# pyCAPS: A Python Extension Module for the Computational Aircraft Prototype Syntheses (CAPS)

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# 0.1 Introduction

## 0.1.1 Overview

pyCAPS is a Python extension module to interact with Computational Aircraft Prototype Syntheses (CAPS) routines in the Python environment. Written in Cython, pyCAPS natively handles all type conversions/casting, while logically grouping CAPS function calls together to simplify a user's experience. Additional functionality not directly available through the CAPS API (such has saving a geometric view) is also provided.

An overview of the basic pyCAPS functionality is provided in gettingStarted.

## 0.1.2 Key differences between pyCAPS and CAPS

- Manipulating the "owner" information for CAPS objects isn't currently supported

## 0.1.3 Clearance Statement

# 0.2 Namespace Index

## 0.2.1 Package List

Here are the packages with brief descriptions (if available):



# 0.3 Hierarchical Index

## 0.3.1 Class Hierarchy

This inheritance list is sorted roughly, but not completely, alphabetically:

## 0.4 Class Index

### 0.4.1 Class List

Here are the classes, structs, unions and interfaces with brief descriptions:



## 0.5 Namespace Documentation

### 0.5.1 pyCAPS Namespace Reference

Python extension module for CAPS.

#### 0.5.1.1 Detailed Description

Python extension module for CAPS.

## 0.6 Class Documentation

### 0.6.1 Analysis Class Reference

Defines a CAPS Analysis Object.

Inherits object.

Inherited by capsAnalysis.

#### Public Member Functions

- **preAnalysis** (self)

  *Run the pre-analysis function for the AIM.*
- **runAnalysis** (self)

  *Run the pre/exec/post functions for the AIM (if AIM execution is available).*
- system (self, cmd, rpath=None)

  *Execute the Command Line String Notes:*
- **postAnalysis** (self)

  *Run post-analysis function for the AIM.*
- **analysisDir** (self)

  *Property returns the path to the analysis directory.*
- **name** (self)

  *Property returns the name of the CAPS Analysis Object.*
- **history** (self)

  *Returns the history list of the CAPS Analysis Object.*
- **markForDelete** (self)

  *Mark a CAPS Analysis Object for deletion on the next Phase.*
- dirty (self)

  *Returns linked analyses that are dirty.*
- info (self, printInfo=False, ∗∗kwargs)

  *Gets analysis information for the analysis object.*
- createTree (self, filename="name", ∗∗kwargs)

  *Create a HTML dendrogram/tree of the current state of the analysis.*
- createOpenMDAOComponent (self, inputVariable, outputVariable, ∗∗kwargs)

  *Create an OpenMDAO Component[1.7.3]/ExplicitComponent[2.8+] object; an external code component (External↩ Code[1.7.2]/ExternalCodeComp[2.8+]) is created if the executeCommand keyword arguement is provided.*

#### 0.6.1.1 Detailed Description

Defines a CAPS Analysis Object.

Created via Problem.analysis.create().

**Parameters**

| | |
|---|---|
| *Analysis.geometry* | AnalysisGeometry instances representing the bodies associated with the analysis |
| *Analysis.input* | ValueInSequence of ValueIn inputs |
| *Analysis.output* | ValueOutSequence of ValueOut outputs |
| *Analysis.attr* | AttrSequence of ValueIn attributes |

#### 0.6.1.2 Member Function Documentation

**createOpenMDAOComponent()**

```
createOpenMDAOComponent (
              self,
              inputVariable,
              outputVariable,
             ** kwargs )
```

Create an OpenMDAO Component[1.7.3]/ExplicitComponent[2.8+] object; an external code component (External↩Code[1.7.2]/ExternalCodeComp[2.8+]) is created if the executeCommand keyword arguement is provided.

This functionality should work with either verison 1.7.3 or >=2.8 of OpenMDAO.

**Parameters**

| | |
|---|---|
| *inputVariable* | Input variable(s)/parameter(s) to add to the OpenMDAO component. Variables may be either analysis input variables or geometry design parameters. Note, that the setting of analysis inputs supersedes the setting of geometry design parameters; issues may arise if analysis input and geometry design variables have the same name. If the analysis parameter wanting to be added to the OpenMDAO component is part of a capsTuple the following notation should be used: "AnalysisInput:TupleKey:DictionaryKey", for example "AVL_Control:ControlSurfaceA:deflectionAngle" would correspond to the AVL_Control input variable, the ControlSurfaceA element of the input values (that is the name of the control surface being created) and finally deflectionAngle corresponds to the name of the dictionary entry that is to be used as the component parameter. If the tuple's value isn't a dictionary just "AnalysisInput:TupleKey" is needed. |
| *outputVariable* | Output variable(s)/parameter(s) to add to the OpenMDAO component. Only scalar output variables are currently supported |
| ∗∗*kwargs* | See below. |

Valid keywords:

**Parameters**

| | |
|---|---|
| *changeDir* | Automatically switch into the analysis directory set for the AIM when executing an external code (default - True). |

**Parameters**

| | |
|---|---|
| *saveIteration* | If the generated OpenMDAO component is going to be called multiple times, the inputs and outputs from the analysis and the AIM will be automatically bookkept ( = True) by moving the files to a folder within the AIM's analysis directory ( analysisDir ) named "Iteration_#" were # represents the iteration number (default - False). By default ( = False) input and output files will be continously overwritten. Notes:<br>• If the AIM has 'parents' their genertated files will not be bookkept.<br>• If previous iteration folders already exist, the iteration folders and any other files in the directory will be moved to a folder named "Instance_#".<br>• This bookkeeping method will likely fail if the iterations are run concurrently! |
| *executeCommand* | Command to be executed when running an external code. Command must be a list of command line arguements (see OpenMDAO documentation). If provided an ExternalCode[1.7.2]/ExternalCodeComp[2.8+] object is created; if not provided or set to None a Component[1.7.3]/ExplicitComponent[2.8+] object is created (default - None). |
| *inputFile* | Optional list of input file names for OpenMDAO to check the existence of before OpenMDAO excutes the "solve_nonlinear"[1.7.3]/"compute"[2.8+] (default - None). This is redundant as the AIM automatically does this already. |
| *outputFile* | Optional list of output names for OpenMDAO to check the existence of before OpenMDAO excutes the "solve_nonlinear"[1.7.3]/"compute"[2.8+] (default - None). This is redundant as the AIM automatically does this already. |
| *stdin* | Set I/O connection for the standard input of an ExternalCode[1.7.2]/ExternalCodeComp[2.8+] component. The use of this depends on the expected AIM execution. |
| *stdout* | Set I/O connection for the standard ouput of an ExternalCode[1.7.2]/ExternalCodeComp[2.8+] component. The use of this depends on the expected AIM execution. |
| *setSensitivity* | Optional dictionary containing sensitivity/derivative settings/parameters. Currently only Finite difference is is supported!. See OpenMDAO documentation for addtional details of "deriv_options"(version 1.7) or "declare_partials"(version 2.8). Common values for a finite difference calculation would be setSensitivity['type'] = "fd" (Note in the version 2.8 documentation this varibale has been changed to "method" both variations will work when using version 2.8+), setSensitivity['form'] = "forward" or "backward" or "central", and setSensitivity['step_size'] = 1.0E-6 (Note in the version 2.8 documentation this varibale has been changed to "step" both variations will work when using version 2.8+). |

**Returns**

Returns the reference to the OpenMDAO component object created.

### createTree()

```
createTree (
              self,
              filename = "name",
             ** kwargs )
```

Create a HTML dendrogram/tree of the current state of the analysis.

The HTML file relies on the open-source JavaScript library, D3, to visualize the data. This library is freely available from https://d3js.org/ and is dynamically loaded within the HTML file. If running on a machine without internet access a (miniaturized) copy of the library may be written to a file alongside the generated HTML file by setting the internetAccess keyword to False. If set to True, internet access will be necessary to view the tree.

