pyAPP6 Documentation

Release 1.1

ALR Aerospace

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This is the documentation for the pyAPP6 package.

CHAPTER

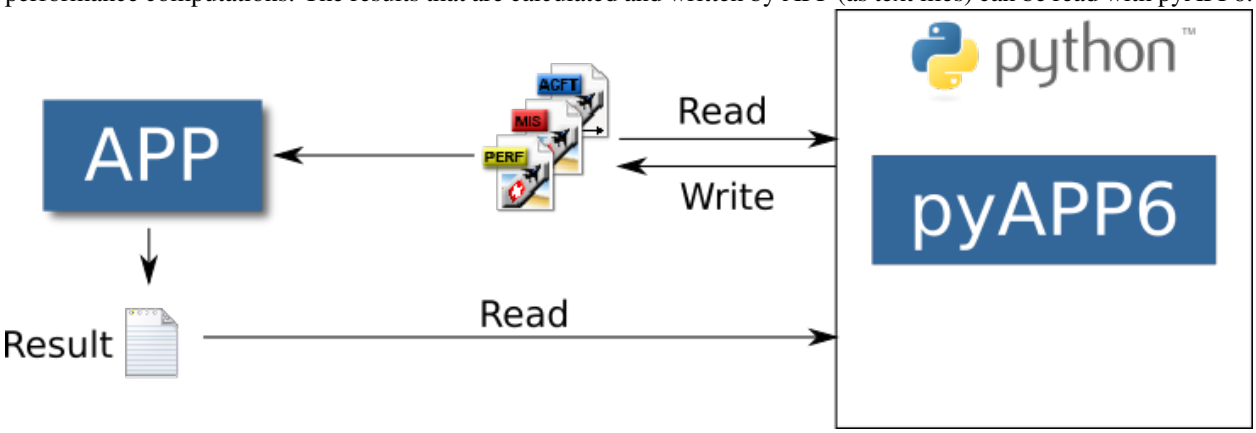
ONE

CONTENTS

1.1 Introduction

pyAPP6 is a Python package to interact with ALR's Aircraft Performance Program APP.

The current implementation of pyAPP6 is a file based interface to APP. pyAPP6's classes enable to read and write APP6 files. Together with the command line interface of APP, pyAPP6 allows for automation of mission and point performance computations. The results that are calculated and written by APP (as text files) can be read with pyAPP6.



1.2 Installation

If you do not already have a Python distribution installed, ALR recommends to use a distribution that is pre-built for windows and includes common modules such as numpy, scipy and matplotlib. Such a distribution is Anaconda, available here: https://www.continuum.io/downloads

Installing pyAPP6 is straight forward, as for any python packge. Navigate to the pyAPP6 folder and open a Windows command line (cmd). Install pyAPP6 by executing:

```
python setup.py install
```

This will add pyAPP6 to your active python distribution. To test the sucessful installation, open a python shell by entering:

```
python
```

and then type:

```
>>> import pyAPP6
```

If no error message appears, the installation was sucessful.

A second method is to either add the path to the pyAPP6 root folder in each script by modifying sys.path or to add the path to the PYTHONPATH environment variable. For futher information, consult the official python documentation on how to install modules: https://docs.python.org/2/install/#modifying-python-s-search-path

1.3 APP Command Line

APP6 offers a command line mode to execute a computation without using the Graphical User Interface (GUI). pyAPP6 has two classes that simplify the execution of APP from a Python script.

The command line mode of APP6 writes the results in ASCII format into a text file (.txt). This file can then be read by pyAPP6.

To calculate a mission saved as myMission.mis, type:

```
App6.exe -m myMission.mis
```

To calculate a Performance Chart saved as myChart.perf, type:

```
App6.exe -pp myChart.perf
```

1.4 Authors

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1.5 User Guide

This user guide to pyAPP6 is structured into four parts. First, an overview over the *package strcuture* is provided. The second section describes how to *read and write APP files* (aircraft, missions and performance charts) using Python. The last two sections describe how to execute APP's *mission computations* and *performance chart computations* by using Python and parse the results written by APP.

1.5.1 Package Structure

The pyAPP6 package comprises the following modules:

Files Classes for *Reading and Writing APP Files*.

Mission Classes for executing *Mission Computations* and reading the results.

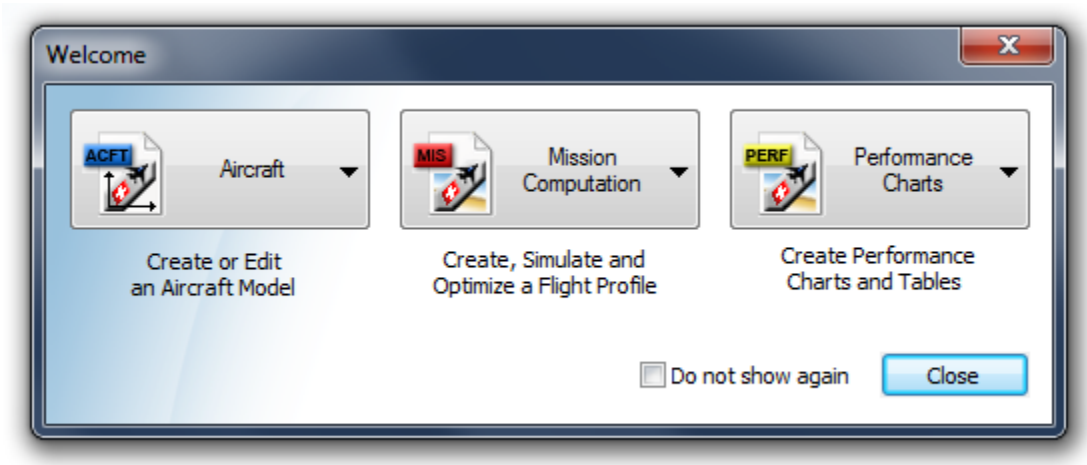
Performance Classes for executing *Performance Charts* computations and reading the results.

Database Helper class to read APP's string table.

Global Constants as used in APP.

Units Unit conversion factors as used in APP.

1.5.2 Reading and Writing APP Files



For each APP6 filetype, pyAPP6 offers a class to read, manipulate and write a file. The classes are located in the Files module:

APP File	pyAPP6 Class
Aircraft (.acft)	Files.AircraftModel
Mission Computation (.mis)	Files.MissionComputationFile
Performance Charts (.perf)	Files.PerformanceChartFile

The classes are located in the Files module:

class pyAPP6.Files.**AircraftModel**

Holds the APP6 aircraft model that is used to read and write APP .acft files

Each type of data (Mass&Limits, Aerodynamcis, Propulsion, Stores) is stored in two lists: one list containing names and one list containing data. These two lists have to have the same length. The configurations are built by using these list indices. Take proper care when manipulating these lists manually and update the 'ProjectAircraft' (m_Prj).

Examples

The best way to create an instance of an AircraftModel is to use the classmethod fromFile:

```
from pyAPP6 import Files

acft = Files.AircraftModel.fromFile(r'myAircraft.acft')
```

Variables

- **m_GeneralData** (*GeneralData*) – General data about the aircraft
- **text** (*Text*) – Content of the comment text box in 'General Data'
- **configName** (*list[str]*) – list holding the names of the Mass&Limits datasets ('Config' classes)

- **aeroName** (*list[str]*) – list holding the names of the Aerodynamics datasets ('Aero' classes)
- **propulsionName** (*list[str]*) – list holding the names of the Propulsion datasets ('PropulsionData' child classes)
- **storeName** (*list[str]*) – list holding the names of the Store datasets ('Store' classes)
- **m_config** (*list[Config]*) – list of the Mass&Limits datasets ('Config' classes)
- **m_aero** (*list[Aero]*) – list of the Aerodynamics datasets ('Aero' classes)
- **m_propulsion** (*list[PropulsionData]*) – list of the Propulsion datasets ('PropulsionData' child classes)
- **m_store** (*list[Store]*) – list of the Store datasets ('Store' classes)
- **m_Prj** (*ProjectAircraft*) – Contains the Configurations and Store Configurations

class pyAPP6.Files.**MissionComputationFile**

Reads an APP .mis file

This class reads an APP mission computation file. Most of the data is stored in a ProjectAircraftSetting object (aircraft configuration and stores) and a MissionDefinition object (initial conditions, list of segments). When manipulating mission files, consult the source code and documentation of these two classes.

Note: Data for APP's "Parameter Study" computation mode is read as well (into the variationData attribute). However, APP's command line mode does not support this computation type

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Examples

The best way to create an instance of a MissionComputationFile is to use the classmethod fromFile:

```
from pyAPP6 import Files

mis = Files.MissionComputationFile.fromFile(r'myMission.mis')
```

Variables

- **text** (*Text*) – Description text
- **name** (*str*) – name of the mission computation
- **author** (*str*) – name of the author of the mission file
- **aircraftpath** (*str*) – path to the aircraft, either relative (to the location of the mis file) or absolute
- **projectAircraftSetting** (*ProjectAircraftSetting*) – holds the used configuration of the aircraft and settings of stores
- **misDef** (*MissionDefinition*) – Holds the initial conditions and the list of segments
- **resData** (*ResArrayData*) – Holds the computation type (CMP_MISSION or CMP_MISSIONVAR)
- **variationData** (*VariationData*) – Holds data for the Parameter Study mission computation type

class pyAPP6.Files.**PerformanceChartFile**

Reads an APP .perf file

This class reads an APP performance chart file. Most of the data is stored in a ProjectAircraftSetting object (aircraft, configuration and stores), a FlightData object (initial conditions and flight state) and a PointPerfSolver child class object (specific data, related to the type of performance chart).

Note: Not all types of point performance charts can be computed by the APP command line mode. See documentation for valid types.

Examples

The best way to create an instance of a PerformanceChartFile is to use the classmethod fromFile:

```
from pyAPP6 import Files

chart = Files.PerformanceChartFile.fromFile(r'myPerfFile.perf')
```

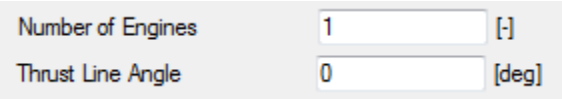
Variables

- **text** (*Text*) – Description text
- **name** (*str*) – name of the mission computation
- **author** (*str*) – name of the author of the mission file
- **aircraftpath** (*str*) – path to the aircraft, either relative (to the location of the perf file) or absolute
- **projectAircraftSetting** (*ProjectAircraftSetting*) – holds the used configuration of the aircraft and settings of stores
- **flightData** (*FlightData*) – holds the flight state (initial conditions)
- **perf** (*PointPerfSolver*) – instance of a child class of PointPerfSolver, defines the type of performance chart

NExtReal

APP defines two custom data types: NExtReal and XTables. When using pyAPP6 to manipulate APP files, it is important to understand these data types.

NExtReals are recognizable in the APP user interface by a text followed by a value and a unit:



class pyAPP6.Files.**NExtReal**

APP datatype that wraps a float and allows to specify a label, type of variable (through an index string) and indicate if the value is a limiter

Variables

- **xx** (*float*) – value of variable
- **label** (*str*) – label of the value, e.g. '[Mach]'

- **realIdx** (*str*) – index (type) of variable, e.g. 'REAL_MACH'
- **limitActive** (*int*) – 0 or 1, depends on whether the variable has an active limit. E.g used for Max. Take-Off Mass
- **note** (**.**) – use readASCIILimited and writeASCIILimited if the variable is a limited value.

Examples

When using pyAPP6 to read APP files, usually no direct use of this type is needed. This information is mostly for developers/maintainers. The text format of a simple, non-limited NExtReal looks like this:

```
[Mach]
REAL_MACH
0.985
```

This is parsed using readASCII with the flag full=True. The full flag has to be set to True to read the index string 'REAL_MACH'.

```
>>> val = NExtReal()
>>> f = open('path to text file')
>>> val.readASCII(f, full=True)
```

resulting in the following attributes:

```
val.xx = 0.985
val.realIdx = 'REAL_MACH'
val.label = '[Mach]'
val.limitActive = 0
```

If the text format has no index string,

```
[Mach]
0.985
```

readASCII is called with with the flag full=False:

```
>>> val = NExtReal()
>>> f = open('path to text file')
>>> val.readASCII(f)
```

XTable

XTables are used everywhere you see a spreadsheet-like table in APP. pyAPP6 uses the **numpy** module to store data tables. **numpy** offers a lot of functionality to manipulate arrays. pyAPP6 defines four different tables, with increasing dimensionality: X0Table, X1Table, X2Table and X3Table.

