

# Melon - a Task Scheduling Package for Personal Todo Lists

using Markov Chain Monte-Carlo Methods

An MMSC Special Topic on [PYTHON IN SCIENTIFIC COMPUTING](#)

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## Abstract

In this project report we will review the central concepts utilised in the group work conducted to make progress in the Partial Differential Equation (PDE) problem associated with the electrochemical model of a battery cell and present numerical results.

**Our Goal:** Numerically obtain the solution  $\{a(x, T), b(x, T)\}$ .

The Finite Difference schemes are implemented in Julia and Python, whereas the Spectral Method is implemented in C++.

**Figure 1:** The Graphical User Interface (GUI) of the Spectral Solver.

# 1 Problem Introduction

UIDs are useful because they make collisions very unlikely, which is not to say that these should not be checked, but if two clients are connected that each generated a set of UIDs it is very unlikely to have to do conflict resolving.

We recommend usage with **xandikos**, a version-controlled DAV server, capable of syncing calendars (events, todos and journals) and contacts.

Published on PyPi.

## 1.1 Usage

Use `invoke -l` to list all available tasks.

```
conan install . --output-folder=build --build=missing
```

Is platform-independent, for example due to the usage of `pathlib.Path`.

# 2 Underlying Theory

The Metropolis-Hastings sub-routine ([Metropolis et al. 1953](#); [Hastings 1970](#))

---

```

1  until convergence , repeat
2    sample a candidate  $\mathbf{x}^*$ .
3    set  $\mathbf{x}^{n+1} = \mathbf{x}^*$  with acceptance probability
4       $p_{\text{accept}} = \min \left( 1, e^{-\beta(F^{n+1} - F^n)} \right)$  , with  $\beta \in \mathbb{R}^+$  a transition factor .
5    Otherwise , let  $\mathbf{x}^{n+1} = \mathbf{x}^n$  .
```

---

Which is a subroutine to an outer iteration, a technique commonly referred to as Simulated Annealing.

Simulated Annealing

---

```

1  until convergence , repeat
```

---

## 3 Code Quality

### 3.1 Formatting

### 3.2 Docstrings

### 3.3 Documentation

### 3.4 Tests

Server can be started using Docker.

As we can see using `pytest --durations=0`,

```
===== slowest durations =====
3.53s call TestScheduler::test_length[NumbaMCMCScheduler]
0.19s call TestMelon::test_init_store_and_load
(...)
```

the slowest test is the Numba scheduler which takes some time to pre-compile the functions. So even when the runtime of the Numba scheduler itself is low (cf. section 4), the test will always take some time.

#### 3.4.1 Coverage

(coverage here)

Which may be reproduced using `pytest -cov=melon`.

### 3.5 Type Checking

Using `pyright` instead of `mypy` as it is much faster.

### 3.6 Using Appropriate Language Features

Using `autoflake` and `pyupgrade`. Used `logging`.

### 3.7 Maintaining Code Quality

Using `pre-commit` and GitHub Actions CI/CD.

### 3.8 Publishing to PyPi

Published [here](#).

Although we believe it would have been possible to compile the C++ and Rust implementations on a CI service using a “platform matrix”, the published package only contains compilation targets for the x86\_64 platform and Python 3.11.

```
prettier.....Passed
fix end of files.....Passed
trim trailing whitespace.....Passed
black.....Passed
ruff.....Passed
check blanket noqa.....Passed
check for eval().....Passed
interrogate.....Passed
autoflake.....Passed
pyupgrade.....Passed
pyright.....Passed
pytest-check.....Passed
clang-format.....Passed
latex-format-all.....Passed
```

Uses `invoke` to manage common development tasks. Running `inv -l` yields the following selection of tasks:

**Table 1:** Invoke Tasks

|                                      |                                                                    |
|--------------------------------------|--------------------------------------------------------------------|
| <code>build-docs</code>              | Builds documentation using Sphinx.                                 |
| <code>compare-runtime</code>         | Compares runtime of the different scheduling implementations.      |
| <code>compile</code>                 | Assuming a full setup, compiles the low-level implementations of t |
| <code>ipython-shell</code>           | Starts an IPython shell with Melon initialised.                    |
| <code>plot-convergence</code>        | Plots scheduler convergence to a file.                             |
| <code>plot-runtime-complexity</code> | Simulates with a varying number of tasks and plots runtime comp    |
| <code>profile-scheduler</code>       | Profile the pure Python MCMC Scheduler.                            |
| <code>schedule-and-export</code>     | Run the MCMC scheduler and export the resulting events as an IC    |
| <code>start-mock-server</code>       | Starts a Xandikos (CalDAV) server on port 8000.                    |

Also have `nitpick` to synchronise linter configuration across projects.

```
1 import numpy
2 x = 5
3 print(x ** 2)
```

interrogate -v einfügen

**Table 2:** RESULT: PASSED (minimum: 80.0%, actual: 100.0%)

| Name                          | Total | Miss | Cover | Cover |
|-------------------------------|-------|------|-------|-------|
| main.py                       | 2     | 0    | 2     | 100 % |
| tasks.py                      | 8     | 0    | 8     | 100 % |
| docs/conf.py                  | 1     | 0    | 1     | 100 % |
| melon/___init___py            | 1     | 0    | 1     | 100 % |
| melon/calendar.py             | 11    | 0    | 11    | 100 % |
| melon/config.py               | 1     | 0    | 1     | 100 % |
| melon/melon.py                | 19    | 0    | 19    | 100 % |
| melon/todo.py                 | 20    | 0    | 20    | 100 % |
| melon/visualise.py            | 3     | 0    | 3     | 100 % |
| melon/scheduler/___init___py  | 1     | 0    | 1     | 100 % |
| melon/scheduler/base.py       | 10    | 0    | 10    | 100 % |
| melon/scheduler/cpp.py        | 3     | 0    | 3     | 100 % |
| melon/scheduler/numba.py      | 8     | 0    | 8     | 100 % |
| melon/scheduler/purepython.py | 12    | 0    | 12    | 100 % |
| melon/scheduler/rust.py       | 3     | 0    | 3     | 100 % |
| melongui/___init___py         | 1     | 0    | 1     | 100 % |
| melongui/calendarlist.py      | 6     | 0    | 6     | 100 % |
| melongui/mainwindow.py        | 14    | 0    | 14    | 100 % |
| melongui/taskitemdelegate.py  | 12    | 0    | 12    | 100 % |
| melongui/tasklist.py          | 14    | 0    | 14    | 100 % |
| melongui/taskwidgets.py       | 8     | 0    | 8     | 100 % |
| tests/___init___py            | 1     | 0    | 1     | 100 % |
| tests/test_melon.py           | 7     | 0    | 7     | 100 % |
| tests/test_scheduler.py       | 9     | 0    | 9     | 100 % |
| <b>TOTAL</b>                  | 175   | 0    | 175   | 100 % |