**Parameters**

| | |
|---|---|
| *filename* | Filename to use when saving the tree (default - "aimName"). Note an ".html" is automatically appended to the name (same with ".json" if embedJSON = False). |
| ∗∗*kwargs* | See below. |

Valid keywords:

**Parameters**

| | |
|---|---|
| *embedJSON* | Embed the JSON tree data in the HTML file itself (default - True). If set to False a seperate file is generated for the JSON tree data. |
| *internetAccess* | Is internet access available (default - True)? If set to True internet access will be necessary to view the tree. |
| *analysisGeom* | Show the geometry currently load into the analysis in the tree (default - False). |
| *internalGeomAttr* | Show the internal attributes (denoted by starting with an underscore, for example "_AttrName") that exist on the geometry (default - False). Note: "analysisGeom" must also be set to True. |
| *reverseMap* | Reverse the attribute map (default - False). See attrMap for details. |

### dirty()

```
dirty (
              self )
```

Returns linked analyses that are dirty.

**Returns**

A list of dirty analyses that need to be exeuted before executing this analysis. An empty list is returned if no linked analyses are dirty.

### info()

```
info (
              self,
              printInfo = False,
             ** kwargs )
```

Gets analysis information for the analysis object.

**Parameters**

| | |
|---|---|
| *printInfo* | Print information to sceen (default - False). |
| ∗∗*kwargs* | See below. |

**Returns**

Cleanliness state of analysis object or a dictionary containing analysis information (infoDict must be set to True). For cleanliness state: 0 = "Up to date", 1 = "Dirty analysis inputs", 2 = "Dirty geometry inputs", 3 = "Both analysis and geometry inputs are dirty", 4 = "New geometry", 5 = "Post analysis required", 6 = "Execution and Post analysis required"

Valid keywords:

**Parameters**

| | |
|---|---|
| *infoDict* | Return a dictionary containing analysis information instead of just the cleanliness state (default - False). |

### system()

```
system (
              self,
              cmd,
              rpath = None )
```

Execute the Command Line String Notes:

1. only needed when explicitly executing the appropriate analysis solver (i.e., not using the AIM)
2. should be invoked after caps_preAnalysis and before caps_postAnalysis
3. this must be used instead of the OS system call to ensure that journaling properly functions

**Parameters**

| | |
|---|---|
| *cmd* | the command line string to execute |
| *rpath* | the relative path from the Analysis' directory or None (in the Analysis path) |

The documentation for this class was generated from the following file:

- pyCAPS/problem.py

## 0.6.2 AnalysisGeometry Class Reference

Defines Analysis Geometry Object.

Inherits object.

### Public Member Functions

- bodies (self)

  *Get dict of geometric bodies.*
- save (self, filename, directory=os.getcwd(), extension=".egads", writeTess=True)

*Save the current geometry used by the AIM to a file.*

- view (self, ∗∗kwargs)

  *View the geometry associated with the analysis.*

- attrList (self, attributeName, ∗∗kwargs)

  *Retrieve a list of geometric attribute values of a given name ("attributeName") for the bodies loaded into the analysis.*

- attrMap (self, getInternal=False, ∗∗kwargs)

  *Create geometric attribution map (embeded dictionaries) for the bodies loaded into the analysis.*

#### 0.6.2.1 Detailed Description

Defines Analysis Geometry Object.

**Parameters**

| | |
|---|---|
| *AnalysisGeometry.despmtr* | ValueInSequence of ValueIn CSM design parameters |
| *AnalysisGeometry.cfgpmtr* | ValueInSequence of ValueIn CSM configuration parameters |
| *AnalysisGeometry.conpmtr* | ValueInSequence of ValueIn CSM constant parameters |
| *AnalysisGeometry.outpmtr* | ValueOutSequence of ValueOut CSM outputs |

#### 0.6.2.2 Member Function Documentation

**attrList()**

```
attrList (
              self,
              attributeName,
             ** kwargs )
```

Retrieve a list of geometric attribute values of a given name ("attributeName") for the bodies loaded into the analysis.

Level in which to search the bodies is determined by the attrLevel keyword argument. See analysis3.py for a representative use case.

**Parameters**

| | |
|---|---|
| *attributeName* | Name of attribute to retrieve values for. |
| ∗∗*kwargs* | See below. |

**Returns**

A list of attribute values.

Valid keywords:

**Parameters**

| | |
|---|---|
| *bodyIndex* | Specific body in which to retrieve attribute information from. |

**Parameters**

| | |
|---|---|
| *attrLevel* | Level to which to search the body(ies). Options:<br>0 (or "Body") - search just body attributes<br>1 (or "Face") - search the body and all the faces [default]<br>2 (or "Edge") - search the body, faces, and all the edges<br>3 (or "Node") - search the body, faces, edges, and all the nodes |

### attrMap()

```
attrMap (
              self,
              getInternal = False,
             ** kwargs )
```

Create geometric attribution map (embeded dictionaries) for the bodies loaded into the analysis.

Dictionary layout:

- Body 1
  - Body : Body level attributes
  - Faces
    - 1 : Attributes on the first face of the body
    - 2 : Attributes on the second face of the body
    - " : ... - Edges - 1 : Attributes on the first edge of the body - 2 : Attributes on the second edge of the body - " : ...
  - Nodes :
    - 1 : Attributes on the first node of the body
    - 2 : Attributes on the second node of the body
    - " : ... - Body 2 - Body : Body level attributes - Faces - 1 : Attributes on the first face of the body - " : ...
  - ...
- ...

Dictionary layout (reverseMap = True):

- Body 1
  - Attribute : Attribute name
    - Value : Value of attribute
      - Body : True if value exist at body level, None if not
      - Faces : Face numbers at which the attribute exist
      - Edges : Edge numbers at which the attribute exist
      - Nodes : Node numbers at which the attribute exist
    - Value : Next value of attribute with the same name
      - Body : True if value exist at body level, None if not
      - " : ... - ... - Atribute : Attribute name - Value : Value of attribute - " : ...
    - ...
- Body 2
  - Attribute : Attribute name
    - Value : Value of attribute
      - Body : True if value exist at body level, None if not
      - " : ... - ... - ... - ... @param getInternal Get internal attributes (denoted by starting with an underscore, for example "_AttrName") that exist on the geometry (default - False).

**Parameters**

| | |
|---|---|
| ∗∗*kwargs* | See below. |

Valid keywords:

**Parameters**

| | |
|---|---|
| *reverseMap* | Reverse the attribute map (default - False). See above table for details. |

**Returns**

Dictionary containing attribution map

### bodies()

```
bodies (
              self )
```

Get dict of geometric bodies.

**Returns**

Returns a dictionary of the bodies in the Analysis Object, as well a the capsLength unit. Keys use the body "_name" attribute or "Body_#".

### save()

```
save (
              self,
              filename,
              directory = os.getcwd(),
              extension = ".egads",
              writeTess = True )
```

Save the current geometry used by the AIM to a file.

**Parameters**

| | |
|---|---|
| *filename* | File name to use when saving geometry file. |
| *directory* | Directory where to save file. Default current working directory. |
| *extension* | Extension type for file if filename does not contain an extension. |
| *writeTess* | Write tessellations to the EGADS file (only applies to .egads extension) |

### view()

```
view (
              self,
             ** kwargs )
```

View the geometry associated with the analysis.

If the analysis produces a surface tessellation, then that is shown. Otherwise the bodies are shown with default tessellation parameters. Note that the geometry must be built and will not autoamtically be built by this function.

**Parameters**

| | |
|---|---|
| ∗∗*kwargs* | See below. |

Valid keywords:

**Parameters**

| | |
|---|---|
| *portNumber* | Port number to start the server listening on (default - 7681). |

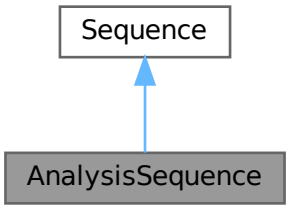
The documentation for this class was generated from the following file:

- pyCAPS/problem.py

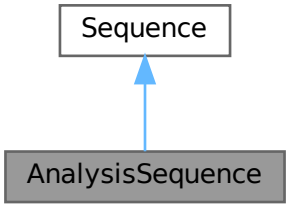
### 0.6.3 AnalysisSequence Class Reference

Defines a Sequence of CAPS Analysis Objects.

