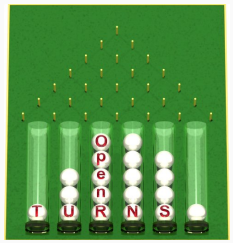

Developing the OpenTURNS documentation

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OpenTURNS Consortium

A few words about the development infrastructure (1/2)

Versioning system

- Git is a software versioning and a revision control system started by Linus Torvalds. It is used for the sources of the platform, the documentation, as well as for the development of modules.
- GitHub is a web-based hosting service for version control using Git. GitHub provides a bug tracker, pull requests (GitLab equivalent: merge requests), continuous integration, and other features.

Official repository and forks

The official repository of the library is `https://github.com/openturns/openturns`.

- All developers have a fork of that repository to host their development branches.
- Only the integrator (and a backup) has write access to the official repository.
- Modules are not part of the library, but some of them are maintained by the consortium: their repositories are hosted at `https://github.com/openturns` and they have the same development process as the library.
- Other modules are hosted elsewhere and do not need to follow the same development process.

A few words about the development infrastructure (2/2)

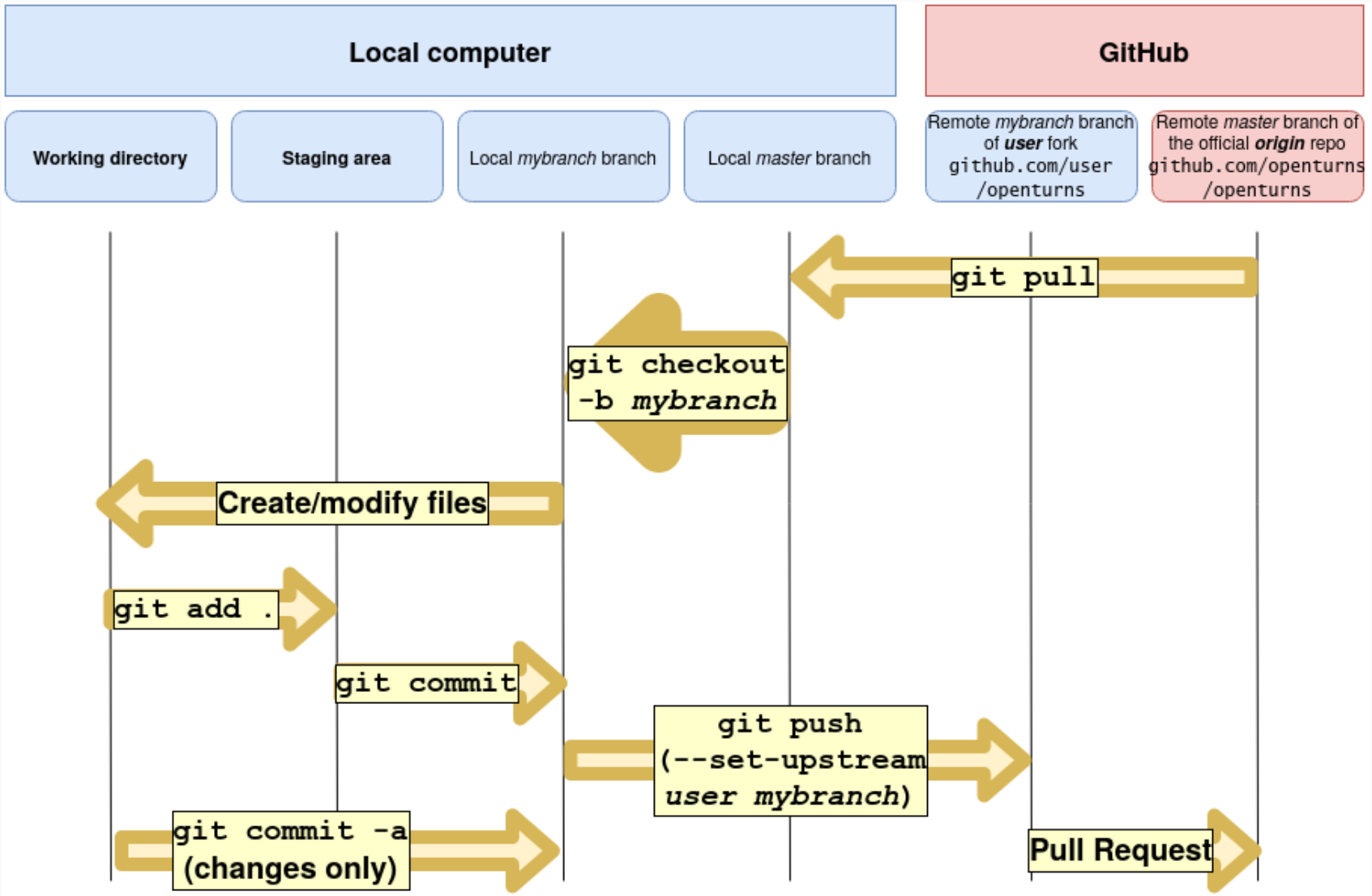
Structure of the library repository
The repository of the library contains source code for the C++ library, the Python interface and the documentation. Its layout is quite standard:

- A master branch that stores the source code of the upcoming version of the platform. The rule is to have only source code that passes all tests.
- Branches for stable versions and tags for releases and release candidates.
- Development branches are part of contributor forks.
- Development branches are merged with master via pull requests.
- At least 2 reviewers must approve the PR, and unanimity is required.

Continuous integration
OpenTURNS makes extensive use of online continuous integration providers to test the library throughout the development process. Currently the following services are used to test the library:

- CircleCI: Linux and MinGW
- GitHub Actions: macOS and Windows

OpenTURNS development workflow



Overview of the OpenTURNS documentation

The OpenTURNS documentation is built using the Python Sphinx package.

One of the Continuous Integration machines (CircleCI `build-linux`) produces the documentation and publishes it online. Several versions are online:

- The version corresponding to the current release has `latest` in its URL: `https://openturns.github.io/openturns/latest/`
- The version corresponding to the master branch has `master` in its URL: `https://openturns.github.io/openturns/master/`
- Older versions are accessible with the version number: `https://openturns.github.io/openturns/1.17/`

If you spot a mistake, make sure you are looking at `master` before correcting!

The built-in search engine distinguishes between 3 main sections:

- Examples
- API (user manual)
- Theory

You may also want to check out:

- Contribute (developer guide)
- Common use cases (added in 2020)

Outline

1. Theory
2. Examples
3. API (user manual)
4. Tips and tricks

Looking up the source file of a theory page

Let us consider the Using QQ-plot to compare two samples page:

`https://openturns.github.io/openturns/master/theory/data_analysis/qqplot_graph.html`

All Theory files are RST and the URL fits the source folder structure, so the relevant source file is: `python/doc/theory/data_analysis/qqplot_graph.rst`

There are great RST and Sphinx cheatsheet available, but here are the basics:

- A page can be indexed as `page_name` by writing `.. _page_name:` at the top.
- Because of this, that page can be linked to from anywhere in the doc with `:ref:‘page_name‘`
- Titles are underlined (the number of underlining characters must match the title).
- Inline math is LaTeX code with `$a=b$` replaced with `:math:‘a=b‘`.
- Display math is LaTeX code with `$$a=b$$` replaced with

```
.. math::
    a = b
```

- Macros are defined in `python/doc/math_notations.sty`
- Try to use notations consistent with other theory pages.
- The bibliography can be found at `python/doc/bibliography.rst`

Adding a new theory page

Code of the main table of contents (python/doc/theory/theory.rst):

```
.. _theory:

======
Theory
======

The theoretical documentation.
This contains an in-depth description of all algorithms.

.. toctree::
    :maxdepth: 2

    data_analysis/data_analysis.rst
    probabilistic_modeling/probabilistic_modeling.rst
    meta_modeling/meta_modeling.rst
    reliability_sensitivity/reliability_sensitivity.rst
    numerical_methods/numerical_methods.rst
```

Table of contents of subdirectories are essentially the same.