Screenshot von gnome-calendar

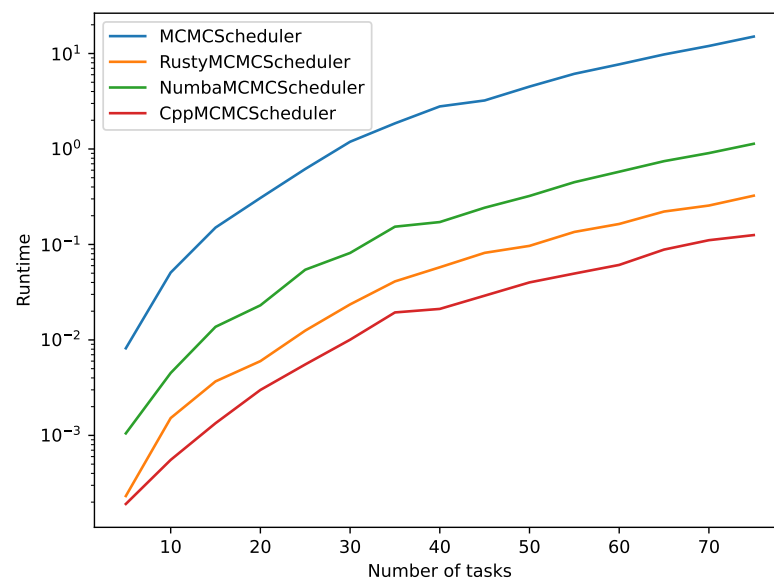
Screenshot GUI

### 3.9 Autocorrelation Analysis

### 3.10 Coole Pie-Plots mit Verteilungen

## 4 Runtime Performance

The following benchmarks were all accumulated on an x86\_64 Intel® i7-5600U CPU running at 2.6 GHz verified through 3 individual runs, keeping parameters consistent along them.



**Figure 2:** Complexity plot

```

1 In [1]: %timeit str(t.icalendar_component("uid"))
2 122 µs ± 1.06 µs per loop (7 runs, 10,000 loops each)
3 In [2]: %timeit t.vtodo.contents["uid"][0].value
4 355 ns ± 7.14 ns per loop (7 runs, 1,000,000 loops each)
5 In [3]: %timeit
6 ↪ t.vobject_instance.contents["vtodo"][0].contents["uid"][0].value
7 296 ns ± 7.06 ns per loop (7 runs, 1,000,000 loops each)
8 In [4]: %timeit
9 ↪ t._vobject_instance.contents["vtodo"][0].contents["uid"][0].value
10 208 ns ± 23.7 ns per loop (7 runs, 10,000,000 loops each)

```

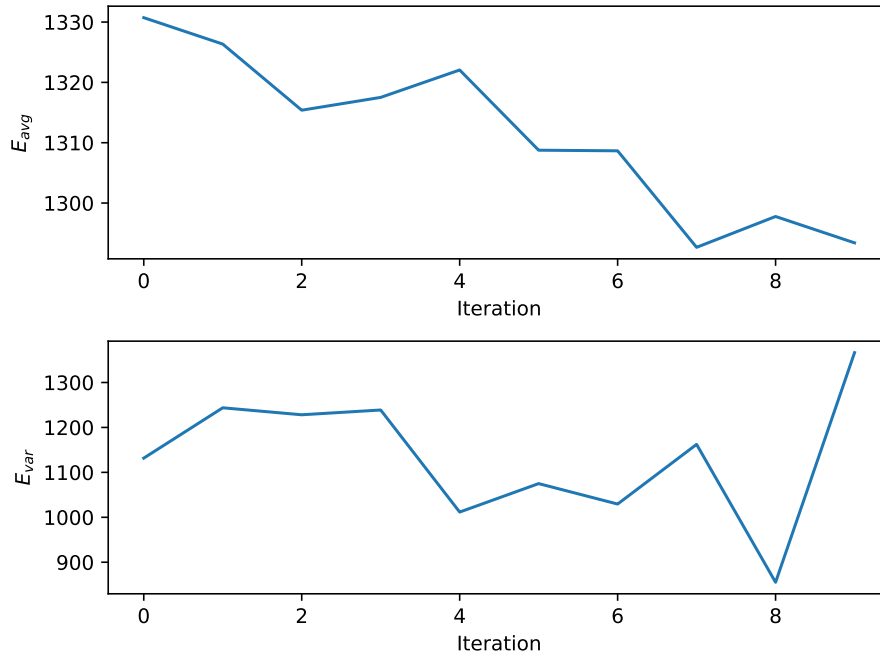
**Table 3:** Profile obtained by running `./main.py --profile & grep todo.py`.

| ncalls | tottime | percall | cumtime | percall | filename:lineno | function     |
|--------|---------|---------|---------|---------|-----------------|--------------|
| 16958  | 0.008   | 0.000   | 0.939   | 0.000   | todo.py:36      | vtodo        |
| 32475  | 0.047   | 0.000   | 0.705   | 0.000   | todo.py:96      | uid          |
| 856    | 0.003   | 0.000   | 0.579   | 0.001   | todo.py:26      | upgrade      |
| 117    | 0.000   | 0.000   | 0.489   | 0.004   | todo.py:111     | priority     |
| 417    | 0.001   | 0.000   | 0.461   | 0.001   | todo.py:121     | isIncomplete |
| 5512   | 0.003   | 0.000   | 0.278   | 0.000   | todo.py:45      | summary      |
| 856    | 0.002   | 0.000   | 0.112   | 0.000   | todo.py:21      | __init__     |
| 1363   | 0.006   | 0.000   | 0.024   | 0.000   | todo.py:164     | __lt__       |
| 7844   | 0.004   | 0.000   | 0.009   | 0.000   | todo.py:61      | dueDate      |
| 2605   | 0.001   | 0.000   | 0.003   | 0.000   | todo.py:85      | dueTime      |

