PySI API

Introduction

The PySI API facilitates its users to build new SI-Plugins from scratch or extend and modify existing ones. Therefore, the PySI API makes heavy use of object-oriented programming, most notably **Inheritance**. An SI-Plugin is an implementation of an *effect* of an *interactive region* (early concept: [1]). Such an *effect* is triggered once end-users overlap two *interactive regions*, defining a *collision*. Additionally, *interactive regions* can be *linked*. Such *linking relationships* are defined according to *attributes*. Application developers specify in the implementation of an *effect* which *attributes* of that *effect* can be linked to which *attributes* of other *effects* and which *linking action* shall occur. Standard *attributes* are either provided by the PySI API, such as *position*, or may be created as ad-hoc identifiers which are chosen by application developers. In Sketchable Interaction, everything is considered an SI-plugin. The very canvas you draw on is a plugin, filesystem entries such as files are plugins, where each file type can be done as a plugin which represents that type, etc.

The PySI API aims to streamline the implementation of an SI-Plugin in partially descriptive, partially imperative and self-documenting fashion. This document's goal is to describe the PySI API beyond its code documentation. Therefore, the next sections describe PySI, its API and use case examples.

If you are just starting out with developing SI-Plugins it may be useful to play around with the PySI API first to get a feel for it. For that, skip ahead to the section Example: Implementation of a Tag-Effect. The more detailed aspects of PySI and its API are present in the other chapters and may be consulted as required. This document applies the best practices proposed by RFC2119 (keywords **must**, **should**, **may**)[2].

Description

API Integration in SIGRun

PySI exposes bindings to C++ datastructures and functions. These bindings are built with the use of Boost.Python [3] Each plugin file is stored in an *object* within SIGRun. This *object* functionally represents the pythonic *self* in SIGrun. Therefore, the python code implemented in the functions of SI-Plugins is executed by SIGRun once end-users trigger their events and actions. In this way, API users build application logic purely in python (with the use of python libraries available to them), while SIGRun provides the *glue* to present those applications to end-users.

End-User interaction

- End-Users **must** first select one of the available effects which are shown in the palette region to the right

- End-Users **must** press the left mouse button to perform selection
- End-Users **must** press and hold the right mouse button to link the position of the *interactive region* of the mouse cursor to colliding *interactive regions*

The Startup File

Goal API users configure the startup sequence of SIGRun

- API users **must** provide a startup file in the *plugins* folder
- API users **may** spawn *interactive regions*
- API users **may** configure logging behaviour

Naming Convention Startup python file **must** be named *StartSIGRun.py*

Structure

```python
from libPySI import PySI
# further imports as you see fit such as plugin files for using their static
# members or auxiliary non-plugin python3 files

# other variables or functions

def on_start():
    # configuration logic **must** be written here
    pass

# other variables or functions
```

Summary:

- *StartSIGRun.py* **must** import libPySI
- *StartSIGRun.py* **must** include a module-level function called *on_start()*
- *on_start* **must** contain all configuration logic
- *on_start()* **must not** have any arguments
- API Users **should** create additional functions and variables on module level

The Plugin File

Goal

- API Users implement *effects* for *interactive regions*
- API Users **must** specify collision capabilities (str-value) and callback functions for *collision event* emissions and receptions
  - on_enter - triggered exactly once when first time collision of *interactive regions* is detected
  - on_continuous - triggered in each subsequent SIGRun update when collision remains ongoing

    - on_leave - triggered exactly once when a previously ongoing collision is detected to have stopped
- API Users **must** specify linking relationships according to attributes (str-values) and linking actions (functions)
- API Users **must** place newly built SI-Plugins and associated qml-files within the *plugins* folder for being usable by SIGRun

Naming Convention

- plugin files **must** contain exactly one class
- names of plugin files **must** be the exact same name as the classes they implement
- example: Tag.py contains a class called Tag

Structure MyEffect.py

```
from libPySI import PySI
from plugins.standard_environment_library.SIEffect import SIEffect

# same name as python file
# it is highly recommended to inherit from SIEffect for ease of use
class MyEffect(SIEffect):
    regiontype = PySI.EffectType.SI_CUSTOM
    regionname = PySI.EffectName.SI_STD_NAME_CUSTOM  # name used only internally
    region_display_name = "MyEffect"  # name to be shown to end-users

    def __init__(self, shape=PySI.PointVector(), uuid="", kwargs={}):
        super(MyEffect, self).__init__(shape, uuid, "res/my_effect.png",
                                       Button.regiontype, Button.regionname,
                                       kwargs)

        self.qml_path = "path/to/MyEffect.qml"

        # further member variables

    # further member functions
```

