FAST-OAD

Release unknown

unknown

Mar 17, 2021

CONTENTS

Note: For a quick overview of the way FAST-OAD works, please go *here*.

For a detailed description of the input files and the command line interface, check out the *usage section*.

If you prefer to work with Python notebooks, you may go directly to the section *Using FAST-OAD through Python*.

For a description of models used in FAST-OAD, you may see the *model documentations* (still a work in progress).

If you want to add your own models, please check out *How to add custom OpenMDAO modules to FAST-OAD*.

CHAPTER ONE

CONTENTS

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- Christophe DAVID <christophe.david@onera.fr>
- Scott DELBECQ <scott.delbecq@isae-supaero.fr>

1.3 Changelog

1.3.1 Version 0.5.4-beta

- Bug fix: An infinite loop could occur if custom modules were declaring the same variable several times with different units or default values.

1.3.2 Version 0.5.3-beta

- Added compatibility with OpenMDAO 3.4, which is now the minimum required version of OpenMDAO. (#231)
- Simplified call to VariableViewer. (#221)
- Bug fix: model for compressibility drag now takes into account sweep angle and thickness ratio. (#237)
- Bug fix: at installation, minimum version of Scipy is forced to 1.2. (#219)
- Bug fix: SpeedChangeSegment class now accepts Mach number as possible target. (#234)
- Bug fix: variable "data:weight:aircraft_empty:mass has now "kg" as unit. (#236)

1.3.3 Version 0.5.2-beta

- Added compatibility with OpenMDAO 3.3. (#210)
- Added computation time in log info. (#211)
- Fixed bug in XFOIL input file. (#208)
- Fixed bug in copy_resource_folder(). (#212)

1.3.4 Version 0.5.1-beta

- Now avoids apparition of numerous deprecation warnings from OpenMDAO.

1.3.5 Version 0.5.0-beta

- Added compatibility with OpenMDAO 3.2.
- Added the mission performance module (currently computes a fixed standard mission).
- Propulsion models are now declared in a specific way so that another module can do a direct call to the needed propulsion model.

1.3.6 Version 0.4.2-beta

- Prevents installation of OpenMDAO 3.2 and above for incompatibility reasons.
- In Breguet module, output values for climb and descent distances were 1000 times too large (computation was correct, though).

1.3.7 Version 0.4.0-beta

Some changes in mass and performances components:

- The Breguet performance model can now be adjusted through input variables in the "settings" section.
- The mass-performance loop is now done through the "fastoad.loop.mtow" component.

1.3.8 Version 0.3.1-beta

- Adapted the FAST-OAD code to handle OpenMDAO version 3.1.1.

1.3.9 Version 0.3.0-beta

- In Jupyter notebooks, VariableViewer now has a column for input/output type.
- Changed base OAD process so that propulsion model can now be directly called by the performance module instead of being a separate OpenMDAO component (which is still possible, though). It prepares the import of FAST legacy mission-based performance model.

1.3.10 Version 0.2.2-beta

- Changed dependency requirement to have OpenMDAO version at most 3.1.0 (FAST-OAD is not yet compatible with 3.1.1)

1.3.11 Version 0.2.1-beta

- Fixed compatibility with wop 1.9 for XDSM generation

1.3.12 Version 0.2.0b

- First beta release

1.3.13 Version 0.1.0a

- First alpha release

1.4 General documentation

Here you will find the first things to know about FAST-OAD.

1.4.1 Installation procedure

Prerequisite:FAST-OAD needs at least **Python 3.6.1**.

It is recommended (but not required) to install FAST-OAD in a virtual environment (conda, venv…)

Once Python is installed, FAST-OAD can be installed using pip.

> **Note**: If your network uses a proxy, you may have to do some settings for pip to work correctly

You can install the latest version with this command:

```
$ pip install --upgrade fast-oad
```

1.4.2 FAST-OAD overview

FAST-OAD is a framework for performing rapid Overall Aircraft Design.

It proposes multi-disciplinary analysis and optimisation by relying on the OpenMDAO framework.

FAST-OAD allows easy switching between models for a same discipline, and also adding/removing disciplines to match the need of your study.

Currently, FAST-OAD is bundled with models for commercial transport aircraft of years 1990-2000. Other models will come and you may create your own models and use them instead of bundled ones.

How it works

A FAST-OAD run wraps up an OpenMDAO problem, which is, in a nutshell, the assembly of components that each have input and output variables. Of course, the outputs of some component can be the inputs of some other ones, so that the whole system can be solved.

FAST-OAD allows to define the problem to solve (or to optimize) through a configuration file that makes easy to add/remove/replace any component. By doing that, the input data of the problem can be very different from one problem to the other, but FAST-OAD comes with facilities to build the needed input data files.

A FAST-OAD problem can be fully run from *command line interface* or from the Python API.

Usage of Python API, including pre-processing and post-processing utilities are currently provided through *Python notebooks*.

Overview of FAST-OAD files

A typical run of FAST-OAD uses two types of user files:

configuration file (.toml)

This file defines the OpenMDAO problem by defining :

- what components will be in the problem
- the files for input and output data
- the problem settings
- the definition of the optimization problem if needed

A detailed description of this file can be found *here*.

The input and output data files (.xml)

These files contain the information of the variables involved in the system model:

1. The input file contains the global inputs values required to run all the model. The user is free to modify the values of the variables in order that these new values are considered during a model run.
2. The output file contains all the variables (inputs + outputs) values obtained after a model run.

The content of these files and the way variables are named and serialized is described *here*.

1.4.3 Usage

FAST-OAD uses a configuration file for defining your OAD problem. You can interact with this problem using command line or Python directly.

You may also use some lower-level features of FAST-OAD to interact with OpenMDAO systems. This part is addressed in the *API documentation*.

Contents

The FAST-OAD configuration file

FAST-OAD configuration files are in TOML format.

```
title = "Sample OAD Process"

# List of folder paths where user added custom registered OpenMDAO components
module_folders = []

# Input and output files
input_file = "./problem_inputs.xml"
output_file = "./problem_outputs.xml"

# Definition of problem driver assuming the OpenMDAO convention "import openmdao.api␣
↪as om"
driver = "om.ScipyOptimizeDriver()"

# Definition of OpenMDAO model
[model]
    # Solvers are defined assuming the OpenMDAO convention "import openmdao.api as om"
    nonlinear_solver = "om.NonlinearBlockGS(maxiter=100)"
    linear_solver = "om.DirectSolver()"

    # Although "model" is a mandatory name for the top level of the model, its sub-
↪components can be freely named by user
    [model.geometry]
        # An OpenMDAO component is identified by its "id"
        id = "fastoad.geometry.legacy"
    [model.weight]
        id = "fastoad.weight.legacy"
    [model.aerodynamics.highspeed]
        id = "fastoad.aerodynamics.highspeed.legacy"
    [model.aerodynamics.landing]
        id = "fastoad.aerodynamics.landing.legacy"
        use_xfoil = false
    [model.performance]
        id = "fastoad.performances.breguet"
    [model.propulsion]
        id = "fastoad.propulsion.rubber_engine"
```

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```
    [model.hq.tail_sizing]
        id = "fastoad.handling_qualities.tail_sizing"
    [model.hq.static_margin]
        id = "fastoad.handling_qualities.static_margin"
        target = 0.05
    [model.loop]
        id = "fastoad.loop.wing_area"

[optimization]
    [[optimization.design_var]]
        name = "data:geometry:wing:MAC:at25percent:x"
        lower = 10.0
        upper = 25.0
        ref = 15.0

    [[optimization.design_var]]
        name = "data:geometry:wing:aspect_ratio"
        lower = 6.0
        upper = 12.0

    [[optimization.constraint]]
        name = "data:geometry:wing:span"
        upper = 35.0

    [[optimization.objective]]
        name = "data:handling_qualities:static_margin:to_target"
```

Now in details:

Custom module path

```
module_folders = []
```

Provides the path where user can have his custom OpenMDAO modules. See section *How to add custom OpenMDAO modules to FAST-OAD*.

Input and output files

```
input_file = "./problem_inputs.xml"
output_file = "./problem_outputs.xml"
```

Specifies the input and output files of the problem. They are defined in the configuration file and DO NOT APPEAR in the command line interface.

Problem driver

```
# Definition of problem driver assuming the OpenMDAO convention "import openmdao.api␣
↪as om"
driver = "om.ScipyOptimizeDriver()"
```

This belongs the domain of the OpenMDAO framework and its utilization. This setting is needed for optimization problems. It is defined as in Python when assuming the OpenMDAO convention `import openmdao.api as om`.

For more details, please see the OpenMDAO documentation on drivers.

Solvers

```
[model]
    nonlinear_solver = "om.NonlinearBlockGS(maxiter=100)"
    linear_solver = "om.DirectSolver()"
```

This is the starting point for defining the model of the problem. The model is a group of components. If the model involves cycles, which happens for instance when some outputs of A are inputs of B, and vice-versa, it is necessary to specify solvers as done above.

For more details, please see the OpenMDAO documentation on nonlinear solvers and linear solvers.

Problem definition

```
[model.geometry]
    # An OpenMDAO component is identified by its "id"
    id = "fastoad.geometry.legacy"
[model.weight]
    id = "fastoad.weight.legacy"
[model.aerodynamics.highspeed]
    id = "fastoad.aerodynamics.highspeed.legacy"
[model.aerodynamics.landing]
    id = "fastoad.aerodynamics.landing.legacy"
    use_xfoil = false
[model.performance]
    id = "fastoad.performances.breguet"
[model.propulsion]
    id = "fastoad.propulsion.rubber_engine"
[model.hq.tail_sizing]
    id = "fastoad.handling_qualities.tail_sizing"
[model.hq.static_margin]
    id = "fastoad.handling_qualities.static_margin"
    target = 0.05
[model.loop]
    id = "fastoad.loop.wing_area"
```

Components of the model can be systems, or sub-groups. They are defined with a section key like `[model.<some_name>]`. Unlike "model", which is the root element, the name of sub-components can be defined freely by user.

Here above are defined systems. A system is defined by its "id" key. See *How to get list of registered systems*.

Optimization settings

This settings are used only when using optimization (see *Run Multi-Disciplinary Optimization*). They are ignored when doing analysis (see *Run Multi-Disciplinary Analysis*)

Design variables

```
[[optimization.design_var]]
    name = "propulsion:MTO_thrust"
    lower = 0
    ref = 1.5e5
    ref0 = 50000
```

Here are defined design variables (relevant only for optimization). Keys of this section are named after parameters of the OpenMDAO System.add_design_var() method

This section can be repeated several times to add as many design variables as necessary.

Also, see *How to get list of variables*.

Objective function

```
[[optimization.objective]]
    name = "weight:aircraft:MTOW"
    ref = 90000
    ref0 = 60000
```

Here is defined the objective function (relevant only for optimization). Keys of this section are named after parameters of the OpenMDAO System.add_objective() method

Also, see *How to get list of variables*.

Constraints

```
[[optimization.constraint]]
    name = "propulsion:thrust_rate"
    lower = 0
    upper = 1
```

Here are defined constraint variables (relevant only for optimization). Keys of this section are named after parameters of the OpenMDAO System.add_constraint() method

This section can be repeated several times to add as many constraint variables as necessary.

Also, see *How to get list of variables*.

Using FAST-OAD through Command line

FAST-OAD can be used through shell command line or Python. This section deals with the shell command line, but if you prefer using Python, you can skip this part and go to *Using FAST-OAD through Python*.

The FAST-OAD command is `fastoad`. Inline help is available with:

```
$ fastoad -h
```

fastoad works through sub-commands. Each sub-command provides its own inline help using

```
$ fastoad <sub-command> -h
```

How to generate a configuration file

FAST-OAD can provide a ready-to use configuration file with:

```
$ fastoad gen_conf my_conf.toml
```

This generates the file *my_conf.toml*

How to get list of registered systems

If you want to change the list of components in the model in the configuration file, you need the list of available systems.

List of FAST-OAD systems can be obtained with:

```
$ fastoad list_systems
```

If you added custom systems in your configuration file *my_conf.toml* (see *how to add custom OpenMDAO modules to FAST-OAD<Add modules>*), they can be listed along FAST-OAD systems with:

```
$ fastoad list_systems my_conf.toml
```

How to get list of variables

Once your problem is defined in *my_conf.toml*, you can get a list of the variables of your problem with:

```
$ fastoad list_variables my_conf.toml
```

How to generate an input file

The name of the input file is defined in your configuration file *my_conf.toml*. This input file can be generated with:

```
$ fastoad gen_inputs my_conf.toml
```

The generated file will be an XML file that contains needed inputs for your problem. Values will be the default values from system definitions, which means several ones will be "nan". Actual value must be filled before the process is run.

If you already have a file that contains these values, you can use it to populate your new input files with:

```
$ fastoad gen_inputs my_conf.toml my_ref_values.xml
```

If you are using the configuration file provided by the gen_conf sub-command (see :ref`Generate conf file`), you may download our CeRAS01_baseline.xml and use it as source for generating your input file.

How to view the problem process

FAST-OAD proposes two graphical ways to look at the problem defined in configuration file. This is especially useful to see how models and variables are connected.

N2 diagram

FAST-OAD can use OpenMDAO to create a N2 diagram. It provides in-depth information about the whole process.

You can create a `n2.html` file with:

```
$ fastoad n2 my_conf.toml
```

XDSM

Using WhatsOpt as web service, FAST-OAD can provide a XDSM.

XDSM offers a more synthetic view than N2 diagram.

As it uses a web service, see WhatsOpt documentation for how to gain access to the online WhatsOpt server, or see WhatsOpt developer documentation to run your own server.

You can create a `xdsm.html` file with:

```
$ fastoad xdsm my_conf.toml
```

Note: it may take a couple of minutes

How to run the problem

Run Multi-Disciplinary Analysis

Once your problem is defined in *my_conf.toml*, you can simply run it with:

```
$ fastoad eval my_conf.toml
```

Note: this is equivalent to OpenMDAO's run_model()

Run Multi-Disciplinary Optimization

You can also run the defined optimization with:

```
$ fastoad optim my_conf.toml
```

Note: this is equivalent to OpenMDAO's run_driver()

Using FAST-OAD through Python

The command line interface can generate Jupyter notebooks that show how to use the high-level interface of FAST-OAD.

To do so, type this command **in your terminal**:

```
$ fastoad notebooks
```

Then run the Jupyter server as indicated in the obtained message.

1.4.4 Problem variables

FAST-OAD process relies on OpenMDAO, and process variables are OpenMDAO variables.

For any component, variables are declared as inputs or outputs as described here.

FAST-OAD uses the promotion system of OpenMDAO, which means that all variables that are exchanged between FAST-OAD registered systems[1] have a unique name and are available for the whole process.

The list of variable names and descriptions for a given problem can be obtained from command line (see *How to get list of variables*).

Variable naming

Variables are named with a path-like pattern where path separator is `:`, e.g.:

- `data:geometry:wing:area`
- `data:weight:airframe:fuselage:mass`
- `data:weight:airframe:fuselage:CG:x`

The first path element distributes variables among three categories:

- `data`: variables that define the aircraft and its behaviour. This is the main category
- `settings`: model settings. Generally coefficients for advanced users
- `tuning`: coefficients that allow to do some assumptions (e.g.: "what if wing mass could be reduced of 20%?")

The second path element tells about the nature of the variable (geometry, aerodynamics, weight, . . .).

The other path elements depend of the variable. The number of path elements is not fixed.

[1] see *Register your system(s)*

Serialization

For writing input and output files, FAST-OAD relies on the path in the variable names.

For example, for the three variables above, the matching part in XML file will be:

```
<data>
    <geometry>
        <wing>
            <area units="m**2">150.0</area>
        </wing>
    </geometry>
    <weight>
        <fuselage>
            <mass units="kg">10000.0</mass>
            <CG>
                <x units="m">20.0</x>
            </CG>
        </fuselage>
    </weight>
</data>
```

Note: *Units are given as a string according to* OpenMDAO units definitions

1.4.5 Adding modules to FAST-OAD

Here you will find information about custom modules in FAST-OAD.

How to add custom OpenMDAO modules to FAST-OAD

With FAST-OAD, you can register any OpenMDAO system of your own so it can be used through the configuration file.

To have your OpenMDAO system available in FAST-OAD, you should follow these steps:

- *Create your OpenMDAO system*
- *Register your system(s)*
- *Modify the configuration file*

Create your OpenMDAO system

It can be a Group or a Component-like class (generally an ExplicitComponent).

You can create the Python file at the location of your choice. You will just have to provide later the folder path in FAST-OAD configuration file (see *Modify the configuration file*).

Variable naming

You have to pay attention to the naming of your input and output variables. As FAST-OAD uses the promotion system of OpenMDAO, which means that variables you want to link to the rest of the process must have the name that is given in the global process.

Nevertheless, you can create new variables for your system:

- Outputs of your system will be available in output file and will be usable as any other variable.
- Unconnected inputs will simply have to be in the input file of the process. They will be automatically included in the input file generated by FAST-OAD (see *How to generate an input file*).
- And if you add more than one system to the FAST-OAD process, outputs created by one of your system can of course be used as inputs by other systems.

Also keep in mind that the naming of your variable will decide of its location in the input and output files. Therefore, the way you name your new variables should be consistent with FAST-OAD convention, as explained in *Problem variables*.

Definition of partial derivatives

Your OpenMDAO system is expected to provide partial derivatives for all its outputs in analytic or approximate way.

At the very least, for most Component classes, the `setup()` method of your class should contain:

```
self.declare_partials("*", "*", method='fd')
```

or for a Group class:

```
self.approx_totals()
```

The two lines above are the most generic and the least CPU-efficient ways of declaring partial derivatives. For better efficiency, see how to work with derivatives in OpenMDAO.

About ImplicitComponent classes

In some cases, you may have to use ImplicitComponent classes.

Just remember, as told in this tutorial, that the loop that will allow to solve it needs usage of the NewtonSolver.

A good way to ensure it is to build a Group class that will solve the ImplicitComponent with NewtonSolver. This Group should be the system you will register in FAST-OAD.

Checking validity domains

Generally, models are valid only when variable values are in given ranges.

OpenMDAO provides a way to specify lower and upper bounds of an output variable and to enforce them when using a Newton solver by using backtracking line searches.

FAST-OAD proposes a way to set lower and upper bounds for input and output variables, but only for checking and giving feedback of variables that would be out of bounds.

If you want your OpenMDAO class to do this checking, simply use the decorator ValidityDomainChecker:

```python
@ValidityDomainChecker
class MyComponent(om.ExplicitComponent):
    def setup(self):
        self.add_input("length", 1., units="km" )
        self.add_input("time", 1., units="h" )
        self.add_output("speed", 1., units="km/h", lower=0., upper=130.)
```

The above code make that FAST-OAD will issue a warning if at the end of the computation, "speed" variable is not between lower and upper bound.

But it is possible to set your own bounds outside of OpenMDAO by following this example:

```python
@ValidityDomainChecker(
    {
        "length": (0.1, None),  # Defines only a lower bound
        "time": (0., 1.),  # Defines lower and upper bounds
        "speed": (None, 150.0),  # Ignores original bounds and sets only upper bound
    }
)
class MyComponent(om.ExplicitComponent):
    def setup(self):
        self.add_input("length", 1., units="km" )
        self.add_input("time", 1., units="h" )
        # Bounds that are set here will still apply if backtracking line search is␣
↪used, but
        # will not be used for validity domain checking because it has been replaced␣
↪above
        self.add_output("speed", 1., units="km/h", lower=0., upper=130.)
```

Register your system(s)

Once your OpenMDAO system is ready, you have to register it to make it discoverable by FAST-OAD. Assuming your OpenMDAO class is named *MyOMClass* in *my_module.py*, you can create, in the same folder, the file *register.py* (name is not mandatory) with following lines:

```python
from my_module import MyOMClass
from fastoad.module_management import OpenMDAOSystemRegistry

OpenMDAOSystemRegistry.register_system(MyOMClass, "my.custom.name")
```

Note: If you work with Jupyter notebook, remember that any change in your Python files will require the kernel to be restarted.

Modify the configuration file

The folders that contain your Python files must be listed in `module_folders` in the configuration file:

```
title = "OAD Process with custom component"

# List of folder paths where user added custom registered OpenMDAO components
module_folders = ["/path/to/my/custom/module/folder", "/another/path/"]
```

Once this is done, (assuming your configuration file is named *my_custom_conf.toml*) your custom, registered, system should appear in the list provided by the command:

```
$ fastoad list_systems my_custom_conf.toml
```

Then your component can be used like any other using the id you have given.

```
# Definition of OpenMDAO model
[model]
    [ ... ]

    [model.my_custom_model]
        id = "my.custom.name"

    [ ... ]
```

Note: FAST-OAD will inspect all sub-folders in a specified module folder, **as long as they are Python packages**, i.e. if they contain a `__init__.py` file.

How to add a custom propulsion model to FAST-OAD

Propulsion models have a specific status because they are directly called by the performance models, so the connection is not done through OpenMDAO.

By following instructions in this page, you should ensure your propulsion model will run smoothly with the existing performance models. You will also be able to access your engine parameters through FAST-OAD process.

The FlightPoint class

The `FlightPoint` class is designed to store flight parameters for one flight point.

It is meant to be the class that performance modules will work with, and that will be exchanged with propulsion models.

FlightPoint class is meant for:

- storing all needed parameters that are needed for performance modelling, including propulsion parameters.
- easily exchanging data with pandas DataFrame.
- being extensible for new parameters.

Note: All parameters in FlightPoint instances are expected to be in SI units.

Available flight parameters

The documentation of *FlightPoint* provides the list of available flight parameters, available as Python properties. This list is available through Python using `FlightPoint.get_attribute_keys()`.

Exchanges with pandas DataFrame

A pandas DataFrame can be easily created from a list of FlightPoint instances:

```
>>> import pandas as pd
>>> from fastoad.base.flight_point import FlightPoint

>>> fp1 = FlightPoint(mass=70000., altitude=0.)
>>> fp2 = FlightPoint(mass=60000., altitude=10000.)
>>> df = pd.DataFrame([fp1, fp2])
```

And FlightPoint instances can be created from DataFrame rows:

```
>>> fp1bis = FlightPoint(df.iloc[0]  # one FlightPoint instance from a row
>>> flight_points = [ FlightPoint(row) for row in df.iloc ]  # a list of FlightPoint␣
↪instances from the whole DataFrame
```

Extensibility

If you need FlightPoint to store parameters that are not already there, you can do this in your Python code (outside of any class or function, preferably in the python module where you will use these new parameters):

```
from fastoad.base.flight_point import FlightPoint
from fastoad.base.dict import AddKeyAttributes

# Simply add the parameters:
AddKeyAttributes(["ion_drive_power", "warp"])(FlightPoint)

# Or add the parameters with associated default values:
AddKeyAttributes({"ion_drive_power":110., "warp":9.0})(FlightPoint)
```

It modifies the definition of the FlightPoint class so that it will accept your newly defined parameters in all your Python code.

The IPropulsion interface

When developing your propulsion model, to ensure that it will work smoothly with current performances models, you have to do it in a class that implements the *IPropulsion* interface, meaning your class must have at least the 2 methods *compute_flight_points()* and *get_consumed_mass()*.

Computation of propulsion data

compute_flight_points() will modify the provided flight point(s) by adding propulsion-related parameters. A conventional fuel engine will rely on parameters like `mach`, `altitude` and will provide parameters like `sfc` (Specific Fuel Consumption).

Propulsion model inputs

For your model to work with current performance models, your model is expected to rely on known flight parameters, i.e. the original parameters of *FlightPoint*.

Note: Special attention has to be paid to the **thrust parameters**. Depending on the flight phase, the aircraft can fly in **manual** mode, with an imposed thrust rate, or in **regulated** mode, where propulsion has to give an imposed thrust. Your model has to provide these two modes, and to use them as intended.

The `thrust_is_regulated` parameter tells what mode is on. If it is True, the model has to rely on the `thrust` parameter. If it False, the model has to rely on the `thrust_rate` parameter.

Propulsion model outputs

If you work with the Breguet module, your model has to compute the `sfc` parameter.

But if you use the mission module, you have total freedom about the output of your model. If you want to use a parameter that is not available, you can add it to the FlightPoint class as described *above*.

The only requirement is that you have to implement *get_consumed_mass()* accordingly for the mission module to have a correct assessment of mass evolution.

Computation of consumed mass

The *get_consumed_mass()* simply provides the mass consumption over the provided time. It is meant to use the parameters computed in *compute_flight_points()*.

The OpenMDAO wrapper

Once your propulsion model is ready, you have to make a wrapper around it for:

- having the possibility to choose it in the FAST-OAD configuration file
- having its parameters available in FAST-OAD data files

Defining the wrapper

Your wrapper class has to implement the *IOMPropulsionWrapper* interface, meaning it should implement the 2 methods *get_model()* and *setup()*.

get_model() has to provide an instance of your model. If the constructor of your propulsion model class needs parameters, you may get them from `inputs`, that will be the `inputs` parameter that OpenMDAO will provide to the performance module when calling `compute()` method.

Therefore, the performance module will have to define the inputs that your propulsion model needs in its `setup` method, as required by OpenMDAO. To do this, the `setup` method ot the performance module calls the *setup()* of your wrapper, that is expected to define the needed input variables.

For an example, please see the source code of *OMRubberEngineWrapper*.

Registering the wrapper

Registering is needed for being able to choose your propulsion wrapper in FAST-OAD configuration file. Due to the specific status of propulsion models, the registering process is different that *the one for classic OpenMDAO modules*.

The registering is done using the *fastoad.module_management.service_registry.RegisterPropulsion* decorator:

```
from fastoad.models.propulsion import IOMPropulsionWrapper
from fastoad.module_management.service_registry import RegisterPropulsion


@RegisterPropulsion("star.trek.propulsion")
class WarpDriveWrapper(IOMPropulsionWrapper):

    [ ... ]
```

Using the wrapper in the configuration file

As for *other custom modules*, the folder that contains your Python module(s) must be listed in the `module_folders` of the configuration file.

The association of the propulsion model to the performance module is done with the *propulsion_id* keyword, as in following example:

```
title = "OAD Process with custom propulsion model"

# List of folder paths where user added custom registered OpenMDAO components
module_folders = ["/path/to/my/propulsion/wrapper/"]

# Definition of OpenMDAO model
[model]
    [ ... ]k

    [model.performance]
        id = "fastoad.performances.sizing_flight"
        propulsion_id = "star.trek.propulsion"

    [ ... ]
```

1.5 fastoad

1.5.1 fastoad package

Subpackages

fastoad.base package

Subpackages

Submodules

fastoad.base.dict module

class fastoad.base.dict.**AddKeyAttribute**(*attr_name*, *default_value=None*, *doc=None*)

Bases: `object`

A decorator for a dict class that adds a property for accessing the matching dict item.

The getter and the setter of the property are defined. Setting None or np.nan when setting the property will delete the dict key, so that next calls to the getter will return default_value.

Calling AddKeyAttribute for an already defined key will redefine the default value.

The "attribute_keys" property is created in decorated class for returning the list of attributes that have been defined by AddKeyAttribute or by `AddKeyAttributes`.

Parameters

- **attr_name** – the dict key that will be paired to a property
- **default_value** – the default value that will be returned if dict has not the attr_name as key

class fastoad.base.dict.**AddKeyAttributes**(*attribute_definition: Union[dict, Iterable[str]]*)

Bases: `object`

A decorator for a dict class that adds properties for accessing the matching dict item.

This class simply does several call of `AddKeyAttribute`.

Parameters **attribute_definition** – the list of keys that will be attributes. If it is a dictionary, the values are the associated default values. If it is a list or a set, default values will be None.

class fastoad.base.dict.**DynamicAttributeDict**(**args*, ***kwargs*)

Bases: `dict`

A dictionary class where keys can also be used as attributes.

The keys that can be used as attributes are defined using decorators `AddKeyAttribute` or `SetKeyAttributes`.

They can also be used as keyword arguments when instantiating this class.

Note: Using this class as a dict is useful when instantiating another dict or a pandas DataFrame, or instantiating from them. Direct interaction with DynamicAttributeDict instance should be done through attributes.

Example:

```
>>> @AddKeyAttributes({"foo": 0.0, "bar": None, "baz": 42.0})
... class MyDict(DynamicAttributeDict):
...     pass
...

>>> d = MyDict(foo=5, bar="aa")
>>> d.foo
5
>>> d.bar
'aa'
>>> d.baz  # returns the default value
42.0
>>> d["foo"] = 10.0  # can still be used as a dict
>>> d.foo  # but change are propagated to/from the matching attribute
10.0
>>> d.foo = np.nan  # setting None or numpy.nan returns to default value
>>> d["foo"]
0.0
>>> d.foo # But the attribute will now return the default value
0.0
>>> d.bar = None  # If default value is None, setting None or numpy.nan deletes␣
↪the key.
>>> # d["bar"]  #would trigger a key error
>>> d.bar # But the attribute will return None
```

Parameters

- **args** – a dict-like object where all keys are contained in `attribute_keys`
- **kwargs** – argument keywords must be names contained in `attribute_keys`

fastoad.base.flight_point module

Structure for managing flight point data.

class `fastoad.base.flight_point.`**FlightPoint**(**args*, ***kwargs*)

Bases: `fastoad.base.dict.DynamicAttributeDict`

Class for storing data for one flight point.

An instance is a simple dict, but for convenience, each item can be accessed as an attribute (inspired by pandas DataFrames). Hence, one can write:

```
>>> fp = FlightPoint(speed=250., altitude=10000.)
>>> fp["speed"]
250.0
>>> fp2 = FlightPoint({"speed":150., "altitude":5000.})
>>> fp2.speed
250.0
>>> fp["mass"] = 70000.
>>> fp.mass
70000.0
>>> fp.mass = 50000.
>>> fp["mass"]
50000.0
```

Note: constructor will forbid usage of unknown keys as keyword argument, but other methods will allow them, while not making the matching between dict keys and attributes, hence:

```
>>> fp["foo"] = 42  # Ok
>>> bar = fp.foo  # raises exception !!!!
>>> fp.foo = 50  # allowed by Python
>>> # But inner dict is not affected:
>>> fp.foo
50
>>> fp["foo"]
42
```

This class is especially useful for generating pandas DataFrame: a pandas DataFrame can be generated from a list of dict... or a list of FlightPoint instances.

The set of dictionary keys that are mapped to instance attributes is given by the *get_attribute_keys()*.

A dictionary class where keys can also be used as attributes.

The keys that can be used as attributes are defined using decorators `AddKeyAttribute` or `SetKeyAttributes`.

They can also be used as keyword arguments when instantiating this class.

Note: Using this class as a dict is useful when instantiating another dict or a pandas DataFrame, or instantiating from them. Direct interaction with DynamicAttributeDict instance should be done through attributes.

Example:

```
>>> @AddKeyAttributes({"foo": 0.0, "bar": None, "baz": 42.0})
... class MyDict(DynamicAttributeDict):
...     pass
...