**Table 4:** Profile obtained by running `inv profile-scheduler & grep purepython.py`.

| Ncalls  | Total | / call | Cum.   | / call | Filename:line  | Function         |
|---------|-------|--------|--------|--------|----------------|------------------|
| 1       | 0.000 | 0.000  | 14.236 | 14.236 | purepython:142 | schedule         |
| 10      | 0.209 | 0.021  | 14.235 | 1.424  | purepython:123 | mcmcSweep        |
| 36010   | 1.144 | 0.000  | 13.784 | 0.000  | purepython:97  | computeEnergy    |
| 2196671 | 5.391 | 0.000  | 11.353 | 0.000  | purepython:41  | spreadTasks      |
| 1006332 | 1.389 | 0.000  | 1.842  | 0.000  | purepython:27  | generateNextSlot |
| 2196610 | 0.798 | 0.000  | 0.972  | 0.000  | purepython:108 | <genexpr>        |
| 2196610 | 0.384 | 0.000  | 0.384  | 0.000  | purepython:106 | <genexpr>        |
| 36000   | 0.082 | 0.000  | 0.217  | 0.000  | purepython:83  | permuteState     |
| 36011   | 0.046 | 0.000  | 0.124  | 0.000  | purepython:19  | startingSlot     |

## 5 Results



**Figure 3:** Convergence

Numba Compilation time: 2.5625428539933637

**Table 5:** Runtime Comparison of the different implementations run on the same scenarios. Each runtime is given as the average over three runs. The finite difference schemes (for the one-dimensional case) were run with  $N_x = N_t = 4000$  up to  $T = 40$ . The spectral method was run using a series expansion of order 15, also up to  $T = 40$ . The remaining parameters ( $\alpha$ ,  $\kappa_0$ ,  $E_0$ , etc.) were all identical.

| Implementation     | Language | Runtime / seconds |
|--------------------|----------|-------------------|
| MCMCScheduler      | Python   | 16.6180           |
| NumbaMCMCScheduler | Python   | 1.3117            |
| RustyMCMCScheduler | Rust     | 0.3660            |
| CppMCMCScheduler   | C++      | 0.1513            |



## 6 Acknowledgements

The visualisation code (`visualise.py`) is adapted from *Optimising todo lists with Monte Carlo simulations.ipynb* 2023.

The task check icon is the logo of the *Tasks.org* Free and Open Source Android App, which may be found [here](#).

## References

- Hastings, W. K. (1970). ‘Monte Carlo Sampling Methods Using Markov Chains and Their Applications’. In: *Biometrika* 57, pp. 97–109. DOI: [10.1093/biomet/57.1.97](https://doi.org/10.1093/biomet/57.1.97).
- Metropolis, N., Arianna W. Rosenbluth, Marshall N. Rosenbluth, A. H. Teller and Edward Teller (1953). ‘Equation of state calculations by fast computing machines’. In: *Journal of Chemical Physics* 21, pp. 1087–1092. DOI: [10.1063/1.1699114](https://doi.org/10.1063/1.1699114).
- Optimising todo lists with Monte Carlo simulations.ipynb* (July 2023). [Online; accessed 1. Jul. 2023]. URL: <https://gist.github.com/sausheong/3997c7ba8f42278866d2d15f9e63f7ad>.

## Acronyms

|     |                               |   |
|-----|-------------------------------|---|
| GUI | Graphical User Interface      | 1 |
| PDE | Partial Differential Equation | 1 |

## MELON

Index file of the *melon* library, a task scheduling software package.

### Modules

|                        |                                                                                                                                          |
|------------------------|------------------------------------------------------------------------------------------------------------------------------------------|
| <i>melon.calendar</i>  | This module contains the Calendar class.                                                                                                 |
| <i>melon.config</i>    | This submodule only does one thing: loading configuration from the right place.                                                          |
| <i>melon.melon</i>     | This file is the main entry point of the melon package, containing the Melon class, the main point of contact for users of this package. |
| <i>melon.scheduler</i> | Melon.Scheduler library housing different implementations of an MCMC task scheduler.                                                     |
| <i>melon.todo</i>      | This module contains the Todo class.                                                                                                     |
| <i>melon.visualise</i> |                                                                                                                                          |

## 1.1 melon.calendar

This module contains the Calendar class.

### Classes

|                                                 |                                                                                                          |
|-------------------------------------------------|----------------------------------------------------------------------------------------------------------|
| <i>Calendar</i> (calendar)                      | Class representing a calendar (or todo list, if you want to call it that, this name is given by CalDAV). |
| <i>Syncable</i> (calendar, objects, sync_token) | The synchronisable collection of CalDAV objects, handling efficient syncs between server and client.     |

### 1.1.1 melon.calendar.Calendar

**class** `melon.calendar.Calendar`(*calendar: Calendar*)

Class representing a calendar (or todo list, if you want to call it that, this name is given by CalDAV). A calendar is a collection of objects that can be synced to a CalDAV server. In this implementation, the objects are stored within the *syncable* subclass.

**\_\_init\_\_**(*calendar: Calendar*) → None

A copy constructor

**Args:**

`calendar (caldav.Calendar):` Argument

#### Methods

|                                                              |                                                                                                                           |
|--------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------|
| <code>__init__(calendar)</code>                              | A copy constructor                                                                                                        |
| <code>add_event([ical, no_overwrite, no_create])</code>      | Add a new event to the calendar, with the given ical.                                                                     |
| <code>add_journal([ical, no_overwrite, no_create])</code>    | Add a new journal entry to the calendar, with the given ical.                                                             |
| <code>add_todo([ical, no_overwrite, no_create])</code>       | Add a new task to the calendar, with the given ical.                                                                      |
| <code>build_date_search_query(start[, end, ...])</code>      | WARNING: DEPRECATED                                                                                                       |
| <code>build_search_xml_query([comp_class, todo, ...])</code> | This method will produce a caldav search query as an etree object.                                                        |
| <code>calendar_multiget(event_urls)</code>                   | get multiple events' data @author <a href="mailto:mtor-ange@gmail.com">mtor-ange@gmail.com</a> @type events list of Event |
| <code>children([type])</code>                                | List children, using a propfind (resourcetype) on the parent object, at depth = 1.                                        |
| <code>createTodo([summary])</code>                           | Args:                                                                                                                     |
| <code>date_search(start[, end, compfilter, ...])</code>      | Deprecated.                                                                                                               |
| <code>delete()</code>                                        | Delete the object.                                                                                                        |
| <code>event(uid)</code>                                      |                                                                                                                           |
| <code>event_by_uid(uid)</code>                               |                                                                                                                           |
| <code>event_by_url(href[, data])</code>                      | Returns the event with the given URL                                                                                      |
| <code>events()</code>                                        | List all events from the calendar.                                                                                        |
| <code>freebusy_request(start, end)</code>                    | Search the calendar, but return only the free/busy information.                                                           |
| <code>get_display_name()</code>                              | Get calendar display name                                                                                                 |
| <code>get_properties([props, depth, ...])</code>             | Get properties (PROPFIND) for this object.                                                                                |
| <code>get_property(prop[, use_cached])</code>                |                                                                                                                           |
| <code>get_supported_components()</code>                      | returns a list of component types supported by the calendar, in string format (typically ['VJOURNAL', 'VTODO', 'VEVENT']) |
| <code>journal_by_uid(uid)</code>                             |                                                                                                                           |
| <code>journals()</code>                                      | List all journals from the calendar.                                                                                      |
| <code>loadFromFile(client, principal, name, ...)</code>      | Args:                                                                                                                     |
| <code>object_by_uid(uid[, comp_filter, comp_class])</code>   | Get one event from the calendar.                                                                                          |
| <code>objects([sync_token, load_objects])</code>             | objects_by_sync_token aka objects                                                                                         |

