cobald Documentation

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Eileen Kuehn, Max Fischer

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USER DOCUMENTATION

CHAPTER

ONE

RESOURCE AND CONTROL MODEL

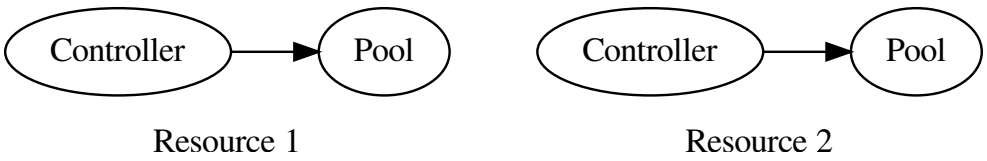
The goal of `cobald` is to simplify the provisioning of *opportunistic resources*. This is achieved with a composable model to define, aggregate, generalise and control resources. The `cobald.interfaces` codify this into a handful of primitive building blocks.

1.1 Pool and Control Model

The `cobald` model for controlling resources is built on four simple types of primitives. Two fundamental primitives represent the actual resources and the provisioning strategy:

- The adapter handling concrete resources is a `Pool`. Each Pool merely communicates the total volume of resources and their overall fitness.
- The decision to add or remove resources is made by a `Controller`. Each Controller only inspects the fitness of its Pools and adjusts their desired volume.

These two primitives are sufficient for direct control of simple resources. It is often feasible to control several pools of resources separately.

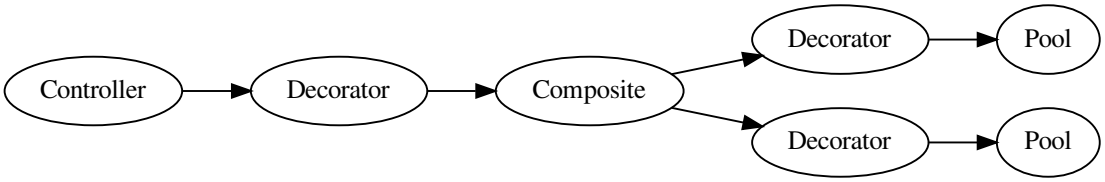


1.2 Composition and Decoration

For complex tasks it may be necessary to combine resources or change their interaction and appearance.

- The details of managing resources are encoded by `Decorator`s. Each Decorator translates between the specific *`Pool`*s and the generic *`Controller`*s.
- The combination of several resources is made by *`CompositePool`*s. Each CompositePool handles several Pools, but gives the outward appearance of a single Pool.

All four primitives can be combined to express even complex resource and control scenarios. However, there is always a *`Controller`* on one end and a *`Pool`* on the other. Since individual primitives can be combined and reused, new use cases require only a minimum of new implementations.



Resource 1 and 2

1.3 Detail Descriptions

1.3.1 Resource Abstraction via Pools

The fundamental abstraction for resources is the `Pool`: a representation for a *number* of *indistinguishable* resources.

As far as `cobald` is concerned, it is inconsequential which specific resources make up a pool. This allows each `Pool` to implement its own strategy for managing resources. For example, a `Pool` providing virtual machines may silently spawn a new machine to replace another.

The purpose of a `Pool` is just to *provide* resources, not use them for any specific task. For example, the aforementioned VM may integrate into a Batch System which provides the VM with work. What matters to `cobald` is only whether resources match their underlying usage.

Supply and Demand

Each `Pool` effectively provides only one type of resources[1]. The only adjustment possible from the outside is how many resources are provided. This is expressed as `supply` and `demand`:

`supply` [r/o]
: The amount of resources a pool currently provides.

`demand` [r/w]
: The amount of resources a pool is expected to provide.

[1] What constitutes a single "type" depends on the intended use of the resource. For example, it might be a generic "bytes of storage space" or a specific "consecutive bytes of HDD at 10 ms access time and 2500000 hrs MTBF".

Note that `demand` is not derived by a `Pool`, but should be adjusted from the outside. The task of a `Pool` is only to adjust its supply to match demand.

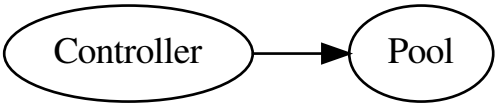
Allocation versus Utilisation

While a `Pool` does not calculate the demand for its resources, it has to track and expose their usage. This is expressed as two attributes that reflect *how much* and *how well* resources are used:

`allocation` [r/o]
: Fraction of the supplied resources which are allocated for usage

`utilisation` [r/o]
: Fraction of the supplied resources which are actively used

1.3.2 Transparent Demand Control



1.3.3 Composing Pools of Resources

CHAPTER

TWO

DAEMON INFRASTRUCTURE AND FACILITIES

The *cobald.daemon* provides the infrastructure to deploy one or more *resource control pipelines*. Any component integrated into this infrastructure can be configured and controlled in the same fashion.

2.1 Component Configuration

Configuration of the *cobald.daemon* is performed at startup via one of two methods: a YAML file or Python code. While the former is more structured and easier to verify, the latter allows for greater freedom.

The configuration file is the only positional argument when launching the *cobald.daemon*. The file extension determines the type of configuration interface to use - `.py` for Python files and `.yaml` for YAML files.

```
$ python3 -m cobald.daemon /etc/cobald/config.yaml
$ python3 -m cobald.daemon /etc/cobald/config.py
```

2.1.1 The YAML Interface

The top level of a YAML configuration file is a mapping with two sections: the `pipeline` section setting up a pool control pipeline, and the `logging` section setting up the logging facilities. The `logging` section is optional and follows the standard configuration dictionary schema.[1]

The `pipeline` section must contain a sequence of `Controller`s, `Decorator`s and `Pool`s. Each `pipeline` is constructed in reverse order: the *last* element should be a `Pool` and is constructed first, then recursively passed to its predecessor for construction.

```
# pool becomes the target of the controller
pipeline:
    - !LinearController
      low_utilisation: 0.9
      high_utilisation: 1.1
    - !CpuPool
      interval: 1
```

[1] YAML configurations allow for additional sections to configure plugins. Additional sections are *logged* to the "`cobald.runtime.config`" channel.

Object References

YAML configurations support `!!` tag and `!` constructor syntax. These allow to use arbitrary Python objects and registered plugins, respectively. Both support keyword and positional arguments.

```yaml
# generic python tag for arbitrary objects
!!python/object:cobald.controller.linear.LinearController {low_utilisation: 0.9}
# constructor tag for registered plugin
!LinearController
low_utilisation: 0.9
```

New in version 0.9.3.

Note: The YAML configuration is read using `yaml.SafeLoader` to avoid arbitrary code execution. Objects must be marked as safe for loading, either as *COBalD plugins* or using PyYAML directly.

A legacy format using explicit type references is available, but discouraged. This uses an invocation mechanism that can use arbitrary callables to construct objects: each mapping with a `__type__` key is invoked with its items as keyword arguments, and the optional `__args__` as positional arguments.

```yaml
pipeline:
    # same as ``package.module.callable(a, b, keyword1="one", keyword2="two")
    - __type__: package.module.callable
      __args__:
        - a
        - b
      keyword1: one
      keyword2: two
```

Deprecated since version 0.9.3: Use YAML tags and constructors instead.

2.1.2 Python Code Inclusion

Python configuration files are loaded like regular modules. This allows to define arbitrary types and functions, and directly chain components or configure logging. At least one pipeline of `Controller`s, `Decorator`s and `Pool`s should be instantiated.

```python
from cobald.controller.linear import LinearController

from cobald_demo.cpu_pool import CpuPool
from cobald_demo.draw_line import DrawLineHook

pipeline = LinearController.s(
    low_utilisation=0.9, high_allocation=1.1
) >> CpuPool()
```

As regular modules, Python configurations must explicitly import the components they use. In addition, everything not bound to a name will be garbage collected. This allows configurations to use temporary objects, e.g. reading from files or sockets, but means persistent objects (such as a pipeline) must be bound to a name.