Inheritance diagram for AnalysisSequence:




Collaboration diagram for AnalysisSequence:



### Public Member Functions

- create (self, aim, name=None, capsIntent=None, unitSystem=None, autoExec=True)

  *Create a CAPS Analysis Object.*
- copy (self, src, name=None)

  *Create a copy of an CAPS Analysis Object.*
- dirty (self)

  *Returns analyses that are dirty.*

### Public Member Functions inherited from Sequence

- **keys** (self)

  *Returns the keys of the Sequence.*
- **values** (self)

  *Returns the values of the Sequence.*
- **items** (self)

  *Returns the items of the Sequence.*

#### 0.6.3.1 Detailed Description

Defines a Sequence of CAPS Analysis Objects.

#### 0.6.3.2 Member Function Documentation

**copy()**

```
copy (
              self,
              src,
              name = None )
```

Create a copy of an CAPS Analysis Object.

**Parameters**

| | |
|---|---|
| *src* | Name of the source Analysis Object or an Analysis Object |
| *name* | Name of the new Analysis Object copy |

**create()**

```
create (
              self,
              aim,
              name = None,
              capsIntent = None,
              unitSystem = None,
              autoExec = True )
```

Create a CAPS Analysis Object.

**Parameters**

| | |
|---|---|
| *aim* | Name of the AIM module |
| *name* | Name (e.g. key) of the Analysis Object. Must be unique if specified. If None, the defalt is aim+str(instanceCount) where instanceCount is the count of the existing 'aim' instances. |
| *capsIntent* | Analysis intention in which to invoke the AIM. |
| *unitSystem* | See AIM documentation for usage. |
| *autoExec* | If false dissable any automatic execution of the AIM. |

**Returns**

The new Analysis Object is added to the sequence and returned

**dirty()**

```
dirty (
              self )
```

Returns analyses that are dirty.

**Returns**

A list of dirty analyses. An empty list is returned if no analyses are dirty.

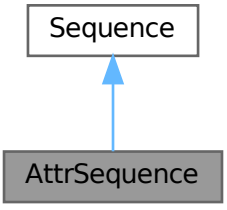
The documentation for this class was generated from the following file:

- pyCAPS/problem.py

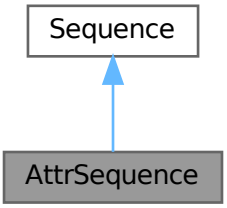
### 0.6.4 AttrSequence Class Reference

Defines a Sequence of CAPS Attribute Value Objects.

Inheritance diagram for AttrSequence:



Collaboration diagram for AttrSequence:




### Public Member Functions

- create (self, name, data, overwrite=False)

  *Create an attribute (that is meta-data) to the CAPS Object.*

### Public Member Functions inherited from Sequence

- **keys** (self)

  *Returns the keys of the Sequence.*
- **values** (self)

  *Returns the values of the Sequence.*
- **items** (self)

  *Returns the items of the Sequence.*

#### 0.6.4.1 Detailed Description

Defines a Sequence of CAPS Attribute Value Objects.

#### 0.6.4.2 Member Function Documentation

**create()**

```
create (
              self,
              name,
              data,
              overwrite = False )
```

Create an attribute (that is meta-data) to the CAPS Object.

See example

**Parameters**

| | |
|---|---|
| *name* | Name used to define the attribute. |
| *data* | Initial data value(s) for the attribute. Note that type casting in done automatically based on the determined type of the Python object. |
| *overwrite* | Flag to overwrite any existing attribute with the same 'name' |

**Returns**

The new Value Object is added to the sequence and returned

The documentation for this class was generated from the following file:

- pyCAPS/problem.py

### 0.6.5 Bound Class Reference

Defines a CAPS Bound Object.

Inherits object.

Inherited by capsBound.

#### Public Member Functions

- **name** (self)
  *Property returns the name of the CAPS Bound Object.*
- **history** (self)
  *Returns the history list of the CAPS Analysis Object.*
- **close** (self)
  *Closes the bound indicating it's complete.*
- **markForDelete** (self)
  *Mark a CAPS Bound Object for deletion on the next Phase.*
- info (self, printInfo=False, ∗∗kwargs)
  *Gets information for the bound object.*
- createTree (self, filename="boundName", ∗∗kwargs)
  *Create a HTML dendrogram/tree of the current state of the bound.*

#### 0.6.5.1 Detailed Description

Defines a CAPS Bound Object.

Created via Problem.bound.create().

**Parameters**

| | |
|---|---|
| *Bound.vertexSet* | VertexSetSequence of VertexSet instances |
| *Bound.attr* | AttrSequence of ValueIn attributes |

#### 0.6.5.2 Member Function Documentation

### createTree()

```
createTree (
              self,
              filename = "boundName",
             ** kwargs )
```

Create a HTML dendrogram/tree of the current state of the bound.

The HTML file relies on the open-source JavaScript library, D3, to visualize the data. This library is freely available from https://d3js.org/ and is dynamically loaded within the HTML file. If running on a machine without internet access a (miniaturized) copy of the library may be written to a file alongside the generated HTML file by setting the internetAccess keyword to False. If set to True, internet access will be necessary to view the tree.

**Parameters**

| | |
|---|---|
| *filename* | Filename to use when saving the tree (default - "boundName"). Note an ".html" is automatically appended to the name (same with ".json" if embedJSON = False). |
| ∗∗*kwargs* | See below. |

Valid keywords:

**Parameters**

| | |
|---|---|
| *embedJSON* | Embed the JSON tree data in the HTML file itself (default - True). If set to False a seperate file is generated for the JSON tree data. |
| *internetAccess* | Is internet access available (default True)? If set to True internet access will be necessary to view the tree. |

### info()

```
info (
              self,
              printInfo = False,
             ** kwargs )
```

Gets information for the bound object.

**Parameters**

| | |
|---|---|
| *printInfo* | Print information to sceen if True. |
| ∗∗*kwargs* | See below. |

**Returns**

State of bound object.

Valid keywords:

**Parameters**

| | |
|---|---|
| *infoDict* | Return a dictionary containing bound information instead of just the state (default - False) |

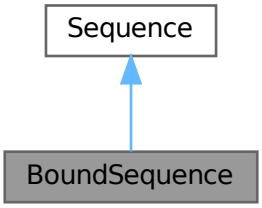
The documentation for this class was generated from the following file:

- pyCAPS/problem.py

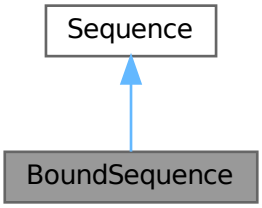
### 0.6.6 BoundSequence Class Reference

Defines a Sequence of CAPS Bound Objects.

Inheritance diagram for BoundSequence:




Collaboration diagram for BoundSequence:




**Public Member Functions**

- create (self, capsBound, dim=2)

  *Create a CAPS Bound Object.*

**Public Member Functions inherited from Sequence**

- **keys** (self)

  *Returns the keys of the Sequence.*
- **values** (self)

  *Returns the values of the Sequence.*
- **items** (self)

  *Returns the items of the Sequence.*

#### 0.6.6.1 Detailed Description

Defines a Sequence of CAPS Bound Objects.

#### 0.6.6.2 Member Function Documentation

**create()**

```
create (
              self,
              capsBound,
              dim = 2 )
```

Create a CAPS Bound Object.

**Parameters**

| | |
|---|---|
| *capsBound* | The string value of the capsBound geometry attributes |
| *dim* | The dimension of the bound |

**Returns**

The new Bound Object is added to the sequence and returned

The documentation for this class was generated from the following file:

- pyCAPS/problem.py

### 0.6.7 DataSet Class Reference

Defines a CAPS DataSet Object.