>>> d = MyDict(foo=5, bar="aa")
>>> d.foo
5
>>> d.bar
'aa'
>>> d.baz  # returns the default value
42.0
>>> d["foo"] = 10.0  # can still be used as a dict
>>> d.foo  # but change are propagated to/from the matching attribute
10.0
>>> d.foo = np.nan  # setting None or numpy.nan returns to default value
>>> d["foo"]
0.0
>>> d.foo # But the attribute will now return the default value
0.0
>>> d.bar = None  # If default value is None, setting None or numpy.nan deletes␣
↪the key.
>>> # d["bar"]  #would trigger a key error
>>> d.bar # But the attribute will return None
```

Parameters

- **args** – a dict-like object where all keys are contained in `attribute_keys`
- **kwargs** – argument keywords must be names contained in `attribute_keys`

property CD
Drag coeffient.

property CL
Lift coeffient.

property acceleration
Acceleration value in m/s**2.

property altitude
Altitude in meters.

property drag
Aircraft drag in Newtons.

property engine_setting
Engine setting (see *EngineSetting*).

property equivalent_airspeed
Equivalent airspeed (EAS) in m/s.

classmethod get_attribute_keys()

Returns list of attributes paired to dict key.

property ground_distance
Covered ground distance in meters.

property mach
Mach number.

property mass
Mass in kg.

property name
Name of current phase.

property sfc
Specific Fuel Consumption in kg/N/s.

property slope_angle
Slope angle in radians.

property thrust
Thrust in Newtons.

property thrust_is_regulated
Boolean. If True, propulsion should match the thrust value. If False, propulsion should match thrust rate.

property thrust_rate
Thrust rate (between 0. and 1.)

property time
Time in seconds.

property true_airspeed
True airspeed (TAS) in m/s.

Module contents

fastoad.cmd package

Subpackages

Submodules

fastoad.cmd.api module

API

`fastoad.cmd.api.`**`evaluate_problem`**(*configuration_file_path: str, overwrite: bool = False*) → *fastoad.openmdao.problem.FASTOADProblem*

Runs model according to provided problem file

Parameters

- **`configuration_file_path`** – problem definition
- **`overwrite`** – if True, output file will be overwritten

Returns the OpenMDAO problem after run

`fastoad.cmd.api.`**`generate_configuration_file`**(*configuration_file_path: str, overwrite: bool = False*)

Generates a sample configuration file.

Parameters

- **`configuration_file_path`** – the path of file to be written
- **`overwrite`** – if True, the file will be written, even if it already exists

Raises ***`FastFileExistsError`*** – if overwrite==False and configuration_file_path already exists

`fastoad.cmd.api.`**`generate_inputs`**(*configuration_file_path: str, source_path: str = None, source_path_schema='native', overwrite: bool = False*)

Generates input file for the `FASTOADProblem` specified in configuration_file_path.

Parameters

- **`configuration_file_path`** – where the path of input file to write is set
- **`source_path`** – path of file data will be taken from
- **`source_path_schema`** – set to 'legacy' if the source file come from legacy FAST
- **`overwrite`** – if True, file will be written even if one already exists

Raises ***`FastFileExistsError`*** – if overwrite==False and configuration_file_path already exists

`fastoad.cmd.api.`**`list_systems`**(*configuration_file_path: str = None, out: Union[IO, str] = <_io.TextIOWrapper name='<stdout>' mode='w' encoding='UTF-8'>, overwrite: bool = False*)

Writes list of available systems. If configuration_file_path is given and if it defines paths where there are registered systems, they will be listed too.

Parameters

- **`configuration_file_path`** –

- **out** – the output stream or a path for the output file
- **overwrite** – if True and out is a file path, the file will be written even if one already exists

Raises ***FastFileExistsError*** – if overwrite==False and out is a file path and the file exists

`fastoad.cmd.api.`**`list_variables`**(*configuration_file_path: str, out: Union[IO, str] = <_io.TextIOWrapper name='<stdout>' mode='w' encoding='UTF-8'>, overwrite: bool = False, force_text_output: bool = False*)

Writes list of variables for the `FASTOADProblem` specified in configuration_file_path.

List is generally written as text. It can be displayed as a scrollable table view if: - function is used in an interactive IPython shell - out == sys.stdout - force_text_output == False

Parameters

- **configuration_file_path** –
- **out** – the output stream or a path for the output file
- **overwrite** – if True and out parameter is a file path, the file will be written even if one already exists
- **force_text_output** – if True, list will be written as text, even if command is used in an interactive IPython shell (Jupyter notebook). Has no effect in other shells or if out parameter is not sys.stdout

Raises ***FastFileExistsError*** – if overwrite==False and out parameter is a file path and the file exists

`fastoad.cmd.api.`**`optimization_viewer`**(*configuration_file_path: str*)

Displays optimization information and enables its editing

Parameters **configuration_file_path** – problem definition

Returns display of the OptimizationViewer

`fastoad.cmd.api.`**`optimize_problem`**(*configuration_file_path: str, overwrite: bool = False, auto_scaling: bool = False*) → *fastoad.openmdao.problem.FASTOADProblem*

Runs driver according to provided problem file

Parameters

- **configuration_file_path** – problem definition
- **overwrite** – if True, output file will be overwritten
- **auto_scaling** – if True, automatic scaling is performed for design variables and constraints

Returns the OpenMDAO problem after run

`fastoad.cmd.api.`**`variable_viewer`**(*file_path: str, file_formatter: fastoad.io.formatter.IVariableIOFormatter = None, editable=True*)

Displays a widget that enables to visualize variables information and edit their values.

Parameters

- **file_path** – the path of file to interact with
- **file_formatter** – the formatter that defines file format. If not provided, default format will be assumed.

- **editable** – if True, an editable table with variable filters will be displayed. If False, the table will not be editable nor searchable, but can be stored in an HTML file.

Returns display handle of the VariableViewer

`fastoad.cmd.api.`**`write_n2`**(*configuration_file_path: str, n2_file_path: str = None, overwrite: bool = False*)

Write the N2 diagram of the problem in file n2.html

Parameters

- **configuration_file_path** –
- **n2_file_path** –
- **overwrite** –

`fastoad.cmd.api.`**`write_xdsm`**(*configuration_file_path: str, xdsm_file_path: str = None, overwrite: bool = False, depth: int = 2, wop_server_url=None, api_key=None*)

Parameters

- **configuration_file_path** –
- **xdsm_file_path** –
- **overwrite** –
- **depth** –
- **wop_server_url** –
- **api_key** –

Returns

fastoad.cmd.exceptions module

Exception for cmd package

exception `fastoad.cmd.exceptions.`**`FastFileExistsError`**(**args*)

Bases: *fastoad.exceptions.FastError*

Raised when asked for writing a file that already exists

fastoad.cmd.fast module

Command Line Interface.

class `fastoad.cmd.fast.`**`Main`**

Bases: `object`

Class for managing command line and doing associated actions

run()

Main function.

`fastoad.cmd.fast.`**`main`**()

Module contents

fastoad.io package

Subpackages

fastoad.io.configuration package

Subpackages

Submodules

fastoad.io.configuration.configuration module

Module for building OpenMDAO problem from configuration file

class fastoad.io.configuration.configuration.**AutoUnitsDefaultGroup**(***kwargs*)

Bases: openmdao.core.group.Group

OpenMDAO group that automatically use self.set_input_defaults() to resolve declaration conflicts in variable units

Set the solvers to nonlinear and linear block Gauss–Seidel by default.

Parameters ****kwargs** (*dict*) – dict of arguments available here and in all descendants of this Group.

configure()

Configure this group to assign children settings.

This method may optionally be overidden by your Group's method.

You may only use this method to change settings on your children subsystems. This includes setting solvers in cases where you want to override the defaults.

You can assume that the full hierarchy below your level has been instantiated and has already called its own configure methods.

Available attributes: name pathname comm options system hieararchy with attribute access

class fastoad.io.configuration.configuration.**FASTOADProblemConfigurator**(*conf_file_path=None*)

Bases: object

class for configuring an OpenMDAO problem from a configuration file

See *description of configuration file*.

Parameters **conf_file_path** – if provided, configuration will be read directly from it

get_optimization_definition() → Dict

Returns information related to the optimization problem:

- Design Variables
- Constraints
- Objectives

Returns dict containing optimization settings for current problem

get_problem(*read_inputs: bool = False*, *auto_scaling: bool = False*) → *fastoad.openmdao.problem.FASTOADProblem*

Builds the OpenMDAO problem from current configuration.

Parameters

- **read_inputs** – if True, the created problem will already be fed with variables from the input file
- **auto_scaling** – if True, automatic scaling is performed for design variables and constraints

Returns the problem instance

property input_file_path

path of file with input variables of the problem

load(*conf_file*)

Reads the problem definition

Parameters **conf_file** – Path to the file to open or a file descriptor

property output_file_path

path of file where output variables will be written

save(*filename: str = None*)

Saves the current configuration If no filename is provided, the initially read file is used.

Parameters **filename** – file where to save configuration

set_optimization_definition(*optimization_definition: Dict*)

Updates configuration with the list of design variables, constraints, objectives contained in the optimization_definition dictionary.

Keys of the dictionary are: "design_var", "constraint", "objective".

Configuration file will not be modified until `write()` is used.

Parameters **optimization_definition** – dict containing the optimization problem definition

write_needed_inputs(*source_file_path: str = None*, *source_formatter: fastoad.io.formatter.IVariableIOFormatter = None*)

Writes the input file of the problem with unconnected inputs of the configured problem.

Written value of each variable will be taken:

1. from input_data if it contains the variable
2. from defined default values in component definitions

Parameters

- **source_file_path** – if provided, variable values will be read from it
- **source_formatter** – the class that defines format of input file. if not provided, expected format will be the default one.

fastoad.io.configuration.exceptions module

Exceptions for package configuration

exception fastoad.io.configuration.exceptions.**FASTConfigurationBadOpenMDAOInstructionError**

Bases: *fastoad.io.configuration.exceptions.FASTConfigurationBaseKeyBuildingError*

Class for managing errors that result from trying to set an attribute by eval.

Constructor

exception fastoad.io.configuration.exceptions.**FASTConfigurationBaseKeyBuildingError**(*original_ Exception*, *key: str*, *value=No*

Bases: *fastoad.exceptions.FastError*

Class for being raised from bottom to top of TOML dict so that in the end, the message provides the full qualified name of the problematic key.

using *new_err = FASTConfigurationBaseKeyBuildingError(err, 'new_err_key', <value>)*:

- **if err is a FASTConfigurationBaseKeyBuildingError instance with err.key=='err_key':**
  - new_err.key will be 'new_err_key.err_key'
  - new_err.value will be err.value (no need to provide a value here)
  - new_err.original_exception will be err.original_exception
- **otherwise, new_err.key will be 'new_err_key' and new_err.value will be <value>**
  - new_err.key will be 'new_err_key'
  - new_err.value will be <value>
  - new_err.original_exception will be err

Parameters

- **original_exception** – the error that happened for raising this one
- **key** – the current key
- **value** – the current value

Constructor

key
the "qualified key" (like "problem.group.component1") related to error, build through raising up the error

original_exception
the original error, when eval failed

value
the value related to error

exception fastoad.io.configuration.exceptions.**FASTConfigurationError**(*missing_key=None*, *missing_section=None*)

Bases: *fastoad.exceptions.FastError*

Raised if incorrect definition found in configuration file

Module contents

Package for building OpenMDAO problem from configuration file

fastoad.io.xml package

Subpackages

Submodules

fastoad.io.xml.constants module

Constants for the XML module

fastoad.io.xml.constants.**DEFAULT_IO_ATTRIBUTE = 'is_input'**
label of tag attribute for providing io variable type as boolean

fastoad.io.xml.constants.**DEFAULT_UNIT_ATTRIBUTE = 'units'**
label of tag attribute for providing units as a string

fastoad.io.xml.constants.**ROOT_TAG = 'FASTOAD_model'**
name of root element for XML files

fastoad.io.xml.exceptions module

Exceptions for io.xml module

exception fastoad.io.xml.exceptions.**FastXPathEvalError**
Bases: *fastoad.exceptions.FastError*

Raised when some xpath could not be resolved

exception fastoad.io.xml.exceptions.**FastXmlFormatterDuplicateVariableError**
Bases: *fastoad.exceptions.FastError*

Raised a variable is defined more than once in a XML file

exception fastoad.io.xml.exceptions.**FastXpathTranslatorDuplicates**
Bases: *fastoad.exceptions.FastError*

Raised when list of variable names or list of XPaths have duplicate entries

exception fastoad.io.xml.exceptions.**FastXpathTranslatorInconsistentLists**
Bases: *fastoad.exceptions.FastError*

Raised when list of variable names and list of XPaths have not the same length

exception fastoad.io.xml.exceptions.**FastXpathTranslatorVariableError**(*variable*)

Bases: *fastoad.exceptions.FastError*

Raised when a variable does not match any xpath in the translator file.

exception fastoad.io.xml.exceptions.**FastXpathTranslatorXPathError**(*xpath*)

Bases: *fastoad.exceptions.FastError*

Raised when a xpath does not match any variable in the translator file.

fastoad.io.xml.translator module

Conversion from OpenMDAO variables to XPath

class fastoad.io.xml.translator.**VarXpathTranslator**(**, variable_names: Sequence[str] = None, xpaths: Sequence[str] = None, source: Union[str, IO] = None*)

Bases: object

Allows to convert OpenMDAO variable names from and to XPath, using a provided conversion table.

At instantiation, user can provide (as keyword arguments only):

- variable_names and xpaths (see *set()*)
- translation file (see *read_translation_table()*)

get_variable_name(*xpath: str*) → str

Parameters **xpath** – XML Path

Returns OpenMDAO variable name that matches xpath

Raises ***FastXpathTranslatorXPathError*** – if xpath is unknown

get_xpath(*var_name: str*) → str

Parameters **var_name** – OpenMDAO variable name

Returns XPath that matches var_name

Raises **VariableError** – if var_name is unknown

read_translation_table(*source: Union[str, IO]*)

Reads a file that sets how OpenMDAO variable are matched to XML Path. Provided file should have 2 comma-separated columns:

- first one with OpenMDAO names
- second one with their matching XPath

Parameters **source** –

set(*variable_names: Sequence[str], xpaths: Sequence[str]*)

Sets the "conversion table", i.e. two lists where each element matches the other with same index. Provided lists must have the same length.

Parameters

- **variable_names** – List of OpenMDAO variable names
- **xpaths** – List of XML Paths

property variable_names
List of variable names as set in `set()`

property xpaths
List of XPaths as set in `set()`

fastoad.io.xml.variable_io_base module

Defines how OpenMDAO variables are serialized to XML using a conversion table

class fastoad.io.xml.variable_io_base.**VariableXmlBaseFormatter**(*translator: fastoad.io.xml.translator.VarXpathTranslato*

Bases: `fastoad.io.formatter.IVariableIOFormatter`

Customizable formatter for variables

User must provide at instantiation a VarXpathTranslator instance that tells how variable names should be converted from/to XPath.

Note: XPath are always considered relatively to the root. Therefore, "foo/bar" should be provided to match following XML structure:

```
<root>
    <foo>
        <bar>
            "some value"
        </bar>
    </foo>
</root>
```

Parameters **translator** – the VarXpathTranslator instance

read_variables(*data_source: Union[str, IO]*) → *fastoad.openmdao.variables.VariableList*
Reads variables from provided data source file.

Parameters **data_source** –

Returns a list of Variable instance

set_translator(*translator: fastoad.io.xml.translator.VarXpathTranslator*)
Sets the VarXpathTranslator() instance that rules how OpenMDAO variable are matched to XML Path.

Parameters **translator** –

unit_translation
Used for converting read units in units recognized by OpenMDAO Dict keys can use regular expressions.

write_variables(*data_source: Union[str, IO], variables: fastoad.openmdao.variables.VariableList*)
Writes variables to defined data source file.

Parameters

- **data_source** –
- **variables** –

fastoad.io.xml.variable_io_legacy module

Readers for legacy XML format

class fastoad.io.xml.variable_io_legacy.**VariableLegacy1XmlFormatter**

Bases: *fastoad.io.xml.variable_io_base.VariableXmlBaseFormatter*

Formatter for legacy XML format (version "1")

fastoad.io.xml.variable_io_standard module

Defines how OpenMDAO variables are serialized to XML

class fastoad.io.xml.variable_io_standard.**BasicVarXpathTranslator**(*path_separator*)

Bases: *fastoad.io.xml.translator.VarXpathTranslator*

Dedicated VarXpathTranslator that builds variable names by simply converting the '/' separator of XPaths into the desired separator.

get_variable_name(*xpath: str*) → str

Parameters **xpath** – XML Path

Returns OpenMDAO variable name that matches xpath

Raises ***FastXpathTranslatorXPathError*** – if xpath is unknown

get_xpath(*var_name: str*) → str

Parameters **var_name** – OpenMDAO variable name

Returns XPath that matches var_name

Raises **VariableError** – if var_name is unknown

class fastoad.io.xml.variable_io_standard.**VariableXmlStandardFormatter**

Bases: *fastoad.io.xml.variable_io_base.VariableXmlBaseFormatter*

Standard XML formatter for variables

Assuming self.path_separator is defined as `:` (default), a variable named like `foo:bar` with units `m/s` will be read and written as:

```
<aircraft>
    <foo>
        <bar units="m/s" >`42.0</bar>
    </foo>
<aircraft>
```

When writing outputs of a model, OpenMDAO component hierarchy may be used by defining

```
self.path_separator = '.'  # Discouraged for reading !
self.use_promoted_names = False
```

This way, a variable like `componentA.subcomponent2.my_var` will be written as:

```
<aircraft>
    <componentA>
        <subcomponent2>
            <my_var units="m/s" >72.0</my_var>
        </subcomponent2>
```

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```
    <componentA>
<aircraft>
```

property path_separator
The separator that will be used in OpenMDAO variable names to match XML path. Warning: The dot "." can be used when writing, but not when reading.

read_variables(*data_source: Union[str, IO]*) → *fastoad.openmdao.variables.VariableList*
Reads variables from provided data source file.

Parameters **data_source** –

Returns a list of Variable instance

write_variables(*data_source: Union[str, IO], variables: fastoad.openmdao.variables.VariableList*)
Writes variables to defined data source file.

Parameters

- **data_source** –
- **variables** –

Module contents

Package for handling XML files

Submodules

fastoad.io.formatter module

class fastoad.io.formatter.**IVariableIOFormatter**
Bases: `abc.ABC`

Interface for formatter classes to be used in VariableIO class.

The file format is defined by the implementation of this interface.

abstract read_variables(*data_source: Union[str, IO]*) → *fastoad.openmdao.variables.VariableList*
Reads variables from provided data source file.

Parameters **data_source** –

Returns a list of Variable instance

abstract write_variables(*data_source: Union[str, IO], variables: fastoad.openmdao.variables.VariableList*)
Writes variables to defined data source file.

Parameters

- **data_source** –
- **variables** –

fastoad.io.variable_io module

class fastoad.io.variable_io.**VariableIO**(*data_source: Union[str, IO], formatter: fastoad.io.formatter.IVariableIOFormatter = None*)

Bases: `object`

Class for reading and writing variable values from/to file.

The file format is defined by the class provided as *formatter* argument.

Parameters

- **data_source** – the I/O stream, or a file path, used for reading or writing data
- **formatter** – a class that determines the file format to be used. Defaults to a VariableBasicXmlFormatter instance

read(*only: List[str] = None, ignore: List[str] = None*) → *fastoad.openmdao.variables.VariableList*

Reads variables from provided data source.

Elements of *only* and *ignore* can be real variable names or Unix-shell-style patterns. In any case, comparison is case-sensitive.

Parameters

- **only** – List of variable names that should be read. Other names will be ignored. If None, all variables will be read.
- **ignore** – List of variable names that should be ignored when reading.

Returns an VariableList instance where outputs have been defined using provided source

write(*variables: fastoad.openmdao.variables.VariableList, only: List[str] = None, ignore: List[str] = None*)

Writes variables from provided VariableList instance.

Elements of *only* and *ignore* can be real variable names or Unix-shell-style patterns. In any case, comparison is case-sensitive.

Parameters

- **variables** – a VariableList instance
- **only** – List of variable names that should be written. Other names will be ignored. If None, all variables will be written.
- **ignore** – List of variable names that should be ignored when writing

Module contents

Package for handling input/output streams

fastoad.models package

Subpackages

fastoad.models.aerodynamics package

Subpackages

fastoad.models.aerodynamics.components package

Subpackages

Submodules

fastoad.models.aerodynamics.components.cd0 module

class `fastoad.models.aerodynamics.components.cd0.`**`CD0`**`(**kwargs)`

Bases: `openmdao.core.group.Group`

Set the solvers to nonlinear and linear block Gauss–Seidel by default.

Parameters **`**kwargs`** (`dict`) – dict of arguments available here and in all descendants of this Group.

`initialize()`

Perform any one-time initialization run at instantiation.

`setup()`

Build this group.

This method should be overidden by your Group's method. The reason for using this method to add subsystem is to save memory and setup time when using your Group while running under MPI. This avoids the creation of systems that will not be used in the current process.

You may call 'add_subsystem' to add systems to this group. You may also issue connections, and set the linear and nonlinear solvers for this group level. You cannot safely change anything on children systems; use the 'configure' method instead.

Available attributes: name pathname comm options

fastoad.models.aerodynamics.components.cd0_fuselage module

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class `fastoad.models.aerodynamics.components.cd0_fuselage.`**`Cd0Fuselage`**`(**kwargs)`

Bases: `openmdao.core.explicitcomponent.ExplicitComponent`

Store some bound methods so we can detect runtime overrides.

Parameters **`**kwargs`** (*`dict of keyword arguments`*) – Keyword arguments that will be mapped into the Component options.

`compute``(inputs, outputs)`

Compute outputs given inputs. The model is assumed to be in an unscaled state.

Parameters

- **inputs** (*Vector*) – unscaled, dimensional input variables read via inputs[key]
- **outputs** (*Vector*) – unscaled, dimensional output variables read via outputs[key]
- **discrete_inputs** (*dict or None*) – If not None, dict containing discrete input values.
- **discrete_outputs** (*dict or None*) – If not None, dict containing discrete output values.

initialize()

Perform any one-time initialization run at instantiation.

setup()

Declare inputs and outputs.

Available attributes: name pathname comm options

fastoad.models.aerodynamics.components.cd0_ht module

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class fastoad.models.aerodynamics.components.cd0_ht.**Cd0HorizontalTail**(***kwargs*)

Bases: openmdao.core.explicitcomponent.ExplicitComponent

Store some bound methods so we can detect runtime overrides.

Parameters ****kwargs** (*dict of keyword arguments*) – Keyword arguments that will be mapped into the Component options.

compute(*inputs*, *outputs*)

Compute outputs given inputs. The model is assumed to be in an unscaled state.

Parameters

- **inputs** (*Vector*) – unscaled, dimensional input variables read via inputs[key]
- **outputs** (*Vector*) – unscaled, dimensional output variables read via outputs[key]
- **discrete_inputs** (*dict or None*) – If not None, dict containing discrete input values.
- **discrete_outputs** (*dict or None*) – If not None, dict containing discrete output values.

initialize()

Perform any one-time initialization run at instantiation.

setup()

Declare inputs and outputs.

Available attributes: name pathname comm options

fastoad.models.aerodynamics.components.cd0_nacelle_pylons module

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class fastoad.models.aerodynamics.components.cd0_nacelle_pylons.**Cd0NacelleAndPylons**(***kwargs*)

Bases: openmdao.core.explicitcomponent.ExplicitComponent

Store some bound methods so we can detect runtime overrides.

Parameters ****kwargs** (*dict of keyword arguments*) – Keyword arguments that will be mapped into the Component options.

compute(*inputs, outputs*)

Compute outputs given inputs. The model is assumed to be in an unscaled state.

Parameters

- **inputs** (*Vector*) – unscaled, dimensional input variables read via inputs[key]
- **outputs** (*Vector*) – unscaled, dimensional output variables read via outputs[key]
- **discrete_inputs** (*dict or None*) – If not None, dict containing discrete input values.
- **discrete_outputs** (*dict or None*) – If not None, dict containing discrete output values.

initialize()

Perform any one-time initialization run at instantiation.

setup()

Declare inputs and outputs.

Available attributes: name pathname comm options

fastoad.models.aerodynamics.components.cd0_total module

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class fastoad.models.aerodynamics.components.cd0_total.**Cd0Total**(***kwargs*)

Bases: openmdao.core.explicitcomponent.ExplicitComponent

Store some bound methods so we can detect runtime overrides.

Parameters ****kwargs** (*dict of keyword arguments*) – Keyword arguments that will be mapped into the Component options.

compute(*inputs, outputs*)

Compute outputs given inputs. The model is assumed to be in an unscaled state.

Parameters

- **inputs** (*Vector*) – unscaled, dimensional input variables read via inputs[key]
- **outputs** (*Vector*) – unscaled, dimensional output variables read via outputs[key]
- **discrete_inputs** (*dict or None*) – If not None, dict containing discrete input values.
- **discrete_outputs** (*dict or None*) – If not None, dict containing discrete output values.

initialize()

Perform any one-time initialization run at instantiation.

setup()
Declare inputs and outputs.

Available attributes: name pathname comm options

fastoad.models.aerodynamics.components.cd0_vt module

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class fastoad.models.aerodynamics.components.cd0_vt.**Cd0VerticalTail**(***kwargs*)
Bases: openmdao.core.explicitcomponent.ExplicitComponent

Store some bound methods so we can detect runtime overrides.

Parameters ****kwargs** (*dict of keyword arguments*) – Keyword arguments that will be mapped into the Component options.

compute(*inputs*, *outputs*)
Compute outputs given inputs. The model is assumed to be in an unscaled state.

Parameters

- **inputs** (*Vector*) – unscaled, dimensional input variables read via inputs[key]
- **outputs** (*Vector*) – unscaled, dimensional output variables read via outputs[key]
- **discrete_inputs** (*dict or None*) – If not None, dict containing discrete input values.
- **discrete_outputs** (*dict or None*) – If not None, dict containing discrete output values.

initialize()
Perform any one-time initialization run at instantiation.

setup()
Declare inputs and outputs.

Available attributes: name pathname comm options

fastoad.models.aerodynamics.components.cd0_wing module

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class fastoad.models.aerodynamics.components.cd0_wing.**Cd0Wing**(***kwargs*)
Bases: openmdao.core.explicitcomponent.ExplicitComponent

Store some bound methods so we can detect runtime overrides.

Parameters ****kwargs** (*dict of keyword arguments*) – Keyword arguments that will be mapped into the Component options.

compute(*inputs*, *outputs*)
Compute outputs given inputs. The model is assumed to be in an unscaled state.

Parameters

- **inputs** (*Vector*) – unscaled, dimensional input variables read via inputs[key]
- **outputs** (*Vector*) – unscaled, dimensional output variables read via outputs[key]

- **discrete_inputs** (*dict or None*) – If not None, dict containing discrete input values.
- **discrete_outputs** (*dict or None*) – If not None, dict containing discrete output values.

initialize()
Perform any one-time initialization run at instantiation.

setup()
Declare inputs and outputs.

Available attributes: name pathname comm options

fastoad.models.aerodynamics.components.cd_compressibility module

Compressibility drag computation.

class fastoad.models.aerodynamics.components.cd_compressibility.**CdCompressibility**(***kwargs*)
Bases: openmdao.core.explicitcomponent.ExplicitComponent

Computation of drag increment due to compressibility effects.

Formula from §4.2.4 of [DCAC14]. This formula can be used for aircraft before year 2000. Earlier aircraft have more optimized wing profiles that are expected to limit the compressibility drag below 2 drag counts. Until a better model can be provided, the variable *tuning:aerodynamics:aircraft:cruise:CD:compressibility:ceiling* allows to control the maximum authorized compressibility drag.

Store some bound methods so we can detect runtime overrides.

Parameters ****kwargs** (*dict of keyword arguments*) – Keyword arguments that will be mapped into the Component options.

compute(*inputs*, *outputs*)
Compute outputs given inputs. The model is assumed to be in an unscaled state.

Parameters

- **inputs** (*Vector*) – unscaled, dimensional input variables read via inputs[key]
- **outputs** (*Vector*) – unscaled, dimensional output variables read via outputs[key]
- **discrete_inputs** (*dict or None*) – If not None, dict containing discrete input values.
- **discrete_outputs** (*dict or None*) – If not None, dict containing discrete output values.

setup()
Declare inputs and outputs.

Available attributes: name pathname comm options

fastoad.models.aerodynamics.components.cd_trim module

FAST - Copyright (c) 2016 ONERA ISAE

class fastoad.models.aerodynamics.components.cd_trim.**CdTrim**(***kwargs*)

Bases: openmdao.core.explicitcomponent.ExplicitComponent

Store some bound methods so we can detect runtime overrides.

Parameters ****kwargs** (*dict of keyword arguments*) – Keyword arguments that will be mapped into the Component options.

compute(*inputs, outputs*)

Compute outputs given inputs. The model is assumed to be in an unscaled state.

Parameters

- **inputs** (*Vector*) – unscaled, dimensional input variables read via inputs[key]
- **outputs** (*Vector*) – unscaled, dimensional output variables read via outputs[key]
- **discrete_inputs** (*dict or None*) – If not None, dict containing discrete input values.
- **discrete_outputs** (*dict or None*) – If not None, dict containing discrete output values.

initialize()

Perform any one-time initialization run at instantiation.

setup()

Declare inputs and outputs.

Available attributes: name pathname comm options

fastoad.models.aerodynamics.components.compute_low_speed_aero module

FAST - Copyright (c) 2016 ONERA ISAE

class fastoad.models.aerodynamics.components.compute_low_speed_aero.**ComputeAerodynamicsLowS**

Bases: openmdao.core.explicitcomponent.ExplicitComponent

Czalpha from Raymer Eq 12.6 TODO: complete source

Store some bound methods so we can detect runtime overrides.

Parameters ****kwargs** (*dict of keyword arguments*) – Keyword arguments that will be mapped into the Component options.

compute(*inputs, outputs*)

Compute outputs given inputs. The model is assumed to be in an unscaled state.

Parameters

- **inputs** (*Vector*) – unscaled, dimensional input variables read via inputs[key]
- **outputs** (*Vector*) – unscaled, dimensional output variables read via outputs[key]
- **discrete_inputs** (*dict or None*) – If not None, dict containing discrete input values.
- **discrete_outputs** (*dict or None*) – If not None, dict containing discrete output values.

setup()
Declare inputs and outputs.

Available attributes: name pathname comm options

fastoad.models.aerodynamics.components.compute_max_cl_landing module

FAST - Copyright (c) 2016 ONERA ISAE

class fastoad.models.aerodynamics.components.compute_max_cl_landing.**ComputeMaxClLanding**(***k*
Bases: openmdao.core.explicitcomponent.ExplicitComponent

Store some bound methods so we can detect runtime overrides.

Parameters ****kwargs** (*dict of keyword arguments*) – Keyword arguments that will be mapped into the Component options.

compute(*inputs*, *outputs*)
Compute outputs given inputs. The model is assumed to be in an unscaled state.

Parameters

- **inputs** (*Vector*) – unscaled, dimensional input variables read via inputs[key]
- **outputs** (*Vector*) – unscaled, dimensional output variables read via outputs[key]
- **discrete_inputs** (*dict or None*) – If not None, dict containing discrete input values.
- **discrete_outputs** (*dict or None*) – If not None, dict containing discrete output values.

setup()
Declare inputs and outputs.

