Open Access

Fiatlight

Abstract

Fiatlight transforms Python functions into interactive GUI applications using an immediate mode approach.

1. Installation

The recommended way to install fiatlight is from source:

```
git clone https://github.com/pthom/fiatlight.git
cd fiatlight

pip install -r requirements.txt
pip install -v -e .
```

(fiatlight is also available on PyPI, but installing from source makes it easier to access the examples in src/python/fiatlight/demos).

1.a. Install optional dependencies

Several requirements files are provided, which you can install via `pip install -r requirements-<name>.txt`:

- requirements.txt: basic requirements
- requirements-ai.txt: requirements for AI demos
- requirements-audio.txt: requirements for audio demos
- requirements-dev.txt: requirements for development

Note: for AI demos, you may have to install pytorch manually.

Published Apr 01, 2026

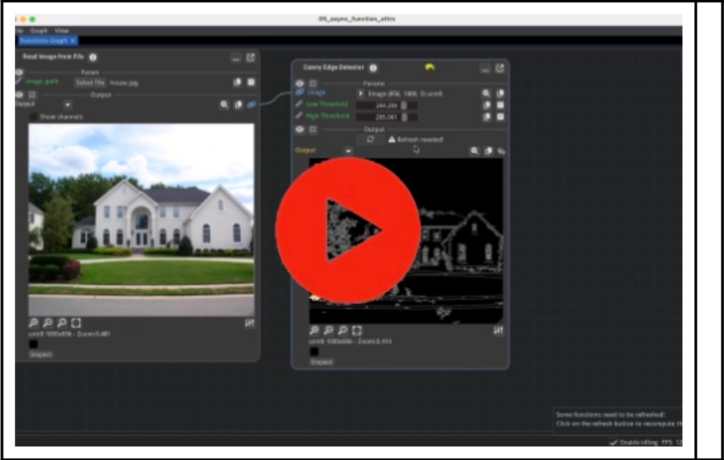
2. Video Tutorials

> **Tip**
>
> The sources for these tutorials are available in fiatlight/src/python/fiatlight/demos/tutorials.

2.a. First Steps Tutorial

Creating GUIs from Functions with Minimal Code

Learn the core concepts of Fiatlight by transforming Python functions into interactive applications. This tutorial demonstrates the fundamental workflow and customization options available.



Key Topics:

- Generate GUIs for any Python function
- Compose functions
- Customize widget behavior using fiat_attributes
- Handle long-running computations
- Automatic state persistence

2.b. Intermediate Tutorial

Exception Handling and Advanced GUI Techniques

Learn about error handling patterns, parameter validation, and custom GUI components.

Key Topics:

- Built-in exception handling with post-mortem debugging capabilities
- Parameter validation using custom validators and runtime checks
- Custom GUI component creation with Dear ImGui integration
- Visual debugging through fiat_tuning to inspect function internals
- Complex function graphs with multiple data flows and GUI nodes

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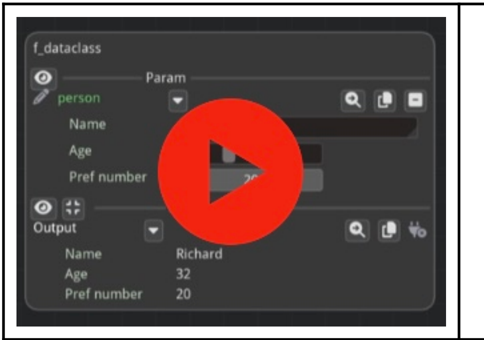
2.c. GUI for Pydantic Models and Dataclasses

Automatic Form Generation from Data Models

Generate validated forms and configuration interfaces directly from dataclasses and Pydantic models. Covers serialization, validation, and customization patterns.



Key Features:

- Automatic GUI generation from existing data model definitions
- Real-time validation with user feedback for invalid inputs
- Customization through fiat_attributes for widget types and constraints
- Built-in serialization and state persistence for Pydantic models
- Structured form layouts with logical field grouping

2.d. Advanced Tutorial

Building a Sorting Algorithm Visualizer

This tutorial walks through the creation of an interactive sorting algorithm visualizer using Fiatlight, in order to explain advanced features.

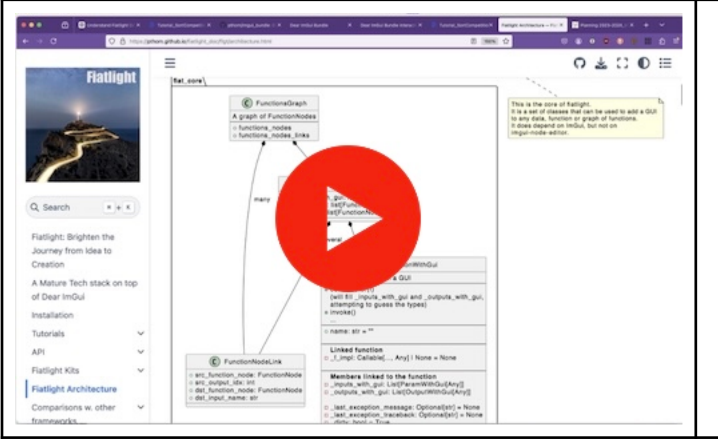
Key Topics:

- Asynchronous function execution with real-time GUI updates
- Custom data visualization using ImPlot for performance charts
- Advanced type registration and GUI customization
- Function composition and workflow management patterns
- Standalone application development and deployment
- Performance monitoring and comparative analysis tools

2.e. Fiatlight Architecture

Understanding the Framework’s Core Components

A technical overview of Fiatlight’s architecture and extension points. Useful for developers who want to understand the framework’s internals or extend its capabilities.



Key Topics:

- Core components: `AnyDataWithGui`, `FunctionWithGui`, `FunctionGraph`
- GUI registry system and type-to-widget mapping mechanisms
- Customization callbacks and data presentation patterns
- Extension points for supporting additional data types

2.f. Full Demo of Fiatlight

A comprehensive Feature Overview:

This video showcases how Fiatlight can rapidly generate UIs for various across different application domains, from AI integration to data analysis and multimedia processing. It is a demo, rather than a tutorial.

Highlights:

- AI-powered meme generator in just 4 lines of code, using Stable Diffusion
- Real-time sorting algorithm visualization: parallel execution and performance comparison
- Tailored kits for image processing, data frames, and audio analysis
- Fine-tuning and debugging with function state introspection

3. First Steps

3.a. *Running functions via Fiatlight*

3.a.i. *Running a single function:*

It is extremely simple to run and test a function with FiatLight. Below is a function that accepts a text path as a parameter and outputs the number of words in this text file.

```
import fiatlight as fl
# Note: TextPath is a synonym for str
#       Within fiatlight, it is associated with a file dialog widget
from fiatlight.fiat_types import TextPath

def count_words(filename: TextPath) -> int:
    """Count the number of words in a text file."""
    with open(filename, "r") as f:
        text = f.read()
    return len(text.split())

# Run the application
fl.run(count_words, app_name="Count Words")
```

Note: TextPath is an alias for str, but it is associated with a file dialog widget in Fiatlight.

3.a.ii. *Composing two functions:*

Below we create a simple application with two functions: "int_source" and "add":

- "int_source" generates an integer value
- "add" adds two or three integer values.

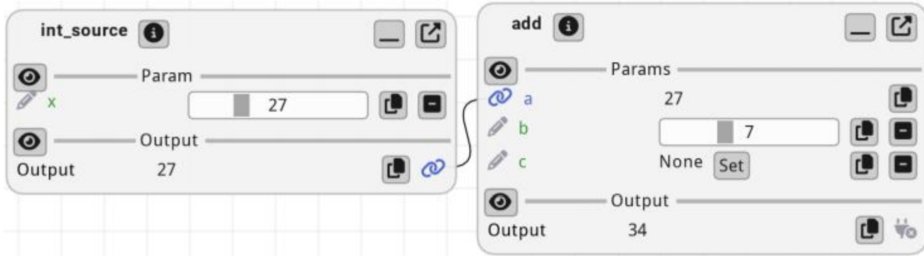
We specify the range of values for the input parameters of the functions using

- either the `fl.add_fiat_attributes` function,
- or the `@fl.with_fiat_attributes` decorator

Finally, we run the application using the "fl.run" function.

Code

```python
import fiatlight as fl


def int_source(x: int) -> int:
    """int_source is the first function of the application
    Since it is not linked to any other function, fiatlight will ask
    the user to specify the value of "x".
    As such, it serves as a source for the next function.
    """
    return x


# Customize the GUI for the `int_source` function. Below, we specify
# the range of values for "x" by adding "fiat_attributes"
fl.add_fiat_attributes(int_source, x__range=(0, 100))


# This second function adds the values of "a", "b", and "c"
# In this case, we add fiat_attributes using a decorator
# to specify the range of values for "a" and "b"
@fl.with_fiat_attributes(a__range=(0, 10), b__range=(0, 20))
def add(a: int, b: int = 0, c: int | None = None) -> int:
    """add is the second function of the application
    It adds the values of "a", "b", and "c" and returns the result.

    In the interface:
    - "a" is linked to the output of int_source and is unspecified
       until "x" is specified in int_source.
    - "b" is equal to its default value (0). It is shown in gray to
       indicate that it is using the default value.
    - "c" is an optional, equal to its default value (None). It is also
shown in gray.
      In order to specify a value for "c", the user must first click on
the
      "Set" button, to specify that this optional has a value, and then
specify the value.
    """
    if c is None:
        c = 0
    return a + b + c


# Run the application, which is a GUI around the composition of the two
functions
# Notes:
#  - if running a single function, you can use fl.run(your_function)
#  - the app_name parameter is optional. It defines the name of the
settings file, and the name of the window
fl.run([int_source, add], app_name="First Example")
```



The image above shows the default state of the application

- int_source:
  - "x" is unspecified
- add:
  - "a" is linked to the output of int_source and is unspecified, since int_source can not be executed (until "x" is specified)
  - "b" is equal to its default value (0). It is shown in gray to indicate that it is using the default value.
  - "c" is equal to its default value (None). It is also shown in gray.

== Video Tutorial of the available controls

The video below shows how to interact with the widgets in a function node

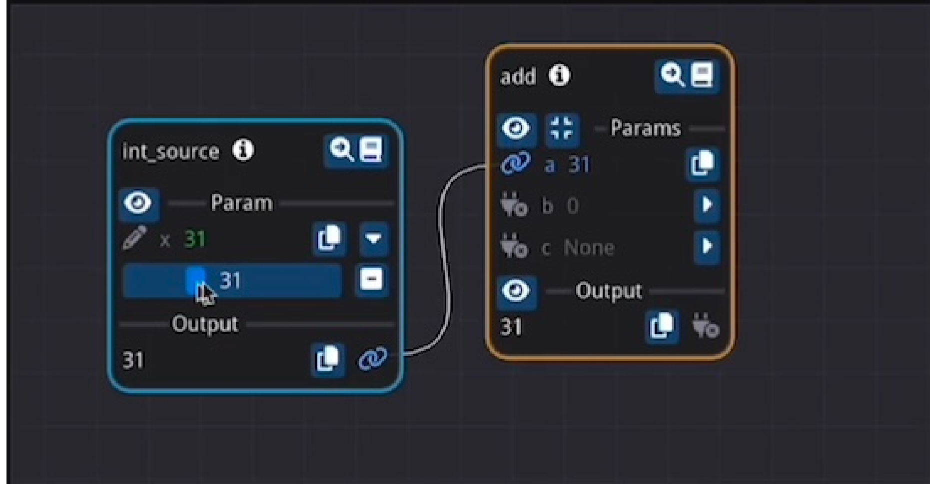


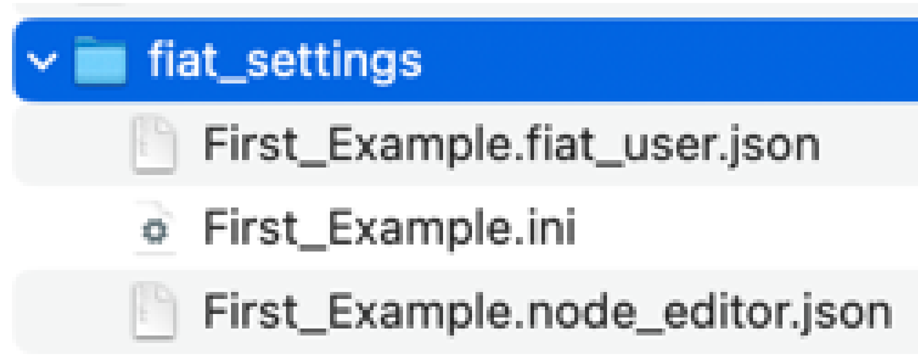
Figure 1: Available controls in a function node

3.b. Save / Load user settings

Automatic user settings saving

Upon exit, Fiatlight automatically saves the user's settings in a folder named `fiat_settings` in the current directory.

The settings are named after the app_name param passed to `fl.run (if app_name is not set, the settings file will use the name of the main application module)



.

Three files are saved each time the application saves the settings:

- First_Example.fiat_user.json: user settings (values of the parameters of the functions)
- First_Example.node_editor.json: settings for the node editor (positions of the nodes)
- First_Example.ini: settings for Dear ImGui (since and positions of the window)

Manually save the user settings

When you manually save the user inputs by clicking on the menu "File / Save user settings", the user settings are saved in a file named "xxx.fiat_user.json", where "xxx" is the file name you selected.