Summary:

- plugin files **must** import libPySI
- plugin files **must** use static member variables *regiontye*, *regionname*, and region_display_name
- *regiontye* and *regionname* **must** be intialized according to PySI effect types and effect names respectively (if unsure use above example initialization)
- *init*'s signature **must** look exactly as the example above
- *self.qml_path* **must** be left empty if no QML file is required to accompany the plugin

- *region_display_name* **should not** be an empty str
- plugin files **should** import SIEffect for ease of use
- *init*'s default parameters **may** be changed

Enabling and Disabling of Effects and Linking Relationships

```
from libPySI import PySI
from plugins.standard_environment_library.SIEffect import SIEffect

class MyEffect(SIEffect):
    regiontype = PySI.EffectType.SI_CUSTOM
    regionname = PySI.EffectName.SI_STD_NAME_CUSTOM
    region_display_name = "MyEffect"

    def __init__(self, shape=PySI.PointVector(), uuid="", kwargs={}):
        super(MyEffect, self).__init__(shape, uuid, "res/my_effect.png",
                                       MyEffect.regiontype, MyEffect.regionname,
                                       kwargs)

        self.qml_path = "path/to/MyEffect.qml"

        # enable an effect, according to a capability (str-value), to be emitted
        # according to the collision event functions

        # collison_event_on_enter_emit must be a function
        # (e.g. self.on_collision_event_enter_emit) as parameter
        # (must not not call the function in the parameter list)

        # collison_event_on_continuous_emit must be a function
        # (e.g. self.on_collision_event_continuous_emit) as parameter
        # (must not not call the function in the parameter list)

        # collison_event_on_leave_emit must be a function
        # (e.g. self.on_collision_event_leave_emit) as parameter
        # (must not not call the function in the parameter list)
        self.enable_effect("your_capability", SIEffect.EMISSION,
                           <collison_event_on_enter_emit>,
                           <collison_event_on_continuous_emit>,
                           <collison_event_on_leave_emit>)

        # enable an effect, according to a capability (str-value),
        # to be received according to the collision event functions

        # "your_other_capability" can be any str-value

        # collison_event_on_enter_recv must be a function
```

```
# (e.g. self.on_collision_event_enter_recv) as parameter
# (must not not call the function in the parameter list)

# collison_event_on_continuous_recv must be a function
# (e.g. self.on_collision_event_continuous_recv) as parameter
# (must not not call the function in the parameter list)

# collison_event_on_leave_recv must be a function
# (e.g. self.on_collision_event_leave_recv) as parameter
# (must not not call the function in the parameter list)
self.enable_effect("your_other_capability", SIEffect.RECEPTION,
                   <collison_event_on_enter_recv>,
                   <collison_event_on_continuous_recv>,
                   <collison_event_on_leave_recv>)

# disable an effect, according to a collision capability (str-value),
# so the effect stops being emitted

# "your_capability" can be any str-value
self.disable_effect("your_capability", SIEffect.EMISSION)

# disable an effect, according to a collision capability (str-value),
# so the effect stops being received

# "your_other_capability" can be any str-value
self.disable_effect("your_other_capability", SIEffect.RECEPTION)

# enable a link, according to an attribute (str-value), so that the
# effect emits the given linking action (function)

# "your_attribute" may be any str-value

# <linking_action_for_emission> must be a function
# (e.g. self.linking_action) as parameter
# (must not not call the function in the parameter list)
self.enable_link_emission("your_attribute",
                          <linking_action_for_emission>)

# enable a link, according to a source attribute (str-value) and target
# attribute, so that the effect receives a linking action according to
# the given function

# "your_attribute" can be any str-value
# <linking_action_for_emission> must be a function
# (e.g. self.linking_action) as parameter
# (must not not call the function in the parameter list)
```

```python
self.enable_link_reception("source_attribute", "your_attribute",
                           <linking_action_for_reception>)

# disable a link, according to an attribute (str-value), so that the
# effect stops emitting that linking action
self.disable_link_emission("your_attribute")

#disable a link, according to a source_attribute and target attribute,
# so that the effect stops receiving that linking action
# specify "your_attribute" to selectively disable that exact linking
# relationship
# leave "your_attribute" empty ("") to disable all linking relationships
# which are triggered by "source_attribute"
self.disable_link_reception("source_attribute", "your_attribute")
```