The X0Table is used for one-column data ranges, for example in performance charts for the **X-Range** and **Parameter** range.

class pyAPP6.Files.**X0Table**

Holds a 1D table (data range)

Variables

- **data** (*list[str]*) – Table data with table factor and interpolation settings
- **table** (*ndarray*) – numpy array of shape (N,1)
- **label** (*str*) – Header string

- **X0Typ** (*str*) – APP variable type

The X1Table is a simple two-column table. An example would be the Mach limit or CLmax table. The data is stored in a two-dimensional numpy array.

class pyAPP6.Files.**X1Table**
Holds a 2D table

Variables

- **data** (*list[str]*) – Table data with table factor and interpolation settings
- **table** (*ndarray*) – numpy array of shape (N,2)
- **label** (*str*) – Header string

The X2Table is a list of two-column tables. An example would be the induced drag tables or the max. thrust tables. The data is stored in a list of two-dimensional numpy arrays (*table* attribute). Each table also has a value (for the induced drag table that would be a Mach number). The values are stored in the *value* list. The *table* and *value* list have the same length and same ordering.

class pyAPP6.Files.**X2Table**(*embedded=False*)
Holds a list of 2D tables

Variables

- **data** (*list[str]*) – Table data with table factor and interpolation settings
- **table** (*list[ndarray]*) – list of numpy arrays of shape (N,2)
- **value** (*list[float]*) – value of each table
- **label** (*str*) – Header string
- **embedded** (*bool*) – True if table is embedded in an 'X3Table'. Disables reading/writing of header (data and label)

The X3Table class is used in APP for the fuel flow table. The X3Table consists of a list of X2Tables and corresponding values.

class pyAPP6.Files.**X3Table**
Holds a list of X2Tables.

This class holds a list of X2Tables and a value for each table.

Variables

- **data** (*list[str]*) – Table data with table factor and interpolation settings
- **table** (*list[X2Table]*) – list of X2Table instances
- **value** (*list[float]*) – value of each table
- **label** (*str*) – Header string

1.5.3 Variables

When executing APP via the command line, the user can specify what variables will be written in the output result file. By default, pyAPP6 uses the included *ParameterList_All.par* file to specify the variables. The ouput data is stored in a large numpy table, and the variable can be best accessed by it's index. The following table presents the current mapping of indices to the variables when using the default parameter list file.

Index	Variable Name	(SI)	(British)

Continued on next page

Table 1.1 – continued from previous page

0	(M/SFC)(L/D)	[-]	[-]
1	Acceleration	[m/sec2]	[ft/sec2]
2	Advance Ratio	[-]	[-]
3	Altitude	[m]	[ft]
4	AoA	[deg]	[deg]
5	Attitude	[deg]	[deg]
6	CAS	[m/sec]	[nm/hr]
7	CD	[-]	[-]
8	CD0	[-]	[-]
9	CDi	[-]	[-]
10	CDs	[-]	[-]
11	CL	[-]	[-]
12	CL/CD	[-]	[-]
13	Climb Angle	[deg]	[deg]
14	Climb Speed	[m/sec]	[ft/sec]
15	CLmax	[-]	[-]
16	CO2 Mass	[kg]	[lbs]
17	CP	[-]	[-]
18	CT	[-]	[-]
19	Density	[kg/m3]	[slug/ft3]
20	Distance	[km]	[nm]
21	Drag	[N]	[lbf]
22	Drag Area	[m2]	[ft2]
23	dT	[K]	[K]
24	Dynamic Pressure	[N/m2]	[lbf/ft2]
25	EAS	[m/sec]	[nm/hr]
26	Ekin	[Nm]	ft]
27	Energy Height	[m]	[ft]
28	Engine Revolution	[rpm]	[rpm]
29	Epot	[Nm]	ft]
30	Etot	[Nm]	ft]
31	Fuel Flow	[kg/sec]	[lbs/hr]
32	Fuel Mass	[kg]	[lbs]
33	Fuel Percent	[%]	[%]
34	Fuel Percent (Internal)	[%]	[%]
35	Lift	[N]	[lbf]
36	Lift Area	[m2]	[ft2]
37	Load Factor	[-]	[-]
38	Mach	[-]	[-]
39	Mass	[kg]	[lbs]
40	Max. Thrust	[N]	[lbf]
41	Min. Thrust	[N]	[lbf]
42	Payload	[%]	[%]
43	Placard Mach	[-]	[-]
44	Power Setting	[%]	[%]
45	Pressure	[N/m2]	[lbf/ft2]
46	Pressure Altitude	[m]	[ft]
47	Propeller Beta	[deg]	[deg]
48	Propeller Efficency	[%]	[%]
49	Pull-Up Rate	[deg/sec]	[deg/sec]

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Table 1.1 – continued from previous page

50	Reference Area	[m2]	[ft2]
51	Seg. CO2 Mass	[kg]	[lbs]
52	Seg. Dist.	[km]	[nm]
53	Seg. Fuel	[kg]	[lbs]
54	Seg. Time	[min]	[min]
55	SEP	[m/sec]	[ft/sec]
56	SFC	N)]	lbf)]
57	Shaft Power	[W]	[shp]
58	Specific Range	[km/kg]	[nm/lbs]
59	Speed of Sound	[m/sec]	[ft/sec]
60	Stall Speed	[m/sec]	[nm/hr]
61	Stall Speed (CAS)	[m/sec]	[nm/hr]
62	T/Tmax	[-]	[-]
63	TAS	[m/sec]	[nm/hr]
64	Temperature	[K]	[K]
65	Thrust	[N]	[lbf]
66	Thrust cos(AoA+sigma)	[N]	[lbf]
67	Time	[sec]	[sec]
68	Turn Radius	[m]	[ft]
69	Turn Rate	[deg/sec]	[deg/sec]
70	Turns	[turn]	[turn]
71	Velocity	[m/sec]	[nm/hr]
72	Vx	[m/sec]	[nm/hr]
73	X-Acc.	[m/sec2]	[ft/sec2]

1.5.4 Mission Computations

The Mission module, specifically the class *MissionComputation*, is used to run the APP command line mode for mission computations and parse the result text file.

class pyAPP6.Mission.**MissionComputation**(*APP6Directory='C:\Program Files (x86)\ALR Aerospace\APP 6 Professional Edition'*)

Class to execute APP and subsequently load the results.

This class is a helper class to execute APP mission computations. After creating an instance of this object, execute the 'run' function. The result will be loaded into the 'result' attribute. 'result' is of type MissionResult, see the documentation of the MissionResult class for further details.

Note: The 'Parameter Study' computation type can not be computed with the APP command line mode.

Examples

This example shows how to run a mission computation and obtain an instance of the mission result:

```
from pyAPP6 import Mission

misCmp = Mission.MissionComputation()
misCmp.run(r'myMission.mis')
result = misCmp.getResult()
```

This example assumes APP is installed in the default directory.

Variables

- **output** (*str*) – Path to the text file with the mission results written by APP
- **result** (MissionResult) – The result of the mission computation, parsed from the 'output' text file
- **misCompFile** (Files.MissionComputationFile) – Instance of a MissionComputationFile (APP .mis file). Is available once the method run was called
- **db** (*Database*) – Instance of a Database object
- **inputfile** (*str*) – Path to the APP mis file

A result from an APP command line computation can also be directly read by using the MissionResult class.

class pyAPP6.Mission.**MissionResult**
This class can read the APP mission result text file.

Examples

This example shows how to read a mission result directly from a text file. This is useful to read results from past mission computations, for example when conduction batch simulations:

```
from pyAPP6 import Mission

res = Mission.MissionResult.fromFile(r'myMission.mis_ouput.txt')
```

Variables

- **output** (*dict*) – Dictionary containing the mission flags, error text, number- and list of variables
- **segments** (*list[MissionResultSegment]*) – A list of MissionResultSegment class instances, holding the results of each segment
- **initialSettings** (*MissionResultSegment()*) – The initial settings of the mission

1.5.5 Performance Charts

The Performance module, specifically the class *PerformanceChart*, is used to run the APP command line mode for performance chart computations and parse the result text file.

class pyAPP6.Performance.**PerformanceChart**(*APP6Directory='C:\Program Files (x86)\ALR Aerospace\APP 6 Professional Edition'*)
Helper class to execute a performance chart computation from an existing .perf file.

Variables

- **inputfile** (*str*) – Path to the input .perf file
- **perfFile** (PerformanceChartFile) – Parsed input APP6 .perf file
- **output** (*str*) – Path to the resulting txt file
- **result** (PerformanceChartResult) – Result
- **APP6Path** (*str*) – Full path to the APP6 executable

Parameters **APP6Directory** (*str, optional*) – Path to the location of the APP6 executable.

Raises `ValueError` – If the APP6 executable is not found in the specified directory

A result from an APP command line computation can also be directly read by using the PerformanceChartResult class.

class `pyAPP6.Performance.`**PerformanceChartResult**
Reads a result txt file written by the APP6 command line mode for a performance chart.

Examples

This example shows how to read a performance chart result directly from a text file. This is useful to read results from past computations, for example when conduction batch computations:

```
from pyAPP6 import Performance

res = Performance.PerformanceChartResult.fromFile(r'myChart.perf_ouput.txt')
```

Variables

- **output** (*dict*) – stores the result meta-data
- **lines** (*List[ResultLine]*) – holds the data of each line of a performanc chart

1.6 Developer Interface

This part of the documentation details the classes and functions available within pyPP6

1.6.1 AircraftModel

class `pyAPP6.Files.`**AircraftModel**
Holds the APP6 aircraft model that is used to read and write APP .acft files

Each type of data (Mass&Limits, Aerodynamcis, Propulsion, Stores) is stored in two lists: one list containing names and one list containing data. These two lists have to have the same length. The configurations are built by using these list indices. Take proper care when manipulating these lists manually and update the 'ProjectAircraft' (m_Prj).

Examples

The best way to create an instance of an AircraftModel is to use the classmethod fromFile:

```
from pyAPP6 import Files

acft = Files.AircraftModel.fromFile(r'myAircraft.acft')
```

Variables

- **m_GeneralData** (*GeneralData*) – General data about the aircraft
- **text** (*Text*) – Content of the comment text box in 'General Data'
- **configName** (*list[str]*) – list holding the names of the Mass&Limits datasets ('Config' classes)

- **aeroName** (*list[str]*) – list holding the names of the Aerodynamics datasets ('Aero' classes)
- **propulsionName** (*list[str]*) – list holding the names of the Propulsion datasets ('PropulsionData' child classes)
- **storeName** (*list[str]*) – list holding the names of the Store datasets ('Store' classes)
- **m_config** (*list[Config]*) – list of the Mass&Limits datasets ('Config' classes)
- **m_aero** (*list[Aero]*) – list of the Aerodynamics datasets ('Aero' classes)
- **m_propulsion** (*list[PropulsionData]*) – list of the Propulsion datasets ('PropulsionData' child classes)
- **m_store** (*list[Store]*) – list of the Store datasets ('Store' classes)
- **m_Prj** (*ProjectAircraft*) – Contains the Configurations and Store Configurations

classmethod fromFile(*filename*)
Creates a new AircraftModel instance from the path 'filename'

Raises

- ValueError – If a parsing error occurs. The aircraft file seems to be corrupted
- IOError – If the file cannot be opened

load(*f*)
load an aircraft from a file handle f. Low level function, use fromFile or loadFromFile.

Raises ValueError – If a parsing error occurs. The aircraft file seems to be corrupted

loadFromFile(*filename*)
load an aircraft from a file path 'filename'

Raises

- ValueError – If a parsing error occurs. The aircraft file seems to be corrupted
- IOError – If the file cannot be opened

saveToFile(*filename*, *overwrite=False*)
Write the APP .acft aircraft file.

Raises ValueError – If file exists but overwrite was set to False

class pyAPP6.Files.**GeneralData**
Class used in 'AircraftModel' to store general data.

Variables

- **m_sAircraftName** (*str*) – Name of the aircraft model ('Model' field in APP)
- **m_sManufacturer** (*str*) – Name of the manufacturer
- **m_sVariant** (*str*) – Name of a specific variant for this aircraft
- **m_sYear** (*str*) – Year
- **m_sAuthor** (*str*) – Name of the author of the APP model
- **m_sVersion** (*str*) – Version description of the APP model
- **m_sDate** (*str*) – Date of the APP model. Format: DD/MM/YYYY (e.g. 24/03/2016)

class pyAPP6.Files.**Config**
Class used in 'AircraftModel', holds Mass&Limits data

Variables

- **text** (*Text*) – Description
- **mass** (*Mass*) – Class holding mass data
- **gear** (*Gear*) – Class holding gear data
- **tolParameter** (*TOLParameter*) – Class holding parameters for take-off and landing
- **nEngines** (NExtReal) – Number of engines
- **thrustMult** (NExtReal) – Thrust multiplier
- **fuelFlowMult** (NExtReal) – Fuel flow multiplier
- **relAoA** (NExtReal) – Thrust line angle
- **dDragArea** (NExtReal) – Delta drag area
- **dragMult** (NExtReal) – Drag multiplier
- **posLimitLF** (NExtReal) – Positive limit load factor
- **negLimitLF** (NExtReal) – Negative limit load factor
- **limitAoAMax** (NExtReal) – Maximum AoA Limit
- **limitAoAMin** (NExtReal) – Minimum AoA Limit
- **limitMass** (NExtReal) – Maximum Take-Off Mass limiter (optional)
- **limitMachTable** (X1Table) – Mach limiter table (altitide, Mach)
- **limitAoAGTable** (X1Table) – AoA-G limiter table (AoA, g)

class pyAPP6.Files.**TOLParameter**

Class used in the 'Config' (Mass&Limits) class for the 'AircraftModel'

Variables

- **tailstrikeAngle** (NExtReal) – Tailsrike angle
- **maxTireSpeed** (NExtReal) – currently unused

class pyAPP6.Files.**Mass**

Class used in the 'Config' (Mass&Limits) class for the 'AircraftModel'

This class holds the mass breakdown. A minimal dataset should have values for the structure, payload and internalFuel entries.