Inherits object.

### Public Member Functions

- **name** (self)

  *Property returns the name of the CAPS DataSet Object.*
- **history** (self)

  *Returns the history list of the CAPS DataSet Object.*
- data (self)

  *Executes caps_getData on data set object to retrieve data set variable.*
- xyz (self)

  *Executes caps_getData on data set object to retrieve XYZ coordinates of the data set.*
- connectivity (self)

  *Executes caps_getTriangles on data set's vertex set to retrieve the connectivity (triangles only) information for the data set.*
- link (self, source, dmethod=caps.dMethod.Interpolate)

  *Link this DataSet to an other CAPS DataSet Object.*
- view (self, fig=None, numDataSet=1, dataSetIndex=0, ∗∗kwargs)

  *Visualize data set.*
- writeTecplot (self, filename=None, file=None)

  *Write data set to a Tecplot compatible data file.*
- writeVTK (self, filename)

  *Write data set to a VTK compatible data file.*

#### 0.6.7.1 Detailed Description

Defines a CAPS DataSet Object.

Created via VertexSet.dataSet.create().

**Parameters**

| | |
|---|---|
| *DataSet.attr* | AttrSequence of ValueIn attributes |

#### 0.6.7.2 Member Function Documentation

**connectivity()**

```
connectivity (
              self )
```

Executes caps_getTriangles on data set's vertex set to retrieve the connectivity (triangles only) information for the data set.

**Returns**

Optionally returns a list of lists of connectivity values (e.g. [ [node1, node2, node3], [node2, node3, node7], etc. ] ) and a list of lists of data connectivity (not this is an empty list if the data is node-based) (eg. [ [node1, node2, node3], [node2, node3, node7], etc. ]

### data()

```
data (
              self )
```

Executes caps_getData on data set object to retrieve data set variable.

#### Returns

Optionally returns a list of data values. Data with a rank greater than 1 returns a list of lists (e.g. data representing a displacement would return [ [Node1_xDisplacement, Node1_yDisplacement, Node1_zDisplacement], [Node2_xDisplacement, Node2_yDisplacement, Node2_zDisplacement], etc. ]

### link()

```
link (
              self,
              source,
              dmethod = caps.dMethod.Interpolate )
```

Link this DataSet to an other CAPS DataSet Object.

#### Parameters

| | |
|---|---|
| *source* | The source DataSEt Object |
| *dmethod* | Transfter method: dMethod.Interpolate or "Interpolate", tMethod.Conserve or "Conserve" |

### view()

```
view (
              self,
              fig = None,
              numDataSet = 1,
              dataSetIndex = 0,
             ** kwargs )
```

Visualize data set.

The function currently relies on matplotlib to plot the data.

#### Parameters

| | |
|---|---|
| *fig* | Figure object (matplotlib::figure) to append image to. |
| *numDataSet* | Number of data sets in DataSet.view$fig. |
| *dataSetIndex* | Index of data set being added to DataSet.view$fig. |
| ∗∗*kwargs* | See below. |

Valid keywords:

**Parameters**

| | |
|---|---|
| *filename* | Save image(s) to file specified (default - None). |
| *colorMap* | Valid string for a, matplotlib::cm, colormap (default - 'Blues'). |
| *showImage* | Show image(s) (default - True). |
| *title* | Set a custom title on the plot (default - VertexSet= 'name', DataSet = 'name', (Var. '#') ). |

### writeTecplot()

```
writeTecplot (
              self,
              filename = None,
              file = None )
```

Write data set to a Tecplot compatible data file.

A triagulation of the data set will be used for the connectivity.

**Parameters**

| | |
|---|---|
| *file* | Optional open file object to append data to. If not provided a filename must be given via the keyword arguement DataSet.writeTecplot$filename. |
| *filename* | Write Tecplot file with the specified name. |

### writeVTK()

```
writeVTK (
              self,
              filename )
```

Write data set to a VTK compatible data file.

A triagulation of the data set will be used for the connectivity.

**Parameters**

| | |
|---|---|
| *filename* | Write VTK file with the specified name. |

### xyz()

```
xyz (
              self )
```

Executes caps_getData on data set object to retrieve XYZ coordinates of the data set.

**Returns**

Optionally returns a list of lists of x,y, z values (e.g. [ [x2, y2, z2], [x2, y2, z2], [x3, y3, z3], etc. ] )

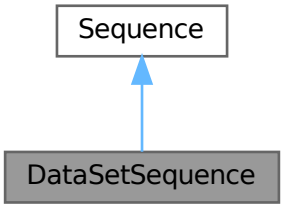
The documentation for this class was generated from the following file:

- pyCAPS/problem.py

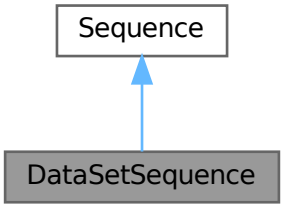
### 0.6.8 DataSetSequence Class Reference

Defines a Sequence of CAPS DataSet Objects.

Inheritance diagram for DataSetSequence:




Collaboration diagram for DataSetSequence:




#### Public Member Functions

- create (self, dname, ftype=None, init=None, rank=None)

  *Create a CAPS DataSet Object.*
- **fields** (self)

  *Returns a list of the fields in the Analysis Object associated with this DataSet.*

**Public Member Functions inherited from Sequence**

- **keys** (self)

  *Returns the keys of the Sequence.*
- **values** (self)

  *Returns the values of the Sequence.*
- **items** (self)

  *Returns the items of the Sequence.*

#### 0.6.8.1 Detailed Description

Defines a Sequence of CAPS DataSet Objects.

#### 0.6.8.2 Member Function Documentation

**create()**

```
create (
              self,
              dname,
              ftype = None,
              init = None,
              rank = None )
```

Create a CAPS DataSet Object.

**Parameters**

| | |
|---|---|
| *dname* | The name of the data set |
| *ftype* | The field type (FieldIn, FieldOut, GeomSens, TessSens, User). Auto detected FieldIn/FieldOut if None |
| *init* | Inital value assiged to the DataSet. Length must be consistent with the rank. |
| *rank* | The rank of the data set (only needed for un-connected data set) |

**Returns**

The new DataSet Object is added to the sequence and returned

The documentation for this class was generated from the following file:

- pyCAPS/problem.py

### 0.6.9 History Class Reference

History information for a CAPS Object.

Inherits object.

**Public Member Functions**

- **processName** (self)

  *The process Name.*
- **processID** (self)

  *The process ID.*
- **userID** (self)

  *The user ID.*
- **intentPhrase** (self)

  *Line-by-line list of inten phrases.*
- **datetime** (self)

  *The filled date/time stamp info - 6 in length: year, month, day, hour, minute, second.*
- **sNum** (self)

  *The sequence number (always increasing)*

#### 0.6.9.1 Detailed Description

History information for a CAPS Object.

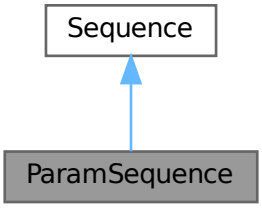
The documentation for this class was generated from the following file:

- pyCAPS/problem.py

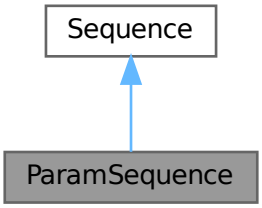
### 0.6.10 ParamSequence Class Reference

Defines a Sequence of CAPS Parameter Value Objects.

Inheritance diagram for ParamSequence:



Collaboration diagram for ParamSequence:




### Public Member Functions

- create (self, name, data, limits=None, fixedLength=True, fixedShape=True)

  *Create an parameter CAPS Value Object.*

### Public Member Functions inherited from Sequence

- **keys** (self)

  *Returns the keys of the Sequence.*
- **values** (self)

  *Returns the values of the Sequence.*
- **items** (self)

  *Returns the items of the Sequence.*

#### 0.6.10.1 Detailed Description

Defines a Sequence of CAPS Parameter Value Objects.

