Intake Documentation

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Anaconda

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Documentation Contents

Taking the pain out of data access and distribution

Intake is a lightweight package for finding, investigating, loading and disseminating data. It will appeal to different groups for some of the reasons below, but is useful for all and acts as a common platform that everyone can use to smooth the progression of data from developers and providers to users.

CHAPTER 1

Data User

- Intake loads the data for a range of formats and types (see *Plugin Directory*) into containers you already use, like Pandas dataframes, Python lists, NumPy arrays, and more
- Intake loads, and gets out of your way
- GUI, search and introspect data-sets in *Catalogs*: quickly find what you need to do your work
- Install data-sets and automatically get requirements
- Leverage cloud resources and distributed computing.

CHAPTER 2

Data Provider

- Simple spec to define data sources
- Single point-of truth, no more copy&paste
- Distribute data using packages, shared files or a server
- Update definitions in-place
- Parametrise user options
- Make use of additional functionality like filename parsing and caching.

CHAPTER 3

IT

- Create catalogs out of established departmental practices
- Provide data access credentials via Intake parameters
- Use server-client architecture as gatekeeper:
  - add authentication methods
  - add monitoring point; track the data-sets being accessed.
- Hook Intake into proprietary data access systems.

CHAPTER 4

Developer

- Turn boilerplate code into a reusable *Driver*
- Pluggable architecture of Intake allows for many points to add and improve
- Open, simple code-base, come and get involved on github!

CHAPTER 5

First steps

For a brief demonstration and tutorial, which you can execute locally, go to *Quickstart*. For a general description of all of the components of Intake and how they fit together, fo to *Overview*. Finally, for some notebooks using Intake and articles about Intake, go to *Examples*. These and other documentation pages will make reference to concepts that are defined in the *Glossary*.

5.1 Quickstart

This guide will show you how to get started using Intake to read data, and give you a flavour of how Intake feels to the *Data User*. It assumes you are working in either a conda or a virtualenv/pip environment. For notebooks with executable code, see the *Examples*. This walk-through can be run from a notebook or interactive python session.

5.1.1 Installation

If you are using Anaconda or Miniconda, install Intake with the following commands:

```
conda install -c conda-forge intake
```

If you are using virtualenv/pip, run the following command:

```
pip install intake
```

5.1.2 Creating Sample Data

Let's begin by creating a sample data set and catalog. At the command line, run the `intake example` command. This will create an example data *Catalog* and two CSV data files. These files contains some basic facts about the 50 US states, and the catalog includes a specification of how to load them.

5.1.3 Loading a Data Source

Data sources can be created directly with the `open_*()` functions in the `intake` module. To read our example data:

```
>>> import intake
>>> ds = intake.open_csv('states_*.csv')
>>> print(ds)
<intake.source.csv.CSVSource object at 0x1163882e8>
```

Each open function has different arguments, specific for the data format or service being used.

5.1.4 Reading Data

Intake reads data into memory using *containers* you are already familiar with:

- Tables: Pandas DataFrames
- Multidimensional arrays: NumPy arrays
- Semistructred data: Python lists of objects (usually dictionaries)

To find out what kind of container a data source will produce, inspect the `container` attribute:

```
>>> ds.container
'dataframe'
```

The result will be `dataframe`, `ndarray`, or `python`. (New container types will be added in the future.)

For data that fits in memory, you can ask Intake to load it directly:

```
>>> df = ds.read()
>>> df.head()
        state        slug code                 nickname  ...
0     Alabama     alabama   AL      Yellowhammer State
1      Alaska      alaska   AK       The Last Frontier
2     Arizona     arizona   AZ  The Grand Canyon State
3    Arkansas    arkansas   AR       The Natural State
4  California  california   CA            Golden State
```

Many data sources will also have quick-look plotting available. The attribute `.plot` will list a number of built-in plotting methods, such as `.scatter()`, see *Plotting*.

Intake data sources can have *partitions*. A partition refers to a contiguous chunk of data that can be loaded independent of any other partition. The partitioning scheme is entirely up to the plugin author. In the case of the CSV plugin, each `.csv` file is a partition.

To read data from a data source one chunk at a time, the `read_chunked()` method returns an iterator:

```
>>> for chunk in ds.read_chunked(): print('Chunk: %d' % len(chunk))
...
Chunk: 24
Chunk: 26
```

5.1.5 Working with Dask

Working with large datasets is much easier with a parallel, out-of-core computing library like Dask. Intake can create Dask containers (like `dask.dataframe`) from data sources that will load their data only when required:

```
>>> ddf = ds.to_dask()
>>> ddf
Dask DataFrame Structure:
            admission_date admission_number capital_city capital_url    code␣
↪constitution_url facebook_url landscape_background_url map_image_url nickname␣
↪population population_rank skyline_background_url    slug   state state_flag_url␣
↪state_seal_url twitter_url website
npartitions=2
                    object            int64       object      object  object          ␣
↪ object       object                   object        object   object      int64     ␣
↪       int64                 object  object  object         object          object   ␣
↪  object  object
                         ...              ...          ...          ...     ...        ␣
↪     ...          ...                      ...          ...      ...        ...    ␣
↪         ...                     ...     ...     ...            ...            ...  ␣
↪      ...     ...
                         ...              ...          ...          ...     ...        ␣
↪     ...          ...                      ...          ...      ...        ...    ␣
↪         ...                     ...     ...     ...            ...            ...  ␣
↪      ...     ...
Dask Name: from-delayed, 4 tasks
```

The Dask containers will be partitioned in the same way as the Intake data source, allowing different chunks to be processed in parallel. Please read the Dask documentation to understand the differences when working with Dask collections (Bag, Array or Data-frames).

5.1.6 Opening a Catalog

It is often useful to move the descriptions of data sources out of your code and into a specification file that can be reused and shared with other projects and people. Intake calls this a "*Catalog*", which contains a list of named entries describing how to load data sources. The `intake example` command, above, created a catalog file with the following *YAML*-syntax content:

```
sources:
  states
    description: US state information from [CivilServices](https://civil.services/)
    driver: csv
    args:
      urlpath: '{{ CATALOG_DIR }}/states_*.csv'
    metadata:
      origin_url: 'https://github.com/CivilServiceUSA/us-states/blob/v1.0.0/data/
↪states.csv'
```

To load a catalog from a catalog file:

```
>>> cat = intake.open_catalog('us_states.yml')
>>> list(cat)
['states']
```

This catalog contains one data source, called `states`. It can be accessed by attribute:

```
>>> cat.states.to_dask()[['state','slug']].head()
        state        slug
0     Alabama     alabama
1      Alaska      alaska
2     Arizona     arizona
3    Arkansas    arkansas
4  California  california
```

Placing data source specifications into a catalog like this enables declaring data sets in a single canonical place, and not having to use boilerplate code in each notebook/script that makes use of the data. The catalogs can also reference one-another, be stored remotely, and include extra metadata such as a set of named quick-look plots that are appropriate for the particular data source.

Note that, if you are *creating* such catalogs, you may well start by trying the `open_csv` command, above, and then use `print(ds.yaml())`. If you do this now, you will see that the output is very similar to the catalog file we have provided.

5.1.7 Installing Data Source Packages with Conda

Intake makes it possible to create *conda packages* that install data sources into a global catalog. For example, we can install a data package containing the same data we have been working with:

```
conda install -c intake data-us-states
```

Conda installs the catalog file in this package to `$CONDA_PREFIX/share/intake/us_states.yml`. Now, when we import `intake`, we will see the data from this package appear as part of a global catalog called `intake.cat`. In this particular case we use Dask to do the reading (which can handle larger-than-memory data and parallel processing), but `read()` would work also:

```
>>> import intake
>>> intake.cat.states.to_dask()[['state','slug']].head()
        state        slug
0     Alabama     alabama
1      Alaska      alaska
2     Arizona     arizona
3    Arkansas    arkansas
4  California  california
```

The global catalog is a union of all catalogs installed in the conda/virtualenv environment and also any catalogs installed in user-specific locations.

Adding Data Source Packages using the Intake path

Intake checks the Intake config file for `catalog_path` or the environment variable `"INTAKE_PATH"` for a colon separated list of paths (semicolon on windows) to search for catalog files. When you import `intake` we will see all entries from all of the catalogues referenced as part of a global catalog called `intake.cat`.

5.1.8 Using the GUI

A graphical data browser is available in the Jupyter notebook environment. It will show the contents of any installed catalogs, plus allows for selecting local and remote catalogs, to browse and select entries from these. See *GUI*.

5.2 Overview

5.2.1 Introduction

This page describes the technical design of Intake, with brief details of the aims of the project and components of the library

5.2.2 Why Intake?

Intake solves a related set of problems:

- Python API standards for loading data (such as DB-API 2.0) are optimized for transactional databases and query results that are processed one row at a time.
- Libraries that do load data in bulk tend to each have their own API for doing so, which adds friction when switching data formats.
- Loading data into a distributed data structure (like those found in Dask and Spark) often require writing a separate loader.
- Abstractions often focus on just one data model (tabular, n-dimensional array, or semi-structured), when many projects need to work with multiple kinds of data.

Intake has the explicit goal of **not** defining a computational expression system. Intake plugins load the data into containers (e.g., arrays or data-frames) that provide their data processing features. As a result, it is very easy to make a new Intake plugin with a relatively small amount of Python.

5.2.3 Structure

Intake is a Python library for accessing data in a simple and uniform way. It consists of three parts:

1. A lightweight plugin system for adding data loader *drivers* for new file formats and servers (like databases, REST endpoints or other cataloging services)

2. A cataloging system for specifying these sources in simple *YAML* syntax, or with plugins that read source specs from some external data service

3. A server-client architecture that can share data catalog metadata over the network, or even stream the data directly to clients if needed

Intake supports loading data into standard Python containers. The list can be easily extended, but the currently supported list is:

- Pandas Dataframes - tabular data
- NumPy Arrays - tensor data
- Python lists of dictionaries - semi-structured data

Additionally, Intake can load data into distributed data structures. Currently it supports Dask, a flexible parallel computing library with distributed containers like dask.dataframe, dask.array, and dask.bag. In the future, other distributed computing systems could use Intake to create similar data structures.

5.2.4 Concepts

Intake is built out of four core concepts:

- Data Source classes: the "driver" plugins that each implement loading of some specific type of data into python, with plugin-specific arguments.
- Data Source: An object that represents a reference to a data source. Data source objects have methods for loading the data into standard containers, like Pandas DataFrames, but do not load any data until specifically requested.
- Catalog: A collection of catalog entries, each of which defines a Data Source. Catalog objects can be created from local YAML definitions, by connecting to remote servers, or by some driver that knows how to query an external data service.
- Catalog Entry: A named data source. The catalog entry includes metadata about the source, as well as the name of the driver and arguments. Arguments can be parameterized, allowing one entry to return different subsets of data depending on the user request.

The business of a plugin is to go from some data format (bunch of files or some remote service) to a "*Container*" of the data (e.g., data-frame), a thing on which you can perform further analysis. Drivers can be used directly by the user, or indirectly through data catalogs. Data sources can be pickled, sent over the network to other hosts, and reopened (assuming the remote system has access to the required files or servers).

See also the *Glossary*.

5.2.5 Future Directions

Ongoing work for enhancements, as well as requests for plugins, etc., can be found at the issue tracker. See the *Roadmap* for general mid- and long-term goals.

5.3 Examples

Here we list links to notebooks and other code demonstrating the use of Intake in various scenarios. The first section is of general interest to various users, and the sections that follow tend to be more specific about particular features and workflows.

Many of the entries here include a link to Binder, which a service that lest you execute code live in a notebook environment. This is a great way to experience using Intake. It can take a while, sometimes, for Binder to come up, please have patience.

See also the example data page, containing data-sets which can be built and installed as conda packages.

5.3.1 General

- Basic Data scientist workflow: using Intake [Static] [Executable].
- Workflow for creating catalogs: a Data Engineer's approach to Intake [Static] [Executable]

5.3.2 Developer

Tutorials delving deeper into the Internals of Intake, for those who wish to contribute

- How you would go about writing a new plugin [Static] [Executable]

5.3.3 Features

More specific examples of Intake functionality

- Caching:
  - Using automatically cached of data-files [Static] [Executable]
  - Earth science demonstration of cached dataset [Static] [Executable]
- File-name pattern parsing:
  - Satellite imagery, science workflow [Static] [Executable]
  - How to set up pattern parsing [Static] [Executable]

5.3.4 Blogs

These are Intake-related articles that may be of interest.