Variables

- **structure** (NExtReal) – Structure mass
- **propulsionGroup** (NExtReal) – Propulsion group mass
- **equipment** (NExtReal) – Equipment mass
- **massDeviations** (NExtReal) – Mass deviation
- **fixedOperatingEquipment** (NExtReal) – Fixed op. equipment mass
- **unusableFuelAndOil** (NExtReal) – Unusable fuel and oil mass
- **gun** (NExtReal) – Gun mass
- **removableOperatingEquipment** (NExtReal) – Removable op. equipment mass
- **usableOil** (NExtReal) – Usable oil mass

- **crew** (NExtReal) – Crew mass
- **specMissionEquipment** (NExtReal) – Spec. mission euqipment mass
- **ammunition** (NExtReal) – Ammunition mass
- **payload** (NExtReal) – Payload mass
- **internalFuel** (NExtReal) – Fuel mass (internal fuel)

class pyAPP6.Files.**Gear**
Class used in the 'Config' (Mass&Limits) class for the 'AircraftModel'

Variables

- **cdGearArea** (NExtReal) – Gear drag area
- **aoaGround** (NExtReal) – AoA on Ground
- **isFixedGear** (*Boolean*) – Fixed gear

class pyAPP6.Files.**Aero**
Class used in 'AircraftModel', holds aerodynamics data

Variables

- **text** (*Text*) – Description
- **aspectRatio** (NExtReal) – Aspect ratio
- **Sref** (NExtReal) – Reference area
- **cd0Table** (X2Table) – Table holding the zero lift drag CD0
- **cdITable** (X2Table) – Table holding the induced drag CDI
- **clmaxTable** (X1Table) – Table holding the maximum CL (CLmax)
- **cl0Table** (X1Table) – Table holding the Cl0 (DCL, i.e. CL for minimum drag)
- **clTable** (X2Table) – Table holding the lift curves (CL)

class pyAPP6.Files.**PropulsionData**
Base class for propulsion datasets. Use the class method 'fromIndex' to create child classes.

classmethod fromIndex(*index*)
Creates a PropulsionData child class using the propulsion type (index)

Parameters **index** (*str*) – The currently available types are 'PROPULSION_JET' and 'PROPULSION_PROP'

class pyAPP6.Files.**JetPropulsionData**
Class used in 'AircraftModel', holds jet propulsion data

Variables

- **m_manufacturer** (*str*) – Manufacturer of the engine
- **m_variant** (*str*) – Variant of the engine
- **nthrustData** (*int*) – Number of thrust characteristics. Equals the length of the thrustData list
- **thrustData** (*list[JetThrust]*) – List containing the thrust characteristics (JetThrust)
- **nfuelData** (*int*) – Number of thrust characteristics. Equals the length of the thrustData list

- **fuelData** (*list[JetFuel]*) – List containing the fuel flow data (JetFuel)
- **m_index** (*str*) – Type of the propulsion, PROPULSION_JET

class pyAPP6.Files.**JetThrust**
Class used in 'JetPropulsionData', holds jet thrust data

Variables

- **name** (*str*) – Name of the dataset
- **text** (*Text*) – Description
- **maxThrustTable** (X2Table) – Table holding the max. thrust data
- **minThrustTable** (X2Table) – Table holding the min. thrust data
- **fuelFlowFileName** (*str*) – Name of the fuel flow data associated with this thrust dataset

class pyAPP6.Files.**JetFuel**
Class used in 'JetPropulsionData', holds jet fuel flow data

Variables

- **name** (*str*) – Name of the dataset
- **text** (*Text*) – Description
- **fuelTable** (X3Table) – Table holding the fuel flow data

class pyAPP6.Files.**PropPropulsionData**
Class used in 'AircraftModel', holds propeller propulsion data

class pyAPP6.Files.**PropThrust**
Class used in 'PropPropulsionData', holds propeller and power data

class pyAPP6.Files.**PropFuel**
Class used in 'PropPropulsionData', holds fuel flow data

class pyAPP6.Files.**Store**
Class used in 'AircraftModel', holds store data

class pyAPP6.Files.**ProjectAircraft**
Class used in 'AircraftModel', holds the configurations and store configurations

Variables

- **storeConfigName** (*list[str]*) – List of the store configuration names
- **storeConfigList** (*list[StoreDataList]*) – List of the store configurations
- **text** (*Text*) – Description. Currently unused
- **nrOfProjects** (*int*) – Number of aircraft configurations
- **nrOfStoreSettings** (*int*) – Number of store configurations
- **settingName** (*list[str]*) – List of the aircraft configuration names
- **configName** (*list[str]*) – List of the mass and limit dataset names
- **aeroName** (*list[str]*) – List of the aerodynamic dataset names
- **propulsionName** (*list[str]*) – List of the propulsion dataset names
- **thrustName** (*list[str]*) – List of the thrust rating dataset names

checkSettings()
Check the project for consistency

Raises AssertionError – If any of the lists do not have the same length as the project

class pyAPP6.Files.**StoreDataList**
Holds a list of StoreData. Used in ProjectAircraft and ProjectAircraftSetting.

class pyAPP6.Files.**StoreDataList**
Holds a list of StoreData. Used in ProjectAircraft and ProjectAircraftSetting.

class pyAPP6.Files.**StoreData**
Holds the state of a store. The correpsonding 'Store' data is identified by its name

Variables

- **name** (*string*) – Name of the 'Store' data
- **autodrop** (*int*) – set to 1 if the store should be dropped when empty, 0 otherwise (if the store is a fuel tank)
- **storestate** (*int*) – Indicates if the store is dropped (1) or attached (0)

1.6.2 MissionComputationFile

class pyAPP6.Files.**MissionComputationFile**
Reads an APP .mis file

This class reads an APP mission computation file. Most of the data is stored in a ProjectAircraftSetting object (aircraft configuration and stores) and a MissionDefinition object (initial conditions, list of segments). When manipulating mission files, consult the source code and documentation of these two classes.

Note: Data for APP's "Parameter Study" computation mode is read as well (into the variationData attribute). However, APP's command line mode does not support this computation type

---

Examples

The best way to create an instance of a MissionComputationFile is to use the classmethod fromFile:

```
from pyAPP6 import Files

mis = Files.MissionComputationFile.fromFile(r'myMission.mis')
```

Variables

- **text** (*Text*) – Description text
- **name** (*str*) – name of the mission computation
- **author** (*str*) – name of the author of the mission file
- **aircraftpath** (*str*) – path to the aircraft, either relative (to the location of the mis file) or absolute
- **projectAircraftSetting** (*ProjectAircraftSetting*) – holds the used configuration of the aircraft and settings of stores
- **misDef** (*MissionDefinition*) – Holds the initial conditions and the list of segments

- **resData** (*ResArrayData*) – Holds the computation type (CMP_MISSION or CMP_MISSIONVAR)
- **variationData** (*VariationData*) – Holds data for the Parameter Study mission computation type

checkAircraftPath()
Check if the aircraft file specified in aircraftpath exists

classmethod fromFile(*filename*)
Creates a new MissionComputationFile instance from the path 'filename'

Raises IOError – If the file cannot be opened

getAbsoluteAircraftPath(*misFilePath*)
If the aircraftpath is relative, this function returns the absolute path with respect to misFilePath

load(*f*)
Loads a mis file using an existing open file handle f. To read from a file path, use the fuction loadFromFile or the classmethod fromFile

class pyAPP6.Files.**MissionDefinition**
Class is used in 'MissionComputationFile'. Holds the initial conditions and the list of segments.

Variables

- **initialFd** (*FlightData*) – Initial conditions of the mission
- **segments** (*list[MissionSegment]*) – List of segments
- **opt** (*MisOptData*) – Optimizer settings

class pyAPP6.Files.**MissionSegment**
Used in the class 'MissionDefinition', holds all data that describes a segment

Variables

- **segmentIndex** (*str*) – type of the segment, e.g. 'SEG_TAKEOFF' or 'SEG_CLIMB'. Refer to the documentation for valid strings
- **versionString** (*list[str]*) – class name and version, set by APP6
- **segFd** (*FlightData*) – parameters of the segment. Not all segments use all data.
- **Timestep** (NExtReal) – timestep of the segment, in seconds
- **endValue1,endValue2** (NExtReal) – Segment stop conditions. See documentation for valid NExtReal.realIdx strings
- **comparatorType1,comparatorType2** (*int*) – Comparator for each segment stop condition. less=0, greater=1
- **increaseX,increaseY,increaseZ** (*int*) – flags for x,y and z integration (the z value is currently unused)
- **specialValue1,specialValue2** (NExtReal) – some segments use additional data. Refer to the documentation
- **specialInteger** (*int*) – some segments use additional data. Refer to the documentation

class pyAPP6.Files.**MisOptData**
Holds mission optimization data, used in 'MissionDefinition'.

class pyAPP6.Files.**ProjectAircraftSetting**
Saves the index of the active configuration and store configuration and holds the initial state of the stores within the selected store configuration

Used in 'PerformanceChartFile' and 'MissionComputationFile'

class pyAPP6.Files.**VariationData**
Holds mission variation data, used in 'MissionComputationFile'.

1.6.3 PerformanceChartFile

class pyAPP6.Files.**PerformanceChartFile**
Reads an APP .perf file

This class reads an APP performance chart file. Most of the data is stored in a ProjectAircraftSetting object (aircraft, configuration and stores), a FlightData object (initial conditions and flight state) and a PointPerfSolver child class object (specific data, related to the type of performance chart).

Note: Not all types of point performance charts can be computed by the APP command line mode. See documentation for valid types.

Examples

The best way to create an instance of a PerformanceChartFile is to use the classmethod fromFile:

```
from pyAPP6 import Files

chart = Files.PerformanceChartFile.fromFile(r'myPerfFile.perf')
```

Variables

- **text** (*Text*) – Description text
- **name** (*str*) – name of the mission computation
- **author** (*str*) – name of the author of the mission file
- **aircraftpath** (*str*) – path to the aircraft, either relative (to the location of the perf file) or absolute
- **projectAircraftSetting** (*ProjectAircraftSetting*) – holds the used configuration of the aircraft and settings of stores
- **flightData** (*FlightData*) – holds the flight state (initial conditions)
- **perf** (*PointPerfSolver*) – instance of a child class of PointPerfSolver, defines the type of performance chart

classmethod fromFile (*filename*)
Creates a new PerformanceChartFile instance from the path 'filename'

Raises IOError – If the file cannot be opened

getAbsoluteAircraftPath (*perfFilePath*)
If the aircraftpath is relative, this function returns the absolute path with respect to the misFilePath

class pyAPP6.Files.**PointPerfSolver**
Base class for a performance chart (PerformanceChartFile) type. Do not use directly, use the class 'PointPerfHelper' to generate child classes.

class pyAPP6.Files.**PointSolveParaStudy**
'Point Performance Computation' performance chart type, used in 'PerformanceChartFile'

class pyAPP6.Files.**PointSolveLFEnvelope**
'G-Envelope' performance chart type, used in 'PerformanceChartFile'

class pyAPP6.Files.**PointSolveSEPEnvelope**
'SEP-Envelope' performance chart type, used in 'PerformanceChartFile'

class pyAPP6.Files.**PointSolveSEPTurnRate**
'Turn-Rate Chart (SEP)' performance chart type, used in 'PerformanceChartFile'

class pyAPP6.Files.**PointSolveAltTurnRate**
'Turn-Rate Chart (Altitude)' performance chart type, used in 'PerformanceChartFile'

class pyAPP6.Files.**PointSolveAltSEP**
'SEP Chart (Altitude)' performance chart type, used in 'PerformanceChartFile'

class pyAPP6.Files.**PointSolveThrustDrag**
'Thrust and Drag' performance chart type, used in 'PerformanceChartFile'

1.6.4 Common Classes

class pyAPP6.Files.**FlightData**
Holds all data that defines a flight state.

class pyAPP6.Files.**ResArrayData**
Holds data for ranges used in performance charts ('PointPerfSolver')

class pyAPP6.Files.**Text**
Multi-line text, used in 'Description' fields of APP

Variables **text** (*list[str]*) – lines of the text. An empty line is written with a single '%' character

Example

```
>>> comment=Text()
>>> comment.text=['This is a multi-line comment.','%','This is another line']
>>> comment.writeASCII(sys.stdout)
[OBJECT VERSION]
CText       1
[USER TEXT]
3
This is a multi-line comment.
%
This is another line
```

1.6.5 Supporting Classes

class pyAPP6.Files.**PointPerfHelper**
Factory class to generate 'PointPerfSolver' child classes corresponding to a specified performance chart type.

Valid chart types are:

- CMP_POINT_PERF
- CMP_G_ENVELOPE
- CMP_SEP_ENVELOPE
- CMP_TURNRATE_SEP_CHART
- CMP_TURNRATE_ALT_CHART
- CMP_THRUSTDRAG_CHART
- CMP_SEP_ALT_CHART

Variables **cmpType** (*string*) – type of performance chart. See the class method 'newSolver' for a list of valid types.

classmethod **fromType**(*cmpType*)

Creates a new 'PointPerfSolver' instance with type cmpType.