3.c. Additional Run parameters

- **top_most**: `fl.run()` also accept a boolean parameter `top_most` to specify whether the window should stay on top of other windows.
- via **FiatRunParams**: For more control over the application, you can use the `FiatRunParams` class:

```
from imgui_bundle import hello_imgui

params = fl.FiatRunParams(
    app_name="My App",
    window_size=(1920, 1080),
    enable_idling=True,  # Save CPU when idle
    theme=hello_imgui.ImGuiTheme_.darcula_darker,
    remember_theme=True,  # Save user's theme choice
    top_most=False,
    delete_settings=False  # Delete settings on startup
)

# Then, call
#     fiatlight.run(my_function, params=params)
```

3.d. *Running in Jupyter Notebooks*

Fiatlight provides special support for Jupyter notebooks through the `fiatlight.nb` module. This module offers two modes of operation:

1. **Blocking mode** with the standard `fl.run()`: in this mode, the application runs and captures a screenshot when closed, displaying it in the cell output.
2. **Non-blocking mode** with `fl.nb.start()` / `fl.nb.stop()` / `fl.nb.is_running()`

> **Note**
>
> - The `app_name` parameter is **required** when running in notebooks, as it determines where settings are saved.
> - When running in a notebook, it is recommended to pass `top_most=True` to keep the application window above the notebook interface.

3.d.i. *Blocking Mode with Screenshot:*

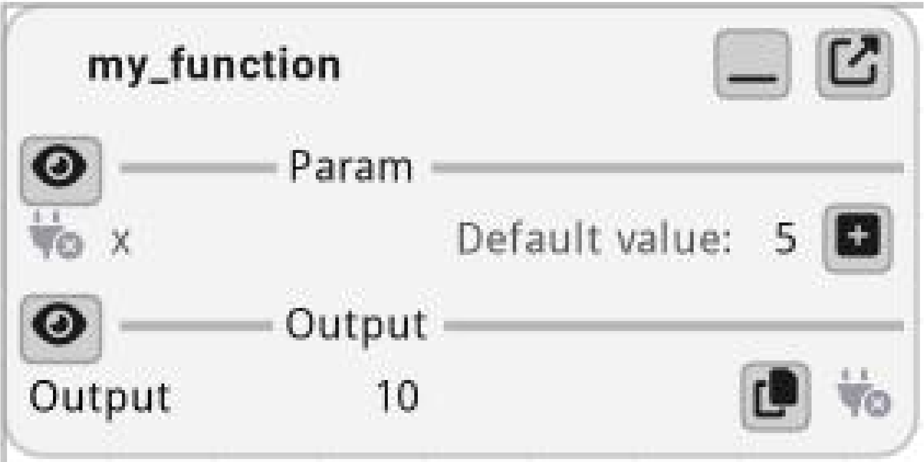
When you call `fl.run()` directly in a Jupyter notebook, Fiatlight automatically:

1. Runs the application in blocking mode: no other cells can be executed until the application window is closed.
2. Captures a screenshot of the application when you close it
3. Displays the screenshot in the notebook cell output

This is useful for documentation and tutorials where you want to capture the final state of the application.

In the cell below, running `fl.run()` will display a screenshot when the window is closed:

```python
import fiatlight as fl

def my_function(x: int = 5) -> int:
    return x * 2

# Run in blocking mode - a screenshot will appear in the output when
closed
fl.run(my_function, app_name="Screenshot Demo", top_most=True)
```



3.d.ii. *Non-Blocking Mode:*

In non-blocking mode, the application runs in the background, allowing you to continue working in your notebook. For this mode, use the following functions from the `fiatlight.nb` module: `fl.nb.start()`, `fl.nb.stop()`, `fl.nb.is_running()`

Starting an Application:

The cell below starts the application without blocking the notebook: the GUI window appears, and you can interact with it while continuing to run other cells. It stays on top of other windows (top_most=True). No screenshot is captured when the application is closed (this is why the cell output below is empty).

```
import fiatlight as fl

def my_function(x: int = 5) -> int:
    return x * 2

# Start the application (non-blocking)
fl.nb.start(my_function, app_name="Notebook App", top_most=True)

# The cell completes immediately, and the GUI runs in the background
```

Checking Status:

```
# Check if an application is running
if fl.nb.is_running():
    print("Application is running")
else:
    print("No application is running")
```

```
Application is running
```

Stopping an Application:

```
# Stop the application
fl.nb.stop()
```

3.e. Async Run

For async workflows, Fiatlight provides `fl.run_async()`, which runs the application asynchronously without blocking the calling code.

`fl.run_async()` accepts exactly the same parameters as `fl.run()`.

example usage:

```
import fiatlight as fl

def my_function(x: int = 5) -> int:
    return x * 2

# You may Run the async function with asyncio, for example:
#    await fl.run_async(my_function, app_name="Async App")
```

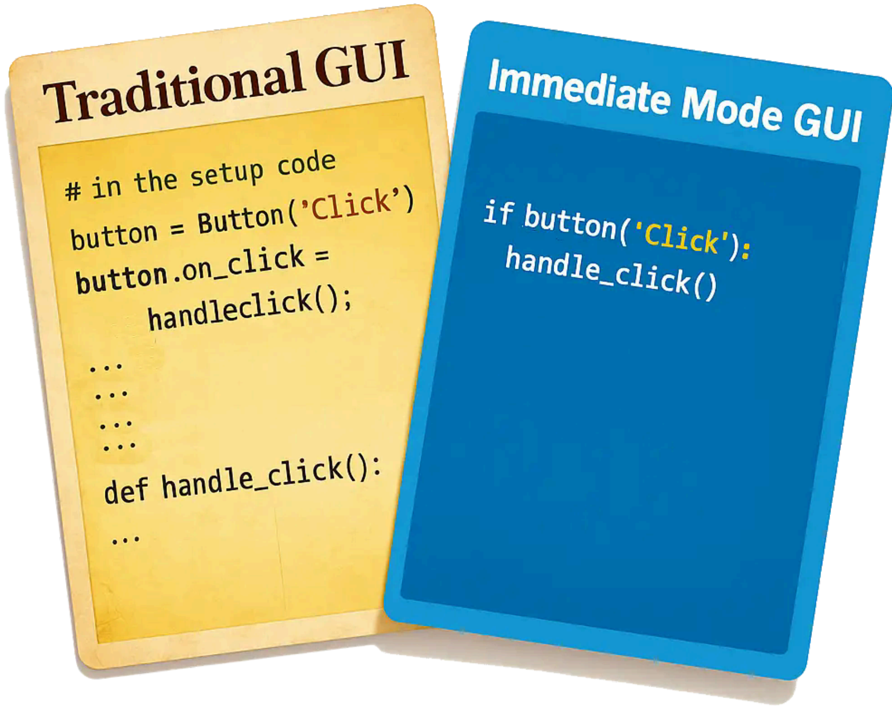
Note: only one instance of fiatlight can run at a time, even in async mode.


```
import fiatlight as fl

def my_function(x: int = 5) -> int:
    return x * 2

# You may Run the async function with asyncio, for example:
#    await fl.run_async(my_function, app_name="Async App")
```

Note: only one instance of fiatlight can run at a time, even in async mode.

4. Immediate Mode GUI with Python

Understanding the foundation that powers Fiatlight



Why Learn About Immediate Mode GUI?

Fiatlight is built on Dear ImGui Bundle, a powerful Immediate Mode GUI library for Python.

Understanding how Immediate Mode GUIs work will help you customize Fiatlight interfaces more effectively, and extend Fiatlight with custom widgets and behaviors

Complete Learning Resource

For a comprehensive introduction to Immediate Mode GUI concepts, deployment options, and practical examples:

Complete Guide: Immediate Mode GUI with Python (opens in a new tab)

5. Manual

Begin with the First steps section to learn how to wrap functions and dataclasses and run them via Fiatlight.

Then, explore the following sections.

5.a. *Introductory topics:*

- Add types to signatures so that Fiatlight can generate a GUI for your functions
- Use fiatlight command line tool to list all supported types and their possible GUI customization options
- Customize widgets using fiat_attributes
- Fully customize any parameter's GUI by writing it by hand
- Add GUI only nodes to your functions graph (i.e. nodes that do not have a function associated with them)
- Run functions asynchronously
- Create GUI for structured data, i.e pydantic models and dataclasses

5.b. *Advanced topics:*

- Validate inputs in the GUI
- Reuse Fiatlight widgets in your own apps, not only in Fiatlight's functions graphs.
- Fully customize functions GUI by subclassing FunctionWithGui
- Fine-tune functions by viewing their internal status. Debug and replay exceptions.
- Create complex functions graph
- Create and register custom widgets for specific types

5.c. *Domain-specific topics:*

Explore Fiatlight Kits, collections of pre-built widgets for specific domains, such as:

- fiat_image: advanced image widget for image processing
- fiat_matplotlib: display matplotlib figures for plotting with Matplotlib
- fiat_dataframe: pandas DataFrame explorer: a widget to display explore pandas dataframes

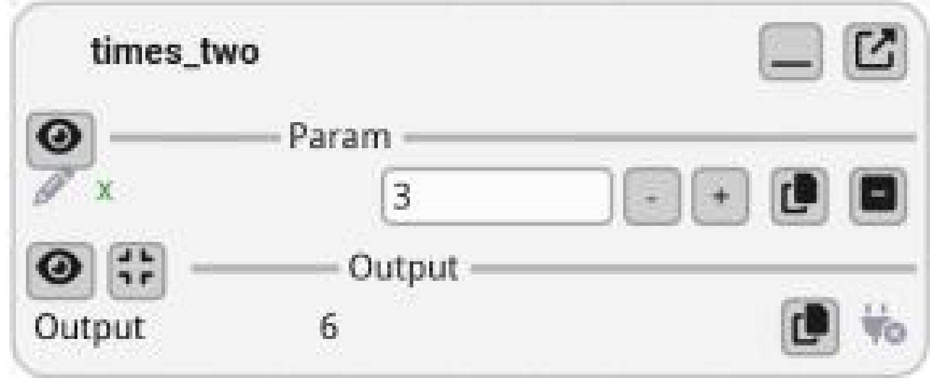
TODO: manual_reuse_widgets

5.d. *Wrapping Functions*

In this tutorial, we will see how to wrap functions in order to make them compatible with Fiatlight.

Most of the time, functions are wrapped automatically. In the example below, the function `times_two` is wrapped automatically by Fiatlight into a `FunctionWithGui` object:

```
import fiatlight as fl
def times_two(x: int) -> int:
    return x * 2
fl.run(times_two, app_name="Times two")  # the function will be wrapped automatically into a FunctionWithGui object
```



> In order to be wrapped automatically, a function must have a typed signature (see Typed signatures).

`FunctionWithGui` is one of the core classes of FiatLight: it wraps a function with a GUI that presents its inputs and outputs.

- **Documentation**: See its API for detailed information.
- **Source code**: View its full code online.

5.d.i. *Typed Signatures:*

Importance of Typed Signatures:

To automatically create a GUI for function parameters, Fiatlight **requires** type information for both the parameters and the return value of the functions. This is achieved using type hints in the function signature.

For example, an untyped function signature looks like this:

```
def foo(a, b):
    return a + b
```

In contrast, a typed version is:

```
def foo(a: int, b: float) -> float:
    return a + b
```

More information about type hints can be found in PEP 484. *Type hints specify the type of a variable in Python. They are not mandatory but are a good practice, as they help catch bugs early in the development process.*

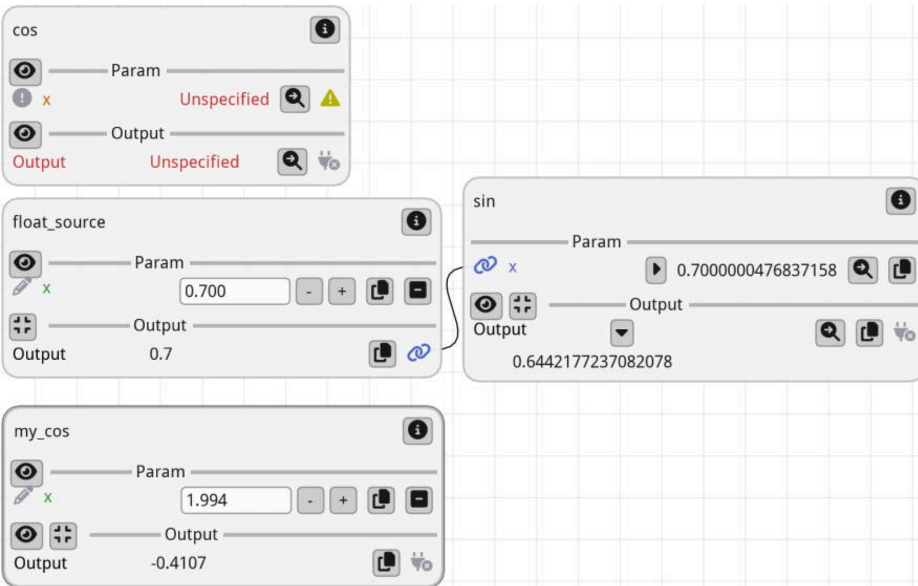
==== Typed vs Untyped Functions GUI

In the example below, `math.sin` and `math.cos` are unfortunately not typed. `my_cos` is a wrapper around `math.cos` that includes type information.