What holds for the Theory section also mostly holds for the Contribute (developer guide) and Common use cases sections.

Outline

1. Theory
2. Examples
3. API (user manual)
4. Tips and tricks

Looking up the source Python script of an example

The Examples section is produced by Sphinx-gallery, a Sphinx extension.

Let us consider the Kriging with an isotropic covariance function example:

`https://openturns.github.io/openturns/master/auto_meta_modeling/kriging_metamodel/plot_kriging_isotropic.html`

Example source files are Python scripts. The URL is still linked to the the source folder structure, but the `auto_` part is a Sphinx-gallery artifact. Its source file is:

`python/doc/examples/meta_modeling/kriging_metamodel/plot_kriging_isotropic.py`

- Use `# %%` to start a new cell.
- Write Python code as you normally would.
- Write text as RST code, but each RST line must start with `#`.
- A cell can contain both RST and Python code, but RST must come first.
- RST rules are the same as in the Theory section.
- A blank line interrupts RST code and switches to Python. For the remainder of the cell, lines starting with `#` are simply interpreted as Python comments.
- By default, the first image is used as thumbnail picture. To use e.g. the third: `# sphinx_gallery_thumbnail_number = 3` (ideally right above the plot code)

Adding a new example

- Normally, you should not need to change `python/doc/examples/examples.rst`.
- Every subfolder has a `README.txt` file, which is actually an RST file that only contains a label for hypertext links and the subsection title.
- All source Python scripts are automatically detected and used to build HTML examples and the corresponding thumbnails, provided their name follows the `plot_xxx.py` template.
- No need to index the files, just put them in the appropriate subfolder.
- You can use the docstring at the start of the file not only to write the title of the example, but also the introductory text. This docstring is the only part of the script that is interpreted as RST code without a # at the start of every line.
- Hypertext links help users connect various aspects of the library:
  - `:class:‘~.openturns.ClassName‘` to link to the API doc of a class.
  - `:meth:‘~.openturns.ClassName.method‘` to link to the API doc of a class method.
  - `:ref:‘_theory_page‘` to link to a Theory doc page using its RST label.
  - `:doc:‘/auto_category/subcategory/plot_xxx‘` (no `.py`) to link to another example.
- Python scripts should be properly formatted according to the PEP8.
  Use Black to format them automatically if needed.
- Examples should combine several classes in order to do something useful.

Examples section: write interesting English (1/2)

In the Examples section, the English content should be an interesting explanation of the Python content.

Do not write:

```
# %%
# Draw the function

n = 10000
sampleX = im.distributionX.getSample(n)
sampleY = im.model(sampleX)
[...]
plotXvsY(sampleX, sampleY)
```

Examples section: write interesting English (2/2)

Write instead:

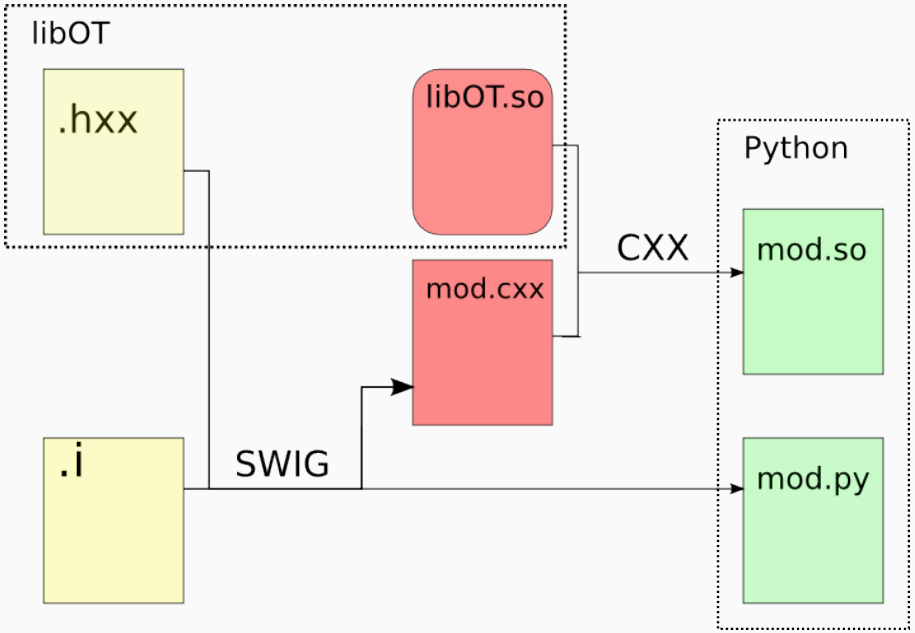
```
# %%
# In the next cell, we create a large sample of the input random
# vector and evaluate the corresponding output from the physical
# model. We then create a function which takes the input and output
# samples as input argument and creates a grid of scatter plots.

n = 10000
sampleX = im.distributionX.getSample(n)
sampleY = im.model(sampleX)
[...]
plotXvsY(sampleX, sampleY)

# %%
# We see that the variance of the output is mostly sensitive to the
# first variable :math:`X_1`.
# The variance of the output is not sensitive to the third
# variable, since the conditional variance is zero.
```

Outline

1. Theory
2. Examples
3. API (user manual)
4. Tips and tricks

SWIG: Simplified Wrapper and Interface Generator

A tool to link C/C++ libraries with script languages
SWIG parses the library headers (`.hxx`) and swig interface files (`.i`) to generate the corresponding module source that must be compiled to produce a binary Python module.



Python docstrings are written in `_doc.i.in` files which supplement the SWIG `.i` files.

These docstrings are then read by Sphinx to build the API doc section.

Looking up the sources of docstrings

Let us consider the LinearCombinationFunction class and its source file:
`https://openturns.github.io/openturns/master/user_manual/_generated/openturns.LinearCombinationFunction.html`
python/src/LinearCombinationFunction_doc.i.in

- Docstring sources are in `src` rather than `doc` because they are part of the library.
- A docstring is just a string `"..."`: double quotes are thus forbidden inside, use `'...'` instead (not to be confused with `` `...` `` as in `` :math:`...` ``). Do not put any whitespace between the opening `"` and the first docstring character, nor between the last docstring character and the closing `"`.
- Docstrings follow Numpydoc style. RST rules remain the same.
- Example code lines start with `>>>` and are run during Python tests! If you call `print`, you need to specify the expected output or the test will fail.
- Numerical values can differ slightly between platforms. To prevent CI failures, you may replace the last digits with an ellipsis: `0.34023...` instead of `0.3402362897`
- Class inheritance extends to docstrings: `LinearCombinationFunction` inherits all its method docstrings from `FunctionImplementation`: look for the docstrings in `python/src/FunctionImplementation_doc.i.in`.
- `FunctionImplementation` has no HTML page, although it has many docstrings. Instead, those docstrings are used to produce the HTML file of Function. This holds for almost all Interface/Implementation couples.

Docstrings of a new class and/or method: SWIG part

To get the docstrings to appear in the Python library:

- Create a docstring file `python/src/MyClass_doc.i.in`
- Declare the class docstring: `%feature("docstring") OT::MyClass`
- Declare a method docstring: `%feature("docstring") OT::MyClass::myMethod`
- Two ways are available to actually create the docstring:
  1. Write the docstring between double-quotes right under the declaration.
  2. Make it a variable so it can be used in several different places:

     ```
     %define OT_MyClass_(myMethod)_doc
     "..."
     %enddef
     ```

- For a new class, do not forget to declare the docstrings in `MyClass.i`: `%include MyClass_doc.i`
- For a new Interface/Implementation couple, define the docstrings in `XxxImplementation_doc.i.in` with `%define` to be able to reuse them in the Interface docstrings file `Xxx_doc.i.in`: see `python/src/Function_doc.i.in` and `python/src/FunctionImplementation_doc.i.in` for example.