#### 0.6.10.2 Member Function Documentation

**create()**

```
create (
              self,
              name,
              data,
              limits = None,
              fixedLength = True,
              fixedShape = True )
```

Create an parameter CAPS Value Object.

**Parameters**

| | |
|---|---|
| *name* | Name used to define the parameter. |
| *data* | Initial data value(s) for the parameter. Note that type casting in done automatically based on the determined type of the Python object. |
| *limits* | Limits on the parameter values |
| *fixedLength* | Boolean if the value is fixed length |
| *fixedShape* | Boolean if the value is fixed shape |

**Returns**

The new Value Object is added to the sequence and returned

The documentation for this class was generated from the following file:

- pyCAPS/problem.py

### 0.6.11 Problem Class Reference

Defines a CAPS Problem Object.

Inherits object.

Inherited by capsProblem.

#### Public Member Functions

- __init__ (self, problemName, phaseName=None, phaseStart=None, capsFile=None, outLevel=1, phaseContinuation=True, phaseReadOnly=False)

  *Initialize the problem.*
- close (self)

  *Exlicitly closes CAPS Problem Object.*
- closePhase (self, phaseName=None)

  *Completes the Phase and closes the CAPS Problem Object.*
- intentPhrase (self, lines)

  *Set the current intent phrase.*
- **name** (self)

  *Property returns the name of the CAPS Problem Object.*
- **journaling** (self)

  *Boolean indicator if the CAPS Problem Object is currently journaling.*
- setOutLevel (self, outLevel)

  *Set the verbosity level of the CAPS output.*
- autoLinkParameter (self, param=None)

  *Create a link between a created CAPS parameter and analyis inputs of **all** loaded AIMs, automatically.*
- createTree (self, filename="myProblem", ∗∗kwargs)

  *Create a HTML dendrogram/tree of the current state of the problem.*

#### 0.6.11.1 Detailed Description

Defines a CAPS Problem Object.

The Problem Object is the top-level object for a single mission/problem. It maintains a single set of interrelated geometric models (see ProblemGeometry), analyses to be executed (see Analysis), connectivity and data (see Bound) associated with the run(s), which can be both multi-fidelity and multi-disciplinary.

**Parameters**

| | |
|---|---|
| *Problem.geometry* | ProblemGeometry instances representing the CSM geometry |
| *Problem.analysis* | AnalysisSequence of Analysis instances |
| *Problem.parameter* | ParamSequence of ValueIn parameters |
| *Problem.bound* | BoundSequence of Bound instances |
| *Problem.attr* | AttrSequence of ValueIn attributes |

#### 0.6.11.2 Constructor & Destructor Documentation

**__init__()**

```
__init__ (
              self,
              problemName,
              phaseName = None,
              phaseStart = None,
              capsFile = None,
              outLevel = 1,
              phaseContinuation = True,
              phaseReadOnly = False )
```

Initialize the problem.

**Parameters**

| | |
|---|---|
| *problemName* | CAPS problem name that serves as the root directory for all file I/O. |
| *phaseName* | the current phase name (None is equivalent to 'Scratch') |
| *phaseStart* | name of the phase used to start the new phase |
| *capsFile* | CAPS file to load. If starting a new phase then this file will replaced the csm file used in previous phases without checking for differences. Options: $*$.csm or $*$.egads. |
| *outLevel* | Level of output verbosity. See setOutLevel . |
| *phaseContinuation* | use continuation for a open phase, otherwise the phase is first deleted on disk |
| *phaseReadOnly* | open a closed Phase in Read Only mode |

#### 0.6.11.3 Member Function Documentation

**autoLinkParameter()**

```
autoLinkParameter (
              self,
              param = None )
```

Create a link between a created CAPS parameter and analyis inputs of **all** loaded AIMs, automatically.

Valid CAPS value, parameter objects must be created with Problam.parameter.create(). Note, only links to ANALYSISIN inputs are currently made at this time.

**Parameters**

| | |
|---|---|
| *param* | Parameter to use when creating the link (default - None). A combination (i.e. a single or list) of ValueIn dictionary entries and/or value object instances (returned from a call to Problam.parameter.create()) can be used. If no value is provided, all entries in the ValueIn dictionary (ValueIn) will be used. |

### close()

```
close (
              self )
```

Exlicitly closes CAPS Problem Object.

This method is mainly useful for testing purposes

### closePhase()

```
closePhase (
              self,
              phaseName = None )
```

Completes the Phase and closes the CAPS Problem Object.

**Parameters**

| | |
|---|---|
| *phaseName* | Phase Name of the Scratch phase is closed as complete |

### createTree()

```
createTree (
              self,
              filename = "myProblem",
             ** kwargs )
```

Create a HTML dendrogram/tree of the current state of the problem.

See example problem6.py for a representative use case. The HTML file relies on the open-source JavaScript library, D3, to visualize the data. This library is freely available from https://d3js.org/ and is dynamically loaded within the HTML file. If running on a machine without internet access a (miniaturized) copy of the library may be written to a file alongside the generated HTML file by setting the internetAccess keyword to False. If set to True, internet access will be necessary to view the tree.

**Parameters**

| | |
|---|---|
| *filename* | Filename to use when saving the tree (default - "myProblem"). Note an ".html" is automatically appended to the name (same with ".json" if embedJSON = False). |
| ∗∗*kwargs* | See below. |

Valid keywords:

**Parameters**

| | |
|---|---|
| *embedJSON* | Embed the JSON tree data in the HTML file itself (default - True). If set to False a seperate file is generated for the JSON tree data. |
| *internetAccess* | Is internet access available (default - True)? If set to True internet access will be necessary to view the tree. |
| *analysisGeom* | Show the geometry for each analysis entity (default - False). |
| *internalGeomAttr* | Show the internal attributes (denoted by starting with an underscore, for example "_AttrName") that exist on the geometry (default - False). |
| *reverseMap* | Reverse the geometry attribute map (default - False). |

#### intentPhrase()

```
intentPhrase (
              self,
              lines )
```

Set the current intent phrase.

**Parameters**

| | |
|---|---|
| *lines* | String or list of strings describing the intent |

#### setOutLevel()

```
setOutLevel (
              self,
              outLevel )
```

Set the verbosity level of the CAPS output.

See problem5.py for a representative use case.

**Parameters**

| | |
|---|---|
| *outLevel* | Level of output verbosity. Options: 0 (or "minimal"), 1 (or "standard") [default], and 2 (or "debug"). |

The documentation for this class was generated from the following file:

- pyCAPS/problem.py

### 0.6.12 ProblemGeometry Class Reference

Defines Problem Geometry Object.

Inherits object.

Inherited by capsGeometry.

### Public Member Functions

- **build** (self)

  *Exlicitly build geometry.*
- save (self, filename="myGeometry", directory=os.getcwd(), extension=".egads")

  *Save the current geometry to a file.*
- view (self, ∗∗kwargs)

  *View or take a screen shot of the geometry configuration.*
- attrList (self, attributeName, ∗∗kwargs)

  *Retrieve a list of attribute values of a given name ("attributeName") for the bodies in the current geometry.*
- attrMap (self, getInternal=False, ∗∗kwargs)

  *Create attribution map (embeded dictionaries) of each body in the current geometry.*
- createTree (self, filename="myGeometry", ∗∗kwargs)

  *Create a HTML dendrogram/tree of the current state of the geometry.*
- bodies (self)

  *Get dict of geometric bodies.*
- lengthUnit (self)

  *Get the lenght Unit of geometric bodies.*
- writeParameters (self, filename)

  *Write an OpenCSM Design Parameter file to disk.*
- readParameters (self, filename)

  *Read an OpenCSM Design Parameter file from disk and and overwrites (makes dirty) the current state of the geometry.*

#### 0.6.12.1 Detailed Description

Defines Problem Geometry Object.