- Taking the Pain out of Data Access
- Caching Data on First Read Makes Future Analysis Faster
- Parsing Data from Filenames and Paths
- Intake for cataloguing Spark
- Intake released on Conda-Forge

5.3.5 Talks

- PyData DC (November 2018)
- PyData NYC (October 2018)
- ESIP tech dive (November 2018)

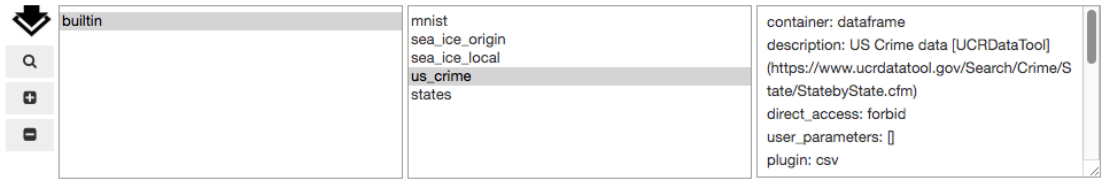
5.4 GUI

5.4.1 Using the Data Browser

Note: the data browser requires `ipywidgets` to be available in the current environment

The Intake top-level singleton `intake.gui` gives access to a graphical data browser within the Jupyter notebook. To expose it, simply enter it into a code cell (Jupyter automatically display the last object in a code cell).

```
In [1]: import intake
In [2]: intake.gui
```




```
In [3]: intake.gui.item
Out[3]: <Catalog Entry: us_crime>
In [4]: intake.gui.item.read()
Out[4]:
```

	Year	Population	Violent crime total	Murder and nonnegligent Manslaughter	Legacy rape /1	Revised rape /2	Robbery	Aggravated assault	Property crime total	Burglary	...	Violent Crime rate	Murder and nonnegligent manslaughter rate	Legacy rape rate /1	Revised rape rate /2	Robbe ra
0	1960	179323175	288460	9110	17190	NaN	107840	154320	3095700	912100	...	160.9	5.1	9.6	NaN	6
1	1961	182992000	289390	8740	17220	NaN	106670	156760	3198600	949600	...	158.1	4.8	9.4	NaN	5

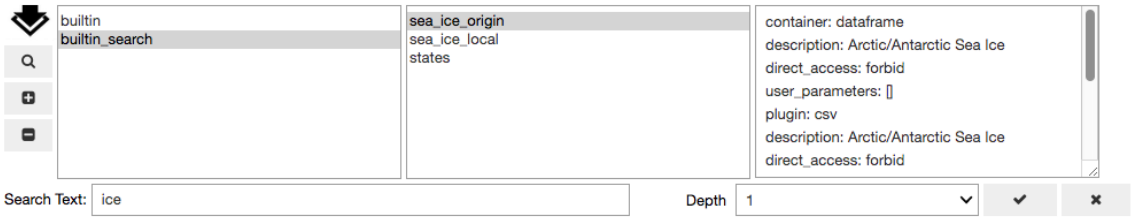
New instances of the GUI are also available by instantiating `intake.DataBrowser`, where you can specify a set of catalogs to initially include.

The GUI contains:

- a list of catalogs. The "builtin" catalog, displayed by default, includes data-sets installed in the system, the same as `intake.cat`.
- a list of entries within the currently-selected catalog. Entries marked with `" ->"` are themselves catalogs, clicking them will load the catalog and update the left-hand listing. Clicking any other entry will display some basic information in the right-hand text box.
- The following controls:
  - Search: opens a sub-panel for finding entries in the currently-selected catalog (and it's sub-catalogs)
  - Add: opens a sub-panden for adding catalogs to the interface, by either browsing for a local YAML file or by entering a URL for a catalog, which can be a remote file or Intake server
  - Remove: delete the currently-selected catalog from the list

Search

```
In [2]: intake.gui
```

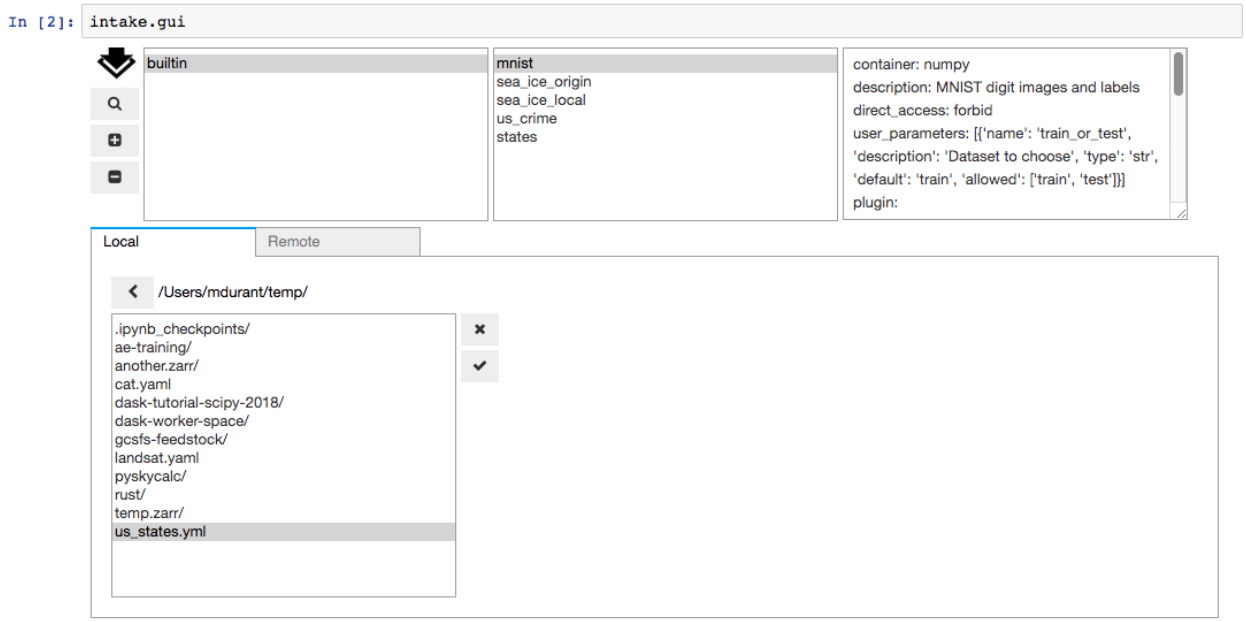


The sub-panel opened by the Search button allows for the entry of free-form text. Upon execution of the search with the check button, the currently-selected catalog will be searched. Entries will be considered to match if any of the entered words is found in the description of the entry (and this is case-insensitive). If any entries match, a new entry will be made in the catalog list, with the suffix "_search".

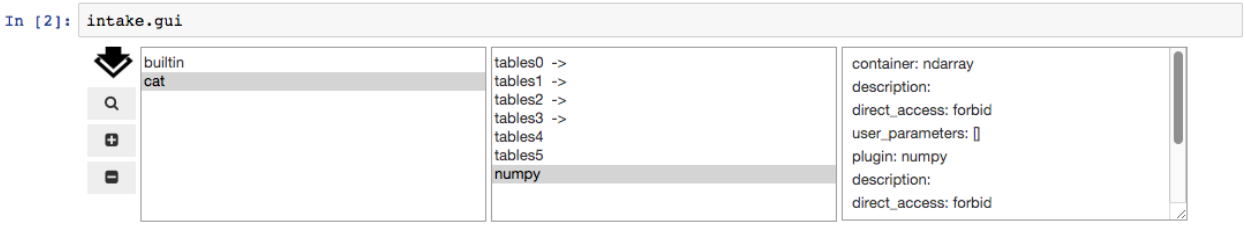
Some catalogs can contain nested sub-catalogs. The Depth selector allows the search to be limited to the stated number of nesting levels. This may be necessary, since, in theory, catalogs can contain circular references, and therefore allow for infinite recursion.

Add Catalogs

The Add button exposes a sub-panel with two main ways to add catalogs to the interface



A *file selector*. Use the folder icon to open this below the main GUI. You can navigate around the filesystem, and select the catalog file you need. Use the tick icon to accept the selection, or the cross button to close the selector without accepting the selection. If accepted, the catalog will appear in the listing, unless parsing of the file fails:



A *URL editor*. Any URL is valid here, including cloud locations, `"gcs://bucket/..."`, and intake servers, `"intake://server:port"`. Without a protocol specifier, this can be a local path. Again, use the check button to accept the value, and attempt to load the file into the interface's catalogs list.

Finally, you can add catalogs to the interface in code, using the `.add_cat()` method, which can take filenames, remote URLs or an existing `Catalog` instance.

5.4.2 Using the Selection

Once catalogs are loaded and the correct entry has been identified and selected, the item in question will be available as the `.item` attribute (`intake.gui.item`), which has informational methods available and can be opened as a data source, as with any catalog entry:

```
In [ ]: intake.gui.item.describe_open()
Out   : {'plugin': 'csv',
         'description': 'Arctic/Antarctic Sea Ice',
         'direct_access': 'forbid',
         'metadata': {},
         'args': {'urlpath': 'https://timeseries.weebly.com/uploads/2/1/0/8/21086414/
↪sea_ice.csv',
         'metadata': {}}}

In [ ]: s = intake.gui.item()  # may specify parameters here
        s.read()
Out   : < some data >

In [ ]: intake.gui.item.plot()  # or skip data source step
Out   : < graphics>
```

5.5 API

Auto-generated reference

5.5.1 End User

These are reference class and function definitions likely to be useful to everyone.

intake.open_catalog([uri])	Create a Catalog object
intake.registry	
*intake.open_*	
intake.source.csv.CSVSource(urlpath[, ...])	Read CSV files into dataframes
intake.source.textfiles.TextFilesSource(urlpath)	Read textfiles as sequence of lines

Continued on next page

Table 1 – continued from previous page

intake.source.npy.NPySource(path[, dtype, ...])	Read numpy binary files into an array
intake.source.zarr.ZarrArraySource(url[, ...])	Read Zarr format files into an array
intake.catalog.local.YAMLFileCatalog(path, ...)	Catalog as described by a single YAML file
intake.catalog.local.YAMLFilesCatalog(path)	Catalog as described by a multiple YAML files
intake.gui.DataBrowser([cats])	Intake data set browser

intake.**open_catalog**(*uri=None*, ***kwargs*)

Create a Catalog object

Can load YAML catalog files, connect to an intake server, or create any arbitrary Catalog subclass instance. In the general case, the user should supply `driver=` with a value from the plugins registry which has a container type of catalog. File locations can generally be remote, if specifying a URL protocol.

The default behaviour if not specifying the driver is as follows:

- if `uri` is a a single string ending in "yml" or "yaml", open it as a catalog file
- if `uri` is a list of strings, a string containing a glob character ("*") or a string not ending in "y(a)ml", open as a set of catalog files. In the latter case, assume it is a directory.
- if `uri` beings with protocol `"intake:"`, connect to a remote Intake server
- otherwise, create a base Catalog object without entries.

Parameters

uri: str Designator for the location of the catalog.

kwargs: passed to subclass instance, see documentation of the individual catalog classes. For example, `yaml_files_cat` (when specifying multiple uris or a glob string) takes the additional parameter `flatten=True|False`, specifying whether all data sources are merged in a single namespace, or each file becomes a sub-catalog.

See also:

`intake.open_yaml_files_cat`, `intake.open_yaml_file_cat`, `intake.open_intake_remote`

intake.**registry**

Mapping from plugin names to the DataSource classes that implement them. These are the names that should appear in the `driver:` key of each source definition in a catalog. See *Plugin Directory* for more details.

intake.**open_**

Set of functions, one for each plugin, for direct opening of a data source. The names are derived from the names of the plugins in the registry at import time.

class intake.source.csv.**CSVSource**(*urlpath*, *csv_kwargs=None*, *metadata=None*, *storage_options=None*, *path_as_pattern=True*)

Read CSV files into dataframes

Prototype of sources reading dataframe data

__init__(*urlpath*, *csv_kwargs=None*, *metadata=None*, *storage_options=None*, *path_as_pattern=True*)

Parameters

urlpath [str or iterable, location of data] May be a local path, or remote path if including a protocol specifier such as `'s3://'`. May include glob wildcards or format pattern strings. Some examples:

- `{{ CATALOG_DIR }}data/precipitation.csv`
- `s3://data/*.csv`
- `s3://data/precipitation_{state}_{zip}.csv`
- `s3://data/{year}/{month}/{day}/precipitation.csv`
- `{{ CATALOG_DIR }}data/precipitation_{date:%Y-%m-%d}.csv`

csv_kwargs [dict] Any further arguments to pass to Dask's read_csv (such as block size) or to the CSV parser in pandas (such as which columns to use, encoding, data-types)

storage_options [dict] Any parameters that need to be passed to the remote data backend, such as credentials.

path_as_pattern [bool or str, optional] Whether to treat the path as a pattern (ie. `data_{field}.csv`) and create new columns in the output corresponding to pattern fields. If str, is treated as pattern to match on. Default is True.

discover()
Open resource and populate the source attributes.

read()
Load entire dataset into a container and return it

read_partition(*i*)
Return a part of the data corresponding to i-th partition.

By default, assumes i should be an integer between zero and npartitions; override for more complex indexing schemes.

to_dask()
Return a dask container for this data source

class intake.source.zarr.**ZarrArraySource**(*url*, *storage_options=None*, *component=None*, *metadata=None*, ***kwargs*)

Read Zarr format files into an array

Zarr is an numerical array storage format which works particularly well with remote and parallel access. For specifics of the format, see https://zarr.readthedocs.io/en/stable/

__init__(*url*, *storage_options=None*, *component=None*, *metadata=None*, ***kwargs*)
The parameters dtype and shape will be determined from the first file, if not given.

Parameters

url [str] Location of data file(s), possibly including and protocol information

storage_options [dict] Passed on to storage backend for remote files

component [str or None] If None, assume the URL points to an array store. If given, assume it is a group, and descend the group to find the array at this location in the data-set.

kwargs [passed on to zarr]

discover()
Open resource and populate the source attributes.

read()
Load entire dataset into a container and return it

read_partition(*i*)
Return a part of the data corresponding to i-th partition.

By default, assumes i should be an integer between zero and npartitions; override for more complex indexing schemes.

to_dask()
Return a dask container for this data source

class intake.source.textfiles.**TextFilesSource**(*urlpath*, *text_mode=True*, *text_encoding='utf8'*, *compression=None*, *decoder=None*, *read=True*, *metadata=None*, *storage_options=None*)

Read textfiles as sequence of lines

Protype of sources reading sequential data.