Summary:

- API users **must** specify own names for capabilities and attributes if those are not part of PySI API
- Emitting *collision event* functions **must** have one additional argument which is the receiving effect (e.g. def collison_event_on_enter_emit(self, other))
- API users **should** use the functions enable_effect, disable_effect, enable_link_emission, disable_link_emission, enable_link_reception, disable_link_reception to register required *collision events* and *linking actions*
- API users **should** use PySI built-in capabilities and attributes if available e.g. PySI.CollisionCapability.DELETION (for collision with deletion region) or PySI.LinkingCapability.POSITION (for linking to position attribute)

The QML File

Goal

- API Users **must** use qml-files to define which styling an *effect* applies to its associated *interactive regions* beyond flat coloring
- API Users **must** place qml-files next to their associated SI-Plugins within the *plugins* folder for being usable by SIGRun
- QML-files and plugin-files **should** come in pairs
- Plugin-files *+may** have no associated qml-file
- QML[4] facilitates styling and modifying the style of regions at runtime for API Users

Naming Convention

- QML-files **must** have exactly the same name as their associated plugin-files except for their file endings
- example: MyEffect.py and MyEffect.qml

Structure

```
Item
{
    function updateData(data)
    {
        // apply data
        // e.g.
        // image.width = data.width;
    }

    id: container
    visible: true

    // further QML components such as Item, Image, etc.
    // .
    // .
    // .
}
```

Summary:

- API Users **must** view the axis-aligned bounding box of a shape or contour of an *interactive region* as a container for QML components
- API Users **must** conform to QML-Syntax
- API Users **must** provide a function *updateData(data)* which takes exactly one argument
- API Users **must** use the *updateData(data)*-function to update qml-file and styling at runtime
- API Users **should** define one *Item* in the qml-file which contains all other qml-components
- API Users **may** change the parameter *data* to another identifier of their choosing

Data Application Data originates from python calls in a SI-Plugin

```
self.set_QML_data("width", 200, PySI.DataType.INT)
self.set_QML_data("height", 300, PySI.DataType.INT)
self.set_QML_data("visible", True, PySI.DataType.BOOL)
```

and then data is applied in QML for registering the styling changes

```
Item
{
    function updateData(data)
    {
        // update the width, height and visibility of the container with data
        //    received from the associated plugin-file
```

```
        // the key/value pairs of data-parameter are equal to the ones specified
        //    in set_QML_data
        container.width = data.width;  // container.width now has the value 200
        container.height = data.height;  // container.height now has the value
        //    300
        container.visible = data.visible;  // container.visible now has the
        //    value true
    }

    id: container
    visible: false

    // further QML components such as Item, Image, etc.
    // .
    // .
    // .
}
```

Summary:

- *data*-parameter is of type JavaScript-Object
- API Users **must** use the *updateData(data)*-function to update qml-file and styling at runtime
- API Users **must** use common JavaScript for the *updateData(data)*-function
- API USers **must** call the function *self.set_QML_data(key, value, datatype)* from within the python plugin to change data in the qml-file
  - *key*-parameter directly translates to the key identifier in the JavaScript object *data* (example: self.set_QML_data("width", 100, PySI.DataType.INT) will result in data.width = 100)
  - *value*-parameter depicts the value assigned to the perviously specified key of the *data*-object
  - *datatype*-parameter is required by SIGRun to transfer the data changes to QML
- API Users **must** assign values of the *data*-object to qml-components predefined in the qml-file
- API Users **may** use this procedure to update any qml-component which is supported by QML such as Image, Item, etc.