**Parameters**

| | |
|---|---|
| *ProblemGeometry.despmtr* | ValueInSequence of ValueIn CSM design parameters |
| *ProblemGeometry.cfgpmtr* | ValueInSequence of ValueIn CSM configuration parameters |
| *ProblemGeometry.conpmtr* | ValueInSequence of ValueIn CSM constant parameters |
| *ProblemGeometry.outpmtr* | ValueOutSequence of ValueOut CSM outputs |

#### 0.6.12.2 Member Function Documentation

**attrList()**

```
attrList (
              self,
              attributeName,
             ** kwargs )
```

Retrieve a list of attribute values of a given name ("attributeName") for the bodies in the current geometry.

Level in which to search the bodies is determined by the attrLevel keyword argument.

**Parameters**

| | |
|---|---|
| *attributeName* | Name of attribute to retrieve values for. |
| ∗∗*kwargs* | See below. |

**Returns**

A list of attribute values.

Valid keywords:

**Parameters**

| | |
|---|---|
| *bodyIndex* | Specific body in which to retrieve attribute information from. |
| *attrLevel* | Level to which to search the body(ies). Options:<br>0 (or "Body") - search just body attributes<br>1 (or "Face") - search the body and all the faces [default]<br>2 (or "Edge") - search the body, faces, and all the edges<br>3 (or "Node") - search the body, faces, edges, and all the nodes |

### attrMap()

```
attrMap (
              self,
              getInternal = False,
             ** kwargs )
```

Create attribution map (embeded dictionaries) of each body in the current geometry.

Dictionary layout:

- Body 1
  - Body : Body level attributes
  - Faces
    - 1 : Attributes on the first face of the body
    - 2 : Attributes on the second face of the body
    - " : ... - Edges - 1 : Attributes on the first edge of the body - 2 : Attributes on the second edge of the body - " : ...
  - Nodes :
    - 1 : Attributes on the first node of the body
    - 2 : Attributes on the second node of the body
    - " : ... - Body 2 - Body : Body level attributes - Faces - 1 : Attributes on the first face of the body - " : ...
  - ...
- ...

Dictionary layout (reverseMap = True):

- Body 1
  - Attribute : Attribute name
    - Value : Value of attribute
      - Body : True if value exist at body level, None if not
      - Faces : Face numbers at which the attribute exist
      - Edges : Edge numbers at which the attribute exist
      - Nodes : Node numbers at which the attribute exist
    - Value : Next value of attribute with the same name
      - Body : True if value exist at body level, None if not
      - " : ... - ... - Atribute : Attribute name - Value : Value of attribute - " : ...
    - ...
- Body 2
  - Attribute : Attribute name
    - Value : Value of attribute
      - Body : True if value exist at body level, None if not
      - " : ... - ... - ... - ... @param getInternal Get internal attributes (denoted by starting with an underscore, for example "_AttrName") that exist on the geometry (default - False).

**Parameters**

| | |
|---|---|
| ∗∗*kwargs* | See below. |

Valid keywords:

**Parameters**

| | |
|---|---|
| *reverseMap* | Reverse the attribute map (default - False). See above table for details. |

**Returns**

Dictionary containing attribution map

### bodies()

```
bodies (
              self )
```

Get dict of geometric bodies.

**Returns**

Returns a dictionary of the bodies and the capsLength unit. Keys use the body "_name" attribute or "Body_#".

### createTree()

```
createTree (
              self,
              filename = "myGeometry",
             ** kwargs )
```

Create a HTML dendrogram/tree of the current state of the geometry.

The HTML file relies on the open-source JavaScript library, D3, to visualize the data. This library is freely available from https://d3js.org/ and is dynamically loaded within the HTML file. If running on a machine without internet access a (miniaturized) copy of the library may be written to a file alongside the generated HTML file by setting the internetAccess keyword to False. If set to True, internet access will be necessary to view the tree.

**Parameters**

| | |
|---|---|
| *filename* | Filename to use when saving the tree (default - "myGeometry"). Note an ".html" is automatically appended to the name (same with ".json" if embedJSON = False). |
| ∗∗*kwargs* | See below. |

Valid keywords:

**Parameters**

| | |
|---|---|
| *embedJSON* | Embed the JSON tree data in the HTML file itself (default - True). If set to False a seperate file is generated for the JSON tree data. |
| *internetAccess* | Is internet access available (default - True)? If set to True internet access will be necessary to view the tree. |
| *internalGeomAttr* | Show the internal attributes (denoted by starting with an underscore, for example "_AttrName") that exist on the geometry (default - False). |
| *reverseMap* | Reverse the attribute map (default - False). See attrMap for details. |

### lengthUnit()

```
lengthUnit (
              self )
```

Get the lenght Unit of geometric bodies.

**Returns**

Returns the length unit defined by capsLength attribute.

### readParameters()

```
readParameters (
              self,
              filename )
```

Read an OpenCSM Design Parameter file from disk and and overwrites (makes dirty) the current state of the geometry.

**Parameters**

| | |
|---|---|
| *filename* | Filename of the OpenCSM Design Parameter file |

### save()

```
save (
              self,
              filename = "myGeometry",
              directory = os.getcwd(),
              extension = ".egads" )
```

Save the current geometry to a file.

**Parameters**

| | |
|---|---|
| *filename* | File name to use when saving geometry file. |
| *directory* | Directory where to save file. Default current working directory. |
| *extension* | Extension type for file if filename does not contain an extension. |

### view()

```
view (
              self,
             ** kwargs )
```

View or take a screen shot of the geometry configuration.

The use of this function to save geometry requires the **matplotlib** module. ***Important***: If both showImage = True and filename is not None, any manual view changes made by the user in the displayed image will be reflected in the saved image.

**Parameters**

| | |
|---|---|
| $**kwargs$ | See below. |

Valid keywords:

**Parameters**

| | |
|---|---|
| *viewerType* | What viewer should be used (default - "capsViewer"). Options: "capsViewer" or "matplotlib" (options are case insensitive). Important: if $filename is not None, the viewer is changed to matplotlib. |
| *portNumber* | Port number to start the server listening on (default - 7681). |
| *title* | Title to add to each figure (default - None). |
| *filename* | Save image(s) to file specified (default - None). Note filename should not contain '.' other than to indicate file type extension (default type = $*$.png). 'file' - OK, 'file2.0Test' - BAD, 'file2_0Test.png' - OK, 'file2.0Test.jpg' - BAD. |
| *directory* | Directory path were to save file. If the directory doesn't exist it will be made. (default - current directory). |
| *viewType* | Type of view for the image(s). Options: "isometric" (default), "fourview", "top" (or "-zaxis"), "bottom" (or "+zaxis"), "right" (or "+yaxis"), "left" (or "-yaxis"), "front" (or "+xaxis"), "back" (or "-xaxis"). |
| *combineBodies* | Combine all bodies into a single image (default - False). |
| *ignoreBndBox* | Ignore the largest body (default - False). |

**Parameters**

| | |
|---|---|
| *showImage* | Show image(s) (default - False). |
| *showAxes* | Show the xyz axes in the image(s) (default - False). |
| *showTess* | Show the edges of the tessellation (default - False). |
| *dpi* | Resolution in dots-per-inch for the figure (default - None). |
| *tessParam* | Custom tessellation paremeters, see EGADS documentation for makeTessBody function. values will be scaled by the norm of the bounding box for the body (default - [0.0250, 0.0010, 15.0]). |

#### writeParameters()

```
writeParameters (
              self,
              filename )
```

Write an OpenCSM Design Parameter file to disk.

