default=0.5*) – bounding box overlap iou threshold required for assignment if a list, then return type is a dict
- **bias** (*float, default=0.0*) – for computing bounding box overlap, either 1 or 0
- **gids** (*List[int], default=None*) – which subset of images ids to compute confusion metrics on. If not specified all images are used.
- **compat** (*str, default='all'*) – can be ('ancestors' | 'mutex' | 'all'). determines which pred boxes are allowed to match which true boxes. If 'mutex', then pred boxes can only match true boxes of the same class. If 'ancestors', then pred boxes can match true boxes that match or have a coarser label. If 'all', then any pred can match any true, regardless of its category label.
- **prioritize** (*str, default='iou'*) – can be ('iou' | 'class' | 'correct') determines which box to assign to if multiple true boxes overlap a predicted box. if prioritize is iou, then the true box with maximum iou (above iou\_thresh) will be chosen. If prioritize is class, then it will prefer matching a compatible class above a higher iou. If prioritize is correct, then ancestors of the true class are preferred over descendants of the true class, over unrelated classes.
- **ignore\_classes** (*set, default={'ignore'}*) – class names indicating ignore regions
- **background\_class** (*str, default=ub.NoParam*) – Name of the background class. If unspecified we try to determine it with heuristics. A value of None means there is no background class.
- **verbose** (*int, default='auto'*) – verbosity flag. In auto mode, verbose=1 if len(gids) > 1000.
- **workers** (*int, default=0*) – number of parallel assignment processes
- **track\_probs** (*str, default='try'*) – can be 'try', 'force', or False. if truthy, we assume probabilities for multiple classes are available.

**Returns** ConfusionVectors | Dict[float, ConfusionVectors]

### Example

```
>>> dmet = DetectionMetrics.demo(nimgs=30, classes=3,
>>>                               nboxes=10, n_fp=3, box_noise=10,
>>>                               with_probs=False)
>>> iou_to_cfsn = dmet.confusion_vectors(iou_thresh=[0.3, 0.5, 0.9])
>>> for t, cfsn in iou_to_cfsn.items():
>>>     print('t = {!r}'.format(t))
...     print(cfsn.binarize_ovr().measures())
...     print(cfsn.binarize_classless().measures())
```

**score\_kwant**(*dmet*, *iou\_thresh*=0.5)

Scores the detections using kwant

**score\_kwcoco**(*dmet*, *iou\_thresh*=0.5, *bias*=0, *gids*=None, *compat*='all', *prioritize*='iou')

our scoring method

**score\_voc**(*dmet*, *iou\_thresh*=0.5, *bias*=1, *method*='voc2012', *gids*=None, *ignore\_classes*='ignore')

score using voc method

### Example

```
>>> dmet = DetectionMetrics.demo(
>>>     nimgs=100, nboxes=(0, 3), n_fn=(0, 1), classes=8,
>>>     score_noise=.5)
>>> print(dmet.score_voc()['mAP'])
0.9399...
```

**\_to\_coco**(*dmet*)

Convert to a coco representation of truth and predictions

with inverse aid mappings

**score\_pycocotools**(*dmet*, *with\_evaler*=False, *with\_confusion*=False, *verbose*=0, *iou\_thresholds*=None)

score using ms-coco method

**Returns** dictionary with pct info

**Return type** Dict

### Example

```
>>> # xdoctest: +REQUIRES(module:pycocotools)
>>> from kwcoco.metrics.detect_metrics import *
>>> dmet = DetectionMetrics.demo(
>>>     nimgs=10, nboxes=(0, 3), n_fn=(0, 1), n_fp=(0, 1), classes=8, with_
>>>     probs=False)
>>> pct_info = dmet.score_pycocotools(verbose=1,
>>>                                     with_evaler=True,
>>>                                     with_confusion=True,
>>>                                     iou_thresholds=[0.5, 0.9])
>>> evaler = pct_info['evaler']
>>> iou_to_cfsn_vecs = pct_info['iou_to_cfsn_vecs']
```

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```

>>> for iou_thresh in iou_to_cfsn_vecs.keys():
>>>     print('iou_thresh = {!r}'.format(iou_thresh))
>>>     cfsn_vecs = iou_to_cfsn_vecs[iou_thresh]
>>>     ovr_measures = cfsn_vecs.binarize_ovr().measures()
>>>     print('ovr_measures = {}'.format(ub.repr2(ovr_measures, nl=1,
↵precision=4)))

```

**Note:** by default pycocotools computes average precision as the literal average of computed precisions at 101 uniformly spaced recall thresholds.

pycocotools seems to only allow predictions with the same category as the truth to match those truth objects. This should be the same as calling `dmet.confusion_vectors` with `compat = mutex`

pycocotools does not take into account the fact that each box often has a score for each category.

pycocotools will be incorrect if any annotation has an id of 0

a major difference in the way kwcoco scores versus pycocotools is the calculation of AP. The assignment between truth and predicted detections produces similar enough results. Given our confusion vectors we use the scikit-learn definition of AP, whereas pycocotools seems to compute precision and recall — more or less correctly — but then it resamples the precision at various specified recall thresholds (in the *accumulate* function, specifically how *pr* is resampled into the *q* array). This can lead to a large difference in reported scores.

pycocotools also smooths out the precision such that it is monotonic decreasing, which might not be the best idea.

pycocotools area ranges are inclusive on both ends, that means the “small” and “medium” truth selections do overlap somewhat.

### **classmethod demo**(cls, *\*\*kwargs*)

Creates random true boxes and predicted boxes that have some noisy offset from the truth.

#### **Kwargs:**

**classes** (int, default=1): class list or the number of foreground classes.

nimgs (int, default=1): number of images in the coco datasets. nboxes (int, default=1): boxes per image.

n\_fp (int, default=0): number of false positives. n\_fn (int, default=0): number of false negatives.

box\_noise (float, default=0): std of a normal distribution used to

perterb both box location and box size.

**cls\_noise** (float, default=0): probability that a class label will change. Must be within 0 and 1.

anchors (ndarray, default=None): used to create random boxes null\_pred (bool, default=0):

if True, predicted classes are returned as null, which means only localization scoring is suitable.

**with\_probs** (bool, default=1): if True, includes per-class probabilities with predictions

## CommandLine

```
xdoctest -m kwcoco.metrics.detect_metrics DetectionMetrics.demo:2 --show
```

## Example

```
>>> kwargs = {}
>>> # Seed the RNG
>>> kwargs['rng'] = 0
>>> # Size parameters determine how big the data is
>>> kwargs['nimgs'] = 5
>>> kwargs['nboxes'] = 7
>>> kwargs['classes'] = 11
>>> # Noise parameters perterb predictions further from the truth
>>> kwargs['n_fp'] = 3
>>> kwargs['box_noise'] = 0.1
>>> kwargs['cls_noise'] = 0.5
>>> dmet = DetectionMetrics.demo(**kwargs)
>>> print('dmet.classes = {}'.format(dmet.classes))
dmet.classes = <CategoryTree(nNodes=12, maxDepth=3, maxBreadth=4...)>
>>> # Can grab kwimage.Detection object for any image
>>> print(dmet.true_detections(gid=0))
<Detections(4)>
>>> print(dmet.pred_detections(gid=0))
<Detections(7)>
```

## Example

```
>>> # Test case with null predicted categories
>>> dmet = DetectionMetrics.demo(nimgs=30, null_pred=1, classes=3,
>>>                               nboxes=10, n_fp=3, box_noise=0.1,
>>>                               with_probs=False)
>>> dmet.gid_to_pred_dets[0].data
>>> dmet.gid_to_true_dets[0].data
>>> cfsn_vecs = dmet.confusion_vectors()
>>> binvecs_ovr = cfsn_vecs.binarize_ovr()
>>> binvecs_per = cfsn_vecs.binarize_classless()
>>> measures_per = binvecs_per.measures()
>>> measures_ovr = binvecs_ovr.measures()
>>> print('measures_per = {!r}'.format(measures_per))
>>> print('measures_ovr = {!r}'.format(measures_ovr))
>>> # xdoctest: +REQUIRES(--show)
>>> import kwplot
>>> kwplot.autompl()
>>> measures_ovr['perclass'].draw(key='pr', fnum=2)
```

### Example

```
>>> from kwcoco.metrics.confusion_vectors import * # NOQA
>>> from kwcoco.metrics.detect_metrics import DetectionMetrics
>>> dmet = DetectionMetrics.demo(
>>>     n_fp=(0, 1), n_fn=(0, 1), nimgs=32, nboxes=(0, 16),
>>>     classes=3, rng=0, newstyle=1, box_noise=0.5, cls_noise=0.0, score_
↳noise=0.3, with_probs=False)
>>> # xdoctest: +REQUIRES(--show)
>>> import kwplot
>>> kwplot.autompl()
>>> summary = dmet.summarize(plot=True, title='DetectionMetrics summary demo',
↳with_ovr=True, with_bin=False)
>>> summary['bin_measures']
>>> kwplot.show_if_requested()
```

`summarize(dmet, out_dpath=None, plot=False, title="", with_bin='auto', with_ovr='auto')`

### Example

```
>>> from kwcoco.metrics.confusion_vectors import * # NOQA
>>> from kwcoco.metrics.detect_metrics import DetectionMetrics
>>> dmet = DetectionMetrics.demo(
>>>     n_fp=(0, 128), n_fn=(0, 4), nimgs=512, nboxes=(0, 32),
>>>     classes=3, rng=0)
>>> # xdoctest: +REQUIRES(--show)
>>> import kwplot
>>> kwplot.autompl()
>>> dmet.summarize(plot=True, title='DetectionMetrics summary demo')
>>> kwplot.show_if_requested()
```

`kwcoco.metrics.eval_detections_cli(**kw)`

DEPRECATED USE `kwcoco eval` instead

### CommandLine

```
xdoctest -m ~/code/kwcoco/kwcoco/metrics/detect_metrics.py eval_detections_cli
```

`class kwcoco.metrics.BinaryConfusionVectors(data, cx=None, classes=None)`

Bases: `ubelt.NiceRepr`

Stores information about a binary classification problem. This is always with respect to a specific class, which is given by `cx` and `classes`.

The **data DataFrameArray** must contain `is_true` - if the row is an instance of class `classes[cx]` `pred_score` - the predicted probability of class `classes[cx]`, and `weight` - sample weight of the example

### Example

```
>>> from kwcoco.metrics.confusion_vectors import * # NOQA
>>> self = BinaryConfusionVectors.demo(n=10)
>>> print('self = {!r}'.format(self))
>>> print('measures = {}'.format(ub.repr2(self.measures())))
```

```
>>> self = BinaryConfusionVectors.demo(n=0)
>>> print('measures = {}'.format(ub.repr2(self.measures())))
```

```
>>> self = BinaryConfusionVectors.demo(n=1)
>>> print('measures = {}'.format(ub.repr2(self.measures())))
```

```
>>> self = BinaryConfusionVectors.demo(n=2)
>>> print('measures = {}'.format(ub.repr2(self.measures())))
```

**classmethod** `demo(cls, n=10, p_true=0.5, p_error=0.2, p_miss=0.0, rng=None)`

Create random data for tests

#### Parameters

- **n** (*int*) – number of rows
- **p\_true** (*int*) – fraction of real positive cases
- **p\_error** (*int*) – probability of making a recoverable mistake
- **p\_miss** (*int*) – probability of making an unrecoverable mistake
- **rng** (*int* | *RandomState*) – random seed / state

**Returns** `BinaryConfusionVectors`

### Example

```
>>> from kwcoco.metrics.confusion_vectors import * # NOQA
>>> cfsn = BinaryConfusionVectors.demo(n=1000, p_error=0.1, p_miss=0.1)
>>> measures = cfsn.measures()
>>> print('measures = {}'.format(ub.repr2(measures, nl=1)))
>>> # xdoctest: +REQUIRES(--show)
>>> import kwplot
>>> kwplot.autompl()
>>> kwplot.figure(fnum=1, pnum=(1, 2, 1))
>>> measures.draw('pr')
>>> kwplot.figure(fnum=1, pnum=(1, 2, 2))
>>> measures.draw('roc')
```

**property** `catname(self)`

`__nice__(self)`

`__len__(self)`

**measures**(*self*, *stabilize\_thresh*=7, *fp\_cutoff*=None, *monotonic\_ppv*=True, *ap\_method*='pycocotools')

Get statistics (F1, G1, MCC) versus thresholds

### Parameters

- **stabilize\_thresh** (*int*, *default=7*) – if fewer than this many data points inserts dummy stabilization data so curves can still be drawn.
- **fp\_cutoff** (*int*, *default=None*) – maximum number of false positives in the truncated roc curves. None is equivalent to `float('inf')`
- **monotonic\_ppv** (*bool*, *default=True*) – if True ensures that precision is always increasing as recall decreases. This is done in pycocotools scoring, but I'm not sure its a good idea.

### Example

```
>>> from kwcoco.metrics.confusion_vectors import * # NOQA
>>> self = BinaryConfusionVectors.demo(n=0)
>>> print('measures = {}'.format(ub.repr2(self.measures())))
>>> self = BinaryConfusionVectors.demo(n=1, p_true=0.5, p_error=0.5)
>>> print('measures = {}'.format(ub.repr2(self.measures())))
>>> self = BinaryConfusionVectors.demo(n=3, p_true=0.5, p_error=0.5)
>>> print('measures = {}'.format(ub.repr2(self.measures())))
```

```
>>> self = BinaryConfusionVectors.demo(n=100, p_true=0.5, p_error=0.5, p_miss=0.
↳ 3)
>>> print('measures = {}'.format(ub.repr2(self.measures())))
>>> print('measures = {}'.format(ub.repr2(ub.odict(self.measures()))))
```

### References

[https://en.wikipedia.org/wiki/Confusion\\_matrix](https://en.wikipedia.org/wiki/Confusion_matrix) [https://en.wikipedia.org/wiki/Precision\\_and\\_recall](https://en.wikipedia.org/wiki/Precision_and_recall) [https://en.wikipedia.org/wiki/Matthews\\_correlation\\_coefficient](https://en.wikipedia.org/wiki/Matthews_correlation_coefficient)

### **\_binary\_clf\_curves**(*self*, *stabilize\_thresh=7*, *fp\_cutoff=None*)

Compute TP, FP, TN, and FN counts for this binary confusion vector.

Code common to ROC, PR, and threshold measures, computes the elements of the binary confusion matrix at all relevant operating point thresholds.

### Parameters

- **stabilize\_thresh** (*int*) – if fewer than this many data points insert stabilization data.
- **fp\_cutoff** (*int*) – maximum number of false positives

### Example

```
>>> from kwcoco.metrics.confusion_vectors import * # NOQA
>>> self = BinaryConfusionVectors.demo(n=1, p_true=0.5, p_error=0.5)
>>> self._binary_clf_curves()
```

```
>>> self = BinaryConfusionVectors.demo(n=0, p_true=0.5, p_error=0.5)
>>> self._binary_clf_curves()
```

```
>>> self = BinaryConfusionVectors.demo(n=100, p_true=0.5, p_error=0.5)
>>> self._binary_clf_curves()
```

```
draw_distribution(self)
```

```
_3dplot(self)
```

### Example

```
>>> # xdoctest: +REQUIRES(module:kwplot)
>>> # xdoctest: +REQUIRES(module:pandas)
>>> from kwcoco.metrics.confusion_vectors import * # NOQA
>>> from kwcoco.metrics.detect_metrics import DetectionMetrics
>>> dmet = DetectionMetrics.demo(
>>>     n_fp=(0, 1), n_fn=(0, 2), nimgs=256, nboxes=(0, 10),
>>>     bbox_noise=10,
>>>     classes=1)
>>> cfsn_vecs = dmet.confusion_vectors()
>>> self = bin_cfsn = cfsn_vecs.binarize_classless()
>>> #dmet.summarize(plot=True)
>>> import kwplot
>>> kwplot.autompl()
>>> kwplot.figure(fnum=3)
>>> self._3dplot()
```

**class** kwcoco.metrics.**ConfusionVectors**(cfsn\_vecs, data, classes, probs=None)

Bases: `ubelt.NiceRepr`

Stores information used to construct a confusion matrix. This includes corresponding vectors of predicted labels, true labels, sample weights, etc...

### Variables

- **data** (`kwarray.DataFrameArray`) – should at least have keys true, pred, weight
- **classes** (`Sequence` | `CategoryTree`) – list of category names or category graph
- **probs** (`ndarray`, optional) – probabilities for each class

### Example

```
>>> # xdoctest: IGNORE_WANT
>>> # xdoctest: +REQUIRES(module:pandas)
>>> from kwcoco.metrics import DetectionMetrics
>>> dmet = DetectionMetrics.demo(
>>>     nimgs=10, nboxes=(0, 10), n_fp=(0, 1), classes=3)
>>> cfsn_vecs = dmet.confusion_vectors()
>>> print(cfsn_vecs.data._pandas())
```

	pred	true	score	weight	iou	txs	pxs	gid
0	2	2	10.0000	1.0000	1.0000	0	4	0
1	2	2	7.5025	1.0000	1.0000	1	3	0
2	1	1	5.0050	1.0000	1.0000	2	2	0
3	3	-1	2.5075	1.0000	-1.0000	-1	1	0

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4	2	-1	0.0100	1.0000	-1.0000	-1	0	0
5	-1	2	0.0000	1.0000	-1.0000	3	-1	0
6	-1	2	0.0000	1.0000	-1.0000	4	-1	0
7	2	2	10.0000	1.0000	1.0000	0	5	1
8	2	2	8.0020	1.0000	1.0000	1	4	1
9	1	1	6.0040	1.0000	1.0000	2	3	1
..	...	...	...	...	...	...	...	...
62	-1	2	0.0000	1.0000	-1.0000	7	-1	7
63	-1	3	0.0000	1.0000	-1.0000	8	-1	7
64	-1	1	0.0000	1.0000	-1.0000	9	-1	7
65	1	-1	10.0000	1.0000	-1.0000	-1	0	8
66	1	1	0.0100	1.0000	1.0000	0	1	8
67	3	-1	10.0000	1.0000	-1.0000	-1	3	9
68	2	2	6.6700	1.0000	1.0000	0	2	9
69	2	2	3.3400	1.0000	1.0000	1	1	9
70	3	-1	0.0100	1.0000	-1.0000	-1	0	9
71	-1	2	0.0000	1.0000	-1.0000	2	-1	9

```

>>> # xdoctest: +REQUIRES(--show)
>>> # xdoctest: +REQUIRES(module:pandas)
>>> import kwplot
>>> kwplot.autompl()
>>> from kw Coco.metrics.confusion_vectors import ConfusionVectors
>>> cfsn_vecs = ConfusionVectors.demo(
>>>     nimgs=128, nboxes=(0, 10), n_fp=(0, 3), n_fn=(0, 3), classes=3)
>>> cx_to_binvecs = cfsn_vecs.binarize_ovr()
>>> measures = cx_to_binvecs.measures()['perclass']
>>> print('measures = {!r}'.format(measures))
measures = <PerClass_Measures({
    'cat_1': <Measures({'ap': 0.227, 'auc': 0.507, 'catname': cat_1, 'max_f1': f1=0.
↪45@0.47, 'nsupport': 788.000})>,
    'cat_2': <Measures({'ap': 0.288, 'auc': 0.572, 'catname': cat_2, 'max_f1': f1=0.
↪51@0.43, 'nsupport': 788.000})>,
    'cat_3': <Measures({'ap': 0.225, 'auc': 0.484, 'catname': cat_3, 'max_f1': f1=0.
↪46@0.40, 'nsupport': 788.000})>,
}) at 0x7facf77bdfd0>
>>> kwplot.figure(fnum=1, doclf=True)
>>> measures.draw(key='pr', fnum=1, pnum=(1, 3, 1))
>>> measures.draw(key='roc', fnum=1, pnum=(1, 3, 2))
>>> measures.draw(key='mcc', fnum=1, pnum=(1, 3, 3))
...

```

`__nice__(cfsn_vecs)`

`__json__(self)`

Serialize to json

### Example

```
>>> # xdoctest: +REQUIRES(module:pandas)
>>> from kwcoco.metrics import ConfusionVectors
>>> self = ConfusionVectors.demo(n_imgs=1, classes=2, n_fp=0, nboxes=1)
>>> state = self.__json__()
>>> print('state = {}'.format(ub.repr2(state, nl=2, precision=2, align=1)))
>>> recon = ConfusionVectors.from_json(state)
```

**classmethod** `from_json(cls, state)`

**classmethod** `demo(cfsn_vecs, **kw)`

**Parameters** **\*\*kwargs** – See `kwcoco.metrics.DetectionMetrics.demo()`

**Returns** `ConfusionVectors`

### Example

```
>>> cfsn_vecs = ConfusionVectors.demo()
>>> print('cfsn_vecs = {}'.format(cfsn_vecs))
>>> cx_to_binvecs = cfsn_vecs.binarize_ovr()
>>> print('cx_to_binvecs = {}'.format(cx_to_binvecs))
```

**classmethod** `from_arrays(ConfusionVectors, true, pred=None, score=None, weight=None, probs=None, classes=None)`

Construct confusion vector data structure from component arrays

### Example

```
>>> # xdoctest: +REQUIRES(module:pandas)
>>> import kwarrray
>>> classes = ['person', 'vehicle', 'object']
>>> rng = kwarrray.ensure_rng(0)
>>> true = (rng.rand(10) * len(classes)).astype(int)
>>> probs = rng.rand(len(true), len(classes))
>>> cfsn_vecs = ConfusionVectors.from_arrays(true=true, probs=probs,
↳ classes=classes)
>>> cfsn_vecs.confusion_matrix()
pred    person  vehicle  object
real
person      0         0         0
vehicle     2         4         1
object      2         1         0
```

**confusion\_matrix(cfsn\_vecs, compress=False)**

Builds a confusion matrix from the confusion vectors.

**Parameters** **compress** (*bool, default=False*) – if True removes rows / columns with no entries

**Returns**

**cm** [the labeled confusion matrix]

(Note: we should write a efficient replacement for this use case. #remove\_pandas)

Return type `pd.DataFrame`

## CommandLine

```
xdoctest -m kwcoco.metrics.confusion_vectors ConfusionVectors.confusion_matrix
```

## Example

```
>>> # xdoctest: +REQUIRES(module:pandas)
>>> from kwcoco.metrics import DetectionMetrics
>>> dmet = DetectionMetrics.demo(
>>>     nimgs=10, nboxes=(0, 10), n_fp=(0, 1), n_fn=(0, 1), classes=3, cls_
↳ noise=.2)
>>> cfsn_vecs = dmet.confusion_vectors()
>>> cm = cfsn_vecs.confusion_matrix()
...
>>> print(cm.to_string(float_format=lambda x: '%.2f' % x))
pred      background  cat_1  cat_2  cat_3
real
background      0.00   1.00   2.00   3.00
cat_1            3.00  12.00   0.00   0.00
cat_2            3.00   0.00  14.00   0.00
cat_3            2.00   0.00   0.00  17.00
```

**coarsen**(*cfsn\_vecs*, *cxs*)

Creates a coarsened set of vectors

**Returns** `ConfusionVectors`

**binarize\_classless**(*cfsn\_vecs*, *negative\_classes=None*)

Creates a binary representation useful for measuring the performance of detectors. It is assumed that scores of “positive” classes should be high and “negative” classes should be low.

**Parameters** **negative\_classes** (*List[str | int]*) – list of negative class names or idxs, by default chooses any class with a true class index of -1. These classes should ideally have low scores.

**Returns** `BinaryConfusionVectors`

---

**Note:** The “classlessness” of this depends on the `compat=”all”` argument being used when constructing confusion vectors, otherwise it becomes something like a macro-average because the class information was used in deciding which true and predicted boxes were allowed to match.

---

### Example

```
>>> from kwcoco.metrics import DetectionMetrics
>>> dmet = DetectionMetrics.demo(
>>>     nimgs=10, nboxes=(0, 10), n_fp=(0, 1), n_fn=(0, 1), classes=3)
>>> cfsn_vecs = dmet.confusion_vectors()
>>> class_idxes = list(dmet.classes.node_to_idx.values())
>>> binvecs = cfsn_vecs.binarize_classless()
```

**binarize\_ovr**(*cfsn\_vecs*, *mode=1*, *keyby='name'*, *ignore\_classes={'ignore'}*, *approx=0*)

Transforms *cfsn\_vecs* into one-vs-rest BinaryConfusionVectors for each category.

#### Parameters

- **mode** (*int*, *default=1*) – 0 for heirarchy aware or 1 for voc like. MODE 0 IS PROBABLY BROKEN
- **keyby** (*int* | *str*) – can be cx or name
- **ignore\_classes** (*Set[str]*) – category names to ignore
- **approx** (*bool*, *default=0*) – if True try and approximate missing scores otherwise assume they are irrecoverable and use -inf

#### Returns

which behaves like Dict[int, BinaryConfusionVectors]: *cx\_to\_binvecs*

Return type *OneVsRestConfusionVectors*

### Example

```
>>> from kwcoco.metrics.confusion_vectors import * # NOQA
>>> cfsn_vecs = ConfusionVectors.demo()
>>> print('cfsn_vecs = {!r}'.format(cfsn_vecs))
>>> catname_to_binvecs = cfsn_vecs.binarize_ovr(keyby='name')
>>> print('catname_to_binvecs = {!r}'.format(catname_to_binvecs))
```

*cfsn\_vecs*.data.pandas() *catname\_to\_binvecs*.cx\_to\_binvecs['class\_1'].data.pandas()

---

#### Note:

---

**classification\_report**(*cfsn\_vecs*, *verbose=0*)

Build a classification report with various metrics.

### Example

```
>>> # xdoctest: +REQUIRES(module:pandas)
>>> from kwcoco.metrics.confusion_vectors import * # NOQA
>>> cfsn_vecs = ConfusionVectors.demo()
>>> report = cfsn_vecs.classification_report(verbose=1)
```

```
class kwcoco.metrics.Measures(info)
```

Bases: `ubelt.NiceRepr`, `kwcoco.metrics.util.DictProxy`

Holds accumulated confusion counts, and derived measures

### Example

```
>>> from kwcoco.metrics.confusion_vectors import BinaryConfusionVectors # NOQA
>>> binvecs = BinaryConfusionVectors.demo(n=100, p_error=0.5)
>>> self = binvecs.measures()
>>> print('self = {!r}'.format(self))
>>> # xdoctest: +REQUIRES(--show)
>>> import kwplot
>>> kwplot.autompl()
>>> self.draw(doclf=True)
>>> self.draw(key='pr', pnum=(1, 2, 1))
>>> self.draw(key='roc', pnum=(1, 2, 2))
>>> kwplot.show_if_requested()
```

```
property catname(self)
```

```
__nice__(self)
```

```
reconstruct(self)
```

```
classmethod from_json(cls, state)
```

```
__json__(self)
```

### Example

```
>>> from kwcoco.metrics.confusion_vectors import BinaryConfusionVectors # NOQA
>>> from kwcoco.metrics.confusion_measures import * # NOQA
>>> binvecs = BinaryConfusionVectors.demo(n=10, p_error=0.5)
>>> self = binvecs.measures()
>>> info = self.__json__()
>>> print('info = {}'.format(ub.repr2(info, nl=1)))
>>> populate_info(info)
>>> print('info = {}'.format(ub.repr2(info, nl=1)))
>>> recon = Measures.from_json(info)
```

```
summary(self)
```

```
maximized_thresholds(self)
```

Returns thresholds that maximize metrics.

`counts(self)`

`draw(self, key=None, prefix="", **kw)`

### Example

```
>>> # xdoctest: +REQUIRES(module:kwplot)
>>> # xdoctest: +REQUIRES(module:pandas)
>>> from kwcoco.metrics.confusion_vectors import ConfusionVectors # NOQA
>>> cfsn_vecs = ConfusionVectors.demo()
>>> ovr_cfsn = cfsn_vecs.binarize_ovr(keyby='name')
>>> self = ovr_cfsn.measures()['perclass']
>>> self.draw('mcc', doclf=True, fnum=1)
>>> self.draw('pr', doclf=1, fnum=2)
>>> self.draw('roc', doclf=1, fnum=3)
```

`summary_plot(self, fnum=1, title="", subplots='auto')`

### Example

```
>>> from kwcoco.metrics.confusion_measures import * # NOQA
>>> from kwcoco.metrics.confusion_vectors import ConfusionVectors # NOQA
>>> cfsn_vecs = ConfusionVectors.demo(n=3, p_error=0.5)
>>> binvecs = cfsn_vecs.binarize_classless()
>>> self = binvecs.measures()
>>> # xdoctest: +REQUIRES(--show)
>>> import kwplot
>>> kwplot.autompl()
>>> self.summary_plot()
>>> kwplot.show_if_requested()
```

**classmethod** `demo(cls, **kwargs)`

Create a demo Measures object for testing / demos

**Parameters** `**kwargs` – passed to `BinaryConfusionVectors.demo()`. some valid keys are:  
n, rng, p\_rue, p\_error, p\_miss.

**classmethod** `combine(cls, tocombine, precision=None, growth=None, thresh_bins=None)`

Combine binary confusion metrics

#### Parameters

- **tocombine** (*List[Measures]*) – a list of measures to combine into one
- **precision** (*int | None*) – If specified rounds thresholds to this precision which can prevent a RAM explosion when combining a large number of measures. However, this is a lossy operation and will impact the underlying scores. NOTE: use `growth` instead.
- **growth** (*int | None*) – if specified this limits how much the resulting measures are allowed to grow by. If `None`, growth is unlimited. Otherwise, if growth is ‘max’, the growth is limited to the maximum length of an input. We might make this more numerical in the future.
- **thresh\_bins** (*int*) – Force this many threshold bins.

**Returns** Measures

### Example

```

>>> from kw Coco.metrics.confusion_measures import * # NOQA
>>> measures1 = Measures.demo(n=15)
>>> measures2 = measures1
>>> tocombine = [measures1, measures2]
>>> new_measures = Measures.combine(tocombine)
>>> new_measures.reconstruct()
>>> print('new_measures = {!r}'.format(new_measures))
>>> print('measures1 = {!r}'.format(measures1))
>>> print('measures2 = {!r}'.format(measures2))
>>> print(ub.repr2(measures1.__json__(), nl=1, sort=0))
>>> print(ub.repr2(measures2.__json__(), nl=1, sort=0))
>>> print(ub.repr2(new_measures.__json__(), nl=1, sort=0))
>>> # xdoctest: +REQUIRES(--show)
>>> import kwplot
>>> kwplot.autompl()
>>> kwplot.figure(fnum=1)
>>> new_measures.summary_plot()
>>> measures1.summary_plot()
>>> measures1.draw('roc')
>>> measures2.draw('roc')
>>> new_measures.draw('roc')

```

### Example

```

>>> # Demonstrate issues that can arise from choosing a precision
>>> # that is too low when combining metrics. Breakpoints
>>> # between different metrics can get muddled, but choosing a
>>> # precision that is too high can overwhelm memory.
>>> from kw Coco.metrics.confusion_measures import * # NOQA
>>> base = ub.map_vals(np.asarray, {
>>>     'tp_count': [1, 1, 2, 2, 2, 2, 3],
>>>     'fp_count': [0, 1, 1, 2, 3, 4, 5],
>>>     'fn_count': [1, 1, 0, 0, 0, 0, 0],
>>>     'tn_count': [5, 4, 4, 3, 2, 1, 0],
>>>     'thresholds': [.0, .0, .0, .0, .0, .0, .0],
>>> })
>>> # Make tiny offsets to thresholds
>>> rng = kwarray.ensure_rng(0)
>>> n = len(base['thresholds'])
>>> offsets = [
>>>     sorted(rng.rand(n) * 10 ** -rng.randint(4, 7))[:-1]
>>>     for _ in range(20)
>>> ]
>>> tocombine = []
>>> for offset in offsets:
>>>     base_n = base.copy()
>>>     base_n['thresholds'] += offset
>>>     measures_n = Measures(base_n).reconstruct()
>>>     tocombine.append(measures_n)

```

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```

>>> for precision in [6, 5, 2]:
>>>     combo = Measures.combine(tocombine, precision=precision).reconstruct()
>>>     print('precision = {!r}'.format(precision))
>>>     print('combo = {}'.format(ub.repr2(combo, nl=1)))
>>>     print('num_thresholds = {}'.format(len(combo['thresholds'])))
>>> for growth in [None, 'max', 'log', 'root', 'half']:
>>>     combo = Measures.combine(tocombine, growth=growth).reconstruct()
>>>     print('growth = {!r}'.format(growth))
>>>     print('combo = {}'.format(ub.repr2(combo, nl=1)))
>>>     print('num_thresholds = {}'.format(len(combo['thresholds'])))
>>>     #print(combo.counts().pandas())

```

### Example

```

>>> # Test case: combining a single measures should leave it unchanged
>>> from kwcoco.metrics.confusion_measures import * # NOQA
>>> measures = Measures.demo(n=40, p_true=0.2, p_error=0.4, p_miss=0.6)
>>> df1 = measures.counts().pandas().fillna(0)
>>> print(df1)
>>> tocombine = [measures]
>>> combo = Measures.combine(tocombine)
>>> df2 = combo.counts().pandas().fillna(0)
>>> print(df2)
>>> assert np.allclose(df1, df2)

```

```

>>> combo = Measures.combine(tocombine, thresh_bins=2)
>>> df3 = combo.counts().pandas().fillna(0)
>>> print(df3)

```

```

>>> # I am NOT sure if this is correct or not
>>> thresh_bins = 20
>>> combo = Measures.combine(tocombine, thresh_bins=thresh_bins)
>>> df4 = combo.counts().pandas().fillna(0)
>>> print(df4)

```

```

>>> combo = Measures.combine(tocombine, thresh_bins=np.linspace(0, 1, 20))
>>> df4 = combo.counts().pandas().fillna(0)
>>> print(df4)

```

```

assert np.allclose(combo['thresholds'], measures['thresholds']) assert np.allclose(combo['fp_count'],
measures['fp_count']) assert np.allclose(combo['tp_count'], measures['tp_count']) assert
np.allclose(combo['tp_count'], measures['tp_count'])

```

```

globals().update(xdev.get_func_kwargs(Measures.combine))

```



**Example**

```

>>> # Test degenerate case
>>> from kwcoco.metrics.confusion_measures import * # NOQA
>>> tocombine = [
>>>     {'fn_count': [0.0], 'fp_count': [359980.0], 'thresholds': [0.0], 'tn_
↳count': [0.0], 'tp_count': [7747.0]},
>>>     {'fn_count': [0.0], 'fp_count': [360849.0], 'thresholds': [0.0], 'tn_
↳count': [0.0], 'tp_count': [424.0]},
>>>     {'fn_count': [0.0], 'fp_count': [367003.0], 'thresholds': [0.0], 'tn_
↳count': [0.0], 'tp_count': [991.0]},
>>>     {'fn_count': [0.0], 'fp_count': [367976.0], 'thresholds': [0.0], 'tn_
↳count': [0.0], 'tp_count': [1017.0]},
>>>     {'fn_count': [0.0], 'fp_count': [676338.0], 'thresholds': [0.0], 'tn_
↳count': [0.0], 'tp_count': [7067.0]},
>>>     {'fn_count': [0.0], 'fp_count': [676348.0], 'thresholds': [0.0], 'tn_
↳count': [0.0], 'tp_count': [7406.0]},
>>>     {'fn_count': [0.0], 'fp_count': [676626.0], 'thresholds': [0.0], 'tn_
↳count': [0.0], 'tp_count': [7858.0]},
>>>     {'fn_count': [0.0], 'fp_count': [676693.0], 'thresholds': [0.0], 'tn_
↳count': [0.0], 'tp_count': [10969.0]},
>>>     {'fn_count': [0.0], 'fp_count': [677269.0], 'thresholds': [0.0], 'tn_
↳count': [0.0], 'tp_count': [11188.0]},
>>>     {'fn_count': [0.0], 'fp_count': [677331.0], 'thresholds': [0.0], 'tn_
↳count': [0.0], 'tp_count': [11734.0]},
>>>     {'fn_count': [0.0], 'fp_count': [677395.0], 'thresholds': [0.0], 'tn_
↳count': [0.0], 'tp_count': [11556.0]},
>>>     {'fn_count': [0.0], 'fp_count': [677418.0], 'thresholds': [0.0], 'tn_
↳count': [0.0], 'tp_count': [11621.0]},
>>>     {'fn_count': [0.0], 'fp_count': [677422.0], 'thresholds': [0.0], 'tn_
↳count': [0.0], 'tp_count': [11424.0]},
>>>     {'fn_count': [0.0], 'fp_count': [677648.0], 'thresholds': [0.0], 'tn_
↳count': [0.0], 'tp_count': [9804.0]},
>>>     {'fn_count': [0.0], 'fp_count': [677826.0], 'thresholds': [0.0], 'tn_
↳count': [0.0], 'tp_count': [2470.0]},
>>>     {'fn_count': [0.0], 'fp_count': [677834.0], 'thresholds': [0.0], 'tn_
↳count': [0.0], 'tp_count': [2470.0]},
>>>     {'fn_count': [0.0], 'fp_count': [677835.0], 'thresholds': [0.0], 'tn_
↳count': [0.0], 'tp_count': [2470.0]},
>>>     {'fn_count': [11123.0, 0.0], 'fp_count': [0.0, 676754.0], 'thresholds': 0.
↳[0.0002442002442002442, 0.0], 'tn_count': [676754.0, 0.0], 'tp_count': [2.0, 0.
↳11125.0]},
>>>     {'fn_count': [7738.0, 0.0], 'fp_count': [0.0, 676466.0], 'thresholds': 0.
↳[0.0002442002442002442, 0.0], 'tn_count': [676466.0, 0.0], 'tp_count': [0.0, 0.
↳7738.0]},
>>>     {'fn_count': [8653.0, 0.0], 'fp_count': [0.0, 676341.0], 'thresholds': 0.
↳[0.0002442002442002442, 0.0], 'tn_count': [676341.0, 0.0], 'tp_count': [0.0, 0.
↳8653.0]},
>>> ]
>>> thresh_bins = np.linspace(0, 1, 4)
>>> combo = Measures.combine(tocombine, thresh_bins=thresh_bins).reconstruct()
>>> print('tocombine = {}'.format(ub.repr2(tocombine, nl=2)))
>>> print('thresh_bins = {!r}'.format(thresh_bins))

```

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```

>>> print(ub.repr2(combo.__json__(), nl=1))
>>> for thresh_bins in [4096, 1]:
>>>     combo = Measures.combine(tocombine, thresh_bins=thresh_bins).
↳reconstruct()
>>>     print('thresh_bins = {!r}'.format(thresh_bins))
>>>     print('combo = {}'.format(ub.repr2(combo, nl=1)))
>>>     print('num_thresholds = {}'.format(len(combo['thresholds'])))
>>> for precision in [6, 5, 2]:
>>>     combo = Measures.combine(tocombine, precision=precision).reconstruct()
>>>     print('precision = {!r}'.format(precision))
>>>     print('combo = {}'.format(ub.repr2(combo, nl=1)))
>>>     print('num_thresholds = {}'.format(len(combo['thresholds'])))
>>> for growth in [None, 'max', 'log', 'root', 'half']:
>>>     combo = Measures.combine(tocombine, growth=growth).reconstruct()
>>>     print('growth = {!r}'.format(growth))
>>>     print('combo = {}'.format(ub.repr2(combo, nl=1)))
>>>     print('num_thresholds = {}'.format(len(combo['thresholds'])))

```

**class** kwcoco.metrics.OneVsRestConfusionVectors(*cx\_to\_binvecs*, *classes*)

Bases: `ubelt.NiceRepr`

Container for multiple one-vs-rest binary confusion vectors

#### Variables

- **cx\_to\_binvecs** –
- **classes** –

#### Example

```

>>> from kwcoco.metrics import DetectionMetrics
>>> dmet = DetectionMetrics.demo(
>>>     nimgs=10, nboxes=(0, 10), n_fp=(0, 1), classes=3)
>>> cfsn_vecs = dmet.confusion_vectors()
>>> self = cfsn_vecs.binarize_ovr(keyby='name')
>>> print('self = {!r}'.format(self))

```

`__nice__`(*self*)

**classmethod** `demo`(*cls*)

**Parameters** **\*\*kwargs** – See `kwcoco.metrics.DetectionMetrics.demo()`

**Returns** ConfusionVectors

**keys**(*self*)

`__getitem__`(*self*, *cx*)

**measures**(*self*, *stabilize\_thresh*=7, *fp\_cutoff*=None, *monotonic\_ppv*=True, *ap\_method*='pycocotools')

Creates binary confusion measures for every one-versus-rest category.

#### Parameters

- **stabilize\_thresh** (*int*, *default*=7) – if fewer than this many data points inserts dummy stabilization data so curves can still be drawn.

- **fp\_cutoff** (*int, default=None*) – maximum number of false positives in the truncated roc curves. None is equivalent to `float('inf')`
- **monotonic\_ppv** (*bool, default=True*) – if True ensures that precision is always increasing as recall decreases. This is done in pycocotools scoring, but I'm not sure its a good idea.

SeeAlso: `BinaryConfusionVectors.measures()`

### Example

```
>>> self = OneVsRestConfusionVectors.demo()
>>> thresh_result = self.measures()['perclass']
```

**abstract ovr\_classification\_report**(*self*)

```
class kwcoco.metrics.PerClass_Measures(cx_to_info)
    Bases: ubelt.NiceRepr, kwcoco.metrics.util.DictProxy
    __nice__(self)
    summary(self)
    classmethod from_json(cls, state)
    __json__(self)
    draw(self, key='mcc', prefix='', **kw)
```

### Example

```
>>> # xdoctest: +REQUIRES(module:kwplot)
>>> from kwcoco.metrics.confusion_vectors import ConfusionVectors # NOQA
>>> cfsn_vecs = ConfusionVectors.demo()
>>> ovr_cfsn = cfsn_vecs.binarize_ovr(keyby='name')
>>> self = ovr_cfsn.measures()['perclass']
>>> self.draw('mcc', doclf=True, fnum=1)
>>> self.draw('pr', doclf=1, fnum=2)
>>> self.draw('roc', doclf=1, fnum=3)
```

**draw\_roc**(*self, prefix='', \*\*kw*)

**draw\_pr**(*self, prefix='', \*\*kw*)

**summary\_plot**(*self, fnum=1, title='', subplots='auto'*)

## CommandLine

```
python ~/code/kwcoco/kwcoco/metrics/confusion_measures.py PerClass_Measures.  
↪summary_plot --show
```

## Example

```
>>> from kwcoco.metrics.confusion_measures import * # NOQA  
>>> from kwcoco.metrics.detect_metrics import DetectionMetrics  
>>> dmet = DetectionMetrics.demo(  
>>>     n_fp=(0, 1), n_fn=(0, 3), nimgs=32, nboxes=(0, 32),  
>>>     classes=3, rng=0, newstyle=1, box_noise=0.7, cls_noise=0.2, score_  
↪noise=0.3, with_probs=False)  
>>> cfsn_vecs = dmet.confusion_vectors()  
>>> ovr_cfsn = cfsn_vecs.binarize_ovr(keyby='name', ignore_classes=['vector',  
↪'raster'])  
>>> self = ovr_cfsn.measures()['perclass']  
>>> # xdoctest: +REQUIRES(--show)  
>>> import kwplot  
>>> kwplot.autompl()  
>>> import seaborn as sns  
>>> sns.set()  
>>> self.summary_plot(title='demo summary_plot ovr', subplots=['pr', 'roc'])  
>>> kwplot.show_if_requested()  
>>> self.summary_plot(title='demo summary_plot ovr', subplots=['mcc', 'acc'],  
↪fnum=2)
```

## 2.2.6 kwcoco.util

```
mkinit ~/code/kwcoco/kwcoco/util/__init__.py -w
```

### Submodules

`kwcoco.util.dict_like`

### Module Contents

### Classes

---

<i>DictLike</i>	An inherited class must specify the <code>getitem</code> , <code>setitem</code> , and
-----------------	---

---

**class** `kwcoco.util.dict_like.DictLike`

Bases: `ubelt.NiceRepr`

An inherited class must specify the `getitem`, `setitem`, and `keys` methods.

A class is dictionary like if it has:

`__iter__`, `__len__`, `__contains__`, `__getitem__`, `items`, `keys`, `values`, `get`,

and if it should be writable it should have: `__delitem__`, `__setitem__`, `update`,

And perhaps: `copy`,

`__iter__`, `__len__`, `__contains__`, `__getitem__`, `items`, `keys`, `values`, `get`,

and if it should be writable it should have: `__delitem__`, `__setitem__`, `update`,

And perhaps: `copy`,

**asdict**

**abstract** `getitem`(*self*, *key*)

**abstract** `setitem`(*self*, *key*, *value*)

**abstract** `delitem`(*self*, *key*)

**abstract** `keys`(*self*)

`__len__`(*self*)

`__iter__`(*self*)

`__contains__`(*self*, *key*)

`__delitem__`(*self*, *key*)

`__getitem__`(*self*, *key*)

`__setitem__`(*self*, *key*, *value*)

`items`(*self*)

`values`(*self*)

`copy`(*self*)

`to_dict`(*self*)

`update`(*self*, *other*)

`get`(*self*, *key*, *default=None*)

## **kwcoco.util.jsonschema\_elements**

Functional interface into defining jsonschema structures.

See mixin classes for details.

## Example

```
>>> from kwcoco.util.jsonschema_elements import * # NOQA
>>> elem = SchemaElements()
>>> for base in SchemaElements.__bases__:
>>>     print('\n\n====\nbase = {!r}'.format(base))
>>>     attrs = [key for key in dir(base) if not key.startswith('_')]
>>>     for key in attrs:
>>>         value = getattr(elem, key)
>>>         print('{} = {}'.format(key, value))
```

## Module Contents

### Classes

<i>Element</i>	A dictionary used to define an element of a JSON Schema.
<i>ScalarElements</i>	Single-valued elements
<i>QuantifierElements</i>	Quantifier types
<i>ContainerElements</i>	Types that contain other types
<i>SchemaElements</i>	Functional interface into defining jsonschema structures.

## Attributes

*elem**ALLOF**ANY**ANYOF**ARRAY**BOOLEAN**INTEGER**NOT**NULL**NUMBER**OBJECT**ONEOF**STRING*

**class** kwcoco.util.jsonschema\_elements.**Element**(base, options={}, \_magic=None)

Bases: `dict`

A dictionary used to define an element of a JSON Schema.

The exact keys/values for the element will depend on the type of element being described. The *SchemaElements* defines exactly what these are for the core elements. (e.g. OBJECT, INTEGER, NULL, ARRAY, ANYOF)

## Example

```
>>> from kwcoco.coco_schema import * # NOQA
>>> self = Element(base={'type': 'demo'}, options={'opt1', 'opt2'})
>>> new = self(opt1=3)
>>> print('self = {}'.format(ub.repr2(self, nl=1, sort=1)))
>>> print('new = {}'.format(ub.repr2(new, nl=1, sort=1)))
>>> print('new2 = {}'.format(ub.repr2(new(), nl=1, sort=1)))
>>> print('new3 = {}'.format(ub.repr2(new(title='myvar'), nl=1, sort=1)))
>>> print('new4 = {}'.format(ub.repr2(new(title='myvar')(examples=['']), nl=1,
↪ sort=1)))
>>> print('new5 = {}'.format(ub.repr2(new(badattr=True), nl=1, sort=1)))
self = {
    'type': 'demo',
```

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```

}
new = {
    'opt1': 3,
    'type': 'demo',
}
new2 = {
    'opt1': 3,
    'type': 'demo',
}
new3 = {
    'opt1': 3,
    'title': 'myvar',
    'type': 'demo',
}
new4 = {
    'examples': [''],
    'opt1': 3,
    'title': 'myvar',
    'type': 'demo',
}
new5 = {
    'opt1': 3,
    'type': 'demo',
}

```

**\_\_generics\_\_**

**\_\_call\_\_**(*self*, \**args*, \*\**kw*)

**validate**(*self*, *instance*=*ub.NoParam*)

If *instance* is given, validates that that dictionary conforms to this schema. Otherwise validates that this is a valid schema element.

**Parameters** *instance* (*dict*) – a dictionary to validate

**\_\_or\_\_**(*self*, *other*)

Syntax for making an anyOf relationship

## Example

```

>>> from kwcoco.util.jsonschema_elements import * # NOQA
>>> obj1 = OBJECT(dict(opt1=NUMBER()))
>>> obj2 = OBJECT(dict(opt2=STRING()))
>>> obj3 = OBJECT(dict(opt3=ANY()))
>>> any_v1 = obj1 | obj2
>>> any_v2 = ANYOF(obj1, obj2)
>>> assert any_v1 == any_v2
>>> any_v3 = any_v1 | obj3
>>> any_v4 = ANYOF(obj1, obj2, obj3)
>>> assert any_v3 == any_v4

```

**class** kwcoco.util.jsonschema\_elements.ScalarElements

Bases: `object`



Single-valued elements

**property** `NULL(self)`

<https://json-schema.org/understanding-json-schema/reference/null.html>

**property** `BOOLEAN(self)`

<https://json-schema.org/understanding-json-schema/reference/null.html>

**property** `STRING(self)`

<https://json-schema.org/understanding-json-schema/reference/string.html>

**property** `NUMBER(self)`

<https://json-schema.org/understanding-json-schema/reference/numeric.html#number>

**property** `INTEGER(self)`

<https://json-schema.org/understanding-json-schema/reference/numeric.html#integer>

**class** `kwcoco.util.jsonschema_elements.QuantifierElements`

Bases: `object`

Quantifier types

<https://json-schema.org/understanding-json-schema/reference/combining.html#allof>

### Example

```
>>> from kwcoco.util.jsonschema_elements import * # NOQA
>>> elem.ANYOF(elem.STRING, elem.NUMBER).validate()
>>> elem.ONEOF(elem.STRING, elem.NUMBER).validate()
>>> elem.NOT(elem.NULL).validate()
>>> elem.NOT(elem.ANY).validate()
>>> elem.ANY.validate()
```

**property** `ANY(self)`

**ALLOF** `(self, *TYPES)`

**ANYOF** `(self, *TYPES)`

**ONEOF** `(self, *TYPES)`

**NOT** `(self, TYPE)`

**class** `kwcoco.util.jsonschema_elements.ContainerElements`

Types that contain other types

### Example

```
>>> from kwcoco.util.jsonschema_elements import * # NOQA
>>> print(elem.ARRAY().validate())
>>> print(elem.OBJECT().validate())
>>> print(elem.OBJECT().validate())
{'type': 'array', 'items': {}}
{'type': 'object', 'properties': {}}
{'type': 'object', 'properties': {}}
```

**ARRAY**(*self*, TYPE={}, \*\**kw*)<https://json-schema.org/understanding-json-schema/reference/array.html>

### Example

```
>>> from kwcoco.util.jsonschema_elements import * # NOQA
>>> ARRAY(numItems=3)
>>> schema = ARRAY(minItems=3)
>>> schema.validate()
{'type': 'array', 'items': {}, 'minItems': 3}
```

**OBJECT**(*self*, PROPERTIES={}, \*\**kw*)<https://json-schema.org/understanding-json-schema/reference/object.html>

### Example

```
>>> import jsonschema
>>> schema = elem.OBJECT()
>>> jsonschema.validate({}, schema)
>>> #
>>> import jsonschema
>>> schema = elem.OBJECT({
>>>     'key1': elem.ANY(),
>>>     'key2': elem.ANY(),
>>> }, required=['key1'])
>>> jsonschema.validate({'key1': None}, schema)
>>> #
>>> import jsonschema
>>> schema = elem.OBJECT({
>>>     'key1': elem.OBJECT({'arr': elem.ARRAY()}),
>>>     'key2': elem.ANY(),
>>> }, required=['key1'], title='a title')
>>> schema.validate()
>>> print('schema = {}'.format(ub.repr2(schema, sort=1, nl=-1)))
>>> jsonschema.validate({'key1': {'arr': []}}, schema)
schema = {
  'properties': {
    'key1': {
      'properties': {
        'arr': {'items': {}, 'type': 'array'}
      },
      'type': 'object'
    },
    'key2': {}
  },
  'required': ['key1'],
  'title': 'a title',
  'type': 'object'
}
```

**class** kwcoco.util.jsonschema\_elements.SchemaElementsBases: *ScalarElements*, *QuantifierElements*, *ContainerElements*

Functional interface into defining jsonschema structures.

See mixin classes for details.