Use Of Non-Plugin Python Files

Goal API Users **may** perform *code decomposition* by defining python files and classes which SIGRun **must not** treat as SI-Plugins

Naming Convention

- Classes in Non-Plugin Python Files **must** be named with two leading underscores (e.g. class __MyClass)

- Non-Plugin Python Files **may** contain classes
- API Users **may** name Non-Plugin Python Files as they chose

Structure Non-Plugin Python File

```
# module level functions
# SIGRun scans for classes and ignores module level functions per default
def do_job():
    pass

# static class for helper functions (e.g. for better definition of namespaces)
# __ as name prefix prevents SIGRun to read it as a SI-Plugin
class __MyHelperFunctions:
    @staticmethod
    def do_work():
        pass

    #function
    # .
    # .
    # .

# class defining behaviour or serving as a complex datastructure for use in
# plugins

# __ as name prefix prevents SIGRun to read it as a SI-Plugin
class __MyHelperDatastructure:
    def __init__(self, args, kwargs):
        # assignment
        pass

    # functions
    # .
    # .
    # .
```

Summary:

- Non-Plugin Python Files **must not** contain classes which names do not start with two leading underscores
- API Users **should** use Non-Plugin Python files for decomposition purposes
- Non-Plugin Python Files **may** have module level functions
- Non-Plugin Python Files **may** have classes

PySI Internal Bindings to C++-Datastructures

The following sections describes the special datastructures of PySI which **must** be used in SI-Plugins. These datastructures originate from SIGRun and are exposed via C++-bindings which are generated with Boost.Python. The PySI API streamlines their usage.

Point2

```
p = PySI.Point2(5, 5)
```

Summary:

- custom datastructure to represent 2D points
- API users **must** provide two float values (x, y) to the constructor
- Point2 is a custom *initialization only* exposure of the datatype *glm::vec2* [5]
- API Users **may not** require to use this datastructure directly

Point3

```
p = PySI.Point3(5, 5, 1)
```

Summary:

- custom datastructure to represent 3D points
- API users **must** provide three float values (x, y, z) to the constructor
- API users **should** should initialize the *z*-value to *1*
- Point3 is a custom *initialization only* exposure of the datatype *glm::vec3* [5]
- API Users **may not** require to use this datastructure directly

Color

```
color = PySI.Color(255, 0, 255, 255)
```

Summary:

- custom datastructure to represent RGBA colors
- API users **must** provide four float values (r, g, b, a) to the constructor
- Color is a custom *initialization only* exposure of the datatype *glm::vec4* [5]

LinkRelation

```
lr = PySI.LinkRelation(source_uuid, source_attrib, target_uuid, target_attrib)
```

Summary:

- custom datastructure to represent linking relationships
- API Users **must** provide four str values (source_effect_uuid, source_effect_attribute, target_effect_uuid, target_effect_attribute) to the constructor

- API Users **may not** require to use this datastructure directly

PointVector

```
# construction
pts = PySI.PointVector()  # empty
pts = PySI.PointVector([[1, 1, 1], ..., [m, n, 1]]) # list of points

# appending
pts.append(PySI.Point3(x, y, z)) # appending Point3 directly
pts.append([x, y, z]) # appending Point3 python list of exactly three floats
```

Summary:

- custom datastructure to represent a list of Point3 datastructures
- PointVector is usable in a pythonic way equally to python lists
- API Users **must** provide a list of lists of three floats to the constructor or leave it empty
- API Users **must** provide three floats inside the inner list when using python lists for initialization or appending
- API Users **may not** require to use this datastructure directly

LinkRelationVector

```
# construction with list of link relationships
lrv = PySI.LinkRelationVector()  # empty
lrv = PySI.PointVector([[source_uuid, source_attribute, target_uuid,
                         target_attribute], ...])

# appending LinkRelation directly
pts.append(PySI.LinkRelation(source_uuid, source_attrib, target_uuid,
                             target_attrib))

# appending LinkRelation indirectly with python list of exactly four strings
pts.append([source_uuid, source_attrib, target_uuid, target_attrib])
```

Summary:

- custom datastructure to represent a list of link relationships
- LinkRelationVector is usable in a pythonic way equally to python lists
- API Users **must** provide a list of lists of four str values to the constructor or leave it empty
- API Users **must** provide four str-values inside the inner list when using python lists for initialization or appending
- API Users **may not** require to use this datastructure directly

StringVector

```python
# construction
sv = PySI.StringVector()  # empty
sv = PySI.StringVector(["str", "str2", ..., "strn"])  # list of link relationships

# appending
sv.append("str")  # appending str value directly
```

Summary:

- custom datastructure to represent a list of strings
- StringVector is usable in a pythonic way equally to python lists
- StringVector is a custom exposure of **std::vector**
- API Users **must** provide a list of str values to the constructor or leave it empty
- API Users **must** provide a str-value when appending to a StringVector
- API Users **may not** require to use this datastructure directly