continues on next page

Table 1 – continued from previous page

|                                                                |                                                                                                                                    |
|----------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------|
| <code>objects_by_sync_token([sync_token, load_objects])</code> | <code>objects_by_sync_token</code> aka <code>objects</code>                                                                        |
| <code>save()</code>                                            | The save method for a calendar is only used to create it, for now.                                                                 |
| <code>save_event([ical, no_overwrite, no_create])</code>       | Add a new event to the calendar, with the given ical.                                                                              |
| <code>save_journal([ical, no_overwrite, no_create])</code>     | Add a new journal entry to the calendar, with the given ical.                                                                      |
| <code>save_todo([ical, no_overwrite, no_create])</code>        | Add a new task to the calendar, with the given ical.                                                                               |
| <code>save_with_invites(ical, attendees, ...)</code>           | sends a schedule request to the server.                                                                                            |
| <code>search([xml, comp_class, todo, ...])</code>              | Creates an XML query, does a REPORT request towards the server and returns objects found, eventually sorting them before delivery. |
| <code>set_properties([props])</code>                           | Set properties (PROPPATCH) for this object.                                                                                        |
| <code>storageObject()</code>                                   | Returns:                                                                                                                           |
| <code>storeToFile()</code>                                     | Save the calendar objects to a local file on disk, in iCal format.                                                                 |
| <code>sync()</code>                                            | Synchronise me                                                                                                                     |
| <code>todo_by_uid(uid)</code>                                  |                                                                                                                                    |
| <code>todos([sort_keys, include_completed, sort_key])</code>   | fetches a list of todo events (refactored to a wrapper around search)                                                              |

## Attributes

|                            |
|----------------------------|
| <code>canonical_url</code> |
| <code>client</code>        |
| <code>id</code>            |
| <code>name</code>          |
| <code>parent</code>        |
| <code>url</code>           |

**createTodo**(*summary: str = 'An exciting new task!'*)

**Args:**

`summary (str): Argument`

**static loadFromFile**(*client: DAVClient, principal: Principal, name: str, sync\_token: str, url: str*)

**Args:**

`client (caldav.DAVClient): Argument` `principal (caldav.Principal): Argument` `name (str): Argument` `sync_token (str): Argument` `url (str): Argument`

**storageObject**() → dict

**Returns:**

(dict):

### **storeToFile()**

Save the calendar objects to a local file on disk, in iCal format.

### **sync()**

Synchronise me

## 1.1.2 melon.calendar.Syncable

**class** `melon.calendar.Syncable(calendar, objects, sync_token)`

The synchronisable collection of CalDAV objects, handling efficient syncs between server and client.

**\_\_init\_\_**(calendar, objects, sync\_token)

### Methods

|                                                      |                                                                                                     |
|------------------------------------------------------|-----------------------------------------------------------------------------------------------------|
| <code>__init__(calendar, objects, sync_token)</code> |                                                                                                     |
| <code>objects_by_url()</code>                        | returns a dict of the contents of the SynchronizableCalendarObjectCollection, URLs -> objects.      |
| <code>sync()</code>                                  | This method will contact the caldav server, request all changes from it, and sync up the collection |
| <code>upgrade(synchronisable, calendarName)</code>   | Upgrades the third-party caldav.SynchronizableCalendarObjectCollection to a Syncable                |
| <code>upgradeObjects(calendarName)</code>            | Converts all objects in self.objects to Todos.                                                      |

### Attributes

|                         |
|-------------------------|
| <code>calendar</code>   |
| <code>objects</code>    |
| <code>sync_token</code> |

**static upgrade**(*synchronisable: SynchronizableCalendarObjectCollection, calendarName: str*) → *Syncable*

Upgrades the third-party caldav.SynchronizableCalendarObjectCollection to a Syncable

#### **Args:**

*synchronisable* (caldav.SynchronizableCalendarObjectCollection): the original instance

#### **Returns:**

(Syncable): the syncable

**upgradeObjects**(*calendarName: str*)

Converts all objects in self.objects to Todos.

## 1.2 melon.config

This submodule only does one thing: loading configuration from the right place.

## 1.3 melon.melon

This file is the main entry point of the melon package, containing the Melon class, the main point of contact for users of this package. It can be initialised like this:

```
melon = Melon() melon.autoInit()
```

### Classes

|                                             |                                                                                             |
|---------------------------------------------|---------------------------------------------------------------------------------------------|
| <code>Melon(url, username, password)</code> | The Melon class, wrapping a caldav client and principal, loading specifics from the config. |
|---------------------------------------------|---------------------------------------------------------------------------------------------|

### 1.3.1 melon.melon.Melon

```
class melon.melon.Melon(url='https://waldcloud.hopto.org:2023/dav/peter/calendars/', username='leser',
                        password='p1140')
```

The Melon class, wrapping a caldav client and principal, loading specifics from the config. Through me, users have access to calendars and todos. I also handle load, sync and store functionality.

```
__init__(url='https://waldcloud.hopto.org:2023/dav/peter/calendars/', username='leser',
        password='p1140') → None
```

Initialises the Melon client

**Args:**

url (str, optional): URL to the CalDAV server. Defaults to CONFIG["client"]["url"]. username (str, optional): Username. Defaults to CONFIG["client"]["username"]. password (str, optional): Password. Defaults to CONFIG["client"]["password"].