**References**<https://json-schema.org/understanding-json-schema/>**Todo:**

- [ ] Generics: title, description, default, examples

**CommandLine**

```
xdoctest -m /home/joncrall/code/kwcoco/kwcoco/util/jsonschema_elements.py
↳ SchemaElements
```

**Example**

```
>>> from kwcoco.util.jsonschema_elements import * # NOQA
>>> elem = SchemaElements()
>>> elem.ARRAY(elem.ANY())
>>> schema = OBJECT({
>>>     'prop1': ARRAY(INTEGER, minItems=3),
>>>     'prop2': ARRAY(String, numItems=2),
>>>     'prop3': ARRAY(OBJECT({
>>>         'subprob1': NUMBER,
>>>         'subprob2': NUMBER,
>>>     }))
>>> })
>>> print('schema = {}'.format(ub.repr2(schema, nl=2, sort=1)))
schema = {
    'properties': {
        'prop1': {'items': {'type': 'integer'}, 'minItems': 3, 'type': 'array'},
        'prop2': {'items': {'type': 'string'}, 'maxItems': 2, 'minItems': 2, 'type': 'array'},
        'prop3': {'items': {'properties': {'subprob1': {'type': 'number'}, 'subprob2': {'type': 'number'}}, 'type': 'object'}, 'type': 'array'},
    },
    'type': 'object',
}
```

```
>>> TYPE = elem.OBJECT({
>>>     'p1': ANY,
>>>     'p2': ANY,
>>> }, required=['p1'])
```

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```
>>> import jsonschema
>>> inst = {'p1': None}
>>> jsonschema.validate(inst, schema=TYPE)
>>> #jsonschema.validate({'p2': None}, schema=TYPE)
```

`kwcoco.util.jsonschema_elements.elem`  
`kwcoco.util.jsonschema_elements.ALLOF`  
`kwcoco.util.jsonschema_elements.ANY`  
`kwcoco.util.jsonschema_elements.ANYOF`  
`kwcoco.util.jsonschema_elements.ARRAY`  
`kwcoco.util.jsonschema_elements.BOOLEAN`  
`kwcoco.util.jsonschema_elements.INTEGER`  
`kwcoco.util.jsonschema_elements.NOT`  
`kwcoco.util.jsonschema_elements.NULL`  
`kwcoco.util.jsonschema_elements.NUMBER`  
`kwcoco.util.jsonschema_elements.OBJECT`  
`kwcoco.util.jsonschema_elements.ONEOF`  
`kwcoco.util.jsonschema_elements.STRING`

`kwcoco.util.lazy_frame_backends`

Ducktyped interfaces for loading subregions of images with standard slice syntax

## Module Contents

### Classes

---

<a href="#"><i>LazySpectralFrameFile</i></a>	Potentially faster than GDAL for HDR formats.
<a href="#"><i>LazyRasterIOFrameFile</i></a>	fpath = '/home/joncrall/.cache/kwcoco/demo/large_hyperspectral/big_img_1'
<a href="#"><i>LazyGDalFrameFile</i></a>	

---

## Functions

---

`_have_gdal()`

---

`_have_rasterio()`

---

`_have_spectral()`

---

`_demo_geoimg_with_nodata()`

## Example

---

`_rectify_slice_dim(part, D)`

---

`_validate_nonzero_data(file)`

Test to see if the image is all black.

---

`_read_envi_header(file)`

USAGE: `hdr = _read_envi_header(file)`

---

## Attributes

---

`profile`

---

`_GDAL_DTYPE_LUT`

---

`kwcoco.util.lazy_frame_backends.profile`

`kwcoco.util.lazy_frame_backends._have_gdal()`

`kwcoco.util.lazy_frame_backends._have_rasterio()`

`kwcoco.util.lazy_frame_backends._have_spectral()`

`kwcoco.util.lazy_frame_backends._GDAL_DTYPE_LUT`

**class** `kwcoco.util.lazy_frame_backends.LazySpectralFrameFile(fpath)`

Bases: `ubelt.NiceRepr`

Potentially faster than GDAL for HDR formats.

`_ds(self)`

**classmethod** `available(self)`

Returns True if this backend is available

**property** `ndim(self)`

**property** `shape(self)`

**property** `dtype(self)`

`__nice__(self)`

`__getitem__(self, index)`

```
class kwcoco.util.lazy_frame_backends.LazyRasterIOFrameFile(fpath)
    Bases: ubelt.NiceRepr

    fpath = '/home/joncrall/.cache/kwcoco/demo/large_hyperspectral/big_img_128.bsq' lazy_rio = LazyRasterI-
    OFrameFile(fpath) ds = lazy_rio._ds

    classmethod available(self)
        Returns True if this backend is available

    _ds(self)

    property ndim(self)

    property shape(self)

    property dtype(self)

    __nice__(self)

    __getitem__(self, index)

kwcoco.util.lazy_frame_backends._demo_geoimg_with_nodata()
```

### Example

```
from kwcoco.util.lazy_frame_backends import * # NOQA fpath = _demo_geoimg_with_nodata() self = LazyG-
DalFrameFile.demo()

class kwcoco.util.lazy_frame_backends.LazyGDalFrameFile(fpath, nodata=None)
    Bases: ubelt.NiceRepr
```

---

#### Todo:

- [ ] Move to its own backend module
  - [ ] When used with COCO, allow the image metadata to populate the height, width, and channels if possible.
- 

### Example

```
>>> # xdoctest: +REQUIRES(module:osgeo)
>>> self = LazyGDalFrameFile.demo()
>>> print('self = {!r}'.format(self))
>>> self[0:3, 0:3]
>>> self[:, :, 0]
>>> self[0]
>>> self[0, 3]
```

```
>>> # import kwplot
>>> # kwplot.imshow(self[:])
```

#### Parameters

- **nodata**

- `masking_method`

### Example

```
>>> # See if we can reproduce the INTERLEAVE bug
```

```
data = np.random.rand(128, 128, 64)
import kwimage
import ubelt as ub
from os.path import join
dpath = ub.ensure_app_cache_dir('kwcoco/tests/reader')
fpath = join(dpath, 'foo.tiff')
kwimage.imwrite(fpath, data, backend='skimage')
recon1 = kwimage.imread(fpath)
recon1.shape
```

```
self = LazyGDalFrameFile(fpath)
self.shape
self[:]
```

**classmethod** `available(self)`

Returns True if this backend is available

`_ds(self)`

**classmethod** `demo(cls, key='astro', dsize=None)`

**property** `ndim(self)`

**property** `shape(self)`

**property** `dtype(self)`

`__nice__(self)`

`__getitem__(self, index)`

### References

<https://gis.stackexchange.com/questions/162095/gdal-driver-create-typeerror>

### Example

```
>>> # Test nodata works correctly
>>> # xdoctest: +REQUIRES(module:osgeo)
>>> from kwcoco.util.lazy_frame_backends import * # NOQA
>>> from kwcoco.util.lazy_frame_backends import _demo_geoimg_with_nodata
>>> fpath = _demo_geoimg_with_nodata()
>>> self = LazyGDalFrameFile(fpath, nodata='auto')
>>> imdata = self[:]
>>> # xdoctest: +REQUIRES(--show)
>>> import kwplot
>>> import kwarray
>>> kwplot.autompl()
>>> imdata = kwimage.normalize_intensity(imdata)
>>> imdata = np.nan_to_num(imdata)
>>> kwplot.imshow(imdata)
```

`__array__(self)`

Allow this object to be passed to `np.asarray`

## References

<https://numpy.org/doc/stable/user/basics.dispatch.html>

`kwcoco.util.lazy_frame_backends._rectify_slice_dim(part, D)`

`kwcoco.util.lazy_frame_backends._validate_nonzero_data(file)`

Test to see if the image is all black.

May fail on all-black images

## Example

```
>>> # xdoctest: +REQUIRES(module:osgeo)
>>> import kwimage
>>> gpath = kwimage.grab_test_image_fpath()
>>> file = LazyGDalFrameFile(gpath)
>>> _validate_nonzero_data(file)
```

`kwcoco.util.lazy_frame_backends._read_envi_header(file)`

USAGE: `hdr = _read_envi_header(file)`

Reads an ENVI “.hdr” file header and returns the parameters in a dictionary as strings. Header field names are treated as case insensitive and all keys in the dictionary are lowercase.

Modified from `spectral/io/envi.py`

## References

<https://github.com/spectralpython/spectral>

`kwcoco.util.util_archive`

## Module Contents

### Classes

---

*Archive*

Abstraction over zipfile and tarfile

---

### Functions

---

*unarchive\_file*(archive\_fpath, output\_dpath='.', verbose=1, overwrite=True)

---

**class** `kwcoco.util.util_archive.Archive(fpath=None, mode='r', backend=None, file=None)`

Bases: `object`

Abstraction over zipfile and tarfile



---

**Todo:** see if we can use one of these other tools instead

---

**SeeAlso:** <https://github.com/RKrahl/archive-tools> <https://pypi.org/project/arlib/>

### Example

```
>>> from os.path import join
>>> dpath = ub.ensure_app_cache_dir('ubelt', 'tests', 'archive')
>>> ub.delete(dpath)
>>> dpath = ub.ensure_app_cache_dir(dpath)
>>> import pathlib
>>> dpath = pathlib.Path(dpath)
>>> #
>>> #
>>> mode = 'w'
>>> self1 = Archive(str(dpath / 'demo.zip'), mode=mode)
>>> self2 = Archive(str(dpath / 'demo.tar.gz'), mode=mode)
>>> #
>>> open(dpath / 'data_1only.txt', 'w').write('bazbzzz')
>>> open(dpath / 'data_2only.txt', 'w').write('bzzzz')
>>> open(dpath / 'data_both.txt', 'w').write('foobar')
>>> #
>>> self1.add(dpath / 'data_both.txt')
>>> self1.add(dpath / 'data_1only.txt')
>>> #
>>> self2.add(dpath / 'data_both.txt')
>>> self2.add(dpath / 'data_2only.txt')
>>> #
>>> self1.close()
>>> self2.close()
>>> #
>>> self1 = Archive(str(dpath / 'demo.zip'), mode='r')
>>> self2 = Archive(str(dpath / 'demo.tar.gz'), mode='r')
>>> #
>>> extract_dpath = ub.ensuredir(str(dpath / 'extracted'))
>>> extracted1 = self1.extractall(extract_dpath)
>>> extracted2 = self2.extractall(extract_dpath)
>>> for fpath in extracted2:
>>>     print(open(fpath, 'r').read())
>>> for fpath in extracted1:
>>>     print(open(fpath, 'r').read())
```

**classmethod** `_open(cls, fpath, mode)`

**\_\_iter\_\_**(*self*)

**classmethod** `coerce(cls, data)`

Either open an archive file path or coerce an existing ZipFile or tarfile structure into this wrapper class

**add**(*self*, *fpath*, *arcname=None*)

```
close(self)

__enter__(self)

__exit__(self, *args)

extractall(self, output_dpath='.', verbose=1, overwrite=True)
```

```
kwcoco.util.util_archive.unarchive_file(archive_fpath, output_dpath='.', verbose=1, overwrite=True)
```

### **kwcoco.util.util\_delayed\_poc**

This module is ported from ndsampler, and will likely eventually move to kwimage and be refactored using pymbolic

The classes in this file represent a tree of delayed operations.

Proof of concept for delayed chainable transforms in Python.

There are several optimizations that could be applied.

This is similar to GDAL's virtual raster table, but it works in memory and I think it is easier to chain operations.

**SeeAlso:** ../../dev/symbolic\_delayed.py

**Warning:** As the name implies this is a proof of concept, and the actual implementation was hacked together too quickly. Serious refactoring will be necessary.

Concepts:

Each class should be a layer that adds a new transformation on top of underlying nested layers. Adding new layers should be quick, and there should always be the option to “finalize” a stack of layers, chaining the transforms / operations and then applying one final efficient transform at the end.

---

**Todo:**

- [ ] **Need to handle masks / nodata values when warping. Might need to** rely more on gdal / rasterio for this.

---

Conventions:

- dsize = (always in width / height), no channels are present
- shape for images is always (height, width, channels)
- channels are always the last dimension of each image, if no channel dim is specified, finalize will add it.
- **Videos must be the last process in the stack, and add a leading** time dimension to the shape. dsize is still width, height, but shape is now: (time, height, width, chan)

## Example

```

>>> # Example demonstrating the motivating use case
>>> # We have multiple aligned frames for a video, but each of
>>> # those frames is in a different resolution. Furthermore,
>>> # each of the frames consists of channels in different resolutions.
>>> # Create raw channels in some "native" resolution for frame 1
>>> from kwcoco.util.util_delayed_poc import * # NOQA
>>> f1_chan1 = DelayedIdentity.demo('astro', chan=0, dsize=(300, 300))
>>> f1_chan2 = DelayedIdentity.demo('astro', chan=1, dsize=(200, 200))
>>> f1_chan3 = DelayedIdentity.demo('astro', chan=2, dsize=(10, 10))
>>> # Create raw channels in some "native" resolution for frame 2
>>> f2_chan1 = DelayedIdentity.demo('carl', dsize=(64, 64), chan=0)
>>> f2_chan2 = DelayedIdentity.demo('carl', dsize=(260, 260), chan=1)
>>> f2_chan3 = DelayedIdentity.demo('carl', dsize=(10, 10), chan=2)
>>> #
>>> # Delayed warp each channel into its "image" space
>>> # Note: the images never actually enter this space we transform through it
>>> f1_dsize = np.array((3, 3))
>>> f2_dsize = np.array((2, 2))
>>> f1_img = DelayedChannelConcat([
>>>     f1_chan1.delayed_warp(kwimage.Affine.scale(f1_dsize / f1_chan1.dsize), dsize=f1_
↳ dsize),
>>>     f1_chan2.delayed_warp(kwimage.Affine.scale(f1_dsize / f1_chan2.dsize), dsize=f1_
↳ dsize),
>>>     f1_chan3.delayed_warp(kwimage.Affine.scale(f1_dsize / f1_chan3.dsize), dsize=f1_
↳ dsize),
>>> ])
>>> f2_img = DelayedChannelConcat([
>>>     f2_chan1.delayed_warp(kwimage.Affine.scale(f2_dsize / f2_chan1.dsize), dsize=f2_
↳ dsize),
>>>     f2_chan2.delayed_warp(kwimage.Affine.scale(f2_dsize / f2_chan2.dsize), dsize=f2_
↳ dsize),
>>>     f2_chan3.delayed_warp(kwimage.Affine.scale(f2_dsize / f2_chan3.dsize), dsize=f2_
↳ dsize),
>>> ])
>>> # Combine frames into a video
>>> vid_dsize = np.array((280, 280))
>>> vid = DelayedFrameConcat([
>>>     f1_img.delayed_warp(kwimage.Affine.scale(vid_dsize / f1_img.dsize), dsize=vid_
↳ dsize),
>>>     f2_img.delayed_warp(kwimage.Affine.scale(vid_dsize / f2_img.dsize), dsize=vid_
↳ dsize),
>>> ])
>>> vid.nesting
>>> print('vid.nesting = {}'.format(ub.repr2(vid.__json__(), nl=-2)))
>>> final = vid.finalize(interpolation='nearest')
>>> # xdoctest: +REQUIRES(--show)
>>> import kwplot
>>> kwplot.autompl()
>>> kwplot.imshow(final[0], pnum=(1, 2, 1), fnum=1)
>>> kwplot.imshow(final[1], pnum=(1, 2, 2), fnum=1)

```

## Example

```
>>> import kwcoco
>>> dset = kwcoco.CocoDataset.demo('vidshapes8-multispectral')
>>> delayed = dset.delayed_load(1)
>>> from kwcoco.util.util_delayed_poc import * # NOQA
>>> astro = DelayedLoad.demo('astro')
>>> print('MSI = ' + ub.repr2(delayed.__json__(), nl=-3, sort=0))
>>> print('ASTRO = ' + ub.repr2(astro.__json__(), nl=2, sort=0))
```

```
>>> subchan = delayed.take_channels('B1|B8')
>>> subcrop = subchan.delayed_crop((slice(10, 80), slice(30, 50)))
>>> #
>>> subcrop.nesting()
>>> subchan.nesting()
>>> subchan.finalize()
>>> subcrop.finalize()
>>> #
>>> msi_crop = delayed.delayed_crop((slice(10, 80), slice(30, 50)))
>>> msi_warp = msi_crop.delayed_warp(kwimage.Affine.scale(3), dsize='auto')
>>> subdata = msi_warp.take_channels('B11|B1')
>>> final = subdata.finalize()
>>> assert final.shape == (210, 60, 2)
```

## Example

```
>>> # test case where an auxiliary image does not map entirely on the image.
>>> from kwcoco.util.util_delayed_poc import * # NOQA
>>> import kwimage
>>> from os.path import join
>>> dpath = ub.ensure_app_cache_dir('kwcoco/tests/delayed_poc')
>>> chan1_fpath = join(dpath, 'chan1.tiff')
>>> chan2_fpath = join(dpath, 'chan2.tiff')
>>> chan3_fpath = join(dpath, 'chan2.tiff')
>>> chan1_raw = np.random.rand(128, 128, 1)
>>> chan2_raw = np.random.rand(64, 64, 1)
>>> chan3_raw = np.random.rand(256, 256, 1)
>>> kwimage.imwrite(chan1_fpath, chan1_raw)
>>> kwimage.imwrite(chan2_fpath, chan2_raw)
>>> kwimage.imwrite(chan3_fpath, chan3_raw)
>>> #
>>> c1 = channel_spec.FusedChannelSpec.coerce('c1')
>>> c2 = channel_spec.FusedChannelSpec.coerce('c2')
>>> c3 = channel_spec.FusedChannelSpec.coerce('c2')
>>> aux1 = DelayedLoad(chan1_fpath, dsize=chan1_raw.shape[0:2][::-1], channels=c1, num_
↳ bands=1)
>>> aux2 = DelayedLoad(chan2_fpath, dsize=chan2_raw.shape[0:2][::-1], channels=c2, num_
↳ bands=1)
>>> aux3 = DelayedLoad(chan3_fpath, dsize=chan3_raw.shape[0:2][::-1], channels=c3, num_
↳ bands=1)
>>> #
```

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```

>>> img_dsize = (128, 128)
>>> transform1 = kwimage.Affine.coerce(scale=0.5)
>>> transform2 = kwimage.Affine.coerce(theta=0.5, shearx=0.01, offset=(-20, -40))
>>> transform3 = kwimage.Affine.coerce(offset=(64, 0)) @ kwimage.Affine.random(rng=10)
>>> part1 = aux1.delayed_warp(np.eye(3), dsize=img_dsize)
>>> part2 = aux2.delayed_warp(transform2, dsize=img_dsize)
>>> part3 = aux3.delayed_warp(transform3, dsize=img_dsize)
>>> delayed = DelayedChannelConcat([part1, part2, part3])
>>> #
>>> delayed_crop = delayed.crop((slice(0, 10), slice(0, 10)))
>>> delayed_final = delayed_crop.finalize()
>>> # xdoctest: +REQUIRES(--show)
>>> import kwplot
>>> kwplot.autompl()
>>> final = delayed.finalize()
>>> kwplot.imshow(final, fnum=1, pnum=(1, 2, 1))
>>> kwplot.imshow(delayed_final, fnum=1, pnum=(1, 2, 2))

```

```
comp = delayed_crop.components[2]
```

```
comp.sub_data.finalize()
```

```
data = np.array([[0]]).astype(np.float32) kwimage.warp_affine(data, np.eye(3), dsize=(32, 32)) kwimage.warp_affine(data, np.eye(3))
```

```
kwimage.warp_affine(data[0:0], np.eye(3))
```

```
transform = kwimage.Affine.coerce(scale=0.1) data = np.array([[0]]).astype(np.float32)
```

```
data = np.array([[]]).astype(np.float32) kwimage.warp_affine(data, transform, dsize=(0, 2), antialias=True)
```

```
data = np.array([[]]).astype(np.float32) kwimage.warp_affine(data, transform, dsize=(10, 10))
```

```
data = np.array([[0]]).astype(np.float32) kwimage.warp_affine(data, transform, dsize=(0, 2), antialias=True)
```

```
data = np.array([[0]]).astype(np.float32) kwimage.warp_affine(data, transform, dsize=(10, 10))
```

```

cv2.warpAffine( kwimage.grab_test_image(dsize=(1, 1)), kwimage.Affine.coerce(scale=0.1).matrix[0:2], dsize=(0,
1),
)

```

## Module Contents

### Classes

<i>DelayedVisionOperation</i>	Base class for nodes in a tree of delayed computer-vision operations
<i>DelayedVideoOperation</i>	Base class for nodes in a tree of delayed computer-vision operations
<i>DelayedImageOperation</i>	Operations that pertain only to images
<i>DelayedIdentity</i>	Noop leaf that does nothing. Can be used to hold raw data.
<i>DelayedNans</i>	Constructs nan channels as needed
<i>DelayedLoad</i>	A load operation for a specific sub-region and sub-bands in a specified
<i>DelayedFrameConcat</i>	Represents multiple frames in a video
<i>DelayedChannelConcat</i>	Represents multiple channels in an image that could be concatenated
<i>DelayedWarp</i>	POC for chainable transforms
<i>DelayedCrop</i>	Represent a delayed crop operation

### Functions

<i>dequantize</i> (quant_data, quantization)	Helper for dequantization
<i>_compute_leaf_subcrop</i> (root_region_bounds, tf_leaf_to_root)	Given a region in a "root" image and a transform between that "root" and
<i>_largest_shape</i> (shapes)	Finds maximum over all shapes
<i>_devcheck_corner</i> ()	
<i>_auto_dsize</i> (transform, sub_dsize)	

### Attributes

<i>xr</i>
<i>profile</i>

kwcoco.util.util\_delayed\_poc.**xr**

kwcoco.util.util\_delayed\_poc.**profile**

**class** kwcoco.util.util\_delayed\_poc.**DelayedVisionOperation**

Bases: `ubelt.NiceRepr`

Base class for nodes in a tree of delayed computer-vision operations

**\_\_nice\_\_**(self)

**abstract finalize**(*self*, *\*\*kwargs*)

**abstract children**(*self*)

Abstract method, which should generate all of the direct children of a node in the operation tree.

**\_optimize\_paths**(*self*, *\*\*kwargs*)

Iterate through the leaf nodes, which are virtually transformed into the root space.

This returns some sort of hueristically optimized leaf repr wrt warps.

**\_\_json\_\_**(*self*)

**nesting**(*self*)

**warp**(*self*, *\*args*, *\*\*kwargs*)

alias for `delayed_warp`, might change to this API in the future

**crop**(*self*, *\*args*, *\*\*kwargs*)

alias for `delayed_crop`, might change to this API in the future

**class** kwcoco.util.util\_delayed\_poc.DelayedVideoOperation

Bases: [DelayedVisionOperation](#)

Base class for nodes in a tree of delayed computer-vision operations

**class** kwcoco.util.util\_delayed\_poc.DelayedImageOperation

Bases: [DelayedVisionOperation](#)

Operations that pertain only to images

**delayed\_crop**(*self*, *region\_slices*)

Create a new delayed image that performs a crop in the transformed “self” space.

**Parameters** *region\_slices* (*Tuple[slice, slice]*) – y-slice and x-slice.

---

**Note:** Returns a heuristically “simplified” tree. In the current implementation there are only 3 operations, cat, warp, and crop. All cats go at the top, all crops go at the bottom, all warps are in the middle.

---

**Returns** lazy executed delayed transform

**Return type** [DelayedWarp](#)

## Example

```
>>> dsize = (100, 100)
>>> tf2 = kwimage.Affine.affine(scale=3).matrix
>>> self = DelayedWarp(np.random.rand(33, 33), tf2, dsize)
>>> region_slices = (slice(5, 10), slice(1, 12))
>>> delayed_crop = self.delayed_crop(region_slices)
>>> print(ub.repr2(delayed_crop.nesting(), nl=-1, sort=0))
>>> delayed_crop.finalize()
```

**Example**

```

>>> chan1 = DelayedLoad.demo('astro')
>>> chan2 = DelayedLoad.demo('carl')
>>> warped1a = chan1.delayed_warp(kwimage.Affine.scale(1.2).matrix)
>>> warped2a = chan2.delayed_warp(kwimage.Affine.scale(1.5))
>>> warped1b = warped1a.delayed_warp(kwimage.Affine.scale(1.2).matrix)
>>> warped2b = warped2a.delayed_warp(kwimage.Affine.scale(1.5))
>>> #
>>> region_slices = (slice(97, 677), slice(5, 691))
>>> self = warped2b
>>> #
>>> crop1 = warped1b.delayed_crop(region_slices)
>>> crop2 = warped2b.delayed_crop(region_slices)
>>> print(ub.repr2(warped1b.nesting(), nl=-1, sort=0))
>>> print(ub.repr2(warped2b.nesting(), nl=-1, sort=0))
>>> # Notice how the crop merges the two nesting layers
>>> # (via the heuristic optimize step)
>>> print(ub.repr2(crop1.nesting(), nl=-1, sort=0))
>>> print(ub.repr2(crop2.nesting(), nl=-1, sort=0))
>>> frame1 = crop1.finalize(dsize=(500, 500))
>>> frame2 = crop2.finalize(dsize=(500, 500))
>>> # xdoctest: +REQUIRES(--show)
>>> import kwplot
>>> kwplot.autopl()
>>> kwplot.imshow(frame1, pnum=(1, 2, 1), fnum=1)
>>> kwplot.imshow(frame2, pnum=(1, 2, 2), fnum=1)

```

**delayed\_warp**(self, transform, dsize=None)

Delayed transform the underlying data.

---

**Note:** this deviates from kwimage warp functions because instead of “output\_dims” (specified in c-style shape) we specify dsize (w, h).

---

**Returns** new delayed transform a chained transform

**Return type** *DelayedWarp*

**abstract take\_channels**(self, channels)

**class** kwcoco.util.util\_delayed\_poc.**DelayedIdentity**(sub\_data, dsize=None, channels=None, quantization=None)

Bases: *DelayedImageOperation*

Noop leaf that does nothing. Can be used to hold raw data.

Typically used to just hold raw data.

DelayedIdentity.demo('astro', chan=0, dsize=(32, 32))



## Example

```

>>> from kwcoco.util.util_delayed_poc import * # NOQA
>>> sub_data = np.random.rand(31, 37, 3)
>>> self = DelayedIdentity(sub_data)
>>> self = DelayedIdentity(sub_data, channels='L|a|b')

>>> # test with quantization
>>> rng = kwarray.ensure_rng(32)
>>> sub_data_quant = (rng.rand(31, 37, 3) * 1000).astype(np.int16)
>>> sub_data_quant[0, 0] = -9999
>>> self = DelayedIdentity(sub_data_quant, channels='L|a|b', quantization={
>>>     'orig_min': 0.,
>>>     'orig_max': 1.,
>>>     'quant_min': 0,
>>>     'quant_max': 1000,
>>>     'nodata': -9999,
>>> })
>>> final1 = self.finalize(dequantize=True)
>>> final2 = self.finalize(dequantize=False)
>>> assert np.all(np.isnan(final1[0, 0]))
>>> scale = final2 / final1
>>> scales = scale[scale > 0]
>>> assert np.all(np.isclose(scales, 1000))
>>> # check that take_channels works
>>> new_subdata = self.take_channels('a')
>>> sub_final1 = new_subdata.finalize(dequantize=True)
>>> sub_final2 = new_subdata.finalize(dequantize=False)
>>> assert sub_final1.dtype.kind == 'f'
>>> assert sub_final2.dtype.kind == 'i'

```

**\_\_hack\_dont\_optimize\_\_** = True

**classmethod demo**(cls, key='astro', chan=None, dsize=None)

**children**(self)

Abstract method, which should generate all of the direct children of a node in the operation tree.

**\_optimize\_paths**(self, \*\*kwargs)

Iterate through the leaf nodes, which are virtually transformed into the root space.

This returns some sort of hueristically optimized leaf repr wrt warps.

**finalize**(self, \*\*kwargs)

**take\_channels**(self, channels)

kwcoco.util.util\_delayed\_poc.**dequantize**(quant\_data, quantization)

Helper for dequantization

**class** kwcoco.util.util\_delayed\_poc.**DelayedNans**(dsize=None, channels=None)

Bases: *DelayedImageOperation*

Constructs nan channels as needed

### Example

```
self = DelayedNans((10, 10), channel_spec.FusedChannelSpec.coerce('rgb')) region_slices = (slice(5, 10), slice(1, 12)) delayed = self.delayed_crop(region_slices)
```

### Example

```
>>> from kwcoco.util.util_delayed_poc import * # NOQA
>>> dsize = (307, 311)
>>> c1 = DelayedNans(dsize=dsize, channels=channel_spec.FusedChannelSpec.coerce('foo
↪'))
>>> c2 = DelayedLoad.demo('astro', dsize=dsize).load_shape(True)
>>> cat = DelayedChannelConcat([c1, c2])
>>> warped_cat = cat.delayed_warp(kwimage.Affine.scale(1.07), dsize=(328, 332))
>>> warped_cat.finalize()
```

```
#>>> cropped = warped_cat.delayed_crop((slice(0, 300), slice(0, 100))) #>>> cropped.finalize().shape
```

**property** `shape(self)`

**property** `num_bands(self)`

**property** `dsize(self)`

**property** `channels(self)`

**children**(`self`)

Abstract method, which should generate all of the direct children of a node in the operation tree.

**\_optimize\_paths**(`self`, *\*\*kwargs*)

Iterate through the leaf nodes, which are virtually transformed into the root space.

This returns some sort of hueristically optimized leaf repr wrt warps.

**finalize**(`self`, *\*\*kwargs*)

**delayed\_crop**(`self`, *region\_slices*)

Create a new delayed image that performs a crop in the transformed “self” space.

**Parameters** `region_slices` (*Tuple[slice, slice]*) – y-slice and x-slice.

---

**Note:** Returns a heuristically “simplified” tree. In the current implementation there are only 3 operations, cat, warp, and crop. All cats go at the top, all crops go at the bottom, all warps are in the middle.

---

**Returns** lazy executed delayed transform

**Return type** *DelayedWarp*

### Example

```

>>> dsize = (100, 100)
>>> tf2 = kwimage.Affine.affine(scale=3).matrix
>>> self = DelayedWarp(np.random.rand(33, 33), tf2, dsize)
>>> region_slices = (slice(5, 10), slice(1, 12))
>>> delayed_crop = self.delayed_crop(region_slices)
>>> print(ub.repr2(delayed_crop.nesting(), nl=-1, sort=0))
>>> delayed_crop.finalize()

```

### Example

```

>>> chan1 = DelayedLoad.demo('astro')
>>> chan2 = DelayedLoad.demo('carl')
>>> warped1a = chan1.delayed_warp(kwimage.Affine.scale(1.2).matrix)
>>> warped2a = chan2.delayed_warp(kwimage.Affine.scale(1.5))
>>> warped1b = warped1a.delayed_warp(kwimage.Affine.scale(1.2).matrix)
>>> warped2b = warped2a.delayed_warp(kwimage.Affine.scale(1.5))
>>> #
>>> region_slices = (slice(97, 677), slice(5, 691))
>>> self = warped2b
>>> #
>>> crop1 = warped1b.delayed_crop(region_slices)
>>> crop2 = warped2b.delayed_crop(region_slices)
>>> print(ub.repr2(warped1b.nesting(), nl=-1, sort=0))
>>> print(ub.repr2(warped2b.nesting(), nl=-1, sort=0))
>>> # Notice how the crop merges the two nesting layers
>>> # (via the heuristic optimize step)
>>> print(ub.repr2(crop1.nesting(), nl=-1, sort=0))
>>> print(ub.repr2(crop2.nesting(), nl=-1, sort=0))
>>> frame1 = crop1.finalize(dsize=(500, 500))
>>> frame2 = crop2.finalize(dsize=(500, 500))
>>> # xdoctest: +REQUIRES(--show)
>>> import kwplot
>>> kwplot.autompl()
>>> kwplot.imshow(frame1, pnum=(1, 2, 1), fnum=1)
>>> kwplot.imshow(frame2, pnum=(1, 2, 2), fnum=1)

```

**delayed\_warp**(self, transform, dsize=None)

Delayed transform the underlying data.

---

**Note:** this deviates from kwimage warp functions because instead of “output\_dims” (specified in c-style shape) we specify dsize (w, h).

---

**Returns** new delayed transform a chained transform

**Return type** *DelayedWarp*

```

class kwcoco.util.util_delayed_poc.DelayedLoad(fpath, channels=None, dsize=None, num_bands=None,
                                              immediate_crop=None, immediate_chan_idxs=None,
                                              immediate_dsize=None, quantization=None)

```

Bases: *DelayedImageOperation*

A load operation for a specific sub-region and sub-bands in a specified image.

---

**Note:** This class contains support for fusing certain lazy operations into this layer, namely cropping, scaling, and channel selection.

For now these are named immediates

---

### Example

```
>>> fpath = kwimage.grab_test_image_fpath()
>>> self = DelayedLoad(fpath)
>>> print('self = {!r}'.format(self))
>>> self.load_shape()
>>> print('self = {!r}'.format(self))
>>> self.finalize()
```

```
>>> f1_img = DelayedLoad.demo('astro', dsize=(300, 300))
>>> f2_img = DelayedLoad.demo('carl', dsize=(256, 320))
>>> print('f1_img = {!r}'.format(f1_img))
>>> print('f2_img = {!r}'.format(f2_img))
>>> print(f2_img.finalize().shape)
>>> print(f1_img.finalize().shape)
```

```
>>> fpath = kwimage.grab_test_image_fpath()
>>> channels = channel_spec.FusedChannelSpec.coerce('rgb')
>>> self = DelayedLoad(fpath, channels=channels)
```

### Example

```
>>> # Test with quantization
>>> fpath = kwimage.grab_test_image_fpath()
>>> channels = channel_spec.FusedChannelSpec.coerce('rgb')
>>> self = DelayedLoad(fpath, channels=channels, quantization={
>>>     'orig_min': 0.,
>>>     'orig_max': 1.,
>>>     'quant_min': 0,
>>>     'quant_max': 256,
>>>     'nodata': None,
>>> })
>>> final1 = self.finalize(dequantize=False)
>>> final2 = self.finalize(dequantize=True)
>>> assert final1.dtype.kind == 'u'
>>> assert final2.dtype.kind == 'f'
>>> assert final2.max() <= 1
```

```
__hack_dont_optimize__ = True
```

**classmethod** `demo(DelayedLoad, key='astro', dsize=None)`

**abstract classmethod** `coerce(cls, data)`

**children**(*self*)

Abstract method, which should generate all of the direct children of a node in the operation tree.

**nesting**(*self*)

**\_optimize\_paths**(*self*, *\*\*kwargs*)

Iterate through the leaf nodes, which are virtually transformed into the root space.

This returns some sort of hueristically optimized leaf repr wrt warps.

**load\_shape**(*self*, *use\_channel\_heuristic=False*)

**\_ensure\_dsize**(*self*)

**property** `shape`(*self*)

**property** `num_bands`(*self*)

**property** `dsize`(*self*)

**property** `channels`(*self*)

**property** `fpath`(*self*)

**finalize**(*self*, *\*\*kwargs*)

---

#### Todo:

- [ ] Load from overviews if a scale will be necessary
- 

**Parameters** *\*\*kwargs* –

**nodata** [if specified this data item is treated as nodata, the] data is then converted to floats and the nodata value is replaced with nan.

**delayed\_crop**(*self*, *region\_slices*)

**Parameters** *region\_slices* (*Tuple[slice, slice]*) – y-slice and x-slice.

**Returns** a new delayed load object with a fused crop operation

**Return type** *DelayedLoad*

#### Example

```
>>> # Test chained crop operations
>>> from kwcoco.util.util_delayed_poc import * # NOQA
>>> self = orig = DelayedLoad.demo('astro').load_shape()
>>> region_slices = slices1 = (slice(0, 90), slice(30, 60))
>>> self = crop1 = orig.delayed_crop(slices1)
>>> region_slices = slices2 = (slice(10, 21), slice(10, 22))
>>> self = crop2 = crop1.delayed_crop(slices2)
```

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```

>>> region_slices = slices3 = (slice(3, 20), slice(5, 20))
>>> crop3 = crop2.delayed_crop(slices3)
>>> # Spot check internals
>>> print('orig = {}'.format(ub.repr2(orig.__json__(), nl=2)))
>>> print('crop1 = {}'.format(ub.repr2(crop1.__json__(), nl=2)))
>>> print('crop2 = {}'.format(ub.repr2(crop2.__json__(), nl=2)))
>>> print('crop3 = {}'.format(ub.repr2(crop3.__json__(), nl=2)))
>>> # Test internals
>>> assert crop3._immediates['crop'][0].start == 13
>>> assert crop3._immediates['crop'][0].stop == 21
>>> # Test shapes work out correctly
>>> assert crop3.finalize().shape == (8, 7, 3)
>>> assert crop2.finalize().shape == (11, 12, 3)
>>> assert crop1.take_channels([1, 2]).finalize().shape == (90, 30, 2)
>>> assert orig.finalize().shape == (512, 512, 3)

```

**Note:**

This chart gives an intuition on how new absolute `slice` coords are computed **from existing** absolute coords and relative coords.

```

    5 7    <- new
    3 5    <- rel

-----
01234567 <- relative coordinates
-----
    2      9 <- curr
-----
0123456789 <- absolute coordinates
-----

```

**take\_channels**(*self*, *channels*)

This method returns a subset of the vision data with only the specified bands / channels.

**Parameters** `channels` (*List[int] | slice | channel\_spec.FusedChannelSpec*) – List of integers indexes, a slice, or a channel spec, which is typically a pipe (|) delimited list of channel codes. See `kwcoco.ChannelSpec` for more details.

**Returns** a new delayed load with a fused take channel operation

**Return type** *DelayedLoad*

**Note:** The channel subset must exist here or it will raise an error. A better implementation (via symbolic) might be able to do better

### Example

```
>>> from kwcoco.util.util_delayed_poc import * # NOQA
>>> import kwcoco
>>> self = DelayedLoad.demo('astro').load_shape()
>>> channels = [2, 0]
>>> new = self.take_channels(channels)
>>> new3 = new.take_channels([1, 0])
```

```
>>> final1 = self.finalize()
>>> final2 = new.finalize()
>>> final3 = new3.finalize()
>>> assert np.all(final1[..., 2] == final2[..., 0])
>>> assert np.all(final1[..., 0] == final2[..., 1])
>>> assert final2.shape[2] == 2
```

```
>>> assert np.all(final1[..., 2] == final3[..., 1])
>>> assert np.all(final1[..., 0] == final3[..., 0])
>>> assert final3.shape[2] == 2
```

**class** kwcoco.util.util\_delayed\_poc.**DelayedFrameConcat**(frames, dsize=None)

Bases: *DelayedVideoOperation*

Represents multiple frames in a video

#### Note:

```
Video[0]:
  Frame[0]:
    Chan[0]: (32) +-----+
    Chan[1]: (16) +-----+
    Chan[2]: ( 8) +-----+
  Frame[1]:
    Chan[0]: (30) +-----+
    Chan[1]: (14) +-----+
    Chan[2]: ( 6) +-----+
```

#### Todo:

- [ ] Support computing the transforms when none of the data is loaded

### Example

```

>>> # Simpler case with fewer nesting levels
>>> rng = kwarray.ensure_rng(None)
>>> # Delayed warp each channel into its "image" space
>>> # Note: the images never enter the space we transform through
>>> f1_img = DelayedLoad.demo('astro', (300, 300))
>>> f2_img = DelayedLoad.demo('carl', (256, 256))
>>> # Combine frames into a video
>>> vid_dsize = np.array((100, 100))
>>> self = vid = DelayedFrameConcat([
>>>     f1_img.delayed_warp(kwimage.Affine.scale(vid_dsize / f1_img.dsize)),
>>>     f2_img.delayed_warp(kwimage.Affine.scale(vid_dsize / f2_img.dsize)),
>>> ], dsize=vid_dsize)
>>> print(ub.repr2(vid.nesting(), nl=-1, sort=0))
>>> final = vid.finalize(interpolation='nearest', dsize=(32, 32))
>>> # xdoctest: +REQUIRES(--show)
>>> import kwplot
>>> kwplot.autompl()
>>> kwplot.imshow(final[0], pnum=(1, 2, 1), fnum=1)
>>> kwplot.imshow(final[1], pnum=(1, 2, 2), fnum=1)
>>> region_slices = (slice(0, 90), slice(30, 60))

```

**children**(*self*)

Abstract method, which should generate all of the direct children of a node in the operation tree.

**property channels**(*self*)

**property shape**(*self*)

**finalize**(*self*, \*\*kwargs)

Execute the final transform

**delayed\_crop**(*self*, *region\_slices*)

### Example

```

>>> from kwcoco.util.util_delayed_poc import * # NOQA
>>> # Create raw channels in some "native" resolution for frame 1
>>> f1_chan1 = DelayedIdentity.demo('astro', chan=(1, 0), dsize=(300, 300))
>>> f1_chan2 = DelayedIdentity.demo('astro', chan=2, dsize=(10, 10))
>>> # Create raw channels in some "native" resolution for frame 2
>>> f2_chan1 = DelayedIdentity.demo('carl', dsize=(64, 64), chan=(1, 0))
>>> f2_chan2 = DelayedIdentity.demo('carl', dsize=(10, 10), chan=2)
>>> #
>>> f1_dsize = np.array(f1_chan1.dsize)
>>> f2_dsize = np.array(f2_chan1.dsize)
>>> f1_img = DelayedChannelConcat([
>>>     f1_chan1.delayed_warp(kwimage.Affine.scale(f1_dsize / f1_chan1.dsize),
>>> ↵ dsize=f1_dsize),
>>>     f1_chan2.delayed_warp(kwimage.Affine.scale(f1_dsize / f1_chan2.dsize),
>>> ↵ dsize=f1_dsize),
>>> ])

```

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```

>>> f2_img = DelayedChannelConcat([
>>>     f2_chan1.delayed_warp(kwimage.Affine.scale(f2_dsize / f2_chan1.dsize),
>>>     ↳dsize=f2_dsize),
>>>     f2_chan2.delayed_warp(kwimage.Affine.scale(f2_dsize / f2_chan2.dsize),
>>>     ↳dsize=f2_dsize),
>>> ])
>>> vid_dsize = np.array((280, 280))
>>> full_vid = DelayedFrameConcat([
>>>     f1_img.delayed_warp(kwimage.Affine.scale(vid_dsize / f1_img.dsize),
>>>     ↳dsize=vid_dsize),
>>>     f2_img.delayed_warp(kwimage.Affine.scale(vid_dsize / f2_img.dsize),
>>>     ↳dsize=vid_dsize),
>>> ])
>>> region_slices = (slice(80, 200), slice(80, 200))
>>> print(ub.repr2(full_vid.nesting(), nl=-1, sort=0))
>>> crop_vid = full_vid.delayed_crop(region_slices)
>>> final_full = full_vid.finalize(interpolation='nearest')
>>> final_crop = crop_vid.finalize(interpolation='nearest')
>>> import pytest
>>> with pytest.raises(ValueError):
>>>     # should not be able to crop a crop yet
>>>     crop_vid.delayed_crop(region_slices)
>>> # xdoctest: +REQUIRES(--show)
>>> import kwplot
>>> kwplot.autompl()
>>> kwplot.imshow(final_full[0], pnum=(2, 2, 1), fnum=1)
>>> kwplot.imshow(final_full[1], pnum=(2, 2, 2), fnum=1)
>>> kwplot.imshow(final_crop[0], pnum=(2, 2, 3), fnum=1)
>>> kwplot.imshow(final_crop[1], pnum=(2, 2, 4), fnum=1)

```

**delayed\_warp**(*self*, *transform*, *dsize=None*)

Delayed transform the underlying data.

---

**Note:** this deviates from kwimage warp functions because instead of “output\_dims” (specified in c-style shape) we specify dsize (w, h).

---

**Returns** new delayed transform a chained transform

**Return type** *DelayedWarp*

**class** kwcoco.util.util\_delayed\_poc.**DelayedChannelConcat**(*components*, *dsize=None*)

Bases: *DelayedImageOperation*

Represents multiple channels in an image that could be concatenated

**Variables** **components** (*List* [*DelayedWarp*]) – a list of stackable channels. Each component may be comprised of multiple channels.

---

**Todo:**

- [ ] can this be generalized into a delayed concat?
- [ ] can all concats be delayed until the very end?

### Example

```

>>> comp1 = DelayedWarp(np.random.rand(11, 7))
>>> comp2 = DelayedWarp(np.random.rand(11, 7, 3))
>>> comp3 = DelayedWarp(
>>>     np.random.rand(3, 5, 2),
>>>     transform=kwimage.Affine.affine(scale=(7/5, 11/3)).matrix,
>>>     dsize=(7, 11)
>>> )
>>> components = [comp1, comp2, comp3]
>>> chans = DelayedChannelConcat(components)
>>> final = chans.finalize()
>>> assert final.shape == chans.shape
>>> assert final.shape == (11, 7, 6)

```

```

>>> # We should be able to nest DelayedChannelConcat inside virtual images
>>> frame1 = DelayedWarp(
>>>     chans, transform=kwimage.Affine.affine(scale=2.2).matrix,
>>>     dsize=(20, 26))
>>> frame2 = DelayedWarp(
>>>     np.random.rand(3, 3, 6), dsize=(20, 26))
>>> frame3 = DelayedWarp(
>>>     np.random.rand(3, 3, 6), dsize=(20, 26))

```

```

>>> print(ub.repr2(frame1.nesting(), nl=-1, sort=False))
>>> frame1.finalize()
>>> vid = DelayedFrameConcat([frame1, frame2, frame3])
>>> print(ub.repr2(vid.nesting(), nl=-1, sort=False))

```

#### **children**(self)

Abstract method, which should generate all of the direct children of a node in the operation tree.

**classmethod** **random**(cls, num\_parts=3, rng=None)

### Example

```

>>> self = DelayedChannelConcat.random()
>>> print('self = {!r}'.format(self))
>>> print(ub.repr2(self.nesting(), nl=-1, sort=0))

```

#### **property** channels(self)

#### **property** shape(self)

#### **finalize**(self, \*\*kwargs)

Execute the final transform

#### **delayed\_warp**(self, transform, dsize=None)

Delayed transform the underlying data.

---

**Note:** this deviates from kwimage warp functions because instead of “output\_dims” (specified in c-style shape) we specify dsize (w, h).

---

**Returns** new delayed transform a chained transform

**Return type** *DelayedWarp*

**take\_channels**(*self*, *channels*)

This method returns a subset of the vision data with only the specified bands / channels.

**Parameters** *channels* (*List[int]* | *slice* | *channel\_spec.FusedChannelSpec*) – List of integers indexes, a slice, or a channel spec, which is typically a pipe (|) delimited list of channel codes. See kwcoco.ChannelSpec for more details.

**Returns** a delayed vision operation that only operates on the following channels.

**Return type** *DelayedVisionOperation*

### Example

```
>>> from kwcoco.util.util_delayed_poc import * # NOQA
>>> import kwcoco
>>> dset = kwcoco.CocoDataset.demo('vidshapes8-multispectral')
>>> self = delayed = dset.delayed_load(1)
>>> channels = 'B11|B8|B1|B10'
>>> new = self.take_channels(channels)
```

### Example

```
>>> # Complex case
>>> import kwcoco
>>> from kwcoco.util.util_delayed_poc import * # NOQA
>>> dset = kwcoco.CocoDataset.demo('vidshapes8-multispectral')
>>> delayed = dset.delayed_load(1)
>>> astro = DelayedLoad.demo('astro').load_shape(use_channel_heuristic=True)
>>> aligned = astro.warp(kwimage.Affine.scale(600 / 512), dsize='auto')
>>> self = combo = DelayedChannelConcat(delayed.components + [aligned])
>>> channels = 'B1|r|B8|g'
>>> new = self.take_channels(channels)
>>> new_cropped = new.crop((slice(10, 200), slice(12, 350)))
>>> datas = new_cropped.finalize()
>>> vizable = kwimage.normalize_intensity(datas, axis=2)
>>> # xdoctest: +REQUIRES(--show)
>>> import kwplot
>>> kwplot.autompl()
>>> stacked = kwimage.stack_images(vizable.transpose(2, 0, 1))
>>> kwplot.imshow(stacked)
```

## CommandLine

```
xdoctest -m /home/joncrall/code/kwcoco/kwcoco/util/util_delayed_poc.py
↳DelayedChannelConcat.take_channels:2 --profile
```

## Example

```
>>> # Test case where requested channel does not exist
>>> import kwcoco
>>> from kwcoco.util.util_delayed_poc import * # NOQA
>>> dset = kwcoco.CocoDataset.demo('vidshapes8-multispectral', use_cache=1,
↳verbose=100)
>>> self = dset.delayed_load(1)
>>> channels = 'B1|foobar|bazbiz|B8'
>>> new = self.take_channels(channels)
>>> new_cropped = new.crop((slice(10, 200), slice(12, 350)))
>>> fused = new_cropped.finalize()
>>> assert fused.shape == (190, 338, 4)
>>> assert np.all(np.isnan(fused[..., 1:3]))
>>> assert not np.any(np.isnan(fused[..., 0]))
>>> assert not np.any(np.isnan(fused[..., 3]))
```

**class** kwcoco.util.util\_delayed\_poc.**DelayedWarp**(sub\_data, transform=None, dsize=None)

Bases: *DelayedImageOperation*

POC for chainable transforms

---

**Note:** “sub” is used to refer to the underlying data in its native coordinates and resolution.

“self” is used to refer to the data in the transformed coordinates that are exposed by this class.

---

## Variables

- **sub\_data** (*DelayedWarp* / *ArrayLike*) – array-like image data at a native resolution
- **transform** (*Transform*) – transforms data from native “sub”-image-space to “self”-image-space.

## Example

```
>>> dsize = (12, 12)
>>> tf1 = np.array([[2, 0, 0], [0, 2, 0], [0, 0, 1]])
>>> tf2 = np.array([[3, 0, 0], [0, 3, 0], [0, 0, 1]])
>>> tf3 = np.array([[4, 0, 0], [0, 4, 0], [0, 0, 1]])
>>> band1 = DelayedWarp(np.random.rand(6, 6), tf1, dsize)
>>> band2 = DelayedWarp(np.random.rand(4, 4), tf2, dsize)
>>> band3 = DelayedWarp(np.random.rand(3, 3), tf3, dsize)
>>> #
>>> # Execute a crop in a one-level transformed space
>>> region_slices = (slice(5, 10), slice(0, 12))
>>> delayed_crop = band2.delayed_crop(region_slices)
```

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```

>>> final_crop = delayed_crop.finalize()
>>> #
>>> # Execute a crop in a nested transformed space
>>> tf4 = np.array([[1.5, 0, 0], [0, 1.5, 0], [0, 0, 1]])
>>> chained = DelayedWarp(band2, tf4, (18, 18))
>>> delayed_crop = chained.delayed_crop(region_slices)
>>> final_crop = delayed_crop.finalize()
>>> #
>>> tf4 = np.array([[.5, 0, 0], [0, .5, 0], [0, 0, 1]])
>>> chained = DelayedWarp(band2, tf4, (6, 6))
>>> delayed_crop = chained.delayed_crop(region_slices)
>>> final_crop = delayed_crop.finalize()
>>> #
>>> region_slices = (slice(1, 5), slice(2, 4))
>>> delayed_crop = chained.delayed_crop(region_slices)
>>> final_crop = delayed_crop.finalize()

```

### Example

```

>>> dsize = (17, 12)
>>> tf = np.array([[5.2, 0, 1.1], [0, 3.1, 2.2], [0, 0, 1]])
>>> self = DelayedWarp(np.random.rand(3, 5, 13), tf, dsize=dsize)
>>> self.finalize().shape

```

**classmethod** `random(cls, nesting=(2, 5), rng=None)`

### Example

```

>>> self = DelayedWarp.random(nesting=(4, 7))
>>> print('self = {!r}'.format(self))
>>> print(ub.repr2(self.nesting(), nl=-1, sort=0))

```

**property** `channels(self)`

**children**(self)

Abstract method, which should generate all of the direct children of a node in the operation tree.

**property** `dsize(self)`

**property** `num_bands(self)`

**property** `shape(self)`

**\_optimize\_paths**(self, \*\*kwargs)

### Example

```
>>> self = DelayedWarp.random()
>>> leafs = list(self._optimize_paths())
>>> print('leafs = {!r}'.format(leafs))
```

**finalize**(*self*, *transform=None*, *dsize=None*, *interpolation='linear'*, *\*\*kwargs*)

Execute the final transform

Can pass a parent transform to augment this underlying transform.

#### Parameters

- **transform** (*Transform*) – an additional transform to perform
- **dsize** (*Tuple[int, int]*) – overrides destination canvas size

### Example

```
>>> tf = np.array([[0.9, 0, 3.9], [0, 1.1, -.5], [0, 0, 1]])
>>> raw = kwimage.grab_test_image(dsize=(54, 65))
>>> raw = kwimage.ensure_float01(raw)
>>> # Test nested finalize
>>> layer1 = raw
>>> num = 10
>>> for _ in range(num):
...     layer1 = DelayedWarp(layer1, tf, dsize='auto')
>>> final1 = layer1.finalize()
>>> # Test non-nested finalize
>>> layer2 = list(layer1._optimize_paths())[0]
>>> final2 = layer2.finalize()
>>> #
>>> print(ub.repr2(layer1.nesting(), nl=-1, sort=0))
>>> print(ub.repr2(layer2.nesting(), nl=-1, sort=0))
>>> print('final1 = {!r}'.format(final1))
>>> print('final2 = {!r}'.format(final2))
>>> print('final1.shape = {!r}'.format(final1.shape))
>>> print('final2.shape = {!r}'.format(final2.shape))
>>> assert np.allclose(final1, final2)
>>> #
>>> # xdoctest: +REQUIRES(--show)
>>> import kwplot
>>> kwplot.autompl()
>>> kwplot.imshow(raw, pnum=(1, 3, 1), fnum=1)
>>> kwplot.imshow(final1, pnum=(1, 3, 2), fnum=1)
>>> kwplot.imshow(final2, pnum=(1, 3, 3), fnum=1)
>>> kwplot.show_if_requested()
```

### Example

```

>>> # Test aliasing
>>> s = DelayedIdentity.demo()
>>> s = DelayedIdentity.demo('checkerboard')
>>> a = s.delayed_warp(kwimage.Affine.scale(0.05), dsize='auto')
>>> b = s.delayed_warp(kwimage.Affine.scale(3), dsize='auto')

>>> # xdoctest: +REQUIRES(--show)
>>> import kwplot
>>> kwplot.autompl()
>>> # It looks like downsampling linear and area is the same
>>> # Does warpAffine have no alias handling?
>>> pnum_ = kwplot.PlotNums(nRows=2, nCols=4)
>>> kwplot.imshow(a.finalize(interpolation='area'), pnum=pnum_(), title=
↳ 'warpAffine area')
>>> kwplot.imshow(a.finalize(interpolation='linear'), pnum=pnum_(), title=
↳ 'warpAffine linear')
>>> kwplot.imshow(a.finalize(interpolation='nearest'), pnum=pnum_(), title=
↳ 'warpAffine nearest')
>>> kwplot.imshow(a.finalize(interpolation='nearest', antialias=False),
↳ pnum=pnum_(), title='warpAffine nearest AA=0')
>>> kwplot.imshow(kwimage.imresize(s.finalize(), dsize=a.dsize, interpolation=
↳ 'area'), pnum=pnum_(), title='resize area')
>>> kwplot.imshow(kwimage.imresize(s.finalize(), dsize=a.dsize, interpolation=
↳ 'linear'), pnum=pnum_(), title='resize linear')
>>> kwplot.imshow(kwimage.imresize(s.finalize(), dsize=a.dsize, interpolation=
↳ 'nearest'), pnum=pnum_(), title='resize nearest')
>>> kwplot.imshow(kwimage.imresize(s.finalize(), dsize=a.dsize, interpolation=
↳ 'cubic'), pnum=pnum_(), title='resize cubic')

```

**take\_channels**(self, channels)

**class** kw Coco.util.util\_delayed\_poc.DelayedCrop(sub\_data, sub\_slices)

Bases: *DelayedImageOperation*

Represent a delayed crop operation

### Example

```

>>> sub_data = DelayedLoad.demo()
>>> sub_slices = (slice(5, 10), slice(1, 12))
>>> self = DelayedCrop(sub_data, sub_slices)
>>> print(ub.repr2(self.nesting(), nl=-1, sort=0))
>>> final = self.finalize()
>>> print('final.shape = {!r}'.format(final.shape))

```

### Example

```
>>> sub_data = DelayedLoad.demo()
>>> sub_slices = (slice(5, 10), slice(1, 12))
>>> crop1 = DelayedCrop(sub_data, sub_slices)
>>> import pytest
>>> # Should only error while huristics are in use.
>>> with pytest.raises(ValueError):
>>>     crop2 = DelayedCrop(crop1, sub_slices)
```

**\_\_hack\_dont\_optimize\_\_** = True

**property channels**(self)

**children**(self)

Abstract method, which should generate all of the direct children of a node in the operation tree.

**finalize**(self, \*\*kwargs)

**abstract \_optimize\_paths**(self, \*\*kwargs)

Iterate through the leaf nodes, which are virtually transformed into the root space.

This returns some sort of hueristically optimized leaf repr wrt warps.

kwcoco.util.util\_delayed\_poc.**\_compute\_leaf\_subcrop**(root\_region\_bounds, tf\_leaf\_to\_root)

Given a region in a “root” image and a trasnform between that “root” and some “leaf” image, compute the appropriate quantized region in the “leaf” image and the adjusted transformation between that root and leaf.

### Example

```
>>> region_slices = (slice(33, 100), slice(22, 62))
>>> region_shape = (100, 100, 1)
>>> root_region_box = kwimage.Boxes.from_slice(region_slices, shape=region_shape)
>>> root_region_bounds = root_region_box.to_polygons()[0]
>>> tf_leaf_to_root = kwimage.Affine.affine(scale=7).matrix
>>> slices, tf_new = _compute_leaf_subcrop(root_region_bounds, tf_leaf_to_root)
>>> print('tf_new =\n{!r}'.format(tf_new))
>>> print('slices = {!r}'.format(slices))
```

kwcoco.util.util\_delayed\_poc.**\_largest\_shape**(shapes)

Finds maximum over all shapes

### Example

```
>>> shapes = [
>>>     (10, 20), None, (None, 30), (40, 50, 60, None), (100,)
>>> ]
>>> largest = _largest_shape(shapes)
>>> print('largest = {!r}'.format(largest))
>>> assert largest == (100, 50, 60, None)
```

kwcoco.util.util\_delayed\_poc.**\_devcheck\_corner**()

kwcoco.util.util\_delayed\_poc.**\_auto\_dsize**(transform, sub\_dsize)



## kwcoco.util.util\_futures

Deprecated and functionality moved to ubelt

## kwcoco.util.util\_json

### Module Contents

### Functions

<code>ensure_json_serializable(dict_,</code>	normal-	Attempt to convert common types (e.g. numpy) into something json compliant
<code>ize_containers=False, verbose=0)</code>		
<code>find_json_unserializable(data,</code>		Recurse through json datastructure and find any component that
<code>quickcheck=False)</code>		
<code>indexable_allclose(dct1, dct2, return_info=False)</code>		Walks through two nested data structures and ensures that everything is

### Attributes

---

`IndexableWalker`

---

## kwcoco.util.util\_json.IndexableWalker

kwcoco.util.util\_json.**ensure\_json\_serializable**(dict\_, normalize\_containers=False, verbose=0)

Attempt to convert common types (e.g. numpy) into something json compliant

Convert numpy and tuples into lists

**Parameters** `normalize_containers` (bool, default=False) – if True, normalizes dict containers to be standard python structures.

### Example

```
>>> data = ub.ddict(lambda: int)
>>> data['foo'] = ub.ddict(lambda: int)
>>> data['bar'] = np.array([1, 2, 3])
>>> data['foo']['a'] = 1
>>> data['foo']['b'] = (1, np.array([1, 2, 3]), {3: np.int32(3), 4: np.float16(1.0)})
↪
>>> dict_ = data
>>> print(ub.repr2(data, nl=-1))
>>> assert list(find_json_unserializable(data))
>>> result = ensure_json_serializable(data, normalize_containers=True)
>>> print(ub.repr2(result, nl=-1))
>>> assert not list(find_json_unserializable(result))
>>> assert type(result) is dict
```

`kwcoco.util.util_json.find_json_unserializable(data, quickcheck=False)`

Recurse through json datastructure and find any component that causes a serialization error. Record the location of these errors in the datastructure as we recurse through the call tree.

#### Parameters

- **data** (*object*) – data that should be json serializable
- **quickcheck** (*bool*) – if True, check the entire datastructure assuming its ok before doing the python-based recursive logic.

#### Returns

**list of “bad part” dictionaries containing items** ‘value’ - the value that caused the serialization error ‘loc’ - which contains a list of key/indexes that can be used

to lookup the location of the unserializable value. If the “loc” is a list, then it indicates a rare case where a key in a dictionary is causing the serialization error.

**Return type** List[Dict]

#### Example

```
>>> from kwcoco.util.util_json import * # NOQA
>>> part = ub.ddict(lambda: int)
>>> part['foo'] = ub.ddict(lambda: int)
>>> part['bar'] = np.array([1, 2, 3])
>>> part['foo']['a'] = 1
>>> # Create a dictionary with two unserializable parts
>>> data = [1, 2, {'nest1': [2, part]}, {'frozenset({'badkey'})': 3, 2: 4}]
>>> parts = list(find_json_unserializable(data))
>>> print('parts = {}'.format(ub.repr2(parts, nl=1)))
>>> # Check expected structure of bad parts
>>> assert len(parts) == 2
>>> part = parts[1]
>>> assert list(part['loc']) == [2, 'nest1', 1, 'bar']
>>> # We can use the "loc" to find the bad value
>>> for part in parts:
>>>     # "loc" is a list of directions containing which keys/indexes
>>>     # to traverse at each descent into the data structure.
>>>     directions = part['loc']
>>>     curr = data
>>>     special_flag = False
>>>     for key in directions:
>>>         if isinstance(key, list):
>>>             # special case for bad keys
>>>             special_flag = True
>>>             break
>>>         else:
>>>             # normal case for bad values
>>>             curr = curr[key]
>>>     if special_flag:
>>>         assert part['data'] in curr.keys()
>>>         assert part['data'] is key[1]
>>>     else:
>>>         assert part['data'] is curr
```

`kwcoco.util.util_json.indexable_allclose(dct1, dct2, return_info=False)`

Walks through two nested data structures and ensures that everything is roughly the same.

#### Parameters

- **dct1** – a nested indexable item
- **dct2** – a nested indexable item

#### Example