Available attributes: name pathname comm options

fastoad.models.aerodynamics.components.compute_polar module

FAST - Copyright (c) 2016 ONERA ISAE

class fastoad.models.aerodynamics.components.compute_polar.**ComputePolar**(***kwargs*)
Bases: openmdao.core.explicitcomponent.ExplicitComponent

Store some bound methods so we can detect runtime overrides.

Parameters ****kwargs** (*dict of keyword arguments*) – Keyword arguments that will be mapped into the Component options.

compute(*inputs*, *outputs*)
Compute outputs given inputs. The model is assumed to be in an unscaled state.

Parameters

- **inputs** (*Vector*) – unscaled, dimensional input variables read via inputs[key]
- **outputs** (*Vector*) – unscaled, dimensional output variables read via outputs[key]
- **discrete_inputs** (*dict or None*) – If not None, dict containing discrete input values.

- **discrete_outputs** (*dict or None*) – If not None, dict containing discrete output values.

initialize()
Perform any one-time initialization run at instantiation.

setup()
Declare inputs and outputs.

Available attributes: name pathname comm options

class fastoad.models.aerodynamics.components.compute_polar.**PolarType**(*value*)
Bases: enum.Enum

An enumeration.

HIGH_SPEED = 'high_speed'

LANDING = 'landing'

LOW_SPEED = 'low_speed'

TAKEOFF = 'takeoff'

fastoad.models.aerodynamics.components.compute_polar.**get_optimum_ClCd**(*ClCd*)

fastoad.models.aerodynamics.components.compute_reynolds module

FAST - Copyright (c) 2016 ONERA ISAE

class fastoad.models.aerodynamics.components.compute_reynolds.**ComputeReynolds**(***kwargs*)
Bases: openmdao.core.explicitcomponent.ExplicitComponent

Store some bound methods so we can detect runtime overrides.

Parameters ****kwargs** (*dict of keyword arguments*) – Keyword arguments that will be mapped into the Component options.

compute(*inputs, outputs*)
Compute outputs given inputs. The model is assumed to be in an unscaled state.

Parameters

- **inputs** (*Vector*) – unscaled, dimensional input variables read via inputs[key]
- **outputs** (*Vector*) – unscaled, dimensional output variables read via outputs[key]
- **discrete_inputs** (*dict or None*) – If not None, dict containing discrete input values.
- **discrete_outputs** (*dict or None*) – If not None, dict containing discrete output values.

initialize()
Perform any one-time initialization run at instantiation.

setup()
Declare inputs and outputs.

Available attributes: name pathname comm options

fastoad.models.aerodynamics.components.high_lift_aero module

Computation of lift and drag increment due to high-lift devices

class fastoad.models.aerodynamics.components.high_lift_aero.**ComputeDeltaHighLift**(***kwargs*)

Bases: `openmdao.core.explicitcomponent.ExplicitComponent`

Provides lift and drag increments due to high-lift devices

Store some bound methods so we can detect runtime overrides.

Parameters ****kwargs** (*dict of keyword arguments*) – Keyword arguments that will be mapped into the Component options.

compute(*inputs, outputs, discrete_inputs=None, discrete_outputs=None*)

Compute outputs given inputs. The model is assumed to be in an unscaled state.

Parameters

- **inputs** (*Vector*) – unscaled, dimensional input variables read via inputs[key]
- **outputs** (*Vector*) – unscaled, dimensional output variables read via outputs[key]
- **discrete_inputs** (*dict or None*) – If not None, dict containing discrete input values.
- **discrete_outputs** (*dict or None*) – If not None, dict containing discrete output values.

initialize()

Perform any one-time initialization run at instantiation.

setup()

Declare inputs and outputs.

Available attributes: name pathname comm options

fastoad.models.aerodynamics.components.initialize_cl module

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class fastoad.models.aerodynamics.components.initialize_cl.**InitializeClPolar**(***kwargs*)

Bases: `openmdao.core.explicitcomponent.ExplicitComponent`

Store some bound methods so we can detect runtime overrides.

Parameters ****kwargs** (*dict of keyword arguments*) – Keyword arguments that will be mapped into the Component options.

compute(*inputs, outputs*)

Compute outputs given inputs. The model is assumed to be in an unscaled state.

Parameters

- **inputs** (*Vector*) – unscaled, dimensional input variables read via inputs[key]
- **outputs** (*Vector*) – unscaled, dimensional output variables read via outputs[key]
- **discrete_inputs** (*dict or None*) – If not None, dict containing discrete input values.
- **discrete_outputs** (*dict or None*) – If not None, dict containing discrete output values.

initialize()
Perform any one-time initialization run at instantiation.

setup()
Declare inputs and outputs.

Available attributes: name pathname comm options

fastoad.models.aerodynamics.components.oswald module

Computation of Oswald coefficient

class fastoad.models.aerodynamics.components.oswald.**OswaldCoefficient**(***kwargs*)
Bases: openmdao.core.explicitcomponent.ExplicitComponent

Computes Oswald efficiency number

Store some bound methods so we can detect runtime overrides.

Parameters ****kwargs** (*dict of keyword arguments*) – Keyword arguments that will be mapped into the Component options.

compute(*inputs, outputs*)
Compute outputs given inputs. The model is assumed to be in an unscaled state.

Parameters

- **inputs** (*Vector*) – unscaled, dimensional input variables read via inputs[key]
- **outputs** (*Vector*) – unscaled, dimensional output variables read via outputs[key]
- **discrete_inputs** (*dict or None*) – If not None, dict containing discrete input values.
- **discrete_outputs** (*dict or None*) – If not None, dict containing discrete output values.

initialize()
Perform any one-time initialization run at instantiation.

setup()
Declare inputs and outputs.

Available attributes: name pathname comm options

Module contents

fastoad.models.aerodynamics.external package

Subpackages

fastoad.models.aerodynamics.external.xfoil package

Subpackages

fastoad.models.aerodynamics.external.xfoil.xfoil699 package

Module contents

Submodules

fastoad.models.aerodynamics.external.xfoil.xfoil_polar module

This module launches XFOIL computations

class `fastoad.models.aerodynamics.external.xfoil.xfoil_polar.`**`XfoilPolar`**(***kwargs*)

Bases: `openmdao.components.external_code_comp.ExternalCodeComp`

Runs a polar computation with XFOIL and returns the 2D max lift coefficient

Intialize the ExternalCodeComp component.

Parameters ****kwargs** (*dict of keyword arguments*) – Keyword arguments that will be mapped into the Component options.

compute(*inputs*, *outputs*)

Run this component.

User should call this method from their overriden compute method.

Parameters

- **inputs** (*Vector*) – Unscaled, dimensional input variables read via inputs[key].
- **outputs** (*Vector*) – Unscaled, dimensional output variables read via outputs[key].

initialize()

Perform any one-time initialization run at instantiation.

setup()

Declare inputs and outputs.

Available attributes: name pathname comm options

Module contents

Module for OpenMDAO-embedded XFOIL

Module contents

Submodules

fastoad.models.aerodynamics.aerodynamics module

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class `fastoad.models.aerodynamics.aerodynamics.`**`Aerodynamics`**(***kwargs*)

Bases: `openmdao.core.group.Group`

Set the solvers to nonlinear and linear block Gauss–Seidel by default.

Parameters ****kwargs** (*dict*) – dict of arguments available here and in all descendants of this Group.

setup()

Build this group.

This method should be overidden by your Group's method. The reason for using this method to add subsystem is to save memory and setup time when using your Group while running under MPI. This avoids the creation of systems that will not be used in the current process.

You may call 'add_subsystem' to add systems to this group. You may also issue connections, and set the linear and nonlinear solvers for this group level. You cannot safely change anything on children systems; use the 'configure' method instead.

Available attributes: name pathname comm options

fastoad.models.aerodynamics.aerodynamics_high_speed module

FAST - Copyright (c) 2016 ONERA ISAE

class `fastoad.models.aerodynamics.aerodynamics_high_speed.`**`AerodynamicsHighSpeed`**(***kwargs*)

Bases: `openmdao.core.group.Group`

Computes aerodynamic polar of the aircraft in cruise conditions.

Drag contributions of each part of the aircraft are computed though analytical models.

Set the solvers to nonlinear and linear block Gauss–Seidel by default.

Parameters ****kwargs** (*dict*) – dict of arguments available here and in all descendants of this Group.

setup()

Build this group.

This method should be overidden by your Group's method. The reason for using this method to add subsystem is to save memory and setup time when using your Group while running under MPI. This avoids the creation of systems that will not be used in the current process.

You may call 'add_subsystem' to add systems to this group. You may also issue connections, and set the linear and nonlinear solvers for this group level. You cannot safely change anything on children systems; use the 'configure' method instead.

Available attributes: name pathname comm options

fastoad.models.aerodynamics.aerodynamics_landing module

Aero computation for landing phase

class `fastoad.models.aerodynamics.aerodynamics_landing.`**`AerodynamicsLanding`**(***kwargs*)

Bases: *fastoad.models.options.OpenMdaoOptionDispatcherGroup*

Computes aerodynamic characteristics at landing.

- Computes CL and CD increments due to high-lift devices at landing.
- Computes maximum CL of the aircraft in landing conditions.

Maximum 2D CL without high-lift is computed using XFoil (or provided as input if option use_xfoil is set to False). 3D CL is deduced using sweep angle.

Contribution of high-lift devices is modelled according to their geometry (span and chord ratio) and their deflection angles.

Options:

- **use_xfoil:**
  - if True, maximum 2D CL without high-lift aerodynamics:aircraft:landing:CL_max_clean_2D is computed using XFOIL
  - if False, aerodynamics:aircraft:landing:CL_max_clean_2D must be provided as input (but process is faster)
- **alpha_min, alpha_max:**
  - used if use_xfoil is True. Sets the alpha range that is explored to find maximum 2D CL without high-lift
- **xfoil_exe_path:**
  - the path to the XFOIL executable. Needed for non-Windows OS.

Set the solvers to nonlinear and linear block Gauss–Seidel by default.

Parameters `**kwargs` (*dict*) – dict of arguments available here and in all descendants of this Group.

initialize()

Perform any one-time initialization run at instantiation.

setup()

Build this group.

This method should be overidden by your Group's method. The reason for using this method to add subsystem is to save memory and setup time when using your Group while running under MPI. This avoids the creation of systems that will not be used in the current process.

You may call 'add_subsystem' to add systems to this group. You may also issue connections, and set the linear and nonlinear solvers for this group level. You cannot safely change anything on children systems; use the 'configure' method instead.

Available attributes: name pathname comm options

class fastoad.models.aerodynamics.aerodynamics_landing.**Compute3DMaxCL**(***kwargs*)

Bases: `openmdao.core.explicitcomponent.ExplicitComponent`

Computes 3D max CL from 2D CL (XFOIL-computed) and sweep angle

Store some bound methods so we can detect runtime overrides.

Parameters `**kwargs` (*dict of keyword arguments*) – Keyword arguments that will be mapped into the Component options.

compute(*inputs*, *outputs*, *discrete_inputs=None*, *discrete_outputs=None*)

Compute outputs given inputs. The model is assumed to be in an unscaled state.

Parameters

- **inputs** (*Vector*) – unscaled, dimensional input variables read via inputs[key]
- **outputs** (*Vector*) – unscaled, dimensional output variables read via outputs[key]
- **discrete_inputs** (*dict or None*) – If not None, dict containing discrete input values.
- **discrete_outputs** (*dict or None*) – If not None, dict containing discrete output values.

setup()
Declare inputs and outputs.

Available attributes: name pathname comm options

class fastoad.models.aerodynamics.aerodynamics_landing.**ComputeMachReynolds**(***kwargs*)
Bases: `openmdao.core.explicitcomponent.ExplicitComponent`

Mach and Reynolds computation

Store some bound methods so we can detect runtime overrides.

Parameters ****kwargs** (*dict of keyword arguments*) – Keyword arguments that will be mapped into the Component options.

compute(*inputs*, *outputs*, *discrete_inputs=None*, *discrete_outputs=None*)
Compute outputs given inputs. The model is assumed to be in an unscaled state.

Parameters

- **inputs** (*Vector*) – unscaled, dimensional input variables read via inputs[key]
- **outputs** (*Vector*) – unscaled, dimensional output variables read via outputs[key]
- **discrete_inputs** (*dict or None*) – If not None, dict containing discrete input values.
- **discrete_outputs** (*dict or None*) – If not None, dict containing discrete output values.

setup()
Declare inputs and outputs.

Available attributes: name pathname comm options

fastoad.models.aerodynamics.aerodynamics_low_speed module

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class fastoad.models.aerodynamics.aerodynamics_low_speed.**AerodynamicsLowSpeed**(***kwargs*)
Bases: `openmdao.core.group.Group`

Models for low speed aerodynamics

Set the solvers to nonlinear and linear block Gauss–Seidel by default.

Parameters ****kwargs** (*dict*) – dict of arguments available here and in all descendants of this Group.

setup()
Build this group.

This method should be overidden by your Group's method. The reason for using this method to add subsystem is to save memory and setup time when using your Group while running under MPI. This avoids the creation of systems that will not be used in the current process.

You may call 'add_subsystem' to add systems to this group. You may also issue connections, and set the linear and nonlinear solvers for this group level. You cannot safely change anything on children systems; use the 'configure' method instead.

Available attributes: name pathname comm options

fastoad.models.aerodynamics.aerodynamics_takeoff module

class fastoad.models.aerodynamics.aerodynamics_takeoff.**AerodynamicsTakeoff**(***kwargs*)

Bases: openmdao.core.group.Group

Computes aerodynamic characteristics at takeoff.

- Computes CL and CD increments due to high-lift devices at takeoff.

Set the solvers to nonlinear and linear block Gauss–Seidel by default.

Parameters ****kwargs** (*dict*) – dict of arguments available here and in all descendants of this Group.

setup()

Build this group.

This method should be overidden by your Group's method. The reason for using this method to add subsystem is to save memory and setup time when using your Group while running under MPI. This avoids the creation of systems that will not be used in the current process.

You may call 'add_subsystem' to add systems to this group. You may also issue connections, and set the linear and nonlinear solvers for this group level. You cannot safely change anything on children systems; use the 'configure' method instead.

Available attributes: name pathname comm options

fastoad.models.aerodynamics.constants module

Module contents

fastoad.models.geometry package

Subpackages

fastoad.models.geometry.geom_components package

Subpackages

fastoad.models.geometry.geom_components.fuselage package

Submodules

fastoad.models.geometry.geom_components.fuselage.compute_cnbeta_fuselage module

Estimation of yawing moment due to sideslip

class fastoad.models.geometry.geom_components.fuselage.compute_cnbeta_fuselage.**ComputeCnBet**

Bases: openmdao.core.explicitcomponent.ExplicitComponent

Yawing moment due to sideslip estimation

Store some bound methods so we can detect runtime overrides.

Parameters ****kwargs** (*dict of keyword arguments*) – Keyword arguments that will be mapped into the Component options.

compute (*inputs*, *outputs*)
Compute outputs given inputs. The model is assumed to be in an unscaled state.

Parameters

- **inputs** (*Vector*) – unscaled, dimensional input variables read via inputs[key]
- **outputs** (*Vector*) – unscaled, dimensional output variables read via outputs[key]
- **discrete_inputs** (*dict or None*) – If not None, dict containing discrete input values.
- **discrete_outputs** (*dict or None*) – If not None, dict containing discrete output values.

setup ()
Declare inputs and outputs.

Available attributes: name pathname comm options

fastoad.models.geometry.geom_components.fuselage.compute_fuselage module

Estimation of geometry of fuselase part A - Cabin (Commercial)

class fastoad.models.geometry.geom_components.fuselage.compute_fuselage.**ComputeFuselageGeon**
Bases: openmdao.core.explicitcomponent.ExplicitComponent

Geometry of fuselage part A - Cabin (Commercial) estimation

Store some bound methods so we can detect runtime overrides.

Parameters ****kwargs** (*dict of keyword arguments*) – Keyword arguments that will be mapped into the Component options.

compute (*inputs*, *outputs*)
Compute outputs given inputs. The model is assumed to be in an unscaled state.

Parameters

- **inputs** (*Vector*) – unscaled, dimensional input variables read via inputs[key]
- **outputs** (*Vector*) – unscaled, dimensional output variables read via outputs[key]
- **discrete_inputs** (*dict or None*) – If not None, dict containing discrete input values.
- **discrete_outputs** (*dict or None*) – If not None, dict containing discrete output values.

setup ()
Declare inputs and outputs.

Available attributes: name pathname comm options

class fastoad.models.geometry.geom_components.fuselage.compute_fuselage.**ComputeFuselageGeon**
Bases: openmdao.core.explicitcomponent.ExplicitComponent

Geometry of fuselage part A - Cabin (Commercial) estimation

Store some bound methods so we can detect runtime overrides.

Parameters ****kwargs** (*dict of keyword arguments*) – Keyword arguments that will be mapped into the Component options.

compute (*inputs*, *outputs*)
Compute outputs given inputs. The model is assumed to be in an unscaled state.

Parameters

- **inputs** (*Vector*) – unscaled, dimensional input variables read via inputs[key]
- **outputs** (*Vector*) – unscaled, dimensional output variables read via outputs[key]
- **discrete_inputs** (*dict or None*) – If not None, dict containing discrete input values.
- **discrete_outputs** (*dict or None*) – If not None, dict containing discrete output values.

setup ()
Declare inputs and outputs.

Available attributes: name pathname comm options

Module contents

Estimation of fuselage geometry

fastoad.models.geometry.geom_components.ht package

Subpackages

fastoad.models.geometry.geom_components.ht.components package

Submodules

fastoad.models.geometry.geom_components.ht.components.compute_ht_chords module

Estimation of horizontal tail chords and span

class fastoad.models.geometry.geom_components.ht.components.compute_ht_chords.**ComputeHTChor**
Bases: `openmdao.core.explicitcomponent.ExplicitComponent`

Horizontal tail chords and span estimation

Store some bound methods so we can detect runtime overrides.

Parameters ****kwargs** (*dict of keyword arguments*) – Keyword arguments that will be mapped into the Component options.

compute (*inputs*, *outputs*)
Compute outputs given inputs. The model is assumed to be in an unscaled state.

Parameters

- **inputs** (*Vector*) – unscaled, dimensional input variables read via inputs[key]
- **outputs** (*Vector*) – unscaled, dimensional output variables read via outputs[key]
- **discrete_inputs** (*dict or None*) – If not None, dict containing discrete input values.

- **discrete_outputs** (*dict or None*) – If not None, dict containing discrete output values.

setup()
Declare inputs and outputs.

Available attributes: name pathname comm options

fastoad.models.geometry.geom_components.ht.components.compute_ht_cl_alpha module

Estimation of horizontal tail lift coefficient

class fastoad.models.geometry.geom_components.ht.components.compute_ht_cl_alpha.**ComputeHTCl**
Bases: openmdao.core.explicitcomponent.ExplicitComponent

Horizontal tail lift coefficient estimation

Store some bound methods so we can detect runtime overrides.

Parameters ****kwargs** (*dict of keyword arguments*) – Keyword arguments that will be mapped into the Component options.

compute(*inputs*, *outputs*)
Compute outputs given inputs. The model is assumed to be in an unscaled state.

Parameters

- **inputs** (*Vector*) – unscaled, dimensional input variables read via inputs[key]
- **outputs** (*Vector*) – unscaled, dimensional output variables read via outputs[key]
- **discrete_inputs** (*dict or None*) – If not None, dict containing discrete input values.
- **discrete_outputs** (*dict or None*) – If not None, dict containing discrete output values.

setup()
Declare inputs and outputs.

Available attributes: name pathname comm options

fastoad.models.geometry.geom_components.ht.components.compute_ht_mac module

Estimation of horizontal tail mean aerodynamic chords

class fastoad.models.geometry.geom_components.ht.components.compute_ht_mac.**ComputeHTMAC**(***k*
Bases: openmdao.core.explicitcomponent.ExplicitComponent

Horizontal tail mean aerodynamic chord estimation

Store some bound methods so we can detect runtime overrides.

Parameters ****kwargs** (*dict of keyword arguments*) – Keyword arguments that will be mapped into the Component options.

compute(*inputs*, *outputs*)
Compute outputs given inputs. The model is assumed to be in an unscaled state.

Parameters

- **inputs** (*Vector*) – unscaled, dimensional input variables read via inputs[key]

- **outputs** (*Vector*) – unscaled, dimensional output variables read via outputs[key]
- **discrete_inputs** (*dict or None*) – If not None, dict containing discrete input values.
- **discrete_outputs** (*dict or None*) – If not None, dict containing discrete output values.

setup()
Declare inputs and outputs.

Available attributes: name pathname comm options

fastoad.models.geometry.geom_components.ht.components.compute_ht_sweep module

Estimation of horizontal tail sweeps

class fastoad.models.geometry.geom_components.ht.components.compute_ht_sweep.**ComputeHTSweep**
Bases: openmdao.core.explicitcomponent.ExplicitComponent

Horizontal tail sweeps estimation

Store some bound methods so we can detect runtime overrides.

Parameters ****kwargs** (*dict of keyword arguments*) – Keyword arguments that will be mapped into the Component options.

compute(*inputs*, *outputs*)
Compute outputs given inputs. The model is assumed to be in an unscaled state.

Parameters

- **inputs** (*Vector*) – unscaled, dimensional input variables read via inputs[key]
- **outputs** (*Vector*) – unscaled, dimensional output variables read via outputs[key]
- **discrete_inputs** (*dict or None*) – If not None, dict containing discrete input values.
- **discrete_outputs** (*dict or None*) – If not None, dict containing discrete output values.

setup()
Declare inputs and outputs.

Available attributes: name pathname comm options

Module contents

Estimation of horizontal tail geometry (components)

Submodules

fastoad.models.geometry.geom_components.ht.compute_horizontal_tail module

Estimation of geometry of horizontal tail

class fastoad.models.geometry.geom_components.ht.compute_horizontal_tail.**ComputeHorizontalT**

Bases: openmdao.core.group.Group

Horizontal tail geometry estimation

Set the solvers to nonlinear and linear block Gauss–Seidel by default.

Parameters ****kwargs** (*dict*) – dict of arguments available here and in all descendants of this Group.

setup()

Build this group.

This method should be overidden by your Group's method. The reason for using this method to add subsystem is to save memory and setup time when using your Group while running under MPI. This avoids the creation of systems that will not be used in the current process.

You may call 'add_subsystem' to add systems to this group. You may also issue connections, and set the linear and nonlinear solvers for this group level. You cannot safely change anything on children systems; use the 'configure' method instead.

Available attributes: name pathname comm options

Module contents

Estimation of horizontal tail geometry (global)

fastoad.models.geometry.geom_components.nacelle_pylons package

Submodules

fastoad.models.geometry.geom_components.nacelle_pylons.compute_nacelle_pylons module

Estimation of nacelle and pylon geometry

class fastoad.models.geometry.geom_components.nacelle_pylons.compute_nacelle_pylons.**Compute**

Bases: openmdao.core.explicitcomponent.ExplicitComponent

Nacelle and pylon geometry estimation

Store some bound methods so we can detect runtime overrides.

Parameters ****kwargs** (*dict of keyword arguments*) – Keyword arguments that will be mapped into the Component options.

compute(*inputs*, *outputs*)

Compute outputs given inputs. The model is assumed to be in an unscaled state.

Parameters

- **inputs** (*Vector*) – unscaled, dimensional input variables read via inputs[key]
- **outputs** (*Vector*) – unscaled, dimensional output variables read via outputs[key]

- **discrete_inputs** (*dict or None*) – If not None, dict containing discrete input values.
- **discrete_outputs** (*dict or None*) – If not None, dict containing discrete output values.

setup()
Declare inputs and outputs.

Available attributes: name pathname comm options

Module contents

Estimation of nacelle and pylons

fastoad.models.geometry.geom_components.vt package

Subpackages

fastoad.models.geometry.geom_components.vt.components package

Submodules

fastoad.models.geometry.geom_components.vt.components.compute_vt_chords module

Estimation of vertical tail chords and span

class fastoad.models.geometry.geom_components.vt.components.compute_vt_chords.**ComputeVTChor**
Bases: openmdao.core.explicitcomponent.ExplicitComponent

Vertical tail chords and span estimation

Store some bound methods so we can detect runtime overrides.

Parameters ****kwargs** (*dict of keyword arguments*) – Keyword arguments that will be mapped into the Component options.

compute(*inputs*, *outputs*)
Compute outputs given inputs. The model is assumed to be in an unscaled state.

Parameters

- **inputs** (*Vector*) – unscaled, dimensional input variables read via inputs[key]
- **outputs** (*Vector*) – unscaled, dimensional output variables read via outputs[key]
- **discrete_inputs** (*dict or None*) – If not None, dict containing discrete input values.
- **discrete_outputs** (*dict or None*) – If not None, dict containing discrete output values.

setup()
Declare inputs and outputs.

Available attributes: name pathname comm options

fastoad.models.geometry.geom_components.vt.components.compute_vt_clalpha module

Estimation of vertical tail lift coefficient

class fastoad.models.geometry.geom_components.vt.components.compute_vt_clalpha.**ComputeVTCla**

Bases: openmdao.core.explicitcomponent.ExplicitComponent

Vertical tail lift coefficient estimation

Store some bound methods so we can detect runtime overrides.

Parameters `**kwargs` (*dict of keyword arguments*) – Keyword arguments that will be mapped into the Component options.

compute (*inputs*, *outputs*, *discrete_inputs=None*, *discrete_outputs=None*)

Compute outputs given inputs. The model is assumed to be in an unscaled state.

Parameters

- **inputs** (*Vector*) – unscaled, dimensional input variables read via inputs[key]
- **outputs** (*Vector*) – unscaled, dimensional output variables read via outputs[key]
- **discrete_inputs** (*dict or None*) – If not None, dict containing discrete input values.
- **discrete_outputs** (*dict or None*) – If not None, dict containing discrete output values.

setup ()

Declare inputs and outputs.

Available attributes: name pathname comm options

fastoad.models.geometry.geom_components.vt.components.compute_vt_distance module

Estimation of vertical tail distance

class fastoad.models.geometry.geom_components.vt.components.compute_vt_distance.**ComputeVTD**

Bases: openmdao.core.explicitcomponent.ExplicitComponent

Vertical tail distance estimation

Store some bound methods so we can detect runtime overrides.

Parameters `**kwargs` (*dict of keyword arguments*) – Keyword arguments that will be mapped into the Component options.

compute (*inputs*, *outputs*, *discrete_inputs=None*, *discrete_outputs=None*)

Compute outputs given inputs. The model is assumed to be in an unscaled state.

Parameters

- **inputs** (*Vector*) – unscaled, dimensional input variables read via inputs[key]
- **outputs** (*Vector*) – unscaled, dimensional output variables read via outputs[key]
- **discrete_inputs** (*dict or None*) – If not None, dict containing discrete input values.
- **discrete_outputs** (*dict or None*) – If not None, dict containing discrete output values.

setup()
Declare inputs and outputs.

Available attributes: name pathname comm options

fastoad.models.geometry.geom_components.vt.components.compute_vt_mac module

Estimation of vertical tail mean aerodynamic chords

class fastoad.models.geometry.geom_components.vt.components.compute_vt_mac.**ComputeVTMAC**(***k*
Bases: openmdao.core.explicitcomponent.ExplicitComponent

Vertical tail mean aerodynamic chord estimation

Store some bound methods so we can detect runtime overrides.

Parameters ****kwargs** (*dict of keyword arguments*) – Keyword arguments that will be mapped into the Component options.

compute(*inputs, outputs*)
Compute outputs given inputs. The model is assumed to be in an unscaled state.

Parameters

- **inputs** (*Vector*) – unscaled, dimensional input variables read via inputs[key]
- **outputs** (*Vector*) – unscaled, dimensional output variables read via outputs[key]
- **discrete_inputs** (*dict or None*) – If not None, dict containing discrete input values.
- **discrete_outputs** (*dict or None*) – If not None, dict containing discrete output values.

setup()
Declare inputs and outputs.

Available attributes: name pathname comm options

fastoad.models.geometry.geom_components.vt.components.compute_vt_sweep module

Estimation of vertical tail sweeps

class fastoad.models.geometry.geom_components.vt.components.compute_vt_sweep.**ComputeVTSweep**
Bases: openmdao.core.explicitcomponent.ExplicitComponent

Vertical tail sweeps estimation

Store some bound methods so we can detect runtime overrides.

Parameters ****kwargs** (*dict of keyword arguments*) – Keyword arguments that will be mapped into the Component options.

compute(*inputs, outputs*)
Compute outputs given inputs. The model is assumed to be in an unscaled state.

Parameters

- **inputs** (*Vector*) – unscaled, dimensional input variables read via inputs[key]
- **outputs** (*Vector*) – unscaled, dimensional output variables read via outputs[key]

- **discrete_inputs** (*dict or None*) – If not None, dict containing discrete input values.
- **discrete_outputs** (*dict or None*) – If not None, dict containing discrete output values.

setup()
Declare inputs and outputs.

Available attributes: name pathname comm options

Module contents

Estimation of vertical tail geometry (components)

Submodules

fastoad.models.geometry.geom_components.vt.compute_vertical_tail module

Estimation of geometry of vertical tail

class fastoad.models.geometry.geom_components.vt.compute_vertical_tail.**ComputeVerticalTail(**
Bases: openmdao.core.group.Group

Vertical tail geometry estimation

Set the solvers to nonlinear and linear block Gauss–Seidel by default.

Parameters ****kwargs** (*dict*) – dict of arguments available here and in all descendants of this Group.

setup()
Build this group.

This method should be overidden by your Group's method. The reason for using this method to add subsystem is to save memory and setup time when using your Group while running under MPI. This avoids the creation of systems that will not be used in the current process.

You may call 'add_subsystem' to add systems to this group. You may also issue connections, and set the linear and nonlinear solvers for this group level. You cannot safely change anything on children systems; use the 'configure' method instead.

Available attributes: name pathname comm options

Module contents

Estimation of vertical tail geometry (global)

fastoad.models.geometry.geom_components.wing package

Subpackages

fastoad.models.geometry.geom_components.wing.components package

Submodules

fastoad.models.geometry.geom_components.wing.components.compute_b_50 module

Estimation of wing B50

class fastoad.models.geometry.geom_components.wing.components.compute_b_50.**ComputeB50**(***kwa*

Bases: openmdao.core.explicitcomponent.ExplicitComponent

Wing B50 estimation

Store some bound methods so we can detect runtime overrides.

Parameters ****kwargs** (*dict of keyword arguments*) – Keyword arguments that will be mapped into the Component options.

compute(*inputs*, *outputs*)

Compute outputs given inputs. The model is assumed to be in an unscaled state.

Parameters

- **inputs** (*Vector*) – unscaled, dimensional input variables read via inputs[key]
- **outputs** (*Vector*) – unscaled, dimensional output variables read via outputs[key]
- **discrete_inputs** (*dict or None*) – If not None, dict containing discrete input values.
- **discrete_outputs** (*dict or None*) – If not None, dict containing discrete output values.

setup()

Declare inputs and outputs.