Docstrings of a new class: Sphinx part

Sphinx looks at `python/doc/user_manual` for the structure of the API documentation.

For example, LinearCombinationFunction is referenced in `python/doc/user_manual/functions.rst`

To get your new class to appear in the HTML API doc section:

- Find the RST file of the appropriate subsection.
- Insert the name of your class where you want it to appear.
- Make sure it uses the correct template, otherwise use the `:template:` directive.

Templates are found in the `python/doc/_templates` folder. The main templates are:

- `class.rst_t`
- `classWithPlot.rst_t`

If you want to use `classWithPlot.rst_t`, you need to provide the code to generate the graph at the top of the page. For example, LinearCombinationFunction runs the code in `python/doc/pyplots/LinearCombinationFunction.py`.

Note that the plot code can be downloaded from the API doc page itself by clicking on "*Source code*".

API example: always document the most significant method

In the API documentation, the most significant method should have an example within the main section, at the top of the help page. This main example should document the *flagship* of the class, that is, the most significant method(s) of the class.

For example, one of the main features of the LinearEnumerateFunction class is its evaluation operator, which is why the first example is:

```
>>> import openturns as ot
>>> enumerateFunction = ot.LinearEnumerateFunction(2, 0.5)
>>> for i in range(10):
>>>     print(enumerateFunction(i))
```

Constrast with examples from the Examples section, which combine several classes in order to do useful Uncertainty Quantification.

Summary of the previous parts

Two tools are involved in the creation of the documentation.

Sphinx:

- Theory files: `python/doc/theory`
- Example files: `python/doc/examples`
- API tables of contents: `python/doc/user_manual`
- API plots: `python/doc/pyplots`
- Math notations are defined in `python/doc/math_notations.sty`

SWIG:

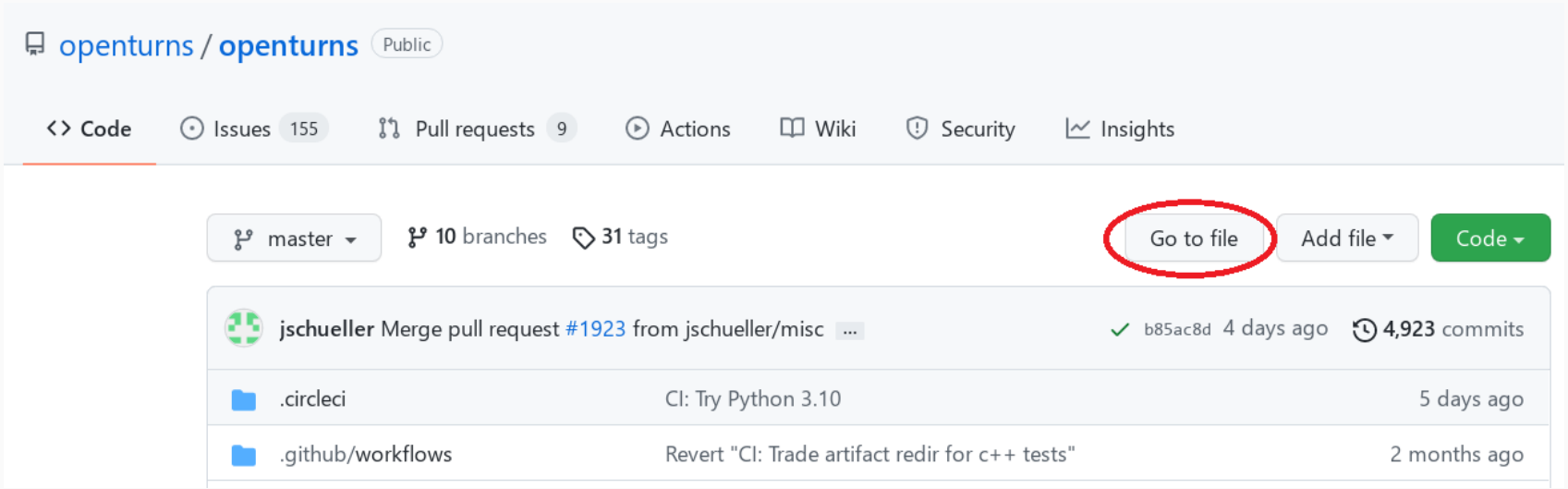
- API docstrings: `*_doc.i.in` files in `python/src`

Docstrings are in `python/src` because they are part of the Python library and not only the HTML documentation.