Raises

- NotImplementedError – If the 'cmpType' has not yet been implemented into pyAPP6
- ValueError – If the 'cmpType' is not a valid chart type.

newSolver(*cmpType*)

Returns a child class instance of base type 'PointPerfSolver' by using the attribure 'cmpType'. cmpType is set using SetType().

Raises

- NotImplementedError – If the 'cmpType' has not yet been implemented into pyAPP6
- ValueError – If the 'cmpType' is not a valid chart type.

1.6.6 Data Types

class pyAPP6.Files.**NExtReal**

APP datatype that wraps a float and allows to specify a label, type of variable (through an index string) and indicate if the value is a limiter

Variables

- **xx** (*float*) – value of variable
- **label** (*str*) – label of the value, e.g. '[Mach]'
- **realIdx** (*str*) – index (type) of variable, e.g. 'REAL_MACH'
- **limitActive** (*int*) – 0 or 1, depends on whether the variable has an active limit. E.g used for Max. Take-Off Mass
- **note** (.) – use readASCIILimited and writeASCIILimited if the variable is a limited value.

Examples

When using pyAPP6 to read APP files, usually no direct use of this type is needed. This information is mostly for developers/maintainers. The text format of a simple, non-limited NExtReal looks like this:

```
[Mach]
REAL_MACH
0.985
```

This is parsed using readASCII with the flag full=True. The full flag has to be set to True to read the index string 'REAL_MACH'.

```
>>> val = NExtReal()
>>> f = open('path to text file')
>>> val.readASCII(f, full=True)
```

resulting in the following attributes:

```
val.xx = 0.985
val.realIdx = 'REAL_MACH'
val.label = '[Mach]'
val.limitActive = 0
```

If the text format has no index string,

```
[Mach]
0.985
```

readASCII is called with with the flag full=False:

```
>>> val = NExtReal()
>>> f = open('path to text file')
>>> val.readASCII(f)
```

class pyAPP6.Files.**Boolean**
Wrapper to read/write an APP boolean

1.6.7 Tables

class pyAPP6.Files.**X0Table**
Holds a 1D table (data range)

Variables

- **data** (*list[str]*) – Table data with table factor and interpolation settings
- **table** (*ndarray*) – numpy array of shape (N,1)
- **label** (*str*) – Header string
- **X0Typ** (*str*) – APP variable type

class pyAPP6.Files.**X1Table**
Holds a 2D table

Variables

- **data** (*list[str]*) – Table data with table factor and interpolation settings
- **table** (*ndarray*) – numpy array of shape (N,2)
- **label** (*str*) – Header string

class pyAPP6.Files.**X2Table**(*embedded=False*)

Holds a list of 2D tables

Variables

- **data** (*list[str]*) – Table data with table factor and interpolation settings
- **table** (*list[ndarray]*) – list of numpy arrays of shape (N,2)
- **value** (*list[float]*) – value of each table
- **label** (*str*) – Header string
- **embedded** (*bool*) – True if table is embedded in an 'X3Table'. Disables reading/writing of header (data and label)

clear()

Remove all elements from the table

getIndex(*value*)

Returns index of table with value "value"

Parameters

- **value** (*float*) – value of the table
- **Retruns** –
- **-------** –
- **int** – index of table with "value"

Raises IndexError – If table value is not in the list

insertTable(*value*, *data*)

Insert a new table (value, data) pair

Parameters

- **value** (*float*) – value of table to add
- **data** (*ndarray*) – data table as a numpy array with shape (N,2)

Raises

- ValueError – If table with value 'value' already exists
- ValueError – If data is not of shape N

remove(*i*)

Remove table of index i

class pyAPP6.Files.**X3Table**

Holds a list of X2Tables.

This class holds a list of X2Tables and a value for each table.

Variables

- **data** (*list[str]*) – Table data with table factor and interpolation settings
- **table** (*list[X2Table]*) – list of X2Table instances
- **value** (*list[float]*) – value of each table
- **label** (*str*) – Header string

clear()

Remove all elements from the table

insertTable(*value*, *x2Table*)
Insert a new table (value, x2Table) pair

Parameters

- **value** (*float*) – value of table to add
- **x2Table** (X2Table) – X2Table to insert

Raises

- ValueError – If table with value 'value' already exists
- ValueError – If x2Table is not of type X2Table

remove(*i*)
Remove table of index i

1.6.8 Mission Computations

class pyAPP6.Mission.**MissionComputation**(*APP6Directory='C:\Program Files (x86)\ALR Aerospace\APP 6 Professional Edition'*)
Class to execute APP and subsequently load the results.

This class is a helper class to execute APP mission computations. After creating an instance of this object, execute the 'run' function. The result will be loaded into the 'result' attribute. 'result' is of type MissionResult, see the documentation of the MissionResult class for further details.

Note: The 'Parameter Study' computation type can not be computed with the APP command line mode.

Examples

This example shows how to run a mission computation and obtain an instance of the mission result:

```
from pyAPP6 import Mission

misCmp = Mission.MissionComputation()
misCmp.run(r'myMission.mis')
result = misCmp.getResult()
```

This example assumes APP is installed in the default directory.

Variables

- **output** (*str*) – Path to the text file with the mission results written by APP
- **result** (MissionResult) – The result of the mission computation, parsed from the 'output' text file
- **misCompFile** (Files.MissionComputationFile) – Instance of a MissionComputationFile (APP .mis file). Is available once the method run was called
- **db** (*Database*) – Instance of a Database object
- **inputfile** (*str*) – Path to the APP mis file

printSegmentNames()
Prints the name of the segments

printStores()
Prints the name of the stores used in the mission

run(*inputfile*, *imperial=False*, *suffix='_output'*, *ParameterList='ParameterList_All.par'*)
This method runs APP6 using the command line mode and loads the results.

After the APP6 computation has terminated, the result is read into 'result'.

Parameters

- **inputfile** (*str*) – path to the APP6 .mis file
- **imperial** (*bool, optional*) – set False for SI units, True for imperial units
- **suffix** (*string, optional*) – suffix of the written result text filename
- **ParameterList** (*string, optional*) – filename of the parameter file. Has to be in the pyAPP6 directory.

Returns True if successful, False otherwise.

Return type bool

Raises

- IOError – If the mission file (inputfile) does not exists
- IOError – If the aircraft file specified in the mission does not exists or if no aircraft path was provided
- ValueError – If the computation type of the mission file is not set to 'Single Mission'

class pyAPP6.Mission.**MissionResult**
This class can read the APP mission result text file.

Examples

This example shows how to read a mission result directly from a text file. This is useful to read results from past mission computations, for example when conduction batch simulations:

```
from pyAPP6 import Mission

res = Mission.MissionResult.fromFile(r'myMission.mis_ouput.txt')
```

Variables

- **output** (*dict*) – Dictionary containing the mission flags, error text, number- and list of variables
- **segments** (*list[MissionResultSegment]*) – A list of MissionResultSegment class instances, holding the results of each segment
- **initialSettings** (*MissionResultSegment()*) – The initial settings of the mission

classmethod fromFile(*filename*)
Creates a new MissionResult instance from the path 'filename'

Raises IOError – If the file cannot be opened

getVariableIndex(*name*)
Returns the first variable index starting with the name 'name'

Parameters **name** (*str*) – name of the variable

Raises ValueError – If the variable with name 'name' does not exists

getVariableList()
Returns an ordered list of the variable names

getVariableName(*idx*)
returns the name of the variable at index idx

class pyAPP6.Mission.**MissionResultSegment**
Class used to store the result of a single mission segment. This class is used in the MissionResult class to parse each segment.

Variables

- **name** (*str*) – Name of the segment
- **data** (*ndarray*) – Data table as a numpy array with shape (ndata,n_var). n_var is stored in the MissionResult.output['n_var']
- **ndata** (*int*) – Number of datapoints in the segment

1.6.9 Performance Chart Computations

class pyAPP6.Performance.**PerformanceChart**(*APP6Directory='C:\Program Files (x86)\ALR Aerospace\APP 6 Professional Edition'*)
Helper class to execute a performance chart computation from an existing .perf file.

Variables

- **inputfile** (*str*) – Path to the input .perf file
- **perfFile** (PerformanceChartFile) – Parsed input APP6 .perf file
- **output** (*str*) – Path to the resulting txt file
- **result** (PerformanceChartResult) – Result
- **APP6Path** (*str*) – Full path to the APP6 executable

Parameters **APP6Directory** (*str, optional*) – Path to the location of the APP6 executable.

Raises ValueError – If the APP6 executable is not found in the specified directory

run(*inputfile*, *imperial=False*, *suffix='_output'*)
This method runs APP6 using the command line mode and load the results.

After the APP6 computation has terminated, the result is read into 'result'.

Parameters

- **inputfile** (*str*) – path to the APP6 .perf file
- **imperial** (*bool, optional*) – set False for SI units, True for imperial units
- **suffix** (*string, optional*) – suffix of the written result text filename

Returns True if successful, False otherwise.

Return type bool

Raises

- IOError – If the performance file (inputfile) does not exists

- `IOError` – If the aircraft file specified in the performance file does not exists or if no aircraft path was provided

class `pyAPP6.Performance.`**PerformanceChartResult**

Reads a result txt file written by the APP6 command line mode for a performance chart.

Examples

This example shows how to read a performance chart result directly from a text file. This is useful to read results from past computations, for example when conduction batch computations:

```
from pyAPP6 import Performance

res = Performance.PerformanceChartResult.fromFile(r'myChart.perf_ouput.txt')
```

Variables

- **output** (*dict*) – stores the result meta-data
- **lines** (*List[ResultLine]*) – holds the data of each line of a performanc chart

classmethod fromFile(*filename*)

Creates a new PerformanceChartResult instance from the path 'filename'

Raises `IOError` – If the file cannot be opened

getErrorText()

Returns the error text

getLine(*idx*)

Returns the ResultLine at index idx

getLineData(*idx*)

Parameters **idx** (*int*) – Index of line

Returns numpy array of all data points, with shape (n_points,n_variables)

Return type ndarray

getLineLabelList()

Returns a list of all line labels

getLineList()

Returns the list of ResultLines

getLineVariableData(*idx*, *varIdx*)

Parameters

- **idx** (*int*) – Index of line
- **varIdx** (*int*) – Index of variable

Returns numpy array with data points and shape (n,)

Return type ndarray

getVariableIndex(*name*)

Returns the first variable index starting with the name 'name'

Parameters **name** (*str*) – name of the variable

Raises `ValueError` – If the variable with name 'name' does not exists

getVariableList()
Returns an ordered list of the variable names

getVariableName(*idx*)
returns the name of the variable at index idx

isSuccessful()
Returns True if the performance result was computed sucessfully

loadFromFile(*filename*)
Read a APP6 performance chart result

Parameters **filename** (*str*) – path to the results txt file written by APP6

class pyAPP6.Performance.**ResultLine**
Represents a line in an APP6 performance chart.

Variables

- **label** (*str*) – Label of the line
- **value** (*str*) – Value of the line
- **ndata** (*int*) – Number of data points of the line
- **data** (*ndarray*) – Data array of all points with shape (ndata,nvariables)

load(*f*)
This function is called by the PerformanceChartResult class, do not use directly. Reads a line from the file handle f.

1.7 pyAPP6 Examples

Content: These examples are grouped into three main sections:

- *Files*
- *Mission Computation*
- *Performance Charts*

Version: pyAPP6 version 1.0

Note: This example was written as a jupyter notebook (version 4.1.0), and has been tested with Python 2.7.11 |Anaconda 4.0.0 (64-bit). The notebook file is available in the *Examples* directory of the pyAPP6 distribution.

1.7.1 Imports & Constants

Imports for plotting (matplotlib) and arrays (numpy):

```
import matplotlib.pyplot as plt
import numpy as np
```

Jupyter Notebook specific imports:

```
%matplotlib inline
```

Constants:

```
APP6DIR = r'C:\Program Files (x86)\ALR Aerospace\APP 6 Professional Edition'
```

1.7.2 Files

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The Files module is used to open, change and save APP Files. It can be used for: * *acft* (Aircraft) * *mis* (Mission Computation) * *perf* (Performance Charts)

file types.

It is recommended to create a new file using the APP GUI and subsequenty modify this file using Python/pyAPP6, instead of creating a file from scratch with pyAPP6.