**Parameters**

| | |
|---|---|
| *filename* | Filename of the OpenCSM Design Parameter file |

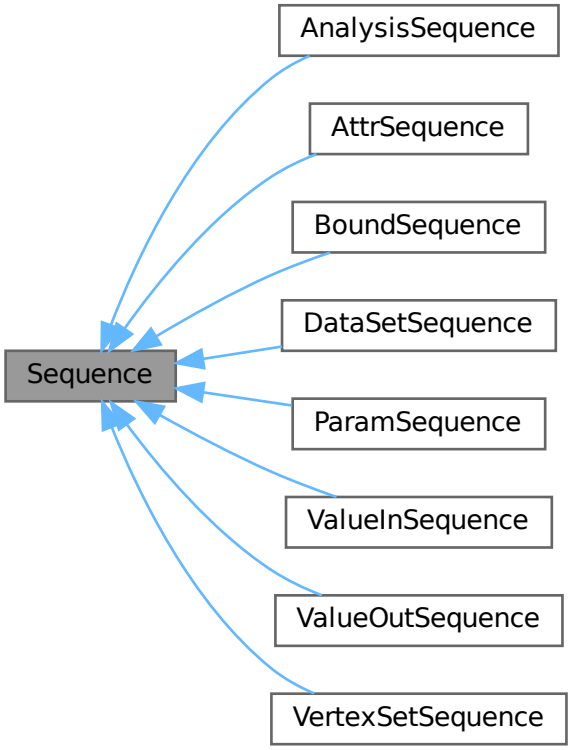
The documentation for this class was generated from the following file:

- pyCAPS/problem.py

### 0.6.13 Sequence Class Reference

Base class for all CAPS Sequence classes.

Inheritance diagram for Sequence:




**Public Member Functions**

- **keys** (self)

  *Returns the keys of the Sequence.*
- **values** (self)

  *Returns the values of the Sequence.*
- **items** (self)

  *Returns the items of the Sequence.*

#### 0.6.13.1 Detailed Description

Base class for all CAPS Sequence classes.

A CAPS Sequence only contains instances of a single type Items are added to the Seqence via the 'create' method in derived classes Items cannot be removed from the sequence (except for CAPS Attributes)

The documentation for this class was generated from the following file:

- pyCAPS/problem.py

## 0.6.14 ValueDynOut Class Reference

Defines a CAPS dynamic output Value Object Not a standalone class.

Inherits object.

### Public Member Functions

- **value** (self)

  *Property getter returns a copy the values stored in the CAPS Value Object.*
- **name** (self)

  *Property returns the name of the CAPS Value Object.*
- **history** (self)

  *Returns the history list of the CAPS Value Object.*
- **props** (self)

  *Property getter returns a copy the values stored in the CAPS Value Object.*
- **hasDeriv** (self)

  *Returns a string list of of the input Value Object names that can be used in deriv.*
- deriv (self, name=None)

  *Returns derivatives of the output Value Object.*

### 0.6.14.1 Detailed Description

Defines a CAPS dynamic output Value Object Not a standalone class.

### 0.6.14.2 Member Function Documentation

#### deriv()

```
deriv (
              self,
              name = None )
```

Returns derivatives of the output Value Object.

**Parameters**

| | |
|---|---|
| *name* | Name of the input Value Object to take derivative w.r.t. if name is None then a dictionary with all dervatives from hasDeriv are returned |

The documentation for this class was generated from the following file:

- pyCAPS/problem.py

## 0.6.15 ValueDynOutSequence Class Reference

Defines a Sequence of CAPS dynamic output Value Objects.

Inherits object.

#### Public Member Functions

- **keys** (self)

  *Returns the keys of the ValueDynOutSequence.*
- **values** (self)

  *Returns the values of the ValueDynOutSequence.*
- **items** (self)

  *Returns the items of the ValueDynOutSequence.*

##### 0.6.15.1 Detailed Description

Defines a Sequence of CAPS dynamic output Value Objects.

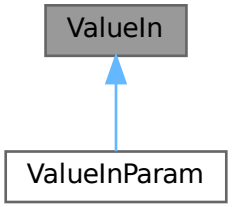
The documentation for this class was generated from the following file:

- pyCAPS/problem.py

### 0.6.16 ValueIn Class Reference

Defines a CAPS input Value Object.

Inheritance diagram for ValueIn:




#### Public Member Functions

- **value** (self)

  *Property getter returns a copy the values stored in the CAPS Value Object.*
- **value** (self, val)

  *Property setter sets the value in the CAPS Value Object.*
- **limits** (self)

  *Property getter returns a copy the limits of the CAPS Value Object.*
- **limits** (self, limit)

  *Property setter sets the limits in the CAPS Value Object (if changable)*
- **name** (self)

  *Property returns the name of the CAPS Value Object.*
- **history** (self)

*Returns the history list of the CAPS Value Object.*

- **props** (self)

  *Returns the CAPS Value Object properties.*

- link (self, source, tmethod=caps.tMethod.Copy)

  *Link this input value to an other CAPS Value Object.*

- **unlink** (self)

  *Remove an existing link.*

- transferValue (self, tmethod, source)

  *Transfer values from src to self.*

- **stepSize** (self)

  *Property getter returns a copy the OpenCSM finite difference step sizes of the CAPS Value Object.*

- **stepSize** (self, sizes)

  *Property setter sets and uses OpenCSM finite difference step sizes in the CAPS Value Object.*

#### 0.6.16.1 Detailed Description

Defines a CAPS input Value Object.

#### 0.6.16.2 Member Function Documentation

**link()**

```
link (
              self,
              source,
              tmethod = caps.tMethod.Copy )
```

Link this input value to an other CAPS Value Object.

**Parameters**

| | |
|---|---|
| *source* | The source Value Object |
| *tmethod* | Transfter method: tMethod.Copy or "Copy", tMethod.Integrate or "Integrate", tMethod.Average or "Average" |

**transferValue()**

```
transferValue (
              self,
              tmethod,
              source )
```

Transfer values from src to self.

**Parameters**

| | |
|---|---|
| *tmethod* | 0 - copy, 1 - integrate, 2 - weighted average – (1 & 2 only for DataSet src) |
| *source* | the source value object |

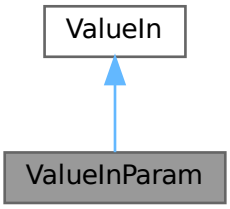
The documentation for this class was generated from the following file:

- pyCAPS/problem.py

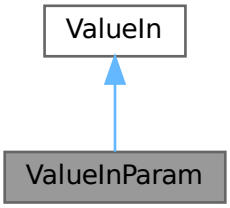
### 0.6.17 ValueInParam Class Reference

Defines a CAPS parameter Value Object.

Inheritance diagram for ValueInParam:




Collaboration diagram for ValueInParam:




#### Public Member Functions

- **markForDelete** (self)

  *Mark a parameter CAPS Value Object for deletion on the next Phase.*

**Public Member Functions inherited from ValueIn**

- **value** (self)

  *Property getter returns a copy the values stored in the CAPS Value Object.*
- **value** (self, val)

  *Property setter sets the value in the CAPS Value Object.*
- **limits** (self)

  *Property getter returns a copy the limits of the CAPS Value Object.*
- **limits** (self, limit)

  *Property setter sets the limits in the CAPS Value Object (if changable)*
- **name** (self)

  *Property returns the name of the CAPS Value Object.*
- **history** (self)

  *Returns the history list of the CAPS Value Object.*
- **props** (self)

  *Returns the CAPS Value Object properties.*
- link (self, source, tmethod=caps.tMethod.Copy)

  *Link this input value to an other CAPS Value Object.*
- **unlink** (self)

  *Remove an existing link.*
- transferValue (self, tmethod, source)

  *Transfer values from src to self.*
- **stepSize** (self)

  *Property getter returns a copy the OpenCSM finite difference step sizes of the CAPS Value Object.*
- **stepSize** (self, sizes)

  *Property setter sets and uses OpenCSM finite difference step sizes in the CAPS Value Object.*

#### 0.6.17.1 Detailed Description

Defines a CAPS parameter Value Object.