## Methods

|                                                      |                                                                    |
|------------------------------------------------------|--------------------------------------------------------------------|
| <code>__init__([url, username, password])</code>     | Initialises the Melon client                                       |
| <code>addOrUpdateTask(todo)</code>                   | Args:                                                              |
| <code>allIncompleteTasks()</code>                    | Returns all incomplete todos                                       |
| <code>allTasks()</code>                              | Returns an iterable of all tasks in all calendars as a single list |
| <code>autoInit()</code>                              | Args:                                                              |
| <code>connect()</code>                               | Args:                                                              |
| <code>exportScheduleAsCalendar(scheduling)</code>    | A read-only ICS calendar containing scheduled tasks.               |
| <code>fetch()</code>                                 | Args:                                                              |
| <code>findTask(string)</code>                        | Finds a task given a search query                                  |
| <code>getTask(uid)</code>                            | Returns task with given UID                                        |
| <code>load()</code>                                  | Args:                                                              |
| <code>scheduleAllAndExport(file[, Scheduler])</code> | Runs the scheduler on all tasks and exports as an ICS file.        |
| <code>store()</code>                                 | Args:                                                              |
| <code>syncAll()</code>                               | Args:                                                              |
| <code>syncCalendar(calendar)</code>                  | Args:                                                              |
| <code>tasksToSchedule()</code>                       | Returns all incomplete tasks as scheduler.Task objects             |

## Attributes

|                  |
|------------------|
| HIDDEN_CALENDARS |
|------------------|

**addOrUpdateTask**(*todo*: [Todo](#))

**Args:**

*todo* ([Todo](#)): Argument

**allIncompleteTasks**() → Iterable[[Todo](#)]

Returns all incomplete todos

**Yields:**

Iterator[Iterable[[Todo](#)]]: incomplete todos

**allTasks**() → Iterable[[Todo](#)]

Returns an iterable of all tasks in all calendars as a single list

**Yields:**

Iterator[Iterable[[Todo](#)]]: iterator of all tasks

**autoInit**()

Args:

**connect**()

Args:

**exportScheduleAsCalendar**(*scheduling*: Mapping[str, [TimeSlot](#)]) → Calendar

A read-only ICS calendar containing scheduled tasks. Can be stored to disk using `schedule.to_ical()`.



**Args:**

scheduling (Mapping[str, TimeSlot]): Mapping of task UID to TimeSlot

**Returns:**

icalendar.Calendar: the calendar containing events (time slots) proposed for the completion of tasks

**fetch()**

Args:

**findTask**(string: str) → Iterable[*Todo*]

Finds a task given a search query

**Args:**

string (str): the search query.

**Yields:**

Iterator[Iterable[*Todo*]]: the generated search results.

**getTask**(uid: str) → *Todo*

Returns task with given UID

**Args:**

uid (str): the Unique Identifier

**Raises:**

ValueError: when the task could not be found

**Returns:**

Todo: the Todo with given uid

**load()**

Args:

**scheduleAllAndExport**(file: str, Scheduler: type[melon.scheduler.base.AbstractScheduler] = <class 'melon.scheduler.purepython.MCMCScheduler'>)

Runs the scheduler on all tasks and exports as an ICS file.

**Args:**

file (str): filesystem path that the ics file should be exported to

**store()**

Args:

**syncAll()**

Args:

**syncCalendar**(calendar: *Calendar*)

**Args:**

calendar: Argument

**tasksToSchedule**() → list[melon.scheduler.base.Task]

Returns all incomplete tasks as scheduler.Task objects

**Returns:**

list[Task]: `_description_`

### 1.4 melon.scheduler

Melon.Scheduler library housing different implementations of an MCMC task scheduler.

#### Modules

|                                   |                         |
|-----------------------------------|-------------------------|
| <i>melon.scheduler.base</i>       | The scheduler algorithm |
| <i>melon.scheduler.cpp</i>        | The scheduler algorithm |
| <i>melon.scheduler.numba</i>      | The scheduler algorithm |
| <i>melon.scheduler.purepython</i> | The scheduler algorithm |
| <i>melon.scheduler.rust</i>       | The scheduler algorithm |

#### 1.4.1 melon.scheduler.base

The scheduler algorithm

#### Functions

|                                 |                                                          |
|---------------------------------|----------------------------------------------------------|
| <i>generateDemoTasks()</i>      | Generates a fixed set of demo tasks.                     |
| <i>generateManyDemoTasks(N)</i> | Generates a larger set of randomly generated demo tasks. |

#### melon.scheduler.base.generateDemoTasks

`melon.scheduler.base.generateDemoTasks()` → list[*melon.scheduler.base.Task*]  
Generates a fixed set of demo tasks.

#### melon.scheduler.base.generateManyDemoTasks

`melon.scheduler.base.generateManyDemoTasks(N: int)` → list[*melon.scheduler.base.Task*]  
Generates a larger set of randomly generated demo tasks.

#### Classes

|                                                 |                                                                                       |
|-------------------------------------------------|---------------------------------------------------------------------------------------|
| <i>AbstractScheduler</i> (tasks)                | Abstract Base Class (ABC) for schedulers.                                             |
| <i>Task</i> (uid, duration, priority, location) | Slim struct representing a task                                                       |
| <i>TimeSlot</i> (timestamp, duration)           | Slim struct representing a time slot, so an event consisting of a start and end date. |

## melon.scheduler.base.AbstractScheduler

**class** melon.scheduler.base.**AbstractScheduler**(tasks: list[melon.scheduler.base.Task])

Abstract Base Class (ABC) for schedulers.

**\_\_init\_\_**(tasks: list[melon.scheduler.base.Task]) → None

Initialises the scheduler, working on a set of pre-defined tasks.

**Args:**

tasks (list[Task]): the tasks to be scheduled

## Methods

|                              |                                                                   |
|------------------------------|-------------------------------------------------------------------|
| <code>__init__(tasks)</code> | Initialises the scheduler, working on a set of pre-defined tasks. |
| <code>schedule()</code>      | Schedules the tasks using an MCMC procedure.                      |

**schedule**() → Mapping[str, TimeSlot]

Schedules the tasks using an MCMC procedure.