Available attributes: name pathname comm options

fastoad.models.geometry.geom_components.wing.components.compute_cl_alpha module

Estimation of wing lift coefficient

class fastoad.models.geometry.geom_components.wing.components.compute_cl_alpha.**ComputeCLal**

Bases: openmdao.core.explicitcomponent.ExplicitComponent

Wing lift coefficient estimation

Store some bound methods so we can detect runtime overrides.

Parameters ****kwargs** (*dict of keyword arguments*) – Keyword arguments that will be mapped into the Component options.

compute(*inputs*, *outputs*)

Compute outputs given inputs. The model is assumed to be in an unscaled state.

Parameters

- **inputs** (*Vector*) – unscaled, dimensional input variables read via inputs[key]
- **outputs** (*Vector*) – unscaled, dimensional output variables read via outputs[key]
- **discrete_inputs** (*dict or None*) – If not None, dict containing discrete input values.
- **discrete_outputs** (*dict or None*) – If not None, dict containing discrete output values.

setup()

Declare inputs and outputs.

Available attributes: name pathname comm options

fastoad.models.geometry.geom_components.wing.components.compute_l1_l4 module

Estimation of wing chords (l1 and l4)

class fastoad.models.geometry.geom_components.wing.components.compute_l1_l4.**ComputeL1AndL4W**

Bases: openmdao.core.explicitcomponent.ExplicitComponent

Wing chords (l1 and l4) estimation

Store some bound methods so we can detect runtime overrides.

Parameters ****kwargs** (*dict of keyword arguments*) – Keyword arguments that will be mapped into the Component options.

compute(*inputs*, *outputs*)

Compute outputs given inputs. The model is assumed to be in an unscaled state.

Parameters

- **inputs** (*Vector*) – unscaled, dimensional input variables read via inputs[key]
- **outputs** (*Vector*) – unscaled, dimensional output variables read via outputs[key]
- **discrete_inputs** (*dict or None*) – If not None, dict containing discrete input values.
- **discrete_outputs** (*dict or None*) – If not None, dict containing discrete output values.

setup()

Declare inputs and outputs.

Available attributes: name pathname comm options

fastoad.models.geometry.geom_components.wing.components.compute_l2_l3 module

Estimation of wing chords (l2 and l3)

class fastoad.models.geometry.geom_components.wing.components.compute_l2_l3.**ComputeL2AndL3W**

Bases: openmdao.core.explicitcomponent.ExplicitComponent

Wing chords (l2 and l3) estimation

Store some bound methods so we can detect runtime overrides.

Parameters ****kwargs** (*dict of keyword arguments*) – Keyword arguments that will be mapped into the Component options.

compute (*inputs*, *outputs*)

Compute outputs given inputs. The model is assumed to be in an unscaled state.

Parameters

- **inputs** (*Vector*) – unscaled, dimensional input variables read via inputs[key]
- **outputs** (*Vector*) – unscaled, dimensional output variables read via outputs[key]
- **discrete_inputs** (*dict or None*) – If not None, dict containing discrete input values.
- **discrete_outputs** (*dict or None*) – If not None, dict containing discrete output values.

setup ()

Declare inputs and outputs.

Available attributes: name pathname comm options

fastoad.models.geometry.geom_components.wing.components.compute_mac_wing module

Estimation of wing mean aerodynamic chord

class fastoad.models.geometry.geom_components.wing.components.compute_mac_wing.**ComputeMACW**

Bases: `openmdao.core.explicitcomponent.ExplicitComponent`

Wing mean aerodynamic chord estimation

Store some bound methods so we can detect runtime overrides.

Parameters ****kwargs** (*dict of keyword arguments*) – Keyword arguments that will be mapped into the Component options.

compute (*inputs*, *outputs*)

Compute outputs given inputs. The model is assumed to be in an unscaled state.

Parameters

- **inputs** (*Vector*) – unscaled, dimensional input variables read via inputs[key]
- **outputs** (*Vector*) – unscaled, dimensional output variables read via outputs[key]
- **discrete_inputs** (*dict or None*) – If not None, dict containing discrete input values.
- **discrete_outputs** (*dict or None*) – If not None, dict containing discrete output values.

setup ()

Declare inputs and outputs.

Available attributes: name pathname comm options

fastoad.models.geometry.geom_components.wing.components.compute_mfw module

Estimation of max fuel weight

class fastoad.models.geometry.geom_components.wing.components.compute_mfw.**ComputeMFW**(***kwarg*

Bases: openmdao.core.explicitcomponent.ExplicitComponent

Max fuel weight estimation

Store some bound methods so we can detect runtime overrides.

Parameters ****kwargs** (*dict of keyword arguments*) – Keyword arguments that will be mapped into the Component options.

compute(*inputs*, *outputs*)

Compute outputs given inputs. The model is assumed to be in an unscaled state.

Parameters

- **inputs** (*Vector*) – unscaled, dimensional input variables read via inputs[key]
- **outputs** (*Vector*) – unscaled, dimensional output variables read via outputs[key]
- **discrete_inputs** (*dict or None*) – If not None, dict containing discrete input values.
- **discrete_outputs** (*dict or None*) – If not None, dict containing discrete output values.

setup()

Declare inputs and outputs.

Available attributes: name pathname comm options

fastoad.models.geometry.geom_components.wing.components.compute_sweep_wing module

Estimation of wing sweeps

class fastoad.models.geometry.geom_components.wing.components.compute_sweep_wing.**ComputeSwe**

Bases: openmdao.core.explicitcomponent.ExplicitComponent

Wing sweeps estimation

Store some bound methods so we can detect runtime overrides.

Parameters ****kwargs** (*dict of keyword arguments*) – Keyword arguments that will be mapped into the Component options.

compute(*inputs*, *outputs*)

Compute outputs given inputs. The model is assumed to be in an unscaled state.

Parameters

- **inputs** (*Vector*) – unscaled, dimensional input variables read via inputs[key]
- **outputs** (*Vector*) – unscaled, dimensional output variables read via outputs[key]
- **discrete_inputs** (*dict or None*) – If not None, dict containing discrete input values.
- **discrete_outputs** (*dict or None*) – If not None, dict containing discrete output values.

setup()
Declare inputs and outputs.

Available attributes: name pathname comm options

fastoad.models.geometry.geom_components.wing.components.compute_toc_wing module

Estimation of wing ToC

class fastoad.models.geometry.geom_components.wing.components.compute_toc_wing.**ComputeToCW**
Bases: openmdao.core.explicitcomponent.ExplicitComponent

Wing ToC estimation

Store some bound methods so we can detect runtime overrides.

Parameters ****kwargs** (*dict of keyword arguments*) – Keyword arguments that will be mapped into the Component options.

compute(*inputs*, *outputs*)
Compute outputs given inputs. The model is assumed to be in an unscaled state.

Parameters

- **inputs** (*Vector*) – unscaled, dimensional input variables read via inputs[key]
- **outputs** (*Vector*) – unscaled, dimensional output variables read via outputs[key]
- **discrete_inputs** (*dict or None*) – If not None, dict containing discrete input values.
- **discrete_outputs** (*dict or None*) – If not None, dict containing discrete output values.

setup()
Declare inputs and outputs.

Available attributes: name pathname comm options

fastoad.models.geometry.geom_components.wing.components.compute_wet_area_wing module

Estimation of wing wet area

class fastoad.models.geometry.geom_components.wing.components.compute_wet_area_wing.**Compute**
Bases: openmdao.core.explicitcomponent.ExplicitComponent

Wing wet area estimation

Store some bound methods so we can detect runtime overrides.

Parameters ****kwargs** (*dict of keyword arguments*) – Keyword arguments that will be mapped into the Component options.

compute(*inputs*, *outputs*)
Compute outputs given inputs. The model is assumed to be in an unscaled state.

Parameters

- **inputs** (*Vector*) – unscaled, dimensional input variables read via inputs[key]
- **outputs** (*Vector*) – unscaled, dimensional output variables read via outputs[key]

- **discrete_inputs** (*dict or None*) – If not None, dict containing discrete input values.
- **discrete_outputs** (*dict or None*) – If not None, dict containing discrete output values.

setup()
Declare inputs and outputs.

Available attributes: name pathname comm options

fastoad.models.geometry.geom_components.wing.components.compute_x_wing module

Estimation of wing Xs

class fastoad.models.geometry.geom_components.wing.components.compute_x_wing.**ComputeXWing**(*
Bases: openmdao.core.explicitcomponent.ExplicitComponent

Wing Xs estimation

Store some bound methods so we can detect runtime overrides.

Parameters ****kwargs** (*dict of keyword arguments*) – Keyword arguments that will be mapped into the Component options.

compute(*inputs*, *outputs*)
Compute outputs given inputs. The model is assumed to be in an unscaled state.

Parameters

- **inputs** (*Vector*) – unscaled, dimensional input variables read via inputs[key]
- **outputs** (*Vector*) – unscaled, dimensional output variables read via outputs[key]
- **discrete_inputs** (*dict or None*) – If not None, dict containing discrete input values.
- **discrete_outputs** (*dict or None*) – If not None, dict containing discrete output values.

setup()
Declare inputs and outputs.

Available attributes: name pathname comm options

fastoad.models.geometry.geom_components.wing.components.compute_y_wing module

Estimation of wing Ys (sections span)

class fastoad.models.geometry.geom_components.wing.components.compute_y_wing.**ComputeYWing**(*
Bases: openmdao.core.explicitcomponent.ExplicitComponent

Wing Ys estimation

Store some bound methods so we can detect runtime overrides.

Parameters ****kwargs** (*dict of keyword arguments*) – Keyword arguments that will be mapped into the Component options.

compute(*inputs*, *outputs*)
Compute outputs given inputs. The model is assumed to be in an unscaled state.

Parameters

- **inputs** (*Vector*) – unscaled, dimensional input variables read via inputs[key]
- **outputs** (*Vector*) – unscaled, dimensional output variables read via outputs[key]
- **discrete_inputs** (*dict or None*) – If not None, dict containing discrete input values.
- **discrete_outputs** (*dict or None*) – If not None, dict containing discrete output values.

setup()

Declare inputs and outputs.

Available attributes: name pathname comm options

Module contents

Estimation of wing geometry (components)

Submodules

fastoad.models.geometry.geom_components.wing.compute_wing module

Estimation of wing geometry

class fastoad.models.geometry.geom_components.wing.compute_wing.**ComputeWingGeometry**(***kwargs*

Bases: openmdao.core.group.Group

Wing geometry estimation

Set the solvers to nonlinear and linear block Gauss–Seidel by default.

Parameters ****kwargs** (*dict*) – dict of arguments available here and in all descendants of this Group.

setup()

Build this group.

This method should be overidden by your Group's method. The reason for using this method to add subsystem is to save memory and setup time when using your Group while running under MPI. This avoids the creation of systems that will not be used in the current process.

You may call 'add_subsystem' to add systems to this group. You may also issue connections, and set the linear and nonlinear solvers for this group level. You cannot safely change anything on children systems; use the 'configure' method instead.

Available attributes: name pathname comm options

Module contents

Estimation of wing (global)

Submodules

fastoad.models.geometry.geom_components.compute_total_area module

Estimation of total aircraft wet area

class fastoad.models.geometry.geom_components.compute_total_area.**ComputeTotalArea**(***kwargs*)
Bases: openmdao.core.explicitcomponent.ExplicitComponent

Total aircraft wet area estimation

Store some bound methods so we can detect runtime overrides.

Parameters ****kwargs** (*dict of keyword arguments*) – Keyword arguments that will be mapped into the Component options.

compute(*inputs*, *outputs*)
Compute outputs given inputs. The model is assumed to be in an unscaled state.

Parameters

- **inputs** (*Vector*) – unscaled, dimensional input variables read via inputs[key]
- **outputs** (*Vector*) – unscaled, dimensional output variables read via outputs[key]
- **discrete_inputs** (*dict or None*) – If not None, dict containing discrete input values.
- **discrete_outputs** (*dict or None*) – If not None, dict containing discrete output values.

setup()
Declare inputs and outputs.

Available attributes: name pathname comm options

Module contents

Estimation of geometry components

fastoad.models.geometry.profiles package

Submodules

fastoad.models.geometry.profiles.get_profile module

Airfoil reshape function

`fastoad.models.geometry.profiles.get_profile.`**`get_profile`**(*file_name: str = 'BACJ.txt'*, *thickness_ratio=None*, *chord_length=None*) → pandas.core.frame.DataFrame

Reads profile from indicated resource file and returns it after resize

Parameters

- **`file_name`** – name of resource (only "BACJ.txt" for now)
- **`thickness_ratio`** –
- **`chord_length`** –

Returns Nx2 pandas.DataFrame with x in 1st column and z in 2nd column

fastoad.models.geometry.profiles.profile module

Management of 2D wing profiles

class `fastoad.models.geometry.profiles.profile.`**`Coordinates2D`**(*x*, *y*)

Bases: `tuple`

Create new instance of Coordinates2D(x, y)

property x

Alias for field number 0

property y

Alias for field number 1

class `fastoad.models.geometry.profiles.profile.`**`Profile`**(*chord_length: float = 0.0*)

Bases: `object`

Class for managing 2D wing profiles :param chord_length: :param x: :param y:

`chord_length`: `float`

in meters

`get_lower_side`() → pandas.core.frame.DataFrame

Point set of lower side of the profile.

DataFrame keys are 'x' and 'z', given in meters.

`get_mean_line`() → pandas.core.frame.DataFrame

Point set of mean line of the profile.

DataFrame keys are 'x' and 'z', given in meters.

`get_relative_thickness`() → pandas.core.frame.DataFrame

Point set of relative thickness of the profile.

DataFrame keys are 'x' and 'thickness' and are relative to chord_length. 'x' is form 0. to 1.

`get_sides`() → pandas.core.frame.DataFrame

Point set of the whole profile

Points are given from trailing edge to trailing edge, starting by upper side.

`get_upper_side`() → pandas.core.frame.DataFrame

Point set of upper side of the profile.

DataFrame keys are 'x' and 'z', given in meters.

set_points(*x: Sequence*, *z: Sequence*, *keep_chord_length: bool = True*, *keep_relative_thickness: bool = True*)

Sets points of the 2D profile.

Provided points are expected to be in order around the profile (clockwise or anti-clockwise).

Parameters

- **x** – in meters
- **z** – in meters
- **keep_relative_thickness** –
- **keep_chord_length** –

property thickness_ratio

thickness-to-chord ratio

Module contents

Different functions available

Submodules

fastoad.models.geometry.compute_aero_center module

Estimation of aerodynamic center

class fastoad.models.geometry.compute_aero_center.**ComputeAeroCenter**(***kwargs*)

Bases: `openmdao.core.explicitcomponent.ExplicitComponent`

Aerodynamic center estimation

Store some bound methods so we can detect runtime overrides.

Parameters ****kwargs** (*dict of keyword arguments*) – Keyword arguments that will be mapped into the Component options.

compute(*inputs*, *outputs*)

Compute outputs given inputs. The model is assumed to be in an unscaled state.

Parameters

- **inputs** (*Vector*) – unscaled, dimensional input variables read via inputs[key]
- **outputs** (*Vector*) – unscaled, dimensional output variables read via outputs[key]
- **discrete_inputs** (*dict or None*) – If not None, dict containing discrete input values.
- **discrete_outputs** (*dict or None*) – If not None, dict containing discrete output values.

setup()

Declare inputs and outputs.

Available attributes: name pathname comm options

fastoad.models.geometry.geometry module

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class fastoad.models.geometry.geometry.**Geometry**(***kwargs*)

Bases: openmdao.core.group.Group

Computes geometric characteristics of the (tube-wing) aircraft:

- fuselage size is computed from payload requirements
- wing dimensions are computed from global parameters (area, taper ratio. . .)
- tail planes are dimensioned from HQ requirements

This module also computes centers of gravity and static margin

Set the solvers to nonlinear and linear block Gauss–Seidel by default.

Parameters ****kwargs** (*dict*) – dict of arguments available here and in all descendants of this Group.

initialize()

Perform any one-time initialization run at instantiation.

setup()

Build this group.

This method should be overidden by your Group's method. The reason for using this method to add subsystem is to save memory and setup time when using your Group while running under MPI. This avoids the creation of systems that will not be used in the current process.

You may call 'add_subsystem' to add systems to this group. You may also issue connections, and set the linear and nonlinear solvers for this group level. You cannot safely change anything on children systems; use the 'configure' method instead.

Available attributes: name pathname comm options

Module contents

Estimation of global geometry components

fastoad.models.handling_qualities package

Subpackages

fastoad.models.handling_qualities.tail_sizing package

Submodules

fastoad.models.handling_qualities.tail_sizing.compute_ht_area module

Estimation of horizontal tail area

class fastoad.models.handling_qualities.tail_sizing.compute_ht_area.**ComputeHTArea**(***kwargs*)

Bases: openmdao.core.explicitcomponent.ExplicitComponent

Computes area of horizontal tail plane

Area is computed to fulfill aircraft balance requirement at rotation speed

Store some bound methods so we can detect runtime overrides.

Parameters `**kwargs` (*dict of keyword arguments*) – Keyword arguments that will be mapped into the Component options.

compute (*inputs*, *outputs*, *discrete_inputs=None*, *discrete_outputs=None*)
Compute outputs given inputs. The model is assumed to be in an unscaled state.

Parameters

- **inputs** (*Vector*) – unscaled, dimensional input variables read via inputs[key]
- **outputs** (*Vector*) – unscaled, dimensional output variables read via outputs[key]
- **discrete_inputs** (*dict or None*) – If not None, dict containing discrete input values.
- **discrete_outputs** (*dict or None*) – If not None, dict containing discrete output values.

setup ()
Declare inputs and outputs.

Available attributes: name pathname comm options

fastoad.models.handling_qualities.tail_sizing.compute_tail_areas module

Computation of tail areas w.r.t. HQ criteria

class fastoad.models.handling_qualities.tail_sizing.compute_tail_areas.**ComputeTailAreas** (***k*
Bases: `openmdao.core.group.Group`

Computes areas of vertical and horizontal tail.

- Horizontal tail area is computed so it can balance pitching moment of aircraft at rotation speed.
- Vertical tail area is computed so aircraft can have the CNbeta in cruise conditions

Set the solvers to nonlinear and linear block Gauss–Seidel by default.

Parameters `**kwargs` (*dict*) – dict of arguments available here and in all descendants of this Group.

setup ()
Build this group.

This method should be overidden by your Group's method. The reason for using this method to add subsystem is to save memory and setup time when using your Group while running under MPI. This avoids the creation of systems that will not be used in the current process.

You may call 'add_subsystem' to add systems to this group. You may also issue connections, and set the linear and nonlinear solvers for this group level. You cannot safely change anything on children systems; use the 'configure' method instead.

Available attributes: name pathname comm options

fastoad.models.handling_qualities.tail_sizing.compute_vt_area module

Estimation of vertical tail area

class fastoad.models.handling_qualities.tail_sizing.compute_vt_area.**ComputeVTArea**(***kwargs*)

Bases: openmdao.core.explicitcomponent.ExplicitComponent

Computes area of vertical tail plane

Area is computed to fulfill lateral stability requirement (with the most aft CG) as stated in :cite:raymer:1992.

Store some bound methods so we can detect runtime overrides.

Parameters ****kwargs** (*dict of keyword arguments*) – Keyword arguments that will be mapped into the Component options.

compute(*inputs*, *outputs*, *discrete_inputs=None*, *discrete_outputs=None*)

Compute outputs given inputs. The model is assumed to be in an unscaled state.

Parameters

- **inputs** (*Vector*) – unscaled, dimensional input variables read via inputs[key]
- **outputs** (*Vector*) – unscaled, dimensional output variables read via outputs[key]
- **discrete_inputs** (*dict or None*) – If not None, dict containing discrete input values.
- **discrete_outputs** (*dict or None*) – If not None, dict containing discrete output values.

setup()

Declare inputs and outputs.

Available attributes: name pathname comm options

Module contents

Submodules

fastoad.models.handling_qualities.compute_static_margin module

Estimation of static margin

class fastoad.models.handling_qualities.compute_static_margin.**ComputeStaticMargin**(***kwargs*)

Bases: openmdao.core.explicitcomponent.ExplicitComponent

Computation of static margin i.e. difference between CG ratio and neutral point.

Store some bound methods so we can detect runtime overrides.

Parameters ****kwargs** (*dict of keyword arguments*) – Keyword arguments that will be mapped into the Component options.

compute(*inputs*, *outputs*, *discrete_inputs=None*, *discrete_outputs=None*)

Compute outputs given inputs. The model is assumed to be in an unscaled state.

Parameters

- **inputs** (*Vector*) – unscaled, dimensional input variables read via inputs[key]
- **outputs** (*Vector*) – unscaled, dimensional output variables read via outputs[key]

- **discrete_inputs** (*dict or None*) – If not None, dict containing discrete input values.
- **discrete_outputs** (*dict or None*) – If not None, dict containing discrete output values.

initialize()
Perform any one-time initialization run at instantiation.

setup()
Declare inputs and outputs.

Available attributes: name pathname comm options

Module contents

fastoad.models.loops package

Subpackages

Submodules

fastoad.models.loops.compute_wing_area module

Computation of wing area

class fastoad.models.loops.compute_wing_area.**ComputeWingArea**(***kwargs*)
Bases: openmdao.core.group.Group

Computes needed wing area for:

- having enough lift at required approach speed
- being able to load enough fuel to achieve the sizing mission

Set the solvers to nonlinear and linear block Gauss–Seidel by default.

Parameters ****kwargs** (*dict*) – dict of arguments available here and in all descendants of this Group.

setup()
Build this group.

This method should be overidden by your Group's method. The reason for using this method to add subsystem is to save memory and setup time when using your Group while running under MPI. This avoids the creation of systems that will not be used in the current process.

You may call 'add_subsystem' to add systems to this group. You may also issue connections, and set the linear and nonlinear solvers for this group level. You cannot safely change anything on children systems; use the 'configure' method instead.

Available attributes: name pathname comm options

Module contents

fastoad.models.performances package

Subpackages

fastoad.models.performances.breguet package

Subpackages

Submodules

fastoad.models.performances.breguet.breguet module

Implementation of the Breguet Formula.

class fastoad.models.performances.breguet.breguet.**Breguet**(*propulsion: fastoad.models.propulsion.propulsion.IPropulsion, lift_drag_ratio: float, cruise_mach: float, cruise_altitude: float, climb_mass_ratio: float = 0.97, descent_mass_ratio: float = 0.98, reserve_mass_ratio: float = 0.06, climb_descent_distance: float = 500000.0*)

Bases: `object`

Class for computing consumed fuel for a simple flight.

Fuel consumption during cruise is computing with Breguet formula. Climb and descent phases are roughly estimated using provided mass ratios.

Parameters

- **propulsion** – the propulsion model for computation of consumption
- **lift_drag_ratio** – the lift/drag ratio that will be used during cruise
- **cruise_mach** – Mach number in cruise
- **cruise_altitude** – in meters. Altitude in cruise
- **climb_mass_ratio** – (mass at end of climb) / (mass at start of climb)
- **descent_mass_ratio** – (mass at end of descent) / (mass at start of descent)
- **reserve_mass_ratio** – (mass of reserve fuel) / ZFW
- **climb_descent_distance** – in meters. Sum of ground distances during climb and descent

compute(*takeoff_weight, flight_range*)

Computes the flight consumption.

Results are provided as class attributes.

Parameters

- **takeoff_weight** –
- **flight_range** –

compute_cruise_mass_ratio(*initial_cruise_mass*, *cruise_distance*)

Parameters

- **initial_cruise_mass** –
- **cruise_distance** –

Returns (mass at end of cruise) / (mass at start of cruise)

fastoad.models.performances.breguet.openmdao module

Simple Breguet-based module for performances.

class fastoad.models.performances.breguet.openmdao.**BreguetWithPropulsion**(***kwargs*)

Bases: `openmdao.core.explicitcomponent.ExplicitComponent`

Store some bound methods so we can detect runtime overrides.

Parameters ****kwargs** (*dict of keyword arguments*) – Keyword arguments that will be mapped into the Component options.

compute(*inputs*, *outputs*, *discrete_inputs=None*, *discrete_outputs=None*)

Compute outputs given inputs. The model is assumed to be in an unscaled state.

Parameters

- **inputs** (*Vector*) – unscaled, dimensional input variables read via inputs[key]
- **outputs** (*Vector*) – unscaled, dimensional output variables read via outputs[key]
- **discrete_inputs** (*dict or None*) – If not None, dict containing discrete input values.
- **discrete_outputs** (*dict or None*) – If not None, dict containing discrete output values.

initialize()

Perform any one-time initialization run at instantiation.

setup()

Declare inputs and outputs.

Available attributes: name pathname comm options

class fastoad.models.performances.breguet.openmdao.**OMBreguet**(***kwargs*)

Bases: `openmdao.core.group.Group`

Estimation of fuel consumption through Breguet formula.

It uses a rough estimate of climb and descent phases.

MTOW (Max TakeOff Weight) being an input, the model computes the ZFW (Zero Fuel Weight) considering that all fuel but the reserve has been consumed during the mission. This model does not ensure consistency with OWE (Operating Empty Weight).

Set the solvers to nonlinear and linear block Gauss–Seidel by default.

Parameters `**kwargs` (*dict*) – dict of arguments available here and in all descendants of this Group.

initialize()

Perform any one-time initialization run at instantiation.

setup()

Build this group.

This method should be overidden by your Group's method. The reason for using this method to add subsystem is to save memory and setup time when using your Group while running under MPI. This avoids the creation of systems that will not be used in the current process.

You may call 'add_subsystem' to add systems to this group. You may also issue connections, and set the linear and nonlinear solvers for this group level. You cannot safely change anything on children systems; use the 'configure' method instead.

Available attributes: name pathname comm options

Module contents

Package for performance computation using Breguet formula.

fastoad.models.performances.mission package

Subpackages

fastoad.models.performances.mission.flight package

Subpackages

Submodules

fastoad.models.performances.mission.flight.base module

Base classes for flight computation.

class fastoad.models.performances.mission.flight.base.**AbstractSimpleFlight**(*cruise_distance: float*, *climb_phases: List[*fastoad.models.pe*r*, *cruise_phase:* fastoad.models.performan, *descent_phases: List[*fastoad.models.pe

Bases: *fastoad.models.performances.mission.base.AbstractFlightSequence*

Computes a simple flight.

The computed flight will be be made of:

- any number of climb phases

- one cruise segment
- any number of descent phases.

Parameters

- **cruise_distance** –
- **climb_phases** –
- **cruise_phase** –
- **descent_phases** –

property cruise_distance

property flight_sequence
Defines the sequence as used in `compute_from()`.

Returns the list of IFlightPart instances for the mission.

class `fastoad.models.performances.mission.flight.base.`**RangedFlight**(*flight_definition:* fastoad.models.performances.mission. *flight_distance: float*)

Bases: *fastoad.models.performances.mission.base.IFlightPart*

Computes a flight so that it covers the specified distance.

Computes the flight and adjust the cruise distance to achieve the provided flight distance.

Parameters

- **flight_definition** –
- **flight_distance** – in meters

compute_from(*start:* fastoad.base.flight_point.FlightPoint) → pandas.core.frame.DataFrame
Computes a flight sequence from provided start point.

Parameters **start** – the initial flight point, defined for *altitude*, *mass* and speed (*true_airspeed*, *equivalent_airspeed* or *mach*). Can also be defined for *time* and/or *ground_distance*.

Returns a pandas DataFrame where columns names match `FlightPoint.labels`

fastoad.models.performances.mission.flight.standard_flight module

Definition of the standard flight missions.

class `fastoad.models.performances.mission.flight.standard_flight.`**ClimbPhase**(***kwargs*)
Bases: *fastoad.models.performances.mission.base.AbstractManualThrustFlightPhase*

Preset for climb phase.

- Climbs up to 10000ft at constant EAS
- Accelerates to EAS = 300kt at constant altitude
- Climbs up to target altitude at constant EAS

Uses keyword arguments as for `AbstractManualThrustFlightPhase()` with these additional keywords:

Parameters

- **maximum_mach** – Mach number that won't be exceeded during climb
- **target_altitude** – target altitude in meters, can be a float or AltitudeChangeSegment.OPTIMAL_ALTITUDE to target altitude with maximum lift/drag ratio

property flight_sequence
Defines the sequence as used in `compute_from()`.

Returns the list of IFlightPart instances for the mission.

class `fastoad.models.performances.mission.flight.standard_flight.`**DescentPhase**(***kwargs*)
Bases: *fastoad.models.performances.mission.base.AbstractManualThrustFlightPhase*

Preset for descent phase.

- Descends down to EAS = 300kt at constant Mach
- Descends down to 10000ft at constant EAS
- Decelerates to EAS = 250kt
- Descends down to target altitude at constant EAS

Uses keyword arguments as for `AbstractManualThrustFlightPhase()` with this additional keyword:

Parameters **target_altitude** – target altitude in meters

property flight_sequence
Defines the sequence as used in `compute_from()`.

Returns the list of IFlightPart instances for the mission.

class `fastoad.models.performances.mission.flight.standard_flight.`**InitialClimbPhase**(**, propulsion: fastoad.model reference_area: float, polar: fastoad.model thrust_rate float = 1.0, name='', time_step=*
Bases: *fastoad.models.performances.mission.base.AbstractManualThrustFlightPhase*

Preset for initial climb phase.

- Climbs up to 400ft at constant EAS
- Accelerates to EAS = 250kt at constant altitude
- Climbs up to 1500ft at constant EAS

Initialization is done only with keyword arguments.

Parameters

- **propulsion** –
- **reference_area** –
- **polar** –
- **thrust_rate** –
- **time_step** – if provided, this time step will be applied for all segments.

property flight_sequence
Defines the sequence as used in `compute_from()`.

Returns the list of IFlightPart instances for the mission.

class fastoad.models.performances.mission.flight.standard_flight.**StandardFlight**(*propulsion: fastoad.models.pro* *reference_area: float*, *low_speed_clim* *fastoad.models.per* *high_speed_pol* *fastoad.models.per* *cruise_mach: float*, *thrust_rates: Dict[fastoad.co* *float]*, *cruise_distance* *float = 0.0*, *climb_target_al* *float = - 20000.0*, *descent_target_al* *float = 457.199999999* *time_step=Non*

Bases: *fastoad.models.performances.mission.flight.base.AbstractSimpleFlight*

Defines and computes a standard flight mission.

The flight sequence is: - initial climb - climb - cruise at constant altitude - descent

Parameters

- **propulsion** –
- **reference_area** –

- **low_speed_climb_polar** –
- **high_speed_polar** –
- **cruise_mach** –
- **thrust_rates** –
- **cruise_distance** –
- **climb_target_altitude** – (in m) altitude where cruise will begin. If value is AltitudeChangeSegment.OPTIMAL_ALTITUDE (default), climb will stop when maximum lift/drag ratio is achieved. Cruise will go on at the same altitude.
- **descent_target_altitude** – (in m) altitude where descent will end in meters Default is 457.2m (1500ft)
- **time_step** – if provided, this time step will be applied for all segments.