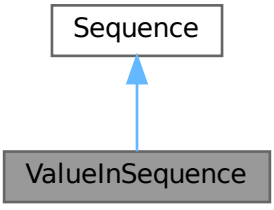
The documentation for this class was generated from the following file:

- pyCAPS/problem.py

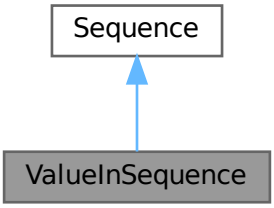
### 0.6.18 ValueInSequence Class Reference

Defines a Sequence of CAPS input Value Objects.

Inheritance diagram for ValueInSequence:



Collaboration diagram for ValueInSequence:




#### Additional Inherited Members

#### Public Member Functions inherited from Sequence

- **keys** (self)
  *Returns the keys of the Sequence.*
- **values** (self)
  *Returns the values of the Sequence.*
- **items** (self)
  *Returns the items of the Sequence.*

#### 0.6.18.1 Detailed Description

Defines a Sequence of CAPS input Value Objects.

The documentation for this class was generated from the following file:

- pyCAPS/problem.py

### 0.6.19 ValueOut Class Reference

Defines a CAPS output Value Object Not a standalone class.

Inherits object.

#### Public Member Functions

- **value** (self)
  *Property getter returns a copy the values stored in the CAPS Value Object.*
- **name** (self)
  *Property returns the name of the CAPS Value Object.*
- **history** (self)
  *Returns the history list of the CAPS Value Object.*
- **props** (self)
  *Property getter returns a copy the values stored in the CAPS Value Object.*
- **hasDeriv** (self)
  *Returns a string list of of the input Value Object names that can be used in deriv.*
- deriv (self, name=None)
  *Returns derivatives of the output Value Object.*

#### 0.6.19.1 Detailed Description

Defines a CAPS output Value Object Not a standalone class.

#### 0.6.19.2 Member Function Documentation

**deriv()**

```
deriv (
              self,
              name = None )
```

Returns derivatives of the output Value Object.

**Parameters**

| | |
|---|---|
| *name* | Name of the input Value Object to take derivative w.r.t. if name is None then a dictionary with all dervatives from hasDeriv are returned |

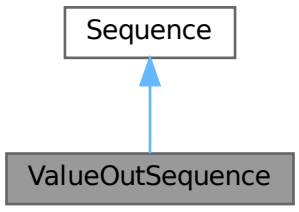
The documentation for this class was generated from the following file:

- pyCAPS/problem.py

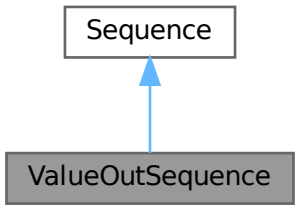
### 0.6.20 ValueOutSequence Class Reference

Defines a Sequence of CAPS output Value Objects.

Inheritance diagram for ValueOutSequence:



Collaboration diagram for ValueOutSequence:




#### Additional Inherited Members

#### Public Member Functions inherited from Sequence

- **keys** (self)
  *Returns the keys of the Sequence.*
- **values** (self)
  *Returns the values of the Sequence.*
- **items** (self)
  *Returns the items of the Sequence.*

#### 0.6.20.1 Detailed Description

Defines a Sequence of CAPS output Value Objects.

The documentation for this class was generated from the following file:

- pyCAPS/problem.py

### 0.6.21 VertexSet Class Reference

Defines a CAPS VertexSet Object.

Inherits object.

#### Public Member Functions

- **name** (self)
  *Property returns the name of the CAPS VertexSet Object.*
- **history** (self)
  *Returns the history list of the CAPS VertexSet Object.*
- getDataConnect (self)
  *Executes caps_getTriangles on data set's vertex set to retrieve the connectivity (triangles only) information for the data set.*

#### 0.6.21.1 Detailed Description

Defines a CAPS VertexSet Object.

Created via Bound.vertexSet.create().

**Parameters**

| | |
|---|---|
| *VertexSet.dataSet* | DataSetSequence of DataSet instances |
| *VertexSet.attr* | AttrSequence of ValueIn attributes |

#### 0.6.21.2 Member Function Documentation

**getDataConnect()**

```
getDataConnect (
               self )
```

Executes caps_getTriangles on data set's vertex set to retrieve the connectivity (triangles only) information for the data set.

**Returns**

Optionally returns a list of lists of connectivity values (e.g. [ [node1, node2, node3], [node2, node3, node7], etc. ] ) and a list of lists of data connectivity (not this is an empty list if the data is node-based) (eg. [ [node1, node2, node3], [node2, node3, node7], etc. ]

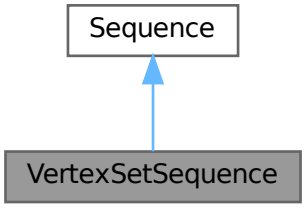
The documentation for this class was generated from the following file:

- pyCAPS/problem.py

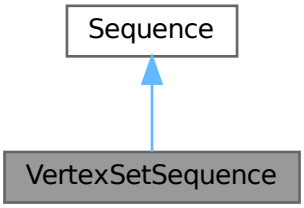
### 0.6.22 VertexSetSequence Class Reference

Defines a Sequence of CAPS Bound Objects.

Inheritance diagram for VertexSetSequence:



Collaboration diagram for VertexSetSequence:




### Public Member Functions

- create (self, analysis, vname=None)

  *Create a CAPS VertexSet Object.*

### Public Member Functions inherited from Sequence

- **keys** (self)

  *Returns the keys of the Sequence.*
- **values** (self)

  *Returns the values of the Sequence.*
- **items** (self)

  *Returns the items of the Sequence.*

#### 0.6.22.1 Detailed Description

Defines a Sequence of CAPS Bound Objects.

#### 0.6.22.2 Member Function Documentation

#### create()

```
create (
              self,
              analysis,
              vname = None )
```

Create a CAPS VertexSet Object.

**Parameters**

| | |
|---|---|
| *analysis* | A CAPS Analysis Object or the string name of an Analsysis Object instance |
| *vname* | Name of the VertexSet (same as the Analysis Object if None) |

**Returns**

The new VertexSet Object is added to the sequence and returned

The documentation for this class was generated from the following file:

- pyCAPS/problem.py

## 0.7 Examples

### 0.7.1 problem5.py

Basic example for setting the verbosity of a problem using pyCAPS.Problem.setOutLevel() function.

Basic example for setting the verbosity of a problem using pyCAPS.Problem.setOutLevel() function.

```
00001 #Use case set verbosity of the problem
00002 import pyCAPS
00003
00004 # Load a *.csm file "./csmData/cfdMultiBody.csm" into our newly created problem. The
00005 # project name "basicTest" may be optionally set here;  if no argument is provided
00006 # the CAPS file provided is used as the project name.
00007 print("Loading file into our Problem")
00008 myProblem = myProblem.Porblem(problemName = "outLevelExample",
00009                                capsFile="csmData/cfdMultiBody.csm",
00010                                outLevel="debug")
00011
00012
00013 # Change verbosity to minimal - 0 (integer value)
00014 myProblem.setOutLevel("minimal")
00015
00016 # Change verbosity to standard - 1 (integer value)
00017 myProblem.setOutLevel("standard")
00018
00019 # Change verbosity to back to minimal using integer value - 0
00020 myProblem.setOutLevel(0)
00021
00022 # Change verbosity to back to debug using integer value - 2
00023 myProblem.setOutLevel(2)
00024
00025 # Give wrong value (raises and Error)
00026 myProblem.setOutLevel(10)
```

### 0.7.2 problem6.py

Example use case for the pyCAPS.capsProblem.createTree() function.

Example use case for the pyCAPS.capsProblem.createTree() function.

```
00001 # Use: Check creating a tree on the problem
00002 import pyCAPS
00003
00004 # Load a *.csm file "./csmData/cfdMultiBody.csm" into our newly created problem.
00005 myProblem = myProblem.Porblem(problemName = "outLevelExample",
00006                                capsFile="csmData/cfdMultiBody.csm",
00007                                outLevel="debug")
00008
00009 # Create problem tree
00010 myProblem.createTree()
```

# Index