**Returns:**

Mapping[str, TimeSlot]: the resulting map of Tasks to TimeSlots

## melon.scheduler.base.Task

**class** melon.scheduler.base.**Task**(uid: str, duration: float, priority: int, location: int)

Slim struct representing a task

**\_\_init\_\_**(uid: str, duration: float, priority: int, location: int) → None

## Methods

|                                                          |
|----------------------------------------------------------|
| <code>__init__(uid, duration, priority, location)</code> |
|----------------------------------------------------------|

## Attributes

|          |
|----------|
| uid      |
| duration |
| priority |
| location |

## melon.scheduler.base.TimeSlot

**class** melon.scheduler.base.**TimeSlot**(*timestamp: datetime, duration: float*)  
 Slim struct representing a time slot, so an event consisting of a start and end date.  
**\_\_init\_\_**(*timestamp: datetime, duration: float*) → None

### Methods

|                                             |
|---------------------------------------------|
| <code>__init__</code> (timestamp, duration) |
|---------------------------------------------|

### Attributes

|                  |          |
|------------------|----------|
| <i>end</i>       | Returns: |
| <i>timedelta</i> | Returns: |
| timestamp        |          |
| duration         |          |

**property end:** datetime

**Returns:**  
 datetime: the end timestamp of this time slot

**property timedelta:** timedelta

**Returns:**  
 timedelta: the duration as a datetime.timedelta instance

## 1.4.2 melon.scheduler.cpp

The scheduler algorithm

### Classes

|                                 |                                                               |
|---------------------------------|---------------------------------------------------------------|
| <i>CppMCMCScheduler</i> (tasks) | Markov Chain Monte-Carlo Task Scheduler, implemented in Rust. |
|---------------------------------|---------------------------------------------------------------|

## melon.scheduler.cpp.CppMCMCScheduler

**class** `melon.scheduler.cpp.CppMCMCScheduler`(*tasks*: list[`melon.scheduler.base.Task`])

Markov Chain Monte-Carlo Task Scheduler, implemented in Rust.

**\_\_init\_\_**(*tasks*: list[`melon.scheduler.base.Task`]) → None

Initialises the scheduler, working on a set of pre-defined tasks.

**Args:**

tasks (list[Task]): the tasks to be scheduled

### Methods

|                               |                                                                   |
|-------------------------------|-------------------------------------------------------------------|
| <code>__init__</code> (tasks) | Initialises the scheduler, working on a set of pre-defined tasks. |
| <code>schedule</code> ()      | Runs the Rust implementation of the scheduler.                    |

**schedule**() → Mapping[str, *TimeSlot*]

Runs the Rust implementation of the scheduler.

**Returns:**

Mapping[str, TimeSlot]: the resulting schedule

## 1.4.3 melon.scheduler.numba

The scheduler algorithm

### Functions

|                                                           |                                                                                       |
|-----------------------------------------------------------|---------------------------------------------------------------------------------------|
| <code>computeEnergy</code> (tasks, state)                 | For the given state, compute an MCMC energy (the lower, the better)                   |
| <code>mcmcSweep</code> (tasks, initialState, temperature) | Performs a full MCMC sweep                                                            |
| <code>permuteState</code> (state)                         | Proposes a new state to use instead of the old state.                                 |
| <code>schedule</code> (tasks)                             | Schedules the given tasks in low-level representation into calendar.                  |
| <code>spreadTasks</code> (tasks)                          | Spreads the given list of tasks across the available slots in the calendar, in order. |

## melon.scheduler.numba.computeEnergy

`melon.scheduler.numba.computeEnergy`(*tasks*: Sequence[tuple[str, float, int, int]], *state*: list[int]) → float

For the given state, compute an MCMC energy (the lower, the better)

**Args:**

state (State): state of the MCMC algorithm

**Returns:**

float: the energy / penalty for this state

### melon.scheduler.numba.mcmcSweep

`melon.scheduler.numba.mcmcSweep`(*tasks*: Sequence[tuple[str, float, int, int]], *initialState*: list[int],  
*temperature*: float) → list[int]

Performs a full MCMC sweep

**Args:**

*tasks* (Sequence[tuple[str, float, int, int]]): list of tasks  
*initialState* (State): initial ordering  
*temperature* (float): temperature for Simulated Annealing

**Returns:**

State: new state

### melon.scheduler.numba.permuteState

`melon.scheduler.numba.permuteState`(*state*: list[int]) → list[int]

Proposes a new state to use instead of the old state.

**Returns:**

State: the new state, a list of indices within tasks representing traversal order

### melon.scheduler.numba.schedule

`melon.scheduler.numba.schedule`(*tasks*: Sequence[tuple[str, float, int, int]]) → Sequence[tuple[str, float,  
float]]

Schedules the given tasks in low-level representation into calendar.

**Args:**

*tasks* (Sequence[tuple[str, float, int, int]]): vector of tasks (uid, duration, priority, location)

**Returns:**

Sequence[tuple[str, float, float]]: vector of allocated timeslots (uid, timestamp, duration)

### melon.scheduler.numba.spreadTasks

`melon.scheduler.numba.spreadTasks`(*tasks*: Sequence[tuple[str, float, int, int]]) → Sequence[tuple[str, float,  
float]]

Spreads the given list of tasks across the available slots in the calendar, in order.

**Args:**

*tasks* (Sequence[Task]): list of tasks to schedule

**Yields:**

Iterator[tuple[str, TimeSlot]]: pairs of (UID, TimeSlot), returned in chronological order

## Classes

|                                        |                                                                                     |
|----------------------------------------|-------------------------------------------------------------------------------------|
| <code>NumbaMCMCScheduler(tasks)</code> | Markov Chain Monte-Carlo Task Scheduler, implemented in Python with numba speed-up. |
|----------------------------------------|-------------------------------------------------------------------------------------|

### `melon.scheduler.numba.NumbaMCMCScheduler`

**class** `melon.scheduler.numba.NumbaMCMCScheduler`(*tasks: list[melon.scheduler.base.Task]*)

Markov Chain Monte-Carlo Task Scheduler, implemented in Python with numba speed-up.

**\_\_init\_\_**(*tasks: list[melon.scheduler.base.Task]*) → None

Initialises the scheduler, working on a set of pre-defined tasks.

**Args:**

*tasks* (list[Task]): the tasks to be scheduled

## Methods

|                                        |                                                                   |
|----------------------------------------|-------------------------------------------------------------------|
| <code>__init__</code> ( <i>tasks</i> ) | Initialises the scheduler, working on a set of pre-defined tasks. |
| <code>schedule</code> ()               | Runs the Rust implementation of the scheduler.                    |

**schedule**() → Mapping[str, *TimeSlot*]

Runs the Rust implementation of the scheduler.

**Returns:**

Mapping[str, TimeSlot]: the resulting schedule

### 1.4.4 `melon.scheduler.purepython`

The scheduler algorithm

## Classes

|                                     |                                                           |
|-------------------------------------|-----------------------------------------------------------|
| <code>AvailabilityManager</code> () | This class manages the user's availability in a calendar. |
| <code>MCMCScheduler(tasks)</code>   | MCMC class to schedule tasks to events in a calendar.     |

### `melon.scheduler.purepython.AvailabilityManager`

**class** `melon.scheduler.purepython.AvailabilityManager`

This class manages the user's availability in a calendar.

**\_\_init\_\_**() → None

Initialises the availability manager according to defaults.