Code

```
import math
import fiatlight as fl


def float_source(x: float) -> float:
    """A float source, where the user can specify the value of x."""
    return x


def my_cos(x: float) -> float:
    """A wrapper around math.cos that adds types,
    so that Fiatlight can infer the widgets in the GUI."""
    return math.cos(x)


# We create a graph of functions, to which we will add functions
manually
graph = fl.FunctionsGraph()

# Add a node that will run math.cos: since this function has no type
information,
# Fiatlight **will not** be able to infer the widgets in the GUI)
graph.add_function(math.cos)

# Add a node that will run my_cos: since this function has type
information,
# Fiatlight **will** be able to infer the widgets in the GUI
graph.add_function(my_cos)

# Add a function composition that will transfer the output of
float_source to math.sin
# (in this case, math.sin will work correctly, since it only has to
display the numerical result,
# and does not require an edition widget)
graph.add_function_composition([float_source, math.sin])
```

```
# Run the graph
fl.run(graph, app_name="Typed Signatures")
```



Visual Output: The image above shows the result of running the above code. Notice the differences in GUI behavior for typed vs untyped functions.

Key Points:

- Since `cos` is untyped, it is impossible to enter a value for its input parameter.
- The function `sin`, however, works correctly in the graph since it receives an input from `float_source` and does not require an edition widget.

Wrapping Functions:

Creating a wrapper is often extremely simple and necessary when dealing with untyped functions. Wrapping a function allows you to add type information, making it compatible with Fiatlight's GUI capabilities. Let's see how to wrap the `math.cos` function.

Why Create a Wrapper?

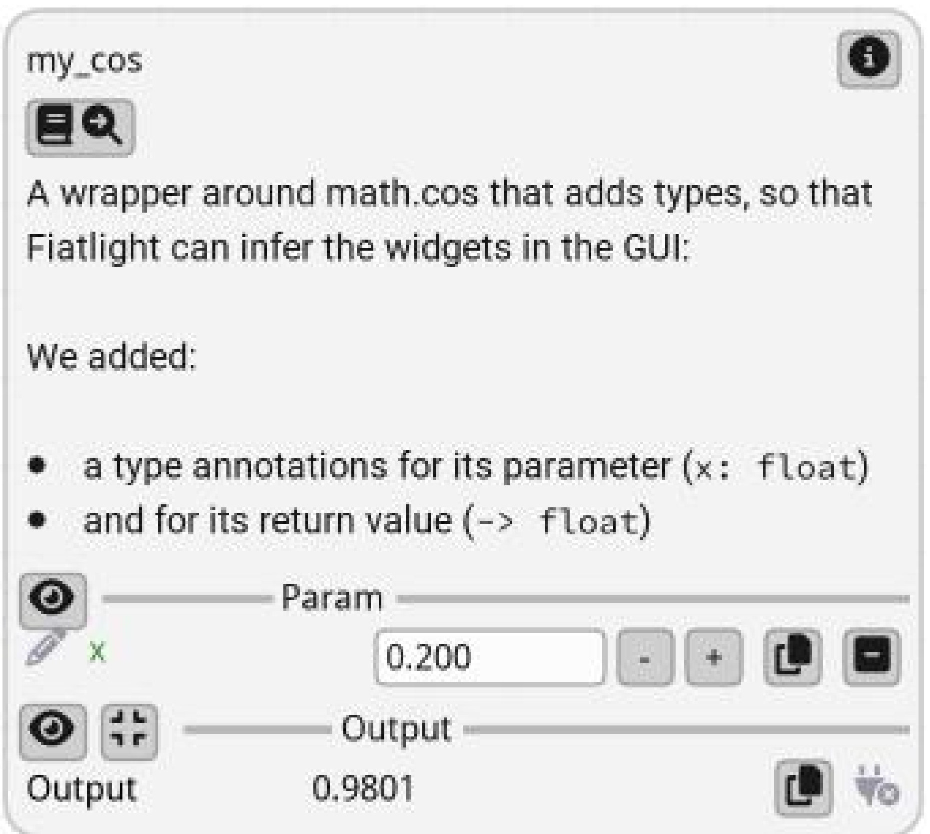
The `math.cos` function from Python's standard library does not have type annotations. Without these annotations, Fiatlight cannot automatically create a GUI for it. By creating a wrapper, we add the necessary type information.

Example: Wrapping `math.cos`

Below, we create a simple wrapper for `math.cos` that includes type annotations. This allows Fiatlight to generate a GUI for the function.

```
import math
import fiatlight as fl
```

```python
# Original function without type annotations
def my_cos(x: float) -> float:
  """A wrapper around math.cos that adds types, so that Fiatlight can
infer the widgets in the GUI:

  We added:
    * a type annotations for its parameter (`x: float`)
    * and for its return value (`-> float`)
  """
  return math.cos(x)

# Run the wrapped function with Fiatlight
fl.run(my_cos, app_name="Wrapped Cosine Function")
```



When running the above code, Fiatlight generates a GUI that allows you to input a float value for `x` and see the result of `math.cos(x)`.

As an additional benefit, the documentation you wrote in the wrapper is visible in the function node!

5.d.ii. *Registered Types:*

Introduction:

Fiatlight maintains a central registry that links data types (e.g., primitive types or custom data types) with GUI types. This registry allows Fiatlight to automatically create GUIs for functions based on their type annotations.

For more information:

- **Gui Registry**: See the documentation for detailed information
- **GUI Types**: The GUI Types are all descendant of `AnyDataWithGui`, which is a generic type that can be used to create custom widgets for your data types. See its API.

Using registered types:

Registered types provide dedicated widgets, enabling automatic GUI creation for function parameters and outputs.

> Tip: use the command `fiatlight types` in a terminal (or console) to list the registered types and their associated widgets. See "Fiatlight command line utility" for more information.

Below is an extract of the output of the `fiatlight types` command:

```
> fiatlight types
+---------------------------------------------------
+-------------------------------------------------------------------
+
| Data Type                                        | Gui Type
|
+==================================================+=================================
| int                                              | IntWithGui
|
|                                                  |   A highly
customizable int widget.                                 |
+---------------------------------------------------
+-------------------------------------------------------------------
+
| float                                            | FloatWithGui
|
|                                                  |   A highly
customizable float widget.                               |
+---------------------------------------------------
+-------------------------------------------------------------------
+
| str                                              | StrWithGui
|
|                                                  |   A Gui for a
string with resizable input text, with a popup for    |
|                                                  | multiline
editing.                                                  |
+---------------------------------------------------
+-------------------------------------------------------------------
```

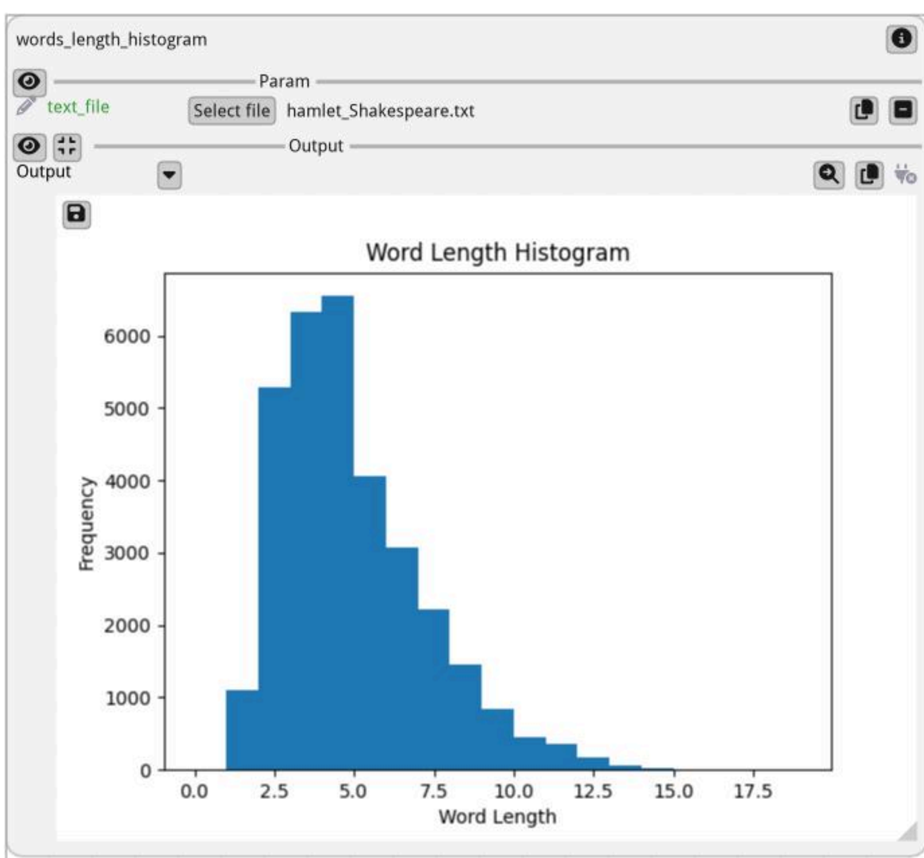
```
+
| bool                                                    | BoolWithGui
|
|                                                         |   A bool widget.
Can use a checkbox or a toggle.                           |
+-----------------------------------------------------
+-----------------------------------------------------------------------
+
| ColorRgb                                                | ColorRgbWithGui
|
|   synonym for tuple[int, int, int] describing an        |   A nice color
picker for RGB colors (int)                                 |
| RGB color, with values in [0, 255] (NewType)            |
|
+-----------------------------------------------------
+-----------------------------------------------------------------------
+
| ...                                                     | ...
|
```

Example with Matplotlib Figures:

Let's look at an example using `TextPath` and `matplotlib.figure.Figure`, which are registered types in Fiatlight:

- `fl.fiat_types.TextPath` is an alias for str, but it is registered to be displayed with a file selection dialog.
- `matplotlib.figure.Figure` is registered to be displayed as a plot in the GUI

```python
import fiatlight as fl
import matplotlib.figure
import matplotlib.pyplot as plt

def words_length_histogram(text_file: fl.fiat_types.TextPath) ->
matplotlib.figure.Figure:
    "Create a histogram of the lengths of words in a text file."
    with open(text_file) as f:
        text = f.read()
    words = text.split()
    lengths = [len(word) for word in words]
    fig, ax = plt.subplots()
    ax.hist(lengths, bins=range(0, 20))
    ax.set_title("Word Length Histogram")
    ax.set_xlabel("Word Length")
    ax.set_ylabel("Frequency")
    return fig


fl.run(words_length_histogram, app_name="Registered types")
```



5.d.iii. *Controlling Function Execution:*

By default, the function will be called only when one of its inputs has changed (either because the user entered a new value, or because an input is connected to another function that has changed).

You can control the behavior of the function by setting attributes on the function object.

- `invoke_async` (default=False): if set to True, the function will be called asynchronously
- `invoke_manually` (default=False): if set to True, the function will be called only if the user clicks on the "invoke" button
- `invoke_always_dirty` (default=False): if set to True, the function output will always be considered out of date. Depending on the value of `invoke_manually`:
  - if "invoke_manually" is True, the "Refresh needed" label will be displayed
  - if "invoke_manually" is False, the function will be called at each frame

Note: a "live" function is thus a function with `invoke_manually=False` and `invoke_always_dirty=True`

==== Configuring "Live" functions

Example: a live function that display a camera image

```
import fiatlight as fl
from fiatlight.fiat_kits.fiat_image import ImageU8_3
import cv2  # we use OpenCV to capture the camera image (pip install
opencv-python)
cap = cv2.VideoCapture(0)  # you will need a camera!

def get_camera_image() -> ImageU8_3 | None:
    ret, frame = cap.read()
    return ImageU8_3(frame) if ret else None

# Set flags to make this a live function (called automatically at each
frame)
fl.add_fiat_attributes(get_camera_image, invoke_always_dirty=True)

fl.run(get_camera_image, app_name="Live camera image")
```

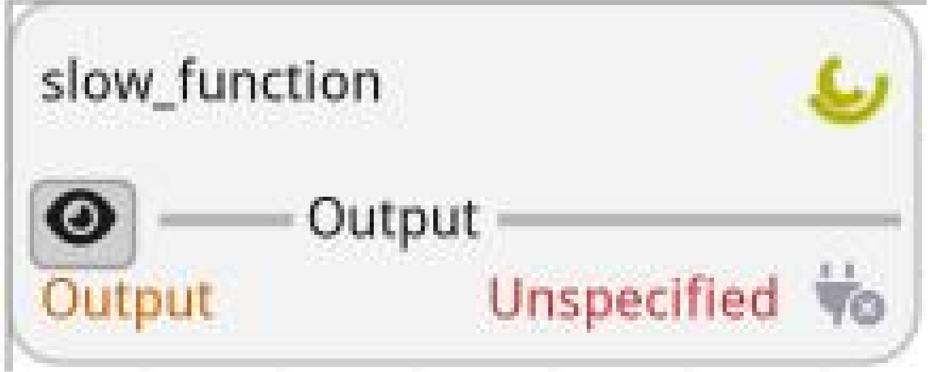
Using Async Functions:

Example: an async function

When your function is slow, you can set the `invoke_async` flag to True. In the example below, the yellow spinner indicates that the function is running, while keeping the GUI responsive.

```
import fiatlight as fl
import time
def slow_function() -> int:
    time.sleep(5)
    return 42

fl.add_fiat_attributes(slow_function, invoke_async=True)
```

```
fl.run(slow_function, app_name="Async function")

# Note:
# You can also use the `@fl.with_fiat_attributes` decorator to set the flags directly on the function:
# @fl.with_fiat_attributes(invoke_async=True)
# def slow_function() -> int:
#     ...
```



"Stoppable" async Functions:

In the case of async function, you may also set:

- `invoke_async_stoppable`(default=False): if true a GUI button will be displayed to stop the async function while it is running.

In this case, you will need to check the flag `invoke_async_shall_stop` in your function to know if the function should stop.