PartialContour

```python
# construction is not performed manually

# appending of new cursor id
# adding PointVector value directly
self.__partial_regions__[cursor_uuid] = PySI.PointVector()

# appending of point according to cursor id
# adding PointVector value directly
# adding PointVector value directly
self.__partial_regions__[cursor_uuid].append(PySI.Point3(x, y, 1))
self.__partial_regions__[cursor_uuid].append([x, y, 1])
```

- Custom datastructure to represent a contour/shape which is currently drawn by an end-user
- PartialContour is usable in a pythonic way equally to python dicts
- PartialContour is custom exposure of a **std::map<std::string, std::vector>** datastructure
- PartialContour uses uuids of cursor plugins as key (str value) for values of type PointVector
- API users **must** provide string/PointVector key/value pair to add data
- API users **must** provide a valid uuid of a valid cursor as key
- API Users **must not** call the constructor directly as this is handled by PySI
- API Users **should not** require to use this datastructure directly as it is only required when building a *canvas* plugin
- API Users **should not** build a new *canvas* plugin

String2FunctionMap

```python
# e.g. linking relationships eligible for emission are stored in a
# String2FunctionMap per SI-plugin

def link_emission():
    return "emit"

# construction
link_emit = PySI.String2FunctionMap()
link_emit = PySI.String2FunctionMap({"my_link_attribute_to_emit", link_emission})

# assignment
link_emit["my_link_attribute_to_emit"] = link_emission
```

- Custom datastructure to represent key/value pairs of str-values and python functions
- String2FunctionMap is usable in a pythonic way equally to python dicts
- API Users **must** provide a python dict with str-value keys and functions as values to the constructor or leave it empty
- API Users **may not** require to use this datastructure directly

String2String2FunctionMapMap In linking action source effect:

```python
# emission functions used in example below
def emit_data(self):
    return x, y, z, self._uuid

self.enable_link_emission("my_source_attribute", self.emit_data)
```

In linking action target effect

```python
# e.g. linking relationships eligible for reception are stored in a
# String2String2FunctionMapMap per SI-plugin
self.enable_link_reception("my_source_attribute", "my_target ", self.receive_data)

# number of args is dependant on the number of returned values (tuple) of
# the emission function
def receive_data(self, x, y, z, source_uuid):
    # use data of linking action
    pass

# construction
link_recv = PySI.String2String2FunctionMapMap()

link = {"my_source_link_attribute": {"my_target_link_attribute": self.receive_data}
link_recv = PySI.String2String2FunctionMapMap(link)

# assignment
```

```
link_recv["my_source_link_attribute"]["my_target_link_attribute"] = self.receive_data
```

- Custom datastructure to represent key/value pairs of str-values and String2FunctionMap
- String2String2FunctionMapMap is usable in a pythonic way equally to python dicts containing values of dicts
- API Users **must** provide a python dict with str-value keys and dicts as values, which represent String2FunctionMap, to the constructor or leave it empty
- API Users **may not** require to use this datastructure directly

Example: Implementation of a Tag-Effect

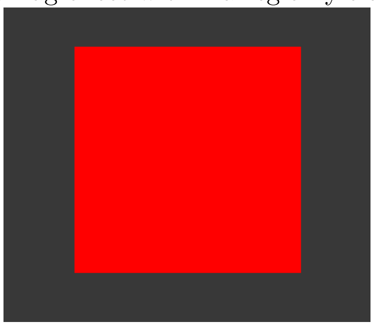
Goal:

- Implement an effect to visually tag a colliding region with a blue square

Building Tag.py

```python
from libPySI import PySI

from plugins.standard_environment_library.SIEffect import SIEffect


class Tag(SIEffect):
    regiontype = PySI.EffectType.SI_CUSTOM
    regionname = PySI.EffectName.SI_STD_NAME_TAG
    region_display_name = "Tag"

    def __init__(self, shape=PySI.PointVector(), uuid="", kwargs={}):
        super(Tag, self).__init__(shape, uuid, "res/tag.png", Tag.regiontype,
                                  Tag.regionname, kwargs)
        # specify which qml file to use
        self.qml_path = "plugins/standard_environment_library/tag/Tag.qml"

        # specify which color a region having the tag-effect should have
        self.color = PySI.Color(255, 0, 0, 255)

        # add and enable the tagging effect by specifying its capability and
        # and assigning its collision event functions
        self.enable_effect("tagging", SIEffect.EMISSION, self.on_tag_enter_emit,
                           self.on_tag_continuous_emit, self.on_tag_leave_emit)

    # define the functions needed for collision events with the "tagging" capability

    # when another eligible effect first collides with this one, emit that the
```

```
    # other one should be tagged
    def on_tag_enter_emit(self, other):
        return True

    # it makes no sense to redundantly tag the other effect on every collision
    # event, so we leave this blank
    def on_tag_continuous_emit(self, other):
        pass

    # we want to keep the tag beyond collision, so we leave this also blank
    def on_tag_leave_emit(self, other):
        pass
```