2.2 Standard Logging Facilities

The *cobald.daemon* provides several separate `logging` channels. Each exposes information from a different view and for a different audience. Both core components and plugins should hook into these channels to supply appropriate information.

2.2.1 Logging Channels

Channels are separated by a hierarchical `logging` name.

"cobald.runtime"
: Diagnostic information on the health of the daemon and its abstractions. This includes resources initialised (e.g. databases or modules), and any failures that may affect daemon stability (e.g. unavailable resources).

"cobald.control"
: Information specific to the pool control model. This includes decisions made and statistics used for this purpose.

"cobald.monitor"
: Monitoring information for automated processing.

Log providers hook into channels by creating a sub-logger. For example, the daemon core uses the `"cobald.runtime.daemon"` logger for diagnostics.

The Monitor Channel

In contrast to other channels, the `"cobald.monitor"` channel provides structured data. This data is suitable for data transfer formats such as JSON or telegraf. Each entry consists of an identifier and a dictionary of data:

```
# get a separate logger in the 'cobald.monitor' channel
logger = logging.getLogger('cobald.monitor.wheatherapi')
# `message` forms the identifier, `args` contains data
logger.info('forecast', {'temperature': 298, 'humidity': 0.45})
```

Note that the message is *not* formatted with the content of *args* ` The specific output format is defined by the `logging.Formatter` used for a `logging.Handler`.

LineProtocolFormatter
: Formatter for the InfluxDB Line Protocol, as used by InfluxDB and Telegraf. This is a structured format, without access to the underlying report metadata. The report message always acts as the measurement key.

  Supports adding default data as tags, e.g. as `LineProtocolFormatter({'latitude': 49, 'longitude': 8})`.

  ```
  forecast,latitude=49,longitude=8 humidity=0.45,temperature=298
  ```

cobald.monitor.format_json.JsonFormatter
: Formatter for the JSON format. This is an unstructured format, with optional access to the underlying report metadata.

  Supports adding default data, e.g. as `JsonFormatter({'latitude': 49, 'longitude': 8})`.

  ```
  {"latitude": 49, "longitude": 8, "temperature": 298, "humidity": 0.45,
  "message": "forecast"}
  ```

2.3 Concurrent Execution

The *cobald.daemon* provides a dedicated concurrent execution environment. This combines several execution mechanisms into a single, consistent runtime. As a result, the daemon can consistently track the lifetime of tasks and react to failures.

The purpose of this is for components to execute concurrently, while ensuring each component is in a valid state. In this regard, the execution environment is similar to an init service such as systemd.

2.3.1 Registering Background Services

The primary entry point to the runtime is defining services: the main threads of service instances are automatically started, tracked and handled by the *cobald.daemon*. This allows services to update information, manage resources and react to changing conditions.

A service is defined by applying the `service()` decorator to a class. This automatically schedules the `run` method of any instances for execution as a background task.

```
@service(flavour=threading)
class MyService(object):
    # run method of any instances is executed in a thread once the daemon starts
    def run():
        ...
```

2.3.2 Task Execution and Abortion

Any background task is adopted by the daemon runtime. Adopted tasks are executed separately for each flavour; this means that `async` code of the same flavour is never run in parallel. However, tasks of non-`async` flavour, such as `threading`, and different flavours can be run in parallel.

Any adopted tasks are considered self-contained by the runtime. Most importantly, they have no parent that can receive return values or exceptions.

> **Warning:** Any unhandled return values and exceptions are considered an error. The daemon automatically terminates in this case.

On termination, the daemon aborts all remaining background tasks. Whether this is graceful or not depends on the flavour of each task. In general, coroutines are gracefully terminated whereas subroutines are not.

2.3.3 Triggering Background Tasks

The execution environment is exposed as *cobald.daemon.runtime*, an instance of `ServiceRunner`. Via this entry point, new tasks may be launched after the daemon has started.

`runtime.adopt(payload, *args, flavour, **kwargs)`

Run a `payload` of the appropriate `flavour` in the background. The caller is not blocked, but cannot receive any return value or exceptions.

> **Note:** It is a fatal error if `payload` produces any value or exception.

runtime.execute(payload, *args, flavour, **kwargs)

Run a `payload` of the appropriate `flavour` until completion. The caller is blocked during execution, and receives any return value or exceptions.

If `*args` or `**kwargs` are provided, the `payload` is run as `payload(*args, **kwargs)`.

2.3.4 Available Flavours

Flavours are identified by the underlying module. The following types are currently supported:

`asnycio`

Coroutines implemented with the `asyncio` library. Payloads are gracefully cancelled.

`trio`

Coroutines implemented with the `trio` library. Payloads are gracefully cancelled.

`threading`

Subroutines implemented with the `threading` library. Payloads run as daemons and ungracefully terminated.

2.4 systemd Configs

You can run `cobald` as a system service. We provide systemd configs for multiple `cobald` instances run as services. You can manage several instances which are identified with a systemd instance name.

Create a file named `cobald@.service` in the `/usr/lib/systemd/system` directory.

An example of a systemd config file:

```
[Unit]
Description=COBalD - the Opportunistic Balancing Daemon for %I
Documentation=https://cobald.readthedocs.io
After=network.target
Wants=network-online.target
After=network-online.target

[Install]
RequiredBy=multi-user.target

[Service]
Type=simple
ExecStart=/usr/bin/python3 -m cobald.daemon /etc/cobald/%i.py
```

In this example, the configs for the different COBalD instances are located at `/etc/cobald/instance-name.py`. `cobald` can handle `.py` and `.yaml` configuration files. Please ensure that the chosen python interpreter has `cobald` installed! We recommend to use a `virtualenv`. By using a `virtualenv` you have to set the `ExecStart` to `ExecStart={{ virtualenv }}/bin/python -m cobald.daemon /etc/cobald/%i.yaml`.

After you created or changed the file you need to run:

```
$ systemctl daemon-reload
```

Now you can manage the `cobald` instance which loads the `/etc/cobald/instance-name.py` config file.

- start one instance of `cobald`

```
$ systemctl start cobald@instance-name
```

- stop the instance of `cobald`

```
$ systemctl stop cobald@instance-name
```

- report the current status of the `cobald` instance

```
$ systemctl status cobald@instance-name
```

- enable `cobald` instance start at boot time

```
$ systemctl enable cobald@instance-name
```

CHAPTER

THREE

CUSTOM CONTROLLERS, POOLS AND EXTENSIONS

The *cobald.daemon* is capable of loading any modules and code importable by its Python interpreter. In addition, plugins can be registered for fast access in configuration files. Extensions are integrated as classes that satisfy the *Controller*, *Pool* or `Decorator` interfaces. Internally, extensions can be organized and implemented as required.

3.1 Custom Pool Semantics

Adding new types of resources requires writing a new *cobald.interfaces.Pool* implementation. While adherence to the interface ensures compatibility, a custom Pool must also conform to some constraints for consistency.

3.1.1 Behaviour of Pool Implementations

The conventions on Pools are minimal, but their prevalence makes following them critical. Basically, the conventions are implied by the semantics of a Pool's properties.

Responsiveness of Properties
: The properties *supply*, *demand*, *allocation*, and *utilisation* should respond similar to regular attributes. Getting and setting properties should return quickly - avoid lengthy computations, queries and interactions with external processes. Never use locking for arbitrary times.

  If you wish to represent external or complex state, buffer values and react to them or update them at regular intervals.