Example:

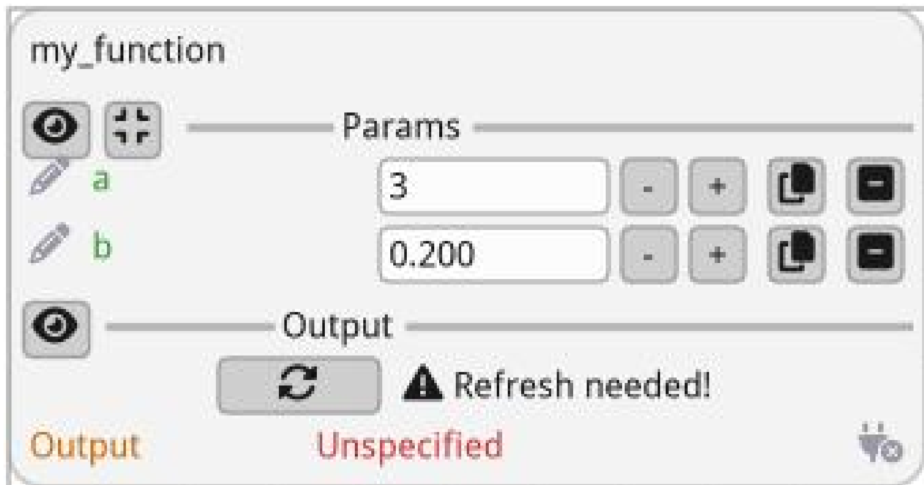
```
def my_async_function():
    # ...  # some initialization
    while True:  # inner loop of the function processing (can be any form of loop)
        # ...  # some processing
        if hasattr(my_async_function, "invoke_async_shall_stop") and my_async_function.invoke_async_shall_stop:
            my_async_function.invoke_async_shall_stop = False  # reset the flag
            break
        # ... # continue the function processing
```

Manual Invocation Example:

Example: a function that needs to be called manually

If you set the `invoke_manually` flag to True, the function will be called only when the user clicks the "invoke" button (indicated by a "recycle" icon). If the inputs have changed, a "Refresh needed" label will be displayed.

```python
import fiatlight as fl
def my_function(a: int, b: float) -> float:
    return a + b

fl.add_fiat_attributes(my_function, invoke_manually=True)
fl.run(my_function, app_name="Manual invocation")
```



5.d.iv. *Handwriting the GUI:*

Using Edit and Present Callbacks:

You can also customize the GUI for a parameter or output by setting custom callbacks function, namely the "edit" and "present" callbacks.

In this case, you will first wrap the function in a `FunctionWithGui` object, and then set the callbacks for the parameter or output.

```python
import fiatlight as fl

def my_function(a: int) -> float:
    return a * 4

my_function_gui = fl.FunctionWithGui(my_function)

# A callback to edit the parameter. Receive the current value, and
return a tuple (bool, new_value)
# my_function_gui.input("a").callbacks.edit = ...

# A callback to present the output. Receive the current value, and
return None
# my_function_gui.output().callbacks.present = ...
```

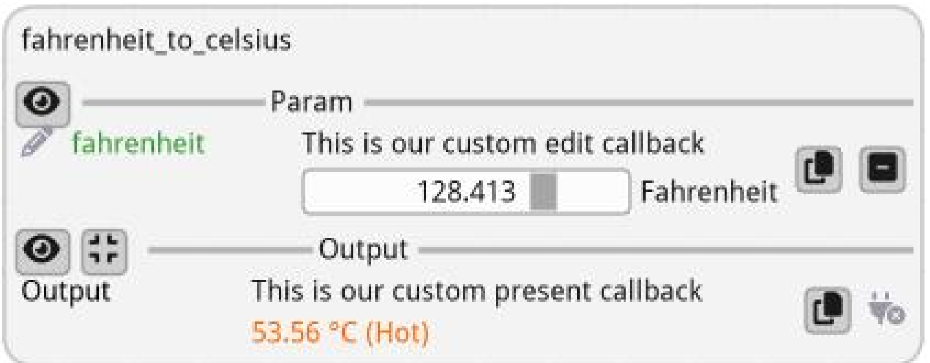
For more information, see:

- **AnyDataWithGui**: See the API for detailed information.
- **AnyDataWithGuiCallbacks**: See the API for detailed information.

Example: Custom Callbacks:

In this example, we define custom edit and present callbacks for the function fahrenheit_to_celsius. The resulting GUI allows the user to input a temperature in Fahrenheit using a custom slider and see the converted temperature in Celsius with a color-coded note indicating whether it is cold, warm, or hot.

```
import fiatlight as fl
from imgui_bundle import imgui, hello_imgui, ImVec4


def fahrenheit_to_celsius(fahrenheit: float = 0) -> float:
    return (fahrenheit - 32) * 5 / 9

# This will be our edit callback: it accepts a float and returns a tuple
(bool, float)
# where the first element is True if the value has changed, and the
second element is the new value
def edit_temperature(fahrenheit: float) -> tuple[bool, float]:
    imgui.text("This is our custom edit callback")
    # Set the width of the slider field to 10 em units (using em units
is a good practice to make the GUI dpi aware)
    imgui.set_next_item_width(hello_imgui.em_size(10))
    changed, new_value = imgui.slider_float("Fahrenheit", fahrenheit,
-100, 200)
    return changed, new_value

# This will be our present callback: it accepts a float and returns None
def present_temperature(celsius: float) -> None:
    imgui.text("This is our custom present callback")
    note = "Cold" if celsius < 20 else "Hot" if celsius > 40 else "Warm"
    color = ImVec4(0, 0.4, 1, 1) if celsius < 20 else ImVec4(1, 0.4, 0,
1) if celsius > 40 else ImVec4(0, 1, 0, 1)
    imgui.text_colored(color, f"{celsius:.2f} °C ({note})")


fahrenheit_to_celsius_gui = fl.FunctionWithGui(fahrenheit_to_celsius)
fahrenheit_to_celsius_gui.output().callbacks.present =
present_temperature
fahrenheit_to_celsius_gui.input("fahrenheit").callbacks.edit =
edit_temperature

fl.run(fahrenheit_to_celsius_gui, app_name="Custom callbacks")
```


fahrenheit_to_celsius
Param
fahrenheit
This is our custom edit callback
128.413
Fahrenheit
Output
Output
This is our custom present callback
53.56 °C (Hot)

5.e. *Customizing Widgets with Fiat Attributes*

5.e.i. *Introduction:*

Fiat attributes allow you to customize various aspects of the GUI for function nodes, dataclasses, and pydantic models. They provide a powerful way to modify the appearance and behavior of function parameters and outputs, adjust the GUI for dataclasses, control how function nodes run (e.g., asynchronously or manually), set labels and tooltips for function nodes and parameters, and validate function parameters and dataclass fields.

There are two main ways to add attributes to a function:

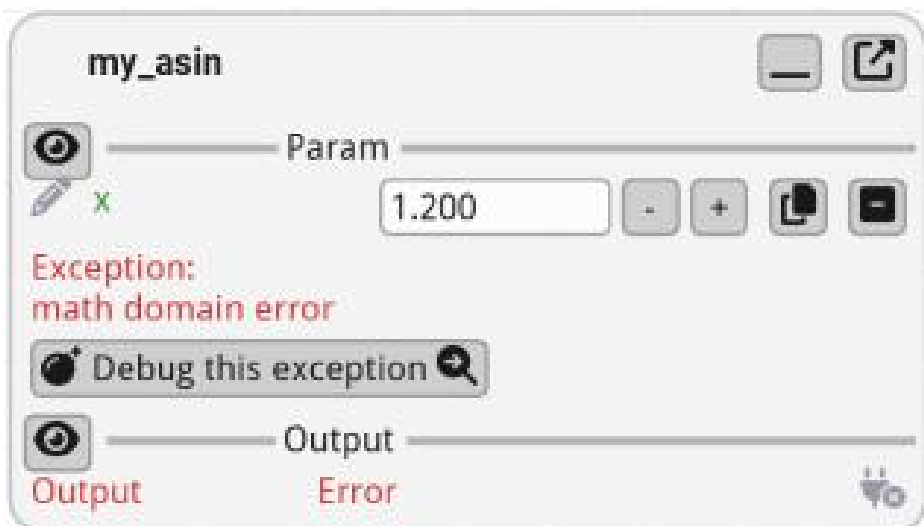
- using a decorator: `@fl.with_fiat_attributes` on top of the function definition
- using the `fl.add_fiat_attributes` function elsewhere in the code

> For more details on customizing dataclasses and pydantic models, see the GUI Registry documentation.

=== Why Customize Widgets?

As an example, let's consider the function "my_asin" below: if you run this function with `run()`, the GUI will allow the user to enter any float value for x. This lets the user enter values that may not be valid for the function.

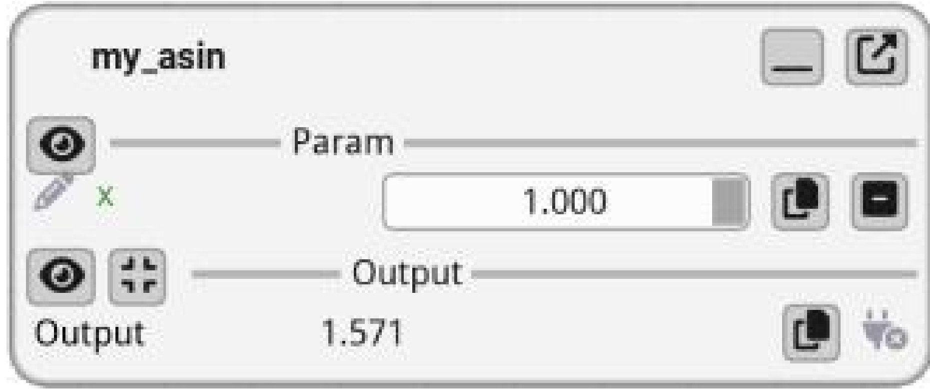
```
import fiatlight as fl

# Ideally, we would like to restrict the range of x to [-1, 1]
def my_asin(x: float = 0.5) -> float:
    import math
    return math.asin(x)

fl.run(my_asin, app_name="No range restriction")
```



5.e.ii. *Adding Attributes with a Decorator:*

It is possible to customize the GUI for parameters using function attributes: below, we set the range for x. As a consequence it will be displayed with a slider widget with a range from −1 to 1.

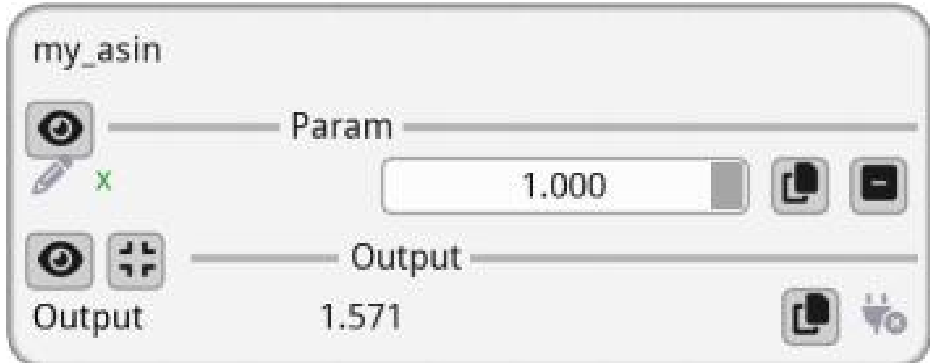
```
import fiatlight as fl

# Use the `with_fiat_attributes` decorator to set custom fiat attributes
for the function:
# Here, we set the range of the x parameter.
# Important: note the double underscore ("_") after the parameter name!
@fl.with_fiat_attributes(x__range=(-1, 1))
def my_asin(x: float = 0.5) -> float:
    import math
    return math.asin(x)


fl.run(my_asin, app_name="Range restriction")
```



5.e.iii. *Adding Attributes Manually:*

If you do not wish or cannot modify the function definition, you can use the `add_fiat_attributes` function to add attributes to the function. This way, your function stays unmodified, and you can specify the attributes only when creating its GUI.

```
import fiatlight as fl

def my_asin(x: float = 0.5) -> float:
    import math
    return math.asin(x)

# Important: note the double underscore ("_") after the parameter name!
fl.add_fiat_attributes(my_asin, x__range=(-1, 1))
fl.run(my_asin, app_name="Range restriction")
```



5.e.iv. *Listing Available Fiat Attributes:*

To customize the GUI for function parameters or outputs, you can list the available fiat attributes for a specific type using the Fiatlight command line utility.

Use the command fiatlight gui int in a terminal (or console) to list available fiat attributes for the int type. For other types, replace int with the type you are interested in.

For more information, see "Fiatlight command line utility".