Module contents

fastoad.models.performances.mission.openmdao package

Subpackages

Submodules

fastoad.models.performances.mission.openmdao.flight module

class `fastoad.models.performances.mission.openmdao.flight.`**SizingFlight**(***kwargs*)

Bases: `openmdao.core.explicitcomponent.ExplicitComponent`

Simulates a complete flight mission with diversion.

Computes thrust, SFC and thrust rate by direct call to engine model.

Options:

- propulsion_id: (mandatory) the identifier of the propulsion wrapper.
- **out_file: if provided, a csv file will be written at provided path with all computed** flight points. If path is relative, it will be resolved from working directory

compute(*inputs*, *outputs*, *discrete_inputs=None*, *discrete_outputs=None*)

Compute outputs given inputs. The model is assumed to be in an unscaled state.

Parameters

- **inputs** (*Vector*) – unscaled, dimensional input variables read via inputs[key]
- **outputs** (*Vector*) – unscaled, dimensional output variables read via outputs[key]
- **discrete_inputs** (*dict or None*) – If not None, dict containing discrete input values.
- **discrete_outputs** (*dict or None*) – If not None, dict containing discrete output values.

compute_breguet(*inputs*, *outputs*)

compute_mission(*inputs*, *outputs*)

initialize()
Perform any one-time initialization run at instantiation.

setup()
Declare inputs and outputs.

Available attributes: name pathname comm options

Module contents

fastoad.models.performances.mission.segments package

Subpackages

Submodules

fastoad.models.performances.mission.segments.altitude_change module

Classes for climb/descent segments.

class fastoad.models.performances.mission.segments.altitude_change.**AltitudeChangeSegment**(*,
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Bases: *fastoad.models.performances.mission.segments.base.ManualThrustSegment*

Computes a flight path segment where altitude is modified with constant speed.

Note: Setting speed

Constant speed may be:

- constant true airspeed (TAS)
- constant equivalent airspeed (EAS)
- constant Mach number

Target should have `"constant"` as definition for one parameter among `true_airspeed`, `equivalent_airspeed` or `mach`. All computed flight points will use the corresponding **start** value. The two other speed values will be computed accordingly.

If not "constant" parameter is set, constant TAS is assumed.

Note: Setting target

Target can be an altitude, or a speed.

Target altitude can be a float value (in **meters**), or can be set to: - *OPTIMAL_ALTITUDE*: in that case, the target altitude will be the altitude

where maximum lift/drag ratio is achieved for target speed, depending on current mass.

- *OPTIMAL_FLIGHT_LEVEL*: same as above, except that altitude will be rounded to the nearest flight level (multiple of 1000 feet).

For a speed target, as explained above, one value TAS, EAS or Mach must be `"constant"`. One of the two other ones can be set as target.

Warning: Whatever the above settings, if `cruise_mach` attribute is set, speed will always be limited so that Mach number keeps lower or equal to this value.

Only keyword arguments are accepted.

Parameters

- **target** – the target flight point, defined for any relevant parameter
- **propulsion** – the propulsion model
- **reference_area** – the reference area for aerodynamic forces
- **polar** – the aerodynamic polar

OPTIMAL_ALTITUDE = -10000.0

Using this value will tell to target the altitude with max lift/drag ratio.

OPTIMAL_FLIGHT_LEVEL = -20000.0

compute_from(*start: fastoad.base.flight_point.FlightPoint*) → pandas.core.frame.DataFrame

Computes the flight path segment from provided start point.

Computation ends when target is attained, or if the computation stops getting closer to target. For instance, a climb computation with too low thrust will only return one flight point, that is the provided start point.

Parameters **start** – the initial flight point, defined for *altitude*, *mass* and speed (*true_airspeed*, *equivalent_airspeed* or *mach*). Can also be defined for *time* and/or *ground_distance*.

Returns a pandas DataFrame where columns are given by `FlightPoint.labels`

classmethod get_attribute_keys()

Returns list of attributes paired to dict key.

property time_step

fastoad.models.performances.mission.segments.base module

Base classes for simulating flight segments.

class fastoad.models.performances.mission.segments.base.**AbstractSegment**(**, target: fastoad.base.flight_point.Fligh, propulsion: fastoad.models.propulsion.pro, reference_area: float, polar: fastoad.models.performances.r, **kwargs*)

Bases: *fastoad.models.performances.mission.base.IFlightPart*, *fastoad.base.dict.DynamicAttributeDict*

Base class for flight path segment.

Behaviour can be modified using following instance attributes (can be set at instantiation using corresponding keyword arguments):

Variables

- ***time_step*** – used time step for computation (actual time step can be lower at some particular times of the flight path).
- ***engine_setting*** – the `EngineSetting` value associated to the segment. Can be used in the propulsion model.
- ***altitude_bounds*** – minimum and maximum authorized altitude values. If computed altitude gets beyond these limits, computation will be interrupted and a warning message will be issued in logger.
- ***mach_bounds*** – minimum and maximum authorized mach values. If computed Mach gets beyond these limits, computation will be interrupted and a warning message will be issued in logger.
- ***maximum_mach*** – if defined, this maximum Mach number will be enforced at each time step, whatever the speed specifications.
- ***name*** – the name of the current flight sequence.

Only keyword arguments are accepted.

Parameters

- **target** – the target flight point, defined for any relevant parameter
- **propulsion** – the propulsion model
- **reference_area** – the reference area for aerodynamic forces
- **polar** – the aerodynamic polar

property altitude_bounds

complete_flight_point (*flight_point:* fastoad.base.flight_point.FlightPoint)
Computes data for provided flight point.

Assumes that it is already defined for time, altitude, mass, ground distance and speed (TAS, EAS, or Mach).

Parameters **flight_point** – the flight point that will be completed in-place

compute_from (*start:* fastoad.base.flight_point.FlightPoint) → pandas.core.frame.DataFrame
Computes the flight path segment from provided start point.

Computation ends when target is attained, or if the computation stops getting closer to target. For instance, a climb computation with too low thrust will only return one flight point, that is the provided start point.

Parameters **start** – the initial flight point, defined for *altitude*, *mass* and speed (*true_airspeed*, *equivalent_airspeed* or *mach*). Can also be defined for *time* and/or *ground_distance*.

Returns a pandas DataFrame where columns are given by `FlightPoint.labels`

compute_next_flight_point (*flight_points: List[*fastoad.base.flight_point.FlightPoint*]*, *time_step:* float) → *fastoad.base.flight_point.FlightPoint*
Computes time, altitude, speed, mass and ground distance of next flight point.

Parameters

- **flight_points** – previous flight points
- **time_step** – time step for computing next point

Returns the computed next flight point

property engine_setting

classmethod get_attribute_keys ()

Returns list of attributes paired to dict key.

property mach_bounds

property maximum_mach

property name

property time_step

class `fastoad.models.performances.mission.segments.base.`**`FixedDurationSegment`**(*, *target: fastoad.base.flight_poi*, *propulsion: fastoad.models.propuls*, *reference_area: float*, *polar: fastoad.models.perform*, ***kwargs*)

Bases: `fastoad.models.performances.mission.segments.base.AbstractSegment`, `abc.ABC`

Class for computing phases where duration is fixed.

Target duration is provide as target.time. When using `compute_from()`, if start.time is not 0, end time will be start.time + target.time.

Only keyword arguments are accepted.

Parameters

- **`target`** – the target flight point, defined for any relevant parameter
- **`propulsion`** – the propulsion model
- **`reference_area`** – the reference area for aerodynamic forces
- **`polar`** – the aerodynamic polar

`compute_from`(*start:* fastoad.base.flight_point.FlightPoint) → pandas.core.frame.DataFrame

Computes the flight path segment from provided start point.

Computation ends when target is attained, or if the computation stops getting closer to target. For instance, a climb computation with too low thrust will only return one flight point, that is the provided start point.

Parameters **`start`** – the initial flight point, defined for *altitude*, *mass* and speed (*true_airspeed*, *equivalent_airspeed* or *mach*). Can also be defined for *time* and/or *ground_distance*.

Returns a pandas DataFrame where columns are given by `FlightPoint.labels`

class fastoad.models.performances.mission.segments.base.**ManualThrustSegment**(*, *target: fastoad.base.flight_point*, *propulsion: fastoad.models.propulsio*, *reference_area: float*, *polar: fastoad.models.performa*, ***kwargs*)

Bases: *fastoad.models.performances.mission.segments.base.AbstractSegment*, abc.ABC

Base class for computing flight segment where thrust rate is imposed.

Variables ***thrust_rate*** – used thrust rate. Can be set at instantiation using a keyword argument.

Only keyword arguments are accepted.

Parameters

- **target** – the target flight point, defined for any relevant parameter
- **propulsion** – the propulsion model
- **reference_area** – the reference area for aerodynamic forces
- **polar** – the aerodynamic polar

classmethod get_attribute_keys()

Returns list of attributes paired to dict key.

property thrust_rate

class fastoad.models.performances.mission.segments.base.**RegulatedThrustSegment**(*args, **kwargs*)

Bases: *fastoad.models.performances.mission.segments.base.AbstractSegment*, abc.ABC

Base class for computing flight segment where thrust rate is adjusted on drag.

Only keyword arguments are accepted.

Parameters

- **target** – the target flight point, defined for any relevant parameter
- **propulsion** – the propulsion model
- **reference_area** – the reference area for aerodynamic forces
- **polar** – the aerodynamic polar

classmethod get_attribute_keys()

Returns list of attributes paired to dict key.

property time_step

fastoad.models.performances.mission.segments.cruise module

Classes for simulating cruise segments.

class fastoad.models.performances.mission.segments.cruise.**CruiseSegment**(**args*, ***kwargs*)

Bases: *fastoad.models.performances.mission.segments.base.RegulatedThrustSegment*

Class for computing cruise flight segment at constant altitude.

Mach is considered constant, equal to Mach at starting point. Altitude is constant. Target is a specified ground_distance. The target definition indicates the ground_distance to be covered during the segment, independently of the initial value.

Only keyword arguments are accepted.

Parameters

- **target** – the target flight point, defined for any relevant parameter
- **propulsion** – the propulsion model
- **reference_area** – the reference area for aerodynamic forces
- **polar** – the aerodynamic polar

compute_from(*start:* fastoad.base.flight_point.FlightPoint) → pandas.core.frame.DataFrame

Computes the flight path segment from provided start point.

Computation ends when target is attained, or if the computation stops getting closer to target. For instance, a climb computation with too low thrust will only return one flight point, that is the provided start point.

Parameters **start** – the initial flight point, defined for *altitude*, *mass* and speed (*true_airspeed*, *equivalent_airspeed* or *mach*). Can also be defined for *time* and/or *ground_distance*.

Returns a pandas DataFrame where columns are given by `FlightPoint.labels`

class fastoad.models.performances.mission.segments.cruise.**OptimalCruiseSegment**(**args*, ***kwargs*)

Bases: *fastoad.models.performances.mission.segments.cruise.CruiseSegment*

Class for computing cruise flight segment at maximum lift/drag ratio.

Mach is considered constant, equal to Mach at starting point. Altitude is set **at every point** to get the optimum CL according to current mass.

Only keyword arguments are accepted.

Parameters

- **target** – the target flight point, defined for any relevant parameter
- **propulsion** – the propulsion model
- **reference_area** – the reference area for aerodynamic forces
- **polar** – the aerodynamic polar

compute_from(*start:* fastoad.base.flight_point.FlightPoint) → pandas.core.frame.DataFrame

Computes the flight path segment from provided start point.

Computation ends when target is attained, or if the computation stops getting closer to target. For instance, a climb computation with too low thrust will only return one flight point, that is the provided start point.

Parameters **start** – the initial flight point, defined for *altitude*, *mass* and speed (*true_airspeed*, *equivalent_airspeed* or *mach*). Can also be defined for *time* and/or *ground_distance*.

Returns a pandas DataFrame where columns are given by `FlightPoint.labels`

fastoad.models.performances.mission.segments.hold module

Class for simulating hold segment.

class `fastoad.models.performances.mission.segments.hold.`**HoldSegment**(**args*, ***kwargs*)

Bases: *fastoad.models.performances.mission.segments.base.RegulatedThrustSegment*, *fastoad.models.performances.mission.segments.base.FixedDurationSegment*

Class for computing hold flight segment.

Mach is considered constant, equal to Mach at starting point. Altitude is constant. Target is a specified time. The target definition indicates the time duration of the segment, independently of the initial time value.

Only keyword arguments are accepted.

Parameters

- **target** – the target flight point, defined for any relevant parameter
- **propulsion** – the propulsion model
- **reference_area** – the reference area for aerodynamic forces
- **polar** – the aerodynamic polar

fastoad.models.performances.mission.segments.speed_change module

Classes for acceleration/deceleration segments.

class `fastoad.models.performances.mission.segments.speed_change.`**SpeedChangeSegment**(**, tar- get: fas- toad.base.fl propul- sion: fas- toad.model ref- er- ence_area: float, po- lar: fas- toad.model **kwargs*)

Bases: *fastoad.models.performances.mission.segments.base.ManualThrustSegment*

Computes a flight path segment where speed is modified with no change in altitude.

The target must define a speed value among true_airspeed, equivalent_airspeed and mach.

Only keyword arguments are accepted.

Parameters

- **target** – the target flight point, defined for any relevant parameter
- **propulsion** – the propulsion model
- **reference_area** – the reference area for aerodynamic forces
- **polar** – the aerodynamic polar

fastoad.models.performances.mission.segments.taxi module

Classes for Taxi sequences.

class fastoad.models.performances.mission.segments.taxi.**TaxiSegment**(***kwargs*)

Bases: *fastoad.models.performances.mission.segments.base.ManualThrustSegment*, *fastoad.models.performances.mission.segments.base.FixedDurationSegment*

Class for computing Taxi phases.

Taxi phase has a target duration (target.time should be provided) and is at constant altitude, speed and thrust rate.

Only keyword arguments are accepted.

Parameters

- **target** – the target flight point, defined for any relevant parameter
- **propulsion** – the propulsion model
- **reference_area** – the reference area for aerodynamic forces
- **polar** – the aerodynamic polar

Module contents

Classes for simulating flight segments.

Submodules

fastoad.models.performances.mission.base module

Base classes for mission computation.

class fastoad.models.performances.mission.base.**AbstractFlightSequence**

Bases: *fastoad.models.performances.mission.base.IFlightPart*

Defines and computes a flight sequence.

compute_from(*start:* fastoad.base.flight_point.FlightPoint) → pandas.core.frame.DataFrame

Computes a flight sequence from provided start point.

Parameters **start** – the initial flight point, defined for *altitude*, *mass* and speed (*true_airspeed*, *equivalent_airspeed* or *mach*). Can also be defined for *time* and/or *ground_distance*.

Returns a pandas DataFrame where columns names match `FlightPoint.labels`

abstract property flight_sequence
Defines the sequence as used in `compute_from()`.

Returns the list of IFlightPart instances for the mission.

class `fastoad.models.performances.mission.base.`**AbstractManualThrustFlightPhase**(*, *propulsion: fastoad.models.prop*, *reference_area: float*, *polar: fastoad.models.perf*, *thrust_rate: float = 1.0*, *name=''*, *time_step=None*)

Bases: `fastoad.models.performances.mission.base.AbstractFlightSequence`, `abc.ABC`

Base class for climb and descent phases.

Initialization is done only with keyword arguments.

Parameters

- **propulsion** –
- **reference_area** –
- **polar** –
- **thrust_rate** –
- **time_step** – if provided, this time step will be applied for all segments.

class `fastoad.models.performances.mission.base.`**IFlightPart**
Bases: `abc.ABC`

compute_from(*start: fastoad.base.flight_point.FlightPoint*) → pandas.core.frame.DataFrame
Computes a flight sequence from provided start point.

Parameters **start** – the initial flight point, defined for *altitude*, *mass* and speed (*true_airspeed*, *equivalent_airspeed* or *mach*). Can also be defined for *time* and/or *ground_distance*.

Returns a pandas DataFrame where columns names match `FlightPoint.labels`

fastoad.models.performances.mission.exceptions module

Exceptions for mission package.

exception `fastoad.models.performances.mission.exceptions.`**`FastFlightPointUnexpectedKeywordAr`**

Bases: *fastoad.exceptions.FastUnexpectedKeywordArgument*

Raised when a FlightPoint is instantiated with an incorrect keyword argument.

exception `fastoad.models.performances.mission.exceptions.`**`FastFlightSegmentIncompleteFlightP`**

Bases: *fastoad.exceptions.FastError*

Raised when a segment computation encounters a FlightPoint instance without needed parameters.

exception `fastoad.models.performances.mission.exceptions.`**`FastFlightSegmentUnexpectedKeyword`**

Bases: *fastoad.exceptions.FastUnexpectedKeywordArgument*

Raised when a segment is instantiated with an incorrect keyword argument.

fastoad.models.performances.mission.polar module

Aerodynamic polar data.

class `fastoad.models.performances.mission.polar.`**`Polar`**(*cl: numpy.ndarray*, *cd: numpy.ndarray*)

Bases: `object`

Class for managing aerodynamic polar data.

Links drag coefficient (CD) to lift coefficient (CL). It is defined by two vectors with CL and CD values.

Once defined, for any CL value, CD can be obtained using `cd()`.

Parameters

- **cl** – a N-elements array with CL values
- **cd** – a N-elements array with CD values that match CL

cd(*cl*)

Computes drag coefficient (CD) by interpolation in definition data.

Parameters **cl** – lift coefficient (CL) values

Returns CD values for each provide CL values

property definition_cl

The vector that has been used for defining lift coefficient.

property optimal_cl

The CL value that provides larger lift/drag ratio.

Module contents

Performance module for mission simulation.

Module contents

Package for performance modules.

fastoad.models.propulsion package

Subpackages

fastoad.models.propulsion.fuel_propulsion package

Subpackages

fastoad.models.propulsion.fuel_propulsion.rubber_engine package

Subpackages

Submodules

fastoad.models.propulsion.fuel_propulsion.rubber_engine.constants module

Constants for rubber engine analytical models

fastoad.models.propulsion.fuel_propulsion.rubber_engine.exceptions module

Exceptions for rubber_engine package.

exception fastoad.models.propulsion.fuel_propulsion.rubber_engine.exceptions.**FastRubberEng**

Bases: `Exception`

Raised when provided parameter combination is incorrect.

fastoad.models.propulsion.fuel_propulsion.rubber_engine.openmdao module

OpenMDAO wrapping of RubberEngine.

class fastoad.models.propulsion.fuel_propulsion.rubber_engine.openmdao.**OMRubberEngineCompo**

Bases: *fastoad.models.propulsion.propulsion.BaseOMPropulsionComponent*

Parametric engine model as OpenMDAO component

See `RubberEngine` for more information.

Store some bound methods so we can detect runtime overrides.

Parameters ****kwargs** (*dict of keyword arguments*) – Keyword arguments that will be mapped into the Component options.

static get_wrapper() → *fastoad.models.propulsion.fuel_propulsion.rubber_engine.openmdao.OMRubberEngineWrappe*

This method defines the used `IOMPropulsionWrapper` instance.

Returns an instance of OpenMDAO wrapper for propulsion model

setup()

Will replace the original setup method.

class fastoad.models.propulsion.fuel_propulsion.rubber_engine.openmdao.**OMRubberEngineWrappe**

Bases: *fastoad.models.propulsion.propulsion.IOMPropulsionWrapper*

Wrapper class of for rubber engine model.

It is made to allow a direct call to *RubberEngine* in an OpenMDAO component.

Example of usage of this class:

```
import openmdao.api as om

class MyComponent(om.ExplicitComponent):
    def initialize():
        self._engine_wrapper = OMRubberEngineWrapper()

    def setup():
        # Adds OpenMDAO variables that define the engine
        self._engine_wrapper.setup(self)

        # Do the normal setup
        self.add_input("my_input")
        [finish the setup...]

    def compute(self, inputs, outputs, discrete_inputs=None, discrete_
↪outputs=None):
        [do something]

        # Get the engine instance, with parameters defined from OpenMDAO inputs
        engine = self._engine_wrapper.get_model(inputs)

        # Run the engine model. This is a pure Python call. You have to define
        # its inputs before, and to use its outputs according to your needs
        sfc, thrust_rate, thrust = engine.compute_flight_points(
            mach,
            altitude,
            engine_setting,
            use_thrust_rate,
            thrust_rate,
            thrust
            )

        [do something else]

)
```

property DESCRIPTION

Retrieves the property value, from the iPOPO dictionaries

static get_model(*inputs*) → *fastoad.models.propulsion.propulsion.IPropulsion*

Parameters inputs – input parameters that define the engine

Returns an `RubberEngine` instance

setup(*component: openmdao.core.component.Component*)

Defines the needed OpenMDAO inputs for propulsion instantiation as done in `get_model()`

Use *add_inputs* and *declare_partials* methods of the provided *component*

Parameters **component** –

fastoad.models.propulsion.fuel_propulsion.rubber_engine.rubber_engine module

Parametric turbofan engine.

class fastoad.models.propulsion.fuel_propulsion.rubber_engine.rubber_engine.**RubberEngine**(*by*
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Bases: `fastoad.models.propulsion.fuel_propulsion.base.AbstractFuelPropulsion`

Parametric turbofan engine.

It computes engine characteristics using analytical model from following sources:

Parameters

- **bypass_ratio** –
- **overall_pressure_ratio** –
- **turbine_inlet_temperature** – (unit=K) also noted T4
- **mto_thrust** – (unit=N) Maximum TakeOff thrust, i.e. maximum thrust on ground at speed 0, also noted F0
- **maximum_mach** –

- **design_altitude** – (unit=m)
- **delta_t4_climb** – (unit=K) difference between T4 during climb and design T4
- **delta_t4_cruise** – (unit=K) difference between T4 during cruise and design T4

compute_flight_points (*flight_points: Union[fastoad.base.flight_point.FlightPoint, pandas.core.frame.DataFrame]*)

Computes Specific Fuel Consumption according to provided conditions.

See `FlightPoint` for available fields that may be used for computation. If a DataFrame instance is provided, it is expected that its columns match field names of FlightPoint (actually, the DataFrame instance should be generated from a list of FlightPoint instances).

Note: About thrust_is_regulated, thrust_rate and thrust

`thrust_is_regulated` tells if a flight point should be computed using `thrust_rate` (when False) or `thrust` (when True) as input. This way, the method can be used in a vectorized mode, where each point can be set to respect a **thrust** order or a **thrust rate** order.

- if `thrust_is_regulated` is not defined, the considered input will be the defined one between `thrust_rate` and `thrust` (if both are provided, `thrust_rate` will be used)
- if `thrust_is_regulated` is `True` or `False` (i.e., not a sequence), the considered input will be taken accordingly, and should of course be defined.
- if there are several flight points, `thrust_is_regulated` is a sequence or array, `thrust_rate` and `thrust` should be provided and have the same shape as `thrust_is_regulated:code:`. The method will consider for each element which input will be used according to `thrust_is_regulated`.

Parameters **flight_points** – FlightPoint or DataFram instance

Returns None (inputs are updated in-place)

compute_flight_points_from_dt4 (*mach: Union[float, Sequence], altitude: Union[float, Sequence], delta_t4: Union[float, Sequence], thrust_is_regulated: Optional[Union[bool, Sequence]] = None, thrust_rate: Optional[Union[float, Sequence]] = None, thrust: Optional[Union[float, Sequence]] = None*) → Tuple[Union[float, Sequence], Union[float, Sequence], Union[float, Sequence]]

Same as *compute_flight_points()* except that delta_t4 is used directly instead of specifying flight engine_setting.

Parameters

- **mach** – Mach number
- **altitude** – (unit=m) altitude w.r.t. to sea level
- **delta_t4** – (unit=K) difference between operational and design values of turbine inlet temperature in K
- **thrust_is_regulated** – tells if thrust_rate or thrust should be used (works element-wise)
- **thrust_rate** – thrust rate (unit=none)
- **thrust** – required thrust (unit=N)

Returns SFC (in kg/s/N), thrust rate, thrust (in N)

installed_weight() → float
Computes weight of installed engine, depending on MTO thrust (F0).

Uses model described in [Rou05], p.74

Returns installed weight (in kg)

length() → float
Computes engine length from MTO thrust and maximum Mach.

Model from [Ray99], p.74

Returns engine length (in m)

max_thrust(*atmosphere: fastoad.utils.physics.atmosphere.Atmosphere, mach: Union[float, Sequence[float]], delta_t4: Union[float, Sequence[float]]*) → numpy.ndarray
Computation of maximum thrust.

Uses model described in [Rou05], p.57-58

Parameters

- **atmosphere** – Atmosphere instance at intended altitude (should be <=20km)
- **mach** – Mach number(s) (should be between 0.05 and 1.0)
- **delta_t4** – (unit=K) difference between operational and design values of turbine inlet temperature in K

Returns maximum thrust (in N)

nacelle_diameter() → float
Computes nacelle diameter from MTO thrust and bypass ratio.

Model of engine diameter from [Ray99], p.235. Nacelle diameter is considered 10% greater ([kro01])

Returns nacelle diameter (in m)

sfc_at_max_thrust(*atmosphere: fastoad.utils.physics.atmosphere.Atmosphere, mach: Union[float, Sequence[float]]*) → numpy.ndarray
Computation of Specific Fuel Consumption at maximum thrust.

Uses model described in [Rou05], p.41.

Parameters

- **atmosphere** – Atmosphere instance at intended altitude
- **mach** – Mach number(s)

Returns SFC (in kg/s/N)

sfc_ratio(*altitude: Union[float, Sequence[float]], thrust_rate: Union[float, Sequence[float]], mach: Union[float, Sequence[float]] = 0.8*) → numpy.ndarray
Computation of ratio $\frac{SFC(F)}{SFC(Fmax)}$, given altitude and thrust_rate $\frac{F}{Fmax}$.

Uses a patched version of model described in [Rou02], p.85.

Warning: this model is very limited

Parameters

- **altitude** –
- **thrust_rate** –
- **mach** – only used for logger checks as model is made for Mach~0.8

Returns SFC ratio

Module contents

Provides a parametric model for turbofan:

- as a pure Python
- as OpenMDAO modules

Submodules

fastoad.models.propulsion.fuel_propulsion.base module

Base classes for fuel-consuming propulsion models.

class fastoad.models.propulsion.fuel_propulsion.base.**AbstractFuelPropulsion**

Bases: *fastoad.models.propulsion.propulsion.IPropulsion*, abc.ABC

Propulsion model that consume any fuel should inherit from this one.

In inheritors, `compute_flight_points()` is expected to define "sfc" and "thrust" in computed FlightPoint instances.

get_consumed_mass (*flight_point:* fastoad.base.flight_point.FlightPoint, *time_step: float*) → float

Computes consumed mass for provided flight point and time step.

This method should rely on FlightPoint fields that are generated by :meth: *compute_flight_points*.

Parameters

- **flight_point** –
- **time_step** –

Returns the consumed mass in kg

class fastoad.models.propulsion.fuel_propulsion.base.**FuelEngineSet** (*engine:* fastoad.models.propulsion.propulsion *engine_count*)

Bases: *fastoad.models.propulsion.fuel_propulsion.base.AbstractFuelPropulsion*

Class for modelling an assembly of identical fuel engines.

Thrust is supposed equally distributed among them.

Parameters

- **engine** – the engine model
- **engine_count** –

compute_flight_points (*flight_points: Union[*fastoad.base.flight_point.FlightPoint*, pandas.core.frame.DataFrame]*)

Computes Specific Fuel Consumption according to provided conditions.

See `FlightPoint` for available fields that may be used for computation. If a DataFrame instance is provided, it is expected that its columns match field names of FlightPoint (actually, the DataFrame instance should be generated from a list of FlightPoint instances).

Note: About thrust_is_regulated, thrust_rate and thrust

`thrust_is_regulated` tells if a flight point should be computed using `thrust_rate` (when False) or `thrust` (when True) as input. This way, the method can be used in a vectorized mode, where each point can be set to respect a **thrust** order or a **thrust rate** order.

- if `thrust_is_regulated` is not defined, the considered input will be the defined one between `thrust_rate` and `thrust` (if both are provided, `thrust_rate` will be used)
- if `thrust_is_regulated` is `True` or `False` (i.e., not a sequence), the considered input will be taken accordingly, and should of course be defined.
- if there are several flight points, `thrust_is_regulated` is a sequence or array, `thrust_rate` and `thrust` should be provided and have the same shape as `thrust_is_regulated:code:`. The method will consider for each element which input will be used according to `thrust_is_regulated`.

Parameters **`flight_points`** – FlightPoint or DataFram instance

Returns None (inputs are updated in-place)

Module contents

Submodules

fastoad.models.propulsion.propulsion module

Base module for propulsion models.

class `fastoad.models.propulsion.propulsion.`**`BaseOMPropulsionComponent`**(***kwargs*)

Bases: `openmdao.core.explicitcomponent.ExplicitComponent`, `abc.ABC`

Base class for OpenMDAO wrapping of subclasses of `IEngineForOpenMDAO`.

Classes that implements this interface should add their own inputs in setup() and implement *`get_wrapper()`*.

Store some bound methods so we can detect runtime overrides.

Parameters **`**kwargs`** (*`dict of keyword arguments`*) – Keyword arguments that will be mapped into the Component options.

`compute`(*inputs*, *outputs*, *discrete_inputs=None*, *discrete_outputs=None*)

Compute outputs given inputs. The model is assumed to be in an unscaled state.

Parameters

- **`inputs`** (*`Vector`*) – unscaled, dimensional input variables read via inputs[key]
- **`outputs`** (*`Vector`*) – unscaled, dimensional output variables read via outputs[key]
- **`discrete_inputs`** (*`dict or None`*) – If not None, dict containing discrete input values.
- **`discrete_outputs`** (*`dict or None`*) – If not None, dict containing discrete output values.

`abstract static get_wrapper`() → *fastoad.models.propulsion.propulsion.IOMPropulsionWrapper*

This method defines the used *`IOMPropulsionWrapper`* instance.

Returns an instance of OpenMDAO wrapper for propulsion model

initialize()
Perform any one-time initialization run at instantiation.

setup()
Declare inputs and outputs.

Available attributes: name pathname comm options

class fastoad.models.propulsion.propulsion.**IOMPropulsionWrapper**
Bases: `object`

Interface for wrapping a *IPropulsion* subclass in OpenMDAO.

The implementation class defines the needed input variables for instantiating the *IPropulsion* subclass in *setup()* and use them for instantiation in *get_model()*

see `OMRubberEngineWrapper` for an example of implementation.

abstract static get_model(*inputs*) → *fastoad.models.propulsion.propulsion.IPropulsion*
This method defines the used *IPropulsion* subclass instance.

Parameters inputs – OpenMDAO input vector where the parameters that define the propulsion model are

Returns the propulsion model instance

abstract setup(*component: openmdao.core.component.Component*)
Defines the needed OpenMDAO inputs for propulsion instantiation as done in *get_model()*

Use *add_inputs* and *declare_partials* methods of the provided *component*

Parameters component –

class fastoad.models.propulsion.propulsion.**IPropulsion**
Bases: `abc.ABC`

Interface that should be implemented by propulsion models.

Using this class allows to delegate to the propulsion model the management of propulsion-related data when computing performances.

The performance model calls *compute_flight_points()* by providing one or several flight points. The method will feed these flight points with results of the model (e.g. thrust, SFC, ..).