## Methods

|                                         |                                                                                       |
|-----------------------------------------|---------------------------------------------------------------------------------------|
| <code>__init__()</code>                 | Initialises the availability manager according to defaults.                           |
| <code>generateNextSlot(previous)</code> | Following a daily schedule, returns the next possible working slot                    |
| <code>spreadTasks(tasks)</code>         | Spreads the given list of tasks across the available slots in the calendar, in order. |
| <code>startingSlot()</code>             | Starting slot, starting at 10am today                                                 |

**generateNextSlot**(*previous*: [TimeSlot](#)) → [TimeSlot](#)

Following a daily schedule, returns the next possible working slot

**Args:**

*previous* ([TimeSlot](#)): the previous working slot

**Returns:**

[TimeSlot](#): the next working slot

**spreadTasks**(*tasks*: [Iterable](#)[[Task](#)]) → [Iterable](#)[[tuple](#)[[str](#), [melon.scheduler.base.TimeSlot](#)]]

Spreads the given list of tasks across the available slots in the calendar, in order.

**Args:**

*tasks* ([Iterable](#)[[Task](#)]): list of tasks to schedule

**Yields:**

[Iterator](#)[[tuple](#)[[str](#), [TimeSlot](#)]]: pairs of (UID, [TimeSlot](#)), returned in chronological order

**startingSlot**() → [TimeSlot](#)

Starting slot, starting at 10am today

**Returns:**

[TimeSlot](#): the first working slot

## [melon.scheduler.purepython.MCMCScheduler](#)

**class** [melon.scheduler.purepython.MCMCScheduler](#)(*tasks*: [list](#)[[melon.scheduler.base.Task](#)])

MCMC class to schedule tasks to events in a calendar.

**\_\_init\_\_**(*tasks*: [list](#)[[melon.scheduler.base.Task](#)]) → None

Initialises the MCMC scheduler, working on a set of pre-defined tasks.

**Args:**

*tasks* ([list](#)[[Task](#)]): the tasks to be scheduled



## Methods

|                                   |                                                                        |
|-----------------------------------|------------------------------------------------------------------------|
| <code>__init__(tasks)</code>      | Initialises the MCMC scheduler, working on a set of pre-defined tasks. |
| <code>computeEnergy(state)</code> | For the given state, compute an MCMC energy (the lower, the better)    |
| <code>mcmcSweep()</code>          | Performs a full MCMC sweep                                             |
| <code>permuteState()</code>       | Proposes a new state to use instead of the old state.                  |
| <code>schedule()</code>           | Schedules the tasks using an MCMC procedure.                           |

## Attributes

|                    |                                       |
|--------------------|---------------------------------------|
| <code>State</code> | alias of <code>tuple[int, ...]</code> |
|--------------------|---------------------------------------|

### State

alias of `tuple[int, ...]`

**computeEnergy**(*state*: `tuple[int, ...]`) → float

For the given state, compute an MCMC energy (the lower, the better)

**Args:**

state (State): state of the MCMC algorithm

**Returns:**

float: the energy / penalty for this state

**mcmcSweep**()

Performs a full MCMC sweep

**permuteState**() → `tuple[int, ...]`

Proposes a new state to use instead of the old state.

**Returns:**

State: the new state, a list of indices within `self.tasks` representing traversal order

**schedule**() → Mapping[str, *TimeSlot*]

Schedules the tasks using an MCMC procedure.

**Returns:**

Mapping[str, TimeSlot]: the resulting map of Tasks to TimeSlots

### 1.4.5 melon.scheduler.rust

The scheduler algorithm

## Melon

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### Classes

|                                         |                                                               |
|-----------------------------------------|---------------------------------------------------------------|
| <code>RustyMCMCScheduler</code> (tasks) | Markov Chain Monte-Carlo Task Scheduler, implemented in Rust. |
|-----------------------------------------|---------------------------------------------------------------|

#### `melon.scheduler.rust.RustyMCMCScheduler`

**class** `melon.scheduler.rust.RustyMCMCScheduler`(tasks: list[`melon.scheduler.base.Task`])

Markov Chain Monte-Carlo Task Scheduler, implemented in Rust.

**\_\_init\_\_**(tasks: list[`melon.scheduler.base.Task`]) → None

Initialises the scheduler, working on a set of pre-defined tasks.

**Args:**

tasks (list[Task]): the tasks to be scheduled

### Methods

|                               |                                                                   |
|-------------------------------|-------------------------------------------------------------------|
| <code>__init__</code> (tasks) | Initialises the scheduler, working on a set of pre-defined tasks. |
| <code>schedule</code> ()      | Runs the Rust implementation of the scheduler.                    |

**schedule**() → Mapping[str, `TimeSlot`]

Runs the Rust implementation of the scheduler.

**Returns:**

Mapping[str, TimeSlot]: the resulting schedule

## 1.5 melon.todo

This module contains the `Todo` class.

### Classes

|                                           |                                                                                                                       |
|-------------------------------------------|-----------------------------------------------------------------------------------------------------------------------|
| <code>Todo</code> (*args[, calendarName]) | A class representing todos (= tasks), subclassing the <code>caldav.TODO</code> object which in turn stores VTOD data. |
|-------------------------------------------|-----------------------------------------------------------------------------------------------------------------------|

### 1.5.1 melon.todo.TODO

**class** `melon.todo.TODO(*args, calendarName: str | None = None, **kwargs)`

A class representing todos (= tasks), subclassing the `caldav.TODO` object which in turn stores VTODO data.