Below is an extract of the output of `fiatlight gui int`:

```
GUI type: int
==============
A highly customizable int widget.
Available fiat attributes for IntWithGui:
+--------------------+----------------+-----------
+--------------------------------------------+
| Name               | Type           | Default   | Explanation
|
+====================+================+===========+===================================
| range              | tuple[int, int] | (0, 10)   | Range of the
integer                       |
+--------------------+----------------+-----------
+--------------------------------------------+
| edit_type          | str            | input     | Type of the edit
widget. Possible values: |
|                    |                |           | slider, input,
drag, knob,              |
|                    |                |           |
slider_and_minus_plus                      |
+--------------------+----------------+-----------
+--------------------------------------------+
| format             | str            | %d        | Format string for
the value                 |
+--------------------+----------------+-----------
+--------------------------------------------+
| ...                | ...            |           |
|
```

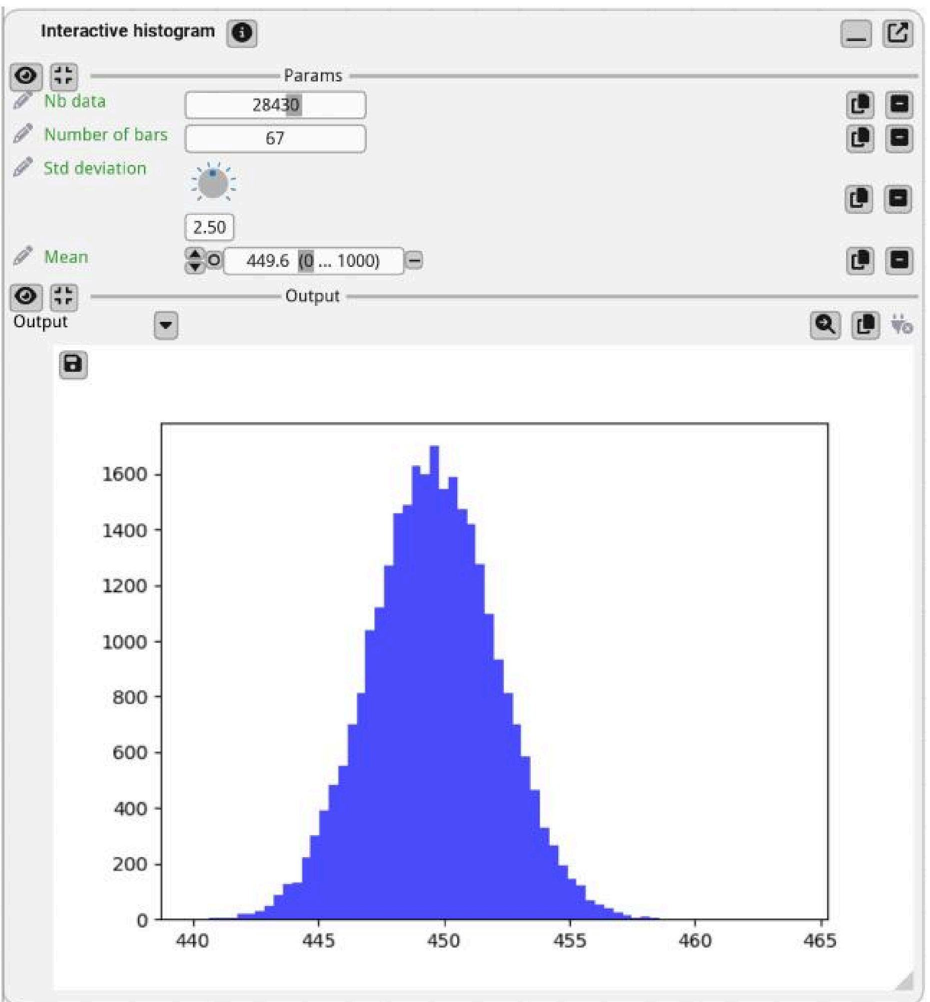
```
Available fiat attributes for AnyDataWithGui Generic attributes:
--------------------------------------------------------------------------------
+-------------+--------+--------------------
+-----------------------------------------------+
| Name        | Type   | Default            | Explanation
|
+=============+========+====================+=========================================
| label       | str    |                    | A label for the
parameter. If empty, the       |
|             |        |                    | function parameter name
is used                |
+-------------+--------+--------------------
+-----------------------------------------------+
| validator   | object | None               | Function to validate a
parameter value: should |
|             |        |                    | raise a ValueError if
invalid, or return the   |
|             |        |                    | value (possibly modified)
|
+-------------+--------+--------------------
+-----------------------------------------------+
| ...         | ...    |                    |
|
```

5.e.v. *Example: Fiat Attributes in Action:*

In the example below, we customize the GUI for the function `interactive_histogram` by setting fiat attributes for the number of data points, the number of bars, the mean, and the standard deviation.

```
import fiatlight
import matplotlib; matplotlib.use('Agg')  # Required to display the
figure in the GUI
from matplotlib.figure import Figure

@fiatlight.with_fiat_attributes(
    # Label displayed as the title of the function node
    label="Interactive histogram",

    # Edit the number of data points with a logarithmic slider
    # Note: by default, you can ctrl+click on a slider to input a value
directly,
    #       this is disabled here with nb_data__slider_no_input
    nb_data__label="Nb data",
    nb_data__edit_type="slider",
    nb_data__range=(100, 1_000_000),
    nb_data__slider_logarithmic=True,
    nb_data__slider_no_input=True,

    # Edit the number of bars with a knob
    n_bars__label="Number of bars",
```

```
    n_bars__edit_type="drag",
    n_bars__range=(1, 300),

    # Edit the average with a slider for a float value with any range
    # (the slider range will adapt interactively, when dragging far to
the left or to the right)
    average__label="Mean",
    average__edit_type="slider_float_any_range",
    average__range=(-5, 5),

    # Edit the standard deviation with a drag
    sigma__label="Std deviation",
    sigma__edit_type="knob",
    sigma__range=(0.1, 5),

)
def interactive_histogram(
    nb_data: int = 4000, n_bars: int = 50, sigma: float = 1, average:
float = 500
) -> Figure:
    '''Generate an interactive histogram with adjustable number of bars,
mean, and standard deviation.'''
    import numpy as np
    import matplotlib.pyplot as plt

    data = np.random.normal(loc=average, scale=sigma, size=nb_data)
    bins = np.linspace(np.min(data), np.max(data), n_bars)
    fig, ax = plt.subplots()
    ax.hist(data, bins=bins, color="blue", alpha=0.7)
    return fig

fiatlight.run(interactive_histogram, app_name="Fiat attributes")
```


Interactive histogram
Params
Nb data
28430
Number of bars
67
Std deviation
2.50
Mean
449.6 (0 ... 1000)
Output
Output
1600
1400
1200
1000
800
600
400
200
0
440
445
450
455
460
465

5.f. *Gui Registry*

`fiatlight.fiat_togui` is the central module that is able to associate a GUI with a type.

It uses sophisticated mechanisms to inspect the type of function parameters and return values.

It handles a registry of types and their associated GUIs, to which you can add your own types, by calling `fiatlight.register_type(DataType, DataTypeWithGui)`, where `DataType` is the type you want to register, and `DataTypeWithGui` is the class that will handle the GUI for this type.

`DataTypeWithGui` must inherit from `AnyDataWithGui` and implement the necessary callbacks.

5.f.i. *Explore the registry:*

The `fiatlight` command line utility is a powerful tool that allows you to explore the available widgets and types in Fiatlight. It can be used to list the available types, to print the GUI info for a given type, and to run a GUI demo for a given type.

Here is the help message for the `fiatlight` command line utility:

```
%%bash
fiatlight --help
```

```
INFO: Showing help with the command 'fiatlight -- --help'.

NAME
    fiatlight

SYNOPSIS
    fiatlight COMMAND

COMMANDS
    COMMAND is one of the following:

     types
       List registered types, with a possible query to filter them. Add
an optional query to filter the types.

     gui
       Print the info and fiat attributes available for a given type.
Add the datatype or Gui type name as an argument (if not provided, all
Gui widgets names are printed)

     fn_attrs
       Display the available fiat attributes for a function
```

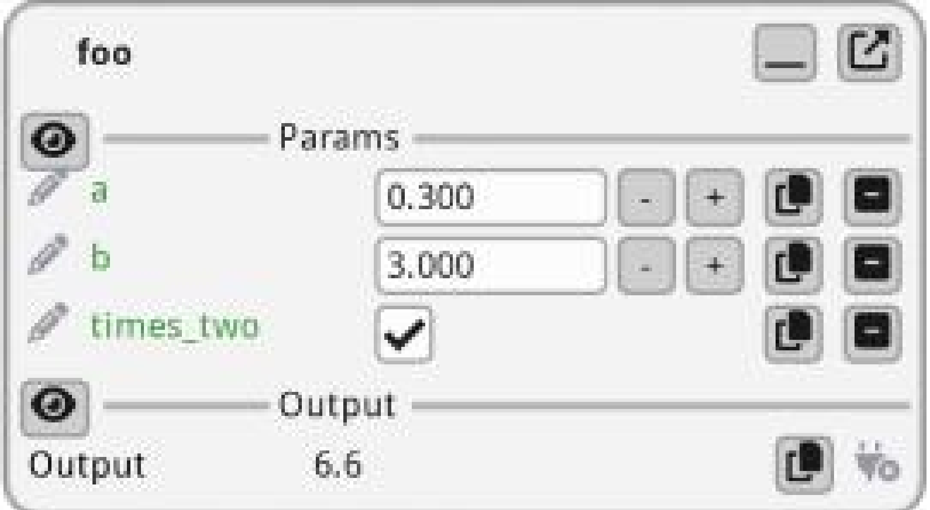
See the page Tutorials/fiatlight command line utility for more information.

5.f.ii. *Primitive types:*

The primitive types int, float, str, bool are registered by default.

Basic example:

```
import fiatlight as fl
def foo(a: float, b: float = 3.0, times_two: bool = False) -> float:
    return (a + b) * (2 if times_two else 1)

# Run an app that displays the GUI for the function
# where the user can input the values of the parameters
# (or use the default values)
fl.run(foo, app_name="Primitive Basic")
```

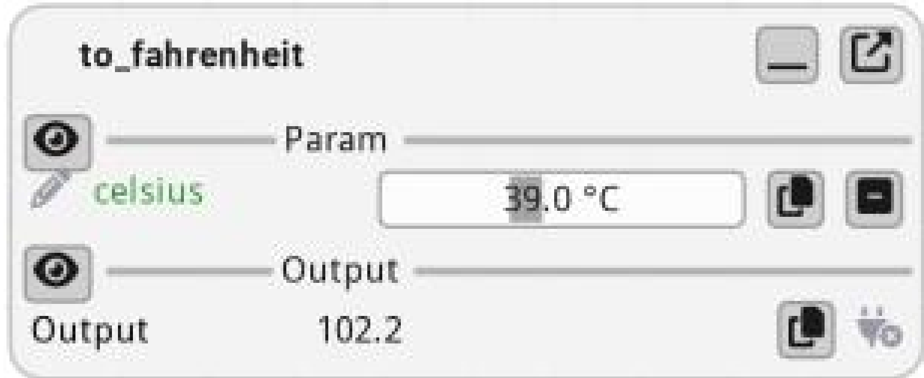


Example with custom GUI options:

The GUI for these primitive types is extensively configurable via fiat attributes. Below, we customize the GUI for the celsius parameter to be a slider ranging from 0 to 100, with a specific format for displaying the value.

See FunctionWithGui for a comprehensive list of all the available attributes (in the "Customizing parameters GUI" section).

```
import fiatlight as fl


@fl.with_fiat_attributes(celsius__range=(0, 100), celsius__format="%.1f
°C")
def to_fahrenheit(celsius: float) -> float:
    return celsius * 9 / 5 + 32


fl.run(to_fahrenheit, app_name="Primitive Custom")
```



Range limited numeric types:

As a convenience, Fiatlight includes those predefined types for which the GUI will take into account their boundings.

```
from typing import NewType

# Float types with specific ranges (bounds included)
Float_0_1 = NewType("Float_0_1", float)  # 0 to 1
Float_0_1.__doc__ = "synonym for float in [0, 1] (NewType)"

Float__1_1 = NewType("Float__1_1", float)  # -1 to 1
Float__1_1.__doc__ = "synonym for float in [-1, 1] (NewType)"

PositiveFloat = NewType("PositiveFloat", float)  # Any positive float
( strictly greater than 0)
PositiveFloat.__doc__ = "synonym for float > 0 (strictly greater than 0)
(NewType)"

# Int types with specific ranges (bounds included)
Int_0_255 = NewType("Int_0_255", int)  # 0 to 255
Int_0_255.__doc__ = "synonym for int in [0, 255] (NewType)"
```

5.f.iii. *File name types:*

Several file types names are registered by default. They are synonyms for `str` and are used to specify file paths. They will be presented with a file dialog in the GUI.

```
from fiatlight.fiat_notebook import look_at_code
%look_at_python_code fiatlight.fiat_types.file_types
```

```
from typing import NewType


# FilePath is a synonym of str, but when used as a function parameter,
# it will be displayed as a widget where you can select a file.
FilePath = NewType("FilePath", str)
FilePath.__doc__ = "synonym for str, describing a file path (NewType)"
# FilePath_Save is a synonym of str, but when used as a function
parameter,
```

```
# it will be displayed as a widget where you can select a file to save
to.
FilePath_Save = NewType("FilePath_Save", str)
FilePath_Save.__doc__ = "synonym for str, describing a file path for
saving (NewType)"

# With ImagePath, you can select an image file.
ImagePath = NewType("ImagePath", FilePath)
ImagePath.__doc__ = "synonym for str, describing an image file path
(NewType)"
ImagePath_Save = NewType("ImagePath_Save", FilePath_Save)
ImagePath_Save.__doc__ = "synonym for str, describing an image file path
for saving (NewType)"

# With TextPath, you can select a text file.
TextPath = NewType("TextPath", FilePath)
TextPath.__doc__ = "synonym for str, describing a text file path
(NewType)"
TextPath_Save = NewType("TextPath_Save", FilePath_Save)
TextPath_Save.__doc__ = "synonym for str, describing a text file path
for saving (NewType)"

# With AudioPath, you can select an audio file.
AudioPath = NewType("AudioPath", FilePath)
AudioPath.__doc__ = "synonym for str, describing an audio file path
(NewType)"
AudioPath_Save = NewType("AudioPath_Save", FilePath_Save)
AudioPath_Save.__doc__ = "synonym for str, describing an audio file path
for saving (NewType)"

# With VideoPath, you can select a video file.
VideoPath = NewType("VideoPath", FilePath)
VideoPath.__doc__ = "synonym for str, describing a video file path
(NewType)"
VideoPath_Save = NewType("VideoPath_Save", FilePath_Save)
VideoPath_Save.__doc__ = "synonym for str, describing a video file path
for saving (NewType)"
```