```
>>> from kwcoco.util.util_json import indexable_allclose
>>> dct1 = {
>>>     'foo': [1.222222, 1.333],
>>>     'bar': 1,
>>>     'baz': [],
>>> }
>>> dct2 = {
>>>     'foo': [1.22222, 1.333],
>>>     'bar': 1,
>>>     'baz': [],
>>> }
>>> assert indexable_allclose(dct1, dct2)
```

`kwcoco.util.util_monkey`

## Module Contents

### Classes

---

*SupressPrint*

Temporarily replace the print function in a module with a noop

---

**class** `kwcoco.util.util_monkey.SupressPrint(*mods, **kw)`

Bases: `object`

Temporarily replace the print function in a module with a noop

#### Parameters

- **\*mods** – the modules to disable print in
- **\*\*kw** – only accepts “enabled” enabled (bool, default=True): enables or disables this context

`__enter__(self)`

`__exit__(self, a, b, c)`

## kwcoco.util.util\_sklearn

Extensions to sklearn constructs

### Module Contents

#### Classes

---

*StratifiedGroupKFold*Stratified K-Folds cross-validator with Grouping

---

**class** kwcoco.util.util\_sklearn.**StratifiedGroupKFold**(*n\_splits=3, shuffle=False, random\_state=None*)

Bases: sklearn.model\_selection.\_split.\_BaseKFold

Stratified K-Folds cross-validator with Grouping

Provides train/test indices to split data in train/test sets.

This cross-validation object is a variation of GroupKFold that returns stratified folds. The folds are made by preserving the percentage of samples for each class.

Read more in the User Guide.

**Parameters** *n\_splits* (*int, default=3*) – Number of folds. Must be at least 2.

**\_make\_test\_folds**(*self, X, y=None, groups=None*)

#### Parameters

- **X** (*ndarray*) – data
- **y** (*ndarray*) – labels
- **groups** (*ndarray*) – groupids for items. Items with the same groupid must be placed in the same group.

**Returns** *test\_folds*

**Return type** *list*

#### Example

```
>>> import kwarrray
>>> rng = kwarrray.ensure_rng(0)
>>> groups = [1, 1, 3, 4, 2, 2, 7, 8, 8]
>>> y      = [1, 1, 1, 1, 2, 2, 2, 3, 3]
>>> X = np.empty((len(y), 0))
>>> self = StratifiedGroupKFold(random_state=rng, shuffle=True)
>>> skf_list = list(self.split(X=X, y=y, groups=groups))
...
>>> import ubelt as ub
>>> print(ub.repr2(skf_list, nl=1, with_dtype=False))
[
  (np.array([2, 3, 4, 5, 6]), np.array([0, 1, 7, 8])),
  (np.array([0, 1, 2, 7, 8]), np.array([3, 4, 5, 6])),
  (np.array([0, 1, 3, 4, 5, 6, 7, 8]), np.array([2])),
]
```

**`_iter_test_masks`**(*self*, *X*, *y=None*, *groups=None*)

Generates boolean masks corresponding to test sets.

By default, delegates to `_iter_test_indices(X, y, groups)`

**`split`**(*self*, *X*, *y*, *groups=None*)

Generate indices to split data into training and test set.

## kwcoco.util.util\_truncate

Truncate utility based on python-slugify.

<https://pypi.org/project/python-slugify/1.2.2/>

## Module Contents

### Functions

---

`_trunc_op`(string, max\_length, trunc\_loc)

---

#### Example

---

```
smart_truncate(string, max_length=0, separator=' ', trunc_loc=0.5)
```

---

`kwcoco.util.util_truncate._trunc_op`(string, max\_length, trunc\_loc)

#### Example

```
>>> from kwcoco.util.util_truncate import _trunc_op
>>> string =
↳ 'DarnOvercastSculptureTipperBlazerConcaveUnsuitedDerangedHexagonRockband'
>>> max_length = 16
>>> trunc_loc = 0.5
>>> _trunc_op(string, max_length, trunc_loc)
```

```
>>> from kwcoco.util.util_truncate import _trunc_op
>>> max_length = 16
>>> string = 'a' * 16
>>> _trunc_op(string, max_length, trunc_loc)
```

```
>>> string = 'a' * 17
>>> _trunc_op(string, max_length, trunc_loc)
```

`kwcoco.util.util_truncate.smart_truncate`(string, max\_length=0, separator=' ', trunc\_loc=0.5)

Truncate a string. :param string (str): string for modification :param max\_length (int): output string length :param word\_boundary (bool): :param save\_order (bool): if True then word order of output string is like input string :param separator (str): separator between words :param trunc\_loc (float): fraction of location where to remove the text :return:

## Package Contents

### Classes

<i>DictLike</i>	An inherited class must specify the <code>getitem</code> , <code>setitem</code> , and
<i>ContainerElements</i>	Types that contain other types
<i>Element</i>	A dictionary used to define an element of a JSON Schema.
<i>QuantifierElements</i>	Quantifier types
<i>ScalarElements</i>	Single-valued elements
<i>SchemaElements</i>	Functional interface into defining jsonschema structures.
<i>LazyGDalFrameFile</i>	
<i>LazyRasterIOFrameFile</i>	fpath = '/home/joncrall/.cache/kwcoco/demo/large_hyperspectral/big_img_1
<i>LazySpectralFrameFile</i>	Potentially faster than GDAL for HDR formats.
<i>Archive</i>	Abstraction over zipfile and tarfile
<i>DelayedChannelConcat</i>	Represents multiple channels in an image that could be concatenated
<i>DelayedCrop</i>	Represent a delayed crop operation
<i>DelayedFrameConcat</i>	Represents multiple frames in a video
<i>DelayedIdentity</i>	Noop leaf that does nothing. Can be used to hold raw data.
<i>DelayedImageOperation</i>	Operations that pertain only to images
<i>DelayedLoad</i>	A load operation for a specific sub-region and sub-bands in a specified
<i>DelayedNans</i>	Constructs nan channels as needed
<i>DelayedVideoOperation</i>	Base class for nodes in a tree of delayed computer-vision operations
<i>DelayedVisionOperation</i>	Base class for nodes in a tree of delayed computer-vision operations
<i>DelayedWarp</i>	POC for chainable transforms
<i>SupressPrint</i>	Temporarily replace the print function in a module with a noop
<i>StratifiedGroupKFold</i>	Stratified K-Folds cross-validator with Grouping

### Functions

<i>unarchive_file</i> (archive_fpath, output_dpath='.', verbose=1, overwrite=True)	
<i>ensure_json_serializable</i> (dict_, normalize_containers=False, verbose=0)	normal- Attempt to convert common types (e.g. numpy) into something json compliant
<i>find_json_unserializable</i> (data, quickcheck=False)	Recurse through json datastructure and find any component that
<i>indexable_allclose</i> (dct1, dct2, return_info=False)	Walks through two nested data structures and ensures that everything is
<i>smart_truncate</i> (string, max_length=0, separator=' ', trunc_loc=0.5)	Truncate a string.

## Attributes

---

*ALLOF*

---

---

*ANY*

---

---

*ANYOF*

---

---

*ARRAY*

---

---

*BOOLEAN*

---

---

*INTEGER*

---

---

*NOT*

---

---

*NULL*

---

---

*NUMBER*

---

---

*OBJECT*

---

---

*ONEOF*

---

---

*STRING*

---

---

*elem*

---

---

*IndexableWalker*

---

### **class** kwcoco.util.DictLike

Bases: `ubelt.NiceRepr`

**An inherited class must specify the `getitem`, `setitem`, and `keys` methods.**

A class is dictionary like if it has:

`__iter__`, `__len__`, `__contains__`, `__getitem__`, `items`, `keys`, `values`, `get`,

and if it should be writable it should have: `__delitem__`, `__setitem__`, `update`,

And perhaps: `copy`,

`__iter__`, `__len__`, `__contains__`, `__getitem__`, `items`, `keys`, `values`, `get`,

and if it should be writable it should have: `__delitem__`, `__setitem__`, `update`,

And perhaps: `copy`,

**asdict**

**abstract** `getitem(self, key)`

**abstract** `setitem(self, key, value)`

```
abstract delitem(self, key)

abstract keys(self)

__len__(self)

__iter__(self)

__contains__(self, key)

__delitem__(self, key)

__getitem__(self, key)

__setitem__(self, key, value)

items(self)

values(self)

copy(self)

to_dict(self)

update(self, other)

get(self, key, default=None)
```

kwcoco.util.ALLOF

kwcoco.util.ANY

kwcoco.util.ANYOF

kwcoco.util.ARRAY

kwcoco.util.BOOLEAN

**class** kwcoco.util.ContainerElements

Types that contain other types

### Example

```
>>> from kwcoco.util.jsonschema_elements import * # NOQA
>>> print(elem.ARRAY().validate())
>>> print(elem.OBJECT().validate())
>>> print(elem.OBJECT().validate())
{'type': 'array', 'items': {}}
{'type': 'object', 'properties': {}}
{'type': 'object', 'properties': {}}
```

**ARRAY**(self, TYPE={}, \*\*kw)

<https://json-schema.org/understanding-json-schema/reference/array.html>



### Example

```
>>> from kwcoco.util.jsonschema_elements import * # NOQA
>>> ARRAY(numItems=3)
>>> schema = ARRAY(minItems=3)
>>> schema.validate()
{'type': 'array', 'items': {}, 'minItems': 3}
```

**OBJECT**(*self*, *PROPERTIES*={}, \*\**kw*)

<https://json-schema.org/understanding-json-schema/reference/object.html>

### Example

```
>>> import jsonschema
>>> schema = elem.OBJECT()
>>> jsonschema.validate({}, schema)
>>> #
>>> import jsonschema
>>> schema = elem.OBJECT({
>>>     'key1': elem.ANY(),
>>>     'key2': elem.ANY(),
>>> }, required=['key1'])
>>> jsonschema.validate({'key1': None}, schema)
>>> #
>>> import jsonschema
>>> schema = elem.OBJECT({
>>>     'key1': elem.OBJECT({'arr': elem.ARRAY()}),
>>>     'key2': elem.ANY(),
>>> }, required=['key1'], title='a title')
>>> schema.validate()
>>> print('schema = {}'.format(ub.repr2(schema, sort=1, nl=-1)))
>>> jsonschema.validate({'key1': {'arr': []}}, schema)
schema = {
    'properties': {
        'key1': {
            'properties': {
                'arr': {'items': {}, 'type': 'array'}
            },
            'type': 'object'
        },
        'key2': {}
    },
    'required': ['key1'],
    'title': 'a title',
    'type': 'object'
}
```

**class** kwcoco.util.**Element**(*base*, *options*={}, *\_magic*=None)

Bases: `dict`

A dictionary used to define an element of a JSON Schema.

The exact keys/values for the element will depend on the type of element being described. The *SchemaElements* defines exactly what these are for the core elements. (e.g. OBJECT, INTEGER, NULL, ARRAY, ANYOF)

### Example

```
>>> from kwcoco.coco_schema import * # NOQA
>>> self = Element(base={'type': 'demo'}, options={'opt1', 'opt2'})
>>> new = self(opt1=3)
>>> print('self = {}'.format(ub.repr2(self, nl=1, sort=1)))
>>> print('new = {}'.format(ub.repr2(new, nl=1, sort=1)))
>>> print('new2 = {}'.format(ub.repr2(new(), nl=1, sort=1)))
>>> print('new3 = {}'.format(ub.repr2(new(title='myvar'), nl=1, sort=1)))
>>> print('new4 = {}'.format(ub.repr2(new(title='myvar')(examples=['']), nl=1,
↵sort=1)))
>>> print('new5 = {}'.format(ub.repr2(new(badattr=True), nl=1, sort=1)))
self = {
    'type': 'demo',
}
new = {
    'opt1': 3,
    'type': 'demo',
}
new2 = {
    'opt1': 3,
    'type': 'demo',
}
new3 = {
    'opt1': 3,
    'title': 'myvar',
    'type': 'demo',
}
new4 = {
    'examples': [''],
    'opt1': 3,
    'title': 'myvar',
    'type': 'demo',
}
new5 = {
    'opt1': 3,
    'type': 'demo',
}
```

**\_\_generics\_\_**

**\_\_call\_\_**(self, \*args, \*\*kw)

**validate**(self, instance=ub.NoParam)

If instance is given, validates that that dictionary conforms to this schema. Otherwise validates that this is a valid schema element.

**Parameters** instance (*dict*) – a dictionary to validate

**\_\_or\_\_**(self, other)

Syntax for making an anyOf relationship

### Example

```

>>> from kwcoco.util.jsonschema_elements import * # NOQA
>>> obj1 = OBJECT(dict(opt1=NUMBER()))
>>> obj2 = OBJECT(dict(opt2=STRING()))
>>> obj3 = OBJECT(dict(opt3=ANY()))
>>> any_v1 = obj1 | obj2
>>> any_v2 = ANYOF(obj1, obj2)
>>> assert any_v1 == any_v2
>>> any_v3 = any_v1 | obj3
>>> any_v4 = ANYOF(obj1, obj2, obj3)
>>> assert any_v3 == any_v4

```

kwcoco.util.INTEGER

kwcoco.util.NOT

kwcoco.util.NULL

kwcoco.util.NUMBER

kwcoco.util.OBJECT

kwcoco.util.ONEOF

**class** kwcoco.util.QuantifierElements

Bases: `object`

Quantifier types

<https://json-schema.org/understanding-json-schema/reference/combining.html#allof>

### Example

```

>>> from kwcoco.util.jsonschema_elements import * # NOQA
>>> elem.ANYOF(elem.STRING, elem.NUMBER).validate()
>>> elem.ONEOF(elem.STRING, elem.NUMBER).validate()
>>> elem.NOT(elem.NULL).validate()
>>> elem.NOT(elem.ANY).validate()
>>> elem.ANY.validate()

```

**property** ANY(*self*)

**ALLOF**(*self*, \*TYPES)

**ANYOF**(*self*, \*TYPES)

**ONEOF**(*self*, \*TYPES)

**NOT**(*self*, TYPE)

kwcoco.util.STRING

**class** kwcoco.util.ScalarElements

Bases: `object`

Single-valued elements

**property** `NULL(self)`

<https://json-schema.org/understanding-json-schema/reference/null.html>

**property** `BOOLEAN(self)`

<https://json-schema.org/understanding-json-schema/reference/null.html>

**property** `STRING(self)`

<https://json-schema.org/understanding-json-schema/reference/string.html>

**property** `NUMBER(self)`

<https://json-schema.org/understanding-json-schema/reference/numeric.html#number>

**property** `INTEGER(self)`

<https://json-schema.org/understanding-json-schema/reference/numeric.html#integer>

**class** `kwcoco.util.SchemaElements`

Bases: *ScalarElements*, *QuantifierElements*, *ContainerElements*

Functional interface into defining jsonschema structures.

See mixin classes for details.

## References

<https://json-schema.org/understanding-json-schema/>

---

## Todo:

- [ ] Generics: title, description, default, examples
- 

## CommandLine

```
xdoctest -m /home/joncrall/code/kwcoco/kwcoco/util/jsonschema_elements.py ↵  
↵ SchemaElements
```

## Example

```
>>> from kwcoco.util.jsonschema_elements import * # NOQA  
>>> elem = SchemaElements()  
>>> elem.ARRAY(elem.ANY())  
>>> schema = OBJECT({  
>>>     'prop1': ARRAY(INTEGER, minItems=3),  
>>>     'prop2': ARRAY(STRING, numItems=2),  
>>>     'prop3': ARRAY(OBJECT({  
>>>         'subprob1': NUMBER,  
>>>         'subprob2': NUMBER,  
>>>     })))  
>>> })  
>>> print('schema = {}'.format(ub.repr2(schema, nl=2, sort=1)))  
schema = {  
    'properties': {
```

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```

        'prop1': {'items': {'type': 'integer'}, 'minItems': 3, 'type': 'array'},
        'prop2': {'items': {'type': 'string'}, 'maxItems': 2, 'minItems': 2, 'type':
→ 'array'},
        'prop3': {'items': {'properties': {'subprob1': {'type': 'number'}, 'subprob2
→ ': {'type': 'number'}}}, 'type': 'object'}, 'type': 'array'},
    },
    'type': 'object',
}

```

```

>>> TYPE = elem.OBJECT({
>>>     'p1': ANY,
>>>     'p2': ANY,
>>> }, required=['p1'])
>>> import jsonschema
>>> inst = {'p1': None}
>>> jsonschema.validate(inst, schema=TYPE)
>>> #jsonschema.validate({'p2': None}, schema=TYPE)

```

kwcoco.util.elem

**class** kwcoco.util.LazyGDalFrameFile(fpath, nodata=None)Bases: `ubelt.NiceRepr`**Todo:**

- [ ] Move to its own backend module
- [ ] **When used with COCO, allow the image metadata to populate the** height, width, and channels if possible.

**Example**

```

>>> # xdoctest: +REQUIRES(module:osgeo)
>>> self = LazyGDalFrameFile.demo()
>>> print('self = {!r}'.format(self))
>>> self[0:3, 0:3]
>>> self[:, :, 0]
>>> self[0]
>>> self[0, 3]

```

```

>>> # import kwplot
>>> # kwplot.imshow(self[:])

```

**Parameters**

- **nodata**
- **masking\_method**

### Example

```
>>> # See if we can reproduce the INTERLEAVE bug
```

```
data = np.random.rand(128, 128, 64)
import kwimage
import ubelt as ub
from os.path import join
dpath = ub.ensure_app_cache_dir('kwcoco/tests/reader')
fpath = join(dpath, 'foo.tiff')
kwimage.imwrite(fpath, data, backend='skimage')
recon1 = kwimage.imread(fpath)
recon1.shape
```

```
self = LazyGDalFrameFile(fpath)
self.shape
self[:]
```

```
classmethod available(self)
```

Returns True if this backend is available

```
_ds(self)
```

```
classmethod demo(cls, key='astro', dsize=None)
```

```
property ndim(self)
```

```
property shape(self)
```

```
property dtype(self)
```

```
__nice__(self)
```

```
__getitem__(self, index)
```

### References

<https://gis.stackexchange.com/questions/162095/gdal-driver-create-typeerror>

### Example

```
>>> # Test nodata works correctly
>>> # xdoctest: +REQUIRES(module:osgeo)
>>> from kwcoco.util.lazy_frame_backends import * # NOQA
>>> from kwcoco.util.lazy_frame_backends import _demo_geoimg_with_nodata
>>> fpath = _demo_geoimg_with_nodata()
>>> self = LazyGDalFrameFile(fpath, nodata='auto')
>>> imdata = self[:]
>>> # xdoctest: +REQUIRES(--show)
>>> import kwplot
>>> import kwarray
>>> kwplot.autompl()
>>> imdata = kwimage.normalize_intensity(imdata)
>>> imdata = np.nan_to_num(imdata)
>>> kwplot.imshow(imdata)
```

```
__array__(self)
```

Allow this object to be passed to np.asarray

## References

<https://numpy.org/doc/stable/user/basics.dispatch.html>

**class** kwcoco.util.**LazyRasterIOFrameFile**(*fpath*)

Bases: `ubelt.NiceRepr`

*fpath* = '/home/joncrall/.cache/kwcoco/demo/large\_hyperspectral/big\_img\_128.bsq' *lazy\_rio* = `LazyRasterIOFrameFile(fpath)` *ds* = *lazy\_rio.\_ds*

**classmethod** **available**(*self*)

Returns True if this backend is available

**\_ds**(*self*)

**property** **ndim**(*self*)

**property** **shape**(*self*)

**property** **dtype**(*self*)

**\_\_nice\_\_**(*self*)

**\_\_getitem\_\_**(*self*, *index*)

**class** kwcoco.util.**LazySpectralFrameFile**(*fpath*)

Bases: `ubelt.NiceRepr`

Potentially faster than GDAL for HDR formats.

**\_ds**(*self*)

**classmethod** **available**(*self*)

Returns True if this backend is available

**property** **ndim**(*self*)

**property** **shape**(*self*)

**property** **dtype**(*self*)

**\_\_nice\_\_**(*self*)

**\_\_getitem\_\_**(*self*, *index*)

**class** kwcoco.util.**Archive**(*fpath=None*, *mode='r'*, *backend=None*, *file=None*)

Bases: `object`

Abstraction over zipfile and tarfile

---

**Todo:** see if we can use one of these other tools instead

---

**SeeAlso:** <https://github.com/RKrahl/archive-tools> <https://pypi.org/project/arlib/>

### Example

```

>>> from os.path import join
>>> dpath = ub.ensure_app_cache_dir('ubelt', 'tests', 'archive')
>>> ub.delete(dpath)
>>> dpath = ub.ensure_app_cache_dir(dpath)
>>> import pathlib
>>> dpath = pathlib.Path(dpath)
>>> #
>>> #
>>> mode = 'w'
>>> self1 = Archive(str(dpath / 'demo.zip'), mode=mode)
>>> self2 = Archive(str(dpath / 'demo.tar.gz'), mode=mode)
>>> #
>>> open(dpath / 'data_1only.txt', 'w').write('bazbzzz')
>>> open(dpath / 'data_2only.txt', 'w').write('buzzz')
>>> open(dpath / 'data_both.txt', 'w').write('foobar')
>>> #
>>> self1.add(dpath / 'data_both.txt')
>>> self1.add(dpath / 'data_1only.txt')
>>> #
>>> self2.add(dpath / 'data_both.txt')
>>> self2.add(dpath / 'data_2only.txt')
>>> #
>>> self1.close()
>>> self2.close()
>>> #
>>> self1 = Archive(str(dpath / 'demo.zip'), mode='r')
>>> self2 = Archive(str(dpath / 'demo.tar.gz'), mode='r')
>>> #
>>> extract_dpath = ub.ensure_dir(str(dpath / 'extracted'))
>>> extracted1 = self1.extractall(extract_dpath)
>>> extracted2 = self2.extractall(extract_dpath)
>>> for fpath in extracted2:
>>>     print(open(fpath, 'r').read())
>>> for fpath in extracted1:
>>>     print(open(fpath, 'r').read())

```

**classmethod** `_open(cls, fpath, mode)`

**\_\_iter\_\_**(self)

**classmethod** `coerce(cls, data)`

Either open an archive file path or coerce an existing ZipFile or tarfile structure into this wrapper class

**add**(self, fpath, arcname=None)

**close**(self)

**\_\_enter\_\_**(self)

**\_\_exit\_\_**(self, \*args)

**extractall**(self, output\_dpath='.', verbose=1, overwrite=True)



---

```
kwcoco.util.unarchive_file(archive_fpath, output_dpath='.', verbose=1, overwrite=True)
```

```
class kwcoco.util.DelayedChannelConcat(components, dsize=None)
```

Bases: [DelayedImageOperation](#)

Represents multiple channels in an image that could be concatenated

**Variables** `components` (`List[DelayedWarp]`) – a list of stackable channels. Each component may be comprised of multiple channels.

---

#### Todo:

- [ ] can this be generalized into a delayed concat?
  - [ ] can all concats be delayed until the very end?
- 

#### Example

```
>>> comp1 = DelayedWarp(np.random.rand(11, 7))
>>> comp2 = DelayedWarp(np.random.rand(11, 7, 3))
>>> comp3 = DelayedWarp(
>>>     np.random.rand(3, 5, 2),
>>>     transform=kwimage.Affine.affine(scale=(7/5, 11/3)).matrix,
>>>     dsize=(7, 11)
>>> )
>>> components = [comp1, comp2, comp3]
>>> chans = DelayedChannelConcat(components)
>>> final = chans.finalize()
>>> assert final.shape == chans.shape
>>> assert final.shape == (11, 7, 6)
```

```
>>> # We should be able to nest DelayedChannelConcat inside virtual images
>>> frame1 = DelayedWarp(
>>>     chans, transform=kwimage.Affine.affine(scale=2.2).matrix,
>>>     dsize=(20, 26))
>>> frame2 = DelayedWarp(
>>>     np.random.rand(3, 3, 6), dsize=(20, 26))
>>> frame3 = DelayedWarp(
>>>     np.random.rand(3, 3, 6), dsize=(20, 26))
```

```
>>> print(ub.repr2(frame1.nesting(), nl=-1, sort=False))
>>> frame1.finalize()
>>> vid = DelayedFrameConcat([frame1, frame2, frame3])
>>> print(ub.repr2(vid.nesting(), nl=-1, sort=False))
```

**children**(*self*)

Abstract method, which should generate all of the direct children of a node in the operation tree.

**classmethod** `random`(*cls*, *num\_parts*=3, *rng*=None)

### Example

```
>>> self = DelayedChannelConcat.random()
>>> print('self = {!r}'.format(self))
>>> print(ub.repr2(self.nesting(), nl=-1, sort=0))
```

**property** `channels(self)`

**property** `shape(self)`

**finalize**(*self*, *\*\*kwargs*)

Execute the final transform

**delayed\_warp**(*self*, *transform*, *dsize=None*)

Delayed transform the underlying data.

---

**Note:** this deviates from kwimage warp functions because instead of “output\_dims” (specified in c-style shape) we specify dsize (w, h).

---

**Returns** new delayed transform a chained transform

**Return type** *DelayedWarp*

**take\_channels**(*self*, *channels*)

This method returns a subset of the vision data with only the specified bands / channels.

**Parameters** **channels** (*List[int]* | *slice* | *channel\_spec.FusedChannelSpec*) – List of integers indexes, a slice, or a channel spec, which is typically a pipe (|) delimited list of channel codes. See kwcoco.ChannelSpec for more details.

**Returns** a delayed vision operation that only operates on the following channels.

**Return type** *DelayedVisionOperation*

### Example

```
>>> from kwcoco.util.util_delayed_poc import * # NOQA
>>> import kwcoco
>>> dset = kwcoco.CocoDataset.demo('vidshapes8-multispectral')
>>> self = delayed = dset.delayed_load(1)
>>> channels = 'B11|B8|B1|B10'
>>> new = self.take_channels(channels)
```

### Example

```
>>> # Complex case
>>> import kwcoco
>>> from kwcoco.util.util_delayed_poc import * # NOQA
>>> dset = kwcoco.CocoDataset.demo('vidshapes8-multispectral')
>>> delayed = dset.delayed_load(1)
>>> astro = DelayedLoad.demo('astro').load_shape(use_channel_heuristic=True)
>>> aligned = astro.warp(kwimage.Affine.scale(600 / 512), dsize='auto')
>>> self = combo = DelayedChannelConcat(delayed.components + [aligned])
>>> channels = 'B1|r|B8|g'
>>> new = self.take_channels(channels)
>>> new_cropped = new.crop((slice(10, 200), slice(12, 350)))
>>> datas = new_cropped.finalize()
>>> vizable = kwimage.normalize_intensity(datas, axis=2)
>>> # xdoctest: +REQUIRES(--show)
>>> import kwplot
>>> kwplot.autompl()
>>> stacked = kwimage.stack_images(vizable.transpose(2, 0, 1))
>>> kwplot.imshow(stacked)
```

### CommandLine

```
xdoctest -m /home/joncrall/code/kwcoco/kwcoco/util/util_delayed_poc.py
DelayedChannelConcat.take_channels:2 --profile
```

### Example

```
>>> # Test case where requested channel does not exist
>>> import kwcoco
>>> from kwcoco.util.util_delayed_poc import * # NOQA
>>> dset = kwcoco.CocoDataset.demo('vidshapes8-multispectral', use_cache=1,
↳ verbose=100)
>>> self = dset.delayed_load(1)
>>> channels = 'B1|foobar|bazbiz|B8'
>>> new = self.take_channels(channels)
>>> new_cropped = new.crop((slice(10, 200), slice(12, 350)))
>>> fused = new_cropped.finalize()
>>> assert fused.shape == (190, 338, 4)
>>> assert np.all(np.isnan(fused[..., 1:3]))
>>> assert not np.any(np.isnan(fused[..., 0]))
>>> assert not np.any(np.isnan(fused[..., 3]))
```

```
class kwcoco.util.DelayedCrop(sub_data, sub_slices)
```

Bases: *DelayedImageOperation*

Represent a delayed crop operation

### Example

```
>>> sub_data = DelayedLoad.demo()
>>> sub_slices = (slice(5, 10), slice(1, 12))
>>> self = DelayedCrop(sub_data, sub_slices)
>>> print(ub.repr2(self.nesting(), nl=-1, sort=0))
>>> final = self.finalize()
>>> print('final.shape = {!r}'.format(final.shape))
```

### Example

```
>>> sub_data = DelayedLoad.demo()
>>> sub_slices = (slice(5, 10), slice(1, 12))
>>> crop1 = DelayedCrop(sub_data, sub_slices)
>>> import pytest
>>> # Should only error while huristics are in use.
>>> with pytest.raises(ValueError):
>>>     crop2 = DelayedCrop(crop1, sub_slices)
```

`__hack_dont_optimize__ = True`

`property channels(self)`

`children(self)`

Abstract method, which should generate all of the direct children of a node in the operation tree.

`finalize(self, **kwargs)`

`abstract _optimize_paths(self, **kwargs)`

Iterate through the leaf nodes, which are virtually transformed into the root space.

This returns some sort of hueristically optimized leaf repr wrt warps.

**class** `kwcoco.util.DelayedFrameConcat(frames, dsize=None)`

Bases: `DelayedVideoOperation`

Represents multiple frames in a video

---

### Note:

```
Video[0]:
  Frame[0]:
    Chan[0]: (32) +-----+
    Chan[1]: (16) +-----+
    Chan[2]: ( 8) +-----+
  Frame[1]:
    Chan[0]: (30) +-----+
    Chan[1]: (14) +-----+
    Chan[2]: ( 6) +-----+
```

---

### Todo:

- [ ] Support computing the transforms when none of the data is loaded

## Example

```
>>> # Simpler case with fewer nesting levels
>>> rng = kwarray.ensure_rng(None)
>>> # Delayed warp each channel into its "image" space
>>> # Note: the images never enter the space we transform through
>>> f1_img = DelayedLoad.demo('astro', (300, 300))
>>> f2_img = DelayedLoad.demo('carl', (256, 256))
>>> # Combine frames into a video
>>> vid_dsize = np.array((100, 100))
>>> self = vid = DelayedFrameConcat([
>>>     f1_img.delayed_warp(kwimage.Affine.scale(vid_dsize / f1_img.dsize)),
>>>     f2_img.delayed_warp(kwimage.Affine.scale(vid_dsize / f2_img.dsize)),
>>> ], dsize=vid_dsize)
>>> print(ub.repr2(vid.nesting(), nl=-1, sort=0))
>>> final = vid.finalize(interpolation='nearest', dsize=(32, 32))
>>> # xdoctest: +REQUIRES(--show)
>>> import kwplot
>>> kwplot.autompl()
>>> kwplot.imshow(final[0], pnum=(1, 2, 1), fnum=1)
>>> kwplot.imshow(final[1], pnum=(1, 2, 2), fnum=1)
>>> region_slices = (slice(0, 90), slice(30, 60))
```

**children**(*self*)

Abstract method, which should generate all of the direct children of a node in the operation tree.

**property channels**(*self*)

**property shape**(*self*)

**finalize**(*self*, *\*\*kwargs*)

Execute the final transform

**delayed\_crop**(*self*, *region\_slices*)

## Example

```
>>> from kwcoco.util.util_delayed_poc import * # NOQA
>>> # Create raw channels in some "native" resolution for frame 1
>>> f1_chan1 = DelayedIdentity.demo('astro', chan=(1, 0), dsize=(300, 300))
>>> f1_chan2 = DelayedIdentity.demo('astro', chan=2, dsize=(10, 10))
>>> # Create raw channels in some "native" resolution for frame 2
>>> f2_chan1 = DelayedIdentity.demo('carl', dsize=(64, 64), chan=(1, 0))
>>> f2_chan2 = DelayedIdentity.demo('carl', dsize=(10, 10), chan=2)
>>> #
>>> f1_dsize = np.array(f1_chan1.dsize)
>>> f2_dsize = np.array(f2_chan1.dsize)
>>> f1_img = DelayedChannelConcat([
>>>     f1_chan1.delayed_warp(kwimage.Affine.scale(f1_dsize / f1_chan1.dsize),
↳ dsize=f1_dsize),
```

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```

>>> f1_chan2.delayed_warp(kwimage.Affine.scale(f1_dsize / f1_chan2.dsize),
↳ dsize=f1_dsize),
>>> ])
>>> f2_img = DelayedChannelConcat([
>>>     f2_chan1.delayed_warp(kwimage.Affine.scale(f2_dsize / f2_chan1.dsize),
↳ dsize=f2_dsize),
>>>     f2_chan2.delayed_warp(kwimage.Affine.scale(f2_dsize / f2_chan2.dsize),
↳ dsize=f2_dsize),
>>> ])
>>> vid_dsize = np.array((280, 280))
>>> full_vid = DelayedFrameConcat([
>>>     f1_img.delayed_warp(kwimage.Affine.scale(vid_dsize / f1_img.dsize),
↳ dsize=vid_dsize),
>>>     f2_img.delayed_warp(kwimage.Affine.scale(vid_dsize / f2_img.dsize),
↳ dsize=vid_dsize),
>>> ])
>>> region_slices = (slice(80, 200), slice(80, 200))
>>> print(ub.repr2(full_vid.nesting(), nl=-1, sort=0))
>>> crop_vid = full_vid.delayed_crop(region_slices)
>>> final_full = full_vid.finalize(interpolation='nearest')
>>> final_crop = crop_vid.finalize(interpolation='nearest')
>>> import pytest
>>> with pytest.raises(ValueError):
>>>     # should not be able to crop a crop yet
>>>     crop_vid.delayed_crop(region_slices)
>>> # xdoctest: +REQUIRES(--show)
>>> import kwplot
>>> kwplot.autompl()
>>> kwplot.imshow(final_full[0], pnum=(2, 2, 1), fnum=1)
>>> kwplot.imshow(final_full[1], pnum=(2, 2, 2), fnum=1)
>>> kwplot.imshow(final_crop[0], pnum=(2, 2, 3), fnum=1)
>>> kwplot.imshow(final_crop[1], pnum=(2, 2, 4), fnum=1)

```

**delayed\_warp**(*self*, *transform*, *dsize=None*)

Delayed transform the underlying data.

---

**Note:** this deviates from kwimage warp functions because instead of “output\_dims” (specified in c-style shape) we specify dsize (w, h).

---

**Returns** new delayed transform a chained transform

**Return type** *DelayedWarp*

**class** kwcoco.util.**DelayedIdentity**(*sub\_data*, *dsize=None*, *channels=None*, *quantization=None*)

Bases: *DelayedImageOperation*

Noop leaf that does nothing. Can be used to hold raw data.

Typically used to just hold raw data.

DelayedIdentity.demo(‘astro’, chan=0, dsize=(32, 32))

## Example

```
>>> from kwcoco.util.util_delayed_poc import * # NOQA
>>> sub_data = np.random.rand(31, 37, 3)
>>> self = DelayedIdentity(sub_data)
>>> self = DelayedIdentity(sub_data, channels='L|a|b')

>>> # test with quantization
>>> rng = kwarray.ensure_rng(32)
>>> sub_data_quant = (rng.rand(31, 37, 3) * 1000).astype(np.int16)
>>> sub_data_quant[0, 0] = -9999
>>> self = DelayedIdentity(sub_data_quant, channels='L|a|b', quantization={
>>>     'orig_min': 0.,
>>>     'orig_max': 1.,
>>>     'quant_min': 0,
>>>     'quant_max': 1000,
>>>     'nodata': -9999,
>>> })
>>> final1 = self.finalize(dequantize=True)
>>> final2 = self.finalize(dequantize=False)
>>> assert np.all(np.isnan(final1[0, 0]))
>>> scale = final2 / final1
>>> scales = scale[scale > 0]
>>> assert np.all(np.isclose(scales, 1000))
>>> # check that take_channels works
>>> new_subdata = self.take_channels('a')
>>> sub_final1 = new_subdata.finalize(dequantize=True)
>>> sub_final2 = new_subdata.finalize(dequantize=False)
>>> assert sub_final1.dtype.kind == 'f'
>>> assert sub_final2.dtype.kind == 'i'
```

`__hack_dont_optimize__ = True`

`classmethod demo(cls, key='astro', chan=None, dsize=None)`

`children(self)`

Abstract method, which should generate all of the direct children of a node in the operation tree.

`_optimize_paths(self, **kwargs)`

Iterate through the leaf nodes, which are virtually transformed into the root space.

This returns some sort of hueristically optimized leaf repr wrt warps.

`finalize(self, **kwargs)`

`take_channels(self, channels)`

**class** `kwcoco.util.DelayedImageOperation`

Bases: `DelayedVisionOperation`

Operations that pertain only to images

`delayed_crop(self, region_slices)`

Create a new delayed image that performs a crop in the transformed “self” space.

**Parameters** `region_slices` (`Tuple[slice, slice]`) – y-slice and x-slice.

---

**Note:** Returns a heuristically “simplified” tree. In the current implementation there are only 3 operations, cat, warp, and crop. All cats go at the top, all crops go at the bottom, all warps are in the middle.

---

**Returns** lazy executed delayed transform

**Return type** *DelayedWarp*

### Example

```
>>> dsize = (100, 100)
>>> tf2 = kwimage.Affine.affine(scale=3).matrix
>>> self = DelayedWarp(np.random.rand(33, 33), tf2, dsize)
>>> region_slices = (slice(5, 10), slice(1, 12))
>>> delayed_crop = self.delayed_crop(region_slices)
>>> print(ub.repr2(delayed_crop.nesting(), nl=-1, sort=0))
>>> delayed_crop.finalize()
```

### Example

```
>>> chan1 = DelayedLoad.demo('astro')
>>> chan2 = DelayedLoad.demo('carl')
>>> warped1a = chan1.delayed_warp(kwimage.Affine.scale(1.2).matrix)
>>> warped2a = chan2.delayed_warp(kwimage.Affine.scale(1.5))
>>> warped1b = warped1a.delayed_warp(kwimage.Affine.scale(1.2).matrix)
>>> warped2b = warped2a.delayed_warp(kwimage.Affine.scale(1.5))
>>> #
>>> region_slices = (slice(97, 677), slice(5, 691))
>>> self = warped2b
>>> #
>>> crop1 = warped1b.delayed_crop(region_slices)
>>> crop2 = warped2b.delayed_crop(region_slices)
>>> print(ub.repr2(warped1b.nesting(), nl=-1, sort=0))
>>> print(ub.repr2(warped2b.nesting(), nl=-1, sort=0))
>>> # Notice how the crop merges the two nesting layers
>>> # (via the heuristic optimize step)
>>> print(ub.repr2(crop1.nesting(), nl=-1, sort=0))
>>> print(ub.repr2(crop2.nesting(), nl=-1, sort=0))
>>> frame1 = crop1.finalize(dsize=(500, 500))
>>> frame2 = crop2.finalize(dsize=(500, 500))
>>> # xdoctest: +REQUIRES(--show)
>>> import kwplot
>>> kwplot.autompl()
>>> kwplot.imshow(frame1, pnum=(1, 2, 1), fnum=1)
>>> kwplot.imshow(frame2, pnum=(1, 2, 2), fnum=1)
```

**delayed\_warp**(*self*, *transform*, *dsize=None*)

Delayed transform the underlying data.

---

**Note:** this deviates from kwimage warp functions because instead of “output\_dims” (specified in c-style



shape) we specify dsize (w, h).

**Returns** new delayed transform a chained transform

**Return type** *DelayedWarp*

**abstract take\_channels**(*self*, *channels*)

```
class kwcoco.util.DelayedLoad(fpath, channels=None, dsize=None, num_bands=None,
                             immediate_crop=None, immediate_chan_idx=None,
                             immediate_dsize=None, quantization=None)
```

Bases: *DelayedImageOperation*

A load operation for a specific sub-region and sub-bands in a specified image.

**Note:** This class contains support for fusing certain lazy operations into this layer, namely cropping, scaling, and channel selection.

For now these are named immediates

## Example

```
>>> fpath = kwimage.grab_test_image_fpath()
>>> self = DelayedLoad(fpath)
>>> print('self = {!r}'.format(self))
>>> self.load_shape()
>>> print('self = {!r}'.format(self))
>>> self.finalize()
```

```
>>> f1_img = DelayedLoad.demo('astro', dsize=(300, 300))
>>> f2_img = DelayedLoad.demo('carl', dsize=(256, 320))
>>> print('f1_img = {!r}'.format(f1_img))
>>> print('f2_img = {!r}'.format(f2_img))
>>> print(f2_img.finalize().shape)
>>> print(f1_img.finalize().shape)
```

```
>>> fpath = kwimage.grab_test_image_fpath()
>>> channels = channel_spec.FusedChannelSpec.coerce('rgb')
>>> self = DelayedLoad(fpath, channels=channels)
```

## Example

```
>>> # Test with quantization
>>> fpath = kwimage.grab_test_image_fpath()
>>> channels = channel_spec.FusedChannelSpec.coerce('rgb')
>>> self = DelayedLoad(fpath, channels=channels, quantization={
>>>     'orig_min': 0.,
>>>     'orig_max': 1.,
>>>     'quant_min': 0,
```

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```
>>>     'quant_max': 256,
>>>     'nodata': None,
>>> })
>>> final1 = self.finalize(dequantize=False)
>>> final2 = self.finalize(dequantize=True)
>>> assert final1.dtype.kind == 'u'
>>> assert final2.dtype.kind == 'f'
>>> assert final2.max() <= 1
```

**`__hack_dont_optimize__`** = True

**`classmethod demo`**(*DelayedLoad*, *key*='astro', *dsize*=None)

**`abstract classmethod coerce`**(*cls*, *data*)

**`children`**(*self*)

Abstract method, which should generate all of the direct children of a node in the operation tree.

**`nesting`**(*self*)

**`_optimize_paths`**(*self*, *\*\*kwargs*)

Iterate through the leaf nodes, which are virtually transformed into the root space.

This returns some sort of hueristically optimized leaf repr wrt warps.

**`load_shape`**(*self*, *use\_channel\_heuristic*=False)

**`_ensure_dsize`**(*self*)

**`property shape`**(*self*)

**`property num_bands`**(*self*)

**`property dsize`**(*self*)

**`property channels`**(*self*)

**`property fpath`**(*self*)

**`finalize`**(*self*, *\*\*kwargs*)

---

**Todo:**

- [ ] Load from overviews if a scale will be necessary
- 

**Parameters** *\*\*kwargs* –

**`nodata`** [if specified this data item is treated as nodata, the] data is then converted to floats and the nodata value is replaced with nan.

**`delayed_crop`**(*self*, *region\_slices*)

**Parameters** *region\_slices* (*Tuple[slice, slice]*) – y-slice and x-slice.

**Returns** a new delayed load object with a fused crop operation

**Return type** *DelayedLoad*

### Example

```

>>> # Test chained crop operations
>>> from kwcoco.util.util_delayed_poc import * # NOQA
>>> self = orig = DelayedLoad.demo('astro').load_shape()
>>> region_slices = slices1 = (slice(0, 90), slice(30, 60))
>>> self = crop1 = orig.delayed_crop(slices1)
>>> region_slices = slices2 = (slice(10, 21), slice(10, 22))
>>> self = crop2 = crop1.delayed_crop(slices2)
>>> region_slices = slices3 = (slice(3, 20), slice(5, 20))
>>> crop3 = crop2.delayed_crop(slices3)
>>> # Spot check internals
>>> print('orig = {}'.format(ub.repr2(orig.__json__(), nl=2)))
>>> print('crop1 = {}'.format(ub.repr2(crop1.__json__(), nl=2)))
>>> print('crop2 = {}'.format(ub.repr2(crop2.__json__(), nl=2)))
>>> print('crop3 = {}'.format(ub.repr2(crop3.__json__(), nl=2)))
>>> # Test internals
>>> assert crop3._immediates['crop'][0].start == 13
>>> assert crop3._immediates['crop'][0].stop == 21
>>> # Test shapes work out correctly
>>> assert crop3.finalize().shape == (8, 7, 3)
>>> assert crop2.finalize().shape == (11, 12, 3)
>>> assert crop1.take_channels([1, 2]).finalize().shape == (90, 30, 2)
>>> assert orig.finalize().shape == (512, 512, 3)

```

### Note:

This chart gives an intuition on how new absolute `slice` coords are computed **from existing** absolute coords and relative coords.

```

    5 7    <- new
    3 5    <- rel
-----
01234567 <- relative coordinates
-----
    2      9 <- curr
-----
0123456789 <- absolute coordinates
-----

```

### `take_channels(self, channels)`

This method returns a subset of the vision data with only the specified bands / channels.

**Parameters** `channels` (`List[int]` | `slice` | `channel_spec.FusedChannelSpec`) – List of integers indexes, a slice, or a channel spec, which is typically a pipe (|) delimited list of channel codes. See `kwcoco.ChannelSpec` for more details.

**Returns** a new delayed load with a fused take channel operation

**Return type** `DelayedLoad`

**Note:** The channel subset must exist here or it will raise an error. A better implementation (via pymbolic)

might be able to do better

---

### Example

```
>>> from kwcoco.util.util_delayed_poc import * # NOQA
>>> import kwcoco
>>> self = DelayedLoad.demo('astro').load_shape()
>>> channels = [2, 0]
>>> new = self.take_channels(channels)
>>> new3 = new.take_channels([1, 0])
```

```
>>> final1 = self.finalize()
>>> final2 = new.finalize()
>>> final3 = new3.finalize()
>>> assert np.all(final1[..., 2] == final2[..., 0])
>>> assert np.all(final1[..., 0] == final2[..., 1])
>>> assert final2.shape[2] == 2
```

```
>>> assert np.all(final1[..., 2] == final3[..., 1])
>>> assert np.all(final1[..., 0] == final3[..., 0])
>>> assert final3.shape[2] == 2
```

**class** kwcoco.util.DelayedNans(*dsize=None, channels=None*)

Bases: [DelayedImageOperation](#)

Constructs nan channels as needed

### Example

```
self = DelayedNans((10, 10), channel_spec.FusedChannelSpec.coerce('rgb'))
region_slices = (slice(5, 10), slice(1, 12))
delayed = self.delayed_crop(region_slices)
```

### Example

```
>>> from kwcoco.util.util_delayed_poc import * # NOQA
>>> dsize = (307, 311)
>>> c1 = DelayedNans(dsize=dsize, channels=channel_spec.FusedChannelSpec.coerce('foo
→'))
>>> c2 = DelayedLoad.demo('astro', dsize=dsize).load_shape(True)
>>> cat = DelayedChannelConcat([c1, c2])
>>> warped_cat = cat.delayed_warp(kwimage.Affine.scale(1.07), dsize=(328, 332))
>>> warped_cat.finalize()
```

```
#>>> cropped = warped_cat.delayed_crop((slice(0, 300), slice(0, 100))) #>>> cropped.finalize().shape
```

**property** `shape(self)`

**property** `num_bands(self)`

**property** `dsize(self)`

**property** `channels(self)`

**children**(`self`)

Abstract method, which should generate all of the direct children of a node in the operation tree.

**\_optimize\_paths**(`self, **kwargs`)

Iterate through the leaf nodes, which are virtually transformed into the root space.

This returns some sort of hueristically optimized leaf repr wrt warps.

**finalize**(`self, **kwargs`)

**delayed\_crop**(`self, region_slices`)

Create a new delayed image that performs a crop in the transformed “self” space.

**Parameters** `region_slices` (*Tuple[slice, slice]*) – y-slice and x-slice.

---

**Note:** Returns a heuristically “simplified” tree. In the current implementation there are only 3 operations, cat, warp, and crop. All cats go at the top, all crops go at the bottom, all warps are in the middle.

---

**Returns** lazy executed delayed transform

**Return type** *DelayedWarp*

### Example

```
>>> dsize = (100, 100)
>>> tf2 = kwimage.Affine.affine(scale=3).matrix
>>> self = DelayedWarp(np.random.rand(33, 33), tf2, dsize)
>>> region_slices = (slice(5, 10), slice(1, 12))
>>> delayed_crop = self.delayed_crop(region_slices)
>>> print(ub.repr2(delayed_crop.nesting(), nl=-1, sort=0))
>>> delayed_crop.finalize()
```

### Example

```
>>> chan1 = DelayedLoad.demo('astro')
>>> chan2 = DelayedLoad.demo('carl')
>>> warped1a = chan1.delayed_warp(kwimage.Affine.scale(1.2).matrix)
>>> warped2a = chan2.delayed_warp(kwimage.Affine.scale(1.5))
>>> warped1b = warped1a.delayed_warp(kwimage.Affine.scale(1.2).matrix)
>>> warped2b = warped2a.delayed_warp(kwimage.Affine.scale(1.5))
>>> #
>>> region_slices = (slice(97, 677), slice(5, 691))
>>> self = warped2b
>>> #
>>> crop1 = warped1b.delayed_crop(region_slices)
>>> crop2 = warped2b.delayed_crop(region_slices)
>>> print(ub.repr2(warped1b.nesting(), nl=-1, sort=0))
>>> print(ub.repr2(warped2b.nesting(), nl=-1, sort=0))
>>> # Notice how the crop merges the two nesting layers
```

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```

>>> # (via the hueristic optimize step)
>>> print(ub.repr2(crop1.nesting(), nl=-1, sort=0))
>>> print(ub.repr2(crop2.nesting(), nl=-1, sort=0))
>>> frame1 = crop1.finalize(dsize=(500, 500))
>>> frame2 = crop2.finalize(dsize=(500, 500))
>>> # xdoctest: +REQUIRES(--show)
>>> import kwplot
>>> kwplot.autompl()
>>> kwplot.imshow(frame1, pnum=(1, 2, 1), fnum=1)
>>> kwplot.imshow(frame2, pnum=(1, 2, 2), fnum=1)

```

**delayed\_warp**(*self*, *transform*, *dsize=None*)

Delayed transform the underlying data.

---

**Note:** this deviates from kwimage warp functions because instead of “output\_dims” (specified in c-style shape) we specify dsize (w, h).

---

**Returns** new delayed transform a chained transform

**Return type** *DelayedWarp*

**class** kwcoco.util.DelayedVideoOperation

Bases: *DelayedVisionOperation*

Base class for nodes in a tree of delayed computer-vision operations

**class** kwcoco.util.DelayedVisionOperation

Bases: *ubelt.NiceRepr*

Base class for nodes in a tree of delayed computer-vision operations

**\_\_nice\_\_**(*self*)

**abstract finalize**(*self*, *\*\*kwargs*)

**abstract children**(*self*)

Abstract method, which should generate all of the direct children of a node in the operation tree.

**\_optimize\_paths**(*self*, *\*\*kwargs*)

Iterate through the leaf nodes, which are virtually transformed into the root space.

This returns some sort of hueristically optimized leaf repr wrt warps.

**\_\_json\_\_**(*self*)

**nesting**(*self*)

**warp**(*self*, *\*args*, *\*\*kwargs*)

alias for delayed\_warp, might change to this API in the future

**crop**(*self*, *\*args*, *\*\*kwargs*)

alias for delayed\_crop, might change to this API in the future

**class** kwcoco.util.DelayedWarp(sub\_data, transform=None, dsize=None)

Bases: [DelayedImageOperation](#)

POC for chainable transforms

---

**Note:** “sub” is used to refer to the underlying data in its native coordinates and resolution.

“self” is used to refer to the data in the transformed coordinates that are exposed by this class.

---

### Variables

- **sub\_data** ([DelayedWarp](#) / [ArrayLike](#)) – array-like image data at a native resolution
- **transform** ([Transform](#)) – transforms data from native “sub”-image-space to “self”-image-space.

### Example

```
>>> dsize = (12, 12)
>>> tf1 = np.array([[2, 0, 0], [0, 2, 0], [0, 0, 1]])
>>> tf2 = np.array([[3, 0, 0], [0, 3, 0], [0, 0, 1]])
>>> tf3 = np.array([[4, 0, 0], [0, 4, 0], [0, 0, 1]])
>>> band1 = DelayedWarp(np.random.rand(6, 6), tf1, dsize)
>>> band2 = DelayedWarp(np.random.rand(4, 4), tf2, dsize)
>>> band3 = DelayedWarp(np.random.rand(3, 3), tf3, dsize)
>>> #
>>> # Execute a crop in a one-level transformed space
>>> region_slices = (slice(5, 10), slice(0, 12))
>>> delayed_crop = band2.delayed_crop(region_slices)
>>> final_crop = delayed_crop.finalize()
>>> #
>>> # Execute a crop in a nested transformed space
>>> tf4 = np.array([[1.5, 0, 0], [0, 1.5, 0], [0, 0, 1]])
>>> chained = DelayedWarp(band2, tf4, (18, 18))
>>> delayed_crop = chained.delayed_crop(region_slices)
>>> final_crop = delayed_crop.finalize()
>>> #
>>> tf4 = np.array([[.5, 0, 0], [0, .5, 0], [0, 0, 1]])
>>> chained = DelayedWarp(band2, tf4, (6, 6))
>>> delayed_crop = chained.delayed_crop(region_slices)
>>> final_crop = delayed_crop.finalize()
>>> #
>>> region_slices = (slice(1, 5), slice(2, 4))
>>> delayed_crop = chained.delayed_crop(region_slices)
>>> final_crop = delayed_crop.finalize()
```

### Example

```
>>> dsize = (17, 12)
>>> tf = np.array([[5.2, 0, 1.1], [0, 3.1, 2.2], [0, 0, 1]])
>>> self = DelayedWarp(np.random.rand(3, 5, 13), tf, dsize=dsize)
>>> self.finalize().shape
```

**classmethod** `random(cls, nesting=(2, 5), rng=None)`

### Example

```
>>> self = DelayedWarp.random(nesting=(4, 7))
>>> print('self = {!r}'.format(self))
>>> print(ub.repr2(self.nesting(), nl=-1, sort=0))
```

**property** `channels(self)`

**children**(*self*)

Abstract method, which should generate all of the direct children of a node in the operation tree.

**property** `dsize(self)`

**property** `num_bands(self)`

**property** `shape(self)`

**\_optimize\_paths**(*self*, *\*\*kwargs*)

### Example

```
>>> self = DelayedWarp.random()
>>> leafs = list(self._optimize_paths())
>>> print('leafs = {!r}'.format(leafs))
```

**finalize**(*self*, *transform=None*, *dsize=None*, *interpolation='linear'*, *\*\*kwargs*)

Execute the final transform

Can pass a parent transform to augment this underlying transform.

#### Parameters

- **transform** (*Transform*) – an additional transform to perform
- **dsize** (*Tuple[int, int]*) – overrides destination canvas size



### Example

```

>>> tf = np.array([[0.9, 0, 3.9], [0, 1.1, -.5], [0, 0, 1]])
>>> raw = kwimage.grab_test_image(dsize=(54, 65))
>>> raw = kwimage.ensure_float01(raw)
>>> # Test nested finalize
>>> layer1 = raw
>>> num = 10
>>> for _ in range(num):
...     layer1 = DelayedWarp(layer1, tf, dsize='auto')
>>> final1 = layer1.finalize()
>>> # Test non-nested finalize
>>> layer2 = list(layer1._optimize_paths())[0]
>>> final2 = layer2.finalize()
>>> #
>>> print(ub.repr2(layer1.nesting(), nl=-1, sort=0))
>>> print(ub.repr2(layer2.nesting(), nl=-1, sort=0))
>>> print('final1 = {!r}'.format(final1))
>>> print('final2 = {!r}'.format(final2))
>>> print('final1.shape = {!r}'.format(final1.shape))
>>> print('final2.shape = {!r}'.format(final2.shape))
>>> assert np.allclose(final1, final2)
>>> #
>>> # xdoctest: +REQUIRES(--show)
>>> import kwplot
>>> kwplot.autompl()
>>> kwplot.imshow(raw, pnum=(1, 3, 1), fnum=1)
>>> kwplot.imshow(final1, pnum=(1, 3, 2), fnum=1)
>>> kwplot.imshow(final2, pnum=(1, 3, 3), fnum=1)
>>> kwplot.show_if_requested()

```

### Example

```

>>> # Test aliasing
>>> s = DelayedIdentity.demo()
>>> s = DelayedIdentity.demo('checkerboard')
>>> a = s.delayed_warp(kwimage.Affine.scale(0.05), dsize='auto')
>>> b = s.delayed_warp(kwimage.Affine.scale(3), dsize='auto')

```

```

>>> # xdoctest: +REQUIRES(--show)
>>> import kwplot
>>> kwplot.autompl()
>>> # It looks like downsampling linear and area is the same
>>> # Does warpAffine have no alias handling?
>>> pnum_ = kwplot.PlotNums(nRows=2, nCols=4)
>>> kwplot.imshow(a.finalize(interpolation='area'), pnum=pnum_(), title=
↳ 'warpAffine area')
>>> kwplot.imshow(a.finalize(interpolation='linear'), pnum=pnum_(), title=
↳ 'warpAffine linear')
>>> kwplot.imshow(a.finalize(interpolation='nearest'), pnum=pnum_(), title=
↳ 'warpAffine nearest')

```

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```

>>> kwplot.imshow(a.finalize(interpolation='nearest', antialias=False),
↳ pnum=pnum_(), title='warpAffine nearest AA=0')
>>> kwplot.imshow(kwimage.imresize(s.finalize(), dsize=a.dsize, interpolation=
↳ 'area'), pnum=pnum_(), title='resize area')
>>> kwplot.imshow(kwimage.imresize(s.finalize(), dsize=a.dsize, interpolation=
↳ 'linear'), pnum=pnum_(), title='resize linear')
>>> kwplot.imshow(kwimage.imresize(s.finalize(), dsize=a.dsize, interpolation=
↳ 'nearest'), pnum=pnum_(), title='resize nearest')
>>> kwplot.imshow(kwimage.imresize(s.finalize(), dsize=a.dsize, interpolation=
↳ 'cubic'), pnum=pnum_(), title='resize cubic')

```

**take\_channels**(*self*, *channels*)

kwcoco.util.IndexableWalker

kwcoco.util.ensure\_json\_serializable(*dict\_*, *normalize\_containers=False*, *verbose=0*)

Attempt to convert common types (e.g. numpy) into something json compliant

Convert numpy and tuples into lists

**Parameters** **normalize\_containers** (*bool*, *default=False*) – if True, normalizes dict containers to be standard python structures.