Using the Tag-effect within a region yields something like this when drawn in SIGRun: 

Even though we specified a texture path (res/tag.png) in the constructor and specified a qml-file path (plugins/standard_environment_library/tag/Tag.qml), we do not see the texture on top of our region. In order to to make this styling visible we have to build the qml-file which associated with the Tag-effect.

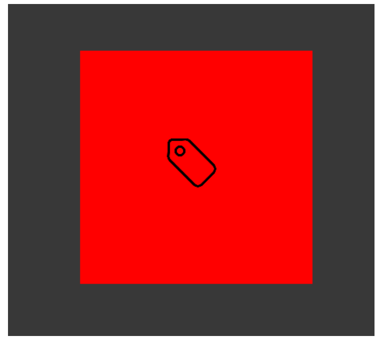
Building Tag.qml

```
import QtQuick 2.7

Item
{
    // apply data provided by the SI-plugin
    function updateData(data)
    {
        image.width = data.img_width;
        image.height = data.img_height;
        image.source = data.img_path;

        image.anchors.leftMargin = data.widget_width / 2 - image.width / 2;
        image.anchors.topMargin = data.widget_height / 2 - image.height / 2;
    }
```

```
    id: container
    visible: true

    Image {
        id: image
        anchors.left: parent.left
        anchors.top: parent.top

        visible: true
    }
}
```

Above example is the default qml-file for each SI-Plugin. It provides the functionality to draw a texture on top of a region and center it in the region. This file can automatically be created if the SIQML file template is used. PySI SIEffect automatically manages texture application once a texture path is provided in the constructor of an effect. This may look like this (in SIEffect constructor):

```
self.texture_path = texture_path

if self.texture_path != "":
    ## member attribute variable storing the width of a texture of a region
    # drawing as a float
    #
    # This value is only set if texture_path is a valid path
    self.texture_width = 75

    ## member attribute variable storing the height of a texture of a region
    # drawing as a float
    #
    # This value is only set if texture_path is a valid path
    self.texture_height = 75

    # apply data in QML
    self.__set_data__("img_width", self.texture_width, PySI.DataType.INT)
    self.__set_data__("img_height", self.texture_height, PySI.DataType.INT)
    self.__set_data__("img_path", self.texture_path, PySI.DataType.STRING)
    self.__set_data__("widget_width", self.width, PySI.DataType.FLOAT)
    self.__set_data__("widget_height", self.height, PySI.DataType.FLOAT)
```

Now that we have created a qml-file for our SI-Plugin, we finally can see the region texture on top of our region: 

Now that we can fully draw our newly created Tag-effect in SIGRun, we want to see it in action. In order to do so, we have to adjust or create effects which can receive Tag-effects.

Adjusting a receiver effect

For this example, we expand the TextFile-plugin from the SI standard environment library. First, we have to enable the Tag-effect in TextFile.py.

```python
# in the constructor
# note that the "tagging" capability has to be received here
# we only implemented on_enter in Tag.py so here we only need on_enter as well
self.enable_effect("tagging", self.RECEPTION, self.on_tag_enter_recv, None, None)

# outside of the constructor but inside the class, we have to define
# on_tag_enter_recv
# note that we have the is_tagged parameter due to returning one value
# in the emission function in Tag.py
# modify qml in order to show the tag on a region having the TextFile-effect
def on_tag_enter_recv(self, is_tagged):
    self.set_QML_data("visible", is_tagged, PySI.DataType.BOOL)
```

Additionally, we have to adjust TextFile.qml as well to support this new functionality. In updateData(data)-function we add the line:

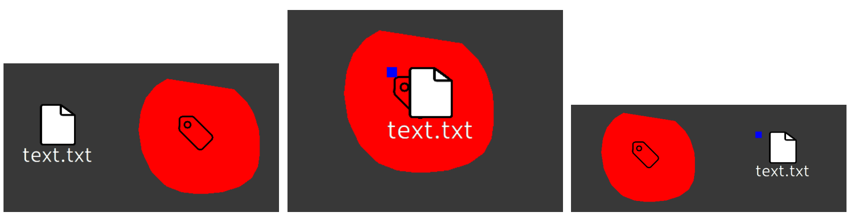
```
function updateData(data)
{
    // .
    // .
    // .

   tag.visible = data.visible;
}
```

And within the container component (*Item*), we add a *Rectangle* component:

```
Item
```

```
{
    function updateData(data)
    {
        // .
        // .
        // .

        tag.visible = data.visible;
    }

    id: container

    visible: true

    // .
    // .
    // .

    Rectangle {
       id: tag
       width: 15
       height: 15
       color: "blue"
       visible: false
    }
}
```

And finally after that, we can visually tag our TextFiles:



However, this is a minimal example for visually tagging a TextFile. Of course, you can expand this approach by passing meta data, use different colors and shapes, according to your preferences and requirements.

A More Complex Use Case Example: Plot.py and Plot.qml

Preface:

The Tag-Effect is fairly simple and may hide the possibilities of SI, or at least makes it more difficult to grasp what is actually possible. To see the more powerful side of SI, you should have a look at the following sections. In that sections, an SI-Plugin is implemented which displays the result of a **matplotlib** plot within an *interactive region*.

Prerequesites:

- SIGRun *must* represent *interactive regions* as Qt5 QWidgets which *should* have exactly one QML QQuickWidget as a child object
- SIGRun *must* apply the size of the axis-aligned bounding box (AABB) of a region drawing to that region's Qwidget's size to be displayed correctly
- SIGRun *may* display regions in unexpected ways if data such as images exceed the regions' AABB's or qml container component's dimensions

Application:

- API Users *must* define a new and big enough shape or contour of an effect's associated *interactive region* for data such as images to be properly displayed by SIRen if the region's original AABB's are exceeded
- API Users *must* define new and big enough dimensions of the container component in the associated qml file for data such as images to be properly displayed by SIRen if the region's original qml container component's dimenions are exceeded

```
from libPySI import PySI
from plugins.standard_environment_library.SIEffect import SIEffect
import matplotlib
matplotlib.use('Agg')  # required
import matplotlib.pyplot as plt
import numpy as np

class Plot(SIEffect):
    regiontype = PySI.EffectType.SI_CUSTOM
    regionname = "__PLOT__"
    region_display_name = "Plot"

    def __init__(self, shape=PySI.PointVector(), uuid="", kwargs={}):
        super(Plot, self).__init__(shape, uuid, "res/dot-plot.png",
                                   Plot.regiontype, Plot.regionname, kwargs)
        self.qml_path = "plugins/standard_environment_library/plot/Plot.qml"
        self.color = PySI.Color(63, 136, 143, 255)

        # matplotlib code required to plot a graph
        figure = plt.figure()
        plot = figure.add_subplot(111)

        x = np.arange(0, 100, 0.1)
        y = np.sin(x) / x
        plot.plot(x, y)
```

```
    # retrieve the plot as numpy.ndarray
    np_fig = self.fig_2_ndarray(figure)

    # get image dimensions
    self.width, self.height, _ = np_fig.shape

    # get effect's associated region's current x and y coordinates
    # (top left corner of region's axis-aligned bounding box)
    # for relative_x_pos() and relative_y_pos() see code documentation of PySI
    x = self.relative_x_pos()
    y = self.relative_y_pos()

    # current shape may be too small to contain the complete image
    # recompute shape according to image size at the regions position
    # now image exactly fits into the shape (and therefore Qt5 QWidget)
    self.shape = PySI.PointVector([[x, y], [x, y + self.height],
                                   [x + self.width, y + self.height],
                                   [x + self.width, y]])

    # assign new data to QML for styling
    self.set_QML_data("image", np_fig.tobytes(), PySI.DataType.BYTES,
                      {"width": self.width, "height": self.height})

    self.set_QML_data("img_width", self.width, PySI.DataType.INT)
    self.set_QML_data("img_height", self.height, PySI.DataType.INT)

    # adjust the container component's dimensions to fith the target image
    # adjust the container component's width to target image's width
    self.set_QML_data("widget_width", self.width, PySI.DataType.FLOAT)
    # adjust the container component's height to target image's height
    self.set_QML_data("widget_height", self.height, PySI.DataType.FLOAT)

# helper function for getting a plot as numpy.ndarray
def fig_2_ndarray(self, fig, mode="rgba"):
    fig.canvas.draw()

    w, h = fig.canvas.get_width_height()
    buf = np.fromstring(fig.canvas.tostring_argb(), dtype=np.uint8)
    buf.shape = (w, h, 4)

    if mode == "rgba":
        # convert to rgba
        buf = np.roll(buf, 3, axis=2)
        return buf
    elif mode == "argb":
        return buf
```