5.f.iv. *Color types:*

Several color types are registered by default.

```
%look_at_python_code fiatlight.fiat_types.color_types
```

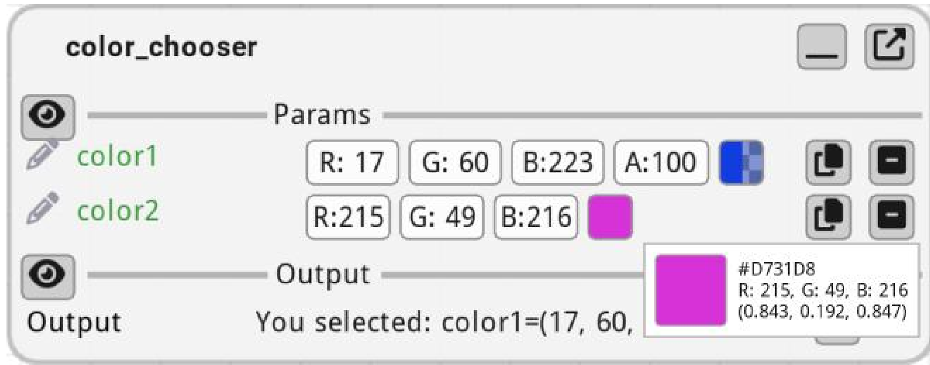
```
from typing import NewType
from imgui_bundle import ImVec4


ColorRgb = NewType("ColorRgb", tuple[int, int, int])
ColorRgb.__doc__ = "synonym for tuple[int, int, int] describing an RGB
color, with values in [0, 255] (NewType)"

ColorRgba = NewType("ColorRgba", tuple[int, int, int, int])
```

```
ColorRgba.__doc__ = "synonym for tuple[int, int, int, int] describing an
RGBA color, with values in [0, 255] (NewType)"

ColorRgbFloat = NewType("ColorRgbFloat", tuple[float, float, float])
ColorRgbFloat.__doc__ = (
    "synonym for tuple[float, float, float] describing an RGB color,
with values in [0, 1] (NewType)"
)

ColorRgbaFloat = NewType("ColorRgbaFloat", tuple[float, float, float,
float])
ColorRgbaFloat.__doc__ = (
    "synonym for tuple[float, float, float, float] describing an RGBA
color, with values in [0, 1] (NewType)"
)


def _int255_to_float(value: int) -> float:
    return value / 255.0


def _float_to_int255(value: float) -> int:
    return int(value * 255)


def color_rgb_to_color_rgb_float(color_rgb: ColorRgb) -> ColorRgbFloat:
    return ColorRgbFloat(tuple(_int255_to_float(value) for value in
color_rgb))  # type: ignore


def color_rgba_to_color_rgba_float(color_rgba: ColorRgba) ->
ColorRgbaFloat:
    return ColorRgbaFloat(tuple(_int255_to_float(value) for value in
color_rgba))  # type: ignore


def color_rgb_float_to_color_rgb(color_rgb_float: ColorRgbFloat) ->
ColorRgb:
    return ColorRgb(tuple(_float_to_int255(value) for value in
color_rgb_float))  # type: ignore


def color_rgba_float_to_color_rgba(color_rgba_float: ColorRgbaFloat) ->
ColorRgba:
    return ColorRgba(tuple(_float_to_int255(value) for value in
color_rgba_float))  # type: ignore


def color_rgb_to_color_rgba(color_rgb: ColorRgb) -> ColorRgba:
    return ColorRgba(color_rgb + (255,))
```

```
def color_rgb_float_to_color_rgba_float(color_rgb_float: ColorRgbFloat)
-> ColorRgbaFloat:
    return ColorRgbaFloat(color_rgb_float + (1.0,))


def color_rgb_to_imvec4(v: ColorRgb) -> ImVec4:
    return ImVec4(v[0] / 255.0, v[1] / 255.0, v[2] / 255.0, 1.0)


def color_rgba_to_imvec4(v: ColorRgba) -> ImVec4:
    return ImVec4(v[0] / 255.0, v[1] / 255.0, v[2] / 255.0, v[3] /
255.0)


def color_rgb_float_to_imvec4(v: ColorRgbFloat) -> ImVec4:
    return ImVec4(v[0], v[1], v[2], 1.0)


def color_rgba_float_to_imvec4(v: ColorRgbaFloat) -> ImVec4:
    return ImVec4(v[0], v[1], v[2], v[3])
```

Example: using color types in function

```
import fiatlight as fl
from fiatlight.fiat_types import ColorRgb, ColorRgba

def color_chooser(color1: ColorRgba, color2: ColorRgb) -> str:
    return f"You selected: {color1=}, {color2=}"

fl.run(color_chooser, app_name="Color Chooser")
```



5.f.v. *Optional types:*

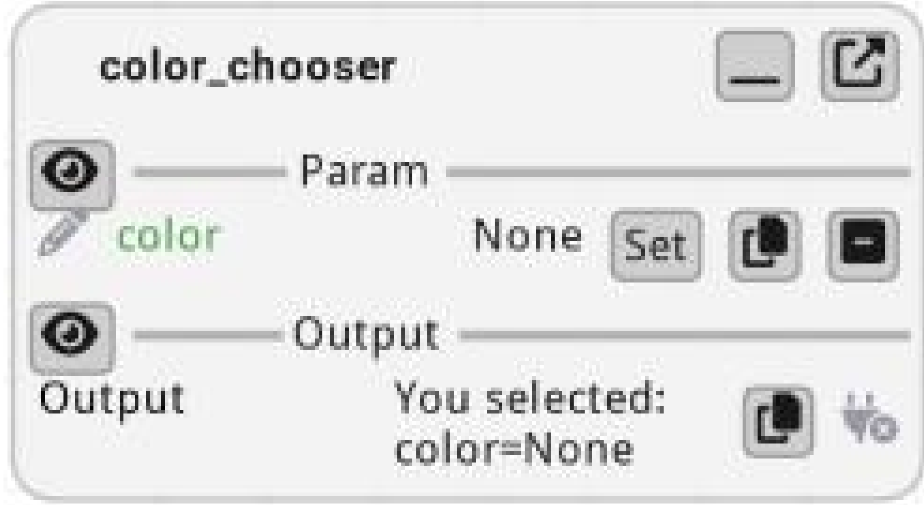
If a type is registered, its optional version is also registered.

Example: using an optional color in a function

(In this example, the user needs to click on “Set” to set a value to the optional color)

```
import fiatlight as fl
from fiatlight.fiat_types import ColorRgb, ColorRgba
```

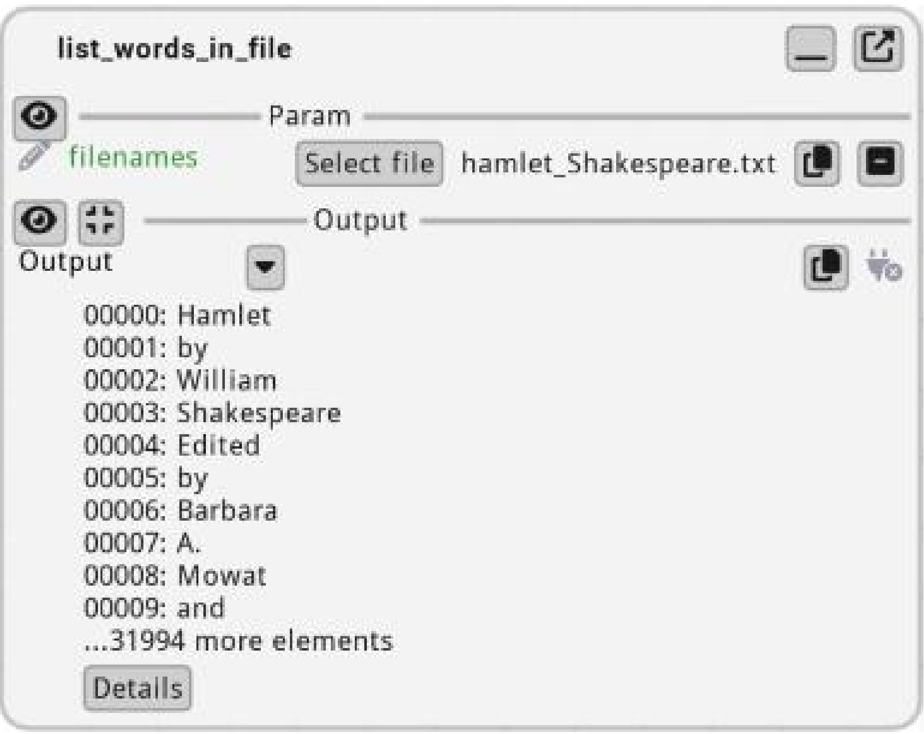
```python
def color_chooser(color: ColorRgb | None = None) -> str:
    return f"You selected: {color=}"

fl.run(color_chooser, app_name="Optional Color")
```



5.f.vi. *Lists:*

A very basic support is provided for lists. It does not allow to edit the values. However, it can present a list of values using (all of them will be rendered as string using str() function).

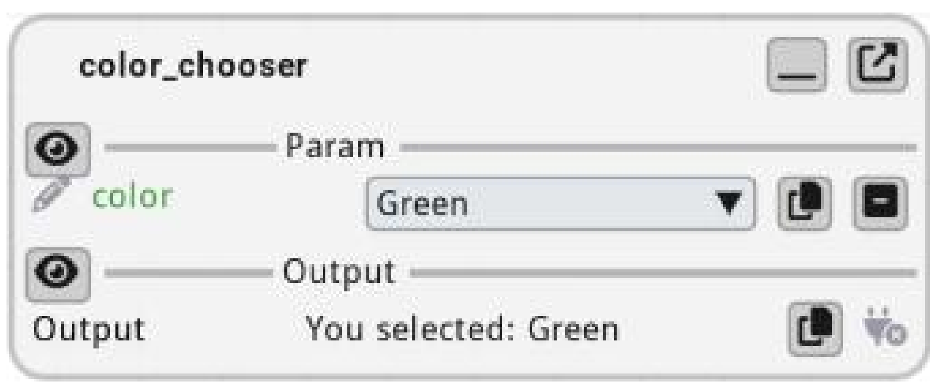
```python
import fiatlight as fl
from fiatlight.fiat_types import TextPath

def list_words_in_file(filenames: TextPath) -> list[str]:
    with open(filenames) as f:
        return f.read().split()

fl.run(list_words_in_file, app_name="List Words in File")
```



5.f.vii. *Enum classes:*

Enum classes are automatically associated to a GUI.

```
import fiatlight as fl
from enum import Enum

class Color(Enum):
    Red = 1
    Green = 2
    Blue = 3

def color_chooser(color: Color) -> str:
    return f"You selected: {color.name}"

fl.run(color_chooser, app_name="Enum Color")
```



5.g. Gui Nodes

Gui Nodes are specialized nodes in Fiatlight, dedicated to functions which do not return values but instead displaying a user interface using ImGui widgets. Gui Nodes are called at every frame, ensuring that the GUI is always responsive and up-to-date.

Gui Nodes are particularly useful for:

- Displaying interactive visualizations (plots, etc)
- Creating dashboards
- Providing user controls (e.g., sliders, buttons) that alter global variables

Notes:

- Gui Nodes are not meant to return values
- Your GUI function should be fast. If you need to perform heavy computations, consider using AnyDataWithGui, where the "on_change" callback can be used to cache heavy computations.

=== Example: Visualizing a Heart Curve with a GUI Node

In this example, we demonstrate how to create a GUI node that visualizes a heart curve. The size of the heart dynamically changes over time to simulate a heartbeat.