Outline

Quickly find the appropriate source file

The GitHub "*Go to file*" button does wonders to find the source file you need.



- API: simply type the class name.
- Examples: scroll down to "*Download Python source code*" for the script name.
- Theory: click on "*Show source*", the exact `.rst` file name appears in the URL.

Write clear commit messages: examples

```
Create a quick start example for points and samples
```

```
Add new ResourceMap keys for Mesh checking

We add a new RM key for mesh checking. Default value is set to False
as the method might be costly.
```

```
Doc: Fix keyword in graph example

Closes #1742
```

```
Fixed GaussianNonLinearCalibration

The estimation of distribution of the observations error was
incorrect. It was created using a zero mean to compute the Cholesky
factor of its (known) covariance matrix in order to compute the
residual function, but was not updated once the residual function
was known.

Closes #1529
```

Write clear commit messages: the rules

- First line: a title of 50 characters or less.
- Second line: blank
- Next lines: body of the message with unlimited length.
- If your commit closes an issue, use one of the following keywords in the body:
  - `Close #....`
  - `Closes #....`
  - `Fix #....`
  - `Fixes #....`
  - `Solve #....`
  - `Solves #....`

Some text editors like Vim use syntax coloring to help you remember these rules.

Closing keywords are recognized by GitHub: when your commit enters the master branch, the corresponding issue is automatically closed.

Remember to also use these keywords in the first message of your pull request, so that GitHub registers the PR as fixing the issue.

The first message of the PR should summarize the changes made by the commits of the PR.

Tip for reviewers: always look at the HTML output, not the source file!

CircleCI `build_linux` builds the doc in addition to the library when a PR is submitted.

For easy access, click on the "*Details*" link of the `build_linux artifact` "check".

- The `build_linux artifact` pseudo-check "succeeds" if, and only if, the `build_linux` check succeds. This means that a test failure could cause a red cross to appear in front of both of them, even though the doc was actually successfully generated.
- If the person submitting the Pull Request has CircleCI set up on their fork, then the `build_linux artifact` link is always broken regardless of whether or not the doc was successfully built. You can still access it through the "*Artifacts*" tab in CircleCI after clicking on the `build_linux` "*Details*" link.

Build the documentation with the library

Pass the following option to CMake in order to build the doc with the library:

`-DSPHINX_FLAGS="-j6"` (to build with 6 cores)

Pass the following option to CMake in order to not build the doc:

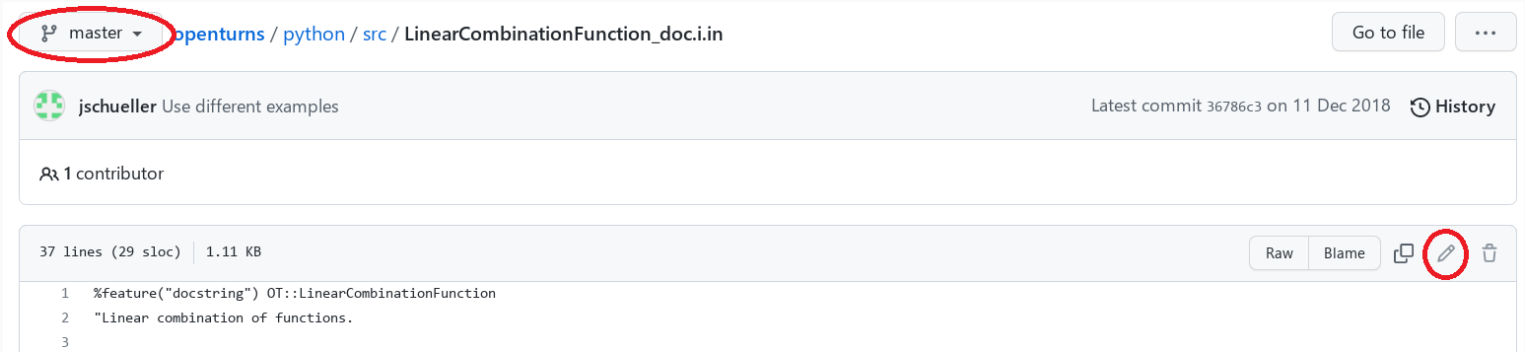
`-DUSE_SPHINX=OFF`

Building the doc takes a while if you build from scratch. It is much shorter afterwards.

Quick patch to the doc (1/2)

You can patch the doc directly from GitHub:

1. Go to the master branch of the official repository: `https://github.com/openturns/openturns`
2. Find the file you want to edit (with "*Go to file*" for example).
3. Click on the pencil button.



4. Make your change and click on "*Preview changes*" to make sure you have not made any mistake.
5. Scroll down to write the title (with 50 characters or fewer) and the body of your commit message. You cannot edit more than one file in a GitHub commit.
6. Click on "*Propose changes*" to:
   - Create a new `patch-1` (or more) branch on your fork.
   - Validate the commit.

Quick patch to the doc (2/2)

7. GitHub will ask if you want to create a Pull Request. If you accept, you are done!
8. If you want to add more commits to your newly created branch, close the tab.
9. Go to your fork and select the `patch-1` (for example) branch from the menu.
10. Edit a file as before and create a new commit.
11. After you have created all the commits you want, create a Pull Request.

Advantage of this method:

- Do everything remotely. No need to worry about local/remote branches.

Drawbacks of this method:

- Only one file can be changed per commit.
- No way to inspect the HTML output before pushing.

Build select parts of the documentation without the library with `docfast.py`

The Python script `utils/docfast.py` can build selected parts of the library and only requires OpenTURNS to be installed, not necessarily compiled.

Prerequisites: python 3.8+, sphinx, sphinx-gallery, numpydoc, openturns, matplotlib.

```
$ docfast.py build-sphinxonly smirnov_test.rst plot_smoothing_mixture.py
```

- `build-sphinxonly` is the name of the build folder: HTML output files will be stored in `build-sphinxonly/install`
- `smirnov_test.rst` is the source file of the Kolmogorov-Smirnov two samples test theory page.
- `plot_smoothing_mixture.py` is the source file of the Bandwidth sensitivity in kernel smoothing example.

Advantages of this method:

- Fast: the command above only builds one example and one theory page.
- Does not require a full compilation environment.

Drawbacks of this method:

- If the installed version ot OpenTURNS is older than `master`, examples relying on new classes or methods will fail.
- Since it does not use SWIG, how can it deal with docstrings?

Docstring handling with `docfast.py`

- Recall: docstring source files are stored in `python/src` as `_doc.i.in` files.
- Sphinx does not deal with them: that is part of SWIG's job.
- In a normal build, SWIG creates the Python library with the docstrings.
- Sphinx reads the docstrings in the Python library, not its source files.

Since Sphinx reads the docstrings of the installed OpenTURNS Python library, `docstring.py` attempts to patch them with the changes made to the `python/src/*_doc.i.in` source files.

By default, it relies on `git diff`: this only takes unstaged changes into account.
You can pass an additional argument to `git diff` with the `--diff` option:

`$ docfast.py --diff master ...` uses `git diff master` instead.

Regardless, to tell `docfast.py` which API page(s) it needs to build, you need to pass the name of a file from `python/doc/user_manual`. They are RST table of content files.

```
$ docfast.py [--diff master] functions.rst plot_smoothing_mixture.py
```

Unfortunately, docstring patches can fail in various ways.
To disable them and build from the installed docstrings, use the `--nodiff` option:

```
$ docfast.py --nodiff functions.rst plot_smoothing_mixture.py
```