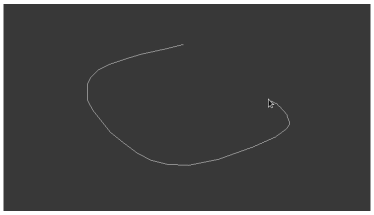
QML-file:

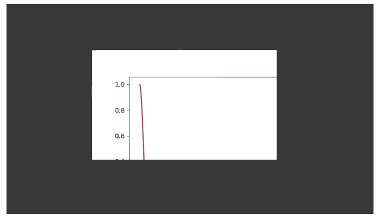
```
import QtQuick 2.7
import siqml 1.0

Item {
    function updateData(data) {
        if(data.image)
        {
            plot_texture.image = data.image;
            plot_texture.width = data.img_width;
            plot_texture.height = data.img_height;

            plot_texture.anchors.leftMargin = data.widget_width / 2 - plot_texture.width / 2
            plot_texture.anchors.topMargin = data.widget_height / 2 - plot_texture.height /
        }

        idle_texture.width = data.icon_width;
        idle_texture.height = data.icon_height;
        idle_texture.source = data.img_path;

        idle_texture.anchors.leftMargin = data.widget_width / 2 - idle_texture.width / 2;
        idle_texture.anchors.topMargin = data.widget_height / 2 - idle_texture.height / 2;
    }

    id: container
        visible: true

    Image {
        id: idle_texture

        anchors.left: parent.left
        anchors.top: parent.top
    }

    PlotItem {
        id: plot_texture
    }
}
```

Without adjusting the shape and qml container component of the target *interactive region*, behaviour such as this can be expected:

```
    # shape and container will not be adjusted
    # self.shape = PySI.PointVector([[x, y], [x, y + self.height],
    #                                 [x + self.width, y + self.height], [x + self.width, y]]),
    #
```

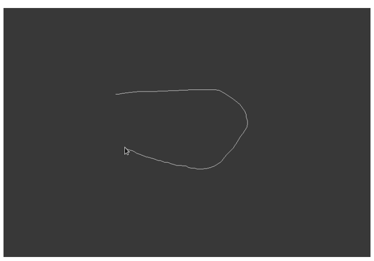
```
# self.set_QML_data("widget_width", self.width, PySI.DataType.FLOAT)
# self.set_QML_data("widget_height", self.height, PySI.DataType.FLOAT)
```

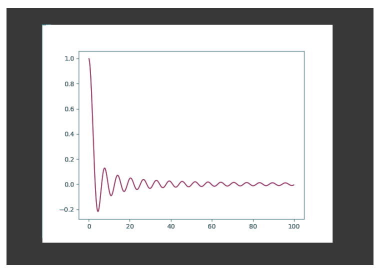




However, adjusting the shape of the target region yields the desired output:

```
# shape will be adjusted
self.shape = PySI.PointVector([[x, y], [x, y + self.height],
                              [x + self.width, y + self.height], [x + self.width, y]])

self.set_QML_data("widget_width", self.width, PySI.DataType.FLOAT)
self.set_QML_data("widget_height", self.height, PySI.DataType.FLOAT)
```





Summary:

- API Users *must* use self.shape in conjunction with the assignment of a new PySI.PointVector which is initialized with a python list (see example above) to reassign the shape of the effect's associated shape or contour
- API Users *should* compute a new and big enough shape to fit an image which exceeds the region's AABB's current dimensions as the AABB **must** be viewed as the QML container
- API Users *may* encounter unexpected behaviour in terms of rendering a region when its styling data and size do not match

References

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[4] QML. https://doc.qt.io/qt-5/qtqml-index.html

[5] GLM. https://glm.g-truc.net/0.9.9/index.html