The performance model will then be able to call *get_consumed_mass()* to know the mass consumption for each flight point.

Note:

```
If the propulsion model needs fields that are not among defined fields
of the :class`FlightPoint class`, these fields can be made authorized by
:class`FlightPoint class` by putting such command before defining the
class::

    >>> # Simply adds the fields:
    >>> AddKeyAttributes(["ion_drive_power", "warp"])(FlightPoint)
    >>> # Adds the fields with associated default values:
    >>> AddKeyAttributes({"ion_drive_power":110., "warp":9.0})(FlightPoint)
```

abstract compute_flight_points(*flight_points: Union[*fastoad.base.flight_point.FlightPoint*, pandas.core.frame.DataFrame]*)
Computes Specific Fuel Consumption according to provided conditions.

See `FlightPoint` for available fields that may be used for computation. If a DataFrame instance is provided, it is expected that its columns match field names of FlightPoint (actually, the DataFrame instance should be generated from a list of FlightPoint instances).

Note: About thrust_is_regulated, thrust_rate and thrust

`thrust_is_regulated` tells if a flight point should be computed using `thrust_rate` (when False) or `thrust` (when True) as input. This way, the method can be used in a vectorized mode, where each point can be set to respect a **thrust** order or a **thrust rate** order.

- if `thrust_is_regulated` is not defined, the considered input will be the defined one between `thrust_rate` and `thrust` (if both are provided, `thrust_rate` will be used)
- if `thrust_is_regulated` is `True` or `False` (i.e., not a sequence), the considered input will be taken accordingly, and should of course be defined.
- if there are several flight points, `thrust_is_regulated` is a sequence or array, `thrust_rate` and `thrust` should be provided and have the same shape as `thrust_is_regulated:code:`. The method will consider for each element which input will be used according to `thrust_is_regulated`.

Parameters **`flight_points`** – FlightPoint or DataFram instance

Returns None (inputs are updated in-place)

abstract get_consumed_mass (*flight_point:* fastoad.base.flight_point.FlightPoint, *time_step: float*) → float

Computes consumed mass for provided flight point and time step.

This method should rely on FlightPoint fields that are generated by :meth: *compute_flight_points*.

Parameters

- **`flight_point`** –
- **`time_step`** –

Returns the consumed mass in kg

Module contents

Package for propulsion modules

fastoad.models.weight package

Subpackages

fastoad.models.weight.cg package

Subpackages

fastoad.models.weight.cg.cg_components package

Submodules

fastoad.models.weight.cg.cg_components.compute_cg_control_surfaces module

Estimation of control surfaces center of gravity

class fastoad.models.weight.cg.cg_components.compute_cg_control_surfaces.**ComputeControlSur**
Bases: openmdao.core.explicitcomponent.ExplicitComponent

Control surfaces center of gravity estimation

Store some bound methods so we can detect runtime overrides.

Parameters ****kwargs** (*dict of keyword arguments*) – Keyword arguments that will be mapped into the Component options.

compute (*inputs*, *outputs*)
Compute outputs given inputs. The model is assumed to be in an unscaled state.

Parameters

- **inputs** (*Vector*) – unscaled, dimensional input variables read via inputs[key]
- **outputs** (*Vector*) – unscaled, dimensional output variables read via outputs[key]
- **discrete_inputs** (*dict or None*) – If not None, dict containing discrete input values.
- **discrete_outputs** (*dict or None*) – If not None, dict containing discrete output values.

setup ()
Declare inputs and outputs.

Available attributes: name pathname comm options

fastoad.models.weight.cg.cg_components.compute_cg_loadcase1 module

Estimation of center of gravity for load case 1

class fastoad.models.weight.cg.cg_components.compute_cg_loadcase1.**ComputeCGLoadCase1** (***kwarg*
Bases: openmdao.core.explicitcomponent.ExplicitComponent

Center of gravity estimation for load case 1

Store some bound methods so we can detect runtime overrides.

Parameters ****kwargs** (*dict of keyword arguments*) – Keyword arguments that will be mapped into the Component options.

compute (*inputs*, *outputs*, *discrete_inputs=None*, *discrete_outputs=None*)
Compute outputs given inputs. The model is assumed to be in an unscaled state.

Parameters

- **inputs** (*Vector*) – unscaled, dimensional input variables read via inputs[key]
- **outputs** (*Vector*) – unscaled, dimensional output variables read via outputs[key]
- **discrete_inputs** (*dict or None*) – If not None, dict containing discrete input values.

- **discrete_outputs** (*dict or None*) – If not None, dict containing discrete output values.

setup()
Declare inputs and outputs.

Available attributes: name pathname comm options

fastoad.models.weight.cg.cg_components.compute_cg_loadcase2 module

Estimation of center of gravity for load case 2

class fastoad.models.weight.cg.cg_components.compute_cg_loadcase2.**ComputeCGLoadCase2**(***kwarg*
Bases: openmdao.core.explicitcomponent.ExplicitComponent

Center of gravity estimation for load case 2

Store some bound methods so we can detect runtime overrides.

Parameters ****kwargs** (*dict of keyword arguments*) – Keyword arguments that will be mapped into the Component options.

compute(*inputs*, *outputs*, *discrete_inputs=None*, *discrete_outputs=None*)
Compute outputs given inputs. The model is assumed to be in an unscaled state.

Parameters

- **inputs** (*Vector*) – unscaled, dimensional input variables read via inputs[key]
- **outputs** (*Vector*) – unscaled, dimensional output variables read via outputs[key]
- **discrete_inputs** (*dict or None*) – If not None, dict containing discrete input values.
- **discrete_outputs** (*dict or None*) – If not None, dict containing discrete output values.

setup()
Declare inputs and outputs.

Available attributes: name pathname comm options

fastoad.models.weight.cg.cg_components.compute_cg_loadcase3 module

Estimation of center of gravity for load case 3

class fastoad.models.weight.cg.cg_components.compute_cg_loadcase3.**ComputeCGLoadCase3**(***kwarg*
Bases: openmdao.core.explicitcomponent.ExplicitComponent

Center of gravity estimation for load case 3

Store some bound methods so we can detect runtime overrides.

Parameters ****kwargs** (*dict of keyword arguments*) – Keyword arguments that will be mapped into the Component options.

compute(*inputs*, *outputs*, *discrete_inputs=None*, *discrete_outputs=None*)
Compute outputs given inputs. The model is assumed to be in an unscaled state.

Parameters

- **inputs** (*Vector*) – unscaled, dimensional input variables read via inputs[key]

- **outputs** (*Vector*) – unscaled, dimensional output variables read via outputs[key]
- **discrete_inputs** (*dict or None*) – If not None, dict containing discrete input values.
- **discrete_outputs** (*dict or None*) – If not None, dict containing discrete output values.

setup()
Declare inputs and outputs.

Available attributes: name pathname comm options

fastoad.models.weight.cg.cg_components.compute_cg_loadcase4 module

Estimation of center of gravity for load case 4

class fastoad.models.weight.cg.cg_components.compute_cg_loadcase4.**ComputeCGLoadCase4**(***kwarg*
Bases: openmdao.core.explicitcomponent.ExplicitComponent

Center of gravity estimation for load case 4

Store some bound methods so we can detect runtime overrides.

Parameters ****kwargs** (*dict of keyword arguments*) – Keyword arguments that will be mapped into the Component options.

compute(*inputs, outputs, discrete_inputs=None, discrete_outputs=None*)
Compute outputs given inputs. The model is assumed to be in an unscaled state.

Parameters

- **inputs** (*Vector*) – unscaled, dimensional input variables read via inputs[key]
- **outputs** (*Vector*) – unscaled, dimensional output variables read via outputs[key]
- **discrete_inputs** (*dict or None*) – If not None, dict containing discrete input values.
- **discrete_outputs** (*dict or None*) – If not None, dict containing discrete output values.

setup()
Declare inputs and outputs.

Available attributes: name pathname comm options

fastoad.models.weight.cg.cg_components.compute_cg_others module

Estimation of other components center of gravities

class fastoad.models.weight.cg.cg_components.compute_cg_others.**ComputeOthersCG**(***kwargs*)
Bases: openmdao.core.explicitcomponent.ExplicitComponent

Other components center of gravities estimation

Store some bound methods so we can detect runtime overrides.

Parameters ****kwargs** (*dict of keyword arguments*) – Keyword arguments that will be mapped into the Component options.

compute (*inputs*, *outputs*)
Compute outputs given inputs. The model is assumed to be in an unscaled state.

Parameters

- **inputs** (*Vector*) – unscaled, dimensional input variables read via inputs[key]
- **outputs** (*Vector*) – unscaled, dimensional output variables read via outputs[key]
- **discrete_inputs** (*dict or None*) – If not None, dict containing discrete input values.
- **discrete_outputs** (*dict or None*) – If not None, dict containing discrete output values.

setup ()
Declare inputs and outputs.

Available attributes: name pathname comm options

fastoad.models.weight.cg.cg_components.compute_cg_ratio_aft module

Estimation of center of gravity ratio with aft

class fastoad.models.weight.cg.cg_components.compute_cg_ratio_aft.**CGRatio** (***kwargs*)
Bases: openmdao.core.explicitcomponent.ExplicitComponent

Store some bound methods so we can detect runtime overrides.

Parameters ****kwargs** (*dict of keyword arguments*) – Keyword arguments that will be mapped into the Component options.

compute (*inputs*, *outputs*, *discrete_inputs=None*, *discrete_outputs=None*)
Compute outputs given inputs. The model is assumed to be in an unscaled state.

Parameters

- **inputs** (*Vector*) – unscaled, dimensional input variables read via inputs[key]
- **outputs** (*Vector*) – unscaled, dimensional output variables read via outputs[key]
- **discrete_inputs** (*dict or None*) – If not None, dict containing discrete input values.
- **discrete_outputs** (*dict or None*) – If not None, dict containing discrete output values.

setup ()
Declare inputs and outputs.

Available attributes: name pathname comm options

class fastoad.models.weight.cg.cg_components.compute_cg_ratio_aft.**ComputeCG** (***kwargs*)
Bases: openmdao.core.explicitcomponent.ExplicitComponent

Store some bound methods so we can detect runtime overrides.

Parameters ****kwargs** (*dict of keyword arguments*) – Keyword arguments that will be mapped into the Component options.

compute (*inputs*, *outputs*, *discrete_inputs=None*, *discrete_outputs=None*)
Compute outputs given inputs. The model is assumed to be in an unscaled state.

Parameters

- **inputs** (*Vector*) – unscaled, dimensional input variables read via inputs[key]
- **outputs** (*Vector*) – unscaled, dimensional output variables read via outputs[key]
- **discrete_inputs** (*dict or None*) – If not None, dict containing discrete input values.
- **discrete_outputs** (*dict or None*) – If not None, dict containing discrete output values.

initialize()
Perform any one-time initialization run at instantiation.

setup()
Declare inputs and outputs.

Available attributes: name pathname comm options

class fastoad.models.weight.cg.cg_components.compute_cg_ratio_aft.**ComputeCGRatioAft**(***kwargs*)
Bases: openmdao.core.group.Group

Set the solvers to nonlinear and linear block Gauss–Seidel by default.

Parameters ****kwargs** (*dict*) – dict of arguments available here and in all descendants of this Group.

setup()
Build this group.

This method should be overidden by your Group's method. The reason for using this method to add subsystem is to save memory and setup time when using your Group while running under MPI. This avoids the creation of systems that will not be used in the current process.

You may call 'add_subsystem' to add systems to this group. You may also issue connections, and set the linear and nonlinear solvers for this group level. You cannot safely change anything on children systems; use the 'configure' method instead.

Available attributes: name pathname comm options

fastoad.models.weight.cg.cg_components.compute_cg_tanks module

Estimation of tanks center of gravity

class fastoad.models.weight.cg.cg_components.compute_cg_tanks.**ComputeTanksCG**(***kwargs*)
Bases: openmdao.core.explicitcomponent.ExplicitComponent

Tanks center of gravity estimation

Store some bound methods so we can detect runtime overrides.

Parameters ****kwargs** (*dict of keyword arguments*) – Keyword arguments that will be mapped into the Component options.

compute(*inputs*, *outputs*)
Compute outputs given inputs. The model is assumed to be in an unscaled state.

Parameters

- **inputs** (*Vector*) – unscaled, dimensional input variables read via inputs[key]
- **outputs** (*Vector*) – unscaled, dimensional output variables read via outputs[key]
- **discrete_inputs** (*dict or None*) – If not None, dict containing discrete input values.

- **discrete_outputs** (*dict or None*) – If not None, dict containing discrete output values.

initialize()
Perform any one-time initialization run at instantiation.

setup()
Declare inputs and outputs.

Available attributes: name pathname comm options

fastoad.models.weight.cg.cg_components.compute_cg_wing module

Estimation of wing center of gravity

class fastoad.models.weight.cg.cg_components.compute_cg_wing.**ComputeWingCG**(***kwargs*)
Bases: openmdao.core.explicitcomponent.ExplicitComponent

Wing center of gravity estimation

Store some bound methods so we can detect runtime overrides.

Parameters ****kwargs** (*dict of keyword arguments*) – Keyword arguments that will be mapped into the Component options.

compute(*inputs, outputs*)
Compute outputs given inputs. The model is assumed to be in an unscaled state.

Parameters

- **inputs** (*Vector*) – unscaled, dimensional input variables read via inputs[key]
- **outputs** (*Vector*) – unscaled, dimensional output variables read via outputs[key]
- **discrete_inputs** (*dict or None*) – If not None, dict containing discrete input values.
- **discrete_outputs** (*dict or None*) – If not None, dict containing discrete output values.

setup()
Declare inputs and outputs.

Available attributes: name pathname comm options

fastoad.models.weight.cg.cg_components.compute_global_cg module

Estimation of global center of gravity

class fastoad.models.weight.cg.cg_components.compute_global_cg.**ComputeGlobalCG**(***kwargs*)
Bases: openmdao.core.group.Group

Global center of gravity estimation

Set the solvers to nonlinear and linear block Gauss–Seidel by default.

Parameters ****kwargs** (*dict*) – dict of arguments available here and in all descendants of this Group.

setup()
Build this group.

This method should be overidden by your Group's method. The reason for using this method to add subsystem is to save memory and setup time when using your Group while running under MPI. This avoids the creation of systems that will not be used in the current process.

You may call 'add_subsystem' to add systems to this group. You may also issue connections, and set the linear and nonlinear solvers for this group level. You cannot safely change anything on children systems; use the 'configure' method instead.

Available attributes: name pathname comm options

fastoad.models.weight.cg.cg_components.compute_ht_cg module

Estimation of horizontal tail center of gravity

class `fastoad.models.weight.cg.cg_components.compute_ht_cg.`**`ComputeHTcg`**(***kwargs*)

Bases: `openmdao.core.explicitcomponent.ExplicitComponent`

Horizontal tail center of gravity estimation

Store some bound methods so we can detect runtime overrides.

Parameters ****kwargs** (*dict of keyword arguments*) – Keyword arguments that will be mapped into the Component options.

`compute`(*inputs*, *outputs*)

Compute outputs given inputs. The model is assumed to be in an unscaled state.

Parameters

- **inputs** (*Vector*) – unscaled, dimensional input variables read via inputs[key]
- **outputs** (*Vector*) – unscaled, dimensional output variables read via outputs[key]
- **discrete_inputs** (*dict or None*) – If not None, dict containing discrete input values.
- **discrete_outputs** (*dict or None*) – If not None, dict containing discrete output values.

`setup`()

Declare inputs and outputs.

Available attributes: name pathname comm options

fastoad.models.weight.cg.cg_components.compute_max_cg_ratio module

Estimation of maximum center of gravity ratio

class `fastoad.models.weight.cg.cg_components.compute_max_cg_ratio.`**`ComputeMaxCGratio`**(***kwargs*)

Bases: `openmdao.core.explicitcomponent.ExplicitComponent`

Maximum center of gravity ratio estimation

Store some bound methods so we can detect runtime overrides.

Parameters ****kwargs** (*dict of keyword arguments*) – Keyword arguments that will be mapped into the Component options.

`compute`(*inputs*, *outputs*)

Compute outputs given inputs. The model is assumed to be in an unscaled state.

Parameters

- **inputs** (*Vector*) – unscaled, dimensional input variables read via inputs[key]
- **outputs** (*Vector*) – unscaled, dimensional output variables read via outputs[key]
- **discrete_inputs** (*dict or None*) – If not None, dict containing discrete input values.
- **discrete_outputs** (*dict or None*) – If not None, dict containing discrete output values.

setup()

Declare inputs and outputs.

Available attributes: name pathname comm options

fastoad.models.weight.cg.cg_components.compute_vt_cg module

Estimation of vertical tail center of gravity

class fastoad.models.weight.cg.cg_components.compute_vt_cg.**ComputeVTcg**(***kwargs*)

Bases: `openmdao.core.explicitcomponent.ExplicitComponent`

Vertical tail center of gravity estimation

Store some bound methods so we can detect runtime overrides.

Parameters ****kwargs** (*dict of keyword arguments*) – Keyword arguments that will be mapped into the Component options.

compute(*inputs*, *outputs*)

Compute outputs given inputs. The model is assumed to be in an unscaled state.

Parameters

- **inputs** (*Vector*) – unscaled, dimensional input variables read via inputs[key]
- **outputs** (*Vector*) – unscaled, dimensional output variables read via outputs[key]
- **discrete_inputs** (*dict or None*) – If not None, dict containing discrete input values.
- **discrete_outputs** (*dict or None*) – If not None, dict containing discrete output values.

setup()

Declare inputs and outputs.

Available attributes: name pathname comm options

fastoad.models.weight.cg.cg_components.update_mlg module

Estimation of main landing gear center of gravity

class fastoad.models.weight.cg.cg_components.update_mlg.**UpdateMLG**(***kwargs*)

Bases: `openmdao.core.explicitcomponent.ExplicitComponent`

Main landing gear center of gravity estimation

Store some bound methods so we can detect runtime overrides.

Parameters ****kwargs** (*dict of keyword arguments*) – Keyword arguments that will be mapped into the Component options.

compute (*inputs*, *outputs*)
Compute outputs given inputs. The model is assumed to be in an unscaled state.

Parameters

- **inputs** (*Vector*) – unscaled, dimensional input variables read via inputs[key]
- **outputs** (*Vector*) – unscaled, dimensional output variables read via outputs[key]
- **discrete_inputs** (*dict or None*) – If not None, dict containing discrete input values.
- **discrete_outputs** (*dict or None*) – If not None, dict containing discrete output values.

setup ()
Declare inputs and outputs.

Available attributes: name pathname comm options

Module contents

Estimation of centers of gravity

Submodules

fastoad.models.weight.cg.cg module

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class fastoad.models.weight.cg.cg.**CG** (***kwargs*)
Bases: openmdao.core.group.Group

Model that computes the global center of gravity

Set the solvers to nonlinear and linear block Gauss–Seidel by default.

Parameters ****kwargs** (*dict*) – dict of arguments available here and in all descendants of this Group.

setup ()
Build this group.

This method should be overidden by your Group's method. The reason for using this method to add subsystem is to save memory and setup time when using your Group while running under MPI. This avoids the creation of systems that will not be used in the current process.

You may call 'add_subsystem' to add systems to this group. You may also issue connections, and set the linear and nonlinear solvers for this group level. You cannot safely change anything on children systems; use the 'configure' method instead.

Available attributes: name pathname comm options

class fastoad.models.weight.cg.cg.**ComputeAircraftCG** (***kwargs*)
Bases: openmdao.core.explicitcomponent.ExplicitComponent

Compute position of aircraft CG from CG ratio

Store some bound methods so we can detect runtime overrides.

Parameters `**kwargs` (*dict of keyword arguments*) – Keyword arguments that will be mapped into the Component options.

compute (*inputs*, *outputs*)

Compute outputs given inputs. The model is assumed to be in an unscaled state.

Parameters

- **inputs** (*Vector*) – unscaled, dimensional input variables read via inputs[key]
- **outputs** (*Vector*) – unscaled, dimensional output variables read via outputs[key]
- **discrete_inputs** (*dict or None*) – If not None, dict containing discrete input values.
- **discrete_outputs** (*dict or None*) – If not None, dict containing discrete output values.

setup ()

Declare inputs and outputs.

Available attributes: name pathname comm options

Module contents

fastoad.models.weight.mass_breakdown package

Subpackages

fastoad.models.weight.mass_breakdown.a_airframe package

Submodules

fastoad.models.weight.mass_breakdown.a_airframe.a1_wing_weight module

Estimation of wing weight

class `fastoad.models.weight.mass_breakdown.a_airframe.a1_wing_weight.`**WingWeight** (***kwargs*)

Bases: `openmdao.core.explicitcomponent.ExplicitComponent`

Wing weight estimation

This is done by summing following estimations:

- mass from sizing to flexion forces
- mass from sizing to shear forces
- mass of ribs
- mass of reinforcements
- mass of secondary parts

Based on [DCAC14], mass contribution A1

Store some bound methods so we can detect runtime overrides.

Parameters `**kwargs` (*dict of keyword arguments*) – Keyword arguments that will be mapped into the Component options.

compute (*inputs*, *outputs*, *discrete_inputs=None*, *discrete_outputs=None*)
Compute outputs given inputs. The model is assumed to be in an unscaled state.

Parameters

- **inputs** (*Vector*) – unscaled, dimensional input variables read via inputs[key]
- **outputs** (*Vector*) – unscaled, dimensional output variables read via outputs[key]
- **discrete_inputs** (*dict or None*) – If not None, dict containing discrete input values.
- **discrete_outputs** (*dict or None*) – If not None, dict containing discrete output values.

setup ()
Declare inputs and outputs.

Available attributes: name pathname comm options

fastoad.models.weight.mass_breakdown.a_airframe.a2_fuselage_weight module

Estimation of fuselage weight

class fastoad.models.weight.mass_breakdown.a_airframe.a2_fuselage_weight.**FuselageWeight** (***k*
Bases: openmdao.core.explicitcomponent.ExplicitComponent

Fuselage weight estimation

Based on a statistical analysis. See [DCAC14], mass contribution A2

Store some bound methods so we can detect runtime overrides.

Parameters **kwargs (*dict of keyword arguments*) – Keyword arguments that will be mapped into the Component options.

compute (*inputs*, *outputs*, *discrete_inputs=None*, *discrete_outputs=None*)
Compute outputs given inputs. The model is assumed to be in an unscaled state.

Parameters

- **inputs** (*Vector*) – unscaled, dimensional input variables read via inputs[key]
- **outputs** (*Vector*) – unscaled, dimensional output variables read via outputs[key]
- **discrete_inputs** (*dict or None*) – If not None, dict containing discrete input values.
- **discrete_outputs** (*dict or None*) – If not None, dict containing discrete output values.

setup ()
Declare inputs and outputs.

Available attributes: name pathname comm options

fastoad.models.weight.mass_breakdown.a_airframe.a3_empennage_weight module

Estimation of empennage weight

class fastoad.models.weight.mass_breakdown.a_airframe.a3_empennage_weight.**EmpennageWeight**(*

Bases: openmdao.core.explicitcomponent.ExplicitComponent

Weight estimation for tail planes

Based on formulas in [DCAC14], mass contribution A3

Store some bound methods so we can detect runtime overrides.

Parameters ****kwargs** (*dict of keyword arguments*) – Keyword arguments that will be mapped into the Component options.

compute(*inputs*, *outputs*, *discrete_inputs=None*, *discrete_outputs=None*)

Compute outputs given inputs. The model is assumed to be in an unscaled state.

Parameters

- **inputs** (*Vector*) – unscaled, dimensional input variables read via inputs[key]
- **outputs** (*Vector*) – unscaled, dimensional output variables read via outputs[key]
- **discrete_inputs** (*dict or None*) – If not None, dict containing discrete input values.
- **discrete_outputs** (*dict or None*) – If not None, dict containing discrete output values.

setup()

Declare inputs and outputs.

Available attributes: name pathname comm options

fastoad.models.weight.mass_breakdown.a_airframe.a4_flight_control_weight module

Estimation of flight controls weight

class fastoad.models.weight.mass_breakdown.a_airframe.a4_flight_control_weight.**FlightContro**

Bases: openmdao.core.explicitcomponent.ExplicitComponent

Flight controls weight estimation

Based on formulas in [DCAC14], mass contribution A4

Store some bound methods so we can detect runtime overrides.

Parameters ****kwargs** (*dict of keyword arguments*) – Keyword arguments that will be mapped into the Component options.

compute(*inputs*, *outputs*, *discrete_inputs=None*, *discrete_outputs=None*)

Compute outputs given inputs. The model is assumed to be in an unscaled state.

Parameters

- **inputs** (*Vector*) – unscaled, dimensional input variables read via inputs[key]
- **outputs** (*Vector*) – unscaled, dimensional output variables read via outputs[key]
- **discrete_inputs** (*dict or None*) – If not None, dict containing discrete input values.

- **discrete_outputs** (*dict or None*) – If not None, dict containing discrete output values.

setup()
Declare inputs and outputs.

Available attributes: name pathname comm options

fastoad.models.weight.mass_breakdown.a_airframe.a5_landing_gear_weight module

Estimation of landing gear weight

class fastoad.models.weight.mass_breakdown.a_airframe.a5_landing_gear_weight.**LandingGearWe**
Bases: openmdao.core.explicitcomponent.ExplicitComponent

Weight estimation for landing gears

Based on formulas in [DCAC14], mass contribution A5

Store some bound methods so we can detect runtime overrides.

Parameters ****kwargs** (*dict of keyword arguments*) – Keyword arguments that will be mapped into the Component options.

compute(*inputs*, *outputs*, *discrete_inputs=None*, *discrete_outputs=None*)
Compute outputs given inputs. The model is assumed to be in an unscaled state.

Parameters

- **inputs** (*Vector*) – unscaled, dimensional input variables read via inputs[key]
- **outputs** (*Vector*) – unscaled, dimensional output variables read via outputs[key]
- **discrete_inputs** (*dict or None*) – If not None, dict containing discrete input values.
- **discrete_outputs** (*dict or None*) – If not None, dict containing discrete output values.

setup()
Declare inputs and outputs.

Available attributes: name pathname comm options

fastoad.models.weight.mass_breakdown.a_airframe.a6_pylons_weight module

Estimation of pylons weight

class fastoad.models.weight.mass_breakdown.a_airframe.a6_pylons_weight.**PylonsWeight**(***kwargs*
Bases: openmdao.core.explicitcomponent.ExplicitComponent

Weight estimation for pylons

Based on formula in [DCAC14], mass contribution A6

Store some bound methods so we can detect runtime overrides.

Parameters ****kwargs** (*dict of keyword arguments*) – Keyword arguments that will be mapped into the Component options.

compute(*inputs*, *outputs*, *discrete_inputs=None*, *discrete_outputs=None*)
Compute outputs given inputs. The model is assumed to be in an unscaled state.

Parameters

- **inputs** (*Vector*) – unscaled, dimensional input variables read via inputs[key]
- **outputs** (*Vector*) – unscaled, dimensional output variables read via outputs[key]
- **discrete_inputs** (*dict or None*) – If not None, dict containing discrete input values.
- **discrete_outputs** (*dict or None*) – If not None, dict containing discrete output values.

setup()

Declare inputs and outputs.

Available attributes: name pathname comm options

fastoad.models.weight.mass_breakdown.a_airframe.a7_paint_weight module

Estimation of paint weight

class fastoad.models.weight.mass_breakdown.a_airframe.a7_paint_weight.**PaintWeight**(***kwargs*)

Bases: `openmdao.core.explicitcomponent.ExplicitComponent`

Weight estimation for paint

Based on formula in [DCAC14], mass contribution A7

Store some bound methods so we can detect runtime overrides.

Parameters ****kwargs** (*dict of keyword arguments*) – Keyword arguments that will be mapped into the Component options.

compute(*inputs*, *outputs*, *discrete_inputs=None*, *discrete_outputs=None*)

Compute outputs given inputs. The model is assumed to be in an unscaled state.

Parameters

- **inputs** (*Vector*) – unscaled, dimensional input variables read via inputs[key]
- **outputs** (*Vector*) – unscaled, dimensional output variables read via outputs[key]
- **discrete_inputs** (*dict or None*) – If not None, dict containing discrete input values.
- **discrete_outputs** (*dict or None*) – If not None, dict containing discrete output values.

setup()

Declare inputs and outputs.

Available attributes: name pathname comm options

Module contents

Estimation of airframe weight

fastoad.models.weight.mass_breakdown.b_propulsion package

Submodules

fastoad.models.weight.mass_breakdown.b_propulsion.b1_engine_weight module

Estimation of engine weight

class `fastoad.models.weight.mass_breakdown.b_propulsion.b1_engine_weight.`**`EngineWeight`**(***kwa*

Bases: `openmdao.core.explicitcomponent.ExplicitComponent`

Engine weight estimation

Uses model described in [Rou05], p.74

Store some bound methods so we can detect runtime overrides.

Parameters **`**kwargs`** (*dict of keyword arguments*) – Keyword arguments that will be mapped into the Component options.

`compute`(*inputs*, *outputs*, *discrete_inputs=None*, *discrete_outputs=None*)

Compute outputs given inputs. The model is assumed to be in an unscaled state.

Parameters

- **`inputs`** (*Vector*) – unscaled, dimensional input variables read via inputs[key]
- **`outputs`** (*Vector*) – unscaled, dimensional output variables read via outputs[key]
- **`discrete_inputs`** (*dict or None*) – If not None, dict containing discrete input values.
- **`discrete_outputs`** (*dict or None*) – If not None, dict containing discrete output values.

`setup`()

Declare inputs and outputs.

Available attributes: name pathname comm options

fastoad.models.weight.mass_breakdown.b_propulsion.b2_fuel_lines_weight module

Estimation of fuel lines weight

class `fastoad.models.weight.mass_breakdown.b_propulsion.b2_fuel_lines_weight.`**`FuelLinesWeigl`**

Bases: `openmdao.core.explicitcomponent.ExplicitComponent`

Weight estimation for fuel lines

Based on formula in [DCAC14], mass contribution B2

Store some bound methods so we can detect runtime overrides.

Parameters **`**kwargs`** (*dict of keyword arguments*) – Keyword arguments that will be mapped into the Component options.

compute (*inputs*, *outputs*, *discrete_inputs=None*, *discrete_outputs=None*)
Compute outputs given inputs. The model is assumed to be in an unscaled state.

Parameters

- **inputs** (*Vector*) – unscaled, dimensional input variables read via inputs[key]
- **outputs** (*Vector*) – unscaled, dimensional output variables read via outputs[key]
- **discrete_inputs** (*dict or None*) – If not None, dict containing discrete input values.
- **discrete_outputs** (*dict or None*) – If not None, dict containing discrete output values.

setup ()
Declare inputs and outputs.

Available attributes: name pathname comm options

fastoad.models.weight.mass_breakdown.b_propulsion.b3_unconsumables_weight module

Estimation of fuel lines weight

class fastoad.models.weight.mass_breakdown.b_propulsion.b3_unconsumables_weight.**Unconsumabl**
Bases: openmdao.core.explicitcomponent.ExplicitComponent

Weight estimation for oil and unusable fuel

Based on formula in [DCAC14], mass contribution B3

Store some bound methods so we can detect runtime overrides.