Ordering of Utilisation and Allocation
: The model of *allocation* and *utilisation* assumes that only allocated resources can be utilised. As such, *allocation* should generally be greater than *utilisation*. Note that this is a loose assumption that is not enforced. Deviations due to precision or timing should not have a significant impact.

  If you have use-cases where this assumption is not applicable, such as overbooking, you may want to write your own *cobald.interfaces.Controller*.

Common Utilisation and Allocation scenarios

Depending on the actual resources to manage, it might not be possible to accurately track *allocation* or *utilisation*. Furthermore, at times it is not desirable to use meaningless accuracy. This is why *allocation* and *utilisation* are purposely unrestrictive. The following illustrates several scenarios how to define the two consistently.

Multi-Dimensional Allocations

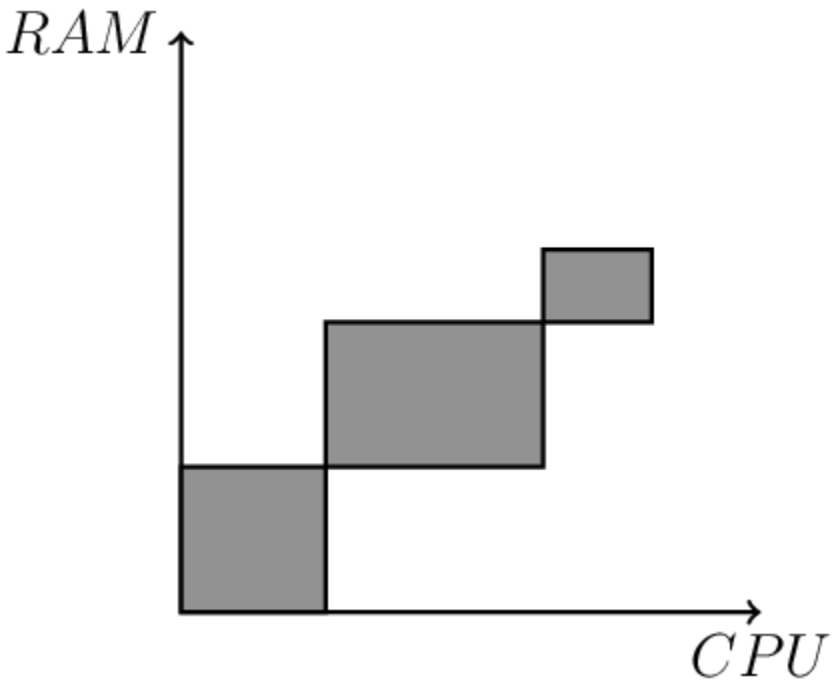


Fig. 1: Allocation of CPU and RAM

3.2 Using and Distributing Extensions

Extensions for `cobald` are regular Python code accessible to the interpreter. For specific problems, extensions can be defined directly in a Python configuration file. General purpose and reusable code should be made available as a Python package. This ensures proper installation and dependency management, and allows quick access from YAML configuration files.

3.2.1 Configuration Files

Using Python *configuration files* allows to define arbitrary objects, functions and helpers. This is ideal for minor modifications of existing objects and experimental extensions. Simply add new definitions to the configuration before using them:

```
#/etc/cobald/my_demo.py
from cobald.interface import Controller

from cobald_demo.cpu_pool import CpuPool
from cobald_demo.draw_line import DrawLineHook


# custom Controller implementation
class StaticController(Controller):
    """Controller that sets demand to a fixed value"""
    def __init__(self, target, demand):
        super().__init__(target)
        self.target.demand = demand
```

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```
# use custom Controller
pipeline = StaticController.s(demand=50) >> DrawLineHook.s() >> CpuPool(interval=1)
```

Configuration files are easy to use and modify, but impractical for reusable extensions.

3.2.2 Python Packages

For generic extensions, Python packages simplify distribution and reuse. Packages are individual *.py* files or folders containing several *.py* files; in addition, packages contain metadata for dependency management and installation.

```
# my_controller.py
from cobald.interfaces import Controller

class StaticController(Controller):
    def __init__(self, target, demand):
        super().__init__(target)
        self.target.demand = demand
```

Packages can be temporarily accessed via `PYTHONPATH` or permanently installed. Once available, packages can be imported and used in any configuration.

```
#/etc/cobald/my_demo.py
from my_controller import StaticController

from cobald_demo.cpu_pool import CpuPool
from cobald_demo.draw_line import DrawLineHook

# use custom Controller from package
pipeline = StaticController.s(demand=50) >> DrawLineHook.s() >> CpuPool(interval=1)
```

Packages require additional effort to create and use, but are easier to automate and maintain. As with any package, authors should follow the PyPA recommendations for python packaging.

The `setup.py` File

The `setup.py` file contains the metadata to install, update and manage a package. For extension packages, it should contain a dependency on `cobald` and the keywords should mention `cobald` for findability.

```
# setup.py

setup(
    # dependency on `cobald` core package
    install_requires=[
        'cobald',
        ...
    ],
    # searchable on pypi index
    keywords='... cobald',
    ...
)
```

YAML Configuration Plugins

Packages may define two different types of plugins for the *YAML configuration* format: readers for entire configuration sections, and tags for individual configuration elements.

Note: YAML Plugins only apply to the YAML configuration format. They have no effect if the Python configuration format is used.

YAML Tag Plugins

Tag Plugins allow to execute extensions as configuration elements by using YAML tag syntax, such as `!MyExtension`. Extensions are treated as callables and receive arguments depending on the type of their element: mappings are used as keyword arguments, and sequences are used as positional arguments.

```
# resolves to ExtensionClass(foo=2, bar="Hello World!")
- !MyExtension
  foo: 2
  bar: "Hello World!"
# resolves to ExtensionClass(2, "Hello World!")
- !MyExtension
  - 2
  - "Hello World!"
```

A packages can declare any callable as a Tag Plugin by adding it to the `cobald.config.yaml_constructors` group of `entry_points`; the name of the entry is converted to a Tag when evaluating the configuration. For example, a plugin class `ExtensionClass` defined in `mypackage.mymodule` can be made available as `MyExtension` in this way:

```
setup(
    ...,
    entry_points={
        'cobald.config.yaml_constructors': [
            'MyExtension = mypackage.mymodule:ExtensionClass',
        ],
    },
    ...
)
```

Hint: Tag Plugins are primarily intended to add custom *Controller*, `Decorator`, and *Pool* types for a COBalD `pipeline`. If a plugin implements a *s()* method, this is used automatically.

Note: If a plugin requires eager loading of its YAML configuration, decorate it with `cobald.daemon.plugins.yaml_tag()`.

New in version 0.12.3: The `cobald.daemon.plugins.yaml_tag()` and eager evaluation.

Section Plugins

Section Plugins allow to accept and digest new configuration sections. In addition, the `cobald` daemon verify that there are no unexpected configuration sections to protect against typos and misconfiguration. Extensions are entire top-level sections in the YAML file, which are passed to the plugin after parsing and tag evaluation:

```
# standard cobald pipeline
pipeline:
    - !DummyPool
# passes [{'some_key': 'a', 'more_key': 'b'}, 'foobar', TagPlugin()]
# to the Plugin requesting 'my_plugin'
my_plugin:
  - some_key: a
    more_key: b
  - foobar
  - !TagPlugin
```

A packages can declare any callable as a Section Plugin by adding it to the `cobald.config.sections` group of `entry_points`; the name of the entry is the top-level name of the configuration section. For example, a plugin callable `ConfigReader` defined in `mypackage.mymodule` can request the configuration section `my_plugin` in this way:

```
setup(
    ...,
    entry_points={
        'cobald.config.sections': [
            'my_plugin = mypackage.mymodule:ConfigReader',
        ],
    },
    ...
)
```

Note: If a plugin must always be covered by configuration, or should run before or after another plugin, decorate it with `cobald.daemon.plugins.constraints()`.

New in version 0.12: The `cobald.daemon.plugins.constraints()` and dependency resolution.

The `cobald` Namespace

The top-level `cobald` package itself is a namespace package. This allows the COBalD developers to add, remove or split sub-packages. In order to not conflict with the core development, do *not* add your own packages to the `cobald` namespace.

CHAPTER

FOUR

GLOSSARY OF TERMS

Opportunistic Resources
: Any resources available for but not dedicated to a specific task. This includes resources which are acquired temporarily, but not owned permanently. Strongly put, any resource borrowed for usage outside of its dedicated purpose. This includes performing a non-dedicated task instead of idling in the absence of a dedicated task.

Indistinguishable Resources
: Any resources that are equally suited to fulfill the same tasks. It is irrelevant which specific resource serves which task. This does not imply strict equality, merely that any differences are inconsequential or negligible.

Pool
: A collection of resources which are *indistinguishable*.

CHAPTER

FIVE

COBALD

5.1 cobald namespace

5.1.1 Subpackages

cobald.composite package

Submodules

cobald.composite.factory module

class cobald.composite.factory.**FactoryPool**(**args*, ***kwargs*)

Bases: *CompositePool*

Composition that adds and removes pools to satisfy demand

Parameters

- **factory** – a callable that produces a new *Pool*
- **interval** – how often to adjust the number of children

Adjustment uses two extensions that children must respond to adequately:

- When spawned via `factory()`, children shall already be set to their expected `demand`.
- When disabled via `demand=0`, children shall shut down and free any resources and tasks.

Once spawned, children are free to adjust their demand if required. A child may disable itself permanently by setting its own `demand = 0`. The *FactoryPool* inspects the demand for all its children before spawning or disabling any children.

Any child which satisfies `supply > 0` **or** `demand > 0` is considered active and contributes to the *FactoryPool* `supply`, `demand`, `allocation`, and `utilisation`. The *FactoryPool* makes no assumption about the validity or fitness of active children. It is the responsibility of children to report their status accordingly. For example, if a child shuts down and does not allocate its `supply` further, it should scale its reported `allocation` accordingly.

property allocation

Fraction of the provided resources which are assigned for usage

property children

The individual resource providers making up this pool

property demand
: The volume of resources to be provided by this pool

async run()
: Service entry point

property supply
: The volume of resources that is provided by this pool

property utilisation
: Fraction of the provided resources which are actively used

cobald.composite.uniform module

class cobald.composite.uniform.**UniformComposite**(**children:* Pool)

Bases: *CompositePool*

Uniform composition of several pools, with each pool weighted the same

property allocation
: Fraction of the provided resources which are assigned for usage

children = []

property demand
: The volume of resources to be provided by this pool

property supply
: The volume of resources that is provided by this pool

property utilisation
: Fraction of the provided resources which are actively used

cobald.composite.weighted module

class cobald.composite.weighted.**WeightedComposite**(**children:* Pool, *weight: typing_extensions.Literal[supply, utilisation, allocation] = 'supply'*)

Bases: *CompositePool*

Composition of pools weighted by their current state

The aggregation of children's *demand*, *utilisation* and *allocation* is weighted by each child's `weight`. Children can be weighted by their *supply*, *utilisation* or *allocation*. Note that weighting the *demand* only applies to *distributing* it to children; the composite's *demand* is always exactly as set by its controller.

If the total weight is 0, the following fallback applies:

- *demand* is applied uniformly, and
- *utilisation* and *allocation* are assumed 1 if there are no children, 0 otherwise.

The latter rule expresses that the total fitness of a Pool is 0 either if the fitness of all its children is 0, or there are no children.

property allocation
: Fraction of the provided resources which are assigned for usage

children = []

property demand

The volume of resources to be provided by this pool

property supply

The volume of resources that is provided by this pool

property utilisation

Fraction of the provided resources which are actively used

cobald.controller package

Submodules

cobald.controller.linear module

class cobald.controller.linear.**LinearController**(**args*, ***kwargs*)

Bases: *Controller*

Controller that linearly increases or decreases demand

Parameters

- **target** – the pool to manage
- **low_utilisation** – pool utilisation below which resources are decreased
- **high_allocation** – pool allocation above which resources are increased
- **rate** – maximum change of demand in resources per second
- **interval** – interval between adjustments in seconds

regulate(*interval*)

async run()

Service entry point

cobald.controller.relative_supply module

class cobald.controller.relative_supply.**RelativeSupplyController**(**args*, ***kwargs*)

Bases: *Controller*

Controller that adjusts demand relative to supply

Parameters

- **target** – the pool to manage
- **low_utilisation** – pool utilisation below which resources are decreased
- **high_allocation** – pool allocation above which resources are increased
- **low_scale** – scale of `target.supply` when decreasing resources
- **high_scale** – scale of `target.supply` when increasing resources
- **interval** – interval between adjustments in seconds

regulate(*interval*)

async run()

Service entry point

cobald.controller.stepwise module

cobald.controller.stepwise.**ControlRule**

Individual control rule for a pool on a given interval

When a rule for a *Stepwise* is invoked, it receives the `pool` to manage and the `interval` elapsed since the last modification. It should either *return* the new *demand*, or `None` to indicate no change; the latter can also mean that the function does not hit a `return` statement.

\ rule(pool: Pool, interval: float) -> Optional[float]

Note that a rule should *not* modify the `pool` directly.

alias of `Callable`[[*Pool*, `float`], `Optional`[`float`]]

class cobald.controller.stepwise.**RangeSelector**(*base: Callable[[*Pool*, float], Optional[float]]*, **rules: Tuple[float, Callable[[*Pool*, float], Optional[float]]]*)

Bases: `object`

Container that stores rules for the range of their supply bounds

Parameters

- **base** – base rule that has no lower bound
- **rules** – lower bound and its control rule

get_rule(*supply: float*)

class cobald.controller.stepwise.**Stepwise**(**args*, ***kwargs*)

Bases: *Controller*

Controller that selects from several strategies based on supply

See

UnboundStepwise allows creating *Stepwise* instances via decorators.

async run()

Service entry point

class cobald.controller.stepwise.**UnboundStepwise**(*base: Callable[[*Pool*, float], Optional[float]]*)

Bases: `object`

Decorator interface for constructing a *Stepwise* controller

Apply this as a decorator to a *ControlRule* callable to create a basic controller skeleton. The initial callable forms the base rule. Additional rules can be added for specific *supply* thresholds using *add()*.

The skeleton can be used like a regular *Controller*: calling it with a *Pool* and update `interval` creates a *Controller* instance with the given rules for the *Pool*.