## Example

```

>>> data = ub.ddict(lambda: int)
>>> data['foo'] = ub.ddict(lambda: int)
>>> data['bar'] = np.array([1, 2, 3])
>>> data['foo']['a'] = 1
>>> data['foo']['b'] = (1, np.array([1, 2, 3]), {3: np.int32(3), 4: np.float16(1.0)})
↳
>>> dict_ = data
>>> print(ub.repr2(data, nl=-1))
>>> assert list(find_json_unserializable(data))
>>> result = ensure_json_serializable(data, normalize_containers=True)
>>> print(ub.repr2(result, nl=-1))
>>> assert not list(find_json_unserializable(result))
>>> assert type(result) is dict

```

kwcoco.util.find\_json\_unserializable(*data*, *quickcheck=False*)

Recurse through json datastructure and find any component that causes a serialization error. Record the location of these errors in the datastructure as we recurse through the call tree.

### Parameters

- **data** (*object*) – data that should be json serializable
- **quickcheck** (*bool*) – if True, check the entire datastructure assuming its ok before doing the python-based recursive logic.

### Returns

**list of “bad part” dictionaries containing items** ‘value’ - the value that caused the serialization error ‘loc’ - which contains a list of key/indexes that can be used

to lookup the location of the unserializable value. If the “loc” is a list, then it indicates a rare case where a key in a dictionary is causing the serialization error.

**Return type** List[Dict]

### Example

```
>>> from kwcoco.util.util_json import * # NOQA
>>> part = ub.ddict(lambda: int)
>>> part['foo'] = ub.ddict(lambda: int)
>>> part['bar'] = np.array([1, 2, 3])
>>> part['foo']['a'] = 1
>>> # Create a dictionary with two unserializable parts
>>> data = [1, 2, {'nest1': [2, part]}, {frozenset({'badkey'}): 3, 2: 4}]
>>> parts = list(find_json_unserializable(data))
>>> print('parts = {}'.format(ub.repr2(parts, nl=1)))
>>> # Check expected structure of bad parts
>>> assert len(parts) == 2
>>> part = parts[1]
>>> assert list(part['loc']) == [2, 'nest1', 1, 'bar']
>>> # We can use the "loc" to find the bad value
>>> for part in parts:
>>>     # "loc" is a list of directions containing which keys/indexes
>>>     # to traverse at each descent into the data structure.
>>>     directions = part['loc']
>>>     curr = data
>>>     special_flag = False
>>>     for key in directions:
>>>         if isinstance(key, list):
>>>             # special case for bad keys
>>>             special_flag = True
>>>             break
>>>         else:
>>>             # normal case for bad values
>>>             curr = curr[key]
>>>     if special_flag:
>>>         assert part['data'] in curr.keys()
>>>         assert part['data'] is key[1]
>>>     else:
>>>         assert part['data'] is curr
```

`kwcoco.util.indexable_allclose(dct1, dct2, return_info=False)`

Walks through two nested data structures and ensures that everything is roughly the same.

#### Parameters

- **dct1** – a nested indexable item
- **dct2** – a nested indexable item

### Example

```
>>> from kwcoco.util.util_json import indexable_allclose
>>> dct1 = {
>>>     'foo': [1.222222, 1.333],
>>>     'bar': 1,
>>>     'baz': [],
>>> }
>>> dct2 = {
>>>     'foo': [1.222222, 1.333],
>>>     'bar': 1,
>>>     'baz': [],
>>> }
>>> assert indexable_allclose(dct1, dct2)
```

**class** kwcoco.util.SuppressPrint(\*mods, \*\*kw)

Bases: `object`

Temporarily replace the print function in a module with a noop

#### Parameters

- **\*mods** – the modules to disable print in
- **\*\*kw** – only accepts “enabled” enabled (bool, default=True): enables or disables this context

`__enter__(self)`

`__exit__(self, a, b, c)`

**class** kwcoco.util.StratifiedGroupKFold(*n\_splits=3, shuffle=False, random\_state=None*)

Bases: `sklearn.model_selection._split._BaseKFold`

Stratified K-Folds cross-validator with Grouping

Provides train/test indices to split data in train/test sets.

This cross-validation object is a variation of GroupKFold that returns stratified folds. The folds are made by preserving the percentage of samples for each class.

Read more in the User Guide.

**Parameters** **n\_splits** (*int, default=3*) – Number of folds. Must be at least 2.

`_make_test_folds(self, X, y=None, groups=None)`

#### Parameters

- **X** (*ndarray*) – data
- **y** (*ndarray*) – labels
- **groups** (*ndarray*) – groupids for items. Items with the same groupid must be placed in the same group.

**Returns** `test_folds`

**Return type** `list`

### Example

```

>>> import kwarrray
>>> rng = kwarrray.ensure_rng(0)
>>> groups = [1, 1, 3, 4, 2, 2, 7, 8, 8]
>>> y      = [1, 1, 1, 1, 2, 2, 2, 3, 3]
>>> X = np.empty((len(y), 0))
>>> self = StratifiedGroupKFold(random_state=rng, shuffle=True)
>>> skf_list = list(self.split(X=X, y=y, groups=groups))
...
>>> import ubelt as ub
>>> print(ub.repr2(skf_list, nl=1, with_dtype=False))
[
  (np.array([2, 3, 4, 5, 6]), np.array([0, 1, 7, 8])),
  (np.array([0, 1, 2, 7, 8]), np.array([3, 4, 5, 6])),
  (np.array([0, 1, 3, 4, 5, 6, 7, 8]), np.array([2])),
]

```

**`_iter_test_masks`**(*self*, *X*, *y=None*, *groups=None*)

Generates boolean masks corresponding to test sets.

By default, delegates to `_iter_test_indices(X, y, groups)`

**`split`**(*self*, *X*, *y*, *groups=None*)

Generate indices to split data into training and test set.

`kwcoco.util.smart_truncate`(*string*, *max\_length=0*, *separator=' '*, *trunc\_loc=0.5*)

Truncate a string. :param *string* (str): string for modification :param *max\_length* (int): output string length :param *word\_boundary* (bool): :param *save\_order* (bool): if True then word order of output string is like input string :param *separator* (str): separator between words :param *trunc\_loc* (float): fraction of location where to remove the text :return:

## 2.3 Submodules

### 2.3.1 `kwcoco.__main__`

### 2.3.2 `kwcoco._helpers`

These items were split out of `coco_dataset.py` which is becoming too big

These are helper data structures used to do things like auto-increment ids, recycle ids, do renaming, extend sortedcontainers etc...

## Module Contents

### Classes

<code>_NextId</code>	Helper class to tracks unused ids for new items
<code>_ID_Remapper</code>	Helper to recycle ids for unions.
<code>UniqueNameRemapper</code>	helper to ensure names will be unique by appending suffixes
<code>SortedSetQuiet</code>	Sorted set is a sorted mutable set.

### Functions

<code>_lut_frame_index</code> (imgs, gid)	
<code>_delitems</code> (items, remove_idx, thresh=750)	
	<b>Parameters</b> <ul style="list-style-type: none"><li>• <b>items</b> (<i>List</i>) -- list which will be modified</li></ul>

**class** kwcoco.\_helpers.\_NextId(*parent*)

Bases: `object`

Helper class to tracks unused ids for new items

`_update_unused`(*self*, *key*)

Scans for what the next safe id can be for *key*

`get`(*self*, *key*)

Get the next safe item id for *key*

**class** kwcoco.\_helpers.\_ID\_Remapper(*reuse=False*)

Bases: `object`

Helper to recycle ids for unions.

For each dataset we create a mapping between each old id and a new id. If possible and *reuse=True* we allow the new id to match the old id. After each dataset is finished we mark all those ids as used and subsequent new-ids cannot be chosen from that pool.

**Parameters** *reuse* (*bool*) – if *True* we are allowed to reuse ids as long as they haven't been used before.

### Example

```

>>> video_trackids = [[1, 1, 3, 3, 200, 4], [204, 1, 2, 3, 3, 4, 5, 9]]
>>> self = _ID_Remapper(reuse=True)
>>> for tids in video_trackids:
>>>     new_tids = [self.remap(old_tid) for old_tid in tids]
>>>     self.block_seen()
>>>     print('new_tids = {!r}'.format(new_tids))
new_tids = [1, 1, 3, 3, 200, 4]
new_tids = [204, 205, 2, 206, 206, 207, 5, 9]
>>> #
>>> self = _ID_Remapper(reuse=False)
>>> for tids in video_trackids:
>>>     new_tids = [self.remap(old_tid) for old_tid in tids]
>>>     self.block_seen()
>>>     print('new_tids = {!r}'.format(new_tids))
new_tids = [0, 0, 1, 1, 2, 3]
new_tids = [4, 5, 6, 7, 7, 8, 9, 10]

```

**remap**(self, old\_id)

Convert a old-id into a new-id. If self.reuse is True then we will return the same id if it hasn't been blocked yet.

**block\_seen**(self)

Mark all seen ids as unable to be used. Any ids sent to remap will now generate new ids.

**next\_id**(self)

Generate a new id that hasnt been used yet

**class** kwcoco.\_helpers.UniqueNameRemapper

Bases: `object`

helper to ensure names will be unique by appending suffixes

### Example

```

>>> from kwcoco.coco_dataset import * # NOQA
>>> self = UniqueNameRemapper()
>>> assert self.remap('foo') == 'foo'
>>> assert self.remap('foo') == 'foo_v001'
>>> assert self.remap('foo') == 'foo_v002'
>>> assert self.remap('foo_v001') == 'foo_v003'

```

**remap**(self, name)

kwcoco.\_helpers.\_lut\_frame\_index(imgs, gid)

**class** kwcoco.\_helpers.SortedSetQuiet(iterable=None, key=None)

Bases: `sortedcontainers.SortedSet`

Sorted set is a sorted mutable set.

Sorted set values are maintained in sorted order. The design of sorted set is simple: sorted set uses a set for set-operations and maintains a sorted list of values.

Sorted set values must be hashable and comparable. The hash and total ordering of values must not change while they are stored in the sorted set.

Mutable set methods:

- `SortedSet.__contains__()`
- `SortedSet.__iter__()`
- `SortedSet.__len__()`
- `SortedSet.add()`
- `SortedSet.discard()`

Sequence methods:

- `SortedSet.__getitem__()`
- `SortedSet.__delitem__()`
- `SortedSet.__reversed__()`

Methods for removing values:

- `SortedSet.clear()`
- `SortedSet.pop()`
- `SortedSet.remove()`

Set-operation methods:

- `SortedSet.difference()`
- `SortedSet.difference_update()`
- `SortedSet.intersection()`
- `SortedSet.intersection_update()`
- `SortedSet.symmetric_difference()`
- `SortedSet.symmetric_difference_update()`
- `SortedSet.union()`
- `SortedSet.update()`

Methods for miscellany:

- `SortedSet.copy()`
- `SortedSet.count()`
- `SortedSet.__repr__()`
- `SortedSet._check()`

Sorted list methods available:

- `SortedList.bisect_left()`
- `SortedList.bisect_right()`
- `SortedList.index()`
- `SortedList.irange()`
- `SortedList.islice()`



- `SortedList._reset()`

Additional sorted list methods available, if key-function used:

- `SortedList.bisect_key_left()`
- `SortedList.bisect_key_right()`
- `SortedList.irange_key()`

Sorted set comparisons use subset and superset relations. Two sorted sets are equal if and only if every element of each sorted set is contained in the other (each is a subset of the other). A sorted set is less than another sorted set if and only if the first sorted set is a proper subset of the second sorted set (is a subset, but is not equal). A sorted set is greater than another sorted set if and only if the first sorted set is a proper superset of the second sorted set (is a superset, but is not equal).

**`__repr__`**(*self*)

Return string representation of sorted set.

`ss.__repr__() <==> repr(ss)`

**Returns** string representation

`kwcoco._helpers._delitems(items, remove_idx, thresh=750)`

**Parameters**

- **items** (*List*) – list which will be modified
- **remove\_idx** (*List[int]*) – integers to remove (MUST BE UNIQUE)

### 2.3.3 kwcoco.abstract\_coco\_dataset

#### Module Contents

#### Classes

---

*AbstractCocoDataset*

This is a common base for all variants of the Coco Dataset

---

**class** `kwcoco.abstract_coco_dataset.AbstractCocoDataset`

Bases: `abc.ABC`

This is a common base for all variants of the Coco Dataset

At the time of writing there is `kwcoco.CocoDataset` (which is the dictionary-based backend), and the `kwcoco.coco_sql_dataset.CocoSqlDataset`, which is experimental.

### 2.3.4 kwcoco.category\_tree

The `category_tree` module defines the `CategoryTree` class, which is used for maintaining flat or hierarchical category information. The kwcoco version of this class only contains the datastructure and does not contain any torch operations. See the ndsampler version for the extension with torch operations.

#### Module Contents

#### Classes

---

<code>CategoryTree</code>	Wrapper that maintains flat or hierarchical category information.
---------------------------	---

---

**class** kwcoco.category\_tree.**CategoryTree**(*graph=None, checks=True*)

Bases: `ubelt.NiceRepr`

Wrapper that maintains flat or hierarchical category information.

Helps compute softmaxes and probabilities for tree-based categories where a directed edge (A, B) represents that A is a superclass of B.

---

**Note:** There are three basic properties that this object maintains:

```
node:
    Alphanumeric string names that should be generally descriptive.
    Using spaces and special characters in these names is
    discouraged, but can be done. This is the COCO category "name"
    attribute. For categories this may be denoted as (name, node,
    cname, catname).

id:
    The integer id of a category should ideally remain consistent.
    These are often given by a dataset (e.g. a COCO dataset). This
    is the COCO category "id" attribute. For categories this is
    often denoted as (id, cid).

index:
    Contiguous zero-based indices that indexes the list of
    categories. These should be used for the fastest access in
    backend computation tasks. Typically corresponds to the
    ordering of the channels in the final linear layer in an
    associated model. For categories this is often denoted as
    (index, cid, idx, or cx).
```

---

#### Variables

- **idx\_to\_node** (`List[str]`) – a list of class names. Implicitly maps from index to category name.
- **id\_to\_node** (`Dict[int, str]`) – maps integer ids to category names
- **node\_to\_id** (`Dict[str, int]`) – maps category names to ids

- **node\_to\_idx** (*Dict[str, int]*) – maps category names to indexes
- **graph** (*networkx.Graph*) – a Graph that stores any hierarchy information. For standard mutually exclusive classes, this graph is edgeless. Nodes in this graph can maintain category attributes / properties.
- **idx\_groups** (*List[List[int]]*) – groups of category indices that share the same parent category.

### Example

```
>>> from kwcoco.category_tree import *
>>> graph = nx.from_dict_of_lists({
>>>     'background': [],
>>>     'foreground': ['animal'],
>>>     'animal': ['mammal', 'fish', 'insect', 'reptile'],
>>>     'mammal': ['dog', 'cat', 'human', 'zebra'],
>>>     'zebra': ['grevys', 'plains'],
>>>     'grevys': ['fred'],
>>>     'dog': ['boxer', 'beagle', 'golden'],
>>>     'cat': ['maine coon', 'persian', 'sphynx'],
>>>     'reptile': ['bearded dragon', 't-rex'],
>>> }, nx.DiGraph)
>>> self = CategoryTree(graph)
>>> print(self)
<CategoryTree(nNodes=22, maxDepth=6, maxBreadth=4...)>
```

### Example

```
>>> # The coerce classmethod is the easiest way to create an instance
>>> import kwcoco
>>> kwcoco.CategoryTree.coerce(['a', 'b', 'c'])
<CategoryTree...nNodes=3, nodes=... 'a', 'b', 'c'...
>>> kwcoco.CategoryTree.coerce(4)
<CategoryTree...nNodes=4, nodes=... 'class_1', 'class_2', 'class_3', ...
>>> kwcoco.CategoryTree.coerce(4)
```

**copy**(*self*)

**classmethod from\_mutex**(*cls, nodes, bg\_hack=True*)

**Parameters** **nodes** (*List[str]*) – or a list of class names (in which case they will all be assumed to be mutually exclusive)

### Example

```
>>> print(CategoryTree.from_mutex(['a', 'b', 'c']))
<CategoryTree(nNodes=3, ...)>
```

**classmethod** `from_json(cls, state)`

**Parameters** `state` (*Dict*) – see `__getstate__` / `__json__` for details

**classmethod** `from_coco(cls, categories)`

Create a `CategoryTree` object from coco categories

**Parameters** `List[Dict]` – list of coco-style categories

**classmethod** `coerce(cls, data, **kw)`

Attempt to coerce data as a `CategoryTree` object.

This is primarily useful for when the software stack depends on categories being represent

This will work if the input data is a specially formatted json dict, a list of mutually exclusive classes, or if it is already a `CategoryTree`. Otherwise an error will be thrown.

#### Parameters

- `data` (*object*) – a known representation of a category tree.
- `**kwargs` – input type specific arguments

**Returns** `self`

**Return type** `CategoryTree`

#### Raises

- `TypeError` – if the input format is unknown –
- `ValueError` – if `kwargs` are not compatible with the input format –

### Example

```
>>> import kwcoco
>>> classes1 = kwcoco.CategoryTree.coerce(3) # integer
>>> classes2 = kwcoco.CategoryTree.coerce(classes1.__json__()) # graph dict
>>> classes3 = kwcoco.CategoryTree.coerce(['class_1', 'class_2', 'class_3']) #_
↳mutex list
>>> classes4 = kwcoco.CategoryTree.coerce(classes1.graph) # nx Graph
>>> classes5 = kwcoco.CategoryTree.coerce(classes1) # cls
>>> # xdoctest: +REQUIRES(module:ndsampler)
>>> import ndsampler
>>> classes6 = ndsampler.CategoryTree.coerce(3)
>>> classes7 = ndsampler.CategoryTree.coerce(classes1)
>>> classes8 = kwcoco.CategoryTree.coerce(classes6)
```

**classmethod** `demo(cls, key='coco', **kwargs)`

**Parameters** `key` (*str*) – specify which demo dataset to use. Can be ‘coco’ (which uses the default coco demo data). Can be ‘btree’ which creates a binary tree and accepts `kwargs` ‘r’ and ‘h’ for branching-factor and height. Can be ‘btree2’, which is the same as btree but returns strings

## CommandLine

```
xdoctest -m ~/code/kwcoco/kwcoco/category_tree.py CategoryTree.demo
```

## Example

```
>>> from kwcoco.category_tree import *
>>> self = CategoryTree.demo()
>>> print('self = {}'.format(self))
self = <CategoryTree(nNodes=10, maxDepth=2, maxBreadth=4...)>
```

**to\_coco**(*self*)

Converts to a coco-style data structure

**Yields** *Dict* – coco category dictionaries

**id\_to\_idx**(*self*)

## Example

```
>>> import kwcoco
>>> self = kwcoco.CategoryTree.demo()
>>> self.id_to_idx[1]
```

**idx\_to\_id**(*self*)

## Example

```
>>> import kwcoco
>>> self = kwcoco.CategoryTree.demo()
>>> self.idx_to_id[0]
```

**idx\_to\_ancestor\_idx**(*self*, *include\_self=True*)

Mapping from a class index to its ancestors

**Parameters** *include\_self* (*bool*, *default=True*) – if True includes each node as its own ancestor.

**idx\_to\_descendants\_idx**(*self*, *include\_self=False*)

Mapping from a class index to its descendants (including itself)

**Parameters** *include\_self* (*bool*, *default=False*) – if True includes each node as its own descendant.

**idx\_pairwise\_distance**(*self*)

Get a matrix encoding the distance from one class to another.

**Distances**

- from parents to children are positive (descendants),
- from children to parents are negative (ancestors),
- between unreachable nodes (wrt to forward and reverse graph) are nan.

```
__len__(self)
__iter__(self)
__getitem__(self, index)
__contains__(self, node)
__json__(self)
```

### Example

```
>>> import pickle
>>> self = CategoryTree.demo()
>>> print('self = {!r}'.format(self.__json__()))
```

```
__getstate__(self)
    Serializes information in this class
```

### Example

```
>>> from kwcoco.category_tree import *
>>> import pickle
>>> self = CategoryTree.demo()
>>> state = self.__getstate__()
>>> serialization = pickle.dumps(self)
>>> recon = pickle.loads(serialization)
>>> assert recon.__json__() == self.__json__()
```

```
__setstate__(self, state)
```

```
__nice__(self)
```

```
is_mutex(self)
```

Returns True if all categories are mutually exclusive (i.e. flat)

If true, then the classes may be represented as a simple list of class names without any loss of information, otherwise the underlying category graph is necessary to preserve all knowledge.

---

#### Todo:

- [ ] what happens when we have a dummy root?
- 

```
property num_classes(self)
```

```
property class_names(self)
```

```
property category_names(self)
```

```
property cats(self)
```

Returns a mapping from category names to category attributes.

If this category tree was constructed from a coco-dataset, then this will contain the coco category attributes.

**Returns** Dict[str, Dict[str, object]]

### Example

```
>>> from kwcoco.category_tree import *
>>> self = CategoryTree.demo()
>>> print('self.cats = {!r}'.format(self.cats))
```

**index**(self, node)

Return the index that corresponds to the category name

**\_build\_index**(self)

construct lookup tables

**show**(self)

**forest\_str**(self)

**normalize**(self)

Applies a normalization scheme to the categories.

Note: this may break other tasks that depend on exact category names.

**Returns** CategoryTree

### Example

```
>>> from kwcoco.category_tree import * # NOQA
>>> import kwcoco
>>> orig = kwcoco.CategoryTree.demo('animals_v1')
>>> self = kwcoco.CategoryTree(nx.relabel_nodes(orig.graph, str.upper))
>>> norm = self.normalize()
```

## 2.3.5 kwcoco.channel\_spec

This module defines the KWCOCO Channel Specification and API.

The KWCOCO Channel specification is a way to semantically express how a combination of image channels are grouped. This can specify how these channels (sometimes called bands or features) are arranged on disk or input to an algorithm. The core idea reduces to a `Set[List[str]]` — or a unordered set of ordered sequences of strings corresponding to channel “names”. The way these are specified is with a “,” to separate lists in an unordered set and with a “|” to separate the channel names. Other syntax exists for convinience, but a strict normalized channel spec only contains these core symbols.

Another way to think of a kwcoco channel spec is that splitting the spec by “,” gives groups of channels that should be processed together and “late-fused”. Within each group the “|” operator “early-fuses” the channels.

For instance, say we had a network and we wanted to process 3-channel rgb images in one stream and 1-channel infrared images in a second stream and then fuse them together. The kwcoco channel specification for channels labled as ‘red’, ‘green’, ‘blue’, and ‘infrared’ would be:

```
infrared, red|green|blue
```

Note, it is up to an algorithm to do any early-late fusion. KWCoco simply provides the specification as a tool to quickly access a particular combination of channels from disk.

The ChannelSpec has these simple rules:

```
* each 1D channel is a alphanumeric string.

* The pipe ('|') separates aligned early fused streamas (non-communative)

* The comma (',') separates late-fused streams, (happens after pipe operations, and is
↳ communative)

* Certain common sets of early fused channels have codenames, for example:

    rgb = r|g|b
    rgba = r|g|b|a
    dxdy = dy|dy

* Multiple channels can be specified via a "slice" notation. For example:

    mychan.0:4

    represents 4 channels:
        mychan.0, mychan.1, mychan.2, and mychan.3

    slices after the "." work like python slices
```

The detailed grammar for the spec is:

```
?start: stream

// An identifier can contain spaces IDEN: ("_"|LETTER) ("_"|" "|LETTER|DIGIT)*

chan_single : IDEN chan_getitem : IDEN "." INT chan_getslice_0b : IDEN ":" INT chan_getslice_ab :
IDEN ":" INT ":" INT

// A channel code can just be an ID, or it can have a getitem // style syntax with a scalar or slice as an
argument chan_code : chan_single | chan_getslice_0b | chan_getslice_ab | chan_getitem

// Fused channels are an ordered sequence of channel codes (without sensors) fused : chan_code ("["
chan_code)*

// Channels can be specified in a sequence but must contain parens fused_seq : "(" fused ("," fused)* ")"

channel_rhs : fused | fused_seq

stream : channel_rhs ("," channel_rhs)*

%import common.DIGIT %import common.LETTER %import common.INT
```

Note that a stream refers to a the full ChannelSpec and fused refers to FusedChannelSpec.

For single arrays, the spec is always an early fused spec.

---

**Todo:**

- [X] : normalize representations? e.g: rgb = r|g|b? - OPTIONAL
- [X] : rename to BandsSpec or SensorSpec? - REJECTED
- [ ] : allow bands to be coerced, i.e. rgb -> gray, or gray->rgb

---

**Todo:**



- [x]: Use FusedChannelSpec as a member of ChannelSpec
- [x]: Handle special slice suffix for length calculations

**Todo:** Let S1 = sensor 1 Let S2 = sensor 2 Let S3 = sensor 3

Using a <sensor>:<pure\_fused\_channel\_spec> indicates that the fused channels belong to that sensor.

For example:

S1:red|green|blue S1:B.0:3 = S1:C.0|C.1|C.2

To specify that R|G|B channels exist in sensor 1 and sensor 2 you could do:

S1:R|G|B,S2:R|G|B

or the more concise syntax allows for a distributive law

(S1,S2):R|G|B

Notice, how the “R|G|B” channel code is distributed over the “,” in the parenthesis.

**Note:**

- do not specify the same channel in FusedChannelSpec twice

## Example

```
>>> import kw coco
>>> spec = kw coco.ChannelSpec('b1|b2|b3,m.0:4|x1|x2,x.3|x.4|x.5')
>>> print(spec)
<ChannelSpec(b1|b2|b3,m.0:4|x1|x2,x.3|x.4|x.5)>
>>> for stream in spec.streams():
>>>     print(stream)
<FusedChannelSpec(b1|b2|b3)>
<FusedChannelSpec(m.0:4|x1|x2)>
<FusedChannelSpec(x.3|x.4|x.5)>
>>> # Normalization
>>> normalized = spec.normalize()
>>> print(normalized)
<ChannelSpec(b1|b2|b3,m.0|m.1|m.2|m.3|x1|x2,x.3|x.4|x.5)>
>>> print(normalized.fuse().spec)
b1|b2|b3|m.0|m.1|m.2|m.3|x1|x2|x.3|x.4|x.5
>>> print(normalized.fuse().concise().spec)
b1|b2|b3|m:4|x1|x2|x.3:6
```

## Module Contents

### Classes

<i>BaseChannelSpec</i>	Common code API between <i>FusedChannelSpec</i> and <i>ChannelSpec</i>
<i>FusedChannelSpec</i>	A specific type of channel spec with only one early fused stream.
<i>ChannelSpec</i>	Parse and extract information about network input channel specs for

### Functions

<i>_cached_single_fused_mapping</i> (item_keys, parsed_items, axis=0)	
<i>_cached_single_stream_idx</i> s(key, axis=0)	
<i>subsequence_index</i> (oset1, oset2)	Returns a slice into the first items indicating the position of
<i>_parse_concise_slice_syntax</i> (v)	Helper for our slice syntax, which is may be a bit strange
<i>oset_insert</i> (self, index, obj)	
<i>oset_delitem</i> (self, index)	for ubelt oset, todo contribute back to luminosoinst

**class** kwcoco.channel\_spec.**BaseChannelSpec**

Bases: `ubelt.NiceRepr`

Common code API between *FusedChannelSpec* and *ChannelSpec*

---

#### Todo:

- [ ] Keep working on this base spec and ensure the inheriting classes conform to it.
- 

**property** *spec*(self)

The string encoding of this spec

**Returns** str

**abstract classmethod** *coerce*(cls, data)

Try and interpret the input data as some sort of spec

**Parameters** *data* (str | int | list | dict | *BaseChannelSpec*) – any input data that is known to represent a spec

**Returns** *BaseChannelSpec*

**abstract** *streams*(self)

Breakup this spec into individual early-fused components

**Returns** List[*FusedChannelSpec*]

**abstract normalize**(*self*)

Expand all channel codes into their normalized long-form

**Returns** BaseChannelSpec

**abstract intersection**(*self*, *other*)

**abstract union**(*self*, *other*)

**abstract difference**(*self*)

**abstract issubset**(*self*, *other*)

**abstract issuperset**(*self*, *other*)

**\_\_sub\_\_**(*self*, *other*)

**\_\_nice\_\_**(*self*)

**\_\_json\_\_**(*self*)

**\_\_and\_\_**(*self*, *other*)

**\_\_or\_\_**(*self*, *other*)

**path\_sanitize**(*self*, *maxlen=None*)

Clean up the channel spec so it can be used in a pathname.

**Parameters** **maxlen** (*int*) – if specified, and the name is longer than this length, it is shortened.

Must be 8 or greater.

**Returns** path suitable for usage in a filename

**Return type** `str`

---

**Note:** This mapping is not invertible and should not be relied on to reconstruct the path spec. This is only a convenience.

---

## Example

```
>>> import kwcoco
>>> print(kwcoco.FusedChannelSpec.coerce('a chan with space|bar|baz').path_
↳sanitize())
a chan with space_bar_baz
>>> print(kwcoco.ChannelSpec.coerce('foo|bar|baz,biz').path_sanitize())
foo_bar_baz,biz
```

### Example

```
>>> import kwcoco
>>> print(kwcoco.ChannelSpec.coerce('foo.0:3').normalize().path_sanitize(24))
foo.0_foo.1_foo.2
>>> print(kwcoco.ChannelSpec.coerce('foo.0:256').normalize().path_sanitize(24))
tuuxtfnrsvdhezkdndysxo_256
```

**class** kwcoco.channel\_spec.FusedChannelSpec(parsed, \_is\_normalized=False)

Bases: [BaseChannelSpec](#)

A specific type of channel spec with only one early fused stream.

The channels in this stream are non-communative

Behaves like a list of atomic-channel codes (which may represent more than 1 channel), normalized codes always represent exactly 1 channel.

---

**Note:** This class name and API is in flux and subject to change.

---

---

**Todo:** A special code indicating a name and some number of bands that that names contains, this would primarily be used for large numbers of channels produced by a network. Like:

resnet\_d35d060\_L5:512

or

resnet\_d35d060\_L5[:512]

might refer to a very specific (hashed) set of resnet parameters with 512 bands

maybe we can do something slicly like:

resnet\_d35d060\_L5[A:B] resnet\_d35d060\_L5:A:B

Do we want to “just store the code” and allow for parsing later?

Or do we want to ensure the serialization is parsed before we construct the data structure?

---

### Example

```
>>> from kwcoco.channel_spec import * # NOQA
>>> import pickle
>>> self = FusedChannelSpec.coerce(3)
>>> recon = pickle.loads(pickle.dumps(self))
>>> self = ChannelSpec.coerce('a|b,c|d')
>>> recon = pickle.loads(pickle.dumps(self))
```

`_alias_lut`

`_memo`

`_size_lut`

`__len__(self)`

```

__getitem__(self, index)

classmethod concat(cls, items)

spec(self)
    The string encoding of this spec
    Returns str

unique(self)

classmethod parse(cls, spec)

classmethod coerce(cls, data)

```

### Example

```

>>> from kwcoco.channel_spec import * # NOQA
>>> FusedChannelSpec.coerce(['a', 'b', 'c'])
>>> FusedChannelSpec.coerce('a|b|c')
>>> FusedChannelSpec.coerce(3)
>>> FusedChannelSpec.coerce(FusedChannelSpec(['a']))
>>> assert FusedChannelSpec.coerce('').numel() == 0

```

```

concise(self)
    Shorted the channel spec by de-normaliz slice syntax
    Returns concise spec
    Return type FusedChannelSpec

```

### Example

```

>>> from kwcoco.channel_spec import * # NOQA
>>> self = FusedChannelSpec.coerce(
>>>     'b|a|a.0|a.1|a.2|a.5|c|a.8|a.9|b.0:3|c.0')
>>> short = self.concise()
>>> long = short.normalize()
>>> numels = [c.numel() for c in [self, short, long]]
>>> print('self.spec = {!r}'.format(self.spec))
>>> print('short.spec = {!r}'.format(short.spec))
>>> print('long.spec = {!r}'.format(long.spec))
>>> print('numels = {!r}'.format(numels))
self.spec = 'b|a|a.0|a.1|a.2|a.5|c|a.8|a.9|b.0:3|c.0'
short.spec = 'b|a|a:3|a.5|c|a.8:10|b:3|c.0'
long.spec = 'b|a|a.0|a.1|a.2|a.5|c|a.8|a.9|b.0|b.1|b.2|c.0'
numels = [13, 13, 13]
>>> assert long.concise().spec == short.spec

```

```

normalize(self)
    Replace aliases with explicit single-band-per-code specs
    Returns normalize spec
    Return type FusedChannelSpec

```

### Example

```

>>> from kwcoco.channel_spec import * # NOQA
>>> self = FusedChannelSpec.coerce('b1|b2|b3|rgb')
>>> normed = self.normalize()
>>> print('self = {}'.format(self))
>>> print('normed = {}'.format(normed))
self = <FusedChannelSpec(b1|b2|b3|rgb)>
normed = <FusedChannelSpec(b1|b2|b3|r|g|b)>
>>> self = FusedChannelSpec.coerce('B:1:11')
>>> normed = self.normalize()
>>> print('self = {}'.format(self))
>>> print('normed = {}'.format(normed))
self = <FusedChannelSpec(B:1:11)>
normed = <FusedChannelSpec(B.1|B.2|B.3|B.4|B.5|B.6|B.7|B.8|B.9|B.10)>
>>> self = FusedChannelSpec.coerce('B.1:11')
>>> normed = self.normalize()
>>> print('self = {}'.format(self))
>>> print('normed = {}'.format(normed))
self = <FusedChannelSpec(B.1:11)>
normed = <FusedChannelSpec(B.1|B.2|B.3|B.4|B.5|B.6|B.7|B.8|B.9|B.10)>

```

**numel**(self)

Total number of channels in this spec

**sizes**(self)

Returns a list indicating the size of each atomic code

**Returns** List[int]

### Example

```

>>> from kwcoco.channel_spec import * # NOQA
>>> self = FusedChannelSpec.coerce('b1|Z:3|b2|b3|rgb')
>>> self.sizes()
[1, 3, 1, 1, 3]
>>> assert(FusedChannelSpec.parse('a:0').numel()) == 1
>>> assert(FusedChannelSpec.parse('a:0').numel()) == 0
>>> assert(FusedChannelSpec.parse('a:1').numel()) == 1

```

**\_\_contains\_\_**(self, key)

### Example

```

>>> FCS = FusedChannelSpec.coerce
>>> 'disparity' in FCS('rgb|disparity|flowx|flowy')
True
>>> 'gray' in FCS('rgb|disparity|flowx|flowy')
False

```

**code\_list**(self)

Return the expanded code list

**as\_list**(*self*)**as\_aset**(*self*)**as\_set**(*self*)**as\_path**(*self*)

Returns a string suitable for use in a path.

Note, this may no longer be a valid channel spec

**\_\_set\_\_**(*self*)**difference**(*self*, *other*)

Set difference

### Example

```

>>> FCS = FusedChannelSpec.coerce
>>> self = FCS('rgb|disparity|flowx|flowy')
>>> other = FCS('r|b')
>>> self.difference(other)
>>> other = FCS('flowx')
>>> self.difference(other)
>>> FCS = FusedChannelSpec.coerce
>>> assert len((FCS('a') - {'a'}).parsed) == 0
>>> assert len((FCS('a.0:3') - {'a.0'}).parsed) == 2

```

**intersection**(*self*, *other*)

### Example

```

>>> FCS = FusedChannelSpec.coerce
>>> self = FCS('rgb|disparity|flowx|flowy')
>>> other = FCS('r|b|XX')
>>> self.intersection(other)

```

**union**(*self*, *other*)

### Example

```

>>> from kwcoco.channel_spec import * # NOQA
>>> FCS = FusedChannelSpec.coerce
>>> self = FCS('rgb|disparity|flowx|flowy')
>>> other = FCS('r|b|XX')
>>> self.union(other)

```

**issubset**(*self*, *other*)**issuperset**(*self*, *other*)**component\_indices**(*self*, *axis*=2)

Look up component indices within this stream

### Example

```
>>> FCS = FusedChannelSpec.coerce
>>> self = FCS('disparity|rgb|flowx|flowy')
>>> component_indices = self.component_indices()
>>> print('component_indices = {}'.format(ub.repr2(component_indices, nl=1)))
component_indices = {
  'disparity': (slice(...), slice(...), slice(0, 1, None)),
  'flowx': (slice(...), slice(...), slice(4, 5, None)),
  'flowy': (slice(...), slice(...), slice(5, 6, None)),
  'rgb': (slice(...), slice(...), slice(1, 4, None)),
}
```

**streams**(*self*)

Idempotence with [ChannelSpec.streams\(\)](#)

**fuse**(*self*)

Idempotence with [ChannelSpec.streams\(\)](#)

**class** kwcoco.channel\_spec.**ChannelSpec**(*spec, parsed=None*)

Bases: [BaseChannelSpec](#)

Parse and extract information about network input channel specs for early or late fusion networks.

Behaves like a dictionary of FusedChannelSpec objects

---

#### Todo:

- [ ] Rename to something that indicates this is a collection of FusedChannelSpec? MultiChannelSpec?

---

**Note:** This class name and API is in flux and subject to change.

---

---

**Note:** The pipe ('|') character represents an early-fused input stream, and order matters (it is non-communative).

The comma (',') character separates different inputs streams/branches for a multi-stream/branch network which will be later fused. Order does not matter

---

### Example

```
>>> from kwcoco.channel_spec import * # NOQA
>>> # Integer spec
>>> ChannelSpec.coerce(3)
<ChannelSpec(u0|u1|u2) ...>
```

```
>>> # single mode spec
>>> ChannelSpec.coerce('rgb')
<ChannelSpec(rgb) ...>
```



```
>>> # early fused input spec
>>> ChannelSpec.coerce('rgb|disprity')
<ChannelSpec(rgb|disprity) ...>
```

```
>>> # late fused input spec
>>> ChannelSpec.coerce('rgb,disprity')
<ChannelSpec(rgb,disprity) ...>
```

```
>>> # early and late fused input spec
>>> ChannelSpec.coerce('rgb|ir,disprity')
<ChannelSpec(rgb|ir,disprity) ...>
```

### Example

```
>>> self = ChannelSpec('gray')
>>> print('self.info = {}'.format(ub.repr2(self.info, nl=1)))
>>> self = ChannelSpec('rgb')
>>> print('self.info = {}'.format(ub.repr2(self.info, nl=1)))
>>> self = ChannelSpec('rgb|disparity')
>>> print('self.info = {}'.format(ub.repr2(self.info, nl=1)))
>>> self = ChannelSpec('rgb|disparity,disparity')
>>> print('self.info = {}'.format(ub.repr2(self.info, nl=1)))
>>> self = ChannelSpec('rgb,disparity,flowx|flowy')
>>> print('self.info = {}'.format(ub.repr2(self.info, nl=1)))
```

### Example

```
>>> specs = [
>>>     'rgb',                # and rgb input
>>>     'rgb|disprity',       # rgb early fused with disparity
>>>     'rgb,disprity',       # rgb early late with disparity
>>>     'rgb|ir,disprity',    # rgb early fused with ir and late fused with disparity
>>>     3,                    # 3 unknown channels
>>> ]
>>> for spec in specs:
>>>     print('=====')
>>>     print('spec = {!r}'.format(spec))
>>>     #
>>>     self = ChannelSpec.coerce(spec)
>>>     print('self = {!r}'.format(self))
>>>     sizes = self.sizes()
>>>     print('sizes = {!r}'.format(sizes))
>>>     print('self.info = {}'.format(ub.repr2(self.info, nl=1)))
>>>     #
>>>     item = self._demo_item((1, 1), rng=0)
>>>     inputs = self.encode(item)
>>>     components = self.decode(inputs)
>>>     input_shapes = ub.map_vals(lambda x: x.shape, inputs)
>>>     component_shapes = ub.map_vals(lambda x: x.shape, components)
```

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```

>>> print('item = {}'.format(ub.repr2(item, precision=1)))
>>> print('inputs = {}'.format(ub.repr2(inputs, precision=1)))
>>> print('input_shapes = {}'.format(ub.repr2(input_shapes)))
>>> print('components = {}'.format(ub.repr2(components, precision=1)))
>>> print('component_shapes = {}'.format(ub.repr2(component_shapes, nl=1)))

```

**property spec(self)**

The string encoding of this spec

**Returns** str

**\_\_contains\_\_(self, key)**

### Example

```

>>> 'disparity' in ChannelSpec('rgb,disparity,flowx|flowy')
True
>>> 'gray' in ChannelSpec('rgb,disparity,flowx|flowy')
False

```

**property info(self)**

**classmethod coerce(cls, data)**

Attempt to interpret the data as a channel specification

**Returns** ChannelSpec

### Example

```

>>> from kwcoco.channel_spec import * # NOQA
>>> data = FusedChannelSpec.coerce(3)
>>> assert ChannelSpec.coerce(data).spec == 'u0|u1|u2'
>>> data = ChannelSpec.coerce(3)
>>> assert data.spec == 'u0|u1|u2'
>>> assert ChannelSpec.coerce(data).spec == 'u0|u1|u2'
>>> data = ChannelSpec.coerce('u:3')
>>> assert data.normalize().spec == 'u.0|u.1|u.2'

```

**parse(self)**

Build internal representation

### Example

```

>>> from kwcoco.channel_spec import * # NOQA
>>> self = ChannelSpec('b1|b2|b3|rgb,B:3')
>>> print(self.parse())
>>> print(self.normalize().parse())
>>> ChannelSpec('').parse()

```

### Example

```
>>> base = ChannelSpec('rgb|disparity,flowx|r|flowy')
>>> other = ChannelSpec('rgb')
>>> self = base.intersection(other)
>>> assert self.numel() == 4
```

**concise**(*self*)

### Example

```
>>> self = ChannelSpec('b1|b2,b3|rgb|B.0,B.1|B.2')
>>> print(self.concise().spec)
b1|b2,b3|r|g|b|B.0,B.1:3
```

**normalize**(*self*)

Replace aliases with explicit single-band-per-code specs

**Returns** normalized spec

**Return type** *ChannelSpec*

### Example

```
>>> self = ChannelSpec('b1|b2,b3|rgb,B:3')
>>> normed = self.normalize()
>>> print('self = {}'.format(self))
>>> print('normed = {}'.format(normed))
self = <ChannelSpec(b1|b2,b3|rgb,B:3)>
normed = <ChannelSpec(b1|b2,b3|r|g|b,B.0|B.1|B.2)>
```

**keys**(*self*)

**values**(*self*)

**items**(*self*)

**fuse**(*self*)

Fuse all parts into an early fused channel spec

**Returns** FusedChannelSpec

### Example

```
>>> from kwcoco.channel_spec import * # NOQA
>>> self = ChannelSpec.coerce('b1|b2,b3|rgb,B:3')
>>> fused = self.fuse()
>>> print('self = {}'.format(self))
>>> print('fused = {}'.format(fused))
self = <ChannelSpec(b1|b2,b3|rgb,B:3)>
fused = <FusedChannelSpec(b1|b2|b3|rgb|B:3)>
```

**streams**(*self*)

Breaks this spec up into one spec for each early-fused input stream

### Example

```
self = ChannelSpec.coerce('r|g,B1|B2,fx|fy') list(map(len, self.streams()))
```

**code\_list**(*self*)**as\_path**(*self*)

Returns a string suitable for use in a path.

Note, this may no longer be a valid channel spec

**difference**(*self*, *other*)

Set difference. Remove all instances of other channels from this set of channels.

### Example

```
>>> from kwcoco.channel_spec import *
>>> self = ChannelSpec('rgb|disparity,flowx|r|flowy')
>>> other = ChannelSpec('rgb')
>>> print(self.difference(other))
>>> other = ChannelSpec('flowx')
>>> print(self.difference(other))
<ChannelSpec(disparity,flowx|flowy)>
<ChannelSpec(r|g|b|disparity,r|flowy)>
```

### Example

```
>>> from kwcoco.channel_spec import *
>>> self = ChannelSpec('a|b,c|d')
>>> new = self - {'a', 'b'}
>>> len(new.sizes()) == 1
>>> empty = new - 'c|d'
>>> assert empty.numel() == 0
```

**intersection**(*self*, *other*)

Set difference. Remove all instances of other channels from this set of channels.

### Example

```
>>> from kwcoco.channel_spec import *
>>> self = ChannelSpec('rgb|disparity,flowx|r|flowy')
>>> other = ChannelSpec('rgb')
>>> new = self.intersection(other)
>>> print(new)
>>> print(new.numel())
>>> other = ChannelSpec('flowx')
>>> new = self.intersection(other)
```

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```
>>> print(new)
>>> print(new.numel())
<ChannelSpec(r|g|b,r)>
4
<ChannelSpec(flowx)>
1
```

**union**(self, other)

Union simply tags on a second channel spec onto this one. Duplicates are maintained.

### Example

```
>>> from kwcoco.channel_spec import *
>>> self = ChannelSpec('rgb|disparity,flowx|r|flowy')
>>> other = ChannelSpec('rgb')
>>> new = self.union(other)
>>> print(new)
>>> print(new.numel())
>>> other = ChannelSpec('flowx')
>>> new = self.union(other)
>>> print(new)
>>> print(new.numel())
<ChannelSpec(r|g|b|disparity,flowx|r|flowy,r|g|b)>
10
<ChannelSpec(r|g|b|disparity,flowx|r|flowy,flowx)>
8
```

**abstract issubset**(self, other)

**abstract issuperset**(self, other)

**numel**(self)

Total number of channels in this spec

**sizes**(self)

Number of dimensions for each fused stream channel

IE: The EARLY-FUSED channel sizes

### Example

```
>>> self = ChannelSpec('rgb|disparity,flowx|flowy,B:10')
>>> self.normalize().concise()
>>> self.sizes()
```

**unique**(self, normalize=False)

Returns the unique channels that will need to be given or loaded

**\_item\_shapes**(self, dims)

Expected shape for an input item

**Parameters** **dims** (*Tuple[int, int]*) – the spatial dimension

**Returns** Dict[int, tuple]

`_demo_item(self, dims=(4, 4), rng=None)`

Create an input that satisfies this spec

**Returns**

an item like it might appear when its returned from the `__getitem__` method of a `torch...Dataset`.

**Return type** dict

### Example

```
>>> dims = (1, 1)
>>> ChannelSpec.coerce(3)._demo_item(dims, rng=0)
>>> ChannelSpec.coerce('r|g|b|disaprity')._demo_item(dims, rng=0)
>>> ChannelSpec.coerce('rgb|disaprity')._demo_item(dims, rng=0)
>>> ChannelSpec.coerce('rgb,disaprity')._demo_item(dims, rng=0)
>>> ChannelSpec.coerce('rgb')._demo_item(dims, rng=0)
>>> ChannelSpec.coerce('gray')._demo_item(dims, rng=0)
```

`encode(self, item, axis=0, mode=1)`

Given a dictionary containing preloaded components of the network inputs, build a concatenated (fused) network representations of each input stream.

**Parameters**

- **item** (Dict[str, Tensor]) – a batch item containing unfused parts. each key should be a single-stream (optionally early fused) channel key.
- **axis** (int, default=0) – concatenation dimension

**Returns** mapping between input stream and its early fused tensor input.

**Return type** Dict[str, Tensor]

### Example

```
>>> from kwcoco.channel_spec import * # NOQA
>>> import numpy as np
>>> dims = (4, 4)
>>> item = {
>>>     'rgb': np.random.rand(3, *dims),
>>>     'disparity': np.random.rand(1, *dims),
>>>     'flowx': np.random.rand(1, *dims),
>>>     'flowy': np.random.rand(1, *dims),
>>> }
>>> # Complex Case
>>> self = ChannelSpec('rgb,disparity,rgb|disparity|flowx|flowy,flowx|flowy')
>>> fused = self.encode(item)
>>> input_shapes = ub.map_vals(lambda x: x.shape, fused)
>>> print('input_shapes = {}'.format(ub.repr2(input_shapes, nl=1)))
>>> # Simpler case
>>> self = ChannelSpec('rgb|disparity')
```

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```
>>> fused = self.encode(item)
>>> input_shapes = ub.map_vals(lambda x: x.shape, fused)
>>> print('input_shapes = {}'.format(ub.repr2(input_shapes, nl=1)))
```

### Example

```
>>> # Case where we have to break up early fused data
>>> import numpy as np
>>> dims = (40, 40)
>>> item = {
>>>     'rgb|disparity': np.random.rand(4, *dims),
>>>     'flowx': np.random.rand(1, *dims),
>>>     'flowy': np.random.rand(1, *dims),
>>> }
>>> # Complex Case
>>> self = ChannelSpec('rgb,disparity,rgb|disparity,rgb|disparity|flowx|flowy,
↳ flowx|flowy,flowx,disparity')
>>> inputs = self.encode(item)
>>> input_shapes = ub.map_vals(lambda x: x.shape, inputs)
>>> print('input_shapes = {}'.format(ub.repr2(input_shapes, nl=1)))
```

```
>>> # xdoctest: +REQUIRES(--bench)
>>> #self = ChannelSpec('rgb|disparity,flowx|flowy')
>>> import timerit
>>> ti = timerit.Timerit(100, bestof=10, verbose=2)
>>> for timer in ti.reset('mode=simple'):
>>>     with timer:
>>>         inputs = self.encode(item, mode=0)
>>> for timer in ti.reset('mode=minimize-concat'):
>>>     with timer:
>>>         inputs = self.encode(item, mode=1)
```

**decode**(self, inputs, axis=1)

break an early fused item into its components

#### Parameters

- **inputs** (*Dict[str, Tensor]*) – dictionary of components
- **axis** (*int, default=1*) – channel dimension

### Example

```
>>> from kwcoco.channel_spec import * # NOQA
>>> import numpy as np
>>> dims = (4, 4)
>>> item_components = {
>>>     'rgb': np.random.rand(3, *dims),
>>>     'ir': np.random.rand(1, *dims),
>>> }
```

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```

>>> self = ChannelSpec('rgb|ir')
>>> item_encoded = self.encode(item_components)
>>> batch = {k: np.concatenate([v[None, :], v[None, :]], axis=0)
...         for k, v in item_encoded.items()}
>>> components = self.decode(batch)

```

### Example

```

>>> # xdoctest: +REQUIRES(module:netharn, module:torch)
>>> import torch
>>> import numpy as np
>>> dims = (4, 4)
>>> components = {
>>>     'rgb': np.random.rand(3, *dims),
>>>     'ir': np.random.rand(1, *dims),
>>> }
>>> components = ub.map_vals(torch.from_numpy, components)
>>> self = ChannelSpec('rgb|ir')
>>> encoded = self.encode(components)
>>> from netharn.data import data_containers
>>> item = {k: data_containers.ItemContainer(v, stack=True)
>>>         for k, v in encoded.items()}
>>> batch = data_containers.container_collate([item, item])
>>> components = self.decode(batch)

```

`component_indices(self, axis=2)`

Look up component indices within fused streams

### Example

```

>>> dims = (4, 4)
>>> inputs = ['flowx', 'flowy', 'disparity']
>>> self = ChannelSpec('disparity,flowx|flowy')
>>> component_indices = self.component_indices()
>>> print('component_indices = {}'.format(ub.repr2(component_indices, nl=1)))
component_indices = {
    'disparity': ('disparity', (slice(None, None, None), slice(None, None, ↵
↵None), slice(0, 1, None))),
    'flowx': ('flowx|flowy', (slice(None, None, None), slice(None, None, None), ↵
↵slice(0, 1, None))),
    'flowy': ('flowx|flowy', (slice(None, None, None), slice(None, None, None), ↵
↵slice(1, 2, None))),
}

```

`kwcoco.channel_spec._cached_single_fused_mapping(item_keys, parsed_items, axis=0)`

`kwcoco.channel_spec._cached_single_stream_idx(key, axis=0)`

`kwcoco.channel_spec.subsequence_index(ose1, ose2)`

Returns a slice into the first items indicating the position of the second items if they exist.



This is a variant of the substring problem.

**Returns** None | slice

### Example

```
>>> oset1 = ub.oset([1, 2, 3, 4, 5, 6])
>>> oset2 = ub.oset([2, 3, 4])
>>> index = subsequence_index(oset1, oset2)
>>> assert index
```

```
>>> oset1 = ub.oset([1, 2, 3, 4, 5, 6])
>>> oset2 = ub.oset([2, 4, 3])
>>> index = subsequence_index(oset1, oset2)
>>> assert not index
```

kwcoco.channel\_spec.\_parse\_concise\_slice\_syntax(v)

Helper for our slice syntax, which is may be a bit strange

### Example

```
>>> print(_parse_concise_slice_syntax('B:10'))
>>> print(_parse_concise_slice_syntax('B.0:10:3'))
>>> print(_parse_concise_slice_syntax('B.:10:3'))
>>> print(_parse_concise_slice_syntax('B::10:3'))
>>> # Careful, this next one is quite different
>>> print(_parse_concise_slice_syntax('B:10:3'))
>>> print(_parse_concise_slice_syntax('B:3:10:3'))
>>> print(_parse_concise_slice_syntax('B.:10'))
>>> print(_parse_concise_slice_syntax('B.:3:'))
>>> print(_parse_concise_slice_syntax('B.:3:2'))
>>> print(_parse_concise_slice_syntax('B::2:3'))
>>> print(_parse_concise_slice_syntax('B.0:10:3'))
>>> print(_parse_concise_slice_syntax('B.:10:3'))
('B', 0, 10, 1)
('B', 0, 10, 3)
('B', 0, 10, 3)
('B', 0, 10, 3)
('B', 10, 3, 1)
('B', 3, 10, 3)
('B', 0, 10, 1)
('B', 0, 3, 1)
('B', 0, 3, 2)
('B', 0, 2, 3)
('B', 0, 10, 3)
('B', 0, 10, 3)
>>> import pytest
>>> with pytest.raises(ValueError):
>>>     _parse_concise_slice_syntax('B.0')
>>> with pytest.raises(ValueError):
>>>     _parse_concise_slice_syntax('B0')
```

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```

>>> with pytest.raises(ValueError):
>>>     _parse_concise_slice_syntax('B:')
>>> with pytest.raises(ValueError):
>>>     _parse_concise_slice_syntax('B:0.10')
>>> with pytest.raises(ValueError):
>>>     _parse_concise_slice_syntax('B::')

```

`kwcoco.channel_spec.oset_insert(self, index, obj)`

`kwcoco.channel_spec.oset_delitem(self, index)`

for ubelt oset, todo contribute back to luminosinsight

```

>>> self = ub.oset([1, 2, 3, 4, 5, 6, 7, 8, 9])
>>> index = slice(3, 5)
>>> oset_delitem(self, index)

```

## 2.3.6 kwcoco.coco\_dataset

An implementation and extension of the original MS-COCO API<sup>1</sup>.

Extends the format to also include line annotations.

The following describes psuedo-code for the high level spec (some of which may not be have full support in the Python API). A formal json-schema is defined in [kwcoco.coco\\_schema](#).

An informal spec is as follows:

```

# All object categories are defined here.
category = {
    'id': int,
    'name': str, # unique name of the category
    'supercategory': str, # parent category name
}

# Videos are used to manage collections or sequences of images.
# Frames do not necesarilly have to be aligned or uniform time steps
video = {
    'id': int,
    'name': str, # a unique name for this video.

    'width': int # the base width of this video (all associated images must have this_
↪width)
    'height': int # the base height of this video (all associated images must have this_
↪height)

    # In the future this may be extended to allow pointing to video files
}

# Specifies how to find sensor data of a particular scene at a particular
# time. This is usually paths to rgb images, but auxiliary information
# can be used to specify multiple bands / etc...

```

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<sup>1</sup> <http://cocodataset.org/#format-data>

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```

# NOTE: in the future we will transition from calling these auxiliary items
# to calling these asset items. As such the key will change from
# "auxiliary" to "asset". The API will be updated to maintain backwards
# compatibility while this transition occurs.

image = {
    'id': int,

    'name': str, # an encouraged but optional unique name
    'file_name': str, # relative path to the "base" image data

    'width': int, # pixel width of "base" image
    'height': int, # pixel height of "base" image

    'channels': <ChannelSpec>, # a string encoding of the channels in the main image

    'auxiliary': [ # information about any auxiliary channels / bands
        {
            'file_name': str, # relative path to associated file
            'channels': <ChannelSpec>, # a string encoding
            'width': <int> # pixel width of image asset
            'height': <int> # pixel height of image asset
            'warp_aux_to_img': <TransformSpec>, # tranform from "base" image space to
↪auxiliary/asset space. (identity if unspecified)
            'quantization': <QuantizationSpec>, # indicates that the underlying data
↪was quantized
        }, ...
    ]

    'video_id': str # if this image is a frame in a video sequence, this id is shared
↪by all frames in that sequence.
    'timestamp': str | int # a iso-string timestamp or an integer in flicks.
    'frame_index': int # ordinal frame index which can be used if timestamp is unknown.
    'warp_img_to_vid': <TransformSpec> # a transform image space to video space
↪(identity if unspecified), can be used for sensor alignment or video stabilization
}

```

**TransformSpec:**

The spec can be anything coercable to a kwimage.Affine object.