Import the pyAPP6 modules

```
from pyAPP6 import Files
from pyAPP6 import Database
from pyAPP6 import Units
```

The Units and Database modules are imported as well for this example. They are useful to convert units and translate APP indices to human-readable text

Aircraft File (*.acft)

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To load an APP aircraft model, the class *AircraftModel* is used. A new instance can be created directly with the *fromFile* class method:

```
aircraftpath = r'data\\LWF.acft'
acft = Files.AircraftModel.fromFile(aircraftpath)
```

Now we have the aircraft file available in the *acft* variable. All data within the aircraft can be accessed through class member variables directly, or by using *get* functions. This examples shows how to access fields in the *General Data* tab of APP's aircraft model GUI:

```
data = acft.getGeneralData()
print ('Aircraft Name:', data.m_sAircraftName)
print ('Author:', data.m_sAuthor)
```

```
('Aircraft Name:', 'LWF')
('Author:', 'ALR')
```

Getter functions exist for all the main datasets. To print lists of the available data sets, use:

```
print(acft.getMassLimitsNames())
print(acft.getAeroNames())
print(acft.getPropulsionNames())
print(acft.getStoreNames())
```

```
['Standard']
['Cruise', `TO Flaps 27xb0']
['LWF']
['AIM-9 Wingtip']
```

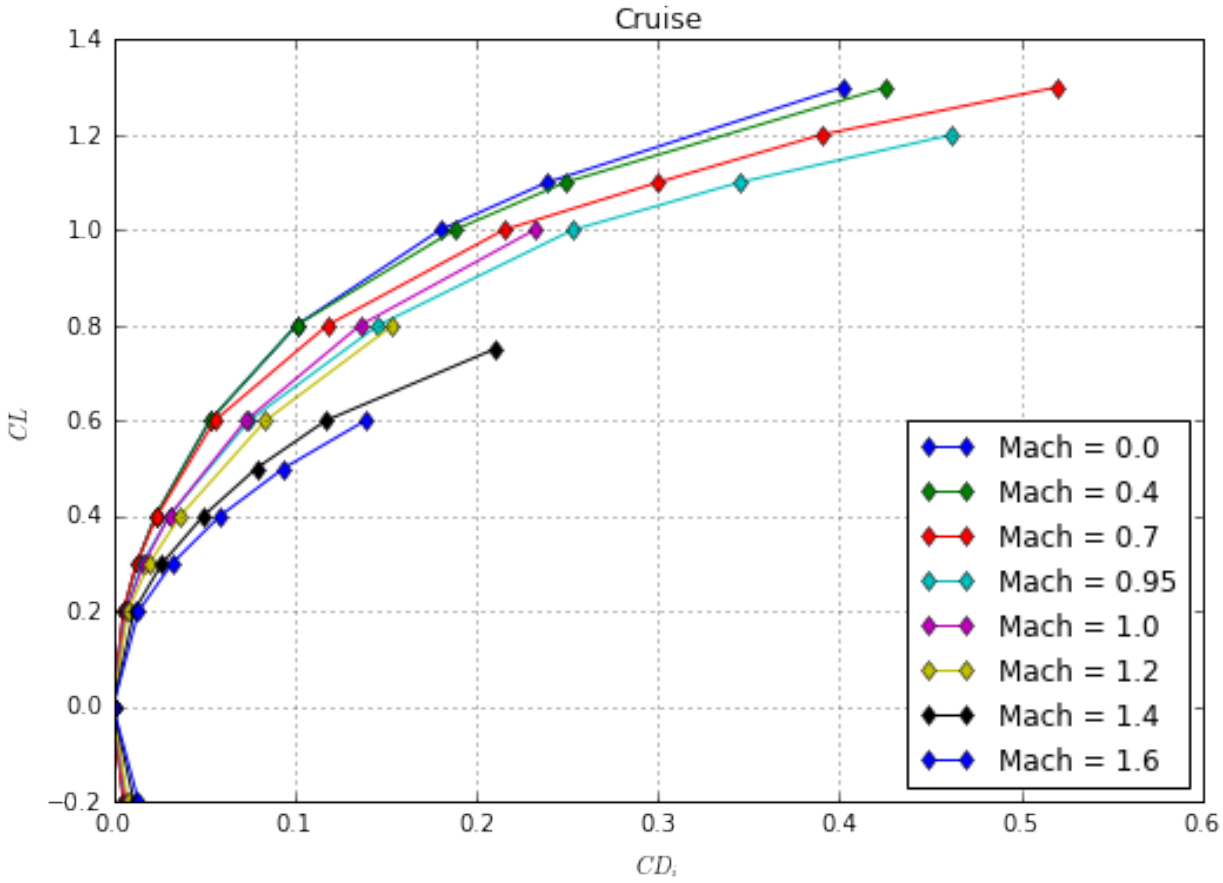
This example demonstrates how to loop through an X2Table (in this case the CL/CDi table) and correctly lable the drag polars:

```
i = 0
aero = acft.getAero(i) #get the first aerodanymic dataset, in this case 'Cruise'
```

```
fig = plt.figure(figsize=(8.3, 5.8)) #A5 landscape figure, size is in inches
ax = plt.subplot(1,1,1)

for val, table in zip(aero.cdITable.value,aero.cdITable.table):
    ax.plot(table[:,1], table[:,0], 'd-', label='Mach = '+str(val))

# adjust Axis properties
ax.set_title(acft.getAeroName(i))
ax.legend(loc='best')
ax.set_xlabel('$CD_i$')
ax.set_ylabel('$CL$')
ax.grid()
```

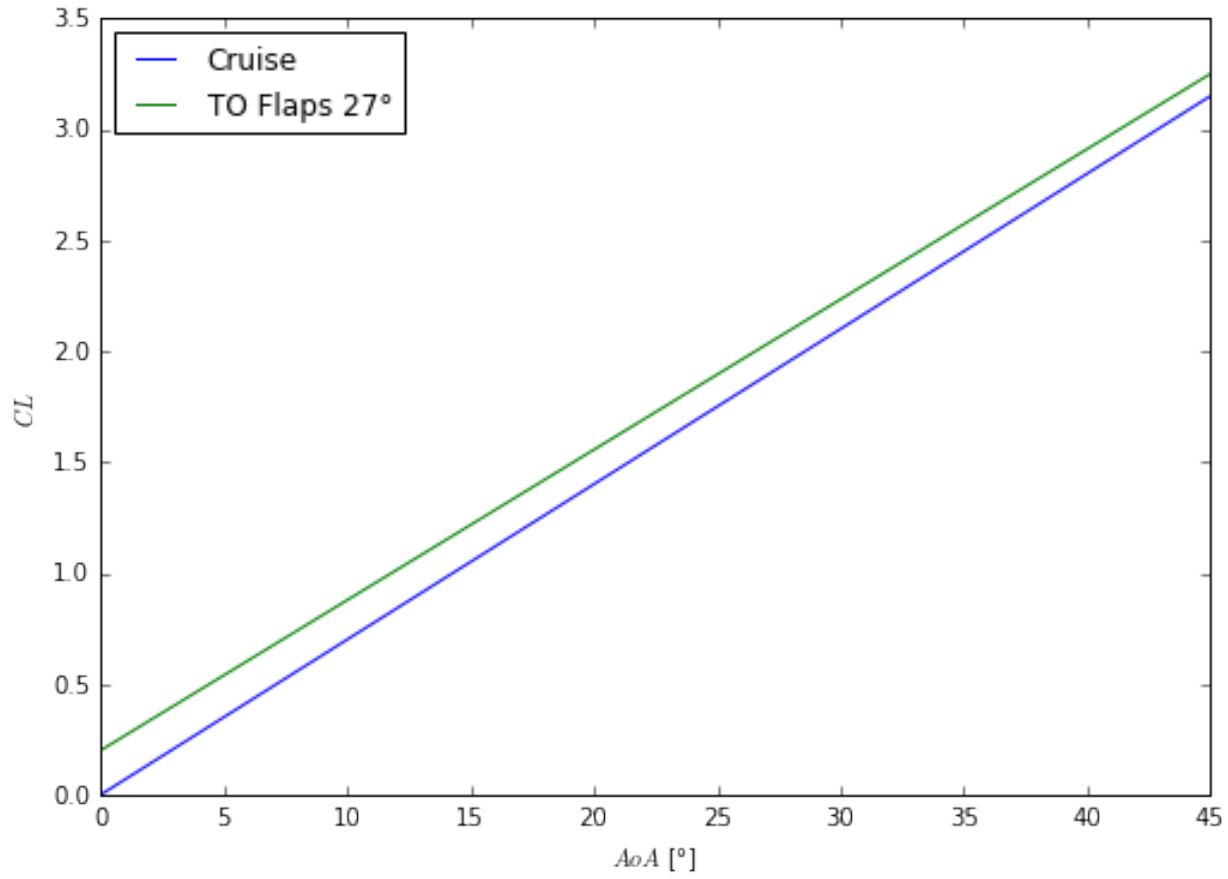


For an detailed explaination of the XTables classes, consult the pyAPP6 user guide.

A more involved example would be to compare lift curves of all available aero datasets:

```
fig = plt.figure(figsize=(8.3, 5.8)) #A5 landscape figure, size is in inches
ax = plt.subplot(1, 1, 1)
for aero, aeroName in zip(acft.getAeroList(), acft.getAeroNames()):
    ax.plot(aero.clTable.table[0][:,0]*Units._DEG, aero.clTable.table[0][:,1], label=aeroName.decode

ax.set_xlabel(u'$AoA$ [°]')
ax.set_ylabel(u'$CL$')
leg = ax.legend(loc=2)
#fig.savefig('CL_comparison.png',dpi=200)
```



Additionally, this example demonstrates the use of the *Units* module to convert from radians to degrees.

Note: In oder for the legend label for the *TO Flaps 27°* setting to be printed correctly, the *aeroName* string has to be converted to unicode with the enconding of the original text file, in this case *cp1252*. In addition, to print the ° sign in the x-axis label, the string has to be unicode and is typed with the prefix 'u'

Mission File (*.mis)

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The mission file is loaded using the classmethod *fromFile* in the MissionComputationFile class:

```
missionpath = r'data\\LWF Air Combat Mission RoA.mis'
missionFile = Files.MissionComputationFile.fromFile(missionpath)
```

The file can now be examined and changed via Python. For example, *getInitialCondition()* can be used to access the initial conditions. The following code changes the initial fuel mass to 80% and the altitude to 1000 m:

```
initFd = missionFile.getInitialCondition()
initFd.fuel.xx = 0.8
initFd.alt.xx = 1000.0
```

To loop through the segments, use *getSegmentList()* to access the list of segments. The following code prints the segment index (identifier) of each segment:

```
for segment in missionFile.getSegmentList():
    print(segment.segmentIndex)
```

```
SEG_GROUNDOP
SEG_TAKEOFF
SEG_CLIMB
SEG_BESTCLIMBRATE
SEG_ACCELERATION
SEG_TARGETMACHCRUISE
SEG_MANEUVRE
SEG_STOREDROP
SEG_MANEUVRE
SEG_STOREDROP
SEG_LOITER
SEG_SPECIFICRANGE
SEG_DECELERATION
SEG_CASDESCENT
SEG_LANDINGROLL
```

In order to display the label of each segment instead of the index string, you can use the Database class:

```
db = Database.Database()
```

```
for segment in missionFile.getSegmentList():
    print(db.GetTextFromID(segment.segmentIndex))
```

```
Ground Operation
Takeoff
Climb
Climb at Best Rate
Acceleration
Cruise at Mach
Maneuver at Max. LF
Store Drop
Maneuver at Max. LF
Store Drop
Loiter
Cruise at Best SR
Deceleration
Descent at CAS
Landing Roll
```

Similarly, the type and value of the segment end condition can shown:

```
for segment in missionFile.getSegmentList():
    print(db.GetTextFromID(segment.endValue1.realIdx),':', segment.endValue1.xx, )
```

```
('Seg. Time', ':', 600.0)
('Velocity', ':', 75.4455900943)
('Altitude', ':', 500.0)
('Altitude', ':', 9500.0)
('Mach', ':', 0.9)
('Seg. Dist.', ':', 320053.202172)
('Turns', ':', 12.5663706144)
('Seg. Time', ':', 100.0)
('Turns', ':', 6.28318530718)
('Seg. Dist.', ':', 100.0)
('Seg. Time', ':', 600.0)
('Seg. Dist.', ':', 402135.694779)
('CAS', ':', 102.888888976)
('Altitude', ':', 500.0)
('Velocity', ':', 0.01)
```

In order to change the altitude of the segment "Climb at Best Rate" (Segment index 3) from 9500m to 7000m, do:

```
print(missionFile.getSegment(3).endValue1.xx)
missionFile.getSegment(3).endValue1.xx = 7000.0
print(missionFile.getSegment(3).endValue1.xx)
```

```
9500.0
7000.0
```

Also change the altitude of the initial climb after takeoff (Segment index 2) to 500m above the starting altitude.

```
print(missionFile.getSegment(2).endValue1.xx)
missionFile.getSegment(2).endValue1.xx = initFd.alt.xx + 500.0
print(missionFile.getSegment(2).endValue1.xx)
```

```
500.0
1500.0
```

```
missionpath_mod = r'data\\LWF Air Combat Mission RoA_mod.mis'
missionFile.saveToFile(missionpath_mod,overwrite=True)
```

Performance Chart File (*.perf)

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A PerformanceChartFile is instantiated via the fromFile classmethod:

```
chartpath = r'data\\LWF Climb Rate Chart 50% Fuel.perf'
chart = Files.PerformanceChartFile.fromFile(chartpath)
```

This example shows how to change the flight state (initial condition). The function *getInitialCondition* returns an instance of type FlightData:

```
fd = chart.getInitialCondition()
```

```
print fd.alt.xx
print fd.speed.xx, db.GetTextFromID(fd.speed.realIdx) #Mach Number
print fd.fuel.xx, db.GetTextFromID(fd.fuel.realIdx)
```

```
0.0
0.0 Mach
0.5 Fuel Percent
```