```
# initial controller skeleton from base case
@stepwise
def control(pool: Pool, interval):
    return 10
```

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```
# additional rules above specific supply thresholds
@control.add(supply=10)
def quantized(pool: Pool, interval):
    if pool.utilisation < 0.5:
        return pool.demand - 1
    elif pool.allocation > 0.5:
        return pool.demand + 1

@control.add(supply=100)
def continuous(pool: Pool, interval):
    if pool.utilisation < 0.5:
        return pool.demand * 1.1
    elif pool.allocation > 0.5:
        return pool.demand * 0.9

# create controller from skeleton
pipeline = control(pool, interval=10)
```

add(*rule: Callable[[Pool, float], Optional[float]]*, *, *supply: float*) → Callable[[*Pool*, float], Optional[float]]

add(*rule: None*, *, *supply: float*) → Callable[[Callable[[*Pool*, float], Optional[float]]], Callable[[*Pool*, float], Optional[float]]]

Register a new rule above a given `supply` threshold

Registration supports a single-argument form for use as a decorator, as well as a two-argument form for direct application. Use the former for `def` or `class` definitions, and the later for `lambda` functions and existing callables.

```
@control.add(supply=10)
def linear(pool, interval):
    if pool.utilisation < 0.75:
        return pool.supply - interval
    elif pool.allocation > 0.95:
        return pool.supply + interval

control.add(
    lambda pool, interval: pool.supply * (
        1.2 if pool.allocation > 0.75 else 0.9
    ),
    supply=100
)
```

s(**args*, ***kwargs*) → *Partial*[*Stepwise*]

Create an unbound prototype of this class, partially applying arguments

```
@stepwise
def control(pool: Pool, interval):
    return 10

pipeline = control.s(interval=20) >> pool
```

Note

The partial rules are sealed, and *add()* cannot be called on it.

cobald.controller.stepwise.**stepwise**
alias of *UnboundStepwise*

cobald.controller.switch module

class cobald.controller.switch.**DemandSwitch**(**args*, ***kwargs*)
Bases: *Controller*

Controller that dispatches to slaved controllers based on demand

```
DemandSwitch(pool, linear_control, 10, supply_control)
```

Parameters

- **target** – the pool on which to regulate demand
- **default** – controller to use by default
- **slaves** – pairs of minimum demand to switch and corresponding controller
- **interval** – interval between adjustments in seconds

regulate(*interval*)

async run()
Service entry point

cobald.daemon package

cobald.daemon.**runtime = <cobald.daemon.runners.service.ServiceRunner object>**
The runner invoked on daemon startup

cobald.daemon.**service**(*flavour*)
Mark a class as implementing a Service

Each Service class must have a `run` method, which does not take any arguments. This method is *adopt()*ed after the daemon starts, unless

- the Service has been garbage collected, or
- the ServiceUnit has been `cancel()`ed.

For each service instance, its *ServiceUnit* is available at `service_instance.__service_unit__`.

Subpackages

cobald.daemon.config package

Submodules

cobald.daemon.config.mapping module

exception cobald.daemon.config.mapping.**ConfigurationError**(*what: Any*, *where: Optional[str] = None*)

Bases: Exception

cobald.daemon.config.mapping.**M**

type of a mapping element, matching JSON/YAML

alias of TypeVar('M', str, int, float, bool, dict, list)

class cobald.daemon.config.mapping.**SectionPlugin**(*section: str*, *digest: Callable[[M], Any]*, *requirements: PluginRequirements*)

Bases: Generic[*M*]

Plugin to digest a top-level configuration section

Parameters

- **section** – Name of the section to digest
- **digest** – callable that receives the section
- **requirements** – plugin requirements

property after

property before

digest

classmethod load(*entry_point: EntryPoint*) → *SectionPlugin*

Load a plugin from a pre-parsed entry point

Parses the following options:

required
If present implies `required=True`.

before=other
This plugin must be processed before `other`.

after=other
This plugin must be processed after `other`.

property required

requirements

section

class cobald.daemon.config.mapping.**Translator**

Bases: object

Translator from a mapping to an initialised object hierarchy

construct(*mapping: dict*, ***kwargs*)

Construct an object from a mapping

Parameters

- **mapping** – constructor definition, with `__type__` and keyword arguments
- **kwargs** – additional keyword arguments to pass to the constructor

static load_name(*absolute_name: str*)

Load an object based on an absolute, dotted name

translate_hierarchy(*structure: M*, *, *where: str = ''*, ***construct_kwargs*) → M

cobald.daemon.config.mapping.**configure_logging**(*logging_mapping: dict*)

cobald.daemon.config.mapping.**load_configuration**(*config_data: Dict[str, Any]*, *plugins: Tuple[SectionPlugin] = ()*) → Dict[*SectionPlugin*, Any]

Load the configuration from a mapping, applying plugins to sections

Parameters

- **config_data** – the raw configuration without any plugins applied
- **plugins** – all plugins that *might* apply, in order

Returns

the output of all applied plugins

cobald.daemon.config.python module

cobald.daemon.config.python.**load_configuration**(*path*)

Load a configuration from a module stored at `path`

The `path` must end in a valid file extension for the appropriate module type, such as `.py` or `.pyc` for a plaintext or bytecode python module.

Raises

`ValueError` – if the extension does not mark a known module type

cobald.daemon.config.yaml module

cobald.daemon.config.yaml.**load_configuration**(*path: str*, *loader: ~typing.Type[~yaml.loader.BaseLoader] = <class 'yaml.loader.SafeLoader'>*, *plugins: ~typing.Tuple[~cobald.daemon.config.mapping.SectionPlugin] = ()*)

cobald.daemon.config.yaml.**yaml_constructor**(*factory: Callable[[...], R]*, *, *eager: bool = False*) → Callable[[...], R]

Convert a factory function/class to a YAML constructor

Parameters

- **factory** – the factory function/class
- **eager** – whether the YAML must be evaluated eagerly

Returns

factory constructor

Applying this helper to a factory allows it to be used as a YAML constructor, without it knowing about YAML itself. It properly constructs nodes and converts mapping nodes to `factory(**node)`, sequence nodes to `factory(*node)`, and scalar nodes to `factory()`.

For example, registering the constructor `yaml_constructor(factory)` as `!factory` means the following YAML is converted to `factory(a=0.3, b=0.7)`:

```
- !factory
  a: 0.3
  b: 0.7
```

Since YAML can express recursive data, nested data structures are evaluated lazily by default. Set `eager=True` to enforce eager evaluation before calling the constructor.

cobald.daemon.core package

Submodules

cobald.daemon.core.cli module

cobald.daemon.core.config module

class cobald.daemon.core.config.**COBalDLoader**(*stream*)

Bases: SafeLoader

Loader with access to COBalD configuration constructors

class cobald.daemon.core.config.**PipelineTranslator**

Bases: *Translator*

Translator for cobald pipelines

This allows for YAML configurations to have one or several `pipeline` elements. Each `pipeline` is translated as a series of nested elements, the way a *Controller* receives a *Pool*.

```
pipeline:
    # same as ``package.module.callable(a, b, keyword1="one", keyword2="two")
    - __type__: package.module.Controller
      interval: 20
    - __type__: package.module.Pool
```

translate_hierarchy(*structure*, *, *where=''*, ***construct_kwargs*)

cobald.daemon.core.config.**add_constructor_plugins**(*entry_point_group: str*, *loader: Type[BaseLoader]*) → None

Add PyYAML constructors from an entry point group to a loader

Parameters

- **loader** – the PyYAML loader which uses the plugins
- **entry_point_group** – entry point group to search

Note: This directly modifies the `loader` by calling `add_constructor()`.

cobald.daemon.core.config.**load**(*config_path: str*)

Load a configuration and keep it alive for the given context

Parameters
config_path – path to a configuration file

cobald.daemon.core.config.**load_pipeline**(*content: list*)

Load a cobald pipeline of Controller >> … >> Pool from a configuration section

Parameters
content – content of the configuration section

Returns

cobald.daemon.core.config.**load_section_plugins**(*entry_point_group: str*) → Tuple[*SectionPlugin*]

Load configuration plugins from an entry point group

Parameters
entry_point_group – entry point group to search

Returns
all loaded plugins

cobald.daemon.core.logger module

cobald.daemon.core.logger.**create_handler**(*target: str*)

Create a handler for logging to `target`

cobald.daemon.core.logger.**initialise_logging**(*level: str*, *target: str*, *short_format: bool*)

Initialise basic logging facilities

cobald.daemon.core.main module

Daemon core specific to cobald

cobald.daemon.core.main.**cli_run**()