Takes a set of files, and returns an iterator over the text in each of them. The files can be local or remote. Extra parameters for encoding, etc., go into `storage_options`.

__init__(*urlpath*, *text_mode=True*, *text_encoding='utf8'*, *compression=None*, *decoder=None*, *read=True*, *metadata=None*, *storage_options=None*)

Parameters

urlpath [str or list(str)] Target files. Can be a glob-path (with "*") and include protocol specified (e.g., "s3://"). Can also be a list of absolute paths.

text_mode [bool] Whether to open the file in text mode, recoding binary characters on the fly

text_encoding [str] If text_mode is True, apply this encoding. UTF* is by far the most common

compression [str or None] If given, decompress the file with the given codec on load. Can be something like "gz", "bz2", or to try to guess from the filename, 'infer'

decoder [function, str or None] Use this to decode the contents of files. If None, you will get a list of lines of text/bytes. If a function, it must operate on an open file-like object or a bytes/str instance, and return a list

read [bool] If decoder is not None, this flag controls whether bytes/str get passed to the function indicated (True) or the open file-like object (False)

storage_options: dict Options to pass to the file reader backend, including text-specific encoding arguments, and parameters specific to the remote file-system driver, if using.

discover()
Open resource and populate the source attributes.

read()
Load entire dataset into a container and return it

read_partition(*i*)
Return a part of the data corresponding to i-th partition.

By default, assumes i should be an integer between zero and npartitions; override for more complex indexing schemes.

to_dask()
Return a dask container for this data source

class intake.source.npy.**NPySource**(*path*, *dtype=None*, *shape=None*, *chunks=None*, *storage_options=None*, *metadata=None*)

Read numpy binary files into an array

Prototype source showing example of working with arrays

Each file becomes one or more partitions, but partitioning within a file is only along the largest dimension, to ensure contiguous data.

__init__(*path*, *dtype=None*, *shape=None*, *chunks=None*, *storage_options=None*, *metadata=None*)

The parameters dtype and shape will be determined from the first file, if not given.

Parameters

path: str of list of str Location of data file(s), possibly including glob and protocol information

dtype: str dtype spec In known, the dtype (e.g., "int64" or "f4").

shape: tuple of int If known, the length of each axis

chunks: int Size of chunks within a file along biggest dimension - need not be an exact factor of the length of that dimension

storage_options: dict Passed to file-system backend.

discover()

Open resource and populate the source attributes.

read()

Load entire dataset into a container and return it

read_partition(*i*)

Return a part of the data corresponding to i-th partition.

By default, assumes i should be an integer between zero and npartitions; override for more complex indexing schemes.

to_dask()

Return a dask container for this data source

class intake.catalog.local.**YAMLFileCatalog**(*path*, ***kwargs*)

Catalog as described by a single YAML file

__init__(*path*, ***kwargs*)

Parameters

path: str Location of the file to parse (can be remote)

reload()

Reload catalog if sufficient time has passed

walk(*sofar=None*, *prefix=None*, *depth=2*)

Get all entries in this catalog and sub-catalogs

Parameters

sofar: dict or None Within recursion, use this dict for output

prefix: list of str or None Names of levels already visited

depth: int Number of levels to descend; needed to truncate circular references and for cleaner output

Returns

Dict where the keys are the entry names in dotted syntax, and the

values are entry instances.

class intake.catalog.local.**YAMLFilesCatalog**(*path*, *flatten=True*, ***kwargs*)
Catalog as described by a multiple YAML files

__init__(*path*, *flatten=True*, ***kwargs*)

Parameters

path: str Location of the files to parse (can be remote), including possible glob (*) character(s). Can also be list of paths, without glob characters.

flatten: bool (True) Whether to list all entries in the cats at the top level (True) or create sub-cats from each file (False).

reload()
Reload catalog if sufficient time has passed

walk(*sofar=None*, *prefix=None*, *depth=2*)
Get all entries in this catalog and sub-catalogs

Parameters

sofar: dict or None Within recursion, use this dict for output

prefix: list of str or None Names of levels already visited

depth: int Number of levels to descend; needed to truncate circular references and for cleaner output

Returns

Dict where the keys are the entry names in dotted syntax, and the

values are entry instances.

class intake.gui.**DataBrowser**(*cats=None*)
Intake data set browser

Examples

Display GUI in a notebook thus:

```
>>> gui = intake.gui.widgets.DataBrowser()
>>> gui.widget
```

Optionally you can specify some Catalog instances to begin with. If none are given, will use the default one, `intake.cat`.

After interacting, the value of `gui.item` will be the entry selected.

add_cat(*ev=None*)
Add catalog instance to the browser

Also called, without a catalog instance, when the (+) button is pressed, which will attempt to read a catalog and, if successful, add it to the browser.

file_chosen(*fn*)
Callback from AddCat panel

5.5.2 Base Classes

This is a reference API class listing, useful mainly for developers.

intake.source.base.DataSource([metadata])	An object which can produce data
intake.source.base.PatternMixin	Helper class to provide file-name parsing abilities to a driver class
intake.source.base.AliasSource(target[, ...])	Refer to another named source, unmodified
intake.container.base.RemoteSource(url, ...)	Base class for all DataSources living on an Intake server
intake.catalog.Catalog(*args[, name, ...])	Manages a hierarchy of data sources as a collective unit.
intake.catalog.entry.CatalogEntry([getenv, ...])	A single item appearing in a catalog
intake.catalog.local.UserParameter(name, ...)	A user-settable item that is passed to a DataSource upon instantiation.
intake.auth.base.BaseAuth(*args)	Base class for authorization
intake.source.cache.BaseCache(driver, spec)	Provides utilities for managing cached data files.
intake.source.base.Schema(**kwargs)	Holds details of data description for any type of data-source
intake.container.persist.PersistStore([path])	Specialised catalog for persisted data-sources

class intake.source.base.**DataSource**(*metadata=None*)

An object which can produce data

This is the base class for all Intake plugins, including catalogs and remote (server) data objects. To produce a new plugin commonly involves subclassing this definition and overriding some or all of the methods.

This class is not useful in itself, most methods raise NotImplemented.

plot

Accessor for HVPlot methods. See *Plotting* for more details.

close()

Close open resources corresponding to this data source.

discover()

Open resource and populate the source attributes.

hvplot

Returns a hvPlot object to provide a high-level plotting API.

persist(*ttl=None*, ***kwargs*)

Save data from this source to local persistent storage

plot

Returns a hvPlot object to provide a high-level plotting API.

To display in a notebook, be sure to run `intake.output_notebook()` first.

plots

List custom associated quick-plots

read()

Load entire dataset into a container and return it

read_chunked()
Return iterator over container fragments of data source

read_partition(*i*)
Return a part of the data corresponding to i-th partition.

By default, assumes i should be an integer between zero and npartitions; override for more complex indexing schemes.

to_dask()
Return a dask container for this data source

to_spark()
Provide an equivalent data object in Apache Spark

The mapping of python-oriented data containers to Spark ones will be imperfect, and only a small number of drivers are expected to be able to produce Spark objects. The standard arguments may b translated, unsupported or ignored, depending on the specific driver.

This method requires the package intake-spark

yaml(*with_plugin=False*)
Return YAML representation of this data-source

The output may be roughly appropriate for inclusion in a YAML catalog. This is a best-effort implementation

Parameters

with_plugin: bool If True, create a "plugins" section, for cases where this source is created with a plugin not expected to be in the global Intake registry.

class intake.catalog.**Catalog**(**args*, *name=None*, *metadata=None*, *auth=None*, *ttl=1*, *getenv=True*, *getshell=True*, *persist_mode='default'*, *storage_options=None*)
Manages a hierarchy of data sources as a collective unit.

A catalog is a set of available data sources for an individual entity (remote server, local file, or a local directory of files). This can be expanded to include a collection of subcatalogs, which are then managed as a single unit.

A catalog is created with a single URI or a collection of URIs. A URI can either be a URL or a file path.

Each catalog in the hierarchy is responsible for caching the most recent refresh time to prevent overeager queries.

Attributes

metadata [dict] Arbitrary information to carry along with the data source specs.

discover()
Open resource and populate the source attributes.

force_reload()
Imperative reload data now

reload()
Reload catalog if sufficient time has passed

walk(*sofar=None*, *prefix=None*, *depth=2*)
Get all entries in this catalog and sub-catalogs

Parameters

sofar: dict or None Within recursion, use this dict for output

prefix: list of str or None Names of levels already visited

depth: int Number of levels to descend; needed to truncate circular references and for cleaner output

Returns

Dict where the keys are the entry names in dotted syntax, and the

values are entry instances.

class intake.catalog.entry.**CatalogEntry**(*getenv=True*, *getshell=True*)
A single item appearing in a catalog

This is the base class, used by local entries (i.e., read from a YAML file) and by remote entries (read from a server).

describe()
Get a dictionary of attributes of this entry.

Returns: dict with keys

container [str] kind of container used by this data source

description [str] Markdown-friendly description of data source

direct_access [str] Mode of remote access: forbid, allow, force

user_parameters [list[dict]] List of user parameters defined by this entry

describe_open(***user_parameters*)
Get a dictionary describing how to open this data source.

Parameters

user_parameters [dict] Values for user-configurable parameters for this data source

Returns: dict with keys

plugin [str] Name of data plugin to use

container: str Data type returned

description [str] Markdown-friendly description of data source

direct_access [str] Mode of remote access: forbid, allow, force

metadata [dict] Dictionary of metadata defined in the catalog for this data source

args: dict Dictionary of keyword arguments for the plugin

get(***user_parameters*)
Open the data source.

Equivalent to calling the catalog entry like a function.

Note: `entry()`, `entry.attr`, `entry[item]` check for persisted sources, but directly calling `.get()` will always ignore the persisted store (equivalent to `self._pmode=='never'`).

Parameters

user_parameters [dict] Values for user-configurable parameters for this data source

Returns: DataSource

has_been_persisted
For the source created with the given args, has it been persisted?

plots
List custom associated quick-plots

class intake.container.base.**RemoteSource**(*url*, *headers*, *name*, *parameters*, *metadata=None*, ***kwargs*)

Base class for all DataSources living on an Intake server

to_dask()

Return a dask container for this data source

class intake.catalog.local.**UserParameter**(*name*, *description*, *type*, *default=None*, *min=None*, *max=None*, *allowed=None*)

A user-settable item that is passed to a DataSource upon instantiation.

For string parameters, default may include special functions `func(args)`, which *may* be expanded from environment variables or by executing a shell command.

Parameters

name: str the key that appears in the DataSource argument strings

description: str narrative text

type: str one of list‘‘(COERSION_RULES)‘‘

default: type value same type as `type`. It a str, may include special functions env, shell, client_env, client_shell.

min, max: type value for validation of user input

allowed: list of type for validation of user input

describe()

Information about this parameter

expand_defaults(*client=False*, *getenv=True*, *getshell=True*)

Compile env, client_env, shell and client_shell commands

validate(*value*)

Does value meet parameter requirements?

class intake.auth.base.**BaseAuth**(**args*)

Base class for authorization

Subclass this and override the methods to implement a new type of auth.

This basic class allows all access.

allow_access(*header*, *source*, *catalog*)

Is the given HTTP header allowed to access given data source

Parameters

header: dict The HTTP header from the incoming request

source: CatalogEntry The data source the user wants to access.

catalog: Catalog The catalog object containing this data source.

allow_connect(*header*)

Is the requests header given allowed to talk to the server

Parameters

header: dict The HTTP header from the incoming request

get_case_insensitive(*dictionary*, *key*, *default=None*)

Case-insensitive search of a dictionary for key.

Returns the value if key match is found, otherwise default.

class intake.source.cache.**BaseCache**(*driver*, *spec*, *catdir=None*, *cache_dir=None*, *storage_options={}*)

Provides utilities for managing cached data files.

Providers of caching functionality should derive from this, and appear as entries in `registry`. The principle methods to override are `_make_files()` and `_load()` and `_from_metadata()`.

clear_all()

Clears all cache and metadata.

clear_cache(*urlpath*)

Clears cache and metadata for a given urlpath.

Parameters

urlpath: str, location of data May be a local path, or remote path if including a protocol specifier such as `'s3://'`. May include glob wildcards.

get_metadata(*urlpath*)

Parameters

urlpath: str, location of data May be a local path, or remote path if including a protocol specifier such as `'s3://'`. May include glob wildcards.

Returns

Metadata (dict) about a given urlpath.

load(*urlpath*, *output=None*, ***kwargs*)

Downloads data from a given url, generates a hashed filename, logs metadata, and caches it locally.

Parameters

urlpath: str, location of data May be a local path, or remote path if including a protocol specifier such as `'s3://'`. May include glob wildcards.

output: bool Whether to show progress bars; turn off for testing

Returns

List of local cache_paths to be opened instead of the remote file(s). If

caching is disable, the urlpath is returned.

class intake.source.base.**AliasSource**(*target*, *mapping=None*, *metadata=None*, ***kwargs*)

Refer to another named source, unmodified

The purpose of an Alias is to be able to refer to other source(s) in the same catalog, perhaps leaving the choice of which target to load up to the user. This source makes no sense outside of a catalog.

In this case, the output of the target source is not modified, but this class acts as a prototype 'derived' source for processing the output of some standard driver.

After initial discovery, the source's container and other details will be updated from the target; initially, the AliasSource container is not any standard.