Explanation:

1. time_seconds: This function returns the current time in seconds and is set to always be re-evaluated at every frame.
2. heart_curve: Generates the x and y coordinates of a heart curve that changes size over time to simulate a heartbeat.
3. gui_curve: A GUI node that visualizes the heart curve using ImPlot. It updates the curve at every frame to reflect the beating heart.
4. gui_curve is a gui function. So, we wrap it in a GuiNode to display the heart curve with either `GuiNode(gui_curve)` or `graph.add_gui_node(gui_curve)`.

```
import fiatlight as fl
from imgui_bundle import hello_imgui, implot
import numpy as np
from numpy.typing import ArrayLike
import time

@fl.with_fiat_attributes(invoke_always_dirty=True)
def time_seconds() -> float:
    """Return the current time in seconds.
    This function is marked as always dirty, so it will be re-evaluated
at every frame.
    """
    return time.time()

def heart_curve(time_: float) -> ArrayLike:
```

```python
    """Return the x and y coordinates of a heart curve whose size
changes over time,
    to simulate a heart beating.
    """
    vals = np.arange(0, np.pi * 2, 0.01)
    x0 = np.power(np.sin(vals), 3) * 16
    y0 = 13 * np.cos(vals) - 5 * np.cos(2 * vals) - 2 * np.cos(3 * vals)
- np.cos(4 * vals)

    # Heart pulse rate and time tracking
    heart_pulse_rate = 80
    phase = time_ * heart_pulse_rate / (np.pi * 2)
    k = 0.8 + 0.1 * np.cos(phase)
    return np.array([x0 * k, y0 * k])

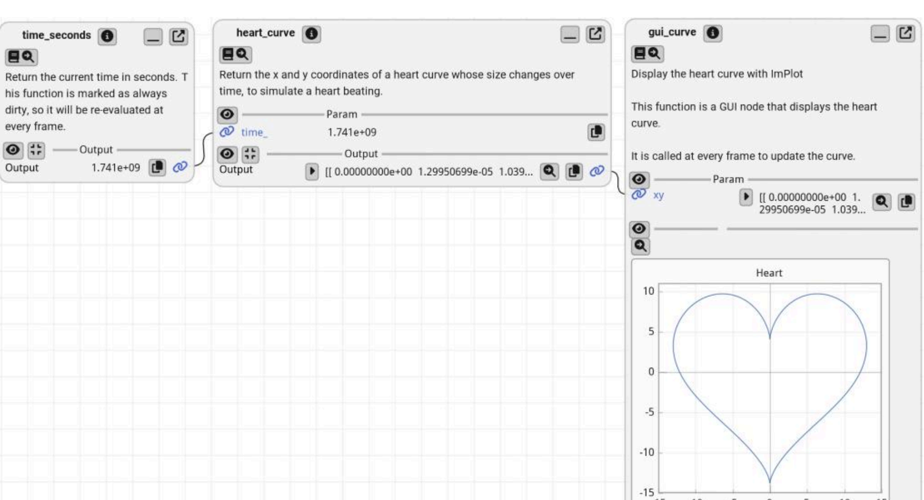
def gui_curve(xy: ArrayLike) -> None:
    """Display the heart curve with ImPlot

    This function is a GUI node that displays the heart curve.

    It is called at every frame to update the curve.
    """
    if implot.begin_plot("Heart", hello_imgui.em_to_vec2(21, 21)):
        implot.setup_axes_limits(-15, 15, -15, 11)
        implot.plot_line("", xy[0], xy[1])
        implot.end_plot()

# Run the graph
# Method 1: Using the run function, and wrapping the gui_curve function
in a GuiNode
fl.run([time_seconds, heart_curve, fl.GuiNode(gui_curve)],
app_name="HeartCurve")

# Method 2: Using a FunctionsGraph
# graph = fl.FunctionsGraph()
# graph.add_function(time_seconds)
# graph.add_function(heart_curve)
# graph.add_gui_node(gui_curve)  # Add the gui_curve function as a
GuiNode
# graph.add_link(time_seconds, heart_curve)
# graph.add_link(heart_curve, gui_curve)
# fl.run(graph, app_name="HeartCurve")
```



5.g.i. *Example: a GUI node with serializable state:*

When adding a GuiNode, you can pass a serializable data class to store the options of the GUI function. This allows you to save the state of the GUI function and reload it when restarting the application.

In the example below, we demonstrate how to create a GUI node that multiplies an input value by a factor. The factor can be adjusted by the user and is stored in a serializable data class. The factor value is reloaded upon restarting the application.

```
import fiatlight as fl
from imgui_bundle import imgui
from pydantic import BaseModel

def input_x(x: int) -> int:
    """a function that will be displayed in the function graph, in order
to let the user input a value."""
    return x

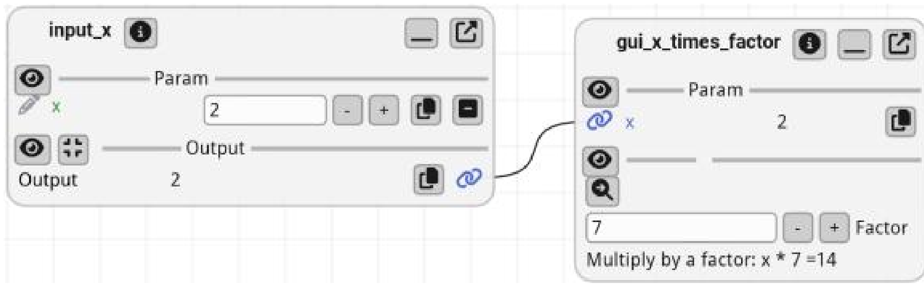
class WhatToMultiply(BaseModel):
    """A serializable data class that will be used to store the options
of the GUI function `gui_x_times_factor"""
    factor: int = 3

WHAT_TO_MULTIPLY = WhatToMultiply()

def gui_x_times_factor(x: int) -> None:
    """A GUI function that multiplies the input by a serializable
factor.
    It will be added via graph.add_gui_node(gui_x_times_factor,
gui_serializable_data=WHAT_TO_MULTIPLY).
    It uses a serializable data class to store its options, which will
be reloaded upon restarting the application.
    """
    _, WHAT_TO_MULTIPLY.factor = imgui.input_int("Factor",
```

```
WHAT_TO_MULTIPLY.factor)
    imgui.text(f"Multiply by a factor: x * {WHAT_TO_MULTIPLY.factor} ={x
* WHAT_TO_MULTIPLY.factor}")

# Run the graph
fl.run([input_x, fl.GuiNode(gui_x_times_factor,
gui_serializable_data=WHAT_TO_MULTIPLY)], app_name="GuiNode with
serializable state")
```



5.h. Fiatlight command line utility

The `fiatlight` command line utility is a powerful tool that allows you to explore the available widgets and types in Fiatlight. It can be used to list the available types, to print the GUI info for a given type, and to run a GUI demo for a given type.

Here is the help message for the `fiatlight` command line utility (ignore the `%%bash` magic command, it is used to run bash commands in Jupyter notebooks):

```
%%bash
fiatlight --help
```

```
INFO: Showing help with the command 'fiatlight -- --help'.

NAME
    fiatlight

SYNOPSIS
    fiatlight COMMAND

COMMANDS
    COMMAND is one of the following:

     types
       List registered types, with a possible query to filter them. Add
an optional query to filter the types.

     gui
       Print the GUI info for a given type. Add the GUI type name as an
argument (if not provided, all Gui widgets names are printed)
```

5.h.i. *List registered types:*

The `types` command lists the registered types in Fiatlight. You can filter the types by adding an optional query.

In the example below, we will run the `fiatlight types str` command to list all the types that contain the string "str".

```
%%bash
fiatlight types str
```

```
+----------------------------------------------------
+------------------------------------------------------------------------
+
| Data Type                                          | Gui Type
|
+====================================================+==================================
| str                                                |
fiatlight.fiat_togui.str_with_gui.StrWithGui                         |
|                                                    |   A Gui for a
string with resizable input text, with a popup for      |
|                                                    | multiline
editing.                                                     |
```

```
+--------------------------------------------------
+------------------------------------------------------------------
+
| fiatlight.fiat_types.fiat_number_types.PositiveFlo |
fiatlight.fiat_togui.primitives_gui.FloatWithGui                 |
| at                                                 |   A highly
customizable float widget.                                |
|   synonym for float > 0 (strictly greater than 0)  |
|
| (NewType)                                          |
|
+--------------------------------------------------
+------------------------------------------------------------------
+
| fiatlight.fiat_types.file_types.FilePath           |
fiatlight.fiat_togui.file_types_gui.FilePathWithGui              |
|   synonym for str, describing a file path          |   A Gui that
enable to select a filename via a file dialog.          |
| (NewType)                                          |
|
+--------------------------------------------------
+------------------------------------------------------------------
+
| fiatlight.fiat_types.file_types.TextPath           |
fiatlight.fiat_togui.file_types_gui.TextPathWithGui              |
|   synonym for str, describing a text file path     |   A Gui that
enable to select a text filename via a file dialog.     |
| (NewType)                                          |
|
+--------------------------------------------------
+------------------------------------------------------------------
+
| fiatlight.fiat_types.file_types.ImagePath          |
fiatlight.fiat_togui.file_types_gui.ImagePathWithGui             |
|   synonym for str, describing an image file path   |   A Gui that
enable to select an image filename via a file dialog.   |
| (NewType)                                          |
|
+--------------------------------------------------
+------------------------------------------------------------------
+
| fiatlight.fiat_types.file_types.AudioPath          |
fiatlight.fiat_togui.file_types_gui.AudioPathWithGui             |
|   synonym for str, describing an audio file path   |   A Gui that
enable to select an audio filename via a file dialog.   |
| (NewType)                                          |
|
+--------------------------------------------------
+------------------------------------------------------------------
+
| fiatlight.fiat_types.file_types.VideoPath          |
fiatlight.fiat_togui.file_types_gui.VideoPathWithGui             |
```

```
|   synonym for str, describing a video file path    |   A Gui that
enable to select a video filename via a file dialog.     |
| (NewType)                                          |
|
+----------------------------------------------------
+----------------------------------------------------------------------
+
| fiatlight.fiat_types.file_types.FilePath_Save      |
fiatlight.fiat_togui.file_types_gui.FilePathSaveWithGui               |
|   synonym for str, describing a file path for      |   A Gui that
enable to select a destination/save filename via a file  |
| saving (NewType)                                   | dialog.
|
+----------------------------------------------------
+----------------------------------------------------------------------
+
| fiatlight.fiat_types.file_types.TextPath_Save      |
fiatlight.fiat_togui.file_types_gui.TextPathSaveWithGui               |
|   synonym for str, describing a text file path for |   A Gui that
enable to select a destination/save text filename via a  |
| saving (NewType)                                   | file dialog.
|
+----------------------------------------------------
+----------------------------------------------------------------------
+
| fiatlight.fiat_types.file_types.ImagePath_Save     |
fiatlight.fiat_togui.file_types_gui.ImagePathSaveWithGui              |
|   synonym for str, describing an image file path   |   A Gui that
enable to select a destination/save image filename via a |
| for saving (NewType)                               | file dialog.
|
+----------------------------------------------------
+----------------------------------------------------------------------
+
| fiatlight.fiat_types.file_types.AudioPath_Save     |
fiatlight.fiat_togui.file_types_gui.AudioPathSaveWithGui              |
|   synonym for str, describing an audio file path   |   A Gui that
enable to select a destination/save audio filename via a |
| for saving (NewType)                               | file dialog.
|
+----------------------------------------------------
+----------------------------------------------------------------------
+
| fiatlight.fiat_types.file_types.VideoPath_Save     |
fiatlight.fiat_togui.file_types_gui.VideoPathSaveWithGui              |
|   synonym for str, describing a video file path    |   A Gui that
enable to select a destination/save video filename via a |
| for saving (NewType)                               | file dialog.
|
+----------------------------------------------------
+----------------------------------------------------------------------
+
```

```
| fiatlight.fiat_kits.fiat_ai.prompt.Prompt          |
fiatlight.fiat_kits.fiat_ai.prompt_with_gui.PromptWithGui              |
|   synonym for a string used as a prompt, used for  |   A Gui to edit a
prompt, with a Submit button, and a multiline edit  |
| AI text and image generation models (NewType)      | in a popup.
|
+-----------------------------------------------------
+-----------------------------------------------------------------------
+
```

Notes:

- If you do not include the `str` argument, all the types will be printed.

5.h.ii. *Print the GUI info for a given type:*

The `gui_info` command prints the GUI info for a given type. You can specify the GUI type name or the data type name as an argument. If you do not provide a type name, all the GUI widget names will be printed.

Example: Print the GUI info for StrWithGui:

In the example below, we will run the `fiatlight gui_info StrWithGui` command to print the GUI info for the `StrWithGui` widget.

```
%%bash
fiatlight gui str
```

```
GUI type: str
==============
  A Gui for a string with resizable input text, with a popup for
multiline editing.

  Available custom attributes for StrWithGui:

--------------------------------------------------------------------------------
  +----------------------+---------------------+--------------
+--------------------------------------------------+
  | Name                 | Type                | Default      |
Explanation                                      |

+======================+=====================+==============+==========================
  | width_em             | float               | 15.0         | Initial
width of the single line text input    |
  |                      |                     |              | (in em
unit). Can be saved if resizable is     |
  |                      |                     |              | True
|
  +----------------------+---------------------+--------------
+--------------------------------------------------+
  | size_multiline_em    | tuple[float, float] | (60.0, 15.0) | Initial
size of the multiline text input (in    |
  |                      |                     |              | em unit)
|
```

```
  +---------------------+---------------------+--------------
+-----------------------------------------------+
  | hint                | str                 |              | Hint
text for the input                      |
  +---------------------+---------------------+--------------
+-----------------------------------------------+
  | allow_multiline_edit | bool               | False        | Whether
the user can edit the string as        |
  |                     |                     |              |
multiline string (when not in a function node) |
  +---------------------+---------------------+--------------
+-----------------------------------------------+
  | resizable           | bool                | True         | Whether
the single line widget is resizable    |
  +---------------------+---------------------+--------------
+-----------------------------------------------+
  | wrap_multiline      | bool                | False        | Whether
the text is wrapped when presented as  |
  |                     |                     |              | a
multiline string                             |
  +---------------------+---------------------+--------------
+-----------------------------------------------+
  | wrap_multiline_width | int                | 80           | Width at
which the text is wrapped when        |
  |                     |                     |              |
presented as a multiline string                |
  +---------------------+---------------------+--------------
+-----------------------------------------------+

  Available custom attributes for AnyDataWithGui Generic attributes:

--------------------------------------------------------------------------------
  +----------------+--------+---------------------
+-----------------------------------------------+
  | Name           | Type   | Default             | Explanation
|
+================+========+=====================+==========================================
  |                |        |                     | **Generic
attributes**                        |
  +----------------+--------+---------------------
+-----------------------------------------------+
  | validate_value | object | None                | Function to validate
a parameter value (should |
  |                |        |                     | return
DataValidationResult.ok() .error()      |
  +----------------+--------+---------------------
+-----------------------------------------------+
  | label          | str    |                     | A label for the
parameter. If empty, the       |
  |                |        |                     | function parameter
name is used               |
  +----------------+--------+---------------------
```

```
+---------------------------------------------+
  | tooltip        | str    |                     | An optional tooltip
to be displayed            |
  +----------------+--------+--------------------
+---------------------------------------------+
  | label_color    | ImVec4 | ImVec4(0.000000,    | The color of the
label (will use the default   |
  |                |        | 0.000000, 0.000000, | text color if not
provided)                    |
  |                |        | 1.000000)           |
|
  +----------------+--------+--------------------
+---------------------------------------------+

Code to test this GUI type:
----------------------------
```python
import typing
import fiatlight