Run the daemon from a command line interface

cobald.daemon.core.main.**run**(*configuration: str*, *level: str*, *target: str*, *short_format: bool*)

Run the daemon and all its services

cobald.daemon.runners package

Submodules

cobald.daemon.runners.async_tools module

cobald.daemon.runners.asyncio_runner module

class cobald.daemon.runners.asyncio_runner.**AsyncioRunner**(*asyncio_loop: AbstractEventLoop*)

Bases: *BaseRunner*

Runner for coroutines with `asyncio`

All active payloads are actively cancelled when the runner is closed.

async aclose()

Shut down this runner

flavour = <module 'asyncio' from '/home/docs/.pyenv/versions/3.7.9/lib/python3.7/asyncio/__init__.py'>

async manage_payloads()

Implementation of managing payloads when *run()*

This method must continuously execute payloads sent to the runner. It may only return when `stop()` is called or if any orphaned payload return or raise. In the latter case, *OrphanedReturn* or the raised exception must re-raised by this method.

register_payload(*payload: Callable[[], Awaitable]*)

Register `payload` for background execution in a threadsafe manner

This runs `payload` as an orphaned background task as soon as possible. It is an error for `payload` to return or raise anything without handling it.

run_payload(*payload: Callable[[], Coroutine]*)

Execute `payload` and return its result in a threadsafe manner

This runs `payload` as soon as possible, blocking until completion. Should `payload` return or raise anything, it is propagated to the caller.

cobald.daemon.runners.asyncio_watcher module

cobald.daemon.runners.base_runner module

class cobald.daemon.runners.base_runner.**BaseRunner**(*asyncio_loop: AbstractEventLoop*)

Bases: `object`

Concurrency backend on top of *asyncio*

abstract async aclose()

Shut down this runner

flavour = None

abstract async manage_payloads()

Implementation of managing payloads when *run()*

This method must continuously execute payloads sent to the runner. It may only return when *stop()* is called or if any orphaned payload return or raise. In the latter case, *OrphanedReturn* or the raised exception must re-raised by this method.

async ready()

Wait until the runner is ready to accept payloads

abstract register_payload(*payload*)

Register `payload` for background execution in a threadsafe manner

This runs `payload` as an orphaned background task as soon as possible. It is an error for `payload` to return or raise anything without handling it.

async run()

Execute all current and future payloads in an *asyncio* coroutine

This method will continuously execute payloads sent to the runner. It only returns when *stop()* is called or if any orphaned payload returns or raises. In the latter case, *OrphanedReturn* or the raised exception is re-raised by this method.

Implementations should override *manage_payloads()* to customize their specific parts.

abstract run_payload(*payload*)

Execute `payload` and return its result in a threadsafe manner

This runs `payload` as soon as possible, blocking until completion. Should `payload` return or raise anything, it is propagated to the caller.

stop()

Stop execution of all current and future payloads and block until success

exception cobald.daemon.runners.base_runner.**OrphanedReturn**(*who*, *value*)

Bases: Exception

A runnable returned a value without anyone to receive it

cobald.daemon.runners.guard module

cobald.daemon.runners.guard.**exclusive**(*via=<built-in function allocate_lock>*) → Callable[[C], C]

Mark a callable as exclusive

Parameters
via – factory for a Lock to guard the callable

Guards the callable against being entered again before completion. Explicitly raises a RuntimeError on violation.

Note
If applied to a method, it is exclusive across all instances.

cobald.daemon.runners.meta_runner module

class cobald.daemon.runners.meta_runner.**MetaRunner**

Bases: object

Unified interface to schedule subroutines and coroutines for concurrent execution

register_payload(**payloads*, *flavour: module*)

Queue one or more payloads for execution after its runner is started

run()

Run all runners, blocking until completion or error

run_payload(*payload*, ***, *flavour: module*)

Execute one payload and return its output

This method will block until the payload is completed. It is an error to call it during initialisation before the runners are started.

runner_types = (<class 'cobald.daemon.runners.trio_runner.TrioRunner'>, <class 'cobald.daemon.runners.asyncio_runner.AsyncioRunner'>, <class 'cobald.daemon.runners.thread_runner.ThreadRunner'>)

property runners

stop()

Stop all runners

cobald.daemon.runners.service module

class cobald.daemon.runners.service.ServiceRunner(*accept_delay: float = 1*)

Bases: object

Runner for coroutines, subroutines and services

The service runner prevents silent failures by tracking concurrent tasks and therefore provides safer concurrency. If any task fails with an exception or provides unexpected output values, this is registered as an error; the runner will gracefully shut down all tasks in this case.

To provide async concurrency, the runner also manages common async event loops and tracks them for failures as well. As a result, async code should usually use the "current" event loop directly.

accept()

Start accepting synchronous, asynchronous and service payloads

Since services are globally defined, only one *ServiceRunner* may *accept()* payloads at any time.

adopt(*payload*, **args*, *flavour: module*, ***kwargs*)

Concurrently run payload in the background

If *args* and/or **kwargs are provided, pass them to payload upon execution.

execute(*payload*, **args*, *flavour: module*, ***kwargs*)

Synchronously run payload and provide its output

If *args* and/or **kwargs are provided, pass them to payload upon execution.

shutdown()

Shutdown the accept loop and stop running payloads

class cobald.daemon.runners.service.ServiceUnit(*service*, *flavour*)

Bases: object

Definition for running a service

Parameters

- **service** – the service to run
- **flavour** – runner flavour to use for running the service

property running

start(*runner:* MetaRunner)

classmethod units() → Set[*ServiceUnit*]

Container of all currently defined units

cobald.daemon.runners.service.**service**(*flavour*)

Mark a class as implementing a Service

Each Service class must have a `run` method, which does not take any arguments. This method is *adopt()*ed after the daemon starts, unless

- the Service has been garbage collected, or
- the ServiceUnit has been `cancel()`ed.

For each service instance, its *ServiceUnit* is available at `service_instance.__service_unit__`.

cobald.daemon.runners.thread_runner module

class cobald.daemon.runners.thread_runner.**ThreadRunner**(*asyncio_loop: AbstractEventLoop*)

Bases: *BaseRunner*

Runner for subroutines with `threading`

Active payloads are *not* cancelled when the runner is closed. Only program termination forcefully cancels leftover payloads.

async aclose()

Shut down this runner

flavour = <module 'threading' from '/home/docs/.pyenv/versions/3.7.9/lib/python3.7/threading.py'>

async manage_payloads()

Implementation of managing payloads when *run()*

This method must continuously execute payloads sent to the runner. It may only return when `stop()` is called or if any orphaned payload return or raise. In the latter case, *OrphanedReturn* or the raised exception must re-raised by this method.

register_payload(*payload*)

Register `payload` for background execution in a threadsafe manner

This runs `payload` as an orphaned background task as soon as possible. It is an error for `payload` to return or raise anything without handling it.

run_payload(*payload*)

Execute `payload` and return its result in a threadsafe manner

This runs `payload` as soon as possible, blocking until completion. Should `payload` return or raise anything, it is propagated to the caller.

cobald.daemon.runners.trio_runner module

class cobald.daemon.runners.trio_runner.**TrioRunner**(*asyncio_loop: AbstractEventLoop*)

Bases: *BaseRunner*

Runner for coroutines with `trio`

All active payloads are actively cancelled when the runner is closed.

async aclose()

Shut down this runner

flavour = <module 'trio' from '/home/docs/checkouts/readthedocs.org/user_builds/cobald/envs/0.13.0/lib/python3.7/site-packages/trio/__init__.py'>

async manage_payloads()

Implementation of managing payloads when *run()*

This method must continuously execute payloads sent to the runner. It may only return when `stop()` is called or if any orphaned payload return or raise. In the latter case, *OrphanedReturn* or the raised exception must re-raised by this method.

async ready()

Wait until the runner is ready to accept payloads

register_payload(*payload: Callable[[], Awaitable]*)

Register `payload` for background execution in a threadsafe manner

This runs `payload` as an orphaned background task as soon as possible. It is an error for `payload` to return or raise anything without handling it.

run_payload(*payload: Callable[[], Coroutine]*)

Execute `payload` and return its result in a threadsafe manner

This runs `payload` as soon as possible, blocking until completion. Should `payload` return or raise anything, it is propagated to the caller.