This can be an explicit affine transform matrix like:

```
{'type': 'affine': 'matrix': <a-3x3 matrix>},
```

But it can also be a concise dict containing one or more of these keys

```

{
    'scale': <float|Tuple[float, float]>,
    'offset': <float|Tuple[float, float]>,
    'skew': <float>,
    'theta': <float>, # radians counter-clock-wise
}

```

**ChannelSpec:**

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This is a string that describes the channel composition of an image. For the purposes of kwcoco, separate different channel names with a pipe ('|'). If the spec is not specified, methods may fall back on grayscale or rgb processing. There are special string. For instance 'rgb' will expand into 'r|g|b'. In other applications you can "late fuse" inputs by separating them with a "," and "early fuse" by separating with a "|". Early fusion returns a solid array/tensor, late fusion returns separated arrays/tensors.

**QuantizationSpec:**

This is a dictionary of the form:

```
{
    'orig_min': <float>, # min original intensity
    'orig_max': <float>, # min original intensity
    'quant_min': <int>, # min quantized intensity
    'quant_max': <int>, # max quantized intensity
    'nodata': <int|None>, # integer value to interpret as nan
}
```

# Ground truth is specified as annotations, each belongs to a spatial region in an image. This must reference a subregion of the image in pixel coordinates. Additional non-schema properties can be specified to track location in other coordinate systems. Annotations can be linked over time by specifying track-ids.

```
annotation = {
    'id': int,
    'image_id': int,
    'category_id': int,

    'track_id': <int | str | uuid> # indicates association between annotations across
    ↪ images

    'bbox': [tl_x, tl_y, w, h], # xywh format)
    'score' : float,
    'prob' : List[float],
    'weight' : float,

    'caption': str, # a text caption for this annotation
    'keypoints' : <Keypoints | List[int]> # an accepted keypoint format
    'segmentation': <RunLengthEncoding | Polygon | MaskPath | WKT >, # an accepted
    ↪ segmentation format
}
```

# A dataset bundles a manifest of all aforementioned data into one structure.

```
dataset = {
    'categories': [category, ...],
    'videos': [video, ...]
    'images': [image, ...]
    'annotations': [annotation, ...]
    'licenses': [],
    'info': [],
}
```

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**Polygon:**

A flattened list of xy coordinates.

```
[x1, y1, x2, y2, ..., xn, yn]
```

or a list of flattened list of xy coordinates if the CCs are disjoint

```
[[x1, y1, x2, y2, ..., xn, yn], [x1, y1, ..., xm, ym],]
```

Note: the original coco spec does not allow for holes in polygons.

We also allow a non-standard dictionary encoding of polygons

```
{'exterior': [(x1, y1)...],
 'interiors': [[(x1, y1), ...], ...]}
```

TODO: Support WTK

**RunLengthEncoding:**

The RLE can be in a special bytes encoding or in a binary array encoding. We reuse the original C functions are in [2]\_ in

``kwimage.structs.Mask`` to provide a convenient way to abstract this rather esoteric bytes encoding.

For pure python implementations see kwimage:

Converting from an image to RLE can be done via `kwimage.run_length_encoding`

Converting from RLE back to an image can be done via:

```
kwimage.decode_run_length
```

For compatibility with the COCO specs ensure the binary flags for these functions are set to true.

**Keypoints:**

Annotation keypoints may also be specified in this non-standard (but ultimately more general) way:

```
'annotations': [
    {
        'keypoints': [
            {
                'xy': <x1, y1>,
                'visible': <0 or 1 or 2>,
                'keypoint_category_id': <kp_cid>,
                'keypoint_category': <kp_name, optional>, # this can be specified_
```

→ instead of an id

```
        }, ...
    ]
}, ...
```

```
],
```

```
'keypoint_categories': [{
```

```
    'name': <str>,
```

```
    'id': <int>, # an id for this keypoint category
```

```
    'supercategory': <kp_name> # name of coarser parent keypoint class (for_
```

→ hierarchical keypoints)

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```

    'reflection_id': <kp_cid> # specify only if the keypoint id would be swapped.
↪with another keypoint type
    },...
  ]

```

In this scheme the "keypoints" property of each annotation (which used to be a list of floats) is now specified as a list of dictionaries that specify each keypoints location, id, and visibility explicitly. This allows for things like non-unique keypoints, partial keypoint annotations. This also removes the ordering requirement, which makes it simpler to keep track of each keypoints class type.

We also have a new top-level dictionary to specify all the possible keypoint categories.

TODO: Support WTK

#### Auxiliary Channels:

For multimodal or multispectral images it is possible to specify auxiliary channels in an image dictionary as follows:

```

{
  'id': int,
  'file_name': str,    # path to the "base" image (may be None)
  'name': str,         # a unique name for the image (must be given if file_name
↪is None)
  'channels': <ChannelSpec>, # a spec code that indicates the layout of the "base
↪" image channels.
  'auxiliary': [ # information about auxiliary channels
    {
      'file_name': str,
      'channels': <ChannelSpec>
    }, ... # can have many auxiliary channels with unique specs
  ]
}

```

Note that specifying a filename / channels for the base image is not necessary, and mainly useful for augmenting an existing single-image dataset with multimodal information. Typically if an image consists of more than one file, all file information should be stored in the "auxiliary" or "assets" list.

#### Video Sequences:

For video sequences, we add the following video level index:

```

'videos': [
  { 'id': <int>, 'name': <video_name:str> },
]

```

Note that the videos might be given as encoded mp4/avi/etc.. files (in which case the name should correspond to a path) or as a series of frames in which case the images should be used to index the extracted

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frames and information in them.

Then image dictionaries are augmented as follows:

```
{
  'video_id': str # optional, if this image is a frame in a video sequence, this_
↳ id is shared by all frames in that sequence.
  'timestamp': int # optional, timestamp (ideally in flicks), used to identify_
↳ the timestamp of the frame. Only applicable video inputs.
  'frame_index': int # optional, ordinal frame index which can be used if_
↳ timestamp is unknown.
}
```

And annotations are augmented as follows:

```
{
  'track_id': <int | str | uuid> # optional, indicates association between_
↳ annotations across frames
}
```

**Note:** The main object in this file is *CocoDataset*, which is composed of several mixin classes. See the class and method documentation for more details.

#### Todo:

- [ ] Use ijson to lazily load pieces of the dataset in the background or on demand. This will give us faster access to categories / images, whereas we will always have to wait for annotations etc...
- [X] Should img\_root be changed to bundle\_dpath?
- [ ] Read video data, return numpy arrays (requires API for images)
- [ ] Spec for video URI, and convert to frames @ framerate function.
- [ ] Document channel spec
- [X] remove videos

## References

## Module Contents

## Classes

<i>MixinCocoDepricate</i>	These functions are marked for deprication and may be removed at any time
<i>MixinCocoAccessors</i>	TODO: better name
<i>MixinCocoExtras</i>	Misc functions for coco
<i>MixinCocoObjects</i>	Expose methods to construct object lists / groups.
<i>MixinCocoStats</i>	Methods for getting stats about the dataset
<i>MixinCocoDraw</i>	Matplotlib / display functionality
<i>MixinCocoAddRemove</i>	Mixin functions to dynamically add / remove annotations images and
<i>CocoIndex</i>	Fast lookup index for the COCO dataset with dynamic modification
<i>MixinCocoIndex</i>	Give the dataset top level access to index attributes
<i>CocoDataset</i>	The main coco dataset class with a json dataset backend.

## Functions

<i>demo_coco_data()</i>	Simple data for testing.
-------------------------	--------------------------

## Attributes

<i>_dict</i>
<i>SPEC_KEYS</i>

kwcoco.coco\_dataset.\_dict

kwcoco.coco\_dataset.SPEC\_KEYS = ['info', 'licenses', 'categories', 'keypoint\_categories', 'videos', 'images', 'annotations']

**class** kwcoco.coco\_dataset.MixinCocoDepricate

Bases: `object`

These functions are marked for deprication and may be removed at any time

**class** kwcoco.coco\_dataset.MixinCocoAccessors

Bases: `object`

TODO: better name

**delayed\_load**(*self*, *gid*, *channels=None*, *space='image'*)

Experimental method

### Parameters



- **gid** (*int*) – image id to load
- **channels** (*FusedChannelSpec*) – specific channels to load. if unspecified, all channels are loaded.
- **space** (*str*) – can either be “image” for loading in image space, or “video” for loading in video space.

**Todo:**

- [X] **Currently can only take all or none of the channels from each** base-image / auxiliary dict.  
For instance if the main image is r|g|b you can’t just select g|b at the moment.
- [X] **The order of the channels in the delayed load should** match the requested channel order.
- [X] TODO: add nans to bands that don’t exist or throw an error

**Example**

```
>>> import kwcoco
>>> gid = 1
>>> #
>>> self = kwcoco.CocoDataset.demo('vidshapes8-multispectral')
>>> delayed = self.delayed_load(gid)
>>> print('delayed = {!r}'.format(delayed))
>>> print('delayed.finalize() = {!r}'.format(delayed.finalize()))
>>> print('delayed.finalize() = {!r}'.format(delayed.finalize(as_xarray=True)))
>>> #
>>> self = kwcoco.CocoDataset.demo('shapes8')
>>> delayed = self.delayed_load(gid)
>>> print('delayed = {!r}'.format(delayed))
>>> print('delayed.finalize() = {!r}'.format(delayed.finalize()))
>>> print('delayed.finalize() = {!r}'.format(delayed.finalize(as_xarray=True)))
```

```
>>> crop = delayed.delayed_crop((slice(0, 3), slice(0, 3)))
>>> crop.finalize()
>>> crop.finalize(as_xarray=True)
```

```
>>> # TODO: should only select the "red" channel
>>> self = kwcoco.CocoDataset.demo('shapes8')
>>> delayed = self.delayed_load(gid, channels='r')
```

```
>>> import kwcoco
>>> gid = 1
>>> #
>>> self = kwcoco.CocoDataset.demo('vidshapes8-multispectral')
>>> delayed = self.delayed_load(gid, channels='B1|B2', space='image')
>>> print('delayed = {!r}'.format(delayed))
>>> print('delayed.finalize() = {!r}'.format(delayed.finalize(as_xarray=True)))
>>> delayed = self.delayed_load(gid, channels='B1|B2|B11', space='image')
>>> print('delayed = {!r}'.format(delayed))
>>> print('delayed.finalize() = {!r}'.format(delayed.finalize(as_xarray=True)))
```

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```
>>> delayed = self.delayed_load(gid, channels='B8|B1', space='video')
>>> print('delayed = {!r}'.format(delayed))
>>> print('delayed.finalize() = {!r}'.format(delayed.finalize(as_xarray=True)))
```

```
>>> delayed = self.delayed_load(gid, channels='B8|foo|bar|B1', space='video')
>>> print('delayed = {!r}'.format(delayed))
>>> print('delayed.finalize() = {!r}'.format(delayed.finalize(as_xarray=True)))
```

**load\_image**(*self*, *gid\_or\_img*, *channels=None*)

Reads an image from disk and

**Parameters**

- **gid\_or\_img** (*int or dict*) – image id or image dict
- **channels** (*str | None*) – if specified, load data from auxiliary channels instead

**Returns** the image**Return type** np.ndarray

---

**Todo:**

- [ ] allow specification of multiple channels - use **delayed image** for this.
- 

**get\_image\_fpath**(*self*, *gid\_or\_img*, *channels=None*)

Returns the full path to the image

**Parameters**

- **gid\_or\_img** (*int or dict*) – image id or image dict
- **channels** (*str, default=None*) – if specified, return a path to data containing auxiliary channels instead

**Returns** full path to the image**Return type** PathLike**\_get\_img\_auxiliary**(*self*, *gid\_or\_img*, *channels*)

returns the auxiliary dictionary for a specific channel

**get\_auxiliary\_fpath**(*self*, *gid\_or\_img*, *channels*)

Returns the full path to auxiliary data for an image

**Parameters**

- **gid\_or\_img** (*int | dict*) – an image or its id
- **channels** (*str*) – the auxiliary channel to load (e.g. disparity)

### Example

```
>>> import kwcoco
>>> self = kwcoco.CocoDataset.demo('shapes8', aux=True)
>>> self.get_auxiliary_fpath(1, 'disparity')
```

**load\_annot\_sample**(*self*, *aid\_or\_ann*, *image=None*, *pad=None*)

Reads the chip of an annotation. Note this is much less efficient than using a sampler, but it doesn't require disk cache.

Maybe depricate?

#### Parameters

- **aid\_or\_int** (*int or dict*) – annot id or dict
- **image** (*ArrayLike, default=None*) – preloaded image (note: this process is inefficient unless image is specified)

### Example

```
>>> import kwcoco
>>> self = kwcoco.CocoDataset.demo()
>>> sample = self.load_annot_sample(2, pad=100)
>>> # xdoctest: +REQUIRES(--show)
>>> import kwplot
>>> kwplot.autompl()
>>> kwplot.imshow(sample['im'])
>>> kwplot.show_if_requested()
```

**\_resolve\_to\_id**(*self*, *id\_or\_dict*)

Ensures output is an id

**\_resolve\_to\_cid**(*self*, *id\_or\_name\_or\_dict*)

Ensures output is an category id

---

**Note:** this does not resolve aliases (yet), for that see `_alias_to_cat`

---



---

**Todo:** we could maintain an alias index to make this fast

---

**\_resolve\_to\_gid**(*self*, *id\_or\_name\_or\_dict*)

Ensures output is an category id

**\_resolve\_to\_vidid**(*self*, *id\_or\_name\_or\_dict*)

Ensures output is an video id

**\_resolve\_to\_ann**(*self*, *aid\_or\_ann*)

Ensures output is an annotation dictionary

**\_resolve\_to\_img**(*self*, *gid\_or\_img*)

Ensures output is an image dictionary

**\_resolve\_to\_kpcat**(*self*, *kp\_identifier*)

Lookup a keypoint-category dict via its name or id

**Parameters** **kp\_identifier** (*int* | *str* | *dict*) – either the keypoint category name, alias, or its keypoint\_category\_id.**Returns** keypoint category dictionary**Return type** Dict

### Example

```
>>> self = CocoDataset.demo('shapes')
>>> kpcat1 = self._resolve_to_kpcat(1)
>>> kpcat2 = self._resolve_to_kpcat('left_eye')
>>> assert kpcat1 is kpcat2
>>> import pytest
>>> with pytest.raises(KeyError):
>>>     self._resolve_to_cat('human')
```

**\_resolve\_to\_cat**(*self*, *cat\_identifier*)

Lookup a coco-category dict via its name, alias, or id.

**Parameters** **cat\_identifier** (*int* | *str* | *dict*) – either the category name, alias, or its category\_id.**Raises** **KeyError** – if the category doesn't exist.

---

**Note:** If the index is not built, the method will work but may be slow.

---

### Example

```
>>> self = CocoDataset.demo()
>>> cat = self._resolve_to_cat('human')
>>> import pytest
>>> assert self._resolve_to_cat(cat['id']) is cat
>>> assert self._resolve_to_cat(cat) is cat
>>> with pytest.raises(KeyError):
>>>     self._resolve_to_cat(32)
>>> self.index.clear()
>>> assert self._resolve_to_cat(cat['id']) is cat
>>> with pytest.raises(KeyError):
>>>     self._resolve_to_cat(32)
```

**\_alias\_to\_cat**(*self*, *alias\_catname*)Lookup a coco-category via its name or an “alias” name. In production code, use `_resolve_to_cat()` instead.**Parameters** **alias\_catname** (*str*) – category name or alias**Returns** coco category dictionary**Return type** dict

### Example

```

>>> self = CocoDataset.demo()
>>> cat = self._alias_to_cat('human')
>>> import pytest
>>> with pytest.raises(KeyError):
>>>     self._alias_to_cat('person')
>>> cat['alias'] = ['person']
>>> self._alias_to_cat('person')
>>> cat['alias'] = 'person'
>>> self._alias_to_cat('person')
>>> assert self._alias_to_cat(None) is None

```

#### **category\_graph(self)**

Construct a networkx category hierarchy

**Returns** graph: a directed graph where category names are the nodes, supercategories define edges, and items in each category dict (e.g. category id) are added as node properties.

**Return type** `networkx.DiGraph`

### Example

```

>>> self = CocoDataset.demo()
>>> graph = self.category_graph()
>>> assert 'astronaut' in graph.nodes()
>>> assert 'keypoints' in graph.nodes['human']

```

#### **object\_categories(self)**

Construct a consistent CategoryTree representation of object classes

**Returns** category data structure

**Return type** `kwcoco.CategoryTree`

### Example

```

>>> self = CocoDataset.demo()
>>> classes = self.object_categories()
>>> print('classes = {}'.format(classes))

```

#### **keypoint\_categories(self)**

Construct a consistent CategoryTree representation of keypoint classes

**Returns** category data structure

**Return type** `kwcoco.CategoryTree`

### Example

```
>>> self = CocoDataset.demo()
>>> classes = self.keypoint_categories()
>>> print('classes = {}'.format(classes))
```

#### `_keypoint_category_names(self)`

Construct keypoint categories names.

Uses new-style if possible, otherwise this falls back on old-style.

**Returns** names: list of keypoint category names

**Return type** List[str]

### Example

```
>>> self = CocoDataset.demo()
>>> names = self._keypoint_category_names()
>>> print(names)
```

#### `_lookup_kpnames(self, cid)`

Get the keypoint categories for a certain class

#### `_coco_image(self, gid)`

#### `coco_image(self, gid)`

**Parameters** `gid` (int) – image id

**Returns** kwcoco.coco\_image.CocoImage

#### `class kwcoco.coco_dataset.MixinCocoExtras`

Bases: `object`

Misc functions for coco

#### `classmethod coerce(cls, key, **kw)`

Attempt to transform the input into the intended CocoDataset.

**Parameters**

- **key** – this can either be an instance of a CocoDataset, a string URI pointing to an on-disk dataset, or a special key for creating demodata.
- **\*\*kw** – passed to whatever constructor is chosen (if any)

### Example

```
>>> # test coerce for various input methods
>>> import kwcoco
>>> from kwcoco.coco_sql_dataset import assert_dsets_allclose
>>> dct_dset = kwcoco.CocoDataset.coerce('special:shapes8')
>>> copy1 = kwcoco.CocoDataset.coerce(dct_dset)
>>> copy2 = kwcoco.CocoDataset.coerce(dct_dset.fpath)
>>> assert assert_dsets_allclose(dct_dset, copy1)
```

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```

>>> assert assert_dsets_allclose(dct_dset, copy2)
>>> # xdoctest: +REQUIRES(module:sqlalchemy)
>>> sql_dset = dct_dset.view_sql()
>>> copy3 = kwcoco.CocoDataset.coerce(sql_dset)
>>> copy4 = kwcoco.CocoDataset.coerce(sql_dset.fpath)
>>> assert assert_dsets_allclose(dct_dset, sql_dset)
>>> assert assert_dsets_allclose(dct_dset, copy3)
>>> assert assert_dsets_allclose(dct_dset, copy4)

```

**classmethod demo**(cls, key='photos', \*\*kwargs)

Create a toy coco dataset for testing and demo puposes

#### Parameters

- **key** (str, default=photos) – Either 'photos', 'shapes', or 'vidshapes'. There are also special suffixes that can control behavior.

Basic options that define which flavor of demodata to generate are: *photos*, *shapes*, and *vidshapes*. A numeric suffix e.g. *vidshapes8* can be specified to indicate the size of the generated demo dataset. There are other special suffixes that are available. See the code in this function for explicit details on what is allowed.

TODO: better documentation for these demo datasets.

As a quick summary: the vidshapes key is the most robust and mature demodata set, and here are several useful variants of the vidshapes key.

- (1) vidshapes8 - the 8 suffix is the number of videos in this case.
- (2) vidshapes8-multispectral - generate 8 multispectral videos.
- (3) vidshapes8-msi - msi is an alias for multispectral.
- (4) vidshapes8-frames5 - generate 8 videos with 5 frames each. (4) vidshapes2-speed0.1-frames7 - generate 2 videos with 7

frames where the objects move with with a speed of 0.1.

- **\*\*kwargs** – if key is shapes, these arguments are passed to toydata generation. The Kwargs section of this docstring documents a subset of the available options. For full details, see `demodata_toy_dset()` and `random_video_dset()`.

**Kwargs:** `image_size` (Tuple[int, int]): width / height size of the images

**dpath** (str): path to the output image directory, defaults to using kwcoco cache dir.

**aux** (bool): if True generates dummy auxiliary channels

**rng** (int | RandomState, default=0): random number generator or seed

**verbose** (int, default=3): verbosity mode

### Example

```
>>> # Basic demodata keys
>>> print(CocoDataset.demo('photos', verbose=1))
>>> print(CocoDataset.demo('shapes', verbose=1))
>>> print(CocoDataset.demo('vidshapes', verbose=1))
>>> # Variants of demodata keys
>>> print(CocoDataset.demo('shapes8', verbose=0))
>>> print(CocoDataset.demo('shapes8-msi', verbose=0))
>>> print(CocoDataset.demo('shapes8-frames1-speed0.2-msi', verbose=0))
```

### Example

```
>>> import kwcoco
>>> dset = kwcoco.CocoDataset.demo('vidshapes5', num_frames=5,
>>>                                verbose=0, rng=None)
>>> dset = kwcoco.CocoDataset.demo('vidshapes5', num_frames=5,
>>>                                num_tracks=4, verbose=0, rng=44)
>>> # xdoctest: +REQUIRES(--show)
>>> import kwplot
>>> kwplot.autompl()
>>> pnums = kwplot.PlotNums(nSubplots=len(dset.index.imgs))
>>> fnum = 1
>>> for gx, gid in enumerate(dset.index.imgs.keys()):
>>>     canvas = dset.draw_image(gid=gid)
>>>     kwplot.imshow(canvas, pnum=pnums[gx], fnum=fnum)
>>>     #dset.show_image(gid=gid, pnum=pnums[gx])
>>> kwplot.show_if_requested()
```

### Example

```
>>> import kwcoco
>>> dset = kwcoco.CocoDataset.demo('vidshapes5-aux', num_frames=1,
>>>                                verbose=0, rng=None)
```

### Example

```
>>> import kwcoco
>>> dset = kwcoco.CocoDataset.demo('vidshapes1-multispectral', num_frames=5,
>>>                                verbose=0, rng=None)
>>> # This is the first use-case of image names
>>> assert len(dset.index.file_name_to_img) == 0, (
>>>     'the multispectral demo case has no "base" image')
>>> assert len(dset.index.name_to_img) == len(dset.index.imgs) == 5
>>> dset.remove_images([1])
>>> assert len(dset.index.name_to_img) == len(dset.index.imgs) == 4
>>> dset.remove_videos([1])
>>> assert len(dset.index.name_to_img) == len(dset.index.imgs) == 0
```



**\_tree(self)**

developer helper

**classmethod random(cls, rng=None)**

Creates a random CocoDataset according to distribution parameters

---

**Todo:**

- [ ] parameterize
- 

**\_build\_hashid(self, hash\_pixels=False, verbose=0)**

Construct a hash that uniquely identifies the state of this dataset.

**Parameters**

- **hash\_pixels** (*bool, default=False*) – If False the image data is not included in the hash, which can speed up computation, but is not 100% robust.
- **verbose** (*int*) – verbosity level

### Example

```
>>> import kwcoco
>>> self = kwcoco.CocoDataset.demo()
>>> self._build_hashid(hash_pixels=True, verbose=3)
...
>>> # Shorten hashes for readability
>>> walker = ub.IndexableWalker(self.hashid_parts)
>>> for path, val in walker:
>>>     if isinstance(val, str):
>>>         walker[path] = val[0:8]
>>> # Note: this may change in different versions of kwcoco
>>> print('self.hashid_parts = ' + ub.repr2(self.hashid_parts))
>>> print('self.hashid = {!r}'.format(self.hashid[0:8]))
self.hashid_parts = {
    'annotations': {
        'json': 'e573f49d',
        'num': 11,
    },
    'images': {
        'pixels': '67d741fe',
        'json': '2221c714',
        'num': 3,
    },
    'categories': {
        'json': '82d22e00',
        'num': 8,
    },
}
self.hashid = '77d445f0'
```

**Doctest:**

```
>>> self = CocoDataset.demo()
>>> self._build_hashid(hash_pixels=True, verbose=3)
>>> self.hashid_parts
>>> # Test that when we modify the dataset only the relevant
>>> # hashid parts are recomputed.
>>> orig = self.hashid_parts['categories']['json']
>>> self.add_category('foobar')
>>> assert 'categories' not in self.hashid_parts
>>> self.hashid_parts
>>> self.hashid_parts['images']['json'] = 'should not change'
>>> self._build_hashid(hash_pixels=True, verbose=3)
>>> assert self.hashid_parts['categories']['json']
>>> assert self.hashid_parts['categories']['json'] != orig
>>> assert self.hashid_parts['images']['json'] == 'should not change'
```

---

**`_invalidate_hashid(self, parts=None)`**

Called whenever the coco dataset is modified. It is possible to specify which parts were modified so unmodified parts can be reused next time the hash is constructed.

---

**Todo:**

- [ ] Rename to `_notify_modification` — or something like that
- 

**`_cached_hashid(self)`**

Under Construction.

The idea is to cache the hashid when we are sure that the dataset was loaded from a file and has not been modified. We can record the modification time of the file (because we know it hasn't changed in memory), and use that as a key to the cache. If the modification time on the file is different than the one recorded in the cache, we know the cache could be invalid, so we recompute the hashid.

**`_dataset_id(self)`**

A human interpretable name that can be used to uniquely identify the dataset.

---

**Note:** This function is currently subject to change.

---

**Example**

```
>>> import kwcoco
>>> self = kwcoco.CocoDataset.demo()
>>> print(self._dataset_id())
>>> self = kwcoco.CocoDataset.demo('vidshapes8')
>>> print(self._dataset_id())
>>> self = kwcoco.CocoDataset()
>>> print(self._dataset_id())
```

**`_ensure_imgsize(self, workers=0, verbose=1, fail=False)`**

Populate the `imgsize` field if it does not exist.

**Parameters**

- **workers** (*int*, *default=0*) – number of workers for parallel processing.
- **verbose** (*int*, *default=1*) – verbosity level
- **fail** (*bool*, *default=False*) – if True, raises an exception if anything size fails to load.

**Returns**

a list of “bad” image dictionaries where the size could not be determined. Typically these are corrupted images and should be removed.

**Return type** List[dict]

**Example**

```
>>> # Normal case
>>> self = CocoDataset.demo()
>>> bad_imgs = self._ensure_imgsize()
>>> assert len(bad_imgs) == 0
>>> assert self.imgs[1]['width'] == 512
>>> assert self.imgs[2]['width'] == 300
>>> assert self.imgs[3]['width'] == 256
```

```
>>> # Fail cases
>>> self = CocoDataset()
>>> self.add_image('does-not-exist.jpg')
>>> bad_imgs = self._ensure_imgsize()
>>> assert len(bad_imgs) == 1
>>> import pytest
>>> with pytest.raises(Exception):
>>>     self._ensure_imgsize(fail=True)
```

**\_ensure\_image\_data**(*self*, *gids=None*, *verbose=1*)

Download data from “url” fields if specified.

**Parameters** *gids* (*List*) – subset of images to download

**missing\_images**(*self*, *check\_aux=False*, *verbose=0*)

Check for images that don’t exist

**Parameters**

- **check\_aux** (*bool*, *default=False*) – if specified also checks auxiliary images
- **verbose** (*int*) – verbosity level

**Returns** bad indexes and paths and ids

**Return type** List[Tuple[int, str, int]]

**corrupted\_images**(*self*, *check\_aux=False*, *verbose=0*)

Check for images that don’t exist or can’t be opened

**Parameters**

- **check\_aux** (*bool*, *default=False*) – if specified also checks auxiliary images
- **verbose** (*int*) – verbosity level

**Returns** bad indexes and paths and ids

**Return type** List[Tuple[int, str, int]]

**rename\_categories**(*self*, *mapper*, *rebuild=True*, *merge\_policy='ignore'*)

Rename categories with a potentially coarser categorization.

**Parameters**

- **mapper** (*dict or Function*) – maps old names to new names. If multiple names are mapped to the same category, those categories will be merged.
- **merge\_policy** (*str*) – How to handle multiple categories that map to the same name. Can be update or ignore.

**Example**

```
>>> import kwcoco
>>> self = kwcoco.CocoDataset.demo()
>>> self.rename_categories({'astronomer': 'person',
>>>                        'astronaut': 'person',
>>>                        'mouth': 'person',
>>>                        'helmet': 'hat'})
>>> assert 'hat' in self.name_to_cat
>>> assert 'helmet' not in self.name_to_cat
>>> # Test merge case
>>> self = kwcoco.CocoDataset.demo()
>>> mapper = {
>>>     'helmet': 'rocket',
>>>     'astronomer': 'rocket',
>>>     'human': 'rocket',
>>>     'mouth': 'helmet',
>>>     'star': 'gas'
>>> }
>>> self.rename_categories(mapper)
```

**\_ensure\_json\_serializable**(*self*)

**\_aspycoco**(*self*)

Converts to the official pycocotools.coco.COCO object

---

**Todo:**

- [ ] Maybe expose as a public API?
- 

**reroot**(*self*, *new\_root=None*, *old\_prefix=None*, *new\_prefix=None*, *absolute=False*, *check=True*, *safe=True*)

Modify the prefix of the image/data paths onto a new image/data root.

**Parameters**

- **new\_root** (*str, default=None*) – New image root. If unspecified the current *self.bundle\_dpath* is used. If *old\_prefix* and *new\_prefix* are unspecified, they will attempt to be determined based on the current root (which assumes the file paths exist at that root) and this new root.
- **old\_prefix** (*str, default=None*) – If specified, removes this prefix from file names. This also prevents any inferences that might be made via “new\_root”.

- **new\_prefix** (*str*, *default=None*) – If specified, adds this prefix to the file names. This also prevents any inferences that might be made via “new\_root”.
- **absolute** (*bool*, *default=False*) – if True, file names are stored as absolute paths, otherwise they are relative to the new image root.
- **check** (*bool*, *default=True*) – if True, checks that the images all exist.
- **safe** (*bool*, *default=True*) – if True, does not overwrite values until all checks pass

## CommandLine

```
xdoctest -m kwcoco.coco_dataset MixinCocoExtras.reroot
```

## Todo:

- [ ] Incorporate maximum ordered subtree embedding?

## Example

```
>>> import kwcoco
>>> def report(dset, name):
>>>     gid = 1
>>>     abs_fpath = dset.get_image_fpath(gid)
>>>     rel_fpath = dset.index.imgs[gid]['file_name']
>>>     color = 'green' if exists(abs_fpath) else 'red'
>>>     print('strategy_name = {!r}'.format(name))
>>>     print(ub.color_text('abs_fpath = {!r}'.format(abs_fpath), color))
>>>     print('rel_fpath = {!r}'.format(rel_fpath))
>>> dset = self = kwcoco.CocoDataset.demo()
>>> # Change base relative directory
>>> bundle_dpath = ub.expandpath('~')
>>> print('ORIG self.imgs = {!r}'.format(self.imgs))
>>> print('ORIG dset.bundle_dpath = {!r}'.format(dset.bundle_dpath))
>>> print('NEW bundle_dpath      = {!r}'.format(bundle_dpath))
>>> self.reroot(bundle_dpath)
>>> report(self, 'self')
>>> print('NEW self.imgs = {!r}'.format(self.imgs))
>>> assert self.imgs[1]['file_name'].startswith('.cache')
```

```
>>> # Use absolute paths
>>> self.reroot(absolute=True)
>>> assert self.imgs[1]['file_name'].startswith(bundle_dpath)
```

```
>>> # Switch back to relative paths
>>> self.reroot()
>>> assert self.imgs[1]['file_name'].startswith('.cache')
```

### Example

```
>>> # demo with auxiliary data
>>> import kwcoco
>>> self = kwcoco.CocoDataset.demo('shapes8', aux=True)
>>> bundle_dpath = ub.expandpath('~')
>>> print(self.imgs[1]['file_name'])
>>> print(self.imgs[1]['auxiliary'][0]['file_name'])
>>> self.reroot(new_root=bundle_dpath)
>>> print(self.imgs[1]['file_name'])
>>> print(self.imgs[1]['auxiliary'][0]['file_name'])
>>> assert self.imgs[1]['file_name'].startswith('.cache')
>>> assert self.imgs[1]['auxiliary'][0]['file_name'].startswith('.cache')
```

**property** `data_root(self)`

In the future we will deprecate `data_root` for `bundle_dpath`

**property** `img_root(self)`

In the future we will deprecate `img_root` for `bundle_dpath`

**property** `data_fpath(self)`

`data_fpath` is an alias of `fpath`

**class** `kwcoco.coco_dataset.MixinCocoObjects`

Bases: `object`

Expose methods to construct object lists / groups.

This is an alternative vectorized ORM-like interface to the coco dataset

**annots**(*self*, *aids=None*, *gid=None*, *trackid=None*)

Return vectorized annotation objects

#### Parameters

- **aids** (*List[int]*) – annotation ids to reference, if unspecified all annotations are returned.
- **gid** (*int*) – return all annotations that belong to this image id. mutually exclusive with other arguments.
- **trackid** (*int*) – return all annotations that belong to this track. mutually exclusive with other arguments.

**Returns** vectorized annotation object

**Return type** *Annots*

### Example

```
>>> import kwcoco
>>> self = kwcoco.CocoDataset.demo()
>>> annots = self.annots()
>>> print(annots)
<Annots(num=11)>
>>> sub_annots = annots.take([1, 2, 3])
>>> print(sub_annots)
<Annots(num=3)>
```

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```
>>> print(ub.repr2(sub_annot.get('bbox', None)))
[
    [350, 5, 130, 290],
    None,
    None,
]
```

**images**(*self*, *gids*=None, *vidid*=None, *names*=None)

Return vectorized image objects

**Parameters**

- **gids** (*List[int]*) – image ids to reference, if unspecified all images are returned.
- **vidid** (*int*) – returns all images that belong to this video id. mutually exclusive with *gids* arg.
- **names** (*List[str]*) – lookup images by their names.

**Returns** vectorized image object

**Return type** *Images*

### Example

```
>>> import kwcoco
>>> self = kwcoco.CocoDataset.demo()
>>> images = self.images()
>>> print(images)
<Images(num=3)>
```

```
>>> self = kwcoco.CocoDataset.demo('vidshapes2')
>>> vidid = 1
>>> images = self.images(vidid=vidid)
>>> assert all(v == vidid for v in images.lookup('video_id'))
>>> print(images)
<Images(num=2)>
```

**categories**(*self*, *cids*=None)

Return vectorized category objects

**Parameters** **cids** (*List[int]*) – category ids to reference, if unspecified all categories are returned.

**Returns** vectorized category object

**Return type** *Categories*

### Example

```
>>> import kwcoco
>>> self = kwcoco.CocoDataset.demo()
>>> categories = self.categories()
>>> print(categories)
<Categories(num=8)>
```

**videos**(*self*, *vidids=None*, *names=None*)

Return vectorized video objects

#### Parameters

- **vidids** (*List[int]*) – video ids to reference, if unspecified all videos are returned.
- **names** (*List[str]*) – lookup videos by their name.

**Returns** vectorized video object

**Return type** *Videos*

---

#### Todo:

- [ ] **This conflicts with what should be the property that** should redirect to `index.videos`, we should resolve this somehow. E.g. all other main members of the index (anns, imgs, cats) have a toplevel dataset property, we don't have one for videos because the name we would pick conflicts with this.
- 

### Example

```
>>> import kwcoco
>>> self = kwcoco.CocoDataset.demo('vidshapes2')
>>> videos = self.videos()
>>> print(videos)
>>> videos.lookup('name')
>>> videos.lookup('id')
>>> print('videos.objs = {}'.format(ub.repr2(videos.objs[0:2], nl=1)))
```

**class** `kwcoco.coco_dataset.MixinCocoStats`

Bases: `object`

Methods for getting stats about the dataset

**property** `n_annots`(*self*)

The number of annotations in the dataset

**property** `n_images`(*self*)

The number of images in the dataset

**property** `n_cats`(*self*)

The number of categories in the dataset

**property** `n_videos`(*self*)

The number of videos in the dataset



**keypoint\_annotation\_frequency(self)**

DEPRECATED

**Example**

```

>>> from kwcoco.coco_dataset import *
>>> self = CocoDataset.demo('shapes', rng=0)
>>> hist = self.keypoint_annotation_frequency()
>>> hist = ub.odict(sorted(hist.items()))
>>> # FIXME: for whatever reason demodata generation is not determenistic when
↳ seeded
>>> print(ub.repr2(hist)) # xdoc: +IGNORE_WANT
{
  'bot_tip': 6,
  'left_eye': 14,
  'mid_tip': 6,
  'right_eye': 14,
  'top_tip': 6,
}

```

**category\_annotation\_frequency(self)**

Reports the number of annotations of each category

**Example**

```

>>> from kwcoco.coco_dataset import *
>>> self = CocoDataset.demo()
>>> hist = self.category_annotation_frequency()
>>> print(ub.repr2(hist))
{
  'astroturf': 0,
  'human': 0,
  'astronaut': 1,
  'astronomer': 1,
  'helmet': 1,
  'rocket': 1,
  'mouth': 2,
  'star': 5,
}

```

**category\_annotation\_type\_frequency(self)**

DEPRECATED

Reports the number of annotations of each type for each category

### Example

```
>>> self = CocoDataset.demo()
>>> hist = self.category_annotation_frequency()
>>> print(ub.repr2(hist))
```

**conform**(*self*, **\*\*config**)

Make the COCO file conform a stricter spec, infers attributes where possible.

Corresponds to the kwcoco conform CLI tool.

#### KWArgs:

**\*\*config** : pycocotools\_info (default=True): returns info required by pycocotools ensure\_imgsize (default=True): ensure image size is populated legacy (default=False): if true tries to convert data structures to items compatible with the original pycocotools spec  
workers (int): number of parallel jobs for IO tasks

### Example

```
>>> import kwcoco
>>> dset = kwcoco.CocoDataset.demo('shapes8')
>>> dset.index.imgs[1].pop('width')
>>> dset.conform(legacy=True)
>>> assert 'width' in dset.index.imgs[1]
>>> assert 'area' in dset.index.anns[1]
```

**validate**(*self*, **\*\*config**)

Performs checks on this coco dataset.

Corresponds to the kwcoco validate CLI tool.

#### KWArgs:

**\*\*config** : schema (default=True): validates the json-schema unique (default=True): validates unique secondary keys missing (default=True): validates registered files exist corrupted (default=False): validates data in registered files verbose (default=1): verbosity flag fastfail (default=False): if True raise errors immediately

#### Returns

**result containing keys:** status (bool): False if any errors occurred errors (List[str]): list of all error messages missing (List): List of any missing images corrupted (List): List of any corrupted images

**Return type** dict

**SeeAlso:** `_check_integrity()` - performs internal checks

### Example

```
>>> from kwcoco.coco_dataset import *
>>> self = CocoDataset.demo()
>>> import pytest
>>> with pytest.warns(UserWarning):
>>>     result = self.validate()
>>> assert not result['errors']
>>> assert result['warnings']
```

**stats**(*self*, *\*\*kwargs*)

Compute summary statistics to describe the dataset at a high level

This function corresponds to `kwcoco.cli.coco_stats`.

**KWargs:** `basic`(bool, default=True): return basic stats' `extended`(bool, default=True): return extended stats' `catfreq`(bool, default=True): return category frequency stats' `boxes`(bool, default=False): return bounding box stats'

`annot_attrs`(bool, default=True): return annotation attribute information' `image_attrs`(bool, default=True): return image attribute information'

**Returns** info

**Return type** dict

**basic\_stats**(*self*)

Reports number of images, annotations, and categories.

**SeeAlso:** `kwcoco.coco_dataset.MixinCocoStats.basic_stats()` `kwcoco.coco_dataset.MixinCocoStats.extended_stats()`

### Example

```
>>> import kwcoco
>>> self = kwcoco.CocoDataset.demo()
>>> print(ub.repr2(self.basic_stats()))
{
    'n_anns': 11,
    'n_imgs': 3,
    'n_videos': 0,
    'n_cats': 8,
}
```

```
>>> from kwcoco.demo.toydata_video import random_video_dset
>>> dset = random_video_dset(render=True, num_frames=2, num_tracks=10, rng=0)
>>> print(ub.repr2(dset.basic_stats()))
{
    'n_anns': 20,
    'n_imgs': 2,
    'n_videos': 1,
    'n_cats': 3,
}
```

**extended\_stats**(*self*)

Reports number of images, annotations, and categories.

**SeeAlso:** `kwcoco.coco_dataset.MixinCocoStats.basic_stats()`      `kwcoco.coco_dataset.MixinCocoStats.extended_stats()`

**Example**

```
>>> self = CocoDataset.demo()
>>> print(ub.repr2(self.extended_stats()))
```

**boxsize\_stats**(*self*, *anchors=None*, *perclass=True*, *gids=None*, *aids=None*, *verbose=0*, *clusterkw={}*, *statskw={}*)

Compute statistics about bounding box sizes.

Also computes anchor boxes using kmeans if *anchors* is specified.

**Parameters**

- **anchors** (*int*) – if specified also computes box anchors via KMeans clustering
- **perclass** (*bool*) – if True also computes stats for each category
- **gids** (*List[int]*, *default=None*) – if specified only compute stats for these image ids.
- **aids** (*List[int]*, *default=None*) – if specified only compute stats for these annotation ids.
- **verbose** (*int*) – verbosity level
- **clusterkw** (*dict*) – kwargs for `sklearn.cluster.KMeans` used if computing anchors.
- **statskw** (*dict*) – kwargs for `kwarray.stats_dict()`

**Returns** Stats are returned in width-height format.

**Return type** Dict[str, Dict[str, Dict | ndarray]]

**Example**

```
>>> import kwcoco
>>> self = kwcoco.CocoDataset.demo('shapes32')
>>> infos = self.boxsize_stats(anchors=4, perclass=False)
>>> print(ub.repr2(infos, nl=-1, precision=2))
```

```
>>> infos = self.boxsize_stats(gids=[1], statskw=dict(median=True))
>>> print(ub.repr2(infos, nl=-1, precision=2))
```

**find\_representative\_images**(*self*, *gids=None*)

Find images that have a wide array of categories.

Attempt to find the fewest images that cover all categories using images that contain both a large and small number of annotations.

**Parameters** **gids** (*None | List*) – Subset of image ids to consider when finding representative images. Uses all images if unspecified.

**Returns** list of image ids determined to be representative

**Return type** List

### Example

```
>>> import kwcoco
>>> self = kwcoco.CocoDataset.demo()
>>> gids = self.find_representative_images()
>>> print('gids = {!r}'.format(gids))
>>> gids = self.find_representative_images([3])
>>> print('gids = {!r}'.format(gids))
```

```
>>> self = kwcoco.CocoDataset.demo('shapes8')
>>> gids = self.find_representative_images()
>>> print('gids = {!r}'.format(gids))
>>> valid = {7, 1}
>>> gids = self.find_representative_images(valid)
>>> assert valid.issuperset(gids)
>>> print('gids = {!r}'.format(gids))
```

**class** kwcoco.coco\_dataset.MixinCocoDraw

Bases: `object`

Matplotlib / display functionality

**imread**(*self*, *gid*)

DEPRECATE: use `load_image` or `delayed_image`

Loads a particular image

**draw\_image**(*self*, *gid*, *channels=None*)

Use `kwimage` to draw all annotations on an image and return the pixels as a numpy array.

**Parameters**

- **gid** (*int*) – image id to draw
- **channels** (*ChannelSpec*) – the channel to draw on

**Returns** canvas

**Return type** ndarray

**SeeAlso** `kwcoco.coco_dataset.MixinCocoDraw.draw_image()`  
`MixinCocoDraw.show_image()`

`kwcoco.coco_dataset.`

### Example

```
>>> import kwcoco
>>> self = kwcoco.CocoDataset.demo('shapes8')
>>> self.draw_image(1)
>>> # Now you can dump the annotated image to disk / whatever
>>> # xdoctest: +REQUIRES(--show)
>>> import kwplot
>>> kwplot.autompl()
>>> kwplot.imshow(canvas)
```

**show\_image**(*self*, *gid=None*, *aids=None*, *aid=None*, *channels=None*, *\*\*kwargs*)

Use matplotlib to show an image with annotations overlaid

#### Parameters

- **gid** (*int*) – image to show
- **aids** (*list*) – aids to highlight within the image
- **aid** (*int*) – a specific aid to focus on. If gid is not give, look up gid based on this aid.
- **\*\*kwargs** – show\_annots, show\_aid, show\_catname, show\_kpname, show\_segmentation, title, show\_gid, show\_filename, show\_boxes,

**SeeAlso** `kwcoco.coco_dataset.MixinCocoDraw.draw_image()` `kwcoco.coco_dataset.MixinCocoDraw.show_image()`

#### Example

```
>>> # xdoctest: +REQUIRES(--show)
>>> import kwcoco
>>> dset = kwcoco.CocoDataset.demo('vidshapes8-msi')
>>> dset.show_image(gid=1, channels='B8')
```

**class** `kwcoco.coco_dataset.MixinCocoAddRemove`

Bases: `object`

Mixin functions to dynamically add / remove annotations images and categories while maintaining lookup indexes.

**add\_video**(*self*, *name*, *id=None*, *\*\*kw*)

Register a new video with the dataset

#### Parameters

- **name** (*str*) – Unique name for this video.
- **id** (*None or int*) – ADVANCED. Force using this image id.
- **\*\*kw** – stores arbitrary key/value pairs in this new video

**Returns** the video id assigned to the new video

**Return type** `int`

#### Example

```
>>> import kwcoco
>>> self = kwcoco.CocoDataset()
>>> print('self.index.videos = {}'.format(ub.repr2(self.index.videos, nl=1)))
>>> print('self.index.imgs = {}'.format(ub.repr2(self.index.imgs, nl=1)))
>>> print('self.index.vidid_to_gids = {}'.format(self.index.vidid_to_gids))
```

```
>>> vidid1 = self.add_video('foo', id=3)
>>> vidid2 = self.add_video('bar')
>>> vidid3 = self.add_video('baz')
>>> print('self.index.videos = {}'.format(ub.repr2(self.index.videos, nl=1)))
```

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```
>>> print('self.index.imgs = {}'.format(ub.repr2(self.index.imgs, nl=1)))
>>> print('self.index.vidid_to_gids = {!r}'.format(self.index.vidid_to_gids))
```

```
>>> gid1 = self.add_image('foo1.jpg', video_id=vidid1, frame_index=0)
>>> gid2 = self.add_image('foo2.jpg', video_id=vidid1, frame_index=1)
>>> gid3 = self.add_image('foo3.jpg', video_id=vidid1, frame_index=2)
>>> gid4 = self.add_image('bar1.jpg', video_id=vidid2, frame_index=0)
>>> print('self.index.videos = {}'.format(ub.repr2(self.index.videos, nl=1)))
>>> print('self.index.imgs = {}'.format(ub.repr2(self.index.imgs, nl=1)))
>>> print('self.index.vidid_to_gids = {!r}'.format(self.index.vidid_to_gids))
```

```
>>> self.remove_images([gid2])
>>> print('self.index.vidid_to_gids = {!r}'.format(self.index.vidid_to_gids))
```

**add\_image**(*self*, *file\_name*=None, *id*=None, **\*\*kw**)

Register a new image with the dataset

#### Parameters

- **file\_name** (*str*) – relative or absolute path to image
- **id** (*None* or *int*) – ADVANCED. Force using this image id.
- **name** (*str*) – a unique key to identify this image
- **width** (*int*) – base width of the image
- **height** (*int*) – base height of the image
- **channels** (*ChannelSpec*) – specification of base channels
- **auxiliary** (*List[Dict]*) – specification of auxiliary information
- **video\_id** (*int*) – parent video, if applicable
- **frame\_index** (*int*) – frame index in parent video
- **timestamp** (*number* | *str*) – timestamp of frame index
- **\*\*kw** – stores arbitrary key/value pairs in this new image

**Returns** the image id assigned to the new image

**Return type** `int`

**SeeAlso:** `add_image()` `add_images()` `ensure_image()`

#### Example

```
>>> self = CocoDataset.demo()
>>> import kwimage
>>> gname = kwimage.grab_test_image_fpath('paraview')
>>> gid = self.add_image(gname)
>>> assert self.imgs[gid]['file_name'] == gname
```

**add\_annotation**(*self*, *image\_id*, *category\_id*=None, *bbox*=ub.NoParam, *segmentation*=ub.NoParam, *keypoints*=ub.NoParam, *id*=None, **\*\*kw**)

Register a new annotation with the dataset

### Parameters

- **image\_id** (*int*) – image\_id the annoation is added to.
- **category\_id** (*int* | *None*) – category\_id for the new annotaiton
- **bbox** (*list* | *kwimage.Boxes*) – bounding box in xywh format
- **segmentation** (*MaskLike* | *MultiPolygonLike*) – keypoints in some accepted format, see `kwimage.Mask.to_coco()` and `kwimage.MultiPolygon.to_coco()`.
- **keypoints** (*KeypointsLike*) – keypoints in some accepted format, see `kwimage.Keypoints.to_coco()`.
- **id** (*None* | *int*) – Force using this annotation id. Typically you should NOT specify this. A new unused id will be chosen and returned.
- **\*\*kw** – stores arbitrary key/value pairs in this new image, Common respected key/values include but are not limited to the following:

**track\_id** (*int* | *str*): some value used to associate annotations that belong to the same “track”.

score : float

prob : List[float]

**weight** (float): a weight, usually used to indicate if a ground truth annotation is difficult / important. This generalizes standard “is\_hard” or “ignore” attributes in other formats.

caption (str): a text caption for this annotation

**Returns** the annotation id assigned to the new annotation

**Return type** `int`

**SeeAlso:** `kwcoco.coco_dataset.MixinCocoAddRemove.add_annotation()` `kwcoco.coco_dataset.MixinCocoAddRemove.add_annotations()`

### Example

```
>>> import kwcoco
>>> self = kwcoco.CocoDataset.demo()
>>> image_id = 1
>>> cid = 1
>>> bbox = [10, 10, 20, 20]
>>> aid = self.add_annotation(image_id, cid, bbox)
>>> assert self.anns[aid]['bbox'] == bbox
```



### Example

```

>>> import kwimage
>>> import kwcoco
>>> self = kwcoco.CocoDataset.demo()
>>> new_det = kwimage.Detections.random(1, segmentations=True, keypoints=True)
>>> # kwimage datastructures have methods to convert to coco recognized formats
>>> new_ann_data = list(new_det.to_coco(style='new'))[0]
>>> image_id = 1
>>> aid = self.add_annotation(image_id, **new_ann_data)
>>> # Lookup the annotation we just added
>>> ann = self.index.anns[aid]
>>> print('ann = {}'.format(ub.repr2(ann, nl=-2)))

```

### Example

```

>>> # Attempt to add annot without a category or bbox
>>> import kwcoco
>>> self = kwcoco.CocoDataset.demo()
>>> image_id = 1
>>> aid = self.add_annotation(image_id)
>>> assert None in self.index.cid_to_aids

```

### Example

```

>>> # Attempt to add annot using various styles of kwimage structures
>>> import kwcoco
>>> import kwimage
>>> self = kwcoco.CocoDataset.demo()
>>> image_id = 1
>>> #--
>>> kw = {}
>>> kw['segmentation'] = kwimage.Polygon.random()
>>> kw['keypoints'] = kwimage.Points.random()
>>> aid = self.add_annotation(image_id, **kw)
>>> ann = self.index.anns[aid]
>>> print('ann = {}'.format(ub.repr2(ann, nl=2)))
>>> #--
>>> kw = {}
>>> kw['segmentation'] = kwimage.Mask.random()
>>> aid = self.add_annotation(image_id, **kw)
>>> ann = self.index.anns[aid]
>>> assert ann.get('segmentation', None) is not None
>>> print('ann = {}'.format(ub.repr2(ann, nl=2)))
>>> #--
>>> kw = {}
>>> kw['segmentation'] = kwimage.Mask.random().to_array_rle()
>>> aid = self.add_annotation(image_id, **kw)
>>> ann = self.index.anns[aid]
>>> assert ann.get('segmentation', None) is not None

```

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```

>>> print('ann = {}'.format(ub.repr2(ann, nl=2)))
>>> #--
>>> kw = {}
>>> kw['segmentation'] = kwimage.Polygon.random().to_coco()
>>> kw['keypoints'] = kwimage.Points.random().to_coco()
>>> aid = self.add_annotation(image_id, **kw)
>>> ann = self.index.anns[aid]
>>> assert ann.get('segmentation', None) is not None
>>> assert ann.get('keypoints', None) is not None
>>> print('ann = {}'.format(ub.repr2(ann, nl=2)))

```

**add\_category**(*self*, *name*, *supercategory*=None, *id*=None, *\*\*kw*)

Register a new category with the dataset

#### Parameters

- **name** (*str*) – name of the new category
- **supercategory** (*str*, *optional*) – parent of this category
- **id** (*int*, *optional*) – use this category id, if it was not taken
- **\*\*kw** – stores arbitrary key/value pairs in this new image

**Returns** the category id assigned to the new category

**Return type** `int`

**SeeAlso:** `kwcoco.coco_dataset.MixinCocoAddRemove.add_category()`  
`coco_dataset.MixinCocoAddRemove.ensure_category()`

`kwcoco.`

#### Example

```

>>> self = CocoDataset.demo()
>>> prev_n_cats = self.n_cats
>>> cid = self.add_category('dog', supercategory='object')
>>> assert self.cats[cid]['name'] == 'dog'
>>> assert self.n_cats == prev_n_cats + 1
>>> import pytest
>>> with pytest.raises(ValueError):
>>>     self.add_category('dog', supercategory='object')

```

**ensure\_image**(*self*, *file\_name*, *id*=None, *\*\*kw*)

Register an image if it is new or returns an existing id.

Like `kwcoco.coco_dataset.MixinCocoAddRemove.add_image()`, but returns the existing image id if it already exists instead of failing. In this case all metadata is ignored.

#### Parameters

- **file\_name** (*str*) – relative or absolute path to image
- **id** (*None* or *int*) – ADVANCED. Force using this image id.
- **\*\*kw** – stores arbitrary key/value pairs in this new image

**Returns** the existing or new image id

**Return type** `int`

**SeeAlso:** `kwcoco.coco_dataset.MixinCocoAddRemove.add_image()` `kwcoco.coco_dataset.MixinCocoAddRemove.add_images()` `kwcoco.coco_dataset.MixinCocoAddRemove.ensure_image()`

**ensure\_category**(*self*, *name*, *supercategory=None*, *id=None*, *\*\*kw*)

Register a category if it is new or returns an existing id.

Like `kwcoco.coco_dataset.MixinCocoAddRemove.add_category()`, but returns the existing category id if it already exists instead of failing. In this case all metadata is ignored.

**Returns** the existing or new category id

**Return type** `int`

**SeeAlso:** `kwcoco.coco_dataset.MixinCocoAddRemove.add_category()` `kwcoco.coco_dataset.MixinCocoAddRemove.ensure_category()`

**add\_annotations**(*self*, *anns*)

Faster less-safe multi-item alternative to `add_annotation`.

We assume the annotations are well formatted in kwcoco compliant dictionaries, including the “id” field. No validation checks are made when calling this function.

**Parameters** *anns* (*List[Dict]*) – list of annotation dictionaries

**SeeAlso:** `add_annotation()` `add_annotations()`

### Example

```
>>> self = CocoDataset.demo()
>>> anns = [self.anns[aid] for aid in [2, 3, 5, 7]]
>>> self.remove_annotations(anns)
>>> assert self.n_annots == 7 and self._check_index()
>>> self.add_annotations(anns)
>>> assert self.n_annots == 11 and self._check_index()
```

**add\_images**(*self*, *imgs*)

Faster less-safe multi-item alternative

We assume the images are well formatted in kwcoco compliant dictionaries, including the “id” field. No validation checks are made when calling this function.

---

**Note:** THIS FUNCTION WAS DESIGNED FOR SPEED, AS SUCH IT DOES NOT CHECK IF THE IMAGE-IDs or FILE\_NAMES ARE DUPLICATED AND WILL BLINDLY ADD DATA EVEN IF IT IS BAD. THE SINGLE IMAGE VERSION IS SLOWER BUT SAFER.

