

# SofaPython plugin

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## **Abstract**

The goal of this plugin is to provide python integration into SOFA.

Therefore, it is possible to add new features in SOFA without modifying SOFACodebase. Moreover, python scripts are stored in the same place as the corresponding scene, for a cleaner integration of scene-specific code without polluting the rest of SOFACodebase.

This plugin provides a **Sofa** module available from python scripts, to interact with SOFA.

# **1 SofaPython graph components**

## **1.1 PythonScriptController**

This controller is an empty Controller, its behavior is driven in the Python script it loads. This is the simplest and the most polyvalent way to imbed Python scripting in a SOFAScene graph.

## 2 SOFA Python API

### 2.1 The Sofa module

The core of this plugin is the `Sofa` Python module available to python scripts from within the `SofaPython` components (they are not available outside `Sofa` environment, in the command-line `python` binary for example).

Therefore, each python script to be imbedded in SOFA should include the following line if it wants to interact with the SOFA framework:

```
1 import Sofa
```

This module provides a wide range of methods and types, bound to essential SOFA framework features.

These can be used from python within scripts loaded by the components provided by this plugin.

### 2.2 Module methods

`SofaPython` provides several module methods, either for general purpose (use of factory, for example) or as convenient helper functions (node functions used directly with the tree root node).

- `createObject(BaseContext, BaseObjectDescription)`
- `getObject(BaseContext,path)`
- `getChildNode(node,path)`
- `sendGUIMessage(msgType,msgValue)`

### 2.3 Types hierarchy

The class hierarchy in the `Sofa` module is quite different from the C++ SOFA class hierarchy. Not all SOFA classes are bound in Python, and some levels in the hierarchy are skipped.

Despite the ability of Python to support multi-heritage, this feature has not been implemented in the `Sofa` module, for code simplicity.

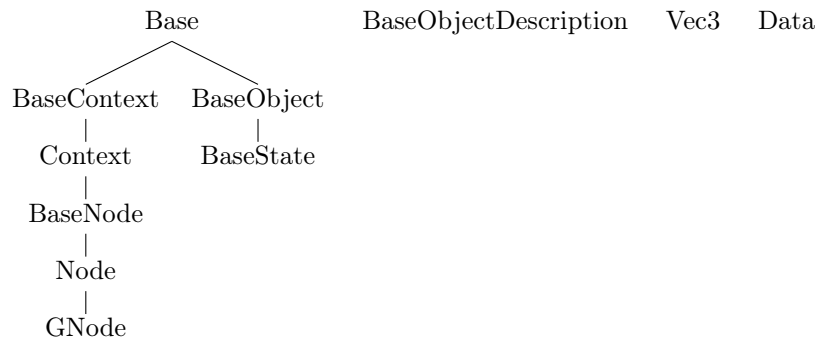


Figure 1: Sofa python types hierarchy

### 2.3.1 Sofa.BaseObjectDescription

Used to create objects with the Method `Sofa.createObject` :

```

1 desc = Sofa.BaseObjectDescription('particle', 'MechanicalObject')
2 particle = Sofa.createObject(node, desc)

```

Methods :

- `setAttributes`
- `getAttributes`

Constructor :

- `BaseObjectDescription(name, type)`

Attributes :

- `name`

### 2.3.2 Sofa.Vec3

Attributes :

- `x`
- `y`
- `z`

### 2.3.3 Sofa.Base

Methods :

- `findData(name)` returns a `Sofa.Data` object (if it exists)

Attributes:

- `name`

#### **2.3.4 Sofa.BaseObject**

(empty)

#### **2.3.5 Sofa.BaseState**

Methods :

- `resize(size)`

#### **2.3.6 Sofa.BaseContext**

Methods :

- `getRootContext()`
- `getTime()`
- `getDt()`
- `getGravity()` returns a `Sofa.vec3` object
- `setGravity(Vec3)`
- `createObject(BaseObjectDescription)`
- `getObject(path)`

Attributes:

- `active` (boolean)
- `animate` (boolean)

#### **2.3.7 Sofa.Context**

(empty)

#### **2.3.8 Sofa.Node**

- `getRoot()` returns the root node of the graph (if any)
- `getChildNode(path)` returns a child node, given its path (if any)
- `executeVisitor(visitor)`
- `simulationStep(dt)` executes ONE step of simulation, using `dt` (in seconds, float) as delta time.

### 2.3.9 Sofa.Gnode

Methods :

- `createChild(childName)`
- `addChild(childNode)`
- `removeChild(childNode)`
- `moveChild(childNode)`
- `addObject(object)` objets created with `Sofa.createObject` method (see example scene)
- `removeObject(object)`
- `detachFromGraph()`

### 2.3.10 Sofa.Data

Attributes :

- `value`
- `name`

Methods :

- `getValue(index)`
- `setValue(index,value)`

### 2.3.11 Data members: the most important thing in SOFAPython API

The most important class is `Sofa.Base`, and its associated method `findData`. ALMOST EVERYTHING in SOFA is stored in Datas, and with the only `Sofa.Base.findData` method, almost everything is possible. Through the `Sofa.Data` class (returned by `Sofa.Base.findData(name)` ) it is possible to read or write almost any object value, thus interact with the simulation in real-time. This way, even if a specific component isn't bound to python, it's possible to access it by its `Sofa.Base` heritage.

`Data.value` attribute has a versatile behavior, depending on the Data type. On read, `Data.value` can return either an integer, a float, a string, or even a list of one of these 3 types. On write, you have to set EXACTLY the proper type, or you can set a string (same format as in the \*.scn xml files).

Examples:

```
1 print str(node.findData(' gravity ').value)
```

will output the text conversion of a list of 3 floats :

```
1 [0.0, -9.81, 0.0]
```

You can set it in two ways ; the native version :

```
1 node.findData('gravity').value = [0.0, -9.81, 0.0]
```

or by the text version:

```
1 node.findData('gravity').value = '0.0 -9.81 0.0'
```

Use of any other type will result in an error. The following won't work for example :

```
1 node.findData('gravity').value = 9.81
```

## 3 Sofa "PythonScriptController" component

### 3.1 Example scene

```
1 runSofa applications / plugins /SofaPython/examples/ExampleController.scn
```

### 3.2 Component data

- filename is the name of the .py script file.

### 3.3 Python script entry points

- onKeyPressed(c)
- onKeyReleased(c)
- onLoaded(node)
- onMouseButtonLeft(mouseX,mouseY,isPressed)
- onMouseButtonRight(mouseX,mouseY,isPressed)
- onMouseButtonMiddle(mouseX,mouseY,isPressed)
- onMouseWheel(mouseX,mouseY,wheelDelta)
- onGUIEvent(strControlID,valueName,strValue)
- onBeginAnimationStep(deltaTime)
- onEndAnimationStep(deltaTime)
- createGraph(node)
- initGraph(node)
- storeResetState()
- reset()
- cleanup()