Submodules

cobald.daemon.debug module

class cobald.daemon.debug.**NameRepr**(*target*)

Bases: `object`

Lazy pretty formatter for name of objects

cobald.daemon.debug.**pretty_module**(*obj: module*) → str

cobald.daemon.debug.**pretty_partial**(*obj: partial*) → str

cobald.daemon.debug.**pretty_ref**(*obj: Any*) → str

cobald.daemon.debug.**pretty_ref**(*obj: partial*) → str

cobald.daemon.debug.**pretty_ref**(*obj: module*) → str

Pretty object reference using `module.path:qual.name` format

cobald.decorator package

Submodules

cobald.decorator.buffer module

class cobald.decorator.buffer.**Buffer**(**args*, ***kwargs*)

Bases: *PoolDecorator*

A timed buffer for changes to a pool

Parameters

- **target** – the pool to which changes are applied
- **window** – interval after which changes are applied

Any changes made to *demand* are stored internally. Every `window` seconds, the final demand is applied to `target`.

demand = 0.0

async run()

Service entry point

cobald.decorator.coarser module

cobald.decorator.limiter module

cobald.decorator.logger module

class cobald.decorator.logger.**Logger**(*target:* Pool, *name: Optional[str] = None*, *message: str = 'demand = %(value)s [demand=%(demand)s, supply=%(supply)s, utilisation=%(utilisation).2f, allocation=%(allocation).2f]'*, *level: int = 20*)

Bases: *PoolDecorator*

Log a message on every change of `demand`

Parameters

- **name** – name of the `logging.Logger` to log to
- **message** – format for message to emit on every change
- **level** – numerical logging level

The `message` parameter is used as a `%`-style format string with named fields. Valid named format fields are

value
for the new demand being set,

demand, supply, utilisation and allocation
for the current state of `target`, and

target
for the `target` pool itself.

For example, a `message` of `"adjust demand from %(demand)s to %(value)s"` will log the old and new demand value.

Deprecated since version 0.12.2: The `consumption` format field. Use `allocation` instead.

property demand

The volume of resources to be provided by this site

property name: `str`

cobald.decorator.standardiser module

class cobald.decorator.standardiser.**Standardiser**(*target:* Pool, *minimum:* *float* = *-inf*, *maximum:* *float* = *inf*, *granularity:* *int* = *1*, *backlog:* *float* = *inf*, *surplus:* *float* = *inf*)

Bases: *PoolDecorator*

Limits for changes to the demand of a pool

Parameters

- **target** – the pool on which changes are standardised
- **minimum** – minimum `target.demand` allowed
- **maximum** – maximum `target.demand` allowed
- **granularity** – granularity of `target.demand`
- **surplus** – how much `target.demand` may be above `target.supply`
- **backlog** – how much `target.demand` may be below `target.supply`

The `supply` and `backlog` clamp the `demand` such that `supply - backlog <= demand <= supply + surplus` holds.

The default values apply no limits at all so that isolated limits may be used. When several limits are set, `granularity` has the weakest priority, both `surplus` and `backlog` may limit the result of `granularity`, and `minimum` and `maximum` overrule all other limits.

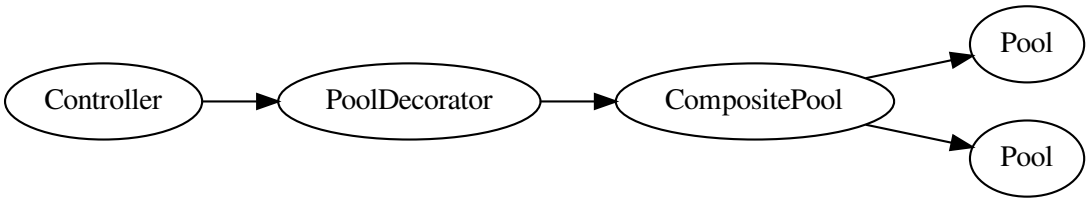
property demand: `float`

The volume of resources to be provided by this site

cobald.interfaces package

Interfaces for primitives of the `cobald` model

Each *Pool* provides a varying number of resources. A *Controller* adjusts the number of resources that a *Pool* must provide. Several *Pool*s can be combined in a single *CompositePool* to appear as one. To modify how a *Pool* presents or digests data, any number of *PoolDecorator* may proceed it.



class cobald.interfaces.**CompositePool**

Bases: *Pool*

Concatenation of multiple providers for a number of indistinguishable resources

abstract property allocation: *float*

Fraction of the provided resources which are assigned for usage

abstract property children: *List[Pool]*

The individual resource providers making up this pool

abstract property demand

The volume of resources to be provided by this pool

abstract property supply

The volume of resources that is provided by this pool

abstract property utilisation: *float*

Fraction of the provided resources which are actively used

class cobald.interfaces.**Controller**(*target:* Pool)

Bases: object

Controller adjusting the demand in a *Pool*

Parameters
target – the resource pool for which demand is adjusted

classmethod s(**args*, ***kwargs*) → *Partial*[C]

Create an unbound prototype of this class, partially applying arguments

```
controller = Controller.s(interval=20)

pipeline = controller(rate=10) >> pool
```

class cobald.interfaces.**Partial**(*ctor: Type[C_co]*, **args*, *__leaf__*, ***kwargs*)

Bases: Generic[C_co]

Partial application and chaining of Pool *Controller*s and Decorators

This class acts similar to `functools.partial`, but allows for repeated application (currying) and explicit binding via the >> operator.

```
# incrementally prepare controller parameters
control = Partial(Controller, rate=10, interval=10)
control = control(low_utilisation=0.5, high_allocation=0.9)

# apply target by chaining
pipeline = control >> Decorator() >> Pool()
```

Note
The keyword argument `__leaf__` is reserved for internal usage.

Note
Binding *Controller*s and Decorators creates a temporary `PartialBind`. Only binding to a *Pool* as the last element creates a concrete binding.

args

ctor

kwargs

leaf

class cobald.interfaces.**Pool**

Bases: object

Individual provider for a number of indistinguishable resources

abstract property allocation: float

Fraction of the provided resources which are assigned for usage

abstract property demand: float

The volume of resources to be provided by this pool

classmethod s(**args*, ***kwargs*) → *Partial*[C]

Create an unbound prototype of this class, partially applying arguments

```
pool = RemotePool.s(port=1337)

pipeline = controller >> pool(host='localhost')
```

abstract property supply: float

The volume of resources that is provided by this pool

abstract property utilisation: float

Fraction of the provided resources which are actively used

class cobald.interfaces.**PoolDecorator**(*target:* Pool)

Bases: *Pool*

Decorator modifying how a pool provides resources

Parameters
target – the resource pool for which demand is adjusted

property allocation: float

Fraction of the provided resources which is assigned for usage

property demand

The volume of resources to be provided by this site

classmethod s(**args*, ***kwargs*) → *Partial*[C]

Create an unbound prototype of this class, partially applying arguments

```
decorator = Buffer.s(window=20)

pipeline = controller >> decorator >> pool
```

property supply

The volume of resources that is provided by this site

property utilisation: float

Fraction of the provided resources which is actively used

cobald.monitor package

Submodules

cobald.monitor.format_json module

class cobald.monitor.format_json.**JsonFormatter**(*fmt: Optional[dict] = None*, *datefmt: Optional[str] = None*)

Bases: Formatter

Formatter that emits data as JSON

Parameters

- **fmt** – default data for all records
- **datefmt** – format for timestamps

The `datefmt` parameter has almost the same meaning as `Formatter`. Setting it to `None` uses the default time format. However, setting it to any other value that is boolean false excludes the timestamp from reports.

format(*record: LogRecord*)

Format the specified record as text.