Parameters ****kwargs** (*dict of keyword arguments*) – Keyword arguments that will be mapped into the Component options.

compute (*inputs*, *outputs*, *discrete_inputs=None*, *discrete_outputs=None*)
Compute outputs given inputs. The model is assumed to be in an unscaled state.

Parameters

- **inputs** (*Vector*) – unscaled, dimensional input variables read via inputs[key]
- **outputs** (*Vector*) – unscaled, dimensional output variables read via outputs[key]
- **discrete_inputs** (*dict or None*) – If not None, dict containing discrete input values.
- **discrete_outputs** (*dict or None*) – If not None, dict containing discrete output values.

setup ()
Declare inputs and outputs.

Available attributes: name pathname comm options

Module contents

Estimation of propulsion weight

fastoad.models.weight.mass_breakdown.c_systems package

Submodules

fastoad.models.weight.mass_breakdown.c_systems.c1_power_systems_weight module

Estimation of power systems weight

class fastoad.models.weight.mass_breakdown.c_systems.c1_power_systems_weight.**PowerSystemsWe**

Bases: openmdao.core.explicitcomponent.ExplicitComponent

Weight estimation for power systems (generation and distribution)

This includes:

- Auxiliary Power Unit (APU)
- electric systems
- hydraulic systems

Based on formulas in [DCAC14], mass contribution C1

Store some bound methods so we can detect runtime overrides.

Parameters ****kwargs** (*dict of keyword arguments*) – Keyword arguments that will be mapped into the Component options.

compute(*inputs*, *outputs*, *discrete_inputs=None*, *discrete_outputs=None*)

Compute outputs given inputs. The model is assumed to be in an unscaled state.

Parameters

- **inputs** (*Vector*) – unscaled, dimensional input variables read via inputs[key]
- **outputs** (*Vector*) – unscaled, dimensional output variables read via outputs[key]
- **discrete_inputs** (*dict or None*) – If not None, dict containing discrete input values.
- **discrete_outputs** (*dict or None*) – If not None, dict containing discrete output values.

setup()

Declare inputs and outputs.

Available attributes: name pathname comm options

fastoad.models.weight.mass_breakdown.c_systems.c2_life_support_systems_weight module

Estimation of life support systems weight

class fastoad.models.weight.mass_breakdown.c_systems.c2_life_support_systems_weight.**LifeSup**

Bases: openmdao.core.explicitcomponent.ExplicitComponent

Weight estimation for life support systems

This includes:

- insulation
- air conditioning / pressurization
- de-icing
- internal lighting system
- seats and installation of crew
- fixed oxygen
- permanent security kits

Based on formulas in [DCAC14], mass contribution C2

Store some bound methods so we can detect runtime overrides.

Parameters ****kwargs** (*dict of keyword arguments*) – Keyword arguments that will be mapped into the Component options.

compute (*inputs*, *outputs*, *discrete_inputs=None*, *discrete_outputs=None*)

Compute outputs given inputs. The model is assumed to be in an unscaled state.

Parameters

- **inputs** (*Vector*) – unscaled, dimensional input variables read via inputs[key]
- **outputs** (*Vector*) – unscaled, dimensional output variables read via outputs[key]
- **discrete_inputs** (*dict or None*) – If not None, dict containing discrete input values.
- **discrete_outputs** (*dict or None*) – If not None, dict containing discrete output values.

setup ()

Declare inputs and outputs.

Available attributes: name pathname comm options

fastoad.models.weight.mass_breakdown.c_systems.c3_navigation_systems_weight module

Estimation of navigation systems weight

class fastoad.models.weight.mass_breakdown.c_systems.c3_navigation_systems_weight.**Navigatio**

Bases: openmdao.core.explicitcomponent.ExplicitComponent

Weight estimation for navigation systems

Based on figures in [DCAC14], mass contribution C3

Store some bound methods so we can detect runtime overrides.

Parameters `**kwargs` (*dict of keyword arguments*) – Keyword arguments that will be mapped into the Component options.

compute (*inputs*, *outputs*, *discrete_inputs=None*, *discrete_outputs=None*)
Compute outputs given inputs. The model is assumed to be in an unscaled state.

Parameters

- **inputs** (*Vector*) – unscaled, dimensional input variables read via inputs[key]
- **outputs** (*Vector*) – unscaled, dimensional output variables read via outputs[key]
- **discrete_inputs** (*dict or None*) – If not None, dict containing discrete input values.
- **discrete_outputs** (*dict or None*) – If not None, dict containing discrete output values.

setup ()
Declare inputs and outputs.

Available attributes: name pathname comm options

fastoad.models.weight.mass_breakdown.c_systems.c4_transmissions_systems_weight module

Estimation of transmissions systems weight

class fastoad.models.weight.mass_breakdown.c_systems.c4_transmissions_systems_weight.**Transm**
Bases: `openmdao.core.explicitcomponent.ExplicitComponent`

Weight estimation for transmission systems

Based on figures in [DCAC14], mass contribution C4

Store some bound methods so we can detect runtime overrides.

Parameters `**kwargs` (*dict of keyword arguments*) – Keyword arguments that will be mapped into the Component options.

compute (*inputs*, *outputs*, *discrete_inputs=None*, *discrete_outputs=None*)
Compute outputs given inputs. The model is assumed to be in an unscaled state.

Parameters

- **inputs** (*Vector*) – unscaled, dimensional input variables read via inputs[key]
- **outputs** (*Vector*) – unscaled, dimensional output variables read via outputs[key]
- **discrete_inputs** (*dict or None*) – If not None, dict containing discrete input values.
- **discrete_outputs** (*dict or None*) – If not None, dict containing discrete output values.

setup ()
Declare inputs and outputs.

Available attributes: name pathname comm options

fastoad.models.weight.mass_breakdown.c_systems.c5_fixed_operational_systems_weight module

Estimation of fixed operational systems weight

class fastoad.models.weight.mass_breakdown.c_systems.c5_fixed_operational_systems_weight.**F**

Bases: openmdao.core.explicitcomponent.ExplicitComponent

Weight estimation for fixed operational systems (weather radar, flight recorder, . . .)

Based on formulas in [DCAC14], mass contribution C5

Store some bound methods so we can detect runtime overrides.

Parameters ****kwargs** (*dict of keyword arguments*) – Keyword arguments that will be mapped into the Component options.

compute (*inputs*, *outputs*, *discrete_inputs=None*, *discrete_outputs=None*)

Compute outputs given inputs. The model is assumed to be in an unscaled state.

Parameters

- **inputs** (*Vector*) – unscaled, dimensional input variables read via inputs[key]
- **outputs** (*Vector*) – unscaled, dimensional output variables read via outputs[key]
- **discrete_inputs** (*dict or None*) – If not None, dict containing discrete input values.
- **discrete_outputs** (*dict or None*) – If not None, dict containing discrete output values.

setup ()

Declare inputs and outputs.

Available attributes: name pathname comm options

fastoad.models.weight.mass_breakdown.c_systems.c6_flight_kit_weight module

Estimation of flight kit weight

class fastoad.models.weight.mass_breakdown.c_systems.c6_flight_kit_weight.**FlightKitWeight** (

Bases: openmdao.core.explicitcomponent.ExplicitComponent

Weight estimation for flight kit (tools that are always on board)

Based on figures in [DCAC14], mass contribution C6

Store some bound methods so we can detect runtime overrides.

Parameters ****kwargs** (*dict of keyword arguments*) – Keyword arguments that will be mapped into the Component options.

compute (*inputs*, *outputs*, *discrete_inputs=None*, *discrete_outputs=None*)

Compute outputs given inputs. The model is assumed to be in an unscaled state.

Parameters

- **inputs** (*Vector*) – unscaled, dimensional input variables read via inputs[key]
- **outputs** (*Vector*) – unscaled, dimensional output variables read via outputs[key]
- **discrete_inputs** (*dict or None*) – If not None, dict containing discrete input values.

- **discrete_outputs** (*dict or None*) – If not None, dict containing discrete output values.

setup()

Declare inputs and outputs.

Available attributes: name pathname comm options

Module contents

Estimation of weight of all-mission systems

fastoad.models.weight.mass_breakdown.d_furniture package

Submodules

fastoad.models.weight.mass_breakdown.d_furniture.d1_cargo_configuration_weight module

Estimation of cargo configuration weight

class fastoad.models.weight.mass_breakdown.d_furniture.d1_cargo_configuration_weight.**Cargo**

Bases: openmdao.core.explicitcomponent.ExplicitComponent

Weight estimation for equipments for freight transport (applies only for freighters)

Based on [DCAC14], mass contribution D1

Store some bound methods so we can detect runtime overrides.

Parameters ****kwargs** (*dict of keyword arguments*) – Keyword arguments that will be mapped into the Component options.

compute(*inputs*, *outputs*, *discrete_inputs=None*, *discrete_outputs=None*)

Compute outputs given inputs. The model is assumed to be in an unscaled state.

Parameters

- **inputs** (*Vector*) – unscaled, dimensional input variables read via inputs[key]
- **outputs** (*Vector*) – unscaled, dimensional output variables read via outputs[key]
- **discrete_inputs** (*dict or None*) – If not None, dict containing discrete input values.
- **discrete_outputs** (*dict or None*) – If not None, dict containing discrete output values.

setup()

Declare inputs and outputs.

Available attributes: name pathname comm options

fastoad.models.weight.mass_breakdown.d_furniture.d2_passenger_seats_weight module

Estimation of passenger seats weight

class fastoad.models.weight.mass_breakdown.d_furniture.d2_passenger_seats_weight.**PassengerS**

Bases: openmdao.core.explicitcomponent.ExplicitComponent

Weight estimation for passenger seats

Based on [DCAC14], mass contribution D2

Store some bound methods so we can detect runtime overrides.

Parameters `**kwargs` (*dict of keyword arguments*) – Keyword arguments that will be mapped into the Component options.

compute (*inputs*, *outputs*, *discrete_inputs=None*, *discrete_outputs=None*)

Compute outputs given inputs. The model is assumed to be in an unscaled state.

Parameters

- **inputs** (*Vector*) – unscaled, dimensional input variables read via inputs[key]
- **outputs** (*Vector*) – unscaled, dimensional output variables read via outputs[key]
- **discrete_inputs** (*dict or None*) – If not None, dict containing discrete input values.
- **discrete_outputs** (*dict or None*) – If not None, dict containing discrete output values.

setup ()

Declare inputs and outputs.

Available attributes: name pathname comm options

fastoad.models.weight.mass_breakdown.d_furniture.d3_food_water_weight module

Estimation of food water weight

class fastoad.models.weight.mass_breakdown.d_furniture.d3_food_water_weight.**FoodWaterWeight**

Bases: openmdao.core.explicitcomponent.ExplicitComponent

Weight estimation for food and water

Includes trolleys, trays, cutlery...

Based on [DCAC14], mass contribution D3

Store some bound methods so we can detect runtime overrides.

Parameters `**kwargs` (*dict of keyword arguments*) – Keyword arguments that will be mapped into the Component options.

compute (*inputs*, *outputs*, *discrete_inputs=None*, *discrete_outputs=None*)

Compute outputs given inputs. The model is assumed to be in an unscaled state.

Parameters

- **inputs** (*Vector*) – unscaled, dimensional input variables read via inputs[key]
- **outputs** (*Vector*) – unscaled, dimensional output variables read via outputs[key]
- **discrete_inputs** (*dict or None*) – If not None, dict containing discrete input values.

- **discrete_outputs** (*dict or None*) – If not None, dict containing discrete output values.

setup()
Declare inputs and outputs.

Available attributes: name pathname comm options

fastoad.models.weight.mass_breakdown.d_furniture.d4_security_kit_weight module

Estimation of security kit weight

class fastoad.models.weight.mass_breakdown.d_furniture.d4_security_kit_weight.**SecurityKitWe**
Bases: openmdao.core.explicitcomponent.ExplicitComponent

Weight estimation for security kit

Based on [DCAC14], mass contribution D4

Store some bound methods so we can detect runtime overrides.

Parameters ****kwargs** (*dict of keyword arguments*) – Keyword arguments that will be mapped into the Component options.

compute(*inputs*, *outputs*, *discrete_inputs=None*, *discrete_outputs=None*)
Compute outputs given inputs. The model is assumed to be in an unscaled state.

Parameters

- **inputs** (*Vector*) – unscaled, dimensional input variables read via inputs[key]
- **outputs** (*Vector*) – unscaled, dimensional output variables read via outputs[key]
- **discrete_inputs** (*dict or None*) – If not None, dict containing discrete input values.
- **discrete_outputs** (*dict or None*) – If not None, dict containing discrete output values.

setup()
Declare inputs and outputs.

Available attributes: name pathname comm options

fastoad.models.weight.mass_breakdown.d_furniture.d5_toilets_weight module

Estimation of toilets weight

class fastoad.models.weight.mass_breakdown.d_furniture.d5_toilets_weight.**ToiletsWeight**(***kw*
Bases: openmdao.core.explicitcomponent.ExplicitComponent

Weight estimation for toilets

Based on [DCAC14], mass contribution D5

Store some bound methods so we can detect runtime overrides.

Parameters ****kwargs** (*dict of keyword arguments*) – Keyword arguments that will be mapped into the Component options.

compute(*inputs*, *outputs*, *discrete_inputs=None*, *discrete_outputs=None*)
Compute outputs given inputs. The model is assumed to be in an unscaled state.

Parameters

- **inputs** (*Vector*) – unscaled, dimensional input variables read via inputs[key]
- **outputs** (*Vector*) – unscaled, dimensional output variables read via outputs[key]
- **discrete_inputs** (*dict or None*) – If not None, dict containing discrete input values.
- **discrete_outputs** (*dict or None*) – If not None, dict containing discrete output values.

setup()

Declare inputs and outputs.

Available attributes: name pathname comm options

Module contents

Estimation of furniture weight

fastoad.models.weight.mass_breakdown.e_crew package

Submodules

fastoad.models.weight.mass_breakdown.e_crew.crew_weight module

Estimation of crew weight

class fastoad.models.weight.mass_breakdown.e_crew.crew_weight.**CrewWeight**(***kwargs*)

Bases: openmdao.core.explicitcomponent.ExplicitComponent

Weight estimation for aircraft crew

Based on [DCAC14], mass contribution E

Store some bound methods so we can detect runtime overrides.

Parameters ****kwargs** (*dict of keyword arguments*) – Keyword arguments that will be mapped into the Component options.

compute(*inputs*, *outputs*, *discrete_inputs=None*, *discrete_outputs=None*)

Compute outputs given inputs. The model is assumed to be in an unscaled state.

Parameters

- **inputs** (*Vector*) – unscaled, dimensional input variables read via inputs[key]
- **outputs** (*Vector*) – unscaled, dimensional output variables read via outputs[key]
- **discrete_inputs** (*dict or None*) – If not None, dict containing discrete input values.
- **discrete_outputs** (*dict or None*) – If not None, dict containing discrete output values.

setup()

Declare inputs and outputs.

Available attributes: name pathname comm options

Module contents

Estimation of crew weight

Submodules

fastoad.models.weight.mass_breakdown.cs25 module

Computation of load cases

class fastoad.models.weight.mass_breakdown.cs25.**Loads**(***kwargs*)
Bases: openmdao.core.explicitcomponent.ExplicitComponent

Computes gust load cases

Load case 1: with wings with almost no fuel Load case 2: at maximum take-off weight

Based on formulas in [DCAC14], §6.3

Store some bound methods so we can detect runtime overrides.

Parameters ****kwargs** (*dict of keyword arguments*) – Keyword arguments that will be mapped into the Component options.

compute(*inputs*, *outputs*, *discrete_inputs=None*, *discrete_outputs=None*)
Compute outputs given inputs. The model is assumed to be in an unscaled state.

Parameters

- **inputs** (*Vector*) – unscaled, dimensional input variables read via inputs[key]
- **outputs** (*Vector*) – unscaled, dimensional output variables read via outputs[key]
- **discrete_inputs** (*dict or None*) – If not None, dict containing discrete input values.
- **discrete_outputs** (*dict or None*) – If not None, dict containing discrete output values.

setup()
Declare inputs and outputs.

Available attributes: name pathname comm options

fastoad.models.weight.mass_breakdown.mass_breakdown module

Main components for mass breakdown.

class fastoad.models.weight.mass_breakdown.mass_breakdown.**AirframeWeight**(***kwargs*)
Bases: openmdao.core.group.Group

Computes mass of airframe.

Set the solvers to nonlinear and linear block Gauss–Seidel by default.

Parameters ****kwargs** (*dict*) – dict of arguments available here and in all descendants of this Group.

setup()

Build this group.

This method should be overidden by your Group's method. The reason for using this method to add subsystem is to save memory and setup time when using your Group while running under MPI. This avoids the creation of systems that will not be used in the current process.

You may call 'add_subsystem' to add systems to this group. You may also issue connections, and set the linear and nonlinear solvers for this group level. You cannot safely change anything on children systems; use the 'configure' method instead.

Available attributes: name pathname comm options

class fastoad.models.weight.mass_breakdown.mass_breakdown.**FurnitureWeight**(***kwargs*)

Bases: openmdao.core.group.Group

Computes mass of furniture.

Set the solvers to nonlinear and linear block Gauss–Seidel by default.

Parameters ****kwargs** (*dict*) – dict of arguments available here and in all descendants of this Group.

setup()

Build this group.

This method should be overidden by your Group's method. The reason for using this method to add subsystem is to save memory and setup time when using your Group while running under MPI. This avoids the creation of systems that will not be used in the current process.

You may call 'add_subsystem' to add systems to this group. You may also issue connections, and set the linear and nonlinear solvers for this group level. You cannot safely change anything on children systems; use the 'configure' method instead.

Available attributes: name pathname comm options

class fastoad.models.weight.mass_breakdown.mass_breakdown.**MTOWComputation**(*output_name=None, input_names=None, vec_size=1, length=1, val=1.0, scaling_factors=None, **kwargs*)

Bases: openmdao.components.add_subtract_comp.AddSubtractComp

Computes MTOW from OWE, design payload and consumed fuel in sizing mission.

Allow user to create an addition/subtracton system with one-liner.

Parameters

- **output_name** (*str*) – (required) name of the result variable in this component's namespace.
- **input_names** (*iterable of str*) – (required) names of the input variables for this system
- **vec_size** (*int*) – Length of the first dimension of the input and output vectors (i.e number of rows, or vector length for a 1D vector) Default is 1
- **length** (*int*) – Length of the second dimension of the input and ouptut vectors (i.e. number of columns) Default is 1 which results in input/output vectors of size (vec_size,)

- **scaling_factors** (*iterable of numeric*) – Scaling factors to apply to each input. Use [1,1,…] for addition, [1,-1,…] for subtraction Must be same length as input_names Default is None which results in a scaling factor of 1 on each input (element-wise addition)
- **val** (*float or list or tuple or ndarray*) – The initial value of the variable being added in user-defined units. Default is 1.0.
- ****kwargs** (*str*) – Any other arguments to pass to the addition system (same as add_output method for ExplicitComponent) Examples include units (str or None), desc (str)

setup()

Declare inputs and outputs.

Available attributes: name pathname comm options

class fastoad.models.weight.mass_breakdown.mass_breakdown.**MassBreakdown**(***kwargs*)

Bases: `openmdao.core.group.Group`

Computes analytically the mass of each part of the aircraft, and the resulting sum, the Overall Weight Empty (OWE).

Some models depend on MZFW (Max Zero Fuel Weight), MLW (Max Landing Weight) and MTOW (Max TakeOff Weight), which depend on OWE.

This model cycles for having consistent OWE, MZFW and MLW.

Options: - payload_from_npax: If True (default), payload masses will be computed from NPAX, if False

design payload mass and maximum payload mass must be provided.

Set the solvers to nonlinear and linear block Gauss–Seidel by default.

Parameters ****kwargs** (*dict*) – dict of arguments available here and in all descendants of this Group.

initialize()

Perform any one-time initialization run at instantiation.

setup()

Build this group.

This method should be overidden by your Group's method. The reason for using this method to add subsystem is to save memory and setup time when using your Group while running under MPI. This avoids the creation of systems that will not be used in the current process.

You may call 'add_subsystem' to add systems to this group. You may also issue connections, and set the linear and nonlinear solvers for this group level. You cannot safely change anything on children systems; use the 'configure' method instead.

Available attributes: name pathname comm options

class fastoad.models.weight.mass_breakdown.mass_breakdown.**OperatingWeightEmpty**(***kwargs*)

Bases: `openmdao.core.group.Group`

Operating Empty Weight (OEW) estimation.

This group aggregates weight from all components of the aircraft.

Set the solvers to nonlinear and linear block Gauss–Seidel by default.

Parameters ****kwargs** (*dict*) – dict of arguments available here and in all descendants of this Group.

setup()
Build this group.

This method should be overidden by your Group's method. The reason for using this method to add subsystem is to save memory and setup time when using your Group while running under MPI. This avoids the creation of systems that will not be used in the current process.

You may call 'add_subsystem' to add systems to this group. You may also issue connections, and set the linear and nonlinear solvers for this group level. You cannot safely change anything on children systems; use the 'configure' method instead.

Available attributes: name pathname comm options

class fastoad.models.weight.mass_breakdown.mass_breakdown.**PropulsionWeight**(***kwargs*)
Bases: `openmdao.core.group.Group`

Computes mass of propulsion.

Set the solvers to nonlinear and linear block Gauss–Seidel by default.

Parameters ****kwargs** (*dict*) – dict of arguments available here and in all descendants of this Group.

setup()
Build this group.

This method should be overidden by your Group's method. The reason for using this method to add subsystem is to save memory and setup time when using your Group while running under MPI. This avoids the creation of systems that will not be used in the current process.

You may call 'add_subsystem' to add systems to this group. You may also issue connections, and set the linear and nonlinear solvers for this group level. You cannot safely change anything on children systems; use the 'configure' method instead.

Available attributes: name pathname comm options

class fastoad.models.weight.mass_breakdown.mass_breakdown.**SystemsWeight**(***kwargs*)
Bases: `openmdao.core.group.Group`

Computes mass of systems.

Set the solvers to nonlinear and linear block Gauss–Seidel by default.

Parameters ****kwargs** (*dict*) – dict of arguments available here and in all descendants of this Group.

setup()
Build this group.

This method should be overidden by your Group's method. The reason for using this method to add subsystem is to save memory and setup time when using your Group while running under MPI. This avoids the creation of systems that will not be used in the current process.

You may call 'add_subsystem' to add systems to this group. You may also issue connections, and set the linear and nonlinear solvers for this group level. You cannot safely change anything on children systems; use the 'configure' method instead.

Available attributes: name pathname comm options

fastoad.models.weight.mass_breakdown.payload module

Payload mass computation

class fastoad.models.weight.mass_breakdown.payload.**ComputePayload**(***kwargs*)

Bases: openmdao.core.explicitcomponent.ExplicitComponent

Computes payload from NPAX

Store some bound methods so we can detect runtime overrides.

Parameters ****kwargs** (*dict of keyword arguments*) – Keyword arguments that will be mapped into the Component options.

compute(*inputs*, *outputs*, *discrete_inputs=None*, *discrete_outputs=None*)

Compute outputs given inputs. The model is assumed to be in an unscaled state.

Parameters

- **inputs** (*Vector*) – unscaled, dimensional input variables read via inputs[key]
- **outputs** (*Vector*) – unscaled, dimensional output variables read via outputs[key]
- **discrete_inputs** (*dict or None*) – If not None, dict containing discrete input values.
- **discrete_outputs** (*dict or None*) – If not None, dict containing discrete output values.

setup()

Declare inputs and outputs.

Available attributes: name pathname comm options

fastoad.models.weight.mass_breakdown.update_mlw_and_mzfw module

Main component for mass breakdown

class fastoad.models.weight.mass_breakdown.update_mlw_and_mzfw.**UpdateMLWandMZFW**(***kwargs*)

Bases: openmdao.core.explicitcomponent.ExplicitComponent

Computes Maximum Landing Weight and Maximum Zero Fuel Weight from Overall Empty Weight and Maximum Payload.

Store some bound methods so we can detect runtime overrides.

Parameters ****kwargs** (*dict of keyword arguments*) – Keyword arguments that will be mapped into the Component options.

compute(*inputs*, *outputs*, *discrete_inputs=None*, *discrete_outputs=None*)

Compute outputs given inputs. The model is assumed to be in an unscaled state.

Parameters

- **inputs** (*Vector*) – unscaled, dimensional input variables read via inputs[key]
- **outputs** (*Vector*) – unscaled, dimensional output variables read via outputs[key]
- **discrete_inputs** (*dict or None*) – If not None, dict containing discrete input values.
- **discrete_outputs** (*dict or None*) – If not None, dict containing discrete output values.

setup()
Declare inputs and outputs.

Available attributes: name pathname comm options

Module contents

Estimation of Aircraft Weight

Submodules

fastoad.models.weight.weight module

Weight computation (mass and CG)

class fastoad.models.weight.weight.**Weight**(***kwargs*)
Bases: openmdao.core.group.Group

Computes masses and Centers of Gravity for each part of the empty operating aircraft, among these 5 categories: airframe, propulsion, systems, furniture, crew

This model uses MTOW as an input, as it allows to size some elements, but resulting OWE do not aim at being consistent with MTOW.

Consistency between OWE and MTOW can be achieved by cycling with a model that computes MTOW from OWE, which should come from a mission computation that will assess needed block fuel.

Set the solvers to nonlinear and linear block Gauss–Seidel by default.

Parameters ****kwargs** (*dict*) – dict of arguments available here and in all descendants of this Group.

setup()
Build this group.

This method should be overidden by your Group's method. The reason for using this method to add subsystem is to save memory and setup time when using your Group while running under MPI. This avoids the creation of systems that will not be used in the current process.

You may call 'add_subsystem' to add systems to this group. You may also issue connections, and set the linear and nonlinear solvers for this group level. You cannot safely change anything on children systems; use the 'configure' method instead.

Available attributes: name pathname comm options

Module contents

Submodules

fastoad.models.options module

Module for management of options and factorizing their definition.

class fastoad.models.options.**OpenMdaoOptionDispatcherGroup**(***kwargs*)
Bases: openmdao.core.group.Group

Helper class for transmitting option values to subsystems during self.configure()

Just create a group by inheriting of this class instead of om.Group. Any option that is defined in the group will be transmitted to its immediate subsystems (no recursive behaviour), if they have the same option.

Set the solvers to nonlinear and linear block Gauss–Seidel by default.

Parameters `**kwargs` (*dict*) – dict of arguments available here and in all descendants of this Group.

configure()
Update options for all subsystems

Module contents

This package contains the OAD models of FAST-OAD.

These models are based on following references:

fastoad.module_management package

Subpackages

Submodules

fastoad.module_management.bundle_loader module

Basis for registering and retrieving services

class fastoad.module_management.bundle_loader.**BundleLoader**
Bases: `object`

Helper class for loading Pelix bundles.

Constructor

property context
BundleContext instance of running Pelix framework

property framework
The currently running Pelix framework instance, or a new one if none is running (anyway, the framework instance will continue after deletion of this BundleLoader instance)

get_factory_names(*service_name: str = None*, *properties: dict = None*, *case_sensitive: bool = False*) → List[str]
Browses the available factory names to find what factories provide *service_name* (if provided) and match provided *properties* (if provided).

if neither service_name nor properties are provided, all registered factory names are returned.

Parameters

- **service_name** –
- **properties** –
- **case_sensitive** – if False, case of property values will be ignored

Returns the list of factory names

get_factory_path (*factory_name: str*) → str

Parameters **factory_name** –

Returns path of the file where the factory is defined

get_factory_properties (*factory_name: str*) → dict

Parameters **factory_name** –

Returns properties of the factory

get_factory_property (*factory_name: str, property_name: str*) → Any

Parameters

- **factory_name** –
- **property_name** –

Returns property value, or None if property is not found

get_instance_property (*instance: Any, property_name: str*) → Any

Parameters

- **instance** – any instance from :meth:~BundleLoader.instantiate_component
- **property_name** –

Returns property value, or None if property is not found

get_services (*service_name: str, properties: dict = None, case_sensitive: bool = False*) → Optional[list]

Returns the services that match *service_name* and provided *properties* (if provided).

Parameters

- **service_name** –
- **properties** –
- **case_sensitive** – if False, case of property values will be ignored

Returns the list of service instances

install_packages (*folder_path: str*) → Tuple[Set[pelix.framework.Bundle], Set[str]]

Installs bundles found in *folder_path*.

Bundles that contain factories that are programmatically registered will try to register them again if they are "started", which will result in error log messages from iPOPO. On the other side, bundles that define factories using iPOPO decorators will need to be started for these factories to be registered.

Parameters **folder_path** – The path of folder to scan

Returns A 2-tuple, with the list of installed bundles (`Bundle`) and the list of the names of the modules which import failed.

Raises **ValueError** – Invalid path

instantiate_component (*factory_name: str, properties: dict = None*) → Any

Instantiates a component from given factory

Parameters

- **factory_name** – name of the factory
- **properties** – Initial properties of the component instance

Returns the component instance

register_factory(*component_class: type*, *factory_name: str*, *service_names: Union[List[str], str]*, *properties: dict = None*) → type

Registers provided class as iPOPO component factory.

Parameters

- **component_class** – the class of the components that will be provided by the factory
- **factory_name** – the name of the factory
- **service_names** – the service(s) that will be provided by the components
- **properties** – the properties associated to the factory

Returns the input class, amended by iPOPO

Raises *FastDuplicateFactoryError* –

fastoad.module_management.constants module

The place for module-level constants.

class fastoad.module_management.constants.**ModelDomain**(*value*)

Bases: enum.Enum

Enumeration of model domains.

AERODYNAMICS = 'Aerodynamics'

GEOMETRY = 'Geometry'

HANDLING_QUALITIES = 'Handling Qualities'

OTHER = 'Other'

PERFORMANCE = 'Performance'

PROPULSION = 'Propulsion'

UNSPECIFIED = 'Unspecified'

WEIGHT = 'Weight'

fastoad.module_management.exceptions module

Exceptions for module_management package.

exception fastoad.module_management.exceptions.**FastBadSystemOptionError**(*identifier*, *option_names*)

Bases: *fastoad.exceptions.FastError*

Raised when some option name is not conform to OpenMDAO system definition.

Parameters

- **identifier** – system identifier
- **option_names** – incorrect option names

exception fastoad.module_management.exceptions.**FastDuplicateFactoryError**(*factory_name*)
Bases: *fastoad.exceptions.FastError*

Raised when trying to register a factory with an already used name.

Parameters **factory_name** –

exception fastoad.module_management.exceptions.**FastDuplicateOMSystemIdentifierException**(*fact*
Bases: *fastoad.module_management.exceptions.FastDuplicateFactoryError*

Raised when trying to register an OpenMDAO System with an already used identifier.

Raised when trying to register a factory with an already used name.

Parameters **factory_name** –

exception fastoad.module_management.exceptions.**FastIncompatibleServiceClass**(*registered_class: type, service_id: str, base_class: type*)
Bases: *fastoad.exceptions.FastError*

Raised when trying to register as service a class that does not implement the specified interface.