__init__(*target*, *mapping=None*, *metadata=None*, ***kwargs*)

Parameters

target: str Name of the source to load, must be a key in the same catalog

mapping: dict or None If given, use this to map the string passed as `target` to entries in the catalog

metadata: dict or None Extra metadata to associate

kwargs: passed on to the target

class intake.source.base.**PatternMixin**
Helper class to provide file-name parsing abilities to a driver class

class intake.source.base.**Schema**(***kwargs*)
Holds details of data description for any type of data-source

This should always be pickleable, so that it can be sent from a server to a client, and contain all information needed to recreate a RemoteSource on the client.

class intake.container.persist.**PersistStore**(*path=None*)
Specialised catalog for persisted data-sources

add(*key*, *source*)
Add the persisted source to the store under the given key

key [str] The unique token of the un-persisted, original source

source [DataSource instance] The thing to add to the persisted catalogue, referring to persisted data

backtrack(*source*)
Given a unique key in the store, recreate original source

get_tok(*source*)
Get string token from object

Strings are assumed to already be a token; if source or entry, see if it is a persisted thing ("original_tok" is in its metadata), else generate its own token.

needs_refresh(*source*)
Has the (persisted) source expired in the store

Will return True if the source is not in the store at all, if it's TTL is set to None, or if more seconds have passed than the TTL.

refresh(*key*)
Recreate and re-persist the source for the given unique ID

remove(*source*, *delfiles=True*)
Remove a dataset from the persist store

source [str or DataSource or Lo] If a str, this is the unique ID of the original source, which is the key of the persisted dataset within the store. If a source, can be either the original or the persisted source.

delfiles [bool] Whether to remove the on-disc artifact

5.6 Catalogs

Data catalogs provide an abstraction that allows you to externally define, and optionally share, descriptions of datasets, called *catalog entries*. A catalog entry for a dataset includes information like:

- The name of the Intake driver that can load the data
- Arguments to the `__init__()` method of the driver
- Metadata provided by the catalog author (such as field descriptions and types, or data provenance)

In addition, Intake allows datasets to be *parameterized* in the catalog. This is most commonly used to allow the user to filter down datasets at load time, rather than having to bring everything into memory first. The data parameters are defined by the catalog author, then templated into the arguments for `__init__()` to modify the data being loaded.

This approach is less flexible for the end user than something like the Blaze expression system, but also significantly reduces the implementation burden for driver authors.

5.6.1 YAML Format

Intake catalogs are typically described with YAML files. Here is an example:

```yaml
metadata:
  version: 1
sources:
  example:
    description: test
    driver: random
    args: {}

  entry1_full:
    description: entry1 full
    metadata:
      foo: 'bar'
      bar: [1, 2, 3]
    driver: csv
    args: # passed to the open() method
      urlpath: '{{ CATALOG_DIR }}/entry1_*.csv'

  entry1_part:
    description: entry1 part
    parameters: # User defined parameters
      part:
        description: part of filename
        type: str
        default: "1"
        allowed: ["1", "2"]
    driver: csv
    args:
      urlpath: '{{ CATALOG_DIR }}/entry1_{{ part }}.csv'
```

Templating

Intake catalog files support Jinja2 templating for driver arguments. Any occurrence of a substring like `{{field}}` will be replaced by the value of the user parameters with that same name. Some additional values are always available:

- `CATALOG_DIR`: The full path to the directory containing the YAML catalog file. This is especially useful for constructing paths relative to the catalog directory to locate data files and custom drivers.

Metadata

Arbitrary extra descriptive information can go into the metadata section. Some fields will be claimed for internal use and some fields may be restricted to local reading; but for now the only field that is expected is `version`, which will be updated when a breaking change is made to the file format. Any catalog will have `.metadata` and `.version` attributes available.

Extra drivers

The `driver:` entry of a data source specification can be a driver name, as has been shown in the examples so far. It can also be an absolute class path to use for the data source, in which case there will be no ambiguity about how to load the data. That is the the preferred way to be explicit, when the driver name alone is not enough (see *Driver Selection*, below). However, it is also possible to specify extra modules and directories to scan for plugins, as an alternative method for finding driver classes.

In addition to using drivers already installed in the Python environment with conda or pip (see *Driver Discovery*), a catalog can also use additional drivers from arbitrary locations listed in the YAML file:

```
plugins:
  source:
    - module: intake.catalog.tests.example1_source
    - dir: '{{ CATALOG_DIR }}/example_plugin_dir'
sources:
  ...
```

The following import methods are allow:

- `- module: my.module.path`: The Python module to import and search for driver classes. This uses the standard notation of the Python `import` command and will search the PYTHONPATH in the same way.
- `- dir: /my/module/directory`: All of the `*.py` files in this directory will be executed, and any driver classes found will be added to the catalog's plugin registry. It is common for the directory of Python files to be stored relative to the catalog file itself, so using the `CATALOG_DIR` variable will allow that relative path to be specified.

Each of the above methods can be used multiple times, and in combination, to load as many extra drivers as are needed. Most drivers should be installed as Python packages (enabling autodiscovery), but sometimes catalog-specific drivers may be needed to perform specific data transformations that are not broadly applicable enough to warrant creating a dedicated package. In those cases, the above options allow the drivers to be bundled with the catalog instead.

Sources

The majority of a catalog file is composed of data sources, which are named data sets that can be loaded for the user. Catalog authors describe the contents of data set, how to load it, and optionally offer some customization of the returned data. Each data source has several attributes:

- `name`: The canonical name of the source. Best practice is to compose source names from valid Python identifiers. This allows Intake to support things like tab completion of data source names on catalog objects. For example, `monthly_downloads` is a good source name.
- `description`: Human readable description of the source. To help catalog browsing tools, the description should be Markdown.
- `driver`: Name of the Intake *Driver* to use with this source. Must either already be installed in the current Python environment (i.e. with conda or pip) or loaded in the `plugin` section of the file.
- `args`: Keyword arguments to the `open()` method of the driver. Arguments may use template expansion.
- `metadata`: Any metadata keys that should be attached to the data source when opened. These will be supplemented by additional metadata provided by the driver. Catalog authors can use whatever key names they would like, with the exception that keys starting with a leading underscore are reserved for future internal use by Intake.
- `direct_access`: Control whether the data is directly accessed by the client, or proxied through a catalog server. See *Catalog Nesting* for more details.

- `parameters`: A dictionary of data source parameters. See below for more details.

Parameters allow the user to customize the data returned by a data source. Most often, parameters are used to filter or reduce the data in specific ways defined by the catalog author. The parameters defined for a given data source are available for use in template strings, which can be used to alter the arguments provided to the driver. For example, a data source might accept a "postal_code" argument which is used to alter a database query, or select a particular group within a file. Users set parameters with keyword arguments to the `get()` method on the catalog object.

Driver Selection

In some cases, it may be possible that multiple backends are capable of loading from the same data format or service. Sometimes, this may mean two drivers with unique names, or a single driver with a parameter to choose between the different backends.

However, it is possible that multiple drivers for reading a particular type of data also share the same driver name: for example, both the intake-iris and the intake-xarray packages contain drivers with the name `"netcdf"`, which are capable of reading the same files, but with different backends. Here we will describe the various possibilities of coping with this situation. Intake's plugin system makes it easy to encode such choices.

It may be acceptable to use any driver which claims to handle that data type, or to give the option of which driver to use to the user, or it may be necessary to specify which precise driver(s) are appropriate for that particular data. Intake allows all of these possibilities, even if the backend drivers require extra arguments.

Specifying a single driver explicitly, rather than using a generic name, would look like this:

```
sources:
  example:
    description: test
    driver: package.module.PluginClass
    args: {}
```

It is also possible to describe a list of drivers with the same syntax. The first one found will be the one used. Note that the class imports will only happen at data source instantiation.

```
sources:
  example:
    description: test
    driver:
      - package.module.PluginClass
      - another_package.PluginClass2
    args: {}
```

These alternative plugins can also be given data-source specific names, allowing the user to choose at load time with *driver=* as a parameter. Additional arguments may also be required for each option (which, as usual, may include user parameters); however, the same global arguments will be passed to all of the drivers listed.

```
sources:
  example:
    description: test
    driver:
      first:
        class: package.module.PluginClass
        args:
          specific_thing: 9
      second:
        class: another_package.PluginClass2
    args: {}
```

Parameter Definition

To enable users to discover parameters on data sources, and to allow UIs to generate interfaces automatically, parameters have the following attributes in the catalog.

- `description`: Human-readable Markdown description of what the parameter means.
- `type`: The type of the parameter. Currently, this may be `bool`, `str`, `int`, `float`, `list[str]`, `list[int]`, `list[float]`, `datetime`.
- `default`: The default value for this parameter. Every parameter must have a default to ensure a catalog user can quickly see some sample data.
- `allowed` (optional): A list of allowed values for this parameter
- `min` (optional): Minimum value (inclusive) for the parameter
- `max` (optional): Maximum value (inclusive) for the parameter

Note both `allowed` and `min`/`max` should not be set for the same parameter.

Also the `datetime` type accepts multiple values:

- a Python datetime object
- an ISO8601 timestamp string
- an integer representing a Unix timestamp
- `now`, a string representing the current timestamp
- `today`, a string representing today at midnight UTC

The `default` field allows for special syntax to get information from the system. This is particularly useful for user credentials, which may be defined by environment variables or fetched by running some external command. The special syntax are:

- `env(USER)`: look in the environment for the named variable; in the example, this will be the username.
- `client_env(USER)`: exactly the same, except that when using a client-server topology, the value will come from the environment of the client.
- `shell(get_login thisuser -t)`: execute the command, and use the output as the value. The output will be trimmed of any trailing whitespace.
- `client_shell(get_login thisuser -t)`: exactly the same, except that when using a client-server topology, the value will come from the system of the client.

Since it may not be desirable to have the access of a catalog get information from the system, the keywords `getenv` and `getshell` (passed to `Catalog`) allow these mechanisms to by turned off, in which case the value of the default will still appear as the original template string (and so the user should override with a value they have obtained elsewhere). Note that in the case of a remote catalog, the client cannot see the values that will be evaluated on the server side, the evaluation only happens if the user did not override the value when accessing the data.

Caching Source Files Locally

To enable caching on the first read of remote data source files, add the `cache` section with the following attributes:

- `argkey`: The args section key which contains the URL(s) of the data to be cached.
- `type`: One of the keys in the cache registry [*intake.source.cache.registry*], referring to an implementation of caching behaviour. The default is "file" for the caching of one or more files.

Example:

```
test_cache:
  description: cache a csv file from the local filesystem
  driver: csv
  cache:
    - argkey: urlpath
      type: file
  args:
    urlpath: '{{ CATALOG_DIR }}/cache_data/states.csv'
```

The `cache_dir` defaults to `~/.intake/cache`, and can be specified in the intake configuration file or `INTAKE_CACHE_DIR` environment variable, or at runtime using the `"cache_dir"` key of the configuration. The special value `"catdir"` implies that cached files will appear in the same directory as the catalog file in which the data source is defined, within a directory named "intake_cache". These will not appear in the cache usage reported by the CLI.

Optionally, the cache section can have a `regex` attribute, that modifies the path of the cache on the disk. By default, the cache path is made by concatenating `cache_dir`, dataset name, hash of the url, and the url itself (without the protocol). `regex` attribute allows to remove part of the url (the matching part).

Caching can be disabled at runtime for all sources regardless of the catalog specificiation:

```
from intake.config import conf

conf['cache_disabled'] = True
```

By default, progress bars are shown during downloads if the package `tqdm` is available, but this can be disabled (e.g., for consoles that don't support complex text) with

conf['cache_download_progress'] = False

or, equivalently, the environment parameter `INTAKE_CACHE_PROGRESS`.

The "types" of caching are that supported are listed in `intake.source.cache.registry`, see the docstrings of each for specific parameters that should appear in the cache block.

5.6.2 Remote Access

(see also *Remote Data* for the implementation details)

Many drives support reading directly from remote data sources such as HTTP, S3 or GCS. In these cases, the path to read from is usually given with a protocol prefix such as `gcs://`. Additional dependencies will typically be required (`requests`, `s3fs`, `gcsfs`, etc.), any any data conda package should specify this. Further parameters may be necessary for communicating with the storage backend and, by convention, the driver should take a parameter `storage_options` containing arguments to pass to the backend.