Note: the speed variable can be either **Mach** or **TAS**. Check the corresponding *realIdx* string. Similarly, the variables *payload*, *climb*, *thrust* and *pull* can be of different type

Change the fuel from the current state (50%) to 100%

```
print(fd.fuel.xx)
```

```
0.5
```

```
fd.fuel.xx = 1.0
```

To change the aircraft **Configuration**, for example from Dry (configuration index 0) to Reheat (configuration index 1), access the *ProjectAircraftSetting* class. To see what configurations are available, open the aircraft model.

```
configNames = acft.getConfigurationNames()
print 'Configurations in the aircraft model:\n', configNames, '\n'

cfg = chart.getAircraftConfiguration()
print cfg.activeSetting, configNames[cfg.activeSetting]
cfg.activeSetting = 1
print cfg.activeSetting, configNames[cfg.activeSetting]
```

```
Configurations in the aircraft model:
['Cruise, Dry', 'Cruise, Reheat', 'TOL, Reheat', 'TOL, Dry']

0 Cruise, Dry
1 Cruise, Reheat
```

Similarly, *External Store Configurations* can be changed:

```
storeConfigNames = acft.getStoreConfigurationNames()
print 'Store configurations in the aircraft model:\n',storeConfigNames,'\n'

cfg = chart.getAircraftConfiguration()
print cfg.activeStoreSetting, storeConfigNames[cfg.activeStoreSetting]
cfg.activeStoreSetting = -1 #use -1 for no external stores (clean)
```

```
Store configurations in the aircraft model:
['Air-to-Air']

0 Air-to-Air
```

To access the computation, use the *getComputation* method. The type of performance chart can be checked with the *CompType* variable. In the case of a **Point Performance Computation**, the type of equation solved is stored in *resData.CmpType*.

```
comp = chart.getComputation()
print db.GetTextFromID(comp.CompType)
print db.GetTextFromID(comp.resData.CmpType)
```

```
Point Performance Computation
Climb
```

The *resData* attribute also holds the data ranges for the chart in two *X0Tables*, one for the **X-Range** the other for the **Parameter**:

```
print comp.resData.X1Range.X0Typ
print comp.resData.X1Range.table

print comp.resData.X2Range.X0Typ
print comp.resData.X2Range.table
```

```
REAL_MACH
[ 0.2   0.25  0.3   0.35  0.4   0.45  0.5   0.55  0.6   0.65  0.7   0.75
  0.8   0.85  0.9   0.95]
REAL_ALT
[     0.   2500.   5000.   7500.  10000.]
```

For example, to change the computed altitudes, replace the *table* with a new numpy array:

```
comp.resData.X2Range.table = np.linspace(0.0, 10000.0, 3)
print comp.resData.X2Range.table
```

```
[     0.   5000.  10000.]
```

or, add values manually (as *floats*):

```
comp.resData.X2Range.table = np.array([0.0, 10000.0])
print comp.resData.X2Range.table
```

```
[     0.  10000.]
```

Save your modified file:

```
chartpath_mod = r'data\\LWF Climb Rate Chart 100% Fuel.perf'
chart.saveToFile(chartpath_mod, overwrite=True)
```

1.7.3 Mission Computation

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Import the *Mission* module from pyAPP6:

```
from pyAPP6 import Mission
```

In order to run APP mission computations, create an instance of the *MissionComputation* class. The path to the directory where the APP executable can be found has to be provided

```
misCmp = Mission.MissionComputation(APP6Directory = APP6DIR)
```

```
misCmp.run(missionpath)
```

```
True
```

```
res = misCmp.result
```

Access data by looping through the segments. To get a specific variable, find the index of the variable by using the function *getVariableIndex*. To access the data of the segment, use *getData*. *getData* returns a 3d numpy array, with the first dimension being the datapoint and the second dimension the variable. For example, the variable *Fuel Mass* at the end of each segment can be obtained by using:

```
idx_fuel = res.getVariableIndex('Fuel Mass')

for seg in res.getSegmentList():
    print res.getVariableName(idx_fuel),':',seg.getData()[-1,idx_fuel]
```

```
Fuel Mass [kg] : 1896.22
Fuel Mass [kg] : 1859.49
Fuel Mass [kg] : 1779.27
Fuel Mass [kg] : 1532.93
Fuel Mass [kg] : 1520.89
Fuel Mass [kg] : 1123.86
Fuel Mass [kg] : 914.584
Fuel Mass [kg] : 914.584
Fuel Mass [kg] : 815.506
Fuel Mass [kg] : 815.506
Fuel Mass [kg] : 619.614
Fuel Mass [kg] : 225.152
Fuel Mass [kg] : 222.696
Fuel Mass [kg] : 104.648
Fuel Mass [kg] : 100.12
```

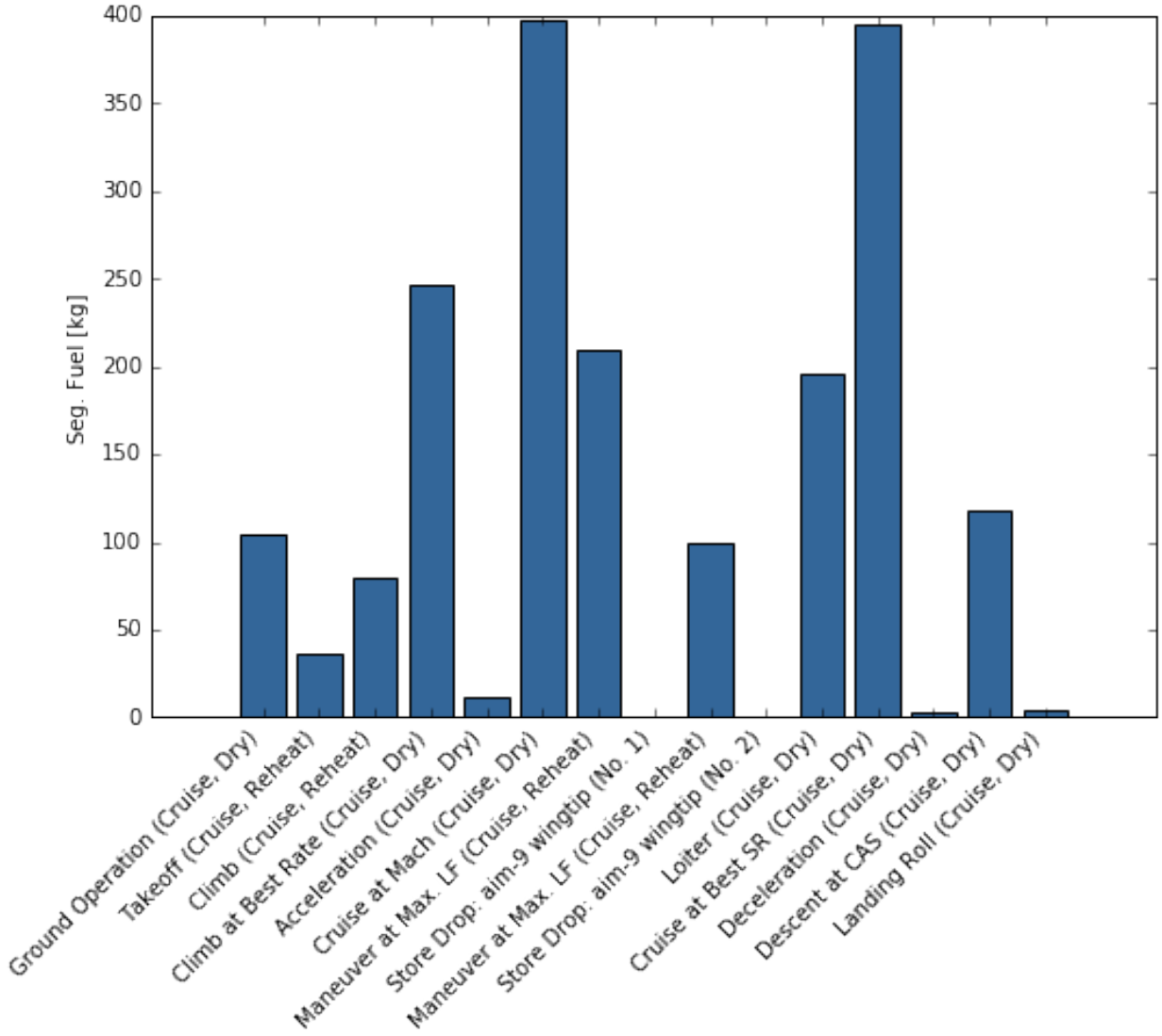
A list of the fuel consumed per segment can be easily ontained using a list comprehension:

```
idx_segFuel = res.getVariableIndex('Seg. Fuel')

segFuelList = [seg.getData()[-1,idx_segFuel] for seg in res.getSegmentList()]
print segFuelList
```

```
[103.782, 36.7258, 80.217600000000004, 246.34299999999999, 12.043900000000001, 397.024, 209.279, 0.0,
```

```
fig = plt.figure(figsize=(8.3, 5.8)) #A5 landscape figure, size is in inches
ax = plt.subplot(1,1,1)
ax.bar(range(len(segFuelList)),
       segFuelList,
       align='center',
       color='#336699')
ax.set_xticks(range(len(segFuelList)))
ax.set_xticklabels(res.getSegmentNameList(), rotation=45, ha='right')
ax.set_ylabel(res.getVariableName(idx_segFuel))
```

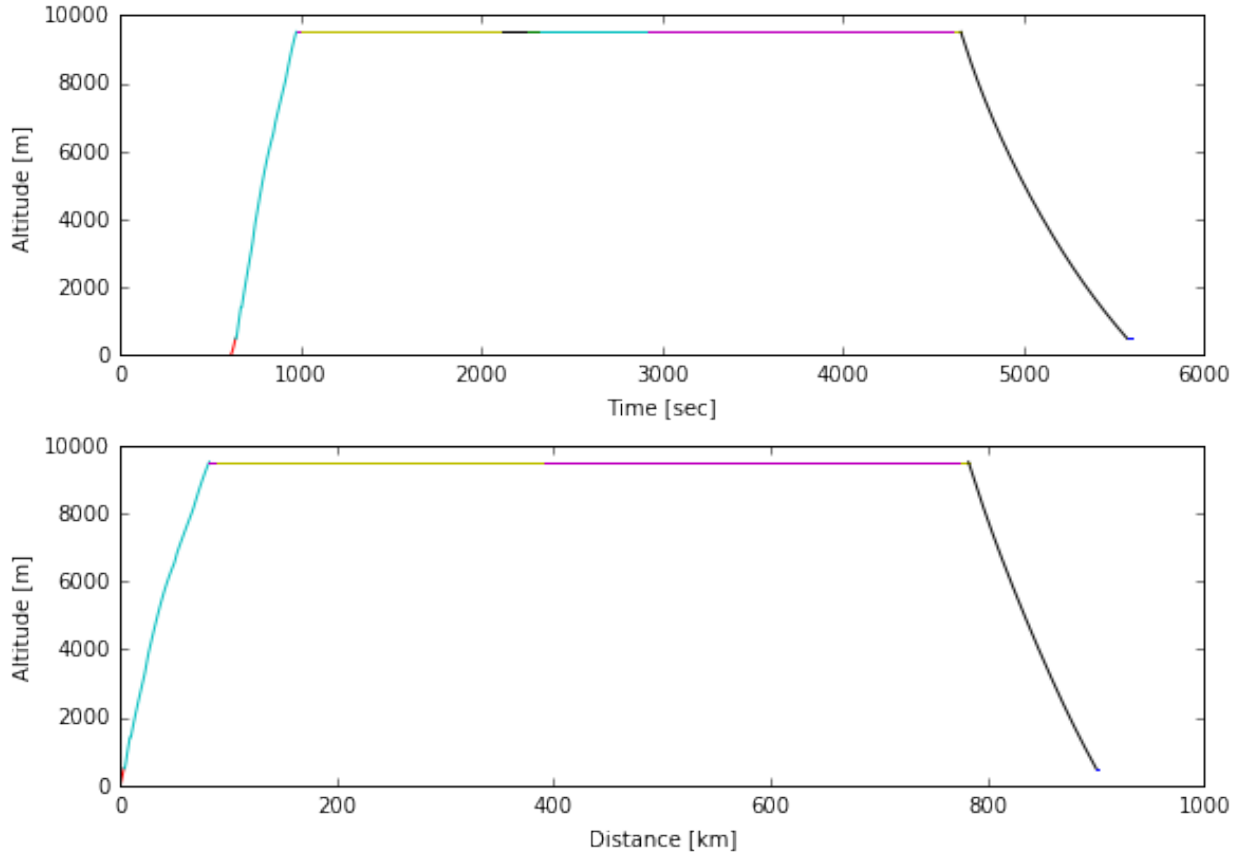
```
<matplotlib.text.Text at 0x8454ef0>
```



Looping through the segments can also be useful to plot the mission profile:

```
idx1 = res.getVariableIndex('Time')
idx2 = res.getVariableIndex('Distance')
idx3 = res.getVariableIndex('Altitude')
```