---

**Parameters** *imgs* (*List[Dict]*) – list of image dictionaries

**SeeAlso:** `kwcoco.coco_dataset.MixinCocoAddRemove.add_image()` `kwcoco.coco_dataset.MixinCocoAddRemove.add_images()` `kwcoco.coco_dataset.MixinCocoAddRemove.ensure_image()`

### Example

```
>>> imgs = CocoDataset.demo().dataset['images']
>>> self = CocoDataset()
>>> self.add_images(imgs)
>>> assert self.n_images == 3 and self._check_index()
```

### `clear_images(self)`

Removes all images and annotations (but not categories)

### Example

```
>>> self = CocoDataset.demo()
>>> self.clear_images()
>>> print(ub.repr2(self.basic_stats(), nobr=1, nl=0, si=1))
n_anns: 0, n_imgs: 0, n_videos: 0, n_cats: 8
```

### `clear_annotations(self)`

Removes all annotations (but not images and categories)

### Example

```
>>> self = CocoDataset.demo()
>>> self.clear_annotations()
>>> print(ub.repr2(self.basic_stats(), nobr=1, nl=0, si=1))
n_anns: 0, n_imgs: 3, n_videos: 0, n_cats: 8
```

### `remove_annotation(self, aid_or_ann)`

Remove a single annotation from the dataset

If you have multiple annotations to remove its more efficient to remove them in batch with [\*kwcoco.CocoDataset.MixinCocoAddRemove.remove\\_annotations\(\)\*](#)

### Example

```
>>> import kwcoco
>>> self = kwcoco.CocoDataset.demo()
>>> aids_or_anns = [self.anns[2], 3, 4, self.anns[1]]
>>> self.remove_annotations(aids_or_anns)
>>> assert len(self.dataset['annotations']) == 7
>>> self._check_index()
```

### `remove_annotations(self, aids_or_anns, verbose=0, safe=True)`

Remove multiple annotations from the dataset.

#### Parameters

- **anns\_or\_aids** (*List*) – list of annotation dicts or ids
- **safe** (*bool*, *default=True*) – if True, we perform checks to remove duplicates and non-existing identifiers.

**Returns** num\_removed: information on the number of items removed

**Return type** Dict

### Example

```
>>> import kwcoco
>>> self = kwcoco.CocoDataset.demo()
>>> prev_n_annots = self.n_annots
>>> aids_or_anns = [self.anns[2], 3, 4, self.anns[1]]
>>> self.remove_annotations(aids_or_anns) # xdoc: +IGNORE_WANT
{'annotations': 4}
>>> assert len(self.dataset['annotations']) == prev_n_annots - 4
>>> self._check_index()
```

**remove\_categories**(self, cat\_identifiers, keep\_annots=False, verbose=0, safe=True)

Remove categories and all annotations in those categories.

Currently does not change any hierarchy information

#### Parameters

- **cat\_identifiers** (*List*) – list of category dicts, names, or ids
- **keep\_annots** (*bool, default=False*) – if True, keeps annotations, but removes category labels.
- **safe** (*bool, default=True*) – if True, we perform checks to remove duplicates and non-existing identifiers.

**Returns** num\_removed: information on the number of items removed

**Return type** Dict

### Example

```
>>> self = CocoDataset.demo()
>>> cat_identifiers = [self.cats[1], 'rocket', 3]
>>> self.remove_categories(cat_identifiers)
>>> assert len(self.dataset['categories']) == 5
>>> self._check_index()
```

**remove\_images**(self, gids\_or\_imgs, verbose=0, safe=True)

Remove images and any annotations contained by them

#### Parameters

- **gids\_or\_imgs** (*List*) – list of image dicts, names, or ids
- **safe** (*bool, default=True*) – if True, we perform checks to remove duplicates and non-existing identifiers.

**Returns** num\_removed: information on the number of items removed

**Return type** Dict

### Example

```
>>> from kwcoco.coco_dataset import *
>>> self = CocoDataset.demo()
>>> assert len(self.dataset['images']) == 3
>>> gids_or_imgs = [self.imgs[2], 'astro.png']
>>> self.remove_images(gids_or_imgs) # xdoc: +IGNORE_WANT
{'annotations': 11, 'images': 2}
>>> assert len(self.dataset['images']) == 1
>>> self._check_index()
>>> gids_or_imgs = [3]
>>> self.remove_images(gids_or_imgs)
>>> assert len(self.dataset['images']) == 0
>>> self._check_index()
```

**remove\_videos**(*self*, *vidids\_or\_videos*, *verbose*=0, *safe*=True)

Remove videos and any images / annotations contained by them

#### Parameters

- **vidids\_or\_videos** (*List*) – list of video dicts, names, or ids
- **safe** (*bool*, *default*=True) – if True, we perform checks to remove duplicates and non-existing identifiers.

**Returns** num\_removed: information on the number of items removed

**Return type** Dict

### Example

```
>>> from kwcoco.coco_dataset import *
>>> self = CocoDataset.demo('vidshapes8')
>>> assert len(self.dataset['videos']) == 8
>>> vidids_or_videos = [self.dataset['videos'][0]['id']]
>>> self.remove_videos(vidids_or_videos) # xdoc: +IGNORE_WANT
{'annotations': 4, 'images': 2, 'videos': 1}
>>> assert len(self.dataset['videos']) == 7
>>> self._check_index()
```

**remove\_annotation\_keypoints**(*self*, *kp\_identifiers*)

Removes all keypoints with a particular category

**Parameters** **kp\_identifiers** (*List*) – list of keypoint category dicts, names, or ids

**Returns** num\_removed: information on the number of items removed

**Return type** Dict

**remove\_keypoint\_categories**(*self*, *kp\_identifiers*)

Removes all keypoints of a particular category as well as all annotation keypoints with those ids.

**Parameters** **kp\_identifiers** (*List*) – list of keypoint category dicts, names, or ids

**Returns** num\_removed: information on the number of items removed

**Return type** Dict

### Example

```

>>> self = CocoDataset.demo('shapes', rng=0)
>>> kp_identifiers = ['left_eye', 'mid_tip']
>>> remove_info = self.remove_keypoint_categories(kp_identifiers)
>>> print('remove_info = {!r}'.format(remove_info))
>>> # FIXME: for whatever reason demodata generation is not deterministic when
↳ seeded
>>> # assert remove_info == {'keypoint_categories': 2, 'annotation_keypoints': 16,
↳ 'reflection_ids': 1}
>>> assert self._resolve_to_kpcat('right_eye')['reflection_id'] is None

```

**set\_annotation\_category**(self, aid\_or\_ann, cid\_or\_cat)

Sets the category of a single annotation

#### Parameters

- **aid\_or\_ann** (*dict* | *int*) – annotation dict or id
- **cid\_or\_cat** (*dict* | *int*) – category dict or id

### Example

```

>>> import kwcoco
>>> self = kwcoco.CocoDataset.demo()
>>> old_freq = self.category_annotation_frequency()
>>> aid_or_ann = aid = 2
>>> cid_or_cat = new_cid = self.ensure_category('kitten')
>>> self.set_annotation_category(aid, new_cid)
>>> new_freq = self.category_annotation_frequency()
>>> print('new_freq = {}'.format(ub.repr2(new_freq, nl=1)))
>>> print('old_freq = {}'.format(ub.repr2(old_freq, nl=1)))
>>> assert sum(new_freq.values()) == sum(old_freq.values())
>>> assert new_freq['kitten'] == 1

```

**class** kwcoco.coco\_dataset.CocoIndex(*index*)

Bases: `object`

Fast lookup index for the COCO dataset with dynamic modification

#### Variables

- **imgs** (*Dict*[*int*, *dict*]) – mapping between image ids and the image dictionaries
- **anns** (*Dict*[*int*, *dict*]) – mapping between annotation ids and the annotation dictionaries
- **cats** (*Dict*[*int*, *dict*]) – mapping between category ids and the category dictionaries
- **kpcats** (*Dict*[*int*, *dict*]) – mapping between keypoint category ids and keypoint category dictionaries
- **gid\_to\_aids** (*Dict*[*int*, *List*[*int*]]) – mapping between an image-id and annotation-ids that belong to it
- **cid\_to\_aids** (*Dict*[*int*, *List*[*int*]]) – mapping between an category-id and annotation-ids that belong to it

- **cid\_to\_gids** (*Dict[int, List[int]]*) – mapping between an category-id and image-ids that contain at least one annotation with this category id.
- **trackid\_to\_aids** (*Dict[int, List[int]]*) – mapping between a track-id and annotation-ids that belong to it
- **vidid\_to\_gids** (*Dict[int, List[int]]*) – mapping between an video-id and images-ids that belong to it
- **name\_to\_video** (*Dict[str, dict]*) – mapping between a video name and the video dictionary.
- **name\_to\_cat** (*Dict[str, dict]*) – mapping between a category name and the category dictionary.
- **name\_to\_img** (*Dict[str, dict]*) – mapping between a image name and the image dictionary.
- **file\_name\_to\_img** (*Dict[str, dict]*) – mapping between a image file\_name and the image dictionary.

**\_set**

**\_\_nonzero\_\_**

**\_set\_sorted\_by\_frame\_index**(*index, gids=None*)

Helper for ensuring that vidid\_to\_gids returns image ids ordered by frame index.

**\_\_bool\_\_**(*index*)

**property cid\_to\_gids**(*index*)

### Example

```
>>> import kwcoco
>>> self = dset = kwcoco.CocoDataset()
>>> self.index.cid_to_gids
```

**\_add\_video**(*index, vidid, video*)

**\_add\_image**(*index, gid, img*)

### Example

```
>>> # Test adding image to video that doesnt exist
>>> import kwcoco
>>> self = dset = kwcoco.CocoDataset()
>>> dset.add_image(file_name='frame1', video_id=1, frame_index=0)
>>> dset.add_image(file_name='frame2', video_id=1, frame_index=0)
>>> dset._check_pointers()
>>> dset._check_index()
>>> print('dset.index.vidid_to_gids = {!r}'.format(dset.index.vidid_to_gids))
>>> assert len(dset.index.vidid_to_gids) == 1
>>> dset.add_video(name='foo-vid', id=1)
>>> assert len(dset.index.vidid_to_gids) == 1
```

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```
>>> dset._check_pointers()
>>> dset._check_index()
```

**\_add\_images**(*index*, *imgs*)

See ../dev/bench/bench\_add\_image\_check.py

---

**Note:** THIS FUNCTION WAS DESIGNED FOR SPEED, AS SUCH IT DOES NOT CHECK IF THE IMAGE-IDs or FILE\_NAMES ARE DUPLICATED AND WILL BLINDLY ADD DATA EVEN IF IT IS BAD. THE SINGLE IMAGE VERSION IS SLOWER BUT SAFER.

---

**\_add\_annotation**(*index*, *aid*, *gid*, *cid*, *tid*, *ann*)

**\_add\_annotations**(*index*, *anns*)

**\_add\_category**(*index*, *cid*, *name*, *cat*)

**\_remove\_all\_annotations**(*index*)

**\_remove\_all\_images**(*index*)

**\_remove\_annotations**(*index*, *remove\_aids*, *verbose=0*)

**\_remove\_categories**(*index*, *remove\_cids*, *verbose=0*)

**\_remove\_images**(*index*, *remove\_gids*, *verbose=0*)

**\_remove\_videos**(*index*, *remove\_vidids*, *verbose=0*)

**clear**(*index*)

**build**(*index*, *parent*)

Build all id-to-obj reverse indexes from scratch.

**Parameters** *parent* (*CocoDataset*) – the dataset to index

**Notation:** aid - Annotation ID gid - imaGe ID cid - Category ID vidid - Video ID

### Example

```
>>> import kwcoco
>>> parent = kwcoco.CocoDataset.demo('vidshapes1', num_frames=4, rng=1)
>>> index = parent.index
>>> index.build(parent)
```

**class** kwcoco.coco\_dataset.**MixinCocoIndex**

Bases: `object`

Give the dataset top level access to index attributes

**property** *anns*(*self*)

**property** *imgs*(*self*)

**property** *cats*(*self*)

```
property gid_to_aids(self)
```

```
property cid_to_aids(self)
```

```
property name_to_cat(self)
```

```
class kwcoco.coco_dataset.CocoDataset(data=None, tag=None, bundle_dpath=None, img_root=None,
                                     fname=None, autobuild=True)
```

Bases: `kwcoco.abstract_coco_dataset.AbstractCocoDataset`, `MixinCocoAddRemove`, `MixinCocoStats`, `MixinCocoObjects`, `MixinCocoDraw`, `MixinCocoAccessors`, `MixinCocoExtras`, `MixinCocoIndex`, `MixinCocoDepricate`, `ubelt.NiceRepr`

The main coco dataset class with a json dataset backend.

### Variables

- **dataset** (*Dict*) – raw json data structure. This is the base dictionary that contains {‘annotations’: List, ‘images’: List, ‘categories’: List}
- **index** (*CocoIndex*) – an efficient lookup index into the coco data structure. The index defines its own attributes like `anns`, `cats`, `imgs`, `gid_to_aids`, `file_name_to_img`, etc. See *CocoIndex* for more details on which attributes are available.
- **fpath** (*PathLike | None*) – if known, this stores the filepath the dataset was loaded from
- **tag** (*str*) – A tag indicating the name of the dataset.
- **bundle\_dpath** (*PathLike | None*) – If known, this is the root path that all image file names are relative to. This can also be manually overwritten by the user.
- **hashid** (*str | None*) – If computed, this will be a hash uniquely identifying the dataset. To ensure this is computed see `kwcoco.coco_dataset.MixinCocoExtras._build_hashid()`.

### References

<http://cocodataset.org/#format> <http://cocodataset.org/#download>

### CommandLine

```
python -m kwcoco.coco_dataset CocoDataset --show
```

### Example

```
>>> from kwcoco.coco_dataset import demo_coco_data
>>> import kwcoco
>>> import ubelt as ub
>>> # Returns a coco json structure
>>> dataset = demo_coco_data()
>>> # Pass the coco json structure to the API
>>> self = kwcoco.CocoDataset(dataset, tag='demo')
>>> # Now you can access the data using the index and helper methods
>>> #
>>> # Start by looking up an image by it's COCO id.
```

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```

>>> image_id = 1
>>> img = self.index.imgs[image_id]
>>> print(ub.repr2(img, nl=1, sort=1))
{
  'file_name': 'astro.png',
  'id': 1,
  'url': 'https://i.imgur.com/KXhKM72.png',
}
>>> #
>>> # Use the (gid_to_aids) index to lookup annotations in the iamge
>>> annotation_id = sorted(self.index.gid_to_aids[image_id])[0]
>>> ann = self.index.anns[annotation_id]
>>> print(ub.repr2(ub.dict_diff(ann, {'segmentation'}), nl=1))
{
  'bbox': [10, 10, 360, 490],
  'category_id': 1,
  'id': 1,
  'image_id': 1,
  'keypoints': [247, 101, 2, 202, 100, 2],
}
>>> #
>>> # Use annotation category id to look up that information
>>> category_id = ann['category_id']
>>> cat = self.index.cats[category_id]
>>> print('cat = {}'.format(ub.repr2(cat, nl=1, sort=1)))
cat = {
  'id': 1,
  'name': 'astronaut',
  'supercategory': 'human',
}
>>> #
>>> # Now play with some helper functions, like extended statistics
>>> extended_stats = self.extended_stats()
>>> # xdoctest: +IGNORE_WANT
>>> print('extended_stats = {}'.format(ub.repr2(extended_stats, nl=1, precision=2, ↵
↵sort=1)))
extended_stats = {
  'anns_per_img': {'mean': 3.67, 'std': 3.86, 'min': 0.00, 'max': 9.00, 'nMin': ↵
↵1, 'nMax': 1, 'shape': (3,)},
  'imgs_per_cat': {'mean': 0.88, 'std': 0.60, 'min': 0.00, 'max': 2.00, 'nMin': 2,
↵ 'nMax': 1, 'shape': (8,)},
  'cats_per_img': {'mean': 2.33, 'std': 2.05, 'min': 0.00, 'max': 5.00, 'nMin': 1,
↵ 'nMax': 1, 'shape': (3,)},
  'anns_per_cat': {'mean': 1.38, 'std': 1.49, 'min': 0.00, 'max': 5.00, 'nMin': ↵
↵2, 'nMax': 1, 'shape': (8,)},
  'imgs_per_video': {'empty_list': True},
}
>>> # You can "draw" a raster of the annotated image with cv2
>>> canvas = self.draw_image(2)
>>> # Or if you have matplotlib you can "show" the image with mpl objects
>>> # xdoctest: +REQUIRES(--show)
>>> from matplotlib import pyplot as plt

```

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```

>>> fig = plt.figure()
>>> ax1 = fig.add_subplot(1, 2, 1)
>>> self.show_image(gid=2)
>>> ax2 = fig.add_subplot(1, 2, 2)
>>> ax2.imshow(canvas)
>>> ax1.set_title('show with matplotlib')
>>> ax2.set_title('draw with cv2')
>>> plt.show()

```

**property** `fpath(self)`

In the future we will deprecate `img_root` for `bundle_dpath`

**property** `_infer_dirs(self)`

**classmethod** `from_data(CocoDataset, data, bundle_dpath=None, img_root=None)`

Constructor from a json dictionary

**classmethod** `from_image_paths(CocoDataset, gpaths, bundle_dpath=None, img_root=None)`

Constructor from a list of images paths.

This is a convinience method.

**Parameters** `gpaths (List[str])` – list of image paths

## Example

```

>>> coco_dset = CocoDataset.from_image_paths(['a.png', 'b.png'])
>>> assert coco_dset.n_images == 2

```

**classmethod** `from_coco_paths(CocoDataset, fpaths, max_workers=0, verbose=1, mode='thread', union='try')`

Constructor from multiple coco file paths.

Loads multiple coco datasets and unions the result

---

**Note:** if the union operation fails, the list of individually loaded files is returned instead.

---

## Parameters

- **fpaths** (*List[str]*) – list of paths to multiple coco files to be loaded and unioned.
- **max\_workers** (*int, default=0*) – number of worker threads / processes
- **verbose** (*int*) – verbosity level
- **mode** (*str*) – thread, process, or serial
- **union** (*str | bool, default='try'*) – If True, unions the result datasets after loading. If False, just returns the result list. If 'try', then try to preform the union, but return the result list if it fails.

**copy(self)**

Deep copies this object

### Example

```
>>> from kwcoco.coco_dataset import *
>>> self = CocoDataset.demo()
>>> new = self.copy()
>>> assert new.imgs[1] is new.dataset['images'][0]
>>> assert new.imgs[1] == self.dataset['images'][0]
>>> assert new.imgs[1] is not self.dataset['images'][0]
```

`__nice__(self)`

`dumps(self, indent=None, newlines=False)`

Writes the dataset out to the json format

**Parameters** `newlines` (*bool*) – if True, each annotation, image, category gets its own line

#### Note:

Using `newlines=True` is similar to: `print(ub.repr2(dset.dataset, nl=2, trailsep=False))` However, the above may not output valid json if it contains ndarrays.

### Example

```
>>> from kwcoco.coco_dataset import *
>>> self = CocoDataset.demo()
>>> text = self.dumps(newlines=True)
>>> print(text)
>>> self2 = CocoDataset(json.loads(text), tag='demo2')
>>> assert self2.dataset == self.dataset
>>> assert self2.dataset is not self.dataset
```

```
>>> text = self.dumps(newlines=True)
>>> print(text)
>>> self2 = CocoDataset(json.loads(text), tag='demo2')
>>> assert self2.dataset == self.dataset
>>> assert self2.dataset is not self.dataset
```

### Example

```
>>> from kwcoco.coco_dataset import *
>>> self = CocoDataset.coerce('vidshapes1-msi-multisensor', verbose=3)
>>> self.remove_annotations(self.annots())
>>> text = self.dumps(newlines=True, indent=' ')
>>> print(text)
```

`dump(self, file, indent=None, newlines=False, temp_file=True)`

Writes the dataset out to the json format

**Parameters**

- **file** (*PathLike | FileLike*) – Where to write the data. Can either be a path to a file or an open file pointer / stream.
- **newlines** (*bool*) – if True, each annotation, image, category gets its own line.
- **temp\_file** (*bool | str, default=True*) – Argument to `safer.open()`. Ignored if `file` is not a `PathLike` object.

### Example

```
>>> import tempfile
>>> from kwcoco.coco_dataset import *
>>> self = CocoDataset.demo()
>>> file = tempfile.NamedTemporaryFile('w')
>>> self.dump(file)
>>> file.seek(0)
>>> text = open(file.name, 'r').read()
>>> print(text)
>>> file.seek(0)
>>> dataset = json.load(open(file.name, 'r'))
>>> self2 = CocoDataset(dataset, tag='demo2')
>>> assert self2.dataset == self.dataset
>>> assert self2.dataset is not self.dataset
```

```
>>> file = tempfile.NamedTemporaryFile('w')
>>> self.dump(file, newlines=True)
>>> file.seek(0)
>>> text = open(file.name, 'r').read()
>>> print(text)
>>> file.seek(0)
>>> dataset = json.load(open(file.name, 'r'))
>>> self2 = CocoDataset(dataset, tag='demo2')
>>> assert self2.dataset == self.dataset
>>> assert self2.dataset is not self.dataset
```

`_check_json_serializable(self, verbose=1)`

Debug which part of a coco dataset might not be json serializable

`_check_integrity(self)`

perform all checks

`_check_index(self)`

### Example

```
>>> import kwcoco
>>> self = kwcoco.CocoDataset.demo()
>>> self._check_index()
>>> # Force a failure
>>> self.index.anns.pop(1)
>>> self.index.anns.pop(2)
>>> import pytest
```

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```
>>> with pytest.raises(AssertionError):
>>>     self._check_index()
```

**`_check_pointers(self, verbose=1)`**

Check that all category and image ids referenced by annotations exist

**`_build_index(self)`**

**`union(*others, disjoint_tracks=True, **kwargs)`**

Merges multiple [CocoDataset](#) items into one. Names and associations are retained, but ids may be different.

#### Parameters

- **`*others`** – a series of [CocoDatasets](#) that we will merge. Note, if called as an instance method, the “self” instance will be the first item in the “others” list. But if called like a classmethod, “others” will be empty by default.
- **`disjoint_tracks`** (*bool, default=True*) – if True, we will assume track-ids are disjoint and if two datasets share the same track-id, we will disambiguate them. Otherwise they will be copied over as-is.
- **`**kwargs`** – constructor options for the new merged [CocoDataset](#)

**Returns** a new merged coco dataset

**Return type** [CocoDataset](#)

## CommandLine

```
xdoctest -m kwcoco.coco_dataset CocoDataset.union
```

## Example

```
>>> # Test union works with different keypoint categories
>>> dset1 = CocoDataset.demo('shapes1')
>>> dset2 = CocoDataset.demo('shapes2')
>>> dset1.remove_keypoint_categories(['bot_tip', 'mid_tip', 'right_eye'])
>>> dset2.remove_keypoint_categories(['top_tip', 'left_eye'])
>>> dset_12a = CocoDataset.union(dset1, dset2)
>>> dset_12b = dset1.union(dset2)
>>> dset_21 = dset2.union(dset1)
>>> def add_hist(h1, h2):
>>>     return {k: h1.get(k, 0) + h2.get(k, 0) for k in set(h1) | set(h2)}
>>> kpfreq1 = dset1.keypoint_annotation_frequency()
>>> kpfreq2 = dset2.keypoint_annotation_frequency()
>>> kpfreq_want = add_hist(kpfreq1, kpfreq2)
>>> kpfreq_got1 = dset_12a.keypoint_annotation_frequency()
>>> kpfreq_got2 = dset_12b.keypoint_annotation_frequency()
>>> assert kpfreq_want == kpfreq_got1
>>> assert kpfreq_want == kpfreq_got2
```

```

>>> # Test disjoint gid datasets
>>> import kwcoco
>>> dset1 = kwcoco.CocoDataset.demo('shapes3')
>>> for new_gid, img in enumerate(dset1.dataset['images'], start=10):
>>>     for aid in dset1.gid_to_aids[img['id']]:
>>>         dset1.anns[aid]['image_id'] = new_gid
>>>         img['id'] = new_gid
>>> dset1.index.clear()
>>> dset1._build_index()
>>> # -----
>>> dset2 = kwcoco.CocoDataset.demo('shapes2')
>>> for new_gid, img in enumerate(dset2.dataset['images'], start=100):
>>>     for aid in dset2.gid_to_aids[img['id']]:
>>>         dset2.anns[aid]['image_id'] = new_gid
>>>         img['id'] = new_gid
>>> dset1.index.clear()
>>> dset2._build_index()
>>> others = [dset1, dset2]
>>> merged = kwcoco.CocoDataset.union(*others)
>>> print('merged = {!r}'.format(merged))
>>> print('merged.imgs = {}'.format(ub.repr2(merged.imgs, nl=1)))
>>> assert set(merged.imgs) & set([10, 11, 12, 100, 101]) == set(merged.imgs)

```

```

>>> # Test data is not preserved
>>> dset2 = kwcoco.CocoDataset.demo('shapes2')
>>> dset1 = kwcoco.CocoDataset.demo('shapes3')
>>> others = (dset1, dset2)
>>> cls = self = kwcoco.CocoDataset
>>> merged = cls.union(*others)
>>> print('merged = {!r}'.format(merged))
>>> print('merged.imgs = {}'.format(ub.repr2(merged.imgs, nl=1)))
>>> assert set(merged.imgs) & set([1, 2, 3, 4, 5]) == set(merged.imgs)

```

```

>>> # Test track-ids are mapped correctly
>>> dset1 = kwcoco.CocoDataset.demo('vidshapes1')
>>> dset2 = kwcoco.CocoDataset.demo('vidshapes2')
>>> dset3 = kwcoco.CocoDataset.demo('vidshapes3')
>>> others = (dset1, dset2, dset3)
>>> for dset in others:
>>>     [a.pop('segmentation', None) for a in dset.index.anns.values()]
>>>     [a.pop('keypoints', None) for a in dset.index.anns.values()]
>>> cls = self = kwcoco.CocoDataset
>>> merged = cls.union(*others, disjoint_tracks=1)
>>> print('dset1.anns = {}'.format(ub.repr2(dset1.anns, nl=1)))
>>> print('dset2.anns = {}'.format(ub.repr2(dset2.anns, nl=1)))
>>> print('dset3.anns = {}'.format(ub.repr2(dset3.anns, nl=1)))
>>> print('merged.anns = {}'.format(ub.repr2(merged.anns, nl=1)))

```



### Example

```
>>> import kwcoco
>>> # Test empty union
>>> empty_union = kwcoco.CocoDataset.union()
>>> assert len(empty_union.index.imgs) == 0
```

#### Todo:

- [ ] are supercategories broken?
- [ ] reuse image ids where possible
- [ ] reuse annotation / category ids where possible
- [X] handle case where no inputs are given
- [x] disambiguate track-ids
- [x] disambiguate video-ids

**subset**(*self*, *gids*, *copy=False*, *autobuild=True*)

Return a subset of the larger coco dataset by specifying which images to port. All annotations in those images will be taken.

#### Parameters

- **gids** (*List[int]*) – image-ids to copy into a new dataset
- **copy** (*bool*, *default=False*) – if True, makes a deep copy of all nested attributes, otherwise makes a shallow copy.
- **autobuild** (*bool*, *default=True*) – if True will automatically build the fast lookup index.

### Example

```
>>> self = CocoDataset.demo()
>>> gids = [1, 3]
>>> sub_dset = self.subset(gids)
>>> assert len(self.index.gid_to_aids) == 3
>>> assert len(sub_dset.gid_to_aids) == 2
```

### Example

```
>>> import kwcoco
>>> self = kwcoco.CocoDataset.demo('vidshapes2')
>>> gids = [1, 2]
>>> sub_dset = self.subset(gids, copy=True)
>>> assert len(sub_dset.index.videos) == 1
>>> assert len(self.index.videos) == 2
```

### Example

```
>>> self = CocoDataset.demo()
>>> sub1 = self.subset([1])
>>> sub2 = self.subset([2])
>>> sub3 = self.subset([3])
>>> others = [sub1, sub2, sub3]
>>> rejoined = CocoDataset.union(*others)
>>> assert len(sub1.anns) == 9
>>> assert len(sub2.anns) == 2
>>> assert len(sub3.anns) == 0
>>> assert rejoined.basic_stats() == self.basic_stats()
```

**view\_sql**(self, force\_rewrite=False, memory=False)

Create a cached SQL interface to this dataset suitable for large scale multiprocessing use cases.

#### Parameters

- **force\_rewrite** (*bool*, *default=False*) – if True, forces an update to any existing cache file on disk
- **memory** (*bool*, *default=False*) – if True, the database is constructed in memory.

---

**Note:** This view cache is experimental and currently depends on the timestamp of the file pointed to by `self.fpath`. In other words don't use this on in-memory datasets.

---

**kwcoco.coco\_dataset.demo\_coco\_data()**

Simple data for testing.

This contains several non-standard fields, which help ensure robustness of functions tested with this data. For more compliant demodata see the `kwcoco.demodata` submodule

### Example

```
>>> # xdoctest: +REQUIRES(--show)
>>> from kwcoco.coco_dataset import demo_coco_data, CocoDataset
>>> dataset = demo_coco_data()
>>> self = CocoDataset(dataset, tag='demo')
>>> import kwplot
>>> kwplot.autompl()
>>> self.show_image(gid=1)
>>> kwplot.show_if_requested()
```

### 2.3.7 kwcoco.coco\_evaluator

Evaluates a predicted coco dataset against a truth coco dataset.

The components in this module work programmatically or as a command line script.

---

#### Todo:

- [ ] **does evaluate return one result or multiple results** based on different configurations?
  - [ ] max\_dets - TODO: in original pycocotools but not here
  - [ ] Flag that allows for polygon instead of bounding box overlap
  - [ ] **How do we note what iou\_thresh and area-range were in** the result plots?
- 

#### CommandLine

```
xdoctest -m kwcoco.coco_evaluator __doc__:0 --vd --slow
```

#### Example

```
>>> from kwcoco.coco_evaluator import * # NOQA
>>> from kwcoco.coco_evaluator import CocoEvaluator
>>> import kwcoco
>>> # note: increase the number of images for better looking metrics
>>> true_dset = kwcoco.CocoDataset.demo('shapes8')
>>> from kwcoco.demo.perterb import perterb_coco
>>> kwargs = {
>>>     'box_noise': 0.5,
>>>     'n_fp': (0, 10),
>>>     'n_fn': (0, 10),
>>>     'with_probs': True,
>>> }
>>> pred_dset = perterb_coco(true_dset, **kwargs)
>>> print('true_dset = {!r}'.format(true_dset))
>>> print('pred_dset = {!r}'.format(pred_dset))
>>> config = {
>>>     'true_dataset': true_dset,
>>>     'pred_dataset': pred_dset,
>>>     'area_range': ['all', 'small'],
>>>     'iou_thresh': [0.3, 0.95],
>>> }
>>> coco_eval = CocoEvaluator(config)
>>> results = coco_eval.evaluate()
>>> # Now we can draw / serialize the results as we please
>>> dpath = ub.ensure_app_cache_dir('kwcoco/tests/test_out_dpath')
>>> results_fpath = join(dpath, 'metrics.json')
>>> print('results_fpath = {!r}'.format(results_fpath))
>>> results.dump(results_fpath, indent='    ')
>>> measures = results['area_range=all,iou_thresh=0.3'].ncls_measures
>>> import pandas as pd
```

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```

>>> print(pd.DataFrame(ub.dict_isect(
>>>     measures, ['f1', 'g1', 'mcc', 'thresholds',
>>>                 'ppv', 'tpr', 'tnr', 'npv', 'fpr',
>>>                 'tp_count', 'fp_count',
>>>                 'tn_count', 'fn_count'])).iloc[:100])
>>> # xdoctest: +REQUIRES(module:kwplot)
>>> # xdoctest: +REQUIRES(--slow)
>>> results.dump_figures(dpath)
>>> print('dpath = {!r}'.format(dpath))
>>> # xdoctest: +REQUIRES(--vd)
>>> if ub.argflag('--vd') or 1:
>>>     import xdev
>>>     xdev.view_directory(dpath)

```

## Module Contents

### Classes

<i>CocoEvalConfig</i>	Evaluate and score predicted versus truth detections / classifications in a COCO dataset
<i>CocoEvaluator</i>	Abstracts the evaluation process to execute on two coco datasets.
<i>CocoResults</i>	

### CommandLine

<i>CocoSingleResult</i>	Container class to store, draw, summarize, and serialize results from
-------------------------	---

### Functions

<i>dmet_area_weights</i> (dmet, orig_weights, cfsn_vecs, area_ranges, coco_eval, use_area_attr=False)	Hacky function to compute confusion vector ignore weights for different
<i>_writefig</i> (fig, metrics_dpath, fname, figsize, verbose, tight)	
<i>_load_dets</i> (pred_fpaths, workers=0)	

### Example

<i>_load_dets_worker</i> (single_pred_fpath, with_coco=True)	
--	--

## Attributes

---

*profile*

---

*COCO\_SAMPLER\_CLS*

---

`kwcoco.coco_evaluator.profile`

`kwcoco.coco_evaluator.COCO_SAMPLER_CLS`

**class** `kwcoco.coco_evaluator.CocoEvalConfig`(*data=None, default=None, cmdline=False*)

Bases: `scriptconfig.Config`

Evaluate and score predicted versus truth detections / classifications in a COCO dataset

**default**

**normalize**(*self*)

overloadable function called after each load

**class** `kwcoco.coco_evaluator.CocoEvaluator`(*coco\_eval, config*)

Bases: `object`

Abstracts the evaluation process to execute on two coco datasets.

This can be run as a standalone script where the user specifies the paths to the true and predited dataset explicitly, or this can be used by a higher level script that produces the predictions and then sends them to this evaluator.

## Example

```
>>> from kwcoco.coco_evaluator import CocoEvaluator
>>> from kwcoco.demo.perterb import perterb_coco
>>> import kwcoco
>>> true_dset = kwcoco.CocoDataset.demo('shapes8')
>>> kwargs = {
>>>     'box_noise': 0.5,
>>>     'n_fp': (0, 10),
>>>     'n_fn': (0, 10),
>>>     'with_probs': True,
>>> }
>>> pred_dset = perterb_coco(true_dset, **kwargs)
>>> config = {
>>>     'true_dataset': true_dset,
>>>     'pred_dataset': pred_dset,
>>>     'classes_of_interest': [],
>>> }
>>> coco_eval = CocoEvaluator(config)
>>> results = coco_eval.evaluate()
```

## Config

`log(coco_eval, msg, level='INFO')`

**`_init(coco_eval)`**

Performs initial coercion from given inputs into dictionaries of kwimage.Detection objects and attempts to ensure comparable category and image ids.

**`_ensure_init(coco_eval)`**

**`classmethod _rectify_classes(coco_eval, true_classes, pred_classes)`**

**`classmethod _coerce_dets(CocoEvaluator, dataset, verbose=0, workers=0)`**

Coerce the input to a mapping from image-id to kwimage.Detection

Also capture a CocoDataset if possible.

**Returns** gid\_to\_det: mapping from gid to dets extra: any extra information we gathered via coercion

**Return type** Tuple[Dict[int, Detections], Dict]

### Example

```
>>> from kwcoco.coco_evaluator import * # NOQA
>>> import kwcoco
>>> coco_dset = kwcoco.CocoDataset.demo('shapes8')
>>> gid_to_det, extras = CocoEvaluator._coerce_dets(coco_dset)
```

### Example

```
>>> # xdoctest: +REQUIRES(module:sqlalchemy)
>>> from kwcoco.coco_evaluator import * # NOQA
>>> import kwcoco
>>> coco_dset = kwcoco.CocoDataset.demo('shapes8').view_sql()
>>> gid_to_det, extras = CocoEvaluator._coerce_dets(coco_dset)
```

**`_build_dmet(coco_eval)`**

Builds the detection metrics object

**Returns**

**DetectionMetrics** - object that can perform assignment and build confusion vectors.

**`evaluate(coco_eval)`**

Executes the main evaluation logic. Performs assignments between detections to make DetectionMetrics object, then creates per-item and ovr confusion vectors, and performs various threshold-vs-confusion analyses.

**Returns**

**container storing (and capable of drawing / serializing) results**

**Return type** *CocoResults*

**`kwcoco.coco_evaluator.dmet_area_weights(dmet, orig_weights, cfsn_vecs, area_ranges, coco_eval, use_area_attr=False)`**

Hacky function to compute confusion vector ignore weights for different area thresholds. Needs to be slightly refactored.

```
class kwcoco.coco_evaluator.CocoResults(results, resdata=None)
```

Bases: `ubelt.NiceRepr`, `kwcoco.metrics.util.DictProxy`

## CommandLine

```
xdoctest -m /home/joncrall/code/kwcoco/kwcoco/coco_evaluator.py CocoResults --
↪profile
```

## Example

```
>>> from kwcoco.coco_evaluator import * # NOQA
>>> from kwcoco.coco_evaluator import CocoEvaluator
>>> import kwcoco
>>> true_dset = kwcoco.CocoDataset.demo('shapes2')
>>> from kwcoco.demo.perterb import perterb_coco
>>> kwargs = {
>>>     'box_noise': 0.5,
>>>     'n_fp': (0, 10),
>>>     'n_fn': (0, 10),
>>> }
>>> pred_dset = perterb_coco(true_dset, **kwargs)
>>> print('true_dset = {!r}'.format(true_dset))
>>> print('pred_dset = {!r}'.format(pred_dset))
>>> config = {
>>>     'true_dataset': true_dset,
>>>     'pred_dataset': pred_dset,
>>>     'area_range': ['small'],
>>>     'iou_thresh': [0.3],
>>> }
>>> coco_eval = CocoEvaluator(config)
>>> results = coco_eval.evaluate()
>>> # Now we can draw / serialize the results as we please
>>> dpath = ub.ensure_app_cache_dir('kwcoco/tests/test_out_dpath')
>>> #
>>> # test deserialization works
>>> state = results.__json__()
>>> self2 = CocoResults.from_json(state)
>>> #
>>> # xdoctest: +REQUIRES(module:kwplot)
>>> results.dump_figures(dpath, figsize=(3, 2), tight=False) # make this go faster
>>> results.dump(join(dpath, 'metrics.json'), indent='')
```

```
dump_figures(results, out_dpath, expt_title=None, figsize='auto', tight=True)
```

```
__json__(results)
```

```
classmethod from_json(cls, state)
```

```
dump(result, file, indent='')
    Serialize to json file
```

```
class kwcoco.coco_evaluator.CocoSingleResult(result, nocls_measures, ovr_measures, cfsn_vecs,  
                                             meta=None)
```

Bases: `ubelt.NiceRepr`

Container class to store, draw, summarize, and serialize results from CocoEvaluator.

### Example

```
>>> # xdoctest: +REQUIRES(--slow)
>>> from kwcoco.coco_evaluator import * # NOQA
>>> from kwcoco.coco_evaluator import CocoEvaluator
>>> import kwcoco
>>> true_dset = kwcoco.CocoDataset.demo('shapes8')
>>> from kwcoco.demo.perterb import perterb_coco
>>> kwargs = {
>>>     'box_noise': 0.2,
>>>     'n_fp': (0, 3),
>>>     'n_fn': (0, 3),
>>>     'with_probs': False,
>>> }
>>> pred_dset = perterb_coco(true_dset, **kwargs)
>>> print('true_dset = {!r}'.format(true_dset))
>>> print('pred_dset = {!r}'.format(pred_dset))
>>> config = {
>>>     'true_dataset': true_dset,
>>>     'pred_dataset': pred_dset,
>>>     'area_range': [(0, 32 ** 2), (32 ** 2, 96 ** 2)],
>>>     'iou_thresh': [0.3, 0.5, 0.95],
>>> }
>>> coco_eval = CocoEvaluator(config)
>>> results = coco_eval.evaluate()
>>> result = ub.peek(results.values())
>>> state = result.__json__()
>>> print('state = {}'.format(ub.repr2(state, nl=-1)))
>>> recon = CocoSingleResult.from_json(state)
>>> state = recon.__json__()
>>> print('state = {}'.format(ub.repr2(state, nl=-1)))
```

`__nice__(result)`

`classmethod from_json(cls, state)`

`__json__(result)`

`dump(result, file, indent='')`

Serialize to json file

`dump_figures(result, out_dpath, expt_title=None, figsize='auto', tight=True, verbose=1)`

`kwcoco.coco_evaluator._writefig(fig, metrics_dpath, fname, figsize, verbose, tight)`

`kwcoco.coco_evaluator._load_dets(pred_fpaths, workers=0)`



### Example

```

>>> from kwcoco.coco_evaluator import _load_dets, _load_dets_worker
>>> import ubelt as ub
>>> import kwcoco
>>> from os.path import join
>>> dpath = ub.ensure_app_cache_dir('kwcoco/tests/load_dets')
>>> N = 4
>>> pred_fpaths = []
>>> for i in range(1, N + 1):
>>>     dset = kwcoco.CocoDataset.demo('shapes{}'.format(i))
>>>     dset.fpath = join(dpath, 'shapes_{}.mscoco.json'.format(i))
>>>     dset.dump(dset.fpath)
>>>     pred_fpaths.append(dset.fpath)
>>> dets, coco_dset = _load_dets(pred_fpaths)
>>> print('dets = {!r}'.format(dets))
>>> print('coco_dset = {!r}'.format(coco_dset))

```

`kwcoco.coco_evaluator._load_dets_worker(single_pred_fpath, with_coco=True)`

## 2.3.8 kwcoco.coco\_image

### Module Contents

#### Classes

<code>CocoImage</code>	An object-oriented representation of a coco image.
<code>CocoAsset</code>	A Coco Asset / Auxiliary Item

#### Functions

<code>_delay_load_imglike(bundle_dpath, obj)</code>
---

#### Attributes

<code>profile</code>
----------------------

`kwcoco.coco_image.profile`

**class** `kwcoco.coco_image.CocoImage`(*img*, *dset=None*)

Bases: `ubelt.NiceRepr`

An object-oriented representation of a coco image.

It provides helper methods that are specific to a single image.

This operates directly on a single coco image dictionary, but it can optionally be connected to a parent dataset, which allows it to use CocoDataset methods to query about relationships and resolve pointers.

This is different than the Images class in coco\_objectId, which is just a vectorized interface to multiple objects.

### Example

```
>>> import kwcoco
>>> dset1 = kwcoco.CocoDataset.demo('shapes8')
>>> dset2 = kwcoco.CocoDataset.demo('vidshapes8-multispectral')
```

```
>>> self = CocoImage(dset1.imgs[1], dset1)
>>> print('self = {!r}'.format(self))
>>> print('self.channels = {}'.format(ub.repr2(self.channels, nl=1)))
```

```
>>> self = CocoImage(dset2.imgs[1], dset2)
>>> print('self.channels = {}'.format(ub.repr2(self.channels, nl=1)))
>>> self.primary_asset()
```

**classmethod** `from_gid(cls, dset, gid)`

**property** `bundle_dpath(self)`

**property** `video(self)`

Helper to grab the video for this image if it exists

**detach(self)**

Removes references to the underlying coco dataset, but keeps special information such that it wont be needed.

**\_\_nice\_\_**(self)

### Example

```
>>> from kwcoco.coco_image import * # NOQA
>>> import kwcoco
>>> with ub.CaptureStdout() as cap:
...     dset = kwcoco.CocoDataset.demo('shapes8')
>>> self = CocoImage(dset.dataset['images'][0], dset)
>>> print('self = {!r}'.format(self))
```

```
>>> dset = kwcoco.CocoDataset.demo()
>>> self = CocoImage(dset.dataset['images'][0], dset)
>>> print('self = {!r}'.format(self))
```

**stats(self)**

**\_\_contains\_\_**(self, key)

**\_\_getitem\_\_**(self, key)

Proxy getter attribute for underlying *self.img* dictionary

**keys**(*self*)

Proxy getter attribute for underlying *self.img* dictionary

**get**(*self*, *key*, *default=ub.NoParam*)

Proxy getter attribute for underlying *self.img* dictionary

### Example

```
>>> import pytest
>>> # without extra populated
>>> import kwcoco
>>> self = kwcoco.CocoImage({'foo': 1})
>>> assert self.get('foo') == 1
>>> assert self.get('foo', None) == 1
>>> # with extra populated
>>> self = kwcoco.CocoImage({'extra': {'foo': 1}})
>>> assert self.get('foo') == 1
>>> assert self.get('foo', None) == 1
>>> # without extra empty
>>> self = kwcoco.CocoImage({})
>>> with pytest.raises(KeyError):
>>>     self.get('foo')
>>> assert self.get('foo', None) is None
>>> # with extra empty
>>> self = kwcoco.CocoImage({'extra': {'bar': 1}})
>>> with pytest.raises(KeyError):
>>>     self.get('foo')
>>> assert self.get('foo', None) is None
```

**property channels**(*self*)

**property num\_channels**(*self*)

**property dsize**(*self*)

**primary\_image\_filepath**(*self*, *requires=None*)

**primary\_asset**(*self*, *requires=None*)

Compute a “main” image asset.

### Notes

Uses a heuristic.

- First, try to find the auxiliary image that has with the smallest distortion to the base image (if known via `warp_aux_to_img`)
- Second, break ties by using the largest image if `w / h` is known
- Last, if previous information not available use the first auxiliary image.

**Parameters** **requires** (*List[str]*) – list of attribute that must be non-None to consider an object as the primary one.

**Todo:**

- [ ] Add in primary heuristics

**Example**

```
>>> import kwarray
>>> from kwcoco.coco_image import * # NOQA
>>> rng = kwarray.ensure_rng(0)
>>> def random_auxiliary(name, w=None, h=None):
>>>     return {'file_name': name, 'width': w, 'height': h}
>>> self = CocoImage({
>>>     'auxiliary': [
>>>         random_auxiliary('1'),
>>>         random_auxiliary('2'),
>>>         random_auxiliary('3'),
>>>     ]
>>> })
>>> assert self.primary_asset()['file_name'] == '1'
>>> self = CocoImage({
>>>     'auxiliary': [
>>>         random_auxiliary('1'),
>>>         random_auxiliary('2', 3, 3),
>>>         random_auxiliary('3'),
>>>     ]
>>> })
>>> assert self.primary_asset()['file_name'] == '2'
```

**iter\_image\_filepaths**(self)

**iter\_asset\_objs**(self)

Iterate through base + auxiliary dicts that have file paths

**Yields** *dict* – an image or auxiliary dictionary

**find\_asset\_obj**(self, channels)

Find the asset dictionary with the specified channels

**Example**

```
>>> import kwcoco
>>> coco_img = kwcoco.CocoImage({'width': 128, 'height': 128})
>>> coco_img.add_auxiliary_item(
>>>     'rgb.png', channels='red|green|blue', width=32, height=32)
>>> assert coco_img.find_asset_obj('red') is not None
>>> assert coco_img.find_asset_obj('green') is not None
>>> assert coco_img.find_asset_obj('blue') is not None
>>> assert coco_img.find_asset_obj('red|blue') is not None
>>> assert coco_img.find_asset_obj('red|green|blue') is not None
>>> assert coco_img.find_asset_obj('red|green|blue') is not None
```

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```
>>> assert coco_img.find_asset_obj('black') is None
>>> assert coco_img.find_asset_obj('r') is None
```

### Example

```
>>> # Test with concise channel code
>>> import kwcoco
>>> coco_img = kwcoco.CocoImage({'width': 128, 'height': 128})
>>> coco_img.add_auxiliary_item(
>>>     'msi.png', channels='foo.0:128', width=32, height=32)
>>> assert coco_img.find_asset_obj('foo') is None
>>> assert coco_img.find_asset_obj('foo.3') is not None
>>> assert coco_img.find_asset_obj('foo.3:5') is not None
>>> assert coco_img.find_asset_obj('foo.3000') is None
```

### `_assets_key(self)`

Internal helper for transition from auxiliary -> assets in the image spec

**add\_auxiliary\_item**(*self*, *file\_name*=None, *channels*=None, *imdata*=None, *warp\_aux\_to\_img*=None, *width*=None, *height*=None, *imwrite*=False)

Adds an auxiliary / asset item to the image dictionary.

This operation can be done purely in-memory (the default), or the image data can be written to a file on disk (via the *imwrite*=True flag).

### Parameters

- **file\_name** (*str* | *None*) – The name of the file relative to the bundle directory. If unspecified, *imdata* must be given.
- **channels** (*str* | *kwcoco.FusedChannelSpec*) – The channel code indicating what each of the bands represents. These channels should be disjoint wrt to the existing data in this image (this is not checked).
- **imdata** (*ndarray* | *None*) – The underlying image data this auxiliary item represents. If unspecified, it is assumed *file\_name* points to a path on disk that will eventually exist. If *imdata*, *file\_name*, and the special *imwrite*=True flag are specified, this function will write the data to disk.
- **warp\_aux\_to\_img** (*kwimage.Affine*) – The transformation from this auxiliary space to image space. If unspecified, assumes this item is related to image space by only a scale factor.
- **width** (*int*) – Width of the data in auxiliary space (inferred if unspecified)
- **height** (*int*) – Height of the data in auxiliary space (inferred if unspecified)
- **imwrite** (*bool*) – If specified, both *imdata* and *file\_name* must be specified, and this will write the data to disk. Note: it is recommended that you simply call *imwrite* yourself before or after calling this function. This lets you better control *imwrite* parameters.

### Todo:

- [ ] Allow *imwrite* to specify an executor that is used to

return a Future so the *imwrite* call does not block.

### Example

```
>>> from kwcoco.coco_image import * # NOQA
>>> import kwcoco
>>> dset = kwcoco.CocoDataset.demo('vidshapes8-multispectral')
>>> coco_img = dset.coco_image(1)
>>> imdata = np.random.rand(32, 32, 5)
>>> channels = kwcoco.FusedChannelSpec.coerce('Aux:5')
>>> coco_img.add_auxiliary_item(imdata=imdata, channels=channels)
```

**delay**(self, channels=None, space='image', bundle\_dpath=None)

Perform a delayed load on the data in this image.

The delayed load can load a subset of channels, and perform lazy warping operations. If the underlying data is in a tiled format this can reduce the amount of disk IO needed to read the data if only a small crop or lower resolution view of the data is needed.

---

**Note:** This method is experimental and relies on the delayed load proof-of-concept.

---

### Parameters

- **gid** (*int*) – image id to load
- **channels** (*FusedChannelSpec*) – specific channels to load. if unspecified, all channels are loaded.
- **space** (*str*) – can either be “image” for loading in image space, or “video” for loading in video space.