Parameters

- **registered_class** –
- **service_id** –
- **base_class** – the unmatched interface

exception fastoad.module_management.exceptions.**FastNoOMSystemFoundError**(*properties*)
Bases: *fastoad.exceptions.FastError*

Raised when no registered OpenMDAO system could be found from asked properties.

Parameters **properties** –

exception fastoad.module_management.exceptions.**FastUnknownOMSystemIdentifierError**(*identifier*)
Bases: *fastoad.exceptions.FastError*

Raised when no OpenMDAO system is registered with asked identifier.

Parameters **identifier** –

fastoad.module_management.openmdao_system_registry module

The base layer for registering and retrieving OpenMDAO systems

class fastoad.module_management.openmdao_system_registry.**OpenMDAOSystemRegistry**
Bases: object

Class for registering and providing OpenMDAO System objects.

classmethod explore_folder(*folder_path: str*)
Explores provided folder for Systems to register (i.e. modules that use *register_system()*)

Parameters **folder_path** –

classmethod get_system(*identifier: str, options: dict = None*) → SystemSubclass

Parameters

- **identifier** – identifier of the registered class
- **options** – option values at system instantiation

Returns an OpenMDAO system instantiated from the registered class

classmethod get_system_description(*system_or_id: Union[str, SystemSubclass]*) → str

Parameters **system_or_id** – an identifier of a registered OpenMDAO System class or an instance of a registered OpenMDAO System class

Returns the description associated to given system or system identifier

classmethod get_system_domain(*system_or_id: Union[str, SystemSubclass]*) → *fastoad.module_management.constants.ModelDomain*

Parameters **system_or_id** – an identifier of a registered OpenMDAO System class or an instance of a registered OpenMDAO System class

Returns the model domain associated to given system or system identifier

classmethod get_system_ids(*properties: dict = None*) → List[str]

Parameters **properties** – if provided, only factories that match all provided properties will be returned

Returns the list of identifiers for registered factories.

classmethod register_system(*system_class: type, identifier: str, domain: fastoad.module_management.constants.ModelDomain = None, desc=None, options: dict = None*)

Registers the System (or subclass) so it can later be retrieved and instantiated.

Parameters

- **system_class** –
- **identifier** –
- **domain** – information about model domain
- **desc** – description of the model. If not provided, the docstring of the class will be used.
- **options** – options to be transmitted to OpenMDAO class at run-time

Raises ***FastDuplicateOMSystemIdentifierException*** –

fastoad.module_management.service_registry module

Module for registering services.

class fastoad.module_management.service_registry.**RegisterPropulsion**(*model_id, desc=None*)

Bases: *fastoad.module_management.service_registry.RegisterService*

Decorator class for registering a propulsion-dedicated model.

Warning: the module must be started as an iPOPO bundle for the decorator to work.

Parameters

- **model_id** – the identifier of the propulsion model
- **desc** – description of the model. If not provided, the docstring will be used.

classmethod get_model_ids() → List[str]

Returns the list of identifiers for registered propulsion models.

class fastoad.module_management.service_registry.**RegisterService**(*provider_id: str, service_id: str, base_class: type = None, desc=None*)

Bases: object

Decorator class that allows to register a service.

The service can be associated to a base class (or interface). Then all registered classes must inherit from this base class.

Warning: the module must be started as an iPOPO bundle for the decorator to work.

Parameters

- **provider_id** – the identifier of the service provider to register
- **service_id** – the identifier of the service
- **base_class** – the class that should be parent to the registered class
- **desc** – description of the service. If not provided, the docstring will be used.

classmethod get_service_description(*service_id: str*) → str

Parameters **service_id** – an identifier of a registered service

Returns the description associated to given system or system identifier

Module contents

Management of modules using Pelix/iPOPO

fastoad.openmdao package

Subpackages

Submodules

fastoad.openmdao.problem module

class fastoad.openmdao.problem.**FASTOADProblem**(**args, **kwargs*)

Bases: openmdao.core.problem.Problem

Vanilla OpenMDAO Problem except that it can read and write its variables from/to files.

It also runs *ValidityDomainChecker* after each *run_model()* or *run_driver()* (but it does nothing if no check has been registered)

A classical usage of this class would be:

```
problem = FASTOADProblem()  # instantiation
[... configuration as for any OpenMDAO problem ...]

problem.input_file_path = "inputs.xml"
problem.output_file_path = "outputs.xml"
problem.write_needed_inputs()  # writes the input file (defined above) with
                               # needed variables so user can fill it with proper␣
↪values
# or
problem.write_needed_inputs('previous.xml')  # writes the input file with needed␣
↪variables
                                             # and values taken from provided␣
↪file when
                                             # available
problem.read_inputs()    # reads the input file
problem.run_driver()     # runs the OpenMDAO problem
problem.write_outputs()  # writes the output file
```

Initialize attributes.

Parameters

- **model** (*<System> or None*) – The top-level <System>. If not specified, an empty <Group> will be created.
- **driver** (*<Driver> or None*) – The driver for the problem. If not specified, a simple "Run Once" driver will be used.
- **comm** (*MPI.Comm or <FakeComm> or None*) – The global communicator.
- **name** (*str*) – Problem name. Can be used to specify a Problem instance when multiple Problems exist.
- ****options** (*named args*) – All remaining named args are converted to options.

read_inputs()

Reads inputs from the configured input file.

run_driver(*case_prefix=None*, *reset_iter_counts=True*)

Run the driver on the model.

Parameters

- **case_prefix** (*str or None*) – Prefix to prepend to coordinates when recording.
- **reset_iter_counts** (*bool*) – If True and model has been run previously, reset all iteration counters.

Returns Failure flag; True if failed to converge, False is successful.

Return type boolean

run_model(*case_prefix=None*, *reset_iter_counts=True*)

Run the model by calling the root system's solve_nonlinear.

Parameters

- **case_prefix** (*str or None*) – Prefix to prepend to coordinates when recording.
- **reset_iter_counts** (*bool*) – If True and model has been run previously, reset all iteration counters.

write_needed_inputs (*source_file_path: str = None, source_formatter: fastoad.io.formatter.IVariableIOFormatter = None*)

Writes the input file of the problem with unconnected inputs of the problem.

> **Warning:** `setup()` must have been run on this Problem instance.

Written value of each variable will be taken: 1. from input_data if it contains the variable 2. from defined default values in component definitions

WARNING: if inputs have already been read, they won't be needed any more and won't be in written file.

Parameters

- **source_file_path** – if provided, variable values will be read from it
- **source_formatter** – the class that defines format of input file. if not provided, expected format will be the default one.

write_outputs ()

Writes all outputs in the configured output file.

fastoad.openmdao.types module

Types to interact with OpenMDAO

`fastoad.openmdao.types.`**SystemSubclass**

OpenMDAO System subclass

alias of TypeVar('SystemSubclass')

fastoad.openmdao.utils module

Utility functions for OpenMDAO classes/instances

`fastoad.openmdao.utils.`**get_problem_after_setup** (*problem: T*) → T

Returns a copy of the provided problem, where setup() has been run on the copy.

> **Warning:** problem.setup() must NOT have been run.

This method should be used when an operation is needed that requires setup() to be run, without having the problem being actually setup.

Parameters **problem** –

Returns the problem itself if setup() has already been run, or a copy of the provided problem after setup() has been run

`fastoad.openmdao.utils.`**get_unconnected_input_names** (*problem: openmdao.core.problem.Problem, promoted_names=False*) → Tuple[List[str], List[str]]

For provided OpenMDAO problem, looks for inputs that are connected to no output.

Warning: problem.setup() must have been run.

Inputs that have numpy.nan as default value are considered as mandatory. Other ones are considered as optional.

Parameters

- **problem** – OpenMDAO Problem or System instance to inspect
- **promoted_names** – if True, promoted names will be returned instead of absolute ones

Returns tuple(list of missing mandatory inputs, list of missing optional inputs)

fastoad.openmdao.validity_checker module

For checking validity domain of OpenMDAO variables.

class fastoad.openmdao.validity_checker.**CheckRecord**(*variable_name*, *status*, *limit_value*, *limit_units*, *value*, *value_units*, *source_file*, *logger_name*)

Bases: tuple

A namedtuple that contains result of one variable check

property limit_units
Alias for field number 3

property limit_value
Alias for field number 2

property logger_name
Alias for field number 7

property source_file
Alias for field number 6

property status
Alias for field number 1

property value
Alias for field number 4

property value_units
Alias for field number 5

property variable_name
Alias for field number 0

class fastoad.openmdao.validity_checker.**ValidityDomainChecker**(*limits: Dict[str, tuple] = None*, *logger_name: str = None*)

Bases: object

Decorator class that checks variable values against limit bounds

This class aims at producing a status of out of limits variables at the end of an OpenMDAO computation.

The point is to allow to define limit bounds when defining an OpenMDAO system, but to make the check on the OpenMDAO problem after the run.

When defining an OpenMDAO system, use this class as Python decorator to define validity domains:

```
@ValidityDomainChecker
class MyComponent(om.explicitComponent):
    ...
```

The above code will check values against lower and upper bounds that have been defined when adding OpenMDAO outputs.

Next code shows how to define lower and upper bounds, for inputs and/or outputs.

```
@ValidityDomainChecker(
    {
        "a:variable:with:two:bounds": (-10.0, 1.0),
        "a:variable:with:lower:bound:only": (0.0, None),
        "a:variable:with:upper:bound:only": (None, 4.2),
    },
)
class MyComponent(om.explicitComponent):
    ...
```

The defined domain limits supersedes lower and upper bounds from OpenMDAO output definitions, but only in the frame of ValidityDomainChecker. In any case, OpenMDAO process is not affected by usage of ValidityDomainChecker.

Validity status can be obtained through log messages from Python logging module after problem has been run with:

```
...
problem.run_model()
ValidityDomainChecker.check_problem_variables(problem)
```

Warnings: - Units of limit values defined in ValidityDomainChecker are assumed to be the

same as in add_input() and add_output() statements of decorated class

- Validity check currently only applies to scalar values

Parameters

- **`limits`** – a dictionary where keys are variable names and values are two-values tuples that give lower and upper bound. One bound can be set to None.
- **`logger_name`** – The named of the logger that will be used. If not provided, name of current module (i.e. "__name__"") will be used.

classmethod check_problem_variables(*problem: openmdao.core.problem.Problem*)

Checks variable values in provided problem and logs warnings for each variable that is out of registered limits.

Parameters **`problem`** –

Returns

classmethod check_variables(*variables:* fastoad.openmdao.variables.VariableList) → List[*fastoad.openmdao.validity_checker.CheckRecord*]

Check values of provided variables against registered limits.

Parameters **`variables`** –

Returns a list of CheckRecord instances

static log_records(*records: List[*fastoad.openmdao.validity_checker.CheckRecord*]*)
Logs warnings through Python logging module for each CheckRecord in provided list if it is not OK.

Parameters **records** –

Returns

class fastoad.openmdao.validity_checker.**ValidityStatus**(*value*)
Bases: `enum.IntEnum`

Simple enumeration for validity status.

OK = 0

TOO_HIGH = 1

TOO_LOW = -1

fastoad.openmdao.variables module

Module for managing OpenMDAO variables

class fastoad.openmdao.variables.**Variable**(**args*, ***kwds*)
Bases: `collections.abc.Hashable`, `typing.Generic`

A class for storing data of OpenMDAO variables.

Instantiation is expected to be done through keyword arguments only.

Beside the mandatory parameter 'name, kwargs is expected to have keys 'value', 'units' and 'desc', that are accessible respectively through properties *name()*, *value()*, *units()* and *description()*.

Other keys are possible. They match the definition of OpenMDAO's method `Component.add_output()` described here.

These keys can be listed with class method `get_authorized_keys()`. **Any other key in kwargs will be silently ignored.**

Special behaviour: *description()* will return the content of kwargs['desc'] unless these 2 conditions are met:

- kwargs['desc'] is None or 'desc' key is missing
- a description exists in FAST-OAD internal data for the variable name

Then, the internal description will be returned by *description()*

Parameters **kwargs** – the attributes of the variable, as keyword arguments

property description
description of the variable (or None if not found)

classmethod get_openmdao_keys()

Returns the keys that are used in OpenMDAO variables

property is_input
I/O status of the variable.

- True if variable is a problem input
- False if it is an output
- None if information not found

metadata: Dict
Dictionary for metadata of the variable

name
Name of the variable

property units
units associated to value (or None if not found)

property value
value of the variable

class fastoad.openmdao.variables.**VariableList**(*iterable=()*, */*)
Bases: `list`

Class for storing OpenMDAO variables

A list of Variable instances, but items can also be accessed through variable names.

There are 2 ways for adding a variable:

```
# Assuming these Python variables are ready
var_1 = Variable('var/1', value=0.)
metadata_2 = {'value': 1., 'units': 'm'}

# ... a VariableList instance can be populated like this
vars = VariableList()
vars.append(var_1)              # Adds directly a Variable instance
vars['var/2'] = metadata_2      # Adds the variable with given name and given␣
↪metadata
```

After that, following equalities are True:

```
print( var_1 in vars )
print( 'var/1' in vars.names() )
print( 'var/2' in vars.names() )
```

Note: Adding a Variable instance that has a name that is already in the VariableList instance will replace the previous Variable instance instead of adding a new one.

---

append(*var: fastoad.openmdao.variables.Variable*) → None
Append var to the end of the list, unless its name is already used. In that case, var will replace the previous Variable instance with the same name.

classmethod from_dataframe(*df: pandas.core.frame.DataFrame*) → *fastoad.openmdao.variables.VariableList*
Creates a VariableList instance from a pandas DataFrame instance.

The DataFrame instance is expected to have column names "name" + some keys among the ones given by `Variable.get_authorized_keys()`.

Parameters df – a DataFrame instance

Returns a VariableList instance

classmethod from_ivc(*ivc: openmdao.core.indepvarcomp.IndepVarComp*) → *fastoad.openmdao.variables.VariableList*
Creates a VariableList instance from an OpenMDAO IndepVarComp instance

Parameters ivc – an IndepVarComp instance

Returns a VariableList instance

classmethod from_problem(*problem: openmdao.core.problem.Problem*, *use_initial_values: bool = False*, *get_promoted_names=True*) → *fastoad.openmdao.variables.VariableList*

Creates a VariableList instance containing inputs and outputs of a an OpenMDAO Problem.

Warning: problem.setup() must have been run.

The inputs (is_input=True) correspond to the variables of IndepVarComp components and all the unconnected variables.

If variables are promoted, the promoted name will be used. Otherwise (and if promoted_only is False), the absolute name will be used.

Note: Variables from _auto_ivc are ignored.

Parameters

- **problem** – OpenMDAO Problem instance to inspect
- **use_initial_values** – if True, returned instance will contain values before computation
- **get_promoted_names** – if True, only promoted variable names will be returned

Returns VariableList instance

classmethod from_system(*system: openmdao.core.system.System*) → *fastoad.openmdao.variables.VariableList*

Creates a VariableList instance containing inputs and outputs of a an OpenMDAO System. The inputs (is_input=True) correspond to the variables of IndepVarComp components and all the unconnected variables.

Warning: setup() must NOT have been called.

In the case of a group, if variables are promoted, the promoted name will be used. Otherwise, the absolute name will be used.

Parameters **system** – OpenMDAO Component instance to inspect

Returns VariableList instance

classmethod from_unconnected_inputs(*problem: openmdao.core.problem.Problem*, *with_optional_inputs: bool = False*) → *fastoad.openmdao.variables.VariableList*

Creates a VariableList instance containing unconnected inputs of an OpenMDAO Problem.

Warning: problem.setup() must have been run.

If *optional_inputs* is False, only inputs that have numpy.nan as default value (hence considered as mandatory) will be in returned instance. Otherwise, all unconnected inputs will be in returned instance.

Parameters

- **problem** – OpenMDAO Problem instance to inspect

- **with_optional_inputs** – If True, returned instance will contain all unconnected inputs. Otherwise, it will contain only mandatory ones.

Returns VariableList instance

metadata_keys() → List[str]

Returns the metadata keys that are common to all variables in the list

names() → List[str]

Returns names of variables

to_dataframe() → pandas.core.frame.DataFrame

Creates a DataFrame instance from a VariableList instance.

Column names are "name" + the keys returned by `Variable.get_authorized_keys()`. Values in Series "value" are floats or lists (numpy arrays are converted).

Returns a pandas DataFrame instance with all variables from current list

to_ivc() → openmdao.core.indepvarcomp.IndepVarComp

Returns an OpenMDAO IndepVarComp instance with all variables from current list

update(*other_var_list: fastoad.openmdao.variables.VariableList*, *add_variables: bool = False*)

Uses variables in other_var_list to update the current VariableList instance.

For each Variable instance in other_var_list:

- if a Variable instance with same name exists, it is replaced by the one in other_var_list
- if not, Variable instance from other_var_list will be added only if add_variables==True

Parameters

- **other_var_list** – source for new Variable data
- **add_variables** – if True, variables can be added instead of just updated

Module contents

fastoad.utils package

Subpackages

fastoad.utils.physics package

Subpackages

Submodules

fastoad.utils.physics.atmosphere module

Simple implementation of International Standard Atmosphere.

class fastoad.utils.physics.atmosphere.**Atmosphere**(*altitude: Union[float, Sequence[float]]*, *delta_t: float = 0.0*, *altitude_in_feet: bool = True*)

Bases: `object`

Simple implementation of International Standard Atmosphere for troposphere and stratosphere.

Atmosphere properties are provided in the same "shape" as provided altitude:

- if altitude is given as a float, returned values will be floats
- if altitude is given as a sequence (list, 1D numpy array, . . .), returned values will be 1D numpy arrays
- if altitude is given as nD numpy array, returned values will be nD numpy arrays

Usage:

```
>>> pressure = Atmosphere(30000).pressure # pressure at 30,000 feet, dISA = 0 K
>>> density = Atmosphere(5000, 10).density # density at 5,000 feet, dISA = 10 K


>>> atm = Atmosphere(np.arange(0,10001,1000, 15)) # init for alt. 0 to 10,000,␣
↪dISA = 15K
>>> temperatures = atm.pressure # pressures for all defined altitudes
>>> viscosities = atm.kinematic_viscosity # viscosities for all defined altitudes
```

Parameters

- **altitude** – altitude (units decided by altitude_in_feet)
- **delta_t** – temperature increment (°C) applied to whole temperature profile
- **altitude_in_feet** – if True, altitude should be provided in feet. Otherwise, it should be provided in meters.

property delta_t
Temperature increment applied to whole temperature profile as provided at instantiation

property density
Density in kg/m3

get_altitude(*altitude_in_feet: bool = True*) → Union[float, Sequence[float]]

Parameters altitude_in_feet – if True, altitude is returned in feet. Otherwise, it is returned in meters

Returns altitude provided at instantiation

get_equivalent_airspeed(*true_airspeed*)
Computes equivalent airspeed (EAS) from true airspeed (TAS).

Parameters true_airspeed – in m/s

Returns equivalent airspeed in m/s

get_true_airspeed(*equivalent_airspeed*)
Computes true airspeed (TAS) from equivalent airspeed (EAS).

Parameters equivalent_airspeed – in m/s

Returns true airspeed in m/s

get_unitary_reynolds(*mach*)

Parameters mach – Mach number

Returns Unitary Reynolds number in 1/m

property kinematic_viscosity
Kinematic viscosity in m2/s

property pressure
Pressure in Pa

property speed_of_sound
Speed of sound in m/s

property temperature
Temperature in K

class `fastoad.utils.physics.atmosphere.`**`AtmosphereSI`**(*altitude: Union[float, Sequence[float]], delta_t: float = 0.0*)

Bases: `fastoad.utils.physics.atmosphere.Atmosphere`

Same as `Atmosphere` except that altitudes are always in meters.

Parameters

- **altitude** – altitude in meters
- **delta_t** – temperature increment (°C) applied to whole temperature profile

property altitude

Module contents

This package contains utilities regarding physics

fastoad.utils.postprocessing package

Subpackages

Submodules

fastoad.utils.postprocessing.analysis_and_plots module

Defines the analysis and plotting functions for postprocessing

`fastoad.utils.postprocessing.analysis_and_plots.`**`aircraft_geometry_plot`**(*aircraft_file_path: str, name=None, fig=None, file_formatter=None*) → plotly.graph_objs._figurewid

Returns a figure plot of the top view of the wing. Different designs can be superposed by providing an existing fig. Each design can be provided a name.

Parameters

- **aircraft_file_path** – path of data file
- **name** – name to give to the trace added to the figure
- **fig** – existing figure to which add the plot
- **file_formatter** – the formatter that defines the format of data file. If not provided, default format will be assumed.

Returns wing plot figure

`fastoad.utils.postprocessing.analysis_and_plots.`**`drag_polar_plot`**(*aircraft_file_path: str, name=None, fig=None, file_formatter=None*) → plotly.graph_objs._figurewidget.FigureW

Returns a figure plot of the aircraft drag polar. Different designs can be superposed by providing an existing fig. Each design can be provided a name.

Parameters

- **`aircraft_file_path`** – path of data file
- **`name`** – name to give to the trace added to the figure
- **`fig`** – existing figure to which add the plot
- **`file_formatter`** – the formatter that defines the format of data file. If not provided, default format will be assumed.

Returns wing plot figure

`fastoad.utils.postprocessing.analysis_and_plots.`**`mass_breakdown_bar_plot`**(*aircraft_file_path: str, name=None, fig=None, file_formatter=None*) → plotly.graph_objs._figurewi

Returns a figure plot of the aircraft mass breakdown using bar plots. Different designs can be superposed by providing an existing fig. Each design can be provided a name.

Parameters

- **`aircraft_file_path`** – path of data file
- **`name`** – name to give to the trace added to the figure
- **`fig`** – existing figure to which add the plot
- **`file_formatter`** – the formatter that defines the format of data file. If not provided, default format will be assumed.

Returns bar plot figure

`fastoad.utils.postprocessing.analysis_and_plots.`**`mass_breakdown_sun_plot`**(*aircraft_file_path: str, file_formatter=None*)

Returns a figure sunburst plot of the mass breakdown. On the left a MTOW sunburst and on the right a OWE sunburst. Different designs can be superposed by providing an existing fig. Each design can be provided a name.

Parameters

- **`aircraft_file_path`** – path of data file
- **`file_formatter`** – the formatter that defines the format of data file. If not provided, default format will be assumed.

Returns sunburst plot figure

fastoad.utils.postprocessing.analysis_and_plots.**wing_geometry_plot**(*aircraft_file_path: str*, *name=None*, *fig=None*, *file_formatter=None*) → plotly.graph_objs._figurewidget.Fi

Returns a figure plot of the top view of the wing. Different designs can be superposed by providing an existing fig. Each design can be provided a name.

Parameters

- **aircraft_file_path** – path of data file
- **name** – name to give to the trace added to the figure
- **fig** – existing figure to which add the plot
- **file_formatter** – the formatter that defines the format of data file. If not provided, default format will be assumed.

Returns wing plot figure

fastoad.utils.postprocessing.exceptions module

Exception for postprocessing

exception fastoad.utils.postprocessing.exceptions.**FastMissingFile**

Bases: *fastoad.exceptions.FastError*

Raised when a file does not exist

fastoad.utils.postprocessing.optimization_viewer module

Defines the variable viewer for postprocessing

class fastoad.utils.postprocessing.optimization_viewer.**OptimizationViewer**

Bases: object

A class for interacting with FAST-OAD Problem optimization information.

display()

Displays the datasheet. load() must be ran before.

Returns display of the user interface:

get_variables(*column_to_attribute: Dict[str, str] = None*) → *fastoad.openmdao.variables.VariableList*

Parameters **column_to_attribute** – dictionary keys tell what columns are kept and the values tell whatvariable attribute it corresponds to. If not provided, default translation will apply.

Returns a variable list from current data set

load(*problem_configuration:* fastoad.io.configuration.configuration.FASTOADProblemConfigurator)

Loads the FAST-OAD problem and stores its data.

Parameters

- **problem_configuration** – the FASTOADProblem instance.

- **file_formatter** – the formatter that defines file format. If not provided, default format will be assumed.

load_variables (*variables:* fastoad.openmdao.variables.VariableList, *attribute_to_column: Dict[str, str] = None*)
Loads provided variable list and replace current data set.

Parameters

- **variables** – the variables to load
- **attribute_to_column** – dictionary keys tell what variable attributes are kept and the values tell what name will be displayed. If not provided, default translation will apply.

save ()
Save the optimization to the files. Possible files modified are:

- the .toml configuration file
- the input file (initial values)
- the output file (values)

fastoad.utils.postprocessing.variable_viewer module

Defines the variable viewer for postprocessing

class fastoad.utils.postprocessing.variable_viewer.**VariableViewer**
Bases: object

A class for interacting with FAST-OAD files. The file data is stored in a pandas DataFrame. The class built so that a modification of the DataFrame is instantly replicated on the file file. The interaction is achieved using a user interface built with widgets from ipywidgets and Sheets from ipysheet.

A classical usage of this class will be:

```
df = VariableViewer()  # instantiation of dataframe
file = AbstractOMFileIO('problem_outputs.file') #  instantiation of file io
df.load(file)  # load the file
df.display()  # renders a ui for reading/modifying the file
```

display ()
Displays the datasheet :return display of the user interface:

get_variables (*column_to_attribute: Dict[str, str] = None*) → *fastoad.openmdao.variables.VariableList*

Parameters **column_to_attribute** – dictionary keys tell what columns are kept and the values tell what variable attribute it corresponds to. If not provided, default translation will apply.

Returns a variable list from current data set

load (*file_path: str*, *file_formatter:* fastoad.io.formatter.IVariableIOFormatter *= None*)
Loads the file and stores its data.

Parameters

- **file_path** – the path of file to interact with
- **file_formatter** – the formatter that defines file format. If not provided, default format will be assumed.

load_variables (*variables: fastoad.openmdao.variables.VariableList*, *attribute_to_column: Dict[str, str] = None*)

Loads provided variable list and replace current data set.

Parameters

- **variables** – the variables to load
- **attribute_to_column** – dictionary keys tell what variable attributes are kept and the values tell what name will be displayed. If not provided, default translation will apply.

save (*file_path: str = None*, *file_formatter: fastoad.io.formatter.IVariableIOFormatter = None*)

Save the dataframe to the file.

Parameters

- **file_path** – the path of file to save. If not given, the initially read file will be overwritten.
- **file_formatter** – the formatter that defines file format. If not provided, default format will be assumed.

Module contents

fastoad.utils.resource_management package

Subpackages

Submodules

fastoad.utils.resource_management.copy module

Helper module for copying resources

fastoad.utils.resource_management.copy.**copy_resource** (*package: Union[module, str]*, *resource: str*, *target_path*)

Copies the indicated resource file to provided target path.

If target_path matches an already existing folder, resource file will be copied in this folder with same name. Otherwise, target_path will be the used name of copied resource file

Parameters

- **package** – package as in importlib.resources.read_binary()
- **resource** – resource as in importlib.resources.read_binary()
- **target_path** – file system path

fastoad.utils.resource_management.copy.**copy_resource_folder** (*package: Union[module, str]*, *destination_path: str*, *exclude: List[str] = None*)

Copies the full content of provided package in destination folder.

Names of files that should not be copied have to be listed in *exclude*.

> **Warning:** As the resources in the folder are discovered by browsing through the folder, they are not explicitly listed in the Python code. Therefore, to have the install process run smoothly, these resources need to be listed in the MANIFEST.in file.

Parameters

- **package** – name of resource package to copy
- **destination_path** – file system path of destination
- **exclude** – list of item names that should not be copied

Module contents

Submodules

fastoad.utils.files module

Convenience functions for file and directories

fastoad.utils.files.**make_parent_dir**(*path: str*)
Ensures parent directory of provided path exists or is created

fastoad.utils.strings module

Module for string-related operations

exception fastoad.utils.strings.**FastCouldNotParseStringToArrayError**(*parsed_text, original_exception*)

Bases: *fastoad.exceptions.FastError*

Raised when a conversion from string to array failed.

fastoad.utils.strings.**get_float_list_from_string**(*text: str*)
Parses the provided string and returns a list of floats if possible.

If provided text is not numeric, None is returned.

New line characters are simply ignored.

As an example, following patterns will result as list [1., 2., 3.]

```
'[ 1, 2., 3]'
' 1, 2., 3'
' 1 2  3'
' 1 2  3 dummy 4'
```

Module contents

This package contains various utilities

Submodules

fastoad.activator module

Where initialization operations can be done

class fastoad.activator.**FASTOADActivator**

Bases: object

Activator class where internal modules are loaded

Having the loading operation in start() method ensures it is done only once as long as this iPOPO bundle is active.

start(*context*)

Loads inner packages of FAST

fastoad.constants module

Definition of globally used constants.

class fastoad.constants.**EngineSetting**(*value*)

Bases: enum.IntEnum

Enumeration of engine settings.

CLIMB = 2

CRUISE = 3

IDLE = 4

TAKEOFF = 1

class fastoad.constants.**FlightPhase**(*value*)

Bases: enum.Enum

Enumeration of flight phases.

CLIMB = 'climb'

CRUISE = 'cruise'

DESCENT = 'descent'

INITIAL_CLIMB = 'initial_climb'

LANDING = 'landing'

TAKEOFF = 'takeoff'

TAXI_IN = 'taxi_in'

TAXI_OUT = 'taxi_out'

class fastoad.constants.**RangeCategory**(*value*)

Bases: enum.Enum

Definition of lower and upper limits of aircraft range categories, in Nautical Miles.

can be used like::

```
>>> range_value in RangeCategory.SHORT
```

which is equivalent to:

```
>>>  RangeCategory.SHORT.min() <= range_value <= RangeCategory.SHORT.max()
```

LONG = (4500.0, 6000.0)

MEDIUM = (3000.0, 4500.0)

SHORT = (0.0, 1500.0)

SHORT_MEDIUM = (1500.0, 3000.0)

VERY_LONG = (6000.0, 1000000.0)

max ()

Returns maximum range in category

min ()

Returns minimum range in category

fastoad.exceptions module

Module for custom Exception classes

exception fastoad.exceptions.**FastError**

Bases: Exception

Base Class for exceptions related to the FAST framework.

exception fastoad.exceptions.**FastUnexpectedKeywordArgument** (*bad_keyword*)

Bases: *fastoad.exceptions.FastError*

Raised when an instantiation is done with an incorrect keyword argument.

exception fastoad.exceptions.**FastUnknownEngineSettingError**

Bases: *fastoad.exceptions.FastError*

Raised when an unknown engine setting code has been encountered

exception fastoad.exceptions.**NoSetupError**

Bases: *fastoad.exceptions.FastError*

No Setup Error.

This exception indicates that a setup of the OpenMDAO instance has not been done, but was expected to be.

exception fastoad.exceptions.**XMLReadError**

Bases: *fastoad.exceptions.FastError*

XML file read Error.

This exception indicates that an error occurred when reading an xml file.

fastoad.register module

This module is for registering all internal OpenMDAO modules that we want available through OpenMDAOSystem-Registry

`fastoad.register.register_openmdao_systems()`

The place where to register FAST-OAD internal models.

Warning: this function is effective only if called from a Python module that is a started bundle for iPOPO

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