As an example of using `storage_options`, the following two sources would allow for reading CSV data from S3 and GCS backends without authentication (anonymous access), respectively

```
sources:
  s3_csv:
    description: "Publicly accessible CSV data on S3; requires s3fs"
    args:
      urlpath: s3://bucket/path/*.csv
      storage_options:
        anon: true
  gcs_csv:
    description: "Publicly accessible CSV data on GCS; requires gcsfs"
```

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```
    args:
      urlpath: gcs://bucket/path/*.csv
      storage_options:
        token: "anon"
```

5.6.3 Local Catalogs

A Catalog can be loaded from a YAML file on the local filesystem by creating a Catalog object:

```
from intake import open_catalog

cat = open_catalog('catalog.yaml')
```

Then sources can be listed:

```
list(cat)
```

and data sources are loaded via their name:

    data = cat.entry_part1(part='1')

Intake also supports loading all of the files ending in `.yml` and `.yaml` in a directory, or by using an explicit glob-string. Note that the URL provided may refer to a remote storage systems by passing a protocol specifier such as `s3://`, `gcs://`.:

```
cat = open_catalog('/research/my_project/catalog.d/')
```

Intake Catalog objects will automatically detect changes or new additions to catalog files and directories on disk. These changes will not affect already-opened data sources.

5.6.4 Catalog Nesting

A catalog is just another type of data source for Intake. For example, you can print a YAML specification corresponding to a catalog as follows:

```
cat = intake.open_catalog('cat.yaml')
print(cat.yaml())
```

results in:

```
sources:
  cat:
    args:
      path: cat.yaml
    description: ''
    driver: intake.catalog.local.YAMLFileCatalog
    metadata: {}
```

The *point* here, is that this can be included in another catalog. For example, if the entry above were saved to another file, "root.yaml", and the original catalog contained an entry data, you could access it as:

```
root = intake.open_catalog('root.yaml')
root.cat.data
```

It would, of course, be better to include a description and the full path of the catalog file here.

It is, therefore, possible to build up a hierarchy of catalogs referencing each other. Since these can include remote URLs and indeed catalog sources other than simple files (all the tables on a SQL server, for instance). Plus, since the argument and parameter system also applies to entries such as the example above, it would be possible to give the user a runtime choice of multiple catalogs to pick between, or have this decision depend on an environment variable.

5.6.5 Remote Catalogs

Intake also includes a server which can share an Intake catalog over HTTP (or HTTPS with the help of a TLS-enabled reverse proxy). From the user perspective, remote catalogs function identically to local catalogs:

```
cat = open_catalog('intake://catalog1:5000')
list(cat)
```

The difference is that operations on the catalog translate to requests sent to the catalog server. Catalog servers provide access to data sources in one of two modes:

- Direct access: In this mode, the catalog server tells the client how to load the data, but the client uses its local drivers to make the connection. This requires the client has the required driver already installed *and* has direct access to the files or data servers that the driver will connect to.
- Proxied access: In this mode, the catalog server uses its local drivers to open the data source and stream the data over the network to the client. The client does not need *any* special drivers to read the data, and can read data from files and data servers that it cannot access, as long as the catalog server has the required access.

Whether a particular catalog entry supports direct or proxied access is determined by the `direct_access` option:

- `forbid` (default): Force all clients to proxy data through the catalog server
- `allow`: If the client has the required driver, access the source directly, otherwise proxy the data through the catalog server.
- `force`: Force all clients to access the data directly. If they do not have the required driver, an exception will be raised.

Note that when the client is loading a data source via direct access, the catalog server will need to send the driver arguments to the client. Do not include sensitive credentials in a data source that allows direct access.

Client Authorization Plugins

Intake servers can check if clients are authorized to access the catalog as a whole, or individual catalog entries. Typically a matched pair of server-side plugin (called an "auth plugin") and a client-side plugin (called a "client auth plugin) need to be enabled for authorization checks to work. This feature is still in early development, but see module `intake.auth.secret` for a demonstration pair of server and client classes implementation auth via a shared secret. See *Authorization Plugins*.

5.7 Command Line Tools

The package installs two executable commands: for starting the catalog server; and a client for accessing catalogs and manipulating the configuration.

5.7.1 Configuration

A file-based configuration service is available to Intake. This file is by default sought at the location `~/.intake/conf.yaml`, but either of the environment variables `INTAKE_CONF_DIR` or `INTAKE_CONF_FILE` can be used to specify another directory or file. If both are given, the latter takes priority.

At present, the configuration file might look as follows:

```
auth:
  class: "intake.auth.base.BaseAuth"
port: 5000
catalog_path:
  - /home/myusername/special_dir
```

These are the defaults, and any parameters not specified will take the values above

- the Intake Server will listen on port 5000 (this can be overridden on the command line, see below)
- and the auth system used will be the fully-qualified class given (which, for BaseAuth, always allows access). For further information on securing the Intake Server, see the *Authorization Plugins*.

See `intake.config.defaults` for a full list of keys and their default values.

5.7.2 Log Level

The logging level is configurable using Python's built-in logging module.

The config option `'logging'` holds the current level for the intake logger, and can take values such as `'INFO'` or `'DEBUG'`. This can be set in the `conf.yaml` file of the config directory (e.g., `~/.intake/`), or overriden by the environment variable `INTAKE_LOG_LEVEL`.

Furthermore, the level and settings of the logger can be changed programmatically in code:

```
import logging
logger = logging.getLogger('intake')
logger.setLevel(logging.DEBUG)
logget.addHandler(..)
```

5.7.3 Intake Server

The server takes one or more catalog files as input and makes them available on port 5000 by default.

You can see the full description of the server command with:

```
>>> intake-server --help
usage: intake-server [-h] [-p PORT] [--sys-exit-on-sigterm] FILE [FILE ...]

Intake Catalog Server

positional arguments:
  FILE                  Name of catalog YAML file

  optional arguments:
    -h, --help            show this help message and exit
    -p PORT, --port PORT  port number for server to listen on
    --sys-exit-on-sigterm internal flag used during unit testing to ensure
                          .coverage file is written
```

To start the server with a local catalog file, use the following:

```
>>> intake-server intake/catalog/tests/catalog1.yml
Creating catalog from:
  - intake/catalog/tests/catalog1.yml
catalog_args ['intake/catalog/tests/catalog1.yml']
Entries: entry1,entry1_part,use_example1
Listening on port 5000
```

You can use the catalog client (defined below) using:

```
$ intake list intake://localhost:5000
entry1
entry1_part
use_example1
```

5.7.4 Intake Client

While the Intake data sources will typically be accessed through the Python API, you can use the client to verify a catalog file.

Unlike the server command, the client has several subcommands to access a catalog. You can see the list of available subcommands with:

```
>>> intake --help
usage: intake {list,describe,exists,get,discover} ...
```

We go into further detail in the following sections.

List

This subcommand lists the names of all available catalog entries. This is useful since other subcommands require these names.

If you wish to see the details about each catalog entry, use the `--full` flag. This is equivalent to running the `intake describe` subcommand for all catalog entries.

```
>>> intake list --help
usage: intake list [-h] [--full] URI

positional arguments:
  URI         Catalog URI

optional arguments:
  -h, --help  show this help message and exit
  --full
```

```
>>> intake list intake/catalog/tests/catalog1.yml
entry1
entry1_part
use_example1
>>> intake list --full intake/catalog/tests/catalog1.yml
[entry1] container=dataframe
[entry1] description=entry1 full
[entry1] direct_access=forbid
```

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```
[entry1] user_parameters=[]
[entry1_part] container=dataframe
[entry1_part] description=entry1 part
[entry1_part] direct_access=allow
[entry1_part] user_parameters=[{'default': '1', 'allowed': ['1', '2'], 'type': u'str',
↪ 'name': u'part', 'description': u'part of filename'}]
[use_example1] container=dataframe
[use_example1] description=example1 source plugin
[use_example1] direct_access=forbid
[use_example1] user_parameters=[]
```

Describe

Given the name of a catalog entry, this subcommand lists the details of the respective catalog entry.

```
>>> intake describe --help
usage: intake describe [-h] URI NAME

positional arguments:
  URI         Catalog URI
  NAME        Catalog name

optional arguments:
  -h, --help  show this help message and exit
```

```
>>> intake describe intake/catalog/tests/catalog1.yml entry1
[entry1] container=dataframe
[entry1] description=entry1 full
[entry1] direct_access=forbid
[entry1] user_parameters=[]
```

Discover

Given the name of a catalog entry, this subcommand returns a key-value description of the data source. The exact details are subject to change.

```
>>> intake discover --help
usage: intake discover [-h] URI NAME

positional arguments:
  URI         Catalog URI
  NAME        Catalog name

optional arguments:
  -h, --help  show this help message and exit
```

```
>>> intake discover intake/catalog/tests/catalog1.yml entry1
{'npartitions': 2, 'dtype': dtype([('name', 'O'), ('score', '<f8'), ('rank', '<i8')]),
↪ 'shape': (None,), 'datashape':None, 'metadata': {'foo': 'bar', 'bar': [1, 2, 3]}}
```

Exists

Given the name of a catalog entry, this subcommand returns whether or not the respective catalog entry is valid.

```
>>> intake exists --help
usage: intake exists [-h] URI NAME

positional arguments:
  URI         Catalog URI
  NAME        Catalog name

optional arguments:
  -h, --help  show this help message and exit
```

```
>>> intake exists intake/catalog/tests/catalog1.yml entry1
True
>>> intake exists intake/catalog/tests/catalog1.yml entry2
False
```

Get

Given the name of a catalog entry, this subcommand outputs the entire data source to standard output.

```
>>> intake get --help
usage: intake get [-h] URI NAME

positional arguments:
  URI         Catalog URI
  NAME        Catalog name

optional arguments:
  -h, --help  show this help message and exit
```

```
>>> intake get intake/catalog/tests/catalog1.yml entry1
       name  score  rank
0    Alice1  100.5     1
1      Bob1   50.3     2
2  Charlie1   25.0     3
3      Eve1   25.0     3
4    Alice2  100.5     1
5      Bob2   50.3     2
6  Charlie2   25.0     3
7      Eve2   25.0     3
```

Config and Cache

CLI functions starting with `intake cache` and `intake config` are available to provide information about the system: the locations and value of configuration parameters, and the state of cached files.

5.8 Persisting Data

(this is an experimental new feature, expect enhancements and changes)

5.8.1 Introduction

As defined in the glossary, to *Persist* is to convert data into the storage format most appropriate for the container type, and save a copy of this for rapid lookup in the future. This is of great potential benefit where the creation or transfer of the original data source takes some time.

This is not to be confused with the file *Cache*.

5.8.2 Usage

Any *Data Source* has a method `.persist()`. The only option that you will need to pick is a *TTL*, the number of seconds that the persisted version lasts before expiry (leave as `None` for no expiry). This creates a local copy in the persist directory, which may be in `"~/.intake/persist`, but can be configured.

Each container type (dataframe, array, ...) will have its own implementation of persistence, and a particular file storage format associated. The call to `.persist()` may take arguments to tune how the local files are created, and in some cases may require additional optional packages to be installed.

Example:

```
cat = intake.load_catalog('mycat.yaml')  # load a remote cat
source = cat.csvsource()  # source pointing to remote data
source.persist()

source = cat.csvsource()  # future use now gives local intake_parquet.ParquetSource
```

To control whether a catalog will automatically give you the persisted version of a source in this way using the argument `persist_mode`, e.g., to ignore locally persisted versions, you could have done:

```
cat = intake.load_catalog('mycat.yaml', persist_mode='never')
or
source = cat.csvsource(persist_mode='never')
```

Note that if you give a TTL (in seconds), then the original source will be accessed and a new persisted version written transparently when the old persisted version has expired.

Note that after persisting, the original source will have `source.has_been_persisted == True` and the persisted source (i.e., the one loaded from local files) will have `source.is_persisted == True`.

5.8.3 The Persist Store

You can interact directly with the class implementing persistence:

```
from intake.container.persist import store
```

This singleton instance, which acts like a catalog, allows you to query the contents of the instance store and to add and remove entries. It also allows you to find the original source for any given persisted source, and refresh the persisted version on demand.

For details on the methods of the persist store, see the API documentation: *intake.container.persist.PersistStore()*. Sources in the store carry a lot of information about the sources they were made from, so that they can be remade successfully. This all appears in the source metadata. The sources use the "token" of the original data source as their key in the store, a value which can be found by `source._tok` for the original source, or can be taken from the metadata of a persisted source.

5.8.4 Future Enhancements

- Implement persist for all data types, including catalogs, which have a natural representation as YAML files - fetching or querying a remote service to create a catalog can be slow too.
- CLI functionality to investigate and alter the state of the persist store, similar to the cache commands.
- Being able to set the persist store to a remote URL, such that outputs can be shared between users and the nodes of a Dask cluster. Currently, the only way to achieve this would be to use a shared network file-system.
- An "export" function much like persist, but producing a standalone version of the data together with a catalog spec for it, so that it can be easily shared.
- Time check-pointing of persisted data, such that you can not only get the "most recent" but any version in the time-series.
- (eventually) pipeline functionality, whereby a persisted data source depends on another persisted data source, and the whole train can be refreshed on a schedule or on demand.

5.9 Making Drivers

The goal of the Intake plugin system is to make it very simple to implement a *Driver* for a new data source, without any special knowledge of Dask or the Intake catalog system.

5.9.1 Assumptions

Although Intake is very flexible about data, there are some basic assumptions that a driver must satisfy.

Data Model

Intake currently supports 3 kinds of containers, represented the most common data models used in Python:

- dataframe
- ndarray
- python (list of Python objects, usually dictionaries)

Although a driver can load *any* type of data into any container, and new container types can be added to the list above, it is reasonable to expect that the number of container types remains small. Declaring a container type is only informational for the user when read locally, but streaming of data from a server requires that the container type be known to both server and client.

A given driver must only return one kind of container. If a file format (such as HDF5) could reasonably be interpreted as two different data models depending on usage (such as a dataframe or an ndarray), then two different drivers need to be created with different names. If a driver returns the `python` container, it should document what Python objects will appear in the list.

The source of data should be essentially permanent and immutable. That is, loading the data should not destroy or modify the data, nor should closing the data source destroy the data either. When a data source is serialized and sent to another host, it will need to be reopened at the destination, which may cause queries to be re-executed and files to be reopened. Data sources that treat readers as "consumers" and remove data once read will cause erratic behavior, so Intake is not suitable for accessing things like FIFO message queues.

Schema

The schema of a data source is a detailed description of the data, which can be known by loading only metadata or by loading only some small representative portion of the data. It is information to present to the user about the data that they are considering loading, and may be important in the case of server-client communication. In the latter context, the contents of the schema must be serializable by `msgpack` (i.e., numbers, strings, lists and dictionaries only).