---

### Todo:

- [X] **Currently can only take all or none of the channels from each** base-image / auxiliary dict. For instance if the main image is rgb you can’t just select g/b at the moment.
  - [X] **The order of the channels in the delayed load should** match the requested channel order.
  - [X] TODO: add nans to bands that don’t exist or throw an error
  - [ ] **This function could stand to have a better name. Maybe imread** with a delayed=True flag? Or maybe just delayed\_load?
- 

### Example

```
>>> from kwcoco.coco_image import * # NOQA
>>> import kwcoco
>>> gid = 1
>>> #
>>> dset = kwcoco.CocoDataset.demo('vidshapes8-multispectral')
>>> self = CocoImage(dset.imgs[gid], dset)
>>> delayed = self.delay()
>>> print('delayed = {!r}'.format(delayed))
>>> print('delayed.finalize() = {!r}'.format(delayed.finalize()))
```

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```
>>> print('delayed.finalize() = {!r}'.format(delayed.finalize(as_xarray=True)))
>>> #
>>> dset = kwcoco.CocoDataset.demo('shapes8')
>>> delayed = dset.delayed_load(gid)
>>> print('delayed = {!r}'.format(delayed))
>>> print('delayed.finalize() = {!r}'.format(delayed.finalize()))
>>> print('delayed.finalize() = {!r}'.format(delayed.finalize(as_xarray=True)))
```

```
>>> crop = delayed.delayed_crop((slice(0, 3), slice(0, 3)))
>>> crop.finalize()
>>> crop.finalize(as_xarray=True)
```

```
>>> # TODO: should only select the "red" channel
>>> dset = kwcoco.CocoDataset.demo('shapes8')
>>> delayed = CocoImage(dset.imgs[gid], dset).delay(channels='r')
```

```
>>> import kwcoco
>>> gid = 1
>>> #
>>> dset = kwcoco.CocoDataset.demo('vidshapes8-multispectral')
>>> delayed = dset.delayed_load(gid, channels='B1|B2', space='image')
>>> print('delayed = {!r}'.format(delayed))
>>> print('delayed.finalize() = {!r}'.format(delayed.finalize(as_xarray=True)))
>>> delayed = dset.delayed_load(gid, channels='B1|B2|B11', space='image')
>>> print('delayed = {!r}'.format(delayed))
>>> print('delayed.finalize() = {!r}'.format(delayed.finalize(as_xarray=True)))
>>> delayed = dset.delayed_load(gid, channels='B8|B1', space='video')
>>> print('delayed = {!r}'.format(delayed))
>>> print('delayed.finalize() = {!r}'.format(delayed.finalize(as_xarray=True)))
```

```
>>> delayed = dset.delayed_load(gid, channels='B8|foo|bar|B1', space='video')
>>> print('delayed = {!r}'.format(delayed))
>>> print('delayed.finalize() = {!r}'.format(delayed.finalize(as_xarray=True)))
```

## Example

```
>>> import kwcoco
>>> dset = kwcoco.CocoDataset.demo()
>>> coco_img = dset.coco_image(1)
>>> # Test case where nothing is registered in the dataset
>>> delayed = coco_img.delay()
>>> final = delayed.finalize()
>>> assert final.shape == (512, 512, 3)
```

### Example

```

>>> # Test that delay works when imdata is stored in the image
>>> # dictionary itself.
>>> from kwcoco.coco_image import * # NOQA
>>> import kwcoco
>>> dset = kwcoco.CocoDataset.demo('vidshapes8-multispectral')
>>> coco_img = dset.coco_image(1)
>>> imdata = np.random.rand(6, 6, 5)
>>> imdata[:] = np.arange(5)[None, None, :]
>>> channels = kwcoco.FusedChannelSpec.coerce('Aux:5')
>>> coco_img.add_auxiliary_item(imdata=imdata, channels=channels)
>>> delayed = coco_img.delay(channels='B1|Aux:2:4')
>>> final = delayed.finalize()

```

### Example

```

>>> # Test delay when loading in auxiliary space
>>> from kwcoco.coco_image import * # NOQA
>>> import kwcoco
>>> dset = kwcoco.CocoDataset.demo('vidshapes8-msi-multisensor')
>>> coco_img = dset.coco_image(1)
>>> stream1 = coco_img.channels.streams()[0]
>>> stream2 = coco_img.channels.streams()[1]
>>> aux_delayed = coco_img.delay(stream1, space='auxiliary')
>>> img_delayed = coco_img.delay(stream1, space='image')
>>> vid_delayed = coco_img.delay(stream1, space='video')
>>> #
>>> aux_imdata = aux_delayed.finalize()
>>> img_imdata = img_delayed.finalize()
>>> assert aux_imdata.shape != img_imdata.shape
>>> # Cannot load multiple auxiliary items at the same time in
>>> # auxiliary space
>>> import pytest
>>> fused_channels = stream1 | stream2
>>> with pytest.raises(kwcoco.exceptions.CoordinateCompatibilityError):
>>>     aux_delayed2 = coco_img.delay(fused_channels, space='auxiliary')

```

**valid\_region**(self, space='image')

If this image has a valid polygon, return it in image, or video space

**warp\_vid\_from\_img**(self)

**warp\_img\_from\_vid**(self)

**\_annot\_segmentation**(self, ann, space='video')

**class** kwcoco.coco\_image.CocoAsset

Bases: `object`

A Coco Asset / Auxiliary Item

Represents one 2D image file relative to a parent img.

Could be a single asset, or an image with sub-assets, but sub-assets are ignored here.



Initially we called these “auxiliary” items, but I think we should change their name to “assets”, which better maps with STAC terminology.

`__getitem__(self, key)`

Proxy getter attribute for underlying *self.obj* dictionary

`keys(self)`

Proxy getter attribute for underlying *self.obj* dictionary

`get(self, key, default=ub.NoParam)`

Proxy getter attribute for underlying *self.obj* dictionary

`kwcoco.coco_image._delay_load_imglike(bundle_dpath, obj)`

## 2.3.9 kwcoco.coco\_objects1d

Vectorized ORM-like objects used in conjunction with `coco_dataset`

### Module Contents

#### Classes

<i>ObjectList1D</i>	Vectorized access to lists of dictionary objects
<i>ObjectGroups</i>	An object for holding a groups of <i>ObjectList1D</i> objects
<i>Categories</i>	Vectorized access to category attributes
<i>Videos</i>	Vectorized access to video attributes
<i>Images</i>	Vectorized access to image attributes
<i>Annots</i>	Vectorized access to annotation attributes
<i>AnnotGroups</i>	An object for holding a groups of <i>ObjectList1D</i> objects
<i>ImageGroups</i>	An object for holding a groups of <i>ObjectList1D</i> objects

**class** `kwcoco.coco_objects1d.ObjectList1D(ids, dset, key)`

Bases: `ubelt.NiceRepr`

Vectorized access to lists of dictionary objects

Lightweight reference to a set of object (e.g. annotations, images) that allows for convenient property access.

#### Parameters

- **ids** (*List[int]*) – list of ids
- **dset** (*CocoDataset*) – parent dataset
- **key** (*str*) – main object name (e.g. ‘images’, ‘annotations’)

**Types:** `ObjT = Ann | Img | Cat` # can be one of these types `ObjectList1D` gives us access to a `List[ObjT]`

### Example

```
>>> import kwcoco
>>> dset = kwcoco.CocoDataset.demo()
>>> # Both annots and images are object lists
>>> self = dset.annots()
>>> self = dset.images()
>>> # can call with a list of ids or not, for everything
>>> self = dset.annots([1, 2, 11])
>>> self = dset.images([1, 2, 3])
>>> self.lookup('id')
>>> self.lookup(['id'])
```

`__nice__(self)`

`__iter__(self)`

`__len__(self)`

`property _id_to_obj(self)`

`__getitem__(self, index)`

`property objs(self)`

**Returns** all object dictionaries

**Return type** List[ObjT]

`take(self, idxs)`

Take a subset by index

**Returns** ObjectList1D

### Example

```
>>> import kwcoco
>>> self = kwcoco.CocoDataset.demo().annots()
>>> assert len(self.take([0, 2, 3])) == 3
```

`compress(self, flags)`

Take a subset by flags

**Returns** ObjectList1D

### Example

```
>>> import kwcoco
>>> self = kwcoco.CocoDataset.demo().images()
>>> assert len(self.compress([True, False, True])) == 2
```

`peek(self)`

Return the first object dictionary

**Returns** object dictionary

Return type `ObjT`

### Example

```
>>> import kwcoco
>>> dset = kwcoco.CocoDataset.demo()
>>> self = dset.images()
>>> assert self.peak()['id'] == 1
>>> # Check that subsets return correct items
>>> sub0 = self.compress([i % 2 == 0 for i in range(len(self))])
>>> sub1 = self.compress([i % 2 == 1 for i in range(len(self))])
>>> assert sub0.peak()['id'] == 1
>>> assert sub1.peak()['id'] == 2
```

**lookup**(*self*, *key*, *default*=*ub.NoParam*, *keepid*=*False*)

Lookup a list of object attributes

#### Parameters

- **key** (*str* | *Iterable*) – name of the property you want to lookup can also be a list of names, in which case we return a dict
- **default** – if specified, uses this value if it doesn't exist in an `ObjT`.
- **keepid** – if True, return a mapping from ids to the property

**Returns** a list of whatever type the object is `Dict[str, ObjT]`

**Return type** `List[ObjT]`

### Example

```
>>> import kwcoco
>>> dset = kwcoco.CocoDataset.demo()
>>> self = dset.anns()
>>> self.lookup('id')
>>> key = ['id']
>>> default = None
>>> self.lookup(key=['id', 'image_id'])
>>> self.lookup(key=['id', 'image_id'])
>>> self.lookup(key='foo', default=None, keepid=True)
>>> self.lookup(key=['foo'], default=None, keepid=True)
>>> self.lookup(key=['id', 'image_id'], keepid=True)
```

**get**(*self*, *key*, *default*=*ub.NoParam*, *keepid*=*False*)

Lookup a list of object attributes

#### Parameters

- **key** (*str*) – name of the property you want to lookup
- **default** – if specified, uses this value if it doesn't exist in an `ObjT`.
- **keepid** – if True, return a mapping from ids to the property

**Returns** a list of whatever type the object is `Dict[str, ObjT]`

**Return type** `List[ObjT]`

### Example

```
>>> import kwcoco
>>> dset = kwcoco.CocoDataset.demo()
>>> self = dset.anns()
>>> self.get('id')
>>> self.get(key='foo', default=None, keepid=True)
```

`_iter_get(self, key, default=ub.NoParam)`

Iterator version of get, not in stable API yet.

`set(self, key, values)`

Assign a value to each annotation

#### Parameters

- **key** (*str*) – the annotation property to modify
- **values** (*Iterable* | *scalar*) – an iterable of values to set for each annot in the dataset. If the item is not iterable, it is assigned to all objects.

### Example

```
>>> import kwcoco
>>> dset = kwcoco.CocoDataset.demo()
>>> self = dset.anns()
>>> self.set('my-key1', 'my-scalar-value')
>>> self.set('my-key2', np.random.rand(len(self)))
>>> print('dset.imgs = {}'.format(ub.repr2(dset.imgs, nl=1)))
>>> self.get('my-key2')
```

`_set(self, key, values)`

faster less safe version of set

`_lookup(self, key, default=ub.NoParam)`

### Example

```
>>> # xdoctest: +REQUIRES(--benchmark)
>>> import kwcoco
>>> dset = kwcoco.CocoDataset.demo('shapes256')
>>> self = anns = dset.anns()
>>> #
>>> import timerit
>>> ti = timerit.Timerit(100, bestof=10, verbose=2)
>>> #
>>> for timer in ti.reset('lookup'):
>>>     with timer:
>>>         self.lookup('image_id')
>>> #
>>> for timer in ti.reset('_lookup'):
>>>     with timer:
```

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```

>>>         self._lookup('image_id')
>>> #
>>> for timer in ti.reset('image_id'):
>>>     with timer:
>>>         self.image_id
>>> #
>>> for timer in ti.reset('raw1'):
>>>     with timer:
>>>         key = 'image_id'
>>>         [self._dset.anns[_id][key] for _id in self._ids]
>>> #
>>> for timer in ti.reset('raw2'):
>>>     with timer:
>>>         anns = self._dset.anns
>>>         key = 'image_id'
>>>         [anns[_id][key] for _id in self._ids]
>>> #
>>> for timer in ti.reset('lut-gen'):
>>>     with timer:
>>>         _lut = self._obj_lut
>>>         objs = (_lut[_id] for _id in self._ids)
>>>         [obj[key] for obj in objs]
>>> #
>>> for timer in ti.reset('lut-gen-single'):
>>>     with timer:
>>>         _lut = self._obj_lut
>>>         [_lut[_id][key] for _id in self._ids]

```

**attribute\_frequency(self)**

Compute the number of times each key is used in a dictionary

**Returns** Dict[str, int]

**Example**

```

>>> import kwcoco
>>> dset = kwcoco.CocoDataset.demo()
>>> self = dset.anns()
>>> attrs = self.attribute_frequency()
>>> print('attrs = {}'.format(ub.repr2(attrs, nl=1)))

```

**class** kwcoco.coco\_objects1d.**ObjectGroups**(groups, dset)

Bases: `ubelt.NiceRepr`

An object for holding a groups of *ObjectList1D* objects

**\_lookup**(self, key)

**\_\_getitem\_\_**(self, index)

**lookup**(self, key, default=ub.NoParam)

**\_\_nice\_\_**(self)

**class** kwcoco.coco\_objects1d.**Categories**(ids, dset)

Bases: *ObjectList1D*

Vectorized access to category attributes

**SeeAlso:** *kwcoco.coco\_dataset.MixinCocoObjects.categories()*

### Example

```
>>> from kwcoco.coco_objects1d import Categories # NOQA
>>> import kwcoco
>>> dset = kwcoco.CocoDataset.demo()
>>> ids = list(dset.cats.keys())
>>> self = Categories(ids, dset)
>>> print('self.name = {!r}'.format(self.name))
>>> print('self.supercategory = {!r}'.format(self.supercategory))
```

**property** cids(*self*)

**property** name(*self*)

**property** supercategory(*self*)

**class** kwcoco.coco\_objects1d.**Videos**(ids, dset)

Bases: *ObjectList1D*

Vectorized access to video attributes

**SeeAlso:** *kwcoco.coco\_dataset.MixinCocoObjects.videos()*

### Example

```
>>> from kwcoco.coco_objects1d import Videos # NOQA
>>> import kwcoco
>>> dset = kwcoco.CocoDataset.demo('vidshapes5')
>>> ids = list(dset.index.videos.keys())
>>> self = Videos(ids, dset)
>>> print('self = {!r}'.format(self))
```

**property** images(*self*)

### Example

```
>>> import kwcoco
>>> self = kwcoco.CocoDataset.demo('vidshapes8').videos()
>>> print(self.images)
<ImageGroups(n=8, m=2.0, s=0.0)>
```

**class** kwcoco.coco\_objects1d.**Images**(ids, dset)

Bases: *ObjectList1D*

Vectorized access to image attributes

**SeeAlso:** *kwcoco.coco\_dataset.MixinCocoObjects.images()*

```

property coco_images(self)
property gids(self)
property gname(self)
property gpath(self)
property width(self)
property height(self)
property size(self)

```

#### Example

```

>>> import kwcoco
>>> self = kwcoco.CocoDataset.demo().images()
>>> self._dset._ensure_imgsize()
>>> print(self.size)
[(512, 512), (300, 250), (256, 256)]

```

```

property area(self)

```

#### Example

```

>>> import kwcoco
>>> self = kwcoco.CocoDataset.demo().images()
>>> self._dset._ensure_imgsize()
>>> print(self.area)
[262144, 75000, 65536]

```

```

property n_annots(self)

```

#### Example

```

>>> import kwcoco
>>> self = kwcoco.CocoDataset.demo().images()
>>> print(ub.repr2(self.n_annots, nl=0))
[9, 2, 0]

```

```

property aids(self)

```

### Example

```
>>> import kwcoco
>>> self = kwcoco.CocoDataset.demo().images()
>>> print(ub.repr2(list(map(list, self.anns)), nl=0))
[[1, 2, 3, 4, 5, 6, 7, 8, 9], [10, 11], []]
```

**property** `anns(self)`

### Example

```
>>> import kwcoco
>>> self = kwcoco.CocoDataset.demo().images()
>>> print(self.anns)
<AnnotGroups(n=3, m=3.7, s=3.9)>
```

**class** `kwcoco.coco_objects1d.Annos(ids, dset)`

Bases: *ObjectList1D*

Vectorized access to annotation attributes

**SeeAlso:** *kwcoco.coco\_dataset.MixinCocoObjects.anns()*

**property** `ids(self)`

The annotation ids of this column of annotations

**property** `images(self)`

Get the column of images

**Returns** Images

**property** `image_id(self)`

**property** `category_id(self)`

**property** `gids(self)`

Get the column of image-ids

**Returns** list of image ids

**Return type** List[int]

**property** `cids(self)`

Get the column of category-ids

**Returns** List[int]

**property** `cnames(self)`

Get the column of category names

**Returns** List[int]

**property** `detections(self)`

Get the kwimage-style detection objects

**Returns** kwimage.Detections



### Example

```
>>> # xdoctest: +REQUIRES(module:kwimage)
>>> import kwcoco
>>> self = kwcoco.CocoDataset.demo('shapes32').annots([1, 2, 11])
>>> dets = self.detections
>>> print('dets.data = {!r}'.format(dets.data))
>>> print('dets.meta = {!r}'.format(dets.meta))
```

#### property `boxes(self)`

Get the column of kwimage-style bounding boxes

### Example

```
>>> import kwcoco
>>> self = kwcoco.CocoDataset.demo().annots([1, 2, 11])
>>> print(self.boxes)
<Boxes(xywh,
      array([[ 10,  10, 360, 490],
             [350,   5, 130, 290],
             [124,  96,  45,  18]]))>
```

#### property `xywh(self)`

Returns raw boxes

### Example

```
>>> import kwcoco
>>> self = kwcoco.CocoDataset.demo().annots([1, 2, 11])
>>> print(self.xywh)
```

**class** `kwcoco.coco_objects1d.AnnotGroups(groups, dset)`

Bases: *ObjectGroups*

An object for holding a groups of *ObjectList1D* objects

**property** `cids(self)`

**property** `cnames(self)`

**class** `kwcoco.coco_objects1d.ImageGroups(groups, dset)`

Bases: *ObjectGroups*

An object for holding a groups of *ObjectList1D* objects

### 2.3.10 kwcoco.coco\_schema

#### CommandLine

```
python -m kwcoco.coco_schema
xdoctest -m kwcoco.coco_schema __doc__
```

#### Example

```
>>> import kwcoco
>>> from kwcoco.coco_schema import COCO_SCHEMA
>>> import jsonschema
>>> dset = kwcoco.CocoDataset.demo('shapes1')
>>> # print('dset.dataset = {}'.format(ub.repr2(dset.dataset, nl=2)))
>>> COCO_SCHEMA.validate(dset.dataset)
```

```
>>> try:
>>>     jsonschema.validate(dset.dataset, schema=COCO_SCHEMA)
>>> except jsonschema.exceptions.ValidationError as ex:
>>>     vali_ex = ex
>>>     print('ex = {!r}'.format(ex))
>>>     raise
>>> except jsonschema.exceptions.SchemaError as ex:
>>>     print('ex = {!r}'.format(ex))
>>>     schema_ex = ex
>>>     print('schema_ex.instance = {}'.format(ub.repr2(schema_ex.instance, nl=-1)))
>>>     raise
```

```
>>> # Test the multispectral image defintino
>>> import copy
>>> dataset = dset.copy().dataset
>>> img = dataset['images'][0]
>>> img.pop('file_name')
>>> import pytest
>>> with pytest.raises(jsonschema.ValidationError):
>>>     COCO_SCHEMA.validate(dataset)
>>> import pytest
>>> img['auxiliary'] = [{'file_name': 'foobar'}]
>>> with pytest.raises(jsonschema.ValidationError):
>>>     COCO_SCHEMA.validate(dataset)
>>> img['name'] = 'aux-only images must have a name'
>>> COCO_SCHEMA.validate(dataset)
```

## Module Contents

### Functions

---

*deprecated*(\*args)

---

---

*TUPLE*(\*args, \*\*kw)

---

### Attributes

---

*elem*

---

---

*ALLOF*

---

---

*ANY*

---

---

*ANYOF*

---

---

*ARRAY*

---

---

*BOOLEAN*

---

---

*INTEGER*

---

---

*NOT*

---

---

*NULL*

---

---

*NUMBER*

---

---

*OBJECT*

---

---

*ONEOF*

---

---

*STRING*

---

---

*UUID*

---

---

*PATH*

---

---

*KWCOCO\_KEYPOINT*

---

---

*KWCOCO\_POLYGON*

---

---

*ORIG\_COCO\_KEYPOINTS*

---

---

*KWCOCO\_KEYPOINTS*

---

---

continues on next page

---

Table 1 – continued from previous page

<i>KEYPOINTS</i>
<i>ORIG_COCO_POLYGON</i>
<i>POLYGON</i>
<i>RUN_LENGTH_ENCODING</i>
<i>BBOX</i>
<i>SEGMENTATION</i>
<i>CATEGORY</i>
<i>KEYPOINT_CATEGORY</i>
<i>VIDEO</i>
<i>CHANNELS</i>
<i>IMAGE</i>
<i>ANNOTATION</i>
<i>COCO_SCHEMA</i>

`kwcoco.coco_schema.deprecated(*args)``kwcoco.coco_schema.TUPLE(*args, **kw)``kwcoco.coco_schema.elem``kwcoco.coco_schema.ALLOF``kwcoco.coco_schema.ANY``kwcoco.coco_schema.ANYOF``kwcoco.coco_schema.ARRAY``kwcoco.coco_schema.BOOLEAN``kwcoco.coco_schema.INTEGER``kwcoco.coco_schema.NOT``kwcoco.coco_schema.NULL``kwcoco.coco_schema.NUMBER``kwcoco.coco_schema.OBJECT``kwcoco.coco_schema.ONEOF`

---

```

kwcoco.coco_schema.STRING
kwcoco.coco_schema.UUID
kwcoco.coco_schema.PATH
kwcoco.coco_schema.KWCOCO_KEYPOINT
kwcoco.coco_schema.KWCOCO_POLYGON
kwcoco.coco_schema.ORIG_COCO_KEYPOINTS
kwcoco.coco_schema.KWCOCO_KEYPOINTS
kwcoco.coco_schema.KEYPOINTS
kwcoco.coco_schema.ORIG_COCO_POLYGON
kwcoco.coco_schema.POLYGON
kwcoco.coco_schema.RUN_LENGTH_ENCODING
kwcoco.coco_schema.BBOX
kwcoco.coco_schema.SEGMENTATION
kwcoco.coco_schema.CATEGORY
kwcoco.coco_schema.KEYPOINT_CATEGORY
kwcoco.coco_schema.VIDEO
kwcoco.coco_schema.CHANNELS
kwcoco.coco_schema.IMAGE
kwcoco.coco_schema.ANNOTATION
kwcoco.coco_schema.COCO_SCHEMA

```

### 2.3.11 kwcoco.coco\_sql\_dataset

---

speed difference so we can take advantage of alchemy’s expressiveness?:

---

Finally got a baseline implementation of an SQLite backend for COCO datasets. This mostly plugs into my existing tools (as long as only read operations are used; haven’t implemented writing yet) by duck-typing the dict API.

This solves the issue of forking and then accessing nested dictionaries in the JSON-style COCO objects. (When you access the dictionary Python will increment a reference count which triggers copy-on-write for whatever memory page that data happened to live in. Non-contiguous access had the effect of excessive memory copies).

For “medium sized” datasets its quite a bit slower. Running through a torch DataLoader with 4 workers for 10,000 images executes at a rate of 100Hz but takes 850MB of RAM. Using the duck-typed SQL backend only uses 500MB (which includes the cost of caching), but runs at 45Hz (which includes the benefit of caching).

However, once I scale up to 100,000 images I start seeing benefits. The in-memory dictionary interface chugs at 1.05HZ, and is taking more than 4GB of memory at the time I killed the process (eta was over an hour). The SQL backend ran at 45Hz and took about 3 minutes and used about 2.45GB of memory.

Without a cache, SQL runs at 30Hz and takes 400MB for 10,000 images, and for 100,000 images it gets 30Hz with 1.1GB. There is also a much larger startup time. I'm not exactly sure what it is yet, but its probably some preprocessing I'm doing.

Using a LRU cache we get 45Hz and 1.05GB of memory, so that's a clear win. We do need to be sure to disable the cache if we ever implement write mode.

I'd like to be a bit faster on the medium sized datasets (I'd really like to avoid caching rows, which is why the speed is currently semi-reasonable), but I don't think I can do any better than this because single-row lookup time is  $O(\log(N))$  for sqlite, whereas its  $O(1)$  for dictionaries. (I wish sqlite had an option to create a hash-table index for a table, but I dont think it does). I optimized as many of the dictionary operations as possible (for instance, iterating through keys, values, and items should be  $O(N)$  instead of  $O(N \log(N))$ ), but the majority of the runtime cost is in the single-row lookup time.

There are a few questions I still have if anyone has insight:

- Say I want to select a subset of  $K$  rows from a table with  $N$  entries, and I have a list of all of the rowids that I want. Is there any way to do this better than  $O(K \log(N))$ ? I tried using a `SELECT col FROM table WHERE id IN (?, ?, ?, ?, ...)` filling in enough ? as there are rows in my subset. I'm not sure what the complexity of using a query like this is. I'm not sure what the *IN* implementation looks like. Can this be done more efficiently by with a temporary table and a JOIN?
- There really is no way to do  $O(1)$  row lookup in sqlite right? Is there a way in PostgreSQL or some other backend sqlalchemy supports?

I found that PostgreSQL does support hash indexes: <https://www.postgresql.org/docs/13/indexes-types.html> I'm really not interested in setting up a global service though . I also found a 10-year old thread with a hash-index feature request for SQLite, which I unabashedly resurrected <http://sqlite.1065341.n5.nabble.com/Feature-request-hash-index-td23367.html>

## Module Contents

### Classes

<i>Category</i>	
<i>KeypointCategory</i>	
<i>Video</i>	
<i>Image</i>	
<i>Annotation</i>	
<i>SqlListProxy</i>	A view of an SQL table that behaves like a Python list
<i>SqlDictProxy</i>	Duck-types an SQL table as a dictionary of dictionaries.
<i>SqlIdGroupDictProxy</i>	Similar to <i>SqlDictProxy</i> , but maps ids to groups of other ids.
<i>CocoSqlIndex</i>	Simulates the dictionary provided by <i>kwcoco.coco_dataset.CocoIndex</i>
<i>CocoSqlDatabase</i>	Provides an API nearly identical to <i>kwcoco.CocoDatabase</i> , but uses

## Functions

<code>orm_to_dict(obj)</code>	
<code>_orm_yielder(query, size=300)</code>	TODO: figure out the best way to yield, in batches or otherwise
<code>_raw_yielder(result, size=300)</code>	TODO: figure out the best way to yield, in batches or otherwise
<code>_new_proxy_cache()</code>	By returning None, we wont use item caching
<code>_handle_sql_uri(uri)</code>	Temporary function to deal with URI. Modern tools seem to use RFC 3968
<code>cached_sql_coco_view(dct_db_fpath=None, sql_db_fpath=None, dset=None, force_rewrite=False)</code>	Attempts to load a cached SQL-View dataset, only loading and converting the
<code>ensure_sql_coco_view(dset, db_fpath=None, force_rewrite=False)</code>	Create a cached on-disk SQL view of an on-disk COCO dataset.
<code>demo(num=10)</code>	
<code>assert_dsets_allclose(dset1, dset2, tag1='dset1', tag2='dset2')</code>	
<code>_benchmark_dset_readtime(dset, tag='?')</code>	Helper for understanding the time differences between backends
<code>_benchmark_dict_proxy_ops(proxy)</code>	Get insight on the efficiency of operations
<code>devcheck()</code>	Scratch work for things that should eventually become unit or doc tests

## Attributes

<code>CocoBase</code>
<code>ALCHEMY_MODE_DEFAULT</code>
<code>TBLNAME_TO_CLASS</code>
<code>tblname</code>

`kwcoco.coco_sql_dataset.CocoBase`

**class** `kwcoco.coco_sql_dataset.Category`

Bases: `CocoBase`

`__tablename__ = categories`

`id`

`name`

`alias`

`supercategory`

```
    extra

class kwcoco.coco_sql_dataset.KeypointCategory
    Bases: CocoBase
    __tablename__ = keypoint_categories

    id
    name
    alias
    supercategory
    reflection_id
    extra

class kwcoco.coco_sql_dataset.Video
    Bases: CocoBase
    __tablename__ = videos

    id
    name
    caption
    width
    height
    extra

class kwcoco.coco_sql_dataset.Image
    Bases: CocoBase
    __tablename__ = images

    id
    name
    file_name
    width
    height
    video_id
    timestamp
    frame_index
    channels
    auxiliary
```



```

    extra
class kwcoco.coco_sql_dataset.Annotation
    Bases: CocoBase
    __tablename__ = annotations
    id
    image_id
    category_id
    track_id
    segmentation
    keypoints
    bbox
    _bbox_x
    _bbox_y
    _bbox_w
    _bbox_h
    score
    weight
    prob
    iscrowd
    caption
    extra

kwcoco.coco_sql_dataset.ALCHEMY_MODE_DEFAULT = 0

kwcoco.coco_sql_dataset.TBLNAME_TO_CLASS

kwcoco.coco_sql_dataset.tblname

kwcoco.coco_sql_dataset.orm_to_dict(obj)

kwcoco.coco_sql_dataset._orm_yielder(query, size=300)
    TODO: figure out the best way to yield, in batches or otherwise

kwcoco.coco_sql_dataset._raw_yielder(result, size=300)
    TODO: figure out the best way to yield, in batches or otherwise

kwcoco.coco_sql_dataset._new_proxy_cache()
    By returning None, we wont use item caching

```

```
class kwcoco.coco_sql_dataset.SqlListProxy(proxy, session, cls)
```

Bases: [ubelt.NiceRepr](#)

A view of an SQL table that behaves like a Python list

```
__len__(proxy)
```

```
__nice__(proxy)
```

```
__iter__(proxy)
```

```
__getitem__(proxy, index)
```

```
__contains__(proxy, item)
```

```
__setitem__(proxy, index, value)
```

```
__delitem__(proxy, index)
```

```
class kwcoco.coco_sql_dataset.SqlDictProxy(proxy, session, cls, keyattr=None, ignore_null=False)
```

Bases: [kwcoco.util.dict\\_like.DictLike](#)

Duck-types an SQL table as a dictionary of dictionaries.

The key is specified by an indexed column (by default it is the *id* column). The values are dictionaries containing all data for that row.

---

**Note:** With SQLite indexes are B-Trees so lookup is  $O(\log(N))$  and not  $O(1)$  as will regular dictionaries. Iteration should still be  $O(N)$ , but databases have much more overhead than Python dictionaries.

---

### Parameters

- **session** (*Session*) – the sqlalchemy session
- **cls** (*Type*) – the declarative sqlalchemy table class
- **keyattr** – the indexed column to use as the keys
- **ignore\_null** (*bool*) – if True, ignores any keys set to NULL, otherwise NULL keys are allowed.

### Example

```
>>> # xdoctest: +REQUIRES(module:sqlalchemy)
>>> from kwcoco.coco_sql_dataset import * # NOQA
>>> import pytest
>>> sql_dset, dct_dset = demo(num=10)
>>> proxy = sql_dset.index.anns
```

```
>>> keys = list(proxy.keys())
>>> values = list(proxy.values())
>>> items = list(proxy.items())
>>> item_keys = [t[0] for t in items]
>>> item_vals = [t[1] for t in items]
>>> lut_vals = [proxy[key] for key in keys]
>>> assert item_vals == lut_vals == values
```

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```
>>> assert item_keys == keys
>>> assert len(proxy) == len(keys)
```

```
>>> goodkey1 = keys[1]
>>> badkey1 = -1000000000000
>>> badkey2 = 'foobarbazbiz'
>>> badkey3 = object()
>>> assert goodkey1 in proxy
>>> assert badkey1 not in proxy
>>> assert badkey2 not in proxy
>>> assert badkey3 not in proxy
>>> with pytest.raises(KeyError):
>>>     proxy[badkey1]
>>> with pytest.raises(KeyError):
>>>     proxy[badkey2]
>>> with pytest.raises(KeyError):
>>>     proxy[badkey3]
```

```
>>> # xdoctest: +SKIP
>>> from kwcoco.coco_sql_dataset import _benchmark_dict_proxy_ops
>>> ti = _benchmark_dict_proxy_ops(proxy)
>>> print('ti.measures = {}'.format(ub.repr2(ti.measures, nl=2, align=':',
↳precision=6)))
```

## Example

```
>>> # xdoctest: +REQUIRES(module:sqlalchemy)
>>> from kwcoco.coco_sql_dataset import * # NOQA
>>> import kwcoco
>>> # Test the variant of the SqlDictProxy where we ignore None keys
>>> # This is the case for name_to_img and file_name_to_img
>>> dct_dset = kwcoco.CocoDataset.demo('shapes1')
>>> dct_dset.add_image(name='no_file_image1')
>>> dct_dset.add_image(name='no_file_image2')
>>> dct_dset.add_image(name='no_file_image3')
>>> sql_dset = dct_dset.view_sql(memory=True)
>>> assert len(dct_dset.index.imgs) == 4
>>> assert len(dct_dset.index.file_name_to_img) == 1
>>> assert len(dct_dset.index.name_to_img) == 3
>>> assert len(sql_dset.index.imgs) == 4
>>> assert len(sql_dset.index.file_name_to_img) == 1
>>> assert len(sql_dset.index.name_to_img) == 3
```

```
>>> proxy = sql_dset.index.file_name_to_img
>>> assert len(list(proxy.keys())) == 1
>>> assert len(list(proxy.values())) == 1
```

```
>>> proxy = sql_dset.index.name_to_img
>>> assert len(list(proxy.keys())) == 3
>>> assert len(list(proxy.values())) == 3
```

```
>>> proxy = sql_dset.index.imgs
>>> assert len(list(proxy.keys())) == 4
>>> assert len(list(proxy.values())) == 4
```

```
__len__(proxy)
```

```
__nice__(proxy)
```

```
__contains__(proxy, key)
```

```
__getitem__(proxy, key)
```

```
keys(proxy)
```

```
values(proxy)
```

```
items(proxy)
```

```
class kwcoco.coco_sql_dataset.SqlIdGroupDictProxy(proxy, session, valattr, keyattr, parent_keyattr,
                                                    group_order_attr=None)
```

Bases: [kwcoco.util.dict\\_like.DictLike](#)

Similar to [SqlDictProxy](#), but maps ids to groups of other ids.

Simulates a dictionary that maps ids of a parent table to all ids of another table corresponding to rows where a specific column has that parent id.

The items in the group can be sorted by the `group_order_attr` if specified.

For example, imagine two tables: images with one column (id) and annotations with two columns (id, image\_id). This class can help provide a mapping from each *image.id* to a *Set[annotation.id]* where those annotation rows have *annotation.image\_id = image.id*.

## Example

```
>>> # xdoctest: +REQUIRES(module:sqlalchemy)
>>> from kwcoco.coco_sql_dataset import * # NOQA
>>> sql_dset, dct_dset = demo(num=10)
>>> proxy = sql_dset.index.gid_to_aids
```

```
>>> keys = list(proxy.keys())
>>> values = list(proxy.values())
>>> items = list(proxy.items())
>>> item_keys = [t[0] for t in items]
>>> item_vals = [t[1] for t in items]
>>> lut_vals = [proxy[key] for key in keys]
>>> assert item_vals == lut_vals == values
>>> assert item_keys == keys
>>> assert len(proxy) == len(keys)
```

```
>>> # xdoctest: +SKIP
>>> from kwcoco.coco_sql_dataset import _benchmark_dict_proxy_ops
>>> ti = _benchmark_dict_proxy_ops(proxy)
>>> print('ti.measures = {}'.format(ub.repr2(ti.measures, nl=2, align=':',
↵precision=6)))
```

## Example

```
>>> # xdoctest: +REQUIRES(module:sqlalchemy)
>>> from kwcoco.coco_sql_dataset import * # NOQA
>>> import kwcoco
>>> # Test the group sorted variant of this by using vidid_to_gids
>>> # where the "gids" must be sorted by the image frame indexes
>>> dct_dset = kwcoco.CocoDataset.demo('vidshapes1')
>>> dct_dset.add_image(name='frame-index-order-demo1', frame_index=-30, video_id=1)
>>> dct_dset.add_image(name='frame-index-order-demo2', frame_index=10, video_id=1)
>>> dct_dset.add_image(name='frame-index-order-demo3', frame_index=3, video_id=1)
>>> dct_dset.add_video(name='empty-video1')
>>> dct_dset.add_video(name='empty-video2')
>>> dct_dset.add_video(name='empty-video3')
>>> sql_dset = dct_dset.view_sql(memory=True)
>>> orig = dct_dset.index.vidid_to_gids
>>> proxy = sql_dset.index.vidid_to_gids
>>> from kwcoco.util.util_json import indexable_allclose
>>> assert indexable_allclose(orig, dict(proxy))
>>> items = list(proxy.items())
>>> vals = list(proxy.values())
>>> keys = list(proxy.keys())
>>> assert len(keys) == len(vals)
>>> assert dict(zip(keys, vals)) == dict(items)
```

`__nice__(self)`

`__len__(proxy)`

`__getitem__(proxy, key)`

`__contains__(proxy, key)`

`keys(proxy)`

`items(proxy)`

`values(proxy)`

**class** `kwcoco.coco_sql_dataset.CocoSqlIndex(index)`

Bases: `object`

Simulates the dictionary provided by `kwcoco.coco_dataset.CocoIndex`

**build**(`index, parent`)

`kwcoco.coco_sql_dataset._handle_sql_uri(uri)`

Temporary function to deal with URI. Modern tools seem to use RFC 3968 URIs, but sqlalchemy uses RFC 1738. Attempt to gracefully handle special cases. With a better understanding of the above specs, this function may be able to be written more eloquently.

**class** `kwcoco.coco_sql_dataset.CocoSqlDatabase(uri=None, tag=None, img_root=None)`

Bases: `kwcoco.abstract_coco_dataset.AbstractCocoDataset`, `kwcoco.coco_dataset.MixinCocoAccessors`, `kwcoco.coco_dataset.MixinCocoObjects`, `kwcoco.coco_dataset.MixinCocoStats`, `kwcoco.coco_dataset.MixinCocoDraw`, `ubelt.NiceRepr`

Provides an API nearly identical to `kwcoco.CocoDatabase`, but uses an SQL backend data store. This makes it robust to copy-on-write memory issues that arise when forking, as discussed in<sup>1</sup>.

---

**Note:** By default constructing an instance of the `CocoSqlDatabase` does not create a connection to the database. Use the `connect()` method to open a connection.

---

## References

### Example

```
>>> # xdoctest: +REQUIRES(module:sqlalchemy)
>>> from kwcoco.coco_sql_dataset import * # NOQA
>>> sql_dset, dct_dset = demo()
>>> dset1, dset2 = sql_dset, dct_dset
>>> tag1, tag2 = 'dset1', 'dset2'
>>> assert_dsets_allclose(sql_dset, dct_dset)
```

**MEMORY\_URI** = `sqlite:///memory:`

**\_\_nice\_\_**(*self*)

**classmethod** **coerce**(*self*, *data*)

Create an SQL CocoDataset from the input pointer.

### Example

```
import kwcoco dset = kwcoco.CocoDataset.demo('shapes8') data = dset.fpath self = CocoSql-
Database.coerce(data)
```

```
from kwcoco.coco_sql_dataset import CocoSqlDatabase import kwcoco dset = kw-
coco.CocoDataset.coerce('spacenet7.kwcoco.json')
```

```
self = CocoSqlDatabase.coerce(dset)
```

```
from kwcoco.coco_sql_dataset import CocoSqlDatabase sql_dset = CocoSql-
Database.coerce('spacenet7.kwcoco.json')
```

```
# from kwcoco.coco_sql_dataset import CocoSqlDatabase import kwcoco sql_dset = kw-
coco.CocoDataset.coerce('_spacenet7.kwcoco.view.v006.sqlite')
```

**\_\_getstate\_\_**(*self*)

Return only the minimal info when pickling this object.

---

**Note:** This object IS pickling when the multiprocessing context is “spawn”.

This object is NOT pickled when the multiprocessing context is “fork”. In this case the user needs to be careful to create new connections in the forked subprocesses.

---

---

<sup>1</sup> <https://github.com/pytorch/pytorch/issues/13246>

### Example

```

>>> # xdoctest: +REQUIRES(module:sqlalchemy)
>>> from kwcoco.coco_sql_dataset import * # NOQA
>>> sql_dset, dct_dset = demo()
>>> # Test pickling works correctly
>>> import pickle
>>> serialized = pickle.dumps(sql_dset)
>>> assert len(serialized) < 3e4, 'should be very small'
>>> copy = pickle.loads(serialized)
>>> dset1, dset2, tag1, tag2 = sql_dset, copy, 'orig', 'copy'
>>> assert_dsets_allclose(dset1, dset2, tag1, tag2)
>>> # --- other methods of copying ---
>>> rw_copy = CocoSqlDatabase(
>>>     sql_dset.uri, img_root=sql_dset.img_root, tag=sql_dset.tag)
>>> rw_copy.connect()
>>> ro_copy = CocoSqlDatabase(
>>>     sql_dset.uri, img_root=sql_dset.img_root, tag=sql_dset.tag)
>>> ro_copy.connect(readonly=True)
>>> assert_dsets_allclose(dset1, ro_copy, tag1, 'ro-copy')
>>> assert_dsets_allclose(dset1, rw_copy, tag1, 'rw-copy')

```

**\_\_setstate\_\_(self, state)**

Reopen new readonly connections when unpickling the object.

**disconnect(self)**

Drop references to any SQL or cache objects

**connect(self, readonly=False)**

Connects this instance to the underlying database.

### References

# details on read only mode, some of these didnt seem to work <https://github.com/sqlalchemy/sqlalchemy/blob/master/lib/sqlalchemy/dialects/sqlite/pysqlite.py#L71> <https://github.com/pudo/dataset/issues/136>  
<https://writeonly.wordpress.com/2009/07/16/simple-read-only-sqlalchemy-sessions/>

**property fpath(self)**

**delete(self)**

**populate\_from(self, dset, verbose=1)**

Copy the information in a CocoDataset into this SQL database.

### Example

```
>>> # xdoctest: +REQUIRES(module:sqlalchemy)
>>> from kwcoco.coco_sql_dataset import _benchmark_dset_readtime # NOQA
>>> import kwcoco
>>> from kwcoco.coco_sql_dataset import *
>>> dset2 = dset = kwcoco.CocoDataset.demo()
>>> dset1 = self = CocoSqlDatabase('sqlite:///memory:')
>>> self.connect()
>>> self.populate_from(dset)
>>> assert_dsets_allclose(dset1, dset2, tag1='sql', tag2='dct')
>>> ti_sql = _benchmark_dset_readtime(dset1, 'sql')
>>> ti_dct = _benchmark_dset_readtime(dset2, 'dct')
>>> print('ti_sql.rankings = {}'.format(ub.repr2(ti_sql.rankings, nl=2,
↳precision=6, align=':')))
>>> print('ti_dct.rankings = {}'.format(ub.repr2(ti_dct.rankings, nl=2,
↳precision=6, align=':')))
```

**property dataset**(*self*)

**property anns**(*self*)

**property cats**(*self*)

**property imgs**(*self*)

**property name\_to\_cat**(*self*)

**raw\_table**(*self*, *table\_name*)

Loads an entire SQL table as a pandas DataFrame

**Parameters** *table\_name* (*str*) – name of the table

**Returns** DataFrame

### Example

```
>>> # xdoctest: +REQUIRES(module:sqlalchemy)
>>> from kwcoco.coco_sql_dataset import * # NOQA
>>> self, dset = demo()
>>> table_df = self.raw_table('annotations')
>>> print(table_df)
```

**\_column\_lookup**(*self*, *tablename*, *key*, *rowids*, *default=ub.NoParam*, *keepid=False*)

Convenience method to lookup only a single column of information



### Example

```
>>> # xdoctest: +REQUIRES(module:sqlalchemy)
>>> from kwcoco.coco_sql_dataset import * # NOQA
>>> self, dset = demo(10)
>>> tablename = 'annotations'
>>> key = 'category_id'
>>> rowids = list(self.anns.keys())[:3]
>>> cids1 = self._column_lookup(tablename, key, rowids)
>>> cids2 = self.anns(rowids).get(key)
>>> cids3 = dset.anns(rowids).get(key)
>>> assert cids3 == cids2 == cids1
```

**\_all\_rows\_column\_lookup**(self, tablename, keys)

Convenience method to look up all rows from a table and only a few columns.

### Example

```
>>> # xdoctest: +REQUIRES(module:sqlalchemy)
>>> from kwcoco.coco_sql_dataset import * # NOQA
>>> self, dset = demo(10)
>>> tablename = 'annotations'
>>> keys = ['id', 'category_id']
>>> rows = self._all_rows_column_lookup(tablename, keys)
```

**tabular\_targets**(self)

Convenience method to create an in-memory summary of basic annotation properties with minimal SQL overhead.

### Example

```
>>> # xdoctest: +REQUIRES(module:sqlalchemy)
>>> from kwcoco.coco_sql_dataset import * # NOQA
>>> self, dset = demo()
>>> targets = self.tabular_targets()
>>> print(targets.pandas())
```

**property bundle\_dpath**(self)

**property data\_fpath**(self)

data\_fpath is an alias of fpath

**kwcoco.coco\_sql\_dataset.cached\_sql\_coco\_view**(dct\_db\_fpath=None, sql\_db\_fpath=None, dset=None, force\_rewrite=False)

Attempts to load a cached SQL-View dataset, only loading and converting the json dataset if necessary.

**kwcoco.coco\_sql\_dataset.ensure\_sql\_coco\_view**(dset, db\_fpath=None, force\_rewrite=False)

Create a cached on-disk SQL view of an on-disk COCO dataset.

---

**Note:** This function is fragile. It depends on looking at file modified timestamps to determine if it needs to write the dataset.

---

```
kwcoco.coco_sql_dataset.demo(num=10)

kwcoco.coco_sql_dataset.assert_dsets_allclose(dset1, dset2, tag1='dset1', tag2='dset2')

kwcoco.coco_sql_dataset._benchmark_dset_readtime(dset, tag='?')
    Helper for understanding the time differences between backends

kwcoco.coco_sql_dataset._benchmark_dict_proxy_ops(proxy)
    Get insight on the efficiency of operations

kwcoco.coco_sql_dataset.devcheck()
    Scratch work for things that should eventually become unit or doc tests

from kwcoco.coco_sql_dataset import * # NOQA self, dset = demo()
```

### 2.3.12 kwcoco.compat\_dataset

A wrapper around the basic kwcoco dataset with a pycocotools API.

We do not recommend using this API because it has some idiosyncrasies, where names can be misleading and APIs are not always clear / efficient: e.g.

- (1) catToImgs returns integer image ids but imgToAnns returns annotation dictionaries.
- (2) showAnns takes a dictionary list as an argument instead of an integer list

The cool thing is that this extends the kwcoco API so you can drop this for compatibility with the old API, but you still get access to all of the kwcoco API including dynamic addition / removal of categories / annotations / images.

## Module Contents

### Classes

---

<i>COCO</i>	A wrapper around the basic kwcoco dataset with a pycocotools API.
-------------	---

---

```
class kwcoco.compat_dataset.COCO(annotation_file=None, **kw)
```

Bases: *kwcoco.coco\_dataset.CocoDataset*

A wrapper around the basic kwcoco dataset with a pycocotools API.

### Example

```
>>> from kwcoco.compat_dataset import * # NOQA
>>> import kwcoco
>>> basic = kwcoco.CocoDataset.demo('shapes8')
>>> self = COCO(basic.dataset)
>>> self.info()
>>> print('self.imgToAnns = {!r}'.format(self.imgToAnns[1]))
>>> print('self.catToImgs = {!r}'.format(self.catToImgs))
```

```
createIndex(self)
```

**info**(self)

Print information about the annotation file. :return:

**property** **imgToAnns**(self)

**property** **catToImgs**(self)

unlike the name implies, this actually goes from category to image ids Name retained for backward compatibility

**getAnnIds**(self, imgIds=[], catIds=[], areaRng=[], iscrowd=None)

Get ann ids that satisfy given filter conditions. default skips that filter :param imgIds (int array) : get anns for given imgs

catIds (int array) : get anns for given cats areaRng (float array) : get anns for given area range (e.g. [0 inf]) iscrowd (boolean) : get anns for given crowd label (False or True)

**Returns** ids (int array) : integer array of ann ids

### Example

```
>>> from kwcoco.compat_dataset import * # NOQA
>>> import kwcoco
>>> self = COCO(kwcoco.CocoDataset.demo('shapes8').dataset)
>>> self.getAnnIds()
>>> self.getAnnIds(imgIds=1)
>>> self.getAnnIds(imgIds=[1])
>>> self.getAnnIds(catIds=[3])
```

**getCatIds**(self, catNms=[], supNms=[], catIds=[])

filtering parameters. default skips that filter. :param catNms (str array) : get cats for given cat names :param supNms (str array) : get cats for given supercategory names :param catIds (int array) : get cats for given cat ids :return: ids (int array) : integer array of cat ids

### Example

```
>>> from kwcoco.compat_dataset import * # NOQA
>>> import kwcoco
>>> self = COCO(kwcoco.CocoDataset.demo('shapes8').dataset)
>>> self.getCatIds()
>>> self.getCatIds(catNms=['superstar'])
>>> self.getCatIds(supNms=['raster'])
>>> self.getCatIds(catIds=[3])
```

**getImgIds**(self, imgIds=[], catIds=[])

Get img ids that satisfy given filter conditions. :param imgIds (int array) : get imgs for given ids :param catIds (int array) : get imgs with all given cats :return: ids (int array) : integer array of img ids

### Example

```
>>> from kwcoco.compat_dataset import * # NOQA
>>> import kwcoco
>>> self = COCO(kwcoco.CocoDataset.demo('shapes8').dataset)
>>> self.getImgIds(imgIds=[1, 2])
>>> self.getImgIds(catIds=[3, 6, 7])
>>> self.getImgIds(catIds=[3, 6, 7], imgIds=[1, 2])
```

**loadAnns**(*self*, *ids=[]*)

Load anns with the specified ids. :param ids (int array) : integer ids specifying anns :return: anns (object array) : loaded ann objects

**loadCats**(*self*, *ids=[]*)

Load cats with the specified ids. :param ids (int array) : integer ids specifying cats :return: cats (object array) : loaded cat objects

**loadImgs**(*self*, *ids=[]*)

Load anns with the specified ids. :param ids (int array) : integer ids specifying img :return: imgs (object array) : loaded img objects

**showAnns**(*self*, *anns*, *draw\_bbox=False*)

Display the specified annotations. :param anns (array of object): annotations to display :return: None

**loadRes**(*self*, *resFile*)

Load result file and return a result api object. :param resFile (str) : file name of result file :return: res (obj) : result api object

**download**(*self*, *tarDir=None*, *imgIds=[]*)

Download COCO images from mscoco.org server. :param tarDir (str): COCO results directory name  
imgIds (list): images to be downloaded

### Returns

**loadNumpyAnnotations**(*self*, *data*)

Convert result data from a numpy array [Nx7] where each row contains {imageID,x1,y1,w,h,score,class}  
:param data (numpy.ndarray) :return: annotations (python nested list)

**annToRLE**(*self*, *ann*)

Convert annotation which can be polygons, uncompressed RLE to RLE. :return: binary mask (numpy 2D array)

---

**Note:**

- This requires the C-extensions for kwimage to be installed due to the need to interface with the bytes RLE format.
-

### Example

```

>>> from kwcoco.compat_dataset import * # NOQA
>>> import kwcoco
>>> self = COCO(kwcoco.CocoDataset.demo('shapes8').dataset)
>>> try:
>>>     rle = self.annToRLE(self.anns[1])
>>> except NotImplementedError:
>>>     import pytest
>>>     pytest.skip('missing kwimage c-extensions')
>>> else:
>>>     assert len(rle['counts']) > 2
>>> # xdoctest: +REQUIRES(module:pycocotools)
>>> self.conform(legacy=True)
>>> orig = self._aspycoco().annToRLE(self.anns[1])

```

**annToMask**(self, ann)

Convert annotation which can be polygons, uncompressed RLE, or RLE to binary mask.

**Returns** binary mask (numpy 2D array)

---

**Note:** The mask is returned as a fortran (F-style) array with the same dimensions as the parent image.

---

## 2.3.13 kwcoco.exceptions

### Module Contents

**exception** kwcoco.exceptions.**AddError**

Bases: `ValueError`

Generic error when trying to add a category/annotation/image

**exception** kwcoco.exceptions.**DuplicateAddError**

Bases: `ValueError`

Error when trying to add a duplicate item

**exception** kwcoco.exceptions.**InvalidAddError**

Bases: `ValueError`

Error when trying to invalid data

**exception** kwcoco.exceptions.**CoordinateCompatibilityError**

Bases: `ValueError`

Error when trying to perform operations on data in different coordinate systems.

### 2.3.14 kwcoco.kpf

WIP:

Conversions to and from KPF format.

#### Module Contents

#### Functions

---

<code>coco_to_kpf(coco_dset)</code>	<code>import kwcoco</code>
<code>demo()</code>	

---

```
kwcoco.kpf.coco_to_kpf(coco_dset)
    import kwcoco coco_dset = kwcoco.CocoDataset.demo('shapes8')
kwcoco.kpf.demo()
```

### 2.3.15 kwcoco.kw18

A helper for converting COCO to / from KW18 format.

KW18 File Format <https://docs.google.com/spreadsheets/d/1DFCwoTKnDv8qfy3raM7QXtir2Fjfj9j8-z8px5Bu0q8/edit#gid=10>

The kw18.trk files are text files, space delimited; each row is one frame of one track and all rows have the same number of columns. The fields are:

```
01) track_ID      : identifies the track
02) num_frames:   number of frames in the track
03) frame_id     : frame number for this track sample
04) loc_x        : X-coordinate of the track (image/ground coords)
05) loc_y        : Y-coordinate of the track (image/ground coords)
06) vel_x        : X-velocity of the object (image/ground coords)
07) vel_y        : Y-velocity of the object (image/ground coords)
08) obj_loc_x    : X-coordinate of the object (image coords)
09) obj_loc_y    : Y-coordinate of the object (image coords)
10) bbox_min_x   : minimum X-coordinate of bounding box (image coords)
11) bbox_min_y   : minimum Y-coordinate of bounding box (image coords)
12) bbox_max_x   : maximum X-coordinate of bounding box (image coords)
13) bbox_max_y   : maximum Y-coordinate of bounding box (image coords)
14) area         : area of object (pixels)
15) world_loc_x  : X-coordinate of object in world
16) world_loc_y  : Y-coordinate of object in world
17) world_loc_z  : Z-coordiante of object in world
18) timestamp    : timestamp of frame (frames)
```

For the location and velocity of object centroids, use fields 4-7.  
Bounding box is specified using coordinates of the top-left and bottom right corners. Fields 15-17 may be ignored.

The kw19.trk and kw20.trk files, when present, add the following field(s):

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19) **object** class: estimated **class of** the **object**, either 1 (person), 2 (vehicle), **or** 3 (other).

20) Activity ID -- refer to activities.txt **for** index **and** list of activities.

## Module Contents

### Classes

<i>KW18</i>	A DataFrame like object that stores KW18 column data
-------------	--

### Functions

<i>_ensure_kw18_column_order(df)</i>	Ensure expected kw18 columns exist and are in the correct order.
--------------------------------------	--

**class** kwcoco.kw18.**KW18**(*data*)

Bases: `kwarray.DataFrameArray`

A DataFrame like object that stores KW18 column data

### Example

```
>>> import kwcoco
>>> from kwcoco.kw18 import KW18
>>> coco_dset = kwcoco.CocoDataset.demo('shapes')
>>> kw18_dset = KW18.from_coco(coco_dset)
>>> print(kw18_dset.pandas())
```

```
DEFAULT_COLUMNS = ['track_id', 'track_length', 'frame_number',
                    'tracking_plane_loc_x', 'tracking_plane_loc_y', ...]
```

**classmethod** `demo(KW18)`

**classmethod** `from_coco(KW18, coco_dset)`

**to\_coco**(*self, image\_paths=None, video\_name=None*)

Translates a kw18 files to a CocoDataset.

---

**Note:** kw18 does not contain complete information, and as such the returned coco dataset may need to be augmented.

---

### Parameters

- **image\_paths** (*Dict[int, str], default=None*) – if specified, maps frame numbers to image file paths.
- **video\_name** (*str, default=None*) – if specified records the name of the video this kw18 belongs to

**Todo:**

- [X] allow kwargs to specify path to frames / videos

**Example**

```
>>> from kwcoco.kw18 import KW18
>>> from os.path import join
>>> import ubelt as ub
>>> import kwimage
>>> # Prep test data - autogen a demo kw18 and write it to disk
>>> dpath = ub.ensure_app_cache_dir('kwcoco/kw18')
>>> kw18_fpath = join(dpath, 'test.kw18')
>>> KW18.demo().dump(kw18_fpath)
>>> #
>>> # Load the kw18 file
>>> self = KW18.load(kw18_fpath)
>>> # Pretend that these image correspond to kw18 frame numbers
>>> frame_names = [kwimage.grab_test_image_fpath(k) for k in kwimage.grab_test_
↳ image.keys()]
>>> frame_ids = sorted(set(self['frame_number']))
>>> image_paths = dict(zip(frame_ids, frame_names))
>>> #
>>> # Convert the kw18 to kwcoco and specify paths to images
>>> coco_dset = self.to_coco(image_paths=image_paths, video_name='dummy.mp4')
>>> #
>>> # Now we can draw images
>>> canvas = coco_dset.draw_image(1)
>>> # xdoctest: +REQUIRES(--draw)
>>> kwimage.imwrite('foo.jpg', canvas)
>>> # Draw all iamges
>>> for gid in coco_dset.imgs.keys():
>>>     canvas = coco_dset.draw_image(gid)
>>>     fpath = join(dpath, 'gid_{}.jpg'.format(gid))
>>>     print('write fpath = {}'.format(fpath))
>>>     kwimage.imwrite(fpath, canvas)
```

**classmethod** `load(KW18, file)`

**Example**

```
>>> import kwcoco
>>> from kwcoco.kw18 import KW18
>>> coco_dset = kwcoco.CocoDataset.demo('shapes')
>>> kw18_dset = KW18.from_coco(coco_dset)
>>> print(kw18_dset.pandas())
```

**classmethod** `loads(KW18, text)`



### Example

```
>>> self = KW18.demo()
>>> text = self.dumps()
>>> self2 = KW18.loads(text)
>>> empty = KW18.loads('')
```

`dump(self, file)`

`dumps(self)`

### Example

```
>>> self = KW18.demo()
>>> text = self.dumps()
>>> print(text)
```

`kwcoco.kw18._ensure_kw18_column_order(df)`

Ensure expected kw18 columns exist and are in the correct order.

### Example

```
>>> import pandas as pd
>>> df = pd.DataFrame(columns=KW18.DEFAULT_COLUMNS[0:18])
>>> _ensure_kw18_column_order(df)
>>> df = pd.DataFrame(columns=KW18.DEFAULT_COLUMNS[0:19])
>>> _ensure_kw18_column_order(df)
>>> df = pd.DataFrame(columns=KW18.DEFAULT_COLUMNS[0:18] + KW18.DEFAULT_
↳ COLUMNS[20:21])
>>> assert np.all(_ensure_kw18_column_order(df).columns == df.columns)
```

## 2.4 Package Contents

### 2.4.1 Classes

<i>AbstractCocoDataset</i>	This is a common base for all variants of the Coco Dataset
<i>CocoDataset</i>	The main coco dataset class with a json dataset backend.
<i>CocoImage</i>	An object-oriented representation of a coco image.
<i>CategoryTree</i>	Wrapper that maintains flat or hierarchical category information.
<i>ChannelSpec</i>	Parse and extract information about network input channel specs for
<i>FusedChannelSpec</i>	A specific type of channel spec with only one early fused stream.

**class** kwcoco.AbstractCocoDatasetBases: `abc.ABC`

This is a common base for all variants of the Coco Dataset

At the time of writing there is `kwcoco.CocoDataset` (which is the dictionary-based backend), and the `kwcoco.coco_sql_dataset.CocoSqlDataset`, which is experimental.

**class** kwcoco.CocoDataset(*data=None, tag=None, bundle\_dpath=None, img\_root=None, fname=None, autobuild=True*)

Bases: `kwcoco.abstract_coco_dataset.AbstractCocoDataset`, `MixinCocoAddRemove`, `MixinCocoStats`, `MixinCocoObjects`, `MixinCocoDraw`, `MixinCocoAccessors`, `MixinCocoExtras`, `MixinCocoIndex`, `MixinCocoDepricate`, `ubelt.NiceRepr`

The main coco dataset class with a json dataset backend.

**Variables**

- **dataset** (*Dict*) – raw json data structure. This is the base dictionary that contains {‘annotations’: List, ‘images’: List, ‘categories’: List}
- **index** (`CocoIndex`) – an efficient lookup index into the coco data structure. The index defines its own attributes like `anns`, `cats`, `imgs`, `gid_to_aids`, `file_name_to_img`, etc. See `CocoIndex` for more details on which attributes are available.
- **fpath** (*PathLike | None*) – if known, this stores the filepath the dataset was loaded from
- **tag** (*str*) – A tag indicating the name of the dataset.
- **bundle\_dpath** (*PathLike | None*) – If known, this is the root path that all image file names are relative to. This can also be manually overwritten by the user.
- **hashid** (*str | None*) – If computed, this will be a hash uniquely identifying the dataset. To ensure this is computed see `kwcoco.coco_dataset.MixinCocoExtras._build_hashid()`.

**References**

<http://cocodataset.org/#format> <http://cocodataset.org/#download>

**CommandLine**

```
python -m kwcoco.coco_dataset CocoDataset --show
```

**Example**

```
>>> from kwcoco.coco_dataset import demo_coco_data
>>> import kwcoco
>>> import ubelt as ub
>>> # Returns a coco json structure
>>> dataset = demo_coco_data()
>>> # Pass the coco json structure to the API
>>> self = kwcoco.CocoDataset(dataset, tag='demo')
>>> # Now you can access the data using the index and helper methods
>>> #
```

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```

>>> # Start by looking up an image by it's COCO id.
>>> image_id = 1
>>> img = self.index.imgs[image_id]
>>> print(ub.repr2(img, nl=1, sort=1))
{
  'file_name': 'astro.png',
  'id': 1,
  'url': 'https://i.imgur.com/KXhKM72.png',
}
>>> #
>>> # Use the (gid_to_aids) index to lookup annotations in the iamge
>>> annotation_id = sorted(self.index.gid_to_aids[image_id])[0]
>>> ann = self.index.anns[annotation_id]
>>> print(ub.repr2(ub.dict_diff(ann, {'segmentation'}), nl=1))
{
  'bbox': [10, 10, 360, 490],
  'category_id': 1,
  'id': 1,
  'image_id': 1,
  'keypoints': [247, 101, 2, 202, 100, 2],
}
>>> #
>>> # Use annotation category id to look up that information
>>> category_id = ann['category_id']
>>> cat = self.index.cats[category_id]
>>> print('cat = {}'.format(ub.repr2(cat, nl=1, sort=1)))
cat = {
  'id': 1,
  'name': 'astronaut',
  'supercategory': 'human',
}
>>> #
>>> # Now play with some helper functions, like extended statistics
>>> extended_stats = self.extended_stats()
>>> # xdoctest: +IGNORE_WANT
>>> print('extended_stats = {}'.format(ub.repr2(extended_stats, nl=1, precision=2, ↵
↵sort=1)))
extended_stats = {
  'anns_per_img': {'mean': 3.67, 'std': 3.86, 'min': 0.00, 'max': 9.00, 'nMin': ↵
↵1, 'nMax': 1, 'shape': (3,)},
  'imgs_per_cat': {'mean': 0.88, 'std': 0.60, 'min': 0.00, 'max': 2.00, 'nMin': 2,
↵ 'nMax': 1, 'shape': (8,)},
  'cats_per_img': {'mean': 2.33, 'std': 2.05, 'min': 0.00, 'max': 5.00, 'nMin': 1,
↵ 'nMax': 1, 'shape': (3,)},
  'anns_per_cat': {'mean': 1.38, 'std': 1.49, 'min': 0.00, 'max': 5.00, 'nMin': ↵
↵2, 'nMax': 1, 'shape': (8,)},
  'imgs_per_video': {'empty_list': True},
}
>>> # You can "draw" a raster of the annotated image with cv2
>>> canvas = self.draw_image(2)
>>> # Or if you have matplotlib you can "show" the image with mpl objects
>>> # xdoctest: +REQUIRES(--show)

```

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```

>>> from matplotlib import pyplot as plt
>>> fig = plt.figure()
>>> ax1 = fig.add_subplot(1, 2, 1)
>>> self.show_image(gid=2)
>>> ax2 = fig.add_subplot(1, 2, 2)
>>> ax2.imshow(canvas)
>>> ax1.set_title('show with matplotlib')
>>> ax2.set_title('draw with cv2')
>>> plt.show()

```

**property** `fpath(self)`

In the future we will deprecate `img_root` for `bundle_dpath`

**property** `_infer_dirs(self)`

**classmethod** `from_data(CocoDataset, data, bundle_dpath=None, img_root=None)`

Constructor from a json dictionary

**classmethod** `from_image_paths(CocoDataset, gpaths, bundle_dpath=None, img_root=None)`

Constructor from a list of images paths.

This is a convinience method.

**Parameters** `gpaths (List[str])` – list of image paths

## Example

```

>>> coco_dset = CocoDataset.from_image_paths(['a.png', 'b.png'])
>>> assert coco_dset.n_images == 2

```

**classmethod** `from_coco_paths(CocoDataset, fpaths, max_workers=0, verbose=1, mode='thread', union='try')`

Constructor from multiple coco file paths.

Loads multiple coco datasets and unions the result

---

**Note:** if the union operation fails, the list of individually loaded files is returned instead.

---

## Parameters

- **fpaths** (*List[str]*) – list of paths to multiple coco files to be loaded and unioned.
- **max\_workers** (*int, default=0*) – number of worker threads / processes
- **verbose** (*int*) – verbosity level
- **mode** (*str*) – thread, process, or serial
- **union** (*str | bool, default='try'*) – If True, unions the result datasets after loading. If False, just returns the result list. If 'try', then try to preform the union, but return the result list if it fails.

**copy(self)**

Deep copies this object

### Example

```
>>> from kwcoco.coco_dataset import *
>>> self = CocoDataset.demo()
>>> new = self.copy()
>>> assert new.imgs[1] is new.dataset['images'][0]
>>> assert new.imgs[1] == self.dataset['images'][0]
>>> assert new.imgs[1] is not self.dataset['images'][0]
```

`__nice__(self)`

`dumps(self, indent=None, newlines=False)`

Writes the dataset out to the json format

**Parameters** `newlines` (*bool*) – if True, each annotation, image, category gets its own line

#### Note:

**Using `newlines=True` is similar to:** `print(ub.repr2(dset.dataset, nl=2, trailsep=False))` However, the above may not output valid json if it contains ndarrays.

### Example

```
>>> from kwcoco.coco_dataset import *
>>> self = CocoDataset.demo()
>>> text = self.dumps(newlines=True)
>>> print(text)
>>> self2 = CocoDataset(json.loads(text), tag='demo2')
>>> assert self2.dataset == self.dataset
>>> assert self2.dataset is not self.dataset
```

```
>>> text = self.dumps(newlines=True)
>>> print(text)
>>> self2 = CocoDataset(json.loads(text), tag='demo2')
>>> assert self2.dataset == self.dataset
>>> assert self2.dataset is not self.dataset
```

### Example

```
>>> from kwcoco.coco_dataset import *
>>> self = CocoDataset.coerce('vidshapes1-msi-multisensor', verbose=3)
>>> self.remove_annotations(self.annots())
>>> text = self.dumps(newlines=True, indent=' ')
>>> print(text)
```

`dump(self, file, indent=None, newlines=False, temp_file=True)`

Writes the dataset out to the json format

**Parameters**

- **file** (*PathLike | FileLike*) – Where to write the data. Can either be a path to a file or an open file pointer / stream.
- **newlines** (*bool*) – if True, each annotation, image, category gets its own line.
- **temp\_file** (*bool | str, default=True*) – Argument to `safer.open()`. Ignored if `file` is not a `PathLike` object.

### Example

```
>>> import tempfile
>>> from kwcoco.coco_dataset import *
>>> self = CocoDataset.demo()
>>> file = tempfile.NamedTemporaryFile('w')
>>> self.dump(file)
>>> file.seek(0)
>>> text = open(file.name, 'r').read()
>>> print(text)
>>> file.seek(0)
>>> dataset = json.load(open(file.name, 'r'))
>>> self2 = CocoDataset(dataset, tag='demo2')
>>> assert self2.dataset == self.dataset
>>> assert self2.dataset is not self.dataset
```

```
>>> file = tempfile.NamedTemporaryFile('w')
>>> self.dump(file, newlines=True)
>>> file.seek(0)
>>> text = open(file.name, 'r').read()
>>> print(text)
>>> file.seek(0)
>>> dataset = json.load(open(file.name, 'r'))
>>> self2 = CocoDataset(dataset, tag='demo2')
>>> assert self2.dataset == self.dataset
>>> assert self2.dataset is not self.dataset
```

`_check_json_serializable(self, verbose=1)`

Debug which part of a coco dataset might not be json serializable

`_check_integrity(self)`

perform all checks

`_check_index(self)`

### Example

```
>>> import kwcoco
>>> self = kwcoco.CocoDataset.demo()
>>> self._check_index()
>>> # Force a failure
>>> self.index.anns.pop(1)
>>> self.index.anns.pop(2)
>>> import pytest
```

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```
>>> with pytest.raises(AssertionError):
>>>     self._check_index()
```

**`_check_pointers(self, verbose=1)`**

Check that all category and image ids referenced by annotations exist

**`_build_index(self)`**

**`union(*others, disjoint_tracks=True, **kwargs)`**

Merges multiple [CocoDataset](#) items into one. Names and associations are retained, but ids may be different.