The record's attribute dictionary is used as the operand to a string formatting operation which yields the returned string. Before formatting the dictionary, a couple of preparatory steps are carried out. The message attribute of the record is computed using LogRecord.getMessage(). If the formatting string uses the time (as determined by a call to usesTime(), formatTime() is called to format the event time. If there is exception information, it is formatted using formatException() and appended to the message.

cobald.monitor.format_line module

class cobald.monitor.format_line.**LineProtocolFormatter**(*tags: Optional[Union[Dict[str, Any], Set[str]]] = None*, *resolution: Optional[float] = None*)

Bases: Formatter

Formatter that emits data as InfluxDB Line Protocol

Parameters

- **tags** – record data to use as tags
- **resolution** – resolution of timestamps in seconds

The `tags` act as a whitelist for record keys if they are an iterable. When a dictionary is supplied, its values act as default values if the key is not in a record.

The `resolution` allows summarising data by downsampling the timestamps to the given resolution, e.g. for a `resolution` of `10` you can expect timestamps 10, 20, 30, … If `resolution` is `None` the timestamp is omitted from the Line Protocol and Telegraf will take care on setting the current timestamp.

format(*record: LogRecord*) → str

Format the specified record as text.

The record's attribute dictionary is used as the operand to a string formatting operation which yields the returned string. Before formatting the dictionary, a couple of preparatory steps are carried out. The message attribute of the record is computed using LogRecord.getMessage(). If the formatting string uses the time

(as determined by a call to usesTime(), formatTime() is called to format the event time. If there is exception information, it is formatted using formatException() and appended to the message.

cobald.monitor.format_line.**escape_field**(*field: T*) → T

cobald.monitor.format_line.**escape_key**(*key: str*) → str

cobald.monitor.format_line.**line_protocol**(*name*, *tags: Optional[dict] = None*, *fields: Optional[dict] = None*, *timestamp: Optional[float] = None*) → str

Format a report as per InfluxDB line protocol

Parameters

- **name** – name of the report
- **tags** – tags identifying the specific report
- **fields** – measurements of the report
- **timestamp** – when the measurement was taken, in **seconds** since the epoch

cobald.utility package

exception cobald.utility.**InvariantError**

Bases: Exception

An invariant is violated

cobald.utility.**enforce**(*condition: bool*, *exception: BaseException = InvariantError()*)

Enforce that `condition` is set by raising `exception` otherwise

This is a replacement for `assert` statements as part of validation. It cannot be disabled with `-O` and may raise arbitrary exceptions.

```
def sqrt(value):
    condition(value > 0, ValueError('value must be greater than zero')
    return math.sqrt(value)
```

cobald.utility.**pairwise**(*iterable*)

Iterator yielding consecutive pairs from `iterable`

Submodules

cobald.utility.primitives module

CHAPTER

SIX

CHANGELOG

6.1 0.13 Series

6.1.1 Version [0.13.0] - 2022-08-16

- **[Changed]** Configuration is processed after daemon and *asyncio* initialisation
- **[Changed]** Daemon core implementation is based on *asyncio*

6.2 0.12 Series

6.2.1 Version [0.12.3] - 2021-10-29

- **[Added]** YAML `!tags` may be eagerly evaluated

6.2.2 Version [0.12.2] - 2021-09-15

- **[Fixed]** pipeline configuration may combine `__type__` and `!yaml` style
- **[Fixed]** pipeline configuration no longer suppresses `TypeError`

6.2.3 Version [0.12.1] - 2020-04-15

- **[Fixed]** fallback for fitness of WeightedComposite depends on supply

6.2.4 Version [0.12.0] - 2020-02-26

- **[Changed]** Section Plugin settings are now specified via decorators

6.3 0.11 Series

6.3.1 Version [0.11.0] - 2020-02-24

- **[Changed]** COBalD configuration files may include additional sections

6.4 0.10 Series

6.4.1 Version [0.10.0] - 2019-09-03

- **[Added]** Pools can be templated via `.s` in Python configuration files
- **[Added]** YAML configuration files support plugins via `!MyPlugin` tags
- **[Added]** the `cobald` namespace allows for external plugin packages
- **[Fixed]** fixed Line Protocol sending illegal content
- **[Security]** YAML configuration files no longer allow arbitrary `!!python/object` tags

CHAPTER

SEVEN

VERSIONING AND RELEASES

The COBalD versioning follows Semantic Versioning. Releases are automatically pushed to PyPI from the GitHub COBalD repository.

7.1 Versioning and API stability

COBalD is currently published only in the *major version zero* series. The public API is not entirely stable, and may change between releases. However, API changes are already kept to a minimum and significant API changes *SHOULD* relate to an increase of the minor version.

Packages that depend on the COBalD *major version zero* series should accept compatible release versions for minor versions. For example, a package requiring at least `cobald` version `0.12.1` should require `cobald ~= 0.12.1` to not accidentally accept `cobald >= 0.13.0`.

7.2 Release Process

There is no fixed schedule for releases; a release is manually started whenever significant changes have accumulated or a bugfix requires a prompt publication.

Note: The following section is only relevant for maintainers of COBalD.

Releases are automatically published to PyPI when a GitHub release is created. Each release should be prepared and reviewed via a pull request.

1. **Create a new branch `releases/v<version>` and pull request**
    - Add all to-be-released pull requests to the description
2. **Review all changes added by the new release**
    - Ensure naming, unittests and docs are appropriate
3. **Merge new version metadata (e.g. v3.9.2) to repository**
    - Fix change fragment version via `change log ...  release 3.9.2`
    - Adjust and commit `__version__ = "3.9.2"` in `cobald.__about__`
    - Create a git tag such as `git tag -a "v3.9.2" -m "important changes"`

Once the pull request has been reviewed and merged, create a new GitHub release.

The `cobald` is a lightweight framework to balance opportunistic resources: cloud bursting, container orchestration, allocation scaling and more. Its lightweight *model* for resources and their composition makes it easy to integrate custom resources and manage them at a large scale. The idea is as simple as it gets:

> Start good things.
>
> Stop bad things.

See also:

The cobald demo is a minimal working toy example for using `cobald`.

CHAPTER

EIGHT

QUICK INFO

In the current state, `cobald` is a research and expert tool targeting administrators and developers. You have to manually select your resource backends and compose the strategy. Still, the simplicity of `cobald` should make it accessible for interested users as well.

Getting COBalD up and running

Have a look at the cobald demo. It provides a minimal working example for running COBalD. The demo shows you how to install, configure and run your own COBalD instance.

Using COBalD to horizontally scale an HTCondor Pool

The TARDIS project provides backends to several cloud providers. This allows you to orchestrate prebuilt VM images.

CHAPTER

NINE

ABOUT

The `cobald` project originates from research on dynamically providing Cloud resources for analysts of the LHC collaborations. It supersedes past work on the ROCED Cloud resource provider, generalising its goal of provisioning opportunistic resources.

The development of `cobald` is currently organized by the GridKa and CMS research groups at KIT. We openly encourage adoption and contributions outside of KIT, LHC and our current selection of opportunistic resources. Information on deployment as well as creating and publishing custom plugins will follow.

Please contact us on github or gitter if you want to contribute.

CHAPTER

TEN

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