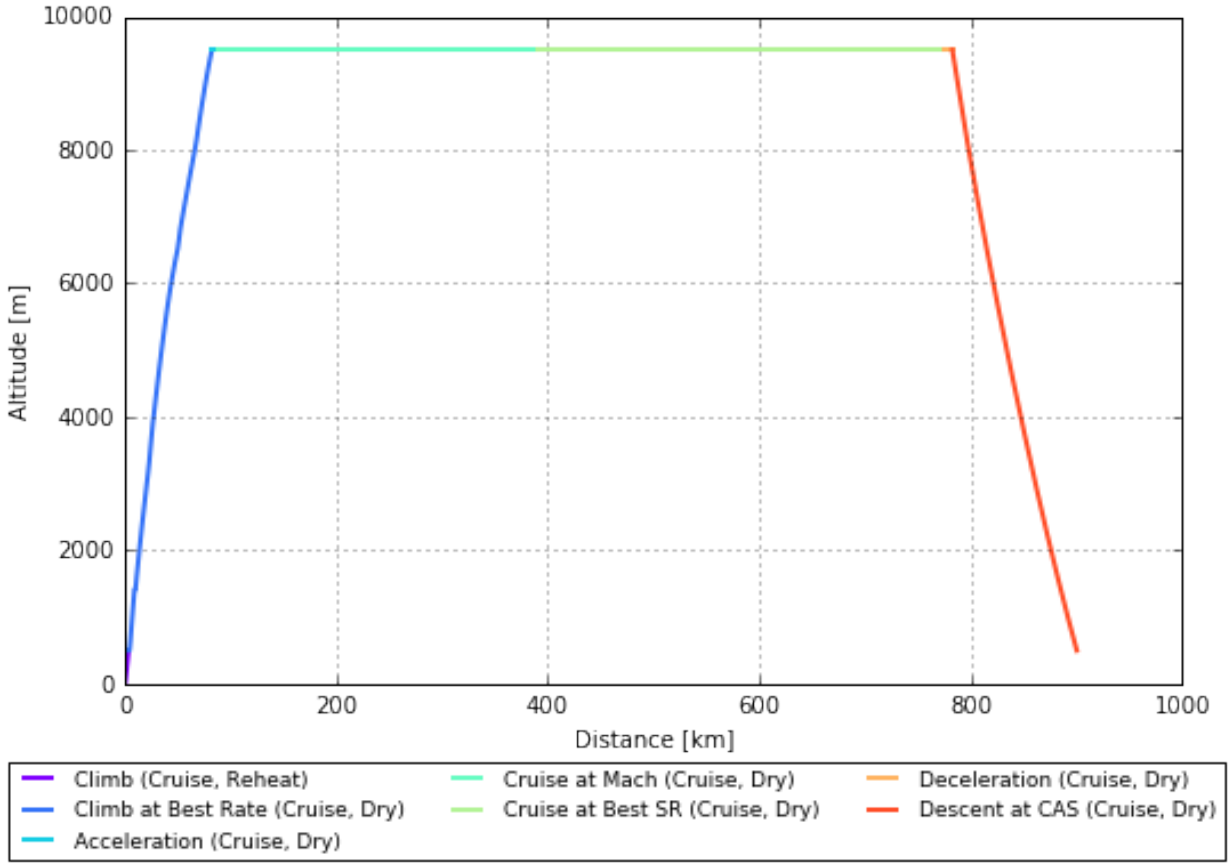
```
fig = plt.figure(figsize=(8.3, 5.8)) #A5 landscape figure, size is in inches

ax = plt.subplot(2,1,1)
for seg in res.getSegmentList():
    ax.plot(seg.getData()[:,idx1],seg.getData()[:,idx3])

ax.set_xlabel(res.getVariableName(idx1))
ax.set_ylabel(res.getVariableName(idx3))

ax = plt.subplot(2,1,2)
for seg in res.getSegmentList():
    ax.plot(seg.getData()[:,idx2],seg.getData()[:,idx3])

ax.set_xlabel(res.getVariableName(idx2))
ax.set_ylabel(res.getVariableName(idx3))

plt.tight_layout()
```



Matplotlib offers a lot of formatting options for legends: http://matplotlib.org/api/legend_api.html#matplotlib.legend.Legend

```
idx1 = res.getVariableIndex('Distance')
idx2 = res.getVariableIndex('Altitude')
idx_segDst = res.getVariableIndex('Seg. Dist')
```

```
fig = plt.figure(figsize=(8.3, 5.8)) #A5 landscape figure, size is in inches
ax = plt.subplot(1,1,1)

colormap = plt.cm.rainbow
ax.set_prop_cycle('color',[colormap(i) for i in np.linspace(0, 0.9, 7)])

for i,seg in enumerate(res.getSegmentList()):
    if seg.getData()[-1,idx_segDst]>2.0:
        ax.plot(seg.getData()[:,idx1], seg.getData()[:,idx2], label=seg.getName(),lw=2.0)

ax.set_xlabel(res.getVariableName(idx1))
ax.set_ylabel(res.getVariableName(idx2))
plt.subplots_adjust(bottom=0.2)
ax.legend(bbox_to_anchor=(1.05,-0.1), ncol=3, fontsize = 9, handlelength = 2.0)
ax.grid()
```



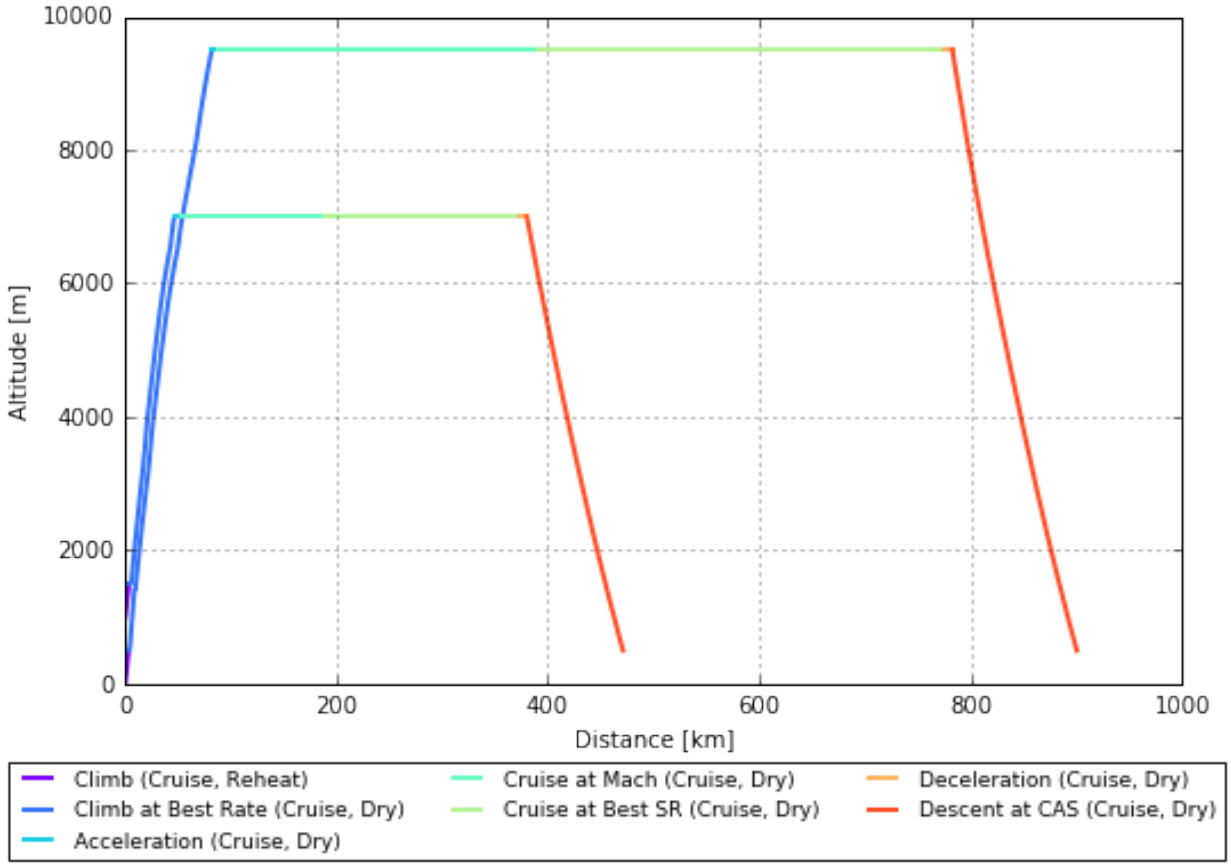

```
misCmp_mod = Mission.MissionComputation(APP6Directory = APP6DIR)
misCmp_mod.run(missionpath_mod)
```

```
True
```

```
res_mod = misCmp_mod.result
idx_segDst = res.getVariableIndex('Seg. Dist')
```

```
fig = plt.figure(figsize=(8.3, 5.8)) #A5 landscape figure, size is in inches
ax = plt.subplot(1,1,1)
```

```
colormap = plt.cm.rainbow
ax.set_prop_cycle('color',[colormap(i) for i in np.linspace(0, 0.9, 7)])

for i,seg in enumerate(res.getSegmentList()):
    if seg.getData()[-1,idx_segDst]>2.0:
        ax.plot(seg.getData()[:,idx1], seg.getData()[:,idx2], label=seg.getName(),lw=2.0)

for i,seg in enumerate(res_mod.getSegmentList()):
    if seg.getData()[-1,idx_segDst]>2.0:
        ax.plot(seg.getData()[:,idx1], seg.getData()[:,idx2],lw=2.0)

ax.set_xlabel(res.getVariableName(idx1))
ax.set_ylabel(res.getVariableName(idx2))
plt.subplots_adjust(bottom=0.2)
ax.legend(bbox_to_anchor=(1.05,-0.1), ncol=3, fontsize = 9, handlelength = 2.0)
ax.grid()
```



The result of a mission computation can also be loaded from the result text-file after the computation:

```
resfile = r'data\\LWF Air Combat Mission RoA.mis_output.txt'
res = Mission.MissionResult.fromFile(resfile)
```

Complex Mission Loop

```
cap_path = r'data\\LWF CAP Loop.mis'
cap_path_mod = r'data\\LWF CAP Loop_mod.mis'
```

```
mis = Files.MissionComputationFile.fromFile(cap_path)
[(i, seg.getName()) for i, seg in enumerate(mis.getSegmentList())]
```

```
[(0, 'SEG_GROUNDOP'),
 (1, 'SEG_TAKEOFF'),
 (2, 'SEG_CLIMB'),
 (3, 'SEG_BESTCLIMBRATE'),
 (4, 'SEG_ACCELERATION'),
 (5, 'SEG_TARGETMACHCRUISE'),
 (6, 'SEG_LOITER'),
 (7, 'SEG_STOREDROP'),
 (8, 'SEG_STOREDROP'),
 (9, 'SEG_MANEUVRE'),
 (10, 'SEG_SPECIFICRANGE'),
 (11, 'SEG_NOCREDIT')]
```

```
idx_loiter = 6
idx_combat = 9
```

```
range_combat = np.linspace(0, 10, 6) # minutes
```

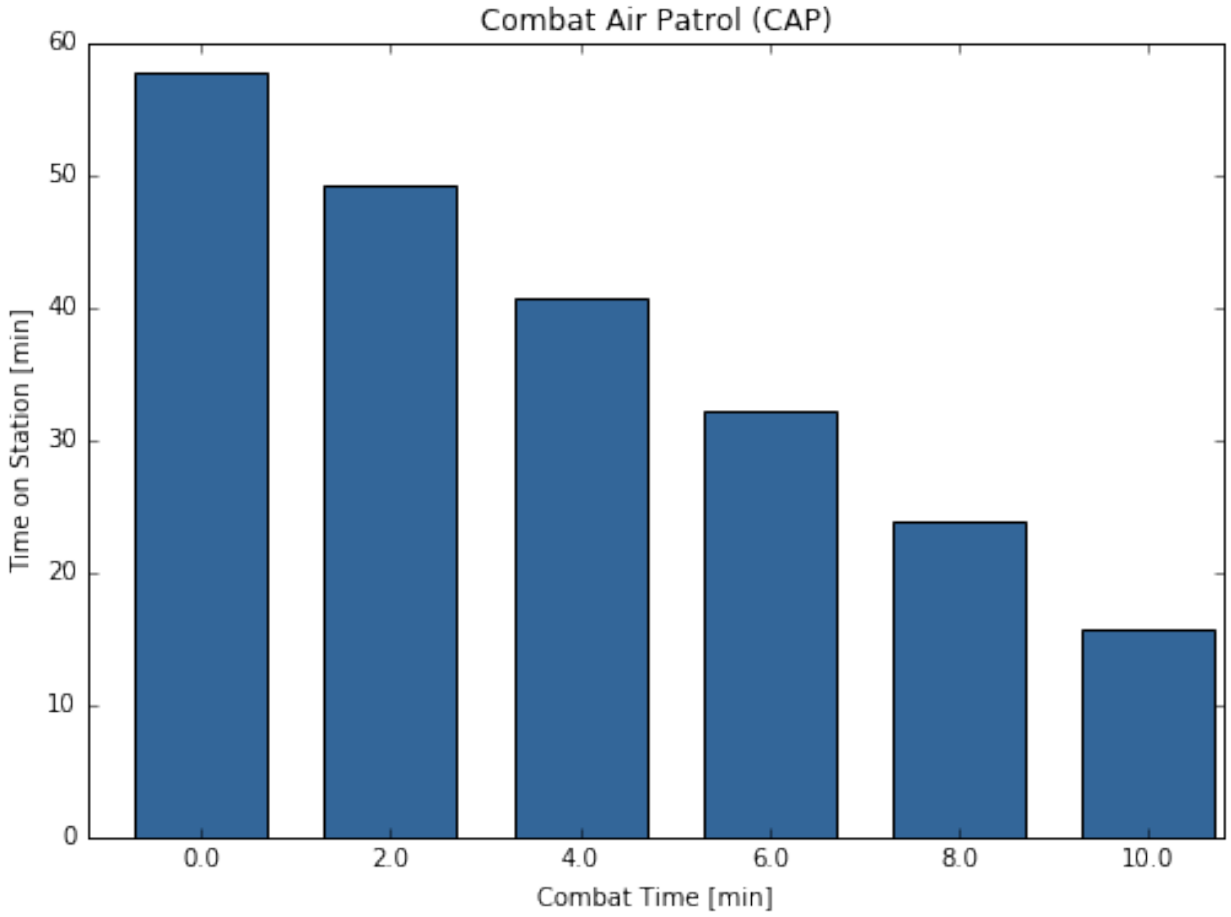
Read a CAP mission from an existing file, adjust the end-value of the combat segment and save the mission to another file. Afterwards, run the mission, extract the result and store it to a list (i.e. *loiter_time*).

```
loiter_time = []
for i in range_combat:
    misFile = Files.MissionComputationFile.fromFile(cap_path)
    combat = misFile.getSegment(idx_combat)
    combat.endValue1.xx = i*60.0 # convert minutes to seconds
    misFile.saveToFile(cap_path_mod, overwrite=True)

    mis = Mission.MissionComputation(APP6DIR)
    mis.run(cap_path_mod)

    res = mis.getResult()

    idx_segTime = res.getVariableIndex('Seg. Time')
    loiter_time.append(res.getSegment(idx_loiter).getData()[-1,idx_segTime])
```