#### Parameters

- **`*others`** – a series of [CocoDatasets](#) that we will merge. Note, if called as an instance method, the “self” instance will be the first item in the “others” list. But if called like a classmethod, “others” will be empty by default.
- **`disjoint_tracks`** (*bool, default=True*) – if True, we will assume track-ids are disjoint and if two datasets share the same track-id, we will disambiguate them. Otherwise they will be copied over as-is.
- **`**kwargs`** – constructor options for the new merged [CocoDataset](#)

**Returns** a new merged coco dataset

**Return type** [CocoDataset](#)

#### CommandLine

```
xdoctest -m kwcoco.coco_dataset CocoDataset.union
```

#### Example

```
>>> # Test union works with different keypoint categories
>>> dset1 = CocoDataset.demo('shapes1')
>>> dset2 = CocoDataset.demo('shapes2')
>>> dset1.remove_keypoint_categories(['bot_tip', 'mid_tip', 'right_eye'])
>>> dset2.remove_keypoint_categories(['top_tip', 'left_eye'])
>>> dset_12a = CocoDataset.union(dset1, dset2)
>>> dset_12b = dset1.union(dset2)
>>> dset_21 = dset2.union(dset1)
>>> def add_hist(h1, h2):
>>>     return {k: h1.get(k, 0) + h2.get(k, 0) for k in set(h1) | set(h2)}
>>> kpfreq1 = dset1.keypoint_annotation_frequency()
>>> kpfreq2 = dset2.keypoint_annotation_frequency()
>>> kpfreq_want = add_hist(kpfreq1, kpfreq2)
>>> kpfreq_got1 = dset_12a.keypoint_annotation_frequency()
>>> kpfreq_got2 = dset_12b.keypoint_annotation_frequency()
>>> assert kpfreq_want == kpfreq_got1
>>> assert kpfreq_want == kpfreq_got2
```

```

>>> # Test disjoint gid datasets
>>> import kwcoco
>>> dset1 = kwcoco.CocoDataset.demo('shapes3')
>>> for new_gid, img in enumerate(dset1.dataset['images'], start=10):
>>>     for aid in dset1.gid_to_aids[img['id']]:
>>>         dset1.anns[aid]['image_id'] = new_gid
>>>         img['id'] = new_gid
>>> dset1.index.clear()
>>> dset1._build_index()
>>> # -----
>>> dset2 = kwcoco.CocoDataset.demo('shapes2')
>>> for new_gid, img in enumerate(dset2.dataset['images'], start=100):
>>>     for aid in dset2.gid_to_aids[img['id']]:
>>>         dset2.anns[aid]['image_id'] = new_gid
>>>         img['id'] = new_gid
>>> dset1.index.clear()
>>> dset2._build_index()
>>> others = [dset1, dset2]
>>> merged = kwcoco.CocoDataset.union(*others)
>>> print('merged = {!r}'.format(merged))
>>> print('merged.imgs = {}'.format(ub.repr2(merged.imgs, nl=1)))
>>> assert set(merged.imgs) & set([10, 11, 12, 100, 101]) == set(merged.imgs)

```

```

>>> # Test data is not preserved
>>> dset2 = kwcoco.CocoDataset.demo('shapes2')
>>> dset1 = kwcoco.CocoDataset.demo('shapes3')
>>> others = (dset1, dset2)
>>> cls = self = kwcoco.CocoDataset
>>> merged = cls.union(*others)
>>> print('merged = {!r}'.format(merged))
>>> print('merged.imgs = {}'.format(ub.repr2(merged.imgs, nl=1)))
>>> assert set(merged.imgs) & set([1, 2, 3, 4, 5]) == set(merged.imgs)

```

```

>>> # Test track-ids are mapped correctly
>>> dset1 = kwcoco.CocoDataset.demo('vidshapes1')
>>> dset2 = kwcoco.CocoDataset.demo('vidshapes2')
>>> dset3 = kwcoco.CocoDataset.demo('vidshapes3')
>>> others = (dset1, dset2, dset3)
>>> for dset in others:
>>>     [a.pop('segmentation', None) for a in dset.index.anns.values()]
>>>     [a.pop('keypoints', None) for a in dset.index.anns.values()]
>>> cls = self = kwcoco.CocoDataset
>>> merged = cls.union(*others, disjoint_tracks=1)
>>> print('dset1.anns = {}'.format(ub.repr2(dset1.anns, nl=1)))
>>> print('dset2.anns = {}'.format(ub.repr2(dset2.anns, nl=1)))
>>> print('dset3.anns = {}'.format(ub.repr2(dset3.anns, nl=1)))
>>> print('merged.anns = {}'.format(ub.repr2(merged.anns, nl=1)))

```



### Example

```
>>> import kwcoco
>>> # Test empty union
>>> empty_union = kwcoco.CocoDataset.union()
>>> assert len(empty_union.index.imgs) == 0
```

#### Todo:

- [ ] are supercategories broken?
- [ ] reuse image ids where possible
- [ ] reuse annotation / category ids where possible
- [X] handle case where no inputs are given
- [x] disambiguate track-ids
- [x] disambiguate video-ids

**subset**(*self*, *gids*, *copy=False*, *autobuild=True*)

Return a subset of the larger coco dataset by specifying which images to port. All annotations in those images will be taken.

#### Parameters

- **gids** (*List[int]*) – image-ids to copy into a new dataset
- **copy** (*bool*, *default=False*) – if True, makes a deep copy of all nested attributes, otherwise makes a shallow copy.
- **autobuild** (*bool*, *default=True*) – if True will automatically build the fast lookup index.

### Example

```
>>> self = CocoDataset.demo()
>>> gids = [1, 3]
>>> sub_dset = self.subset(gids)
>>> assert len(self.index.gid_to_aids) == 3
>>> assert len(sub_dset.gid_to_aids) == 2
```

### Example

```
>>> import kwcoco
>>> self = kwcoco.CocoDataset.demo('vidshapes2')
>>> gids = [1, 2]
>>> sub_dset = self.subset(gids, copy=True)
>>> assert len(sub_dset.index.videos) == 1
>>> assert len(self.index.videos) == 2
```

### Example

```
>>> self = CocoDataset.demo()
>>> sub1 = self.subset([1])
>>> sub2 = self.subset([2])
>>> sub3 = self.subset([3])
>>> others = [sub1, sub2, sub3]
>>> rejoined = CocoDataset.union(*others)
>>> assert len(sub1.anns) == 9
>>> assert len(sub2.anns) == 2
>>> assert len(sub3.anns) == 0
>>> assert rejoined.basic_stats() == self.basic_stats()
```

**view\_sql**(self, force\_rewrite=False, memory=False)

Create a cached SQL interface to this dataset suitable for large scale multiprocessing use cases.

#### Parameters

- **force\_rewrite** (*bool*, *default=False*) – if True, forces an update to any existing cache file on disk
- **memory** (*bool*, *default=False*) – if True, the database is constructed in memory.

---

**Note:** This view cache is experimental and currently depends on the timestamp of the file pointed to by `self.fpath`. In other words dont use this on in-memory datasets.

---

**class** kwcoco.CocoImage(img, dset=None)

Bases: `ubelt.NiceRepr`

An object-oriented representation of a coco image.

It provides helper methods that are specific to a single image.

This operates directly on a single coco image dictionary, but it can optionally be connected to a parent dataset, which allows it to use CocoDataset methods to query about relationships and resolve pointers.

This is different than the Images class in `coco_objectId`, which is just a vectorized interface to multiple objects.

### Example

```
>>> import kwcoco
>>> dset1 = kwcoco.CocoDataset.demo('shapes8')
>>> dset2 = kwcoco.CocoDataset.demo('vidshapes8-multispectral')
```

```
>>> self = CocoImage(dset1.imgs[1], dset1)
>>> print('self = {!r}'.format(self))
>>> print('self.channels = {}'.format(ub.repr2(self.channels, nl=1)))
```

```
>>> self = CocoImage(dset2.imgs[1], dset2)
>>> print('self.channels = {}'.format(ub.repr2(self.channels, nl=1)))
>>> self.primary_asset()
```

**classmethod** from\_gid(cls, dset, gid)

**property** `bundle_dpath(self)`

**property** `video(self)`

Helper to grab the video for this image if it exists

**detach**(`self`)

Removes references to the underlying coco dataset, but keeps special information such that it wont be needed.

**\_\_nice\_\_**(`self`)

### Example

```
>>> from kwcoco.coco_image import * # NOQA
>>> import kwcoco
>>> with ub.CaptureStdout() as cap:
...     dset = kwcoco.CocoDataset.demo('shapes8')
>>> self = CocoImage(dset.dataset['images'][0], dset)
>>> print('self = {!r}'.format(self))
```

```
>>> dset = kwcoco.CocoDataset.demo()
>>> self = CocoImage(dset.dataset['images'][0], dset)
>>> print('self = {!r}'.format(self))
```

**stats**(`self`)

**\_\_contains\_\_**(`self, key`)

**\_\_getitem\_\_**(`self, key`)

Proxy getter attribute for underlying `self.img` dictionary

**keys**(`self`)

Proxy getter attribute for underlying `self.img` dictionary

**get**(`self, key, default=ub.NoParam`)

Proxy getter attribute for underlying `self.img` dictionary

### Example

```
>>> import pytest
>>> # without extra populated
>>> import kwcoco
>>> self = kwcoco.CocoImage({'foo': 1})
>>> assert self.get('foo') == 1
>>> assert self.get('foo', None) == 1
>>> # with extra populated
>>> self = kwcoco.CocoImage({'extra': {'foo': 1}})
>>> assert self.get('foo') == 1
>>> assert self.get('foo', None) == 1
>>> # without extra empty
>>> self = kwcoco.CocoImage({})
>>> with pytest.raises(KeyError):
```

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```

>>> self.get('foo')
>>> assert self.get('foo', None) is None
>>> # with extra empty
>>> self = kwcoco.CocoImage({'extra': {'bar': 1}})
>>> with pytest.raises(KeyError):
>>>     self.get('foo')
>>> assert self.get('foo', None) is None

```

**property** `channels(self)`

**property** `num_channels(self)`

**property** `dsize(self)`

**primary\_image\_filepath**(*self*, *requires=None*)

**primary\_asset**(*self*, *requires=None*)

Compute a “main” image asset.

## Notes

Uses a heuristic.

- First, try to find the auxiliary image that has with the smallest

distortion to the base image (if known via `warp_aux_to_img`)

- Second, break ties by using the largest image if `w / h` is known
- Last, if previous information not available use the first auxiliary image.

**Parameters** `requires` (*List[str]*) – list of attribute that must be non-None to consider an object as the primary one.

---

## Todo:

- [ ] Add in primary heuristics
- 

## Example

```

>>> import kwarray
>>> from kwcoco.coco_image import * # NOQA
>>> rng = kwarray.ensure_rng(0)
>>> def random_auxiliary(name, w=None, h=None):
>>>     return {'file_name': name, 'width': w, 'height': h}
>>> self = CocoImage({
>>>     'auxiliary': [
>>>         random_auxiliary('1'),
>>>         random_auxiliary('2'),
>>>         random_auxiliary('3'),
>>>     ]

```

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```

>>> })
>>> assert self.primary_asset()['file_name'] == '1'
>>> self = CocoImage({
>>>     'auxiliary': [
>>>         random_auxiliary('1'),
>>>         random_auxiliary('2', 3, 3),
>>>         random_auxiliary('3'),
>>>     ]
>>> })
>>> assert self.primary_asset()['file_name'] == '2'

```

**iter\_image\_filepaths**(self)

**iter\_asset\_objs**(self)

Iterate through base + auxiliary dicts that have file paths

**Yields** *dict* – an image or auxiliary dictionary

**find\_asset\_obj**(self, channels)

Find the asset dictionary with the specified channels

### Example

```

>>> import kwcoco
>>> coco_img = kwcoco.CocoImage({'width': 128, 'height': 128})
>>> coco_img.add_auxiliary_item(
>>>     'rgb.png', channels='red|green|blue', width=32, height=32)
>>> assert coco_img.find_asset_obj('red') is not None
>>> assert coco_img.find_asset_obj('green') is not None
>>> assert coco_img.find_asset_obj('blue') is not None
>>> assert coco_img.find_asset_obj('red|blue') is not None
>>> assert coco_img.find_asset_obj('red|green|blue') is not None
>>> assert coco_img.find_asset_obj('red|green|blue') is not None
>>> assert coco_img.find_asset_obj('black') is None
>>> assert coco_img.find_asset_obj('r') is None

```

### Example

```

>>> # Test with concise channel code
>>> import kwcoco
>>> coco_img = kwcoco.CocoImage({'width': 128, 'height': 128})
>>> coco_img.add_auxiliary_item(
>>>     'msi.png', channels='foo.0:128', width=32, height=32)
>>> assert coco_img.find_asset_obj('foo') is None
>>> assert coco_img.find_asset_obj('foo.3') is not None
>>> assert coco_img.find_asset_obj('foo.3:5') is not None
>>> assert coco_img.find_asset_obj('foo.3000') is None

```

**\_assets\_key**(self)

Internal helper for transition from auxiliary -> assets in the image spec

```
add_auxiliary_item(self, file_name=None, channels=None, imdata=None, warp_aux_to_img=None,
                    width=None, height=None, imwrite=False)
```

Adds an auxiliary / asset item to the image dictionary.

This operation can be done purely in-memory (the default), or the image data can be written to a file on disk (via the `imwrite=True` flag).

#### Parameters

- **file\_name** (*str* | *None*) – The name of the file relative to the bundle directory. If unspecified, `imdata` must be given.
- **channels** (*str* | *kwcoco.FusedChannelSpec*) – The channel code indicating what each of the bands represents. These channels should be disjoint wrt to the existing data in this image (this is not checked).
- **imdata** (*ndarray* | *None*) – The underlying image data this auxiliary item represents. If unspecified, it is assumed `file_name` points to a path on disk that will eventually exist. If `imdata`, `file_name`, and the special `imwrite=True` flag are specified, this function will write the data to disk.
- **warp\_aux\_to\_img** (*kwimage.Affine*) – The transformation from this auxiliary space to image space. If unspecified, assumes this item is related to image space by only a scale factor.
- **width** (*int*) – Width of the data in auxiliary space (inferred if unspecified)
- **height** (*int*) – Height of the data in auxiliary space (inferred if unspecified)
- **imwrite** (*bool*) – If specified, both `imdata` and `file_name` must be specified, and this will write the data to disk. Note: it is recommended that you simply call `imwrite` yourself before or after calling this function. This lets you better control `imwrite` parameters.

---

#### Todo:

- [ ] Allow `imwrite` to specify an executor that is used to

return a `Future` so the `imwrite` call does not block.

---

#### Example

```
>>> from kwcoco.coco_image import * # NOQA
>>> import kwcoco
>>> dset = kwcoco.CocoDataset.demo('vidshapes8-multispectral')
>>> coco_img = dset.coco_image(1)
>>> imdata = np.random.rand(32, 32, 5)
>>> channels = kwcoco.FusedChannelSpec.coerce('Aux:5')
>>> coco_img.add_auxiliary_item(imdata=imdata, channels=channels)
```

```
delay(self, channels=None, space='image', bundle_dpath=None)
```

Perform a delayed load on the data in this image.

The delayed load can load a subset of channels, and perform lazy warping operations. If the underlying data is in a tiled format this can reduce the amount of disk IO needed to read the data if only a small crop or lower resolution view of the data is needed.

---

**Note:** This method is experimental and relies on the delayed load proof-of-concept.

---

### Parameters

- **gid** (*int*) – image id to load
- **channels** (*FusedChannelSpec*) – specific channels to load. if unspecified, all channels are loaded.
- **space** (*str*) – can either be “image” for loading in image space, or “video” for loading in video space.

### Todo:

- [X] **Currently can only take all or none of the channels from each** base-image / auxiliary dict. For instance if the main image is r|g|b you can’t just select g|b at the moment.
- [X] **The order of the channels in the delayed load should** match the requested channel order.
- [X] TODO: add nans to bands that don’t exist or throw an error
- [ ] **This function could stand to have a better name. Maybe imread** with a delayed=True flag? Or maybe just delayed\_load?

### Example

```
>>> from kwcoco.coco_image import * # NOQA
>>> import kwcoco
>>> gid = 1
>>> #
>>> dset = kwcoco.CocoDataset.demo('vidshapes8-multispectral')
>>> self = CocoImage(dset.imgs[gid], dset)
>>> delayed = self.delay()
>>> print('delayed = {!r}'.format(delayed))
>>> print('delayed.finalize() = {!r}'.format(delayed.finalize()))
>>> print('delayed.finalize() = {!r}'.format(delayed.finalize(as_xarray=True)))
>>> #
>>> dset = kwcoco.CocoDataset.demo('shapes8')
>>> delayed = dset.delayed_load(gid)
>>> print('delayed = {!r}'.format(delayed))
>>> print('delayed.finalize() = {!r}'.format(delayed.finalize()))
>>> print('delayed.finalize() = {!r}'.format(delayed.finalize(as_xarray=True)))
```

```
>>> crop = delayed.delayed_crop((slice(0, 3), slice(0, 3)))
>>> crop.finalize()
>>> crop.finalize(as_xarray=True)
```

```
>>> # TODO: should only select the "red" channel
>>> dset = kwcoco.CocoDataset.demo('shapes8')
>>> delayed = CocoImage(dset.imgs[gid], dset).delay(channels='r')
```

```
>>> import kwcoco
>>> gid = 1
>>> #
>>> dset = kwcoco.CocoDataset.demo('vidshapes8-multispectral')
```

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```

>>> delayed = dset.delayed_load(gid, channels='B1|B2', space='image')
>>> print('delayed = {!r}'.format(delayed))
>>> print('delayed.finalize() = {!r}'.format(delayed.finalize(as_xarray=True)))
>>> delayed = dset.delayed_load(gid, channels='B1|B2|B11', space='image')
>>> print('delayed = {!r}'.format(delayed))
>>> print('delayed.finalize() = {!r}'.format(delayed.finalize(as_xarray=True)))
>>> delayed = dset.delayed_load(gid, channels='B8|B1', space='video')
>>> print('delayed = {!r}'.format(delayed))
>>> print('delayed.finalize() = {!r}'.format(delayed.finalize(as_xarray=True)))

```

```

>>> delayed = dset.delayed_load(gid, channels='B8|foo|bar|B1', space='video')
>>> print('delayed = {!r}'.format(delayed))
>>> print('delayed.finalize() = {!r}'.format(delayed.finalize(as_xarray=True)))

```

### Example

```

>>> import kwcoco
>>> dset = kwcoco.CocoDataset.demo()
>>> coco_img = dset.coco_image(1)
>>> # Test case where nothing is registered in the dataset
>>> delayed = coco_img.delay()
>>> final = delayed.finalize()
>>> assert final.shape == (512, 512, 3)

```

### Example

```

>>> # Test that delay works when imdata is stored in the image
>>> # dictionary itself.
>>> from kwcoco.coco_image import * # NOQA
>>> import kwcoco
>>> dset = kwcoco.CocoDataset.demo('vidshapes8-multispectral')
>>> coco_img = dset.coco_image(1)
>>> imdata = np.random.rand(6, 6, 5)
>>> imdata[:] = np.arange(5)[None, None, :]
>>> channels = kwcoco.FusedChannelSpec.coerce('Aux:5')
>>> coco_img.add_auxiliary_item(imdata=imdata, channels=channels)
>>> delayed = coco_img.delay(channels='B1|Aux:2:4')
>>> final = delayed.finalize()

```



### Example

```

>>> # Test delay when loading in auxiliary space
>>> from kwcoco.coco_image import * # NOQA
>>> import kwcoco
>>> dset = kwcoco.CocoDataset.demo('vidshapes8-msi-multisensor')
>>> coco_img = dset.coco_image(1)
>>> stream1 = coco_img.channels.streams()[0]
>>> stream2 = coco_img.channels.streams()[1]
>>> aux_delayed = coco_img.delay(stream1, space='auxiliary')
>>> img_delayed = coco_img.delay(stream1, space='image')
>>> vid_delayed = coco_img.delay(stream1, space='video')
>>> #
>>> aux_imdata = aux_delayed.finalize()
>>> img_imdata = img_delayed.finalize()
>>> assert aux_imdata.shape != img_imdata.shape
>>> # Cannot load multiple auxiliary items at the same time in
>>> # auxiliary space
>>> import pytest
>>> fused_channels = stream1 | stream2
>>> with pytest.raises(kwcoco.exceptions.CoordinateCompatibilityError):
>>>     aux_delayed2 = coco_img.delay(fused_channels, space='auxiliary')

```

**valid\_region**(self, space='image')

If this image has a valid polygon, return it in image, or video space

**warp\_vid\_from\_img**(self)

**warp\_img\_from\_vid**(self)

**\_annot\_segmentation**(self, ann, space='video')

**class** kwcoco.CategoryTree(graph=None, checks=True)

Bases: `ubelt.NiceRepr`

Wrapper that maintains flat or hierarchical category information.

Helps compute softmaxes and probabilities for tree-based categories where a directed edge (A, B) represents that A is a superclass of B.

**Note:** There are three basic properties that this object maintains:

**node:**

Alphanumeric string names that should be generally descriptive. Using spaces **and** special characters **in** these names **is** discouraged, but can be done. This **is** the COCO category "name" attribute. For categories this may be denoted **as** (name, node, cname, catname).

**id:**

The integer **id** of a category should ideally remain consistent. These are often given by a dataset (e.g. a COCO dataset). This **is** the COCO category "id" attribute. For categories this **is** often denoted **as** (**id**, **cid**).

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**index:**

Contiguous zero-based indices that indexes the **list** of categories. These should be used **for** the fastest access **in** backend computation tasks. Typically corresponds to the ordering of the channels **in** the final linear layer **in** an associated model. For categories this **is** often denoted **as** (index, cid<sub>x</sub>, id<sub>x</sub>, **or** c<sub>x</sub>).

**Variables**

- **idx\_to\_node** (*List[str]*) – a list of class names. Implicitly maps from index to category name.
- **id\_to\_node** (*Dict[int, str]*) – maps integer ids to category names
- **node\_to\_id** (*Dict[str, int]*) – maps category names to ids
- **node\_to\_idx** (*Dict[str, int]*) – maps category names to indexes
- **graph** (*networkx.Graph*) – a Graph that stores any hierarchy information. For standard mutually exclusive classes, this graph is edgeless. Nodes in this graph can maintain category attributes / properties.
- **idx\_groups** (*List[List[int]]*) – groups of category indices that share the same parent category.

**Example**

```
>>> from kwcoco.category_tree import *
>>> graph = nx.from_dict_of_lists({
>>>     'background': [],
>>>     'foreground': ['animal'],
>>>     'animal': ['mammal', 'fish', 'insect', 'reptile'],
>>>     'mammal': ['dog', 'cat', 'human', 'zebra'],
>>>     'zebra': ['grevys', 'plains'],
>>>     'grevys': ['fred'],
>>>     'dog': ['boxer', 'beagle', 'golden'],
>>>     'cat': ['maine coon', 'persian', 'sphynx'],
>>>     'reptile': ['bearded dragon', 't-rex'],
>>> }, nx.DiGraph)
>>> self = CategoryTree(graph)
>>> print(self)
<CategoryTree(nNodes=22, maxDepth=6, maxBreadth=4...)>
```

### Example

```
>>> # The coerce classmethod is the easiest way to create an instance
>>> import kwcoco
>>> kwcoco.CategoryTree.coerce(['a', 'b', 'c'])
<CategoryTree...nNodes=3, nodes=...'a', 'b', 'c'...
>>> kwcoco.CategoryTree.coerce(4)
<CategoryTree...nNodes=4, nodes=...'class_1', 'class_2', 'class_3', ...
>>> kwcoco.CategoryTree.coerce(4)
```

**copy**(*self*)

**classmethod from\_mutex**(*cls, nodes, bg\_hack=True*)

**Parameters** *nodes* (*List[str]*) – or a list of class names (in which case they will all be assumed to be mutually exclusive)

### Example

```
>>> print(CategoryTree.from_mutex(['a', 'b', 'c']))
<CategoryTree(nNodes=3, ...)>
```

**classmethod from\_json**(*cls, state*)

**Parameters** *state* (*Dict*) – see `__getstate__` / `__json__` for details

**classmethod from\_coco**(*cls, categories*)

Create a CategoryTree object from coco categories

**Parameters** *List[Dict]* – list of coco-style categories

**classmethod coerce**(*cls, data, \*\*kw*)

Attempt to coerce data as a CategoryTree object.

This is primarily useful for when the software stack depends on categories being represent

This will work if the input data is a specially formatted json dict, a list of mutually exclusive classes, or if it is already a CategoryTree. Otherwise an error will be thrown.

#### Parameters

- **data** (*object*) – a known representation of a category tree.
- **\*\*kwargs** – input type specific arguments

**Returns** *self*

**Return type** *CategoryTree*

#### Raises

- **TypeError** – if the input format is unknown –
- **ValueError** – if kwargs are not compatible with the input format –

### Example

```

>>> import kwcoco
>>> classes1 = kwcoco.CategoryTree.coerce(3) # integer
>>> classes2 = kwcoco.CategoryTree.coerce(classes1.__json__()) # graph dict
>>> classes3 = kwcoco.CategoryTree.coerce(['class_1', 'class_2', 'class_3']) #_
↳mutex list
>>> classes4 = kwcoco.CategoryTree.coerce(classes1.graph) # nx Graph
>>> classes5 = kwcoco.CategoryTree.coerce(classes1) # cls
>>> # xdoctest: +REQUIRES(module:ndsampler)
>>> import ndsampler
>>> classes6 = ndsampler.CategoryTree.coerce(3)
>>> classes7 = ndsampler.CategoryTree.coerce(classes1)
>>> classes8 = kwcoco.CategoryTree.coerce(classes6)

```

**classmethod** `demo(cls, key='coco', **kwargs)`

**Parameters** `key` (*str*) – specify which demo dataset to use. Can be ‘coco’ (which uses the default coco demo data). Can be ‘btree’ which creates a binary tree and accepts kwargs ‘r’ and ‘h’ for branching-factor and height. Can be ‘btree2’, which is the same as btree but returns strings

### CommandLine

```
xdoctest -m ~/code/kwcoco/kwcoco/category_tree.py CategoryTree.demo
```

### Example

```

>>> from kwcoco.category_tree import *
>>> self = CategoryTree.demo()
>>> print('self = {}'.format(self))
self = <CategoryTree(nNodes=10, maxDepth=2, maxBreadth=4...)>

```

**to\_coco**(*self*)

Converts to a coco-style data structure

**Yields** *Dict* – coco category dictionaries

**id\_to\_idx**(*self*)

### Example

```

>>> import kwcoco
>>> self = kwcoco.CategoryTree.demo()
>>> self.id_to_idx[1]

```

**idx\_to\_id**(*self*)

### Example

```
>>> import kwcoco
>>> self = kwcoco.CategoryTree.demo()
>>> self.idx_to_id[0]
```

**idx\_to\_ancestor\_idxs**(*self*, *include\_self=True*)

Mapping from a class index to its ancestors

**Parameters** **include\_self** (*bool*, *default=True*) – if True includes each node as its own ancestor.

**idx\_to\_descendants\_idxs**(*self*, *include\_self=False*)

Mapping from a class index to its descendants (including itself)

**Parameters** **include\_self** (*bool*, *default=False*) – if True includes each node as its own descendant.

**idx\_pairwise\_distance**(*self*)

Get a matrix encoding the distance from one class to another.

#### Distances

- from parents to children are positive (descendants),
- from children to parents are negative (ancestors),
- between unreachable nodes (wrt to forward and reverse graph) are nan.

**\_\_len\_\_**(*self*)

**\_\_iter\_\_**(*self*)

**\_\_getitem\_\_**(*self*, *index*)

**\_\_contains\_\_**(*self*, *node*)

**\_\_json\_\_**(*self*)

### Example

```
>>> import pickle
>>> self = CategoryTree.demo()
>>> print('self = {!r}'.format(self.__json__()))
```

**\_\_getstate\_\_**(*self*)

Serializes information in this class

### Example

```
>>> from kwcoco.category_tree import *
>>> import pickle
>>> self = CategoryTree.demo()
>>> state = self.__getstate__()
>>> serialization = pickle.dumps(self)
>>> recon = pickle.loads(serialization)
>>> assert recon.__json__() == self.__json__()
```

**\_\_setstate\_\_**(*self*, *state*)

**\_\_nice\_\_**(*self*)

**is\_mutex**(*self*)

Returns True if all categories are mutually exclusive (i.e. flat)

If true, then the classes may be represented as a simple list of class names without any loss of information, otherwise the underlying category graph is necessary to preserve all knowledge.

---

**Todo:**

- [ ] what happens when we have a dummy root?
- 

**property num\_classes**(*self*)

**property class\_names**(*self*)

**property category\_names**(*self*)

**property cats**(*self*)

Returns a mapping from category names to category attributes.

If this category tree was constructed from a coco-dataset, then this will contain the coco category attributes.

**Returns** Dict[str, Dict[str, object]]

### Example

```
>>> from kwcoco.category_tree import *
>>> self = CategoryTree.demo()
>>> print('self.cats = {!r}'.format(self.cats))
```

**index**(*self*, *node*)

Return the index that corresponds to the category name

**\_build\_index**(*self*)

construct lookup tables

**show**(*self*)

**forest\_str**(*self*)

**normalize**(*self*)

Applies a normalization scheme to the categories.

Note: this may break other tasks that depend on exact category names.

**Returns** CategoryTree

### Example

```
>>> from kwcoco.category_tree import * # NOQA
>>> import kwcoco
>>> orig = kwcoco.CategoryTree.demo('animals_v1')
>>> self = kwcoco.CategoryTree(nx.relabel_nodes(orig.graph, str.upper))
>>> norm = self.normalize()
```

**class** kwcoco.ChannelSpec(spec, parsed=None)

Bases: BaseChannelSpec

Parse and extract information about network input channel specs for early or late fusion networks.

Behaves like a dictionary of FusedChannelSpec objects

#### Todo:

- [ ] Rename to something that indicates this is a collection of FusedChannelSpec? MultiChannelSpec?

**Note:** This class name and API is in flux and subject to change.

**Note:** The pipe ('|') character represents an early-fused input stream, and order matters (it is non-communative).

The comma (',') character separates different inputs streams/branches for a multi-stream/branch network which will be later fused. Order does not matter

### Example

```
>>> from kwcoco.channel_spec import * # NOQA
>>> # Integer spec
>>> ChannelSpec.coerce(3)
<ChannelSpec(u0|u1|u2) ...>
```

```
>>> # single mode spec
>>> ChannelSpec.coerce('rgb')
<ChannelSpec(rgb) ...>
```

```
>>> # early fused input spec
>>> ChannelSpec.coerce('rgb|disprity')
<ChannelSpec(rgb|disprity) ...>
```

```
>>> # late fused input spec
>>> ChannelSpec.coerce('rgb,disprity')
<ChannelSpec(rgb,disprity) ...>
```

```
>>> # early and late fused input spec
>>> ChannelSpec.coerce('rgb|ir,disprity')
<ChannelSpec(rgb|ir,disprity) ...>
```

### Example

```

>>> self = ChannelSpec('gray')
>>> print('self.info = {}'.format(ub.repr2(self.info, nl=1)))
>>> self = ChannelSpec('rgb')
>>> print('self.info = {}'.format(ub.repr2(self.info, nl=1)))
>>> self = ChannelSpec('rgb|disparity')
>>> print('self.info = {}'.format(ub.repr2(self.info, nl=1)))
>>> self = ChannelSpec('rgb|disparity,disparity')
>>> print('self.info = {}'.format(ub.repr2(self.info, nl=1)))
>>> self = ChannelSpec('rgb,disparity,flowx|flowy')
>>> print('self.info = {}'.format(ub.repr2(self.info, nl=1)))

```

### Example

```

>>> specs = [
>>>     'rgb',           # and rgb input
>>>     'rgb|disprity',  # rgb early fused with disparity
>>>     'rgb,disprity',  # rgb early late with disparity
>>>     'rgb|ir,disprity', # rgb early fused with ir and late fused with disparity
>>>     3,               # 3 unknown channels
>>> ]
>>> for spec in specs:
>>>     print('=====')
>>>     print('spec = {!r}'.format(spec))
>>>     #
>>>     self = ChannelSpec.coerce(spec)
>>>     print('self = {!r}'.format(self))
>>>     sizes = self.sizes()
>>>     print('sizes = {!r}'.format(sizes))
>>>     print('self.info = {}'.format(ub.repr2(self.info, nl=1)))
>>>     #
>>>     item = self._demo_item((1, 1), rng=0)
>>>     inputs = self.encode(item)
>>>     components = self.decode(inputs)
>>>     input_shapes = ub.map_vals(lambda x: x.shape, inputs)
>>>     component_shapes = ub.map_vals(lambda x: x.shape, components)
>>>     print('item = {}'.format(ub.repr2(item, precision=1)))
>>>     print('inputs = {}'.format(ub.repr2(inputs, precision=1)))
>>>     print('input_shapes = {}'.format(ub.repr2(input_shapes)))
>>>     print('components = {}'.format(ub.repr2(components, precision=1)))
>>>     print('component_shapes = {}'.format(ub.repr2(component_shapes, nl=1)))

```

**property** `spec(self)`

The string encoding of this spec

**Returns** str

**\_\_contains\_\_**(self, key)



**Example**

```
>>> 'disparity' in ChannelSpec('rgb,disparity,flowx|flowy')
True
>>> 'gray' in ChannelSpec('rgb,disparity,flowx|flowy')
False
```

**property** `info(self)`

**classmethod** `coerce(cls, data)`

Attempt to interpret the data as a channel specification

**Returns** ChannelSpec

**Example**

```
>>> from kwcoco.channel_spec import * # NOQA
>>> data = FusedChannelSpec.coerce(3)
>>> assert ChannelSpec.coerce(data).spec == 'u0|u1|u2'
>>> data = ChannelSpec.coerce(3)
>>> assert data.spec == 'u0|u1|u2'
>>> assert ChannelSpec.coerce(data).spec == 'u0|u1|u2'
>>> data = ChannelSpec.coerce('u:3')
>>> assert data.normalize().spec == 'u.0|u.1|u.2'
```

**parse(self)**

Build internal representation

**Example**

```
>>> from kwcoco.channel_spec import * # NOQA
>>> self = ChannelSpec('b1|b2|b3|rgb,B:3')
>>> print(self.parse())
>>> print(self.normalize().parse())
>>> ChannelSpec('').parse()
```

**Example**

```
>>> base = ChannelSpec('rgb|disparity,flowx|r|flowy')
>>> other = ChannelSpec('rgb')
>>> self = base.intersection(other)
>>> assert self.numel() == 4
```

**concise(self)**

### Example

```
>>> self = ChannelSpec('b1|b2,b3|rgb|B.0,B.1|B.2')
>>> print(self.concise().spec)
b1|b2,b3|r|g|b|B.0,B.1:3
```

#### **normalize**(self)

Replace aliases with explicit single-band-per-code specs

**Returns** normalized spec

**Return type** *ChannelSpec*

### Example

```
>>> self = ChannelSpec('b1|b2,b3|rgb,B:3')
>>> normed = self.normalize()
>>> print('self = {}'.format(self))
>>> print('normed = {}'.format(normed))
self = <ChannelSpec(b1|b2,b3|rgb,B:3)>
normed = <ChannelSpec(b1|b2,b3|r|g|b,B.0|B.1|B.2)>
```

#### **keys**(self)

#### **values**(self)

#### **items**(self)

#### **fuse**(self)

Fuse all parts into an early fused channel spec

**Returns** FusedChannelSpec

### Example

```
>>> from kwcoco.channel_spec import * # NOQA
>>> self = ChannelSpec.coerce('b1|b2,b3|rgb,B:3')
>>> fused = self.fuse()
>>> print('self = {}'.format(self))
>>> print('fused = {}'.format(fused))
self = <ChannelSpec(b1|b2,b3|rgb,B:3)>
fused = <FusedChannelSpec(b1|b2|b3|rgb|B:3)>
```

#### **streams**(self)

Breaks this spec up into one spec for each early-fused input stream

### Example

```
self = ChannelSpec.coerce('r|g,B1|B2,fx|fy') list(map(len, self.streams()))
```

**code\_list**(*self*)

**as\_path**(*self*)

Returns a string suitable for use in a path.

Note, this may no longer be a valid channel spec

**difference**(*self*, *other*)

Set difference. Remove all instances of other channels from this set of channels.

### Example

```
>>> from kwcoco.channel_spec import *
>>> self = ChannelSpec('rgb|disparity,flowx|r|flowy')
>>> other = ChannelSpec('rgb')
>>> print(self.difference(other))
>>> other = ChannelSpec('flowx')
>>> print(self.difference(other))
<ChannelSpec(disparity,flowx|flowy)>
<ChannelSpec(r|g|b|disparity,r|flowy)>
```

### Example

```
>>> from kwcoco.channel_spec import *
>>> self = ChannelSpec('a|b,c|d')
>>> new = self - {'a', 'b'}
>>> len(new.sizes()) == 1
>>> empty = new - 'c|d'
>>> assert empty.numel() == 0
```

**intersection**(*self*, *other*)

Set difference. Remove all instances of other channels from this set of channels.

### Example

```
>>> from kwcoco.channel_spec import *
>>> self = ChannelSpec('rgb|disparity,flowx|r|flowy')
>>> other = ChannelSpec('rgb')
>>> new = self.intersection(other)
>>> print(new)
>>> print(new.numel())
>>> other = ChannelSpec('flowx')
>>> new = self.intersection(other)
>>> print(new)
>>> print(new.numel())
<ChannelSpec(r|g|b,r)>
4
```

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```
<ChannelSpec(flowx)>
1
```

**union**(*self*, *other*)

Union simply tags on a second channel spec onto this one. Duplicates are maintained.

### Example

```
>>> from kwcoco.channel_spec import *
>>> self = ChannelSpec('rgb|disparity,flowx|r|flowy')
>>> other = ChannelSpec('rgb')
>>> new = self.union(other)
>>> print(new)
>>> print(new.numel())
>>> other = ChannelSpec('flowx')
>>> new = self.union(other)
>>> print(new)
>>> print(new.numel())
<ChannelSpec(r|g|b|disparity,flowx|r|flowy,r|g|b)>
10
<ChannelSpec(r|g|b|disparity,flowx|r|flowy,flowx)>
8
```

**abstract issubset**(*self*, *other*)

**abstract issuperset**(*self*, *other*)

**numel**(*self*)

Total number of channels in this spec

**sizes**(*self*)

Number of dimensions for each fused stream channel

IE: The EARLY-FUSED channel sizes

### Example

```
>>> self = ChannelSpec('rgb|disparity,flowx|flowy,B:10')
>>> self.normalize().concise()
>>> self.sizes()
```

**unique**(*self*, *normalize=False*)

Returns the unique channels that will need to be given or loaded

**\_item\_shapes**(*self*, *dims*)

Expected shape for an input item

**Parameters** *dims* (*Tuple[int, int]*) – the spatial dimension

**Returns** Dict[int, tuple]

`_demo_item(self, dims=(4, 4), rng=None)`

Create an input that satisfies this spec

#### Returns

an item like it might appear when its returned from the `__getitem__` method of a `torch...Dataset`.

Return type `dict`

#### Example

```
>>> dims = (1, 1)
>>> ChannelSpec.coerce(3)._demo_item(dims, rng=0)
>>> ChannelSpec.coerce('r|g|b|disaprity')._demo_item(dims, rng=0)
>>> ChannelSpec.coerce('rgb|disaprity')._demo_item(dims, rng=0)
>>> ChannelSpec.coerce('rgb,disaprity')._demo_item(dims, rng=0)
>>> ChannelSpec.coerce('rgb')._demo_item(dims, rng=0)
>>> ChannelSpec.coerce('gray')._demo_item(dims, rng=0)
```

`encode(self, item, axis=0, mode=1)`

Given a dictionary containing preloaded components of the network inputs, build a concatenated (fused) network representations of each input stream.

#### Parameters

- **item** (*Dict[str, Tensor]*) – a batch item containing unfused parts. each key should be a single-stream (optionally early fused) channel key.
- **axis** (*int, default=0*) – concatenation dimension

**Returns** mapping between input stream and its early fused tensor input.

**Return type** `Dict[str, Tensor]`

#### Example

```
>>> from kwcoco.channel_spec import * # NOQA
>>> import numpy as np
>>> dims = (4, 4)
>>> item = {
>>>     'rgb': np.random.rand(3, *dims),
>>>     'disparity': np.random.rand(1, *dims),
>>>     'flowx': np.random.rand(1, *dims),
>>>     'flowy': np.random.rand(1, *dims),
>>> }
>>> # Complex Case
>>> self = ChannelSpec('rgb,disparity,rgb|disparity|flowx|flowy,flowx|flowy')
>>> fused = self.encode(item)
>>> input_shapes = ub.map_vals(lambda x: x.shape, fused)
>>> print('input_shapes = {}'.format(ub.repr2(input_shapes, nl=1)))
>>> # Simpler case
>>> self = ChannelSpec('rgb|disparity')
>>> fused = self.encode(item)
```

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```
>>> input_shapes = ub.map_vals(lambda x: x.shape, fused)
>>> print('input_shapes = {}'.format(ub.repr2(input_shapes, nl=1)))
```

### Example

```
>>> # Case where we have to break up early fused data
>>> import numpy as np
>>> dims = (40, 40)
>>> item = {
>>>     'rgb|disparity': np.random.rand(4, *dims),
>>>     'flowx': np.random.rand(1, *dims),
>>>     'flowy': np.random.rand(1, *dims),
>>> }
>>> # Complex Case
>>> self = ChannelSpec('rgb,disparity,rgb|disparity,rgb|disparity|flowx|flowy,
↳ flowx|flowy,flowx,disparity')
>>> inputs = self.encode(item)
>>> input_shapes = ub.map_vals(lambda x: x.shape, inputs)
>>> print('input_shapes = {}'.format(ub.repr2(input_shapes, nl=1)))
```

```
>>> # xdoctest: +REQUIRES(--bench)
>>> #self = ChannelSpec('rgb|disparity,flowx|flowy')
>>> import timerit
>>> ti = timerit.Timerit(100, bestof=10, verbose=2)
>>> for timer in ti.reset('mode=simple'):
>>>     with timer:
>>>         inputs = self.encode(item, mode=0)
>>> for timer in ti.reset('mode=minimize-concat'):
>>>     with timer:
>>>         inputs = self.encode(item, mode=1)
```

**decode**(self, inputs, axis=1)

break an early fused item into its components

#### Parameters

- **inputs** (*Dict[str, Tensor]*) – dictionary of components
- **axis** (*int, default=1*) – channel dimension

### Example

```
>>> from kwcoco.channel_spec import * # NOQA
>>> import numpy as np
>>> dims = (4, 4)
>>> item_components = {
>>>     'rgb': np.random.rand(3, *dims),
>>>     'ir': np.random.rand(1, *dims),
>>> }
>>> self = ChannelSpec('rgb|ir')
```

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```

>>> item_encoded = self.encode(item_components)
>>> batch = {k: np.concatenate([v[None, :], v[None, :]], axis=0)
...         for k, v in item_encoded.items()}
>>> components = self.decode(batch)

```

### Example

```

>>> # xdoctest: +REQUIRES(module:netharn, module:torch)
>>> import torch
>>> import numpy as np
>>> dims = (4, 4)
>>> components = {
>>>     'rgb': np.random.rand(3, *dims),
>>>     'ir': np.random.rand(1, *dims),
>>> }
>>> components = ub.map_vals(torch.from_numpy, components)
>>> self = ChannelSpec('rgb|ir')
>>> encoded = self.encode(components)
>>> from netharn.data import data_containers
>>> item = {k: data_containers.ItemContainer(v, stack=True)
>>>         for k, v in encoded.items()}
>>> batch = data_containers.container_collate([item, item])
>>> components = self.decode(batch)

```

**component\_indices**(*self*, *axis*=2)

Look up component indices within fused streams

### Example

```

>>> dims = (4, 4)
>>> inputs = ['flowx', 'flowy', 'disparity']
>>> self = ChannelSpec('disparity,flowx|flowy')
>>> component_indices = self.component_indices()
>>> print('component_indices = {}'.format(ub.repr2(component_indices, nl=1)))
component_indices = {
    'disparity': ('disparity', (slice(None, None, None), slice(None, None,
↵None), slice(0, 1, None))),
    'flowx': ('flowx|flowy', (slice(None, None, None), slice(None, None, None),
↵slice(0, 1, None))),
    'flowy': ('flowx|flowy', (slice(None, None, None), slice(None, None, None),
↵slice(1, 2, None))),
}

```

**class** kwcoco.FusedChannelSpec(*parsed*, *\_is\_normalized*=False)

Bases: BaseChannelSpec

A specific type of channel spec with only one early fused stream.

The channels in this stream are non-communative

Behaves like a list of atomic-channel codes (which may represent more than 1 channel), normalized codes always represent exactly 1 channel.

---

**Note:** This class name and API is in flux and subject to change.

---

**Todo:** A special code indicating a name and some number of bands that that names contains, this would primarily be used for large numbers of channels produced by a network. Like:

```
resnet_d35d060_L5:512
```

or

```
resnet_d35d060_L5[:512]
```

might refer to a very specific (hashed) set of resnet parameters with 512 bands

maybe we can do something slicly like:

```
resnet_d35d060_L5[A:B] resnet_d35d060_L5:A:B
```

Do we want to “just store the code” and allow for parsing later?

Or do we want to ensure the serialization is parsed before we construct the data structure?

---

### Example

```
>>> from kwcoco.channel_spec import * # NOQA
>>> import pickle
>>> self = FusedChannelSpec.coerce(3)
>>> recon = pickle.loads(pickle.dumps(self))
>>> self = ChannelSpec.coerce('a|b,c|d')
>>> recon = pickle.loads(pickle.dumps(self))
```

`_alias_lut`

`_memo`

`_size_lut`

`__len__(self)`

`__getitem__(self, index)`

`classmethod concat(cls, items)`

`spec(self)`

The string encodeing of this spec

**Returns** str

`unique(self)`

`classmethod parse(cls, spec)`

`classmethod coerce(cls, data)`



### Example

```
>>> from kwcoco.channel_spec import * # NOQA
>>> FusedChannelSpec.coerce(['a', 'b', 'c'])
>>> FusedChannelSpec.coerce('a|b|c')
>>> FusedChannelSpec.coerce(3)
>>> FusedChannelSpec.coerce(FusedChannelSpec(['a']))
>>> assert FusedChannelSpec.coerce('').numel() == 0
```

#### **concise**(*self*)

Shorted the channel spec by de-normaliz slice syntax

**Returns** concise spec

**Return type** *FusedChannelSpec*

### Example

```
>>> from kwcoco.channel_spec import * # NOQA
>>> self = FusedChannelSpec.coerce(
>>>     'b|a|a.0|a.1|a.2|a.5|c|a.8|a.9|b.0:3|c.0')
>>> short = self.concise()
>>> long = short.normalize()
>>> numels = [c.numel() for c in [self, short, long]]
>>> print('self.spec = {!r}'.format(self.spec))
>>> print('short.spec = {!r}'.format(short.spec))
>>> print('long.spec = {!r}'.format(long.spec))
>>> print('numels = {!r}'.format(numels))
self.spec = 'b|a|a.0|a.1|a.2|a.5|c|a.8|a.9|b.0:3|c.0'
short.spec = 'b|a|a:3|a.5|c|a.8:10|b:3|c.0'
long.spec = 'b|a|a.0|a.1|a.2|a.5|c|a.8|a.9|b.0|b.1|b.2|c.0'
numels = [13, 13, 13]
>>> assert long.concise().spec == short.spec
```

#### **normalize**(*self*)

Replace aliases with explicit single-band-per-code specs

**Returns** normalize spec

**Return type** *FusedChannelSpec*

### Example

```
>>> from kwcoco.channel_spec import * # NOQA
>>> self = FusedChannelSpec.coerce('b1|b2|b3|rgb')
>>> normed = self.normalize()
>>> print('self = {}'.format(self))
>>> print('normed = {}'.format(normed))
self = <FusedChannelSpec(b1|b2|b3|rgb)>
normed = <FusedChannelSpec(b1|b2|b3|r|g|b)>
>>> self = FusedChannelSpec.coerce('B:1:11')
>>> normed = self.normalize()
```

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(continued from previous page)

```

>>> print('self = {}'.format(self))
>>> print('normed = {}'.format(normed))
self = <FusedChannelSpec(B:1:11)>
normed = <FusedChannelSpec(B.1|B.2|B.3|B.4|B.5|B.6|B.7|B.8|B.9|B.10)>
>>> self = FusedChannelSpec.coerce('B.1:11')
>>> normed = self.normalize()
>>> print('self = {}'.format(self))
>>> print('normed = {}'.format(normed))
self = <FusedChannelSpec(B.1:11)>
normed = <FusedChannelSpec(B.1|B.2|B.3|B.4|B.5|B.6|B.7|B.8|B.9|B.10)>

```

**numel**(self)

Total number of channels in this spec

**sizes**(self)

Returns a list indicating the size of each atomic code

**Returns** List[int]

### Example

```

>>> from kwcoco.channel_spec import * # NOQA
>>> self = FusedChannelSpec.coerce('b1|Z:3|b2|b3|rgb')
>>> self.sizes()
[1, 3, 1, 1, 3]
>>> assert(FusedChannelSpec.parse('a.0').numel()) == 1
>>> assert(FusedChannelSpec.parse('a:0').numel()) == 0
>>> assert(FusedChannelSpec.parse('a:1').numel()) == 1

```

**\_\_contains\_\_**(self, key)

### Example

```

>>> FCS = FusedChannelSpec.coerce
>>> 'disparity' in FCS('rgb|disparity|flowx|flowy')
True
>>> 'gray' in FCS('rgb|disparity|flowx|flowy')
False

```

**code\_list**(self)

Return the expanded code list

**as\_list**(self)**as\_oset**(self)**as\_set**(self)**as\_path**(self)

Returns a string suitable for use in a path.

Note, this may no longer be a valid channel spec

`__set__(self)`

`difference(self, other)`

Set difference

### Example

```
>>> FCS = FusedChannelSpec.coerce
>>> self = FCS('rgb|disparity|flowx|flowy')
>>> other = FCS('r|b')
>>> self.difference(other)
>>> other = FCS('flowx')
>>> self.difference(other)
>>> FCS = FusedChannelSpec.coerce
>>> assert len((FCS('a') - {'a'}).parsed) == 0
>>> assert len((FCS('a.0:3') - {'a.0'}).parsed) == 2
```

`intersection(self, other)`

### Example

```
>>> FCS = FusedChannelSpec.coerce
>>> self = FCS('rgb|disparity|flowx|flowy')
>>> other = FCS('r|b|XX')
>>> self.intersection(other)
```

`union(self, other)`

### Example

```
>>> from kwcoco.channel_spec import * # NOQA
>>> FCS = FusedChannelSpec.coerce
>>> self = FCS('rgb|disparity|flowx|flowy')
>>> other = FCS('r|b|XX')
>>> self.union(other)
```

`issubset(self, other)`

`issuperset(self, other)`

`component_indices(self, axis=2)`

Look up component indices within this stream

### Example

```
>>> FCS = FusedChannelSpec.coerce
>>> self = FCS('disparity|rgb|flowx|flowy')
>>> component_indices = self.component_indices()
>>> print('component_indices = {}'.format(ub.repr2(component_indices, nl=1)))
component_indices = {
    'disparity': (slice(...), slice(...), slice(0, 1, None)),
    'flowx': (slice(...), slice(...), slice(4, 5, None)),
    'flowy': (slice(...), slice(...), slice(5, 6, None)),
    'rgb': (slice(...), slice(...), slice(1, 4, None)),
}
```

**streams**(*self*)

Idempotence with [ChannelSpec.streams\(\)](#)

**fuse**(*self*)

Idempotence with [ChannelSpec.streams\(\)](#)

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