There may be unknown parts of the schema before the whole data is read. drivers may require this unknown information in the *__init__()* method (or the catalog spec), or do some kind of partial data inspection to determine the schema; or more simply, may be given as unknown `None` values. Regardless of method used, the time spent figuring out the schema ahead of time should be short and not scale with the size of the data.

Typical fields in a schema dictionary are `npartitions`, `dtype`, `shape`, etc., which will be more appropriate for some drivers/data-types than others.

Partitioning

Data sources are assumed to be *partitionable*. A data partition is a randomly accessible fragment of the data. In the case of sequential and data-frame sources, partitions are numbered, starting from zero, and correspond to contiguous chunks of data divided along the first dimension of the data structure. In general, any partitioning scheme is conceivable, such as a tuple-of-ints to index the chunks of a large numerical array.

Not all data sources can be partitioned. For example, file formats without sufficient indexing often can only be read from beginning to end. In these cases, the DataSource object should report that there is only 1 partition. However, it often makes sense for a data source to be able to represent a directory of files, in which case each file will correspond to one partition.

Metadata

Once opened, a DataSource object can have arbitrary metadata associated with it. The metadata for a data source should be a dictionary that can be serialized as JSON. This metadata comes from the following sources:

1. A data catalog entry can associate fixed metadata with the data source. This is helpful for data formats that do not have any support for metadata within the file format.
2. The driver handling the data source may have some general metadata associated with the state of the system at the time of access, available even before loading any data-specific information.
2. A driver can add additional metadata when the schema is loaded for the data source. This allows metadata embedded in the data source to be exported.

From the user perspective, all of the metadata should be loaded once the data source has loaded the rest of the schema (after `discover()`, `read()`, `to_dask()`, etc have been called).

5.9.2 Subclassing `intake.source.base.DataSource`

Every Intake driver class should be a subclass of `intake.source.base.DataSource`. The class should have the following attributes to identify itself:

- `name`: The short name of the driver. This should be a valid python identifier. You should not include the word `intake` in the driver name.
- `version`: A version string for the driver. This may be reported to the user by tools based on Intake, but has no semantic importance.

- `container`: The container type of data sources created by this object, e.g., `dataframe`, `ndarray`, or `python`, one of the keys of `intake.container.container_map`. For simplicity, a driver many only return one typed of container. If a particular source of data could be used in multiple ways (such as HDF5 files interpreted as dataframes or as ndarrays), two drivers must be created. These two drivers can be part of the same Python package.
- `partition_access`: Do the data sources returned by this driver have multiple partitions? This may help tools in the future make more optimal decisions about how to present data. If in doubt (or the answer depends on init arguments), `True` will always result in correct behavior, even if the data source has only one partition.

The `__init()__` method should always accept a keyword argument `metadata`, a dictionary of metadata from the catalog to associate with the source. This dictionary must be serializable as JSON.

The base *DataSource* class has a small number of methods which should be overridden. Here is an example producing a data-frame:

```
class FooSource(intake.source.base.DataSource):
    container = 'dataframe'
    name = 'foo'
    version = '0.0.1'
    partition_access = True

    def __init__(self, a, b, metadata=None):
        # Do init here with a and b
        super(FooSource, self).__init__(
            metadata=metadata
        )

    def _get_schema(self):
        return intake.source.base.Schema(
            datashape=None,
            dtype={'x': "int64", 'y': "int64"},
            shape=(None, 2),
            npartitions=2,
            extra_metadata=dict(c=3, d=4)
        )

    def _get_partition(self, i):
        # Return the appropriate container of data here
        return pd.DataFrame({'x': [1, 2, 3], 'y': [10, 20, 30]})

    def read(self):
        self._load_metadata()
        return pd.concat([self.read_partition(i) for i in self.npartitions])

    def _close(self):
        # close any files, sockets, etc
        pass
```

Most of the work typically happens in the following methods:

- `__init__()`: Should be very lightweight and fast. No files or network resources should be opened, and no significant memory should be allocated yet. Data sources are often serialized immediately. The default implementation of the pickle protocol in the base class will record all the arguments to `__init__()` and recreate the object with those arguments when unpickled, assuming the class has no side effects.
- `_get_schema()`: May open files and network resources and return as much of the schema as possible in small amount of *approximately* constant time. The `npartitions` and `extra_metadata` attributes must be correct when `_get_schema` returns. Further keys such as `dtype`, `shape`, etc., should reflect the container

type of the data-source, and can be `None` if not easily knowable, or include `None` for some elements. This method should call the `_get_cache` method, if caching on first time read is supported by the driver. For example:

```
urlpath, *_ = self._get_cache(self._urlpath)
```

Will return the location of the cached urlpath for the first matching cache specified in the catalog source.

- `_get_partition(self, i)`: Should return all of the data from partition id `i`, where `i` is typically an integer, but may be something more complex. The base class will automatically verify that `i` is in the range `[0, npartitions)`, so no range checking is required in the typical case.
- `_close(self)`: Close any network or file handles and deallocate any significant memory. Note that these resources may be need to be reopened/reallocated if a read is called again later.

The full set of user methods of interest are as follows:

- `discover(self)`: Read the source attributes, like `npartitions`, etc. As with `_get_schema()` above, this method is assumed to be fast, and make a best effort to set attributes. The output should be serializable, if the source is to be used on a server; the details contained will be used for creating a remote-source on the client.
- `read(self)`: Return all the data in memory in one in-memory container.
- `read_chunked(self)`: Return an iterator that returns contiguous chunks of the data. The chunking is generally assumed to be at the partition level, but could be finer grained if desired.
- `read_partition(self, i)`: Returns the data for a given partition id. It is assumed that reading a given partition does not require reading the data that precedes it. If `i` is out of range, an `IndexError` should be raised.
- `to_dask(self)`: Return a (lazy) Dask data structure corresponding to this data source. It should be assumed that the data can be read from the Dask workers, so the loads can be done in future tasks. For further information, see the Dask documentation.
- `close(self)`: Close network or file handles and deallocate memory. If other methods are called after `close()`, the source is automatically reopened.

It is also important to note that source attributes should be set after `read()`, `read_chunked()`, `read_partition()` and `to_dask()`, even if `discover()` was not called by the user.

5.9.3 Driver Discovery

When Intake is imported, it will search the Python module path (by default includes `site-packages` and other directories in your `$PYTHONPATH`) for packages starting with `intake_` and discover DataSource subclasses inside those packages to register. drivers will be registered based on the‘‘name‘‘ attribute of the object. By convention, drivers should have names that are lowercase, valid Python identifiers that do not contain the word `intake`.

After the discovery phase, Intake will automatically create `open_[driver_name]` convenience functions under the `intake` module namespace. Calling a function like `open_csv()` is equivalent to instantiating the corresponding data-source class.

To take advantage of driver discovery, give your installed package a name that starts with `intake_` and define your driver class(es) in the `__init__.py` of the package.

5.9.4 Remote Data

For drivers loading from files, the author should be aware that it is easy to implement loading from files stored in remote services. A simplistic case is demonstrated by the included CSV driver, which simply passes a URL to Dask,

which in turn can interpret the URL as a remote data service, and use the `storage_options` as required (see the Dask documentation on remote data).

More advanced usage, where a Dask loader does not already exist, will likely rely on dask.bytes.open_files . Use this function to produce lazy `OpenFile` object for local or remote data, based on a URL, which will have a protocol designation and possibly contain glob "*" characters. Additional parameters may be passed to `open_files`, which should, by convention, be supplied by a driver argument named `storage_options` (a dictionary).

To use an `OpenFile` object, make it concrete by using a context:

```
# at setup, to discover the number of files/partitions
set_of_open_files = dask.bytes.open_files(urlpath, mode='rb', **storage_options)

# when actually loading data; here we loop over all files, but maybe we just do one␣
↪partition
for an_open_file in set_of_open_files:
    # `with` causes the object to become concrete until the end of the block
    with an_open_file as f:
        # do things with f, which is a file-like object
        f.seek(); f.read()
```

The `textfiles` builtin drivers implements this mechanism, as an example.

5.9.5 Structured File Paths

The CSV driver sets up an example of how to gather data which is encoded in file paths like (`'data_{site}_.csv'`) and return that data in the output. Other drivers could also follow the same structure where data is being loaded from a set of filenames. Typically this would apply to data-frame output. This is possible as long as the driver has access to each of the file paths at some point in `_get_schema`. Once the file paths are known, the driver developer can use the helper functions defined in `intake.source.utils` to get the values for each field in the pattern for each file in the list. These values should then be added to the data, a process which normally would happen within the _get_schema method.

The PatternMixin defines driver properties such as urlpath, path_as_pattern, and pattern. The implementation might look something like this:

```
from intake.source.utils import reverse_formats

class FooSource(intake.source.base.DataSource, intake.source.base.PatternMixin):
    def __init__(self, a, b, path_as_pattern, urlpath, metadata=None):
        # Do init here with a and b
        self.path_as_pattern = path_as_pattern
        self.urlpath = urlpath

        super(FooSource, self).__init__(
            container='dataframe',
            metadata=metadata
        )
    def _get_schema(self):
        # read in the data
        values_by_field = reverse_formats(self.pattern, file_paths)
        # add these fields and map values to the data
        return data
```

Since dask already has a specific method for including the file paths in the output dataframe, in the CSV driver we set `include_path_column=True`, to get a dataframe where one of the columns contains all the file paths.

In this case, *add these fields and values to data* is a mapping between the categorical file paths column and the `values_by_field`.

In other drivers where each file is read in independently the driver developer can set the new fields on the data from each file before concattenating. This pattern looks more like:

```
from intake.source.utils import reverse_format

class FooSource(intake.source.base.DataSource):
    ...

    def _get_schema(self):
        # get list of file paths
        for path in file_paths:
            # read in the file
            values_by_field = reverse_format(self.pattern, path)
            # add these fields and values to the data
        # concatenate the datasets
        return data
```

To toggle on and off this path as pattern behavior, the CSV and intake-xarray drivers uses the bool `path_as_pattern` keyword argument.

5.10 Authorization Plugins

Authorization plugins are classes that can be used to customize access permissions to the Intake catalog server. The Intake server and client communicate over HTTP, so when security is a concern, the *most important* step to take is to put a TLS-enabled reverse proxy (like `nginx`) in front of the Intake server to encrypt all communication.

Whether or not the connection is encrypted, the Intake server by default allows all clients to list the full catalog, and open any of the entries. For many use cases, this is sufficient, but if the visibility of catalog entries needs to be limited based on some criteria, a server- (and/or client-) side authorization plugin can be used.

5.10.1 Server Side

An Intake server can have exactly one server side plugin enabled at startup. The plugin is activated using the Intake configuration file, which lists the class name and the keyword arguments it takes. For example, the "shared secret" plugin would be configured this way:

```
auth:
  class: intake.auth.secret.Secret
  kwargs:
    secret: A_SECRET_HASH
```

This plugin is very simplistic, and exists as a demonstration of how an auth plugin might function for more realistic scenarios.

For more information about configuring the Intake server, see *Configuration*.

The server auth plugin has two methods. The `allow_connect()` method decides whether to allow a client to make any request to the server at all, and the `allow_access()` method decides whether the client is allowed to see a particular catalog entry in the listing and whether they are allowed to open that data source. Note that for catalog entries which allow direct access to the data (via network or shared filesystem), the Intake authorization plugins have no impact on the visibility of the underlying data, only the entries in the catalog.

The actual implementation of a plugin is very short. Here is a simplified version of the shared secret auth plugin:

```
class SecretAuth(BaseAuth):
    def __init__(self, secret, key='intake-secret'):
        self.secret = secret
        self.key = key

    def allow_connect(self, header):
        try:
            return self.get_case_insensitive(header, self.key, '') \
                        == self.secret
        except:
            return False

    def allow_access(self, header, source, catalog):
        try:
            return self.get_case_insensitive(header, self.key, '') \
                        == self.secret
        except:
            return False
```

The *header* argument is a dictionary of HTTP headers that were present in the client request. In this case, the plugin is looking for a special `intake-secret` header which contains the shared secret token. Because HTTP header names are not case sensitive, the `BaseAuth` class provides a helper method `get_case_insensitive()`, which will match dictionary keys in a case-insensitive way.

The `allow_access` method also takes two additional arguments. The `source` argument is the instance of `LocalCatalogEntry` for the data source being checked. Most commonly auth plugins will want to inspect the `_metadata` dictionary for information used to make the authorization decision. Note that it is entirely up to the plugin author to decide what sections they want to require in the metadata section. The `catalog` argument is the instance of `Catalog` that contains the catalog entry. Typically, plugins will want to use information from the `catalog.metadata` dictionary to control global defaults, although this is also up to the plugin.

5.10.2 Client Side

Although server side auth plugins can function entirely independently, some authorization schemes will require the client to add special HTTP headers for the server to look for. To facilitate this, the Catalog constructor accepts an optional `auth` parameter with an instance of a client auth plugin class.

The corresponding client plugin for the shared secret use case describe above looks like:

```
class SecretClientAuth(BaseClientAuth):
    def __init__(self, secret, key='intake-secret'):
        self.secret = secret
        self.key = key

    def get_headers(self):
        return {self.key: self.secret}
```

It defines a single method, `get_headers()`, which is called to get a dictionary of additional headers to add to the HTTP request to the catalog server. To use this plugin, we would do the following:

```
import intake
from intake.auth.secret import SecretClientAuth

auth = SecretClientAuth('A_SECRET_HASH')
cat = intake.Catalog('http://example.com:5000', auth=auth)
```

Now all requests made to the remote catalog will contain the `intake-secret` header.