Plot the results as a bar-chart.

```
fig = plt.figure(figsize=(8.3, 5.8)) #A5 landscape figure, size is in inches
ax = plt.subplot(1,1,1)
width = 1.4
ax.bar(left=range_combat-2.0*width,
       height=loiter_time, width=width,
       tick_label=[str(c) for c in range_combat],
       align='center',
       color='#336699')
ax.set_title('Combat Air Patrol (CAP)')
ax.set_xlabel('Combat Time [min]')
ax.set_ylabel('Time on Station [min]')
```

```
<matplotlib.text.Text at 0x93027f0>
```



Note: input data is always in SI units (e.g. the combat time segment *endValue* is in seconds), but the output values are formatted (e.g. loiter time is in minutes)

1.7.4 Performance Charts

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Import the Performance module from pyAPP6

```
from pyAPP6 import Performance
```

```
perf = Performance.PerformanceChart(APP6Directory=APP6DIR)
perf.run(chartpath)
```

```
True
```

The result is loaded into a *PerformanceChartResult* instance:

```
res = perf.result
```

A *PerformanceChartResult* contains a list of *ResultLine* objects. The *ResultLine* contains the data as a 2d numpy array, with the first dimension being the datapoints and the second dimension the variable index:

```
line = res.getLine(0)
data = line.getData()
print data.shape
print data
```

```
(16L, 74L)
[[  3.01753000e+04   0.00000000e+00   0.00000000e+00 ...,   6.80588000e+01
    6.49318000e+01   0.00000000e+00]
 [  5.57759000e+04   0.00000000e+00   0.00000000e+00 ...,   8.50735000e+01
    7.92340000e+01   0.00000000e+00]
 [  7.24756000e+04   0.00000000e+00   0.00000000e+00 ...,   1.02088000e+02
    9.46049000e+01   0.00000000e+00]
 ...,
 [  5.32038000e+04   0.00000000e+00   0.00000000e+00 ...,   2.89250000e+02
    2.88040000e+02   0.00000000e+00]
 [  4.42996000e+04   0.00000000e+00   0.00000000e+00 ...,   3.06265000e+02
    3.06247000e+02   0.00000000e+00]
 [  2.83537000e+04   0.00000000e+00   0.00000000e+00 ...,   3.23279000e+02
    3.15662000e+02   0.00000000e+00]]
```

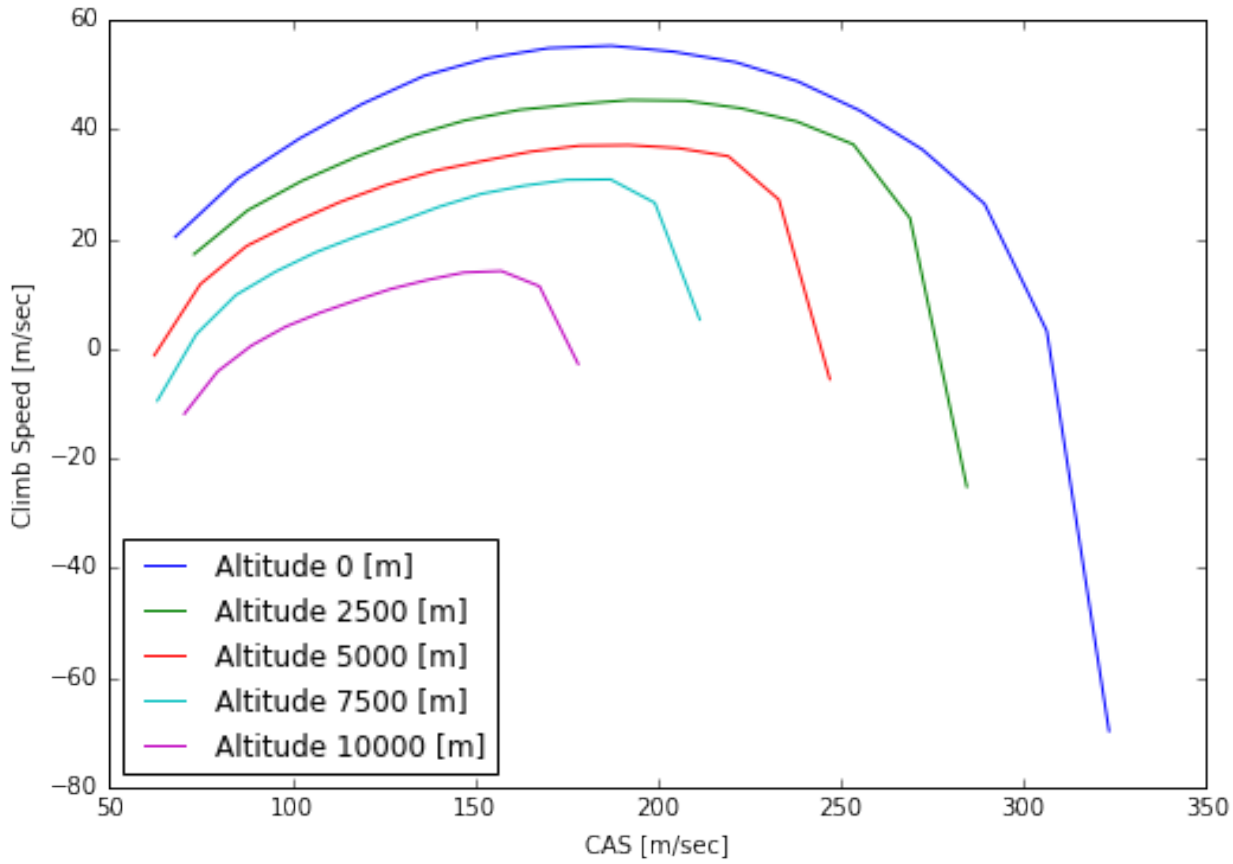
To find the index of the desired variable, use the *getVariableIndex* function:

```
idx1 = res.getVariableIndex('CAS')
idx2 = res.getVariableIndex('Climb Speed')
```

The lines can then be plotted using Matploltib:

```
fig = plt.figure(figsize=(8.3, 5.8)) #A5 landscape figure, size is in inches
ax = plt.subplot(1,1,1)

#Plot the lines
for line in res.getLineList():
    ax.plot(line.getData()[:,idx1],line.getData()[:,idx2], label=line.getLabel())

ax.legend(loc=3)
ax.set_xlabel(res.getVariableName(idx1))
ax.set_ylabel(res.getVariableName(idx2))
```

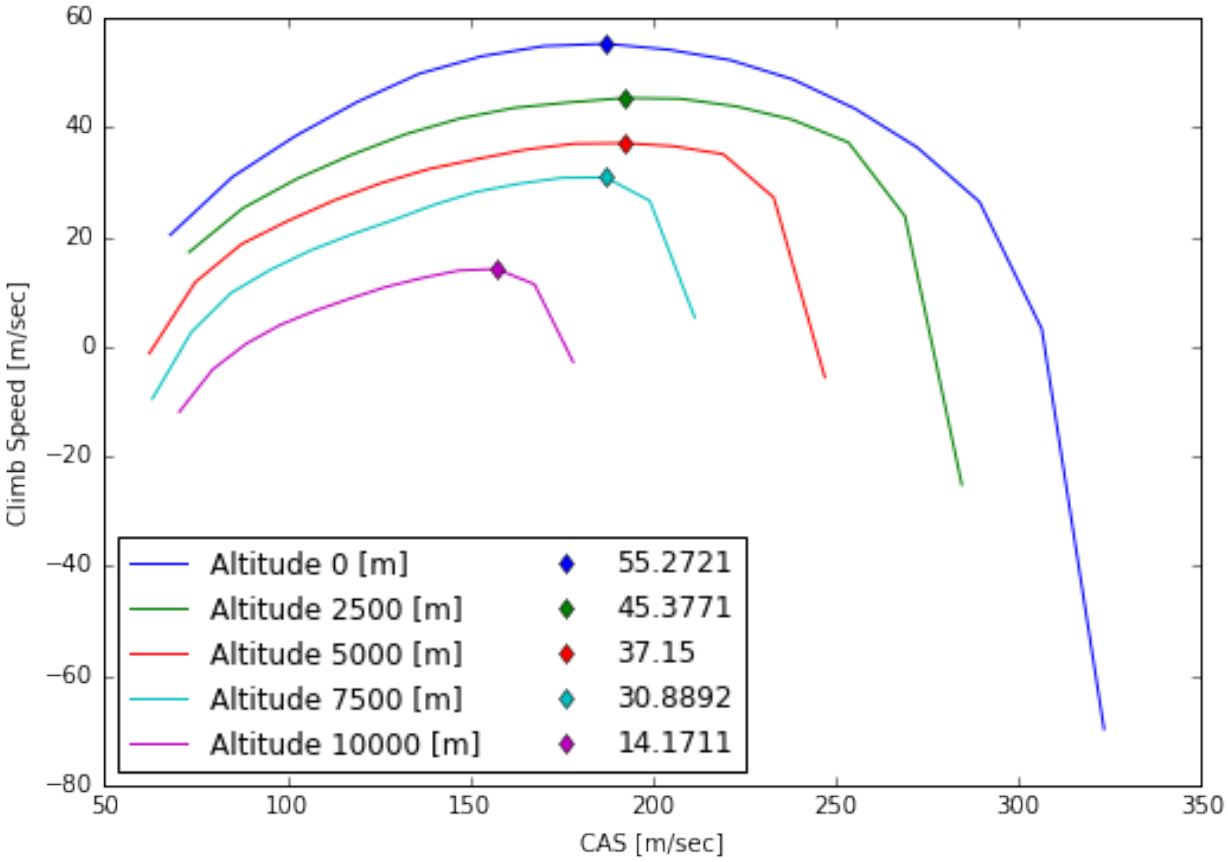
```
<matplotlib.text.Text at 0x8f8f2b0>
```



Since each data line is a numpy array, data can easily be processed using the powerful functions of numpy. This example extracts the maxima of each line and plots them. **Note:** the line contains NaNs, therefore the function *np.nanargmax* is used to extract the maxima.

```
fig = plt.figure(figsize=(8.3, 5.8)) #A5 landscape figure, size is in inches
ax = plt.subplot(1,1,1)

#Plot the lines
for line in res.getLineList():
    ax.plot(line.getData()[:,idx1], line.getData()[:,idx2], label=line.getLabel())

ax.set_prop_cycle(None) #Resets the color cycle

#Plot the maxima
for line in res.getLineList():
    xdata = line.getData()[:,idx1]
    ydata = line.getData()[:,idx2]
    idx_max = np.nanargmax(ydata) #find the location of the maximum
    ax.plot(xdata[idx_max], ydata[idx_max], 'd', label=str(ydata[idx_max]))

ax.legend(loc=3, numpoints=1, ncol=2)
ax.set_xlabel(res.getVariableName(idx1))
ax.set_ylabel(res.getVariableName(idx2))
```

```
<matplotlib.text.Text at 0x92ec9e8>
```



1.8 Version History

1.8.1 1.1 (2017-04-26)

- Added a clear function to X2Table and X3Table
- Minor changes
- Database updated for APP 6.0.2.0

1.8.2 1.0 (2016-05-27)

- Initial release, corresponds to APP 6.0.1.8

CHAPTER

TWO

INDICES AND TABLES

- genindex
- modindex
- search