**\_\_init\_\_**(\*args, calendarName: str | None = None, \*\*kwargs)

Initialises the base class

#### Methods

|                                                                                                   |                                                                                                                                                                                                          |
|---------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <code>__init__(*args[, calendarName])</code>                                                      | Initialises the base class                                                                                                                                                                               |
| <code>accept_invite([calendar])</code>                                                            |                                                                                                                                                                                                          |
| <code>add_attendee(attendee[, no_default_parameters])</code><br><code>add_organizer()</code>      | For the current (event/todo/journal), add an attendee. goes via <code>self.client</code> , finds the principal, figures out the right attendee-format and adds an organizer line to the event            |
| <code>change_attendee_status([attendee])</code>                                                   |                                                                                                                                                                                                          |
| <code>children([type])</code>                                                                     | List children, using a propfind (resourcetype) on the parent object, at depth = 1.                                                                                                                       |
| <code>complete([completion_timestamp, ...])</code><br><code>copy([keep_uid, new_parent])</code>   | Args:<br>Events, todos etc can be copied within the same calendar, to another calendar or even to another caldav server                                                                                  |
| <code>decline_invite([calendar])</code>                                                           |                                                                                                                                                                                                          |
| <code>delete()</code>                                                                             | Delete the object.                                                                                                                                                                                       |
| <code>expand_rrule(start, end)</code>                                                             | This method will transform the calendar content of the event and expand the calendar data from a "master copy" with RRULE set and into a "recurrence set" with RECURRENCE-ID set and no RRULE set.       |
| <code>generate_url()</code>                                                                       |                                                                                                                                                                                                          |
| <code>get_display_name()</code>                                                                   | Get calendar display name                                                                                                                                                                                |
| <code>get_due()</code>                                                                            | A VTODO may have due or duration set.                                                                                                                                                                    |
| <code>get_duration()</code>                                                                       | According to the RFC, either DURATION or DUE should be set for a task, but never both - implicitly meaning that DURATION is the difference between DTSTART and DUE (personally I believe that's stupid). |
| <code>get_properties([props, depth, ...])</code><br><code>get_property(prop[, use_cached])</code> | Get properties (PROPFIND) for this object.                                                                                                                                                               |
| <code>isComplete()</code>                                                                         | Returns:                                                                                                                                                                                                 |
| <code>isIncomplete()</code>                                                                       | Returns:                                                                                                                                                                                                 |
| <code>isTodo()</code>                                                                             | Returns:                                                                                                                                                                                                 |
| <code>is_invite_request()</code>                                                                  |                                                                                                                                                                                                          |
| <code>is_loaded()</code>                                                                          |                                                                                                                                                                                                          |

continues on next page

Table 2 – continued from previous page

|                                                             |                                                                                                                            |
|-------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------|
| <code>load([only_if_unloaded])</code>                       | (Re)load the object from the caldav server.                                                                                |
| <code>save([no_overwrite, no_create, obj_type, ...])</code> | Save the object, can be used for creation and update.                                                                      |
| <code>set_due(due[, move_dtstart, check_dependent])</code>  | The RFC specifies that a VTODDO cannot have both due and duration, so when setting due, the duration field must be evicted |
| <code>set_duration(duration[, movable_attr])</code>         | If DTSTART and DUE/DTEND is already set, one of them should be moved.                                                      |
| <code>set_properties([props])</code>                        | Set properties (PROPPATCH) for this object.                                                                                |
| <code>set_relation(other[, reltype, set_reverse])</code>    | Sets a relation between this object and another object (given by uid or object).                                           |
| <code>split_expanded()</code>                               |                                                                                                                            |
| <code>tentatively_accept_invite([calendar])</code>          |                                                                                                                            |
| <code>toTask()</code>                                       | Converts this Todo into the scheduler-compatible Task struct.                                                              |
| <code>uncomplete()</code>                                   | Undo completion - marks a completed task as not completed                                                                  |
| <code>upgrade(todo, calendarName)</code>                    | A copy constructor constructing a melon.TODO from a caldav.TODO                                                            |

## Attributes

|                                  |                                                                                             |
|----------------------------------|---------------------------------------------------------------------------------------------|
| <code>canonical_url</code>       |                                                                                             |
| <code>client</code>              |                                                                                             |
| <code>data</code>                | vCal representation of the object as normal string                                          |
| <code>dueDate</code>             | Returns:                                                                                    |
| <code>dueTime</code>             | Returns:                                                                                    |
| <code>icalendar_component</code> | icalendar component - should not be used with recurrence sets                               |
| <code>icalendar_instance</code>  | icalendar instance of the object                                                            |
| <code>id</code>                  |                                                                                             |
| <code>instance</code>            | vobject instance of the object                                                              |
| <code>name</code>                |                                                                                             |
| <code>parent</code>              |                                                                                             |
| <code>priority</code>            | Returns:                                                                                    |
| <code>summary</code>             | Returns:                                                                                    |
| <code>uid</code>                 | This method has to be fast, as it is accessed very frequently according to profiler output. |
| <code>url</code>                 |                                                                                             |
| <code>vobject_instance</code>    | vobject instance of the object                                                              |
| <code>vtodo</code>               | Returns the VTODDO object stored within me.                                                 |
| <code>wire_data</code>           | vCal representation of the object in wire format (UTF-8, CRLN)                              |

**complete**(*completion\_timestamp: datetime | None = None, handle\_rrule: bool = True, rrule\_mode: Literal['safe', 'this\_and\_future'] = 'safe'*) → None

**Args:**

**completion\_timestamp** (Union[datetime.datetime, None], optional): Argument  
(default is None)

**handle\_rrule** (bool, optional): Argument  
(default is True)

**rrule\_mode** (Literal['safe', 'this\_and\_future'], optional): Argument  
(default is 'safe')

**property dueDate:** date | None

**Returns:**

(datetime.datetime | datetime.date | None):

**property dueTime:** time | None

**Returns:**

(datetime.datetime | datetime.date | None):

**isComplete()** → bool

**Returns:**

(bool):

**isIncomplete()** → bool

**Returns:**

(bool):

**isTodo()** → bool

**Returns:**

bool: whether this object is a VTODDO or not (i.e. an event or journal).

**property priority:** int

**Returns:**

**int:** the priority of the task, an integer between 1 and 9,  
where 1 corresponds to the highest and 9 to the lowest priority

**property summary:** str

**Returns:**

(str):

**toTask()** → Task

Converts this Todo into the scheduler-compatible Task struct.

**Returns:**

Task: a melon.scheduler.Task

**property uid:** str | None

This method has to be fast, as it is accessed very frequently according to profiler output. Therefore we use do not use self.vtodo.

**Returns:**

(Union[str, None]):

**static upgrade**(*todo: Todo, calendarName: str*) → *Todo*

A copy constructor constructing a melon.Todo from a caldav.Todo

**Args:**

todo (caldav.Todo): Argument calendarName (str): Argument

**property vtodo: Component**

Returns the VTODO object stored within me. This is faster than accessing the icalendar\_component.

**Returns:**

(vobject.base.Component):

## 1.6 melon.visualise

### Functions

|                                         |                                  |
|-----------------------------------------|----------------------------------|
| <i>plotConvergence</i> (data, filename) | Plots convergence data to a file |
| <i>priorityChart</i> (data, title)      | Plots a helpful priority chart   |

### 1.6.1 melon.visualise.plotConvergence

melon.visualise.**plotConvergence**(*data: ndarray, filename: str*)

Plots convergence data to a file

**Args:**

data (np.array): data of temp, E\_avg, E\_var filename (str): path to file

### 1.6.2 melon.visualise.priorityChart

melon.visualise.**priorityChart**(*data, title*)

Plots a helpful priority chart

**Args:**

data (): data title (str): titles of plots

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