5.11 Making Data Packages

Combined with the Conda Package Manger, Intake makes it possible to create *data packages* which can be installed and upgraded just like software packages. This offers several advantages:

- Distributing datasets becomes as easy `conda install`
- Data packages can be versioned, improving reproducibility in some cases
- Data packages can depend on the libraries required for reading
- Data packages can be self-describing using Intake catalog files
- Applications that need certain datasets can include data packages in their dependency list

In this tutorial, we give a walkthrough to enable you to distribute any dataset to others, so that they can access the data using Intake without worrying about where it resides or how it should be loaded.

5.11.1 Defining a Package

The steps involved in creating a data package are:

1. Identifying a dataset, which can be accessed via a URL or included directly as one or more files in the package.
2. Creating a package containing:
    - an intake catalog file
    - a `meta.yaml` file (description of the data, version, requirements, etc.)
    - a script to copy the data
3. Building the package using the command `conda build`.
4. Uploading the package to a package repository such as Anaconda Cloud or your own private repository.

Data packages are standard conda packages that install an Intake catalog file into the user's conda environment (`$CONDA_PREFIX/share/intake`). A data package does not necessarily imply there are data files inside the package. A data package could describe remote data sources (such as files in S3) and take up very little space on disk.

These packages are considered `noarch` packages, so that one package can be installed on any platform, with any version of Python (or no Python at all). The easiest way to create such a package is using a conda build recipe.

Conda-build recipes are stored in a directory that contains a files like:

- `meta.yaml` - description of package metadata
- `build.sh` - script for building/installing package contents (on Linux/macOS)
- other files needed by the package (catalog files and data files for data packages)

An example that packages up data from a Github repository would look like this:

```
# meta.yaml
package:
  version: '1.0.0'
  name: 'data-us-states'

source:
  git_rev: v1.0.0
  git_url: https://github.com/CivilServiceUSA/us-states

build:
```

(continues on next page)

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```
  number: 0
  noarch: generic

requirements:
  run:
    - intake
  build: []

about:
  description: Data about US states from CivilServices (https://civil.services/)
  license: MIT
  license_family: MIT
  summary: Data about US states from CivilServices
```

The key parts of a data package recipe (different from typical conda recipes) is the `build` section:

```
build:
  number: 0
  noarch: generic
```

This will create a package that can be installed on any platform, regardless of the platform where the package is built. If you need to rebuild a package, the build number can be incremented to ensure users get the latest version when they conda update.

The corresponding `build.sh` file in the recipe looks like this:

```
#!/bin/bash

mkdir -p $PREFIX/share/intake/civilservices
cp $SRC_DIR/data/states.csv $PREFIX/share/intake/civilservices
cp $RECIPE_DIR/us_states.yaml $PREFIX/share/intake/
```

The `$SRC_DIR` variable refers to any source tree checked out (from Github or other service), and the `$RECIPE_DIR` refers to the directory where the `meta.yaml` is located.

Finishing out this example, the catalog file for this data source looks like this:

```
sources:
  states:
    description: US state information from [CivilServices](https://civil.services/)
    driver: csv
    args:
      urlpath: '{{ CATALOG_DIR }}/civilservices/states.csv'
    metadata:
      origin_url: 'https://github.com/CivilServiceUSA/us-states/blob/v1.0.0/data/
↪states.csv'
```

The `{{ CATALOG_DIR }}` Jinja2 variable is used to construct a path relative to where the catalog file was installed.

To build the package, you must have conda-build installed:

```
conda install conda-build
```

Building the package requires no special arguments:

```
conda build my_recipe_dir
```

Conda-build will display the path of the built package, which you will need to upload it.

If you want your data package to be publicly available on Anaconda Cloud, you can install the anaconda-client utility:

```
conda install anaconda-client
```

Then you can register your Anaconda Cloud credentials and upload the package:

```
anaconda login
anaconda upload /Users/intake_user/anaconda/conda-bld/noarch/data-us-states-1.0.0-0.
↪tar.bz2
```

5.11.2 Best Practices

Versioning

- Versions for data packages should be used to indicate changes in the data values or schema. This allows applications to easily pin to the specific data version they depend on.
- Package build numbers should be used to indicate changes in the packaging of the data (fixes to conda package metadata, like dependencies). If you need to change the data format (like CSV to Parquet), this can be indicated with a new build number, but only if the data contents and schema are identical even after the format change. (When in doubt, assign a new version number.)
- Putting data files into a package ensures reproducibility by allowing a version number to be associated with files on disk. This can consume quite a bit of disk space for the user, however. Conda does use hard-links when installing packages into an environment, so the disk space used by a data package will not multiply as it is added to more environments in the same Anaconda installation.

Packaging

- Packages that refer to remote data sources (such as databases and REST APIs) need to think about authentication. Do not include authentication credentials inside a data package. They should be obtained from the environment.
- Data packages should depend on the Intake plugins required to read the data, or Intake itself.
- Although it is technically possible to embed plugin code into a data package, this is discouraged. It is better to break that code out into a separate package so that it can be updated independent of the data.
- Anaconda Cloud accounts have disk usage limits, so be careful uploading data packages there. You may want to host them on a separate web server or cloud storage bucket. conda index will help you construct the required JSON metadata to host conda packages.

5.12 Plotting

Intake provides a plotting API based on the hvPlot library, which closely mirrors the pandas plotting API but generates interactive plots using HoloViews and Bokeh.

The hvPlot website provides comprehensive documentation on using the plotting API to quickly visualize and explore small and large datasets. The main features offered by the plotting API include:

- Support for tabular data stored in pandas and dask dataframes
- Support for gridded data stored in xarray backed nD-arrays
- Support for plotting large datasets with datashader

Using Intake alongside hvPlot allows declaratively persisting plot declarations and default options in the regular catalog.yaml files.

5.12.1 Setup

For detailed installation instructions see the getting started section in the hvPlot documentation. To start with install hvplot using conda:

```
conda install -c conda-forge hvplot
```

or using pip:

```
pip install hvplot
```

5.12.2 Usage

The plotting API is designed to work well in and outside the Jupyter notebook, however when using it in JupyterLab the PyViz lab extension must be installed first:

```
jupyter labextension install @pyviz/jupyterlab_pyviz
```

For detailed instructions on displaying plots in the notebook and from the Python command prompt see the hvPlot user guide.

Python Command Prompt & Scripts

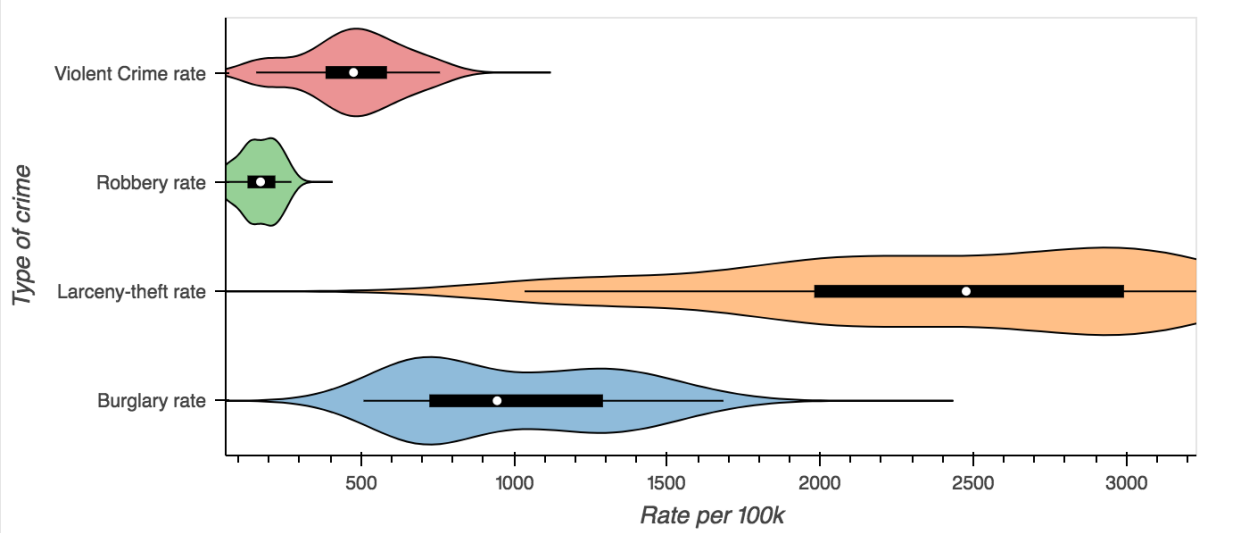
Assuming the US Crime dataset has been installed (in this repo's *examples/* directory, or from conda with *conda install -c intake us_crime*):

Once installed the plot API can be used, by using the `.plot` method on an intake `DataSource`:

```
import intake
import hvplot as hp

crime = intake.cat.us_crime
columns = ['Burglary rate', 'Larceny-theft rate', 'Robbery rate', 'Violent Crime rate
↪']

violin = crime.plot.violin(y=columns, group_label='Type of crime',
                           value_label='Rate per 100k', invert=True)
hp.show(violin)
```



Notebook

Inside the notebook plots will display themselves, however the notebook extension must be loaded first. The extension may be loaded by importing `hvplot.intake` module or explicitly loading the holoviews extension, or by calling `intake.output_notebook()`:

```
# To load the extension run this import
import hvplot.intake

# Or load the holoviews extension directly
import holoviews as hv
hv.extension('bokeh')

# convenience function
import intake
intake.output_notebook()

crime = intake.cat.us_crime
columns = ['Violent Crime rate', 'Robbery rate', 'Burglary rate']
crime.plot(x='Year', y=columns, value_label='Rate (per 100k people)')
```

Predefined Plots

Some catalogs will define plots appropriate to a specific data source. These will be specified such that the user gets the right view with the right columns and labels, without having to investigate the data in details - this is idea for quick-look plotting when browsing sources.

```
import intake
intake.us_crime.plots
```

Returns *['example']*. This works whether accessing the entry object or the source instance. To visualise

```
intake.us_crime.plot.example()
```

5.12.3 Persisting metadata

Intake allows catalog yaml files to declare metadata fields for each data source which are made available alongside the actual dataset. The plotting API reserves certain fields to define default plot options, to label and annotate the data fields in a dataset and to declare pre-defined plots.

Declaring defaults

The first set of metadata used by the plotting API is the *plot* field in the metadata section. Any options found in the metadata field will apply to all plots generated from that data source, allowing the definition of plotting defaults. For example when plotting a fairly large dataset such as the NYC Taxi data, it might be desirable to enable datashader by default ensuring that any plot that supports it is datashaded. The syntax to declare default plot options is as follows:

```
sources:
  nyc_taxi:
    description: NYC Taxi dataset
    driver: parquet
    args:
      urlpath: 's3://datashader-data/nyc_taxi_wide.parq'
    metadata:
      plot:
        datashade: true
```

Declaring data fields

The columns of a CSV or parquet file or the coordinates and data variables in a NetCDF file often have shortened, or cryptic names with underscores. They also do not provide additional information about the units of the data or the range of values, therefore the catalog yaml specification also provides the ability to define additional information about the *fields* in a dataset.

Valid attributes that may be defined for the data *fields* include:

- *label*: A readable label for the field which will be used to label axes and widgets
- *unit*: A unit associated with the values inside a data field
- *range*: A range associated with a field declaring limits which will override those computed from the data

Just like the default plot options the *fields* may be declared under the metadata section of a data source:

```
sources:
  nyc_taxi:
    description: NYC Taxi dataset
    driver: parquet
    args:
      urlpath: 's3://datashader-data/nyc_taxi_wide.parq'
    metadata:
      fields:
        dropoff_x:
          label: Longitude
        dropoff_y:
          label: Latitude
        total_fare:
          label: Fare
          unit: $
```

Declaring custom plots

As shown in the hvPlot user guide, the plotting API provides a variety of plot types, which can be declared using the *kind* argument or via convenience methods on the plotting API, e.g. *cat.source.plot.scatter()*. In addition to declaring default plot options and field metadata data sources may also declare custom plot, which will be made available as methods on the plotting API. In this way a catalogue may declare any number of custom plots alongside a datasource.

To make this more concrete consider the following custom plot declaration on the *plots* field in the metadata section:

```
sources:
  nyc_taxi:
    description: NYC Taxi dataset
    driver: parquet
    args:
      urlpath: 's3://datashader-data/nyc_taxi_wide.parq'
    metadata:
      plots:
        dropoff_scatter:
          kind: scatter
          x: dropoff_x
          y: dropoff_y
          datashade: True
          width: 800
          height: 600
```

This declarative specification creates a new custom plot called *dropoff_scatter*, which will be available on the catalog under *cat.nyc_taxi.plot.dropoff_scatter()*. Calling this method on the plot API will automatically generate a datashaded scatter plot of the dropoff locations in the NYC taxi dataset.

Of course the three metadata fields may also be used together, declaring global defaults under the *plot* field, annotations for the data *fields* under the *fields* key and custom plots via the *plots* field.

5.13 Plugin Directory

This is a list of known projects which install driver plugins for Intake, and the named drivers each contains in parentheses:

- builtin to Intake (`catalog`, `csv`, `intake_remote`, `ndzarr`, `numpy`, `textfiles`, `yaml_file_cat`, `yaml_files_cat`)
- intake-astro Table and array loading of FITS astronomical data (`fits_array`, `fits_table`)
- intake-accumulo Apache Accumulo clustered data storage (`accumulo`)
- intake-avro: Apache Avro data serialization format (`avro_table`, `avro_sequence`
- intake-cmip: load CMIP (Coupled Model Intercomparison Project) data (`cmip5`)
- intake-bluesky: search and retrieve data in the bluesky data model
- intake-dynamodb link to Amazon DynamoDB (`dynamodb`)
- intake-elasticsearch: Elasticsearch search and analytics engine (`elasticsearch_seq`, `elasticsearch_table`)
- intake-geopandas: load ESRI Shape Files with geopandas (`shape`)
- intake-hbase: Apache HBase database (`hbase`)
- intake-iris load netCDF and GRIB files with IRIS (`grib`, `netcdf`)

- intake-mongo: MongoDB noSQL query (`mongo`)
- intake-netflow: Netflow packet format (`netflow`)
- intake-odbc: ODBC database (`odbc`)
- intake-parquet: Apache Parquet file format (`parquet`)
- intake-pcap: PCAP network packet format (`pcap`)
- intake-postgres: PostgreSQL database (`postgres`)
- intake-s3-manifests (`s3_manifest`)
- intake-solr: Apache Solr search platform (`solr`)
- intake-spark: data processed by Apache Spark (`spark_cat`, `spark_rdd`, `spark_dataframe`)
- intake-sql: Generic SQL queries via SQLAlchemy (`sql_cat`, `sql`, `sql_auto`, `sql_manual`)
- intake-splunk: Splunk machine data query (`splunk`)
- intake-xarray: load netCDF, Zarr and other multi-dimensional data (`xarray_image`, `netcdf`, `opendap`, `rasterio`, `remote-xarray`, `zarr`)

The status of these projects is available at Status Dashboard.

Don't see your favorite format? See *Making Drivers* for how to create new plugins.

Note that if you want your plugin listed here, open an issue in the Intake issue repository and add an entry to the status dashboard repository. We also have a plugin wishlist Github issue that shows the breadth of plugins we hope to see for Intake.

5.14 Roadmap

Some high-level work that we expect to be achieved ont he time-scale of months. This list is not exhaustive, but rather aims to whet the appetite for what Intake can be in the future.

Since Intake aims to be a community of data-oriented pythoneers, nothing written here is laid in stone, and users and devs are encouraged to make their opinions known!

5.14.1 Broaden the coverage of formats

Data-type drivers are easy to write, but still require some effort, and therefore reasonable impetus to get the work done. Conversations over the coming months can help determine the drivers that should be created by the Intake team, and those that might be contributed by the community.

5.14.2 Streaming Source

Many data sources are inherently time-sensitive and event-wise. These are not covered well by existing Python tools, but the `streamz` library may present a nice way to model them. From the Intake point of view, the task would be to develop a streaming type, and at least one data driver that uses it.

The most obvious place to start would be read a file: every time a new line appears in the file, an event is emitted. This is appropriate, for instance, for watching the log files of a web-server, and indeed could be extended to read from an arbitrary socket.

5.14.3 Persistence

Intake is not in the business or *writing* data. However, each of the container types do lend themselves to a particular on-disc format, wherever they came from. This proposal is to allow for a persist method on every source, which loads the data and saves it to a configured storage location (local or remote), and automatically adds an entry to some "persisted data" catalog. Such entries may be time-restricted and eventually expire, or perhaps automatically renew themselves.

This is the counterpart to caching, which involves making local copies of remote files. Here we can save anything, for example the output of an expensive SQL query.

5.14.4 Next-generation GUI

The jupyter-widgets GUI is useful and simple, but we can do better. See the long form proposal.

5.14.5 Catalog services

We are experimenting with reflecting external catalog-like data servers as Intake catalogs, so that the familiar API can be used for all the disparate services. See for example this discussion.

5.14.6 Use DAT as a cache service

The [DAT protocol](https://datproject.org/)

5.15 Glossary

Cache Local copies of remote files. Intake allows for download-on-first-use for data-sources, so that subsequent access is much faster, see *Caching Source Files Locally*. The format of the files is unchanged in this case, but may be decompressed.

Catalog A collection of entries, each of which corresponds to a specific *Data-set*. Within Intake, a catalog is most commonly defined in a *YAML* file, but there are other possibilities, such as connecting to an Intake server or another third-party data service, like a SQL database. Thus, catalogs form a hierarchy: any catalog can contain other, nested catalogs.

Conda A package and environment management package for the python ecosystem, see the conda website. Conda ensures dependencies and correct versions are installed for you, provides precompiled, binary-compatible software, and extends to many languages beyond python, such as R, javascript and C.

Conda package A single installable item which the *Conda* application can install. A package may include a *Catalog*, data-files and maybe some additional code. It will also include a specification of the dependencies that it requires (e.g., Intake and any additional *Driver*), so that Conda can install those automatically. Packages can be created locally, or can be found on anaconda.org or other package repositories.

Container One of the supported data formats. Each *Driver* outputs its data in one of these. The containers correspond to familiar data structures for end-analysis, such as list-of-dicts, Numpy nd-array or Pandas data-frame.

Data-set A specific collection of data. The type of data (tabular, multi-dimensional or something else) and the format (file type, data service type) are all attributes of the data-set. In addition, in the context of Intake, data-sets are usually entries within a *Catalog* with additional descriptive text and metadata and a specification of *how* to load the data.

Data Source An Intake specification for a specific *Data-set*. In most cases, the two terms are synonymous.

Data User A person who uses data to produce models and other inferences/conclusions. This person generally uses standard python analysis packages like Numpy, Pandas, SKLearn and may produce graphical output. They will want to be able to find the right data for a given job, and for the data to be available in a standard format as quickly and easily as possible. In many organisations, the appropriate job title may be Data Scientist, but research scientists and BI/analysts also fit this description.

Data Provider A person whose main objective is to curate data sources, get them into appropriate formats, describe the contents, and disseminate the data to those that need to use them. Such a person may care about the specifics of the storage format and backing store, the right number of fields to keep and removing bad data. They may have a good idea of the best way to visualise any give data-set. In an organisation, this job may be known as Data Engineer, but it could as easily be done by a member of the IT team. These people are the most likely to author *Catalogs*.

Developer A person who writes or fixes code. In the context of Intake, a developer may make new format *Drivers*, create authentication systems or add functionality to Intake itself. They can take existing code for loading data in other projects, and use Intake to add extra functionality to it, for instance, remote data access, parallel processing, or file-name parsing.

Driver The thing that does the work of reading the data for a catalog entry is known as a driver, often referred to using a simple name such as "csv". Intake has a plugin architecture, and new drivers can be created or installed, and specific catalogs/data-sets may require particular drivers for their contained data-sets. If installed as *Conda* packages, then these requirements will be automatically installed for you. The driver's output will be a *Container*, and often the code is a simpler layer over existing functionality in a third-party package.

GUI A Graphical User Interface. Intake comes with a GUI for finding and selecting data-sets, see *GUI*.

IT The Information Technology team for an organisation. Such a team may have control of the computing infrastructure and security (sys-ops), and may well act as gate-keepers when exposing data for use by other colleagues. Commonly, IT has stronger policy enforcement requirements that other groups, for instance requiring all data-set copy actions to be logged centrally.

Persist A process of making a local version of a data-source. One canonical format is used for each of the container types, optimised for quick and parallel access. This is particularly useful if the data takes a long time to acquire, perhaps because it is the result of a complex query on a remote service. The resultant output can be set to expire and be automatically refreshed, see *Persisting Data*. Not to be confused with the *cache*.

Plugin Modular extra functionality for Intake, provided by a package that is installed separately. The most common type of plugin will be for a *Driver* to load some particular data format; but other parts of Intake are pluggable, such as authentication mechanisms for the server.

Server A remote source for Intake catalogs. The server will provide data source specifications (i.e., a remote *Catalog*), and may also provide the raw data, in situations where the client is not able or not allowed to access it directly. As such, the server can act as a gatekeeper of the data for security and monitoring purposes. The implementation of the server in Intake is accessible as the `intake-server` command, and acts as a reference: other implementations can easily be created for specific circumstances.

TTL Time-to-live, how long before the give entity is considered to have expired. Usually in seconds.

YAML A text-based format for expressing data with a dictionary (key-value) and list structure, with a limited number of data-types, such as strings and numbers. YAML uses indentations to nest objects, making it easy to read and write for humans, compared to JSON. Intake's catalogs and config are usually expressed in YAML files.

5.16 Server Protocol

This page gives deeper details on how the Intake *server* is implemented. For those simply wishing to run and configure a server, see the *Command Line Tools* section.

Communication between the intake client and server happens exclusively over HTTP, with all parameters passed using msgpack UTF8 encoding. The server side is implemented by the module `intake.cli.server`. Currently, only the following two routes are available:

- `http://server:port/v1/info`
- `http://server:port/v1/source`.

The server may be configured to use auth services, which, when passed the header of the incoming call, can determine whether the given request is allowed. See *Authorization Plugins*.

5.16.1 GET /info

Retrieve information about the data-sets available on this server. The list of data-sets may be paginated, in order to avoid excessively long transactions. Notice that the catalog for which a listing is being requested can itself be a data-source (when `source_id` is passed) - this is how nested sub-catalogs are handled on the server.

Parameters

- `page_size`, int or none (optional): to enable pagination, set this value. The number of entries returned will be this value at most. If None, returns all entries.
- `page_offset`, int (optional): when paginating, start the list from this numerical offset. The order of entries is guaranteed if the base catalog has not changed.
- `source_id`, uuid string (optional): when the catalog being accessed is not the route catalog, but an open data-source on the server, this is its unique identifier. See `POST /source` for how these IDs are generated. If the catalog being accessed is the root Catalog, this parameter should be omitted.

Returns

- `version`, string: the server's Intake version
- `sources`, list of objects: the main payload, where each object contains a `name`, and the result of calling `.describe()` on the corresponding data-source, i.e., the container type, description, metadata.
- `metadata`, object: any metadata associated with the whole catalog

5.16.2 GET /source

Fetch information about a specific source. This is the random-access variant of the `GET /info` route, by which a particular data-source can be accessed without paginating through all of the sources.

Parameters

- `name`, string (required): the data source name being accessed, one of the members of the catalog
- `source_id`, uuid string (optional): when the catalog being accessed is not the root catalog, but an open data-source on the server, this is its unique identifier. See `POST /source` for how these IDs are generated. If the catalog being accessed is the root Catalog, this parameter should be omitted.

Returns

Same as one of the entries in `sources` for `GET /info`: the result of `.describe()` on the given data-source in the server

5.16.3 POST /source, action="search"

Searching a Catalog returns search results in the form of a new Catalog. This "results" Catalog is cached on the server the same as any other Catalog.

Paramters

- `source_id`, uuid string (optional): When the catalog being searched is not the root catalog, but a subcatalog on the server, this is its unique identifier. If the catalog being searched is the root Catalog, this parameter should be omitted.
- `query`: tuple of `(args, kwargs)`: These will be unpacked into `Catalog.search` on the server to create the "results" Catalog.

Returns

- `source_id`, uuid string: the identifier of the results Catalog in the server's source cache

5.16.4 POST /source, action="open"

This is a more involved processing of a data-source, and, if successful, returns one of two possible scenarios:

- direct-access, in which all the details required for reading the data directly from the client are passed, and the client then creates a local copy of the data source and needs no further involvement from the server in order to fetch the data
- remote-access, in which the client is unable or unwilling to create a local version of the data-source, and instead created a remote data-source which will fetch the data for each partition from the server.

The set of parameters supplied and the server/client policies will define which method of access is employed. In the case of remote-access, the data source is instantiated on the server, and `.discover()` run on it. The resulting information is passed back, and must be enough to instantiate a subclass of `intake.container.base.RemoteSource` appropriate for the container of the data-set in question (e.g., `RemoteArray` when `container="ndarray"`). In this case, the response also includes a UUID string for the open instance on the server, referencing the cache of open sources maintained by the server.

Note that "opening" a data entry which is itself is a catalog implies instantiating that catalog object on the server and returning its UUID, such that a listing can be made using `GET/ info` or `GET /source`.

Parameters

- `name`, string (required): the data source name being accessed, one of the members of the catalog
- `source_id`, uuid string (optional): when the catalog being accessed is not the root catalog, but an open data-source on the server, this is its unique identifier. If the catalog being accessed is the root Catalog, this parameter should be omitted.
- `available_plugins`, list of string (optional): the set of named data drivers supported by the client. If the driver required by the data-source is not supported by the client, then the source must be opened remote-access.

- `parameters`, object (optional): user parameters to pass to the data-source when instantiating. Whether or not direct-access is possible may, in principle, depend on these parameters, but this is unlikely. Note that some parameter default value functions are designed to be evaluated on the server, which may have access to, for example, some credentials service (see *Parameter Definition*).

Returns

If direct-access, the driver plugin name and set of arguments for instantiating the data-soruce in the client.

If remote-access, the data-source container, schema and source-ID so that further reads can be made from the server.

5.16.5 POST /source, action="read"

This route fetches data from the server once a data-source has been opened in remote-access mode.

Parameters

- `source_id`, uuid string (required): the identifier of the data-source in the server's source cache. This is returned when `action="open"`.
- `partition`, int or tuple (optional, but necessary for some sources): section/chunk of the data to fetch. In cases where the data-source is partitioned, the client will fetch the data one partition at a time, so that it will appear partitioned in the same manner on the client side for iteration of passing to Dask. Some data-sources do not support partitioning, and then this parameter is not required/ignored.
- `accepted_formats`, `accepted_compression`, list of strings (required): to specify how serialization of data happens. This is an expert feature, see docs in the module `intake.container.serializer`.

CHAPTER 6

Indices and tables

- genindex
- modindex
- search

Index

Symbols

A

B

C

D

E

F

W

Y

Z