@fiatlight.with_fiat_attributes(
    str_param__width_em = 15.0,
    str_param__size_multiline_em = (60.0, 15.0),
    str_param__hint = "",
    str_param__allow_multiline_edit = False,
    str_param__resizable = True,
    str_param__wrap_multiline = False,
    str_param__wrap_multiline_width = 80,
    #  Generic attributes
    str_param__validate_value = None,
    str_param__label = "",
    str_param__tooltip = "",
    str_param__label_color = ImVec4(0.000000, 0.000000, 0.000000,
1.000000))
def f(str_param: str) -> str:
    return str_param

fiatlight.run(f)
```
```

Example: Print the GUI info for ImageWithGui:

```
%%bash
fiatlight gui ImageWithGui
```

```
GUI type: ImageWithGui
=======================
  A highly sophisticated GUI for displaying and analysing images. Zoom/
Pan, show channels, show pixel values, sync zoom accross images, etc.

  Available custom attributes for fiat_image.ImageWithGui:

--------------------------------------------------------------------------------
```

Name	Type	Default	Explanation
			Main attributes for the image viewer
only_display	bool	False	Only display the image, no info displayed, no zoom, no pan
image_display_size	tuple[int, int]	(200, 0)	Initial size of the displayed image (width, height). One of them can be 0
zoom_key	str	z	Key to zoom in the image. All images with the same zoom key will be zoomed together
is_color_order_bgr	bool	True	Color order is BGR (default is True). OpenCV uses BGR by default, unfortunately.
can_resize	bool	True	Can resize the image by dragging the mouse at the bottom right corner
			Channels
show_channels	bool	False	Show channels
channel_layout_vertically	bool	False	Layout channels vertically

```
**Zoom & Pan**                                  |
  +---------------------------------+-----------------+-----------
+-----------------------------------------------+
  | pan_with_mouse                  | bool            | True      | Pan
with mouse                                  |
  +---------------------------------+-----------------+-----------
+-----------------------------------------------+
  | zoom_with_mouse_wheel           | bool            | True      | Zoom
with mouse wheel                            |
  +---------------------------------+-----------------+-----------
+-----------------------------------------------+
  |                                 |                 |           |
**Info displayed on image**                     |
  +---------------------------------+-----------------+-----------
+-----------------------------------------------+
  | show_school_paper_background    | bool            | True      | Show
school paper background, when the image  |
  |                                 |                 |           | is
unzoomed                                      |
  +---------------------------------+-----------------+-----------
+-----------------------------------------------+
  | show_alpha_channel_checkerboard | bool            | True      | Show
alpha channel checkerboard               |
  +---------------------------------+-----------------+-----------
+-----------------------------------------------+
  | show_grid                       | bool            | True      | Show
grid with the zoom level is high         |
  +---------------------------------+-----------------+-----------
+-----------------------------------------------+
  | draw_values_on_zoomed_pixels    | bool            | True      | Draw
values on pixels, when the zoom is high  |
  +---------------------------------+-----------------+-----------
+-----------------------------------------------+
  |                                 |                 |           |
**Info displayed under the image**              |
  +---------------------------------+-----------------+-----------
+-----------------------------------------------+
  | show_image_info                 | bool            | True      | Show
image info, i.e image size and type      |
  +---------------------------------+-----------------+-----------
+-----------------------------------------------+
  | show_pixel_info                 | bool            | True      | Show
pixel info, i.e. show pixel value and    |
  |                                 |                 |           |
position under the mouse                        |
  +---------------------------------+-----------------+-----------
+-----------------------------------------------+
  |                                 |                 |           |
**Control buttons under the image**             |
  +---------------------------------+-----------------+-----------
+-----------------------------------------------+
  | show_zoom_buttons               | bool            | True      | Show
```

```
zoom buttons                             |
  +---------------------------------+-----------------+-----------
+-------------------------------------------------+
  | show_options_panel              | bool            | True      | Show
options panel                            |
  +---------------------------------+-----------------+-----------
+-------------------------------------------------+
  | show_options_button             | bool            | True      | Show
options button                           |
  +---------------------------------+-----------------+-----------
+-------------------------------------------------+
  | show_inspect_button             | bool            | True      | Show
the inspect button, that enables to open |
  |                                 |                 |           | a
large version of image in the Image         |
  |                                 |                 |           |
Inspector                                     |
  +---------------------------------+-----------------+-----------
+-------------------------------------------------+

  Available custom attributes for AnyDataWithGui Generic attributes:

--------------------------------------------------------------------------------
  +----------------+--------+--------------------
+--------------------------------------------------+
  | Name           | Type   | Default             | Explanation
|
+================+========+=====================+======================================
  |                |        |                     | **Generic
attributes**                         |
  +----------------+--------+--------------------
+--------------------------------------------------+
  | validate_value | object | None                | Function to validate
a parameter value (should |
  |                |        |                     | return
DataValidationResult.ok() .error()      |
  +----------------+--------+--------------------
+--------------------------------------------------+
  | label          | str    |                     | A label for the
parameter. If empty, the       |
  |                |        |                     | function parameter
name is used                |
  +----------------+--------+--------------------
+--------------------------------------------------+
  | tooltip        | str    |                     | An optional tooltip
to be displayed            |
  +----------------+--------+--------------------
+--------------------------------------------------+
  | label_color    | ImVec4 | ImVec4(0.000000,    | The color of the
label (will use the default   |
  |                |        | 0.000000, 0.000000, | text color if not
provided)                    |
```

```
  |                |        | 1.000000)          |
|
  +----------------+--------+--------------------
+--------------------------------------------------+

Code to test this GUI type:
----------------------------
```python
import typing
import fiatlight

@fiatlight.with_fiat_attributes(
    #  Main attributes for the image viewer
    union_param__only_display = False,
    union_param__image_display_size = (200, 0),
    union_param__zoom_key = "z",
    union_param__is_color_order_bgr = True,
    union_param__can_resize = True,
    #  Channels
    union_param__show_channels = False,
    union_param__channel_layout_vertically = False,
    #  Zoom & Pan
    union_param__pan_with_mouse = True,
    union_param__zoom_with_mouse_wheel = True,
    #  Info displayed on image
    union_param__show_school_paper_background = True,
    union_param__show_alpha_channel_checkerboard = True,
    union_param__show_grid = True,
    union_param__draw_values_on_zoomed_pixels = True,
    #  Info displayed under the image
    union_param__show_image_info = True,
    union_param__show_pixel_info = True,
    #  Control buttons under the image
    union_param__show_zoom_buttons = True,
    union_param__show_options_panel = True,
    union_param__show_options_button = True,
    union_param__show_inspect_button = True,
    #  Generic attributes
    union_param__validate_value = None,
    union_param__label = "",
    union_param__tooltip = "",
    union_param__label_color = ImVec4(0.000000, 0.000000, 0.000000,
1.000000))
def f(union_param:
typing.Union[fiatlight.fiat_kits.fiat_image.image_types.ImageU8_1,
fiatlight.fiat_kits.fiat_image.image_types.ImageU8_2,
fiatlight.fiat_kits.fiat_image.image_types.ImageU8_3,
fiatlight.fiat_kits.fiat_image.image_types.ImageU8_4,
fiatlight.fiat_kits.fiat_image.image_types.ImageU8_RGB,
fiatlight.fiat_kits.fiat_image.image_types.ImageU8_RGBA,
fiatlight.fiat_kits.fiat_image.image_types.ImageU8_BGRA,
fiatlight.fiat_kits.fiat_image.image_types.ImageU8_BGR,
```
```

````
fiatlight.fiat_kits.fiat_image.image_types.ImageU8_GRAY,
fiatlight.fiat_kits.fiat_image.image_types.ImageFloat_1,
fiatlight.fiat_kits.fiat_image.image_types.ImageFloat_2,
fiatlight.fiat_kits.fiat_image.image_types.ImageFloat_3,
fiatlight.fiat_kits.fiat_image.image_types.ImageFloat_4]) ->
typing.Union[fiatlight.fiat_kits.fiat_image.image_types.ImageU8_1,
fiatlight.fiat_kits.fiat_image.image_types.ImageU8_2,
fiatlight.fiat_kits.fiat_image.image_types.ImageU8_3,
fiatlight.fiat_kits.fiat_image.image_types.ImageU8_4,
fiatlight.fiat_kits.fiat_image.image_types.ImageU8_RGB,
fiatlight.fiat_kits.fiat_image.image_types.ImageU8_RGBA,
fiatlight.fiat_kits.fiat_image.image_types.ImageU8_BGRA,
fiatlight.fiat_kits.fiat_image.image_types.ImageU8_BGR,
fiatlight.fiat_kits.fiat_image.image_types.ImageU8_GRAY,
fiatlight.fiat_kits.fiat_image.image_types.ImageFloat_1,
fiatlight.fiat_kits.fiat_image.image_types.ImageFloat_2,
fiatlight.fiat_kits.fiat_image.image_types.ImageFloat_3,
fiatlight.fiat_kits.fiat_image.image_types.ImageFloat_4]:
    return union_param

fiatlight.run(f)
```
````

5.h.iii. *Annex: list of registered types:*

By running the `fiatlight types` command, you can list all the registered types in Fiatlight. Here is a list of the available types:

```
%%bash
fiatlight types
```

```
+----------------------------------------------------
+------------------------------------------------------------------------
+
| Data Type                                          | Gui Type
|
+====================================================+=================================
| fiatlight.fiat_types.fiat_number_types.Float_0_1   |
fiatlight.fiat_togui.primitives_gui.FloatWithGui                       |
|   synonym for float in [0, 1] (NewType)            |   A highly
customizable float widget.                                  |
+----------------------------------------------------
+------------------------------------------------------------------------
+
| fiatlight.fiat_types.fiat_number_types.Float__1_1  |
fiatlight.fiat_togui.primitives_gui.FloatWithGui                       |
|   synonym for float in [-1, 1] (NewType)           |   A highly
customizable float widget.                                  |
+----------------------------------------------------
+------------------------------------------------------------------------
+
| fiatlight.fiat_types.fiat_number_types.Int_0_255   |
```
```

```
fiatlight.fiat_togui.primitives_gui.IntWithGui                         |
|   synonym for int in [0, 255] (NewType)            |   A highly
customizable int widget.                                   |
+----------------------------------------------------
+----------------------------------------------------------------------
+
| int                                                |
fiatlight.fiat_togui.primitives_gui.IntWithGui                         |
|                                                    |   A highly
customizable int widget.                                   |
+----------------------------------------------------
+----------------------------------------------------------------------
+
| float                                              |
fiatlight.fiat_togui.primitives_gui.FloatWithGui                       |
|                                                    |   A highly
customizable float widget.                                 |
+----------------------------------------------------
+----------------------------------------------------------------------
+
| str                                                |
fiatlight.fiat_togui.str_with_gui.StrWithGui                           |
|                                                    |   A Gui for a
string with resizable input text, with a popup for      |
|                                                    | multiline
editing.                                                    |
+----------------------------------------------------
+----------------------------------------------------------------------
+
| bool                                               |
fiatlight.fiat_togui.primitives_gui.BoolWithGui                        |
|                                                    |   A bool widget.
Can use a checkbox or a toggle.                       |
+----------------------------------------------------
+----------------------------------------------------------------------
+
| fiatlight.fiat_types.color_types.ColorRgb          |
fiatlight.fiat_togui.primitives_gui.ColorRgbWithGui                    |
|   synonym for tuple[int, int, int] describing an   |   A nice color
picker for RGB colors (int)                               |
| RGB color, with values in [0, 255] (NewType)       |
|
+----------------------------------------------------
+----------------------------------------------------------------------
+
| fiatlight.fiat_types.color_types.ColorRgba         |
fiatlight.fiat_togui.primitives_gui.ColorRgbaWithGui                   |
|   synonym for tuple[int, int, int, int] describing |   A nice color
picker for RGBA colors (int)                              |
| an RGBA color, with values in [0, 255] (NewType)   |
|
+----------------------------------------------------
```

```
+---------------------------------------------------------------------
+
| fiatlight.fiat_types.color_types.ColorRgbFloat     |
fiatlight.fiat_togui.primitives_gui.ColorRgbFloatWithGui             |
|   synonym for tuple[float, float, float]           |   A nice color
picker for RGB colors (float)                                    |
| describing an RGB color, with values in [0, 1]     |
|
| (NewType)                                          |
|
+-----------------------------------------------------
+---------------------------------------------------------------------
+
| fiatlight.fiat_types.color_types.ColorRgbaFloat    |
fiatlight.fiat_togui.primitives_gui.ColorRgbaFloatWithGui            |
|   synonym for tuple[float, float, float, float]    |   A nice color
picker for RGBA colors (float)                                   |
| describing an RGBA color, with values in [0, 1]    |
|
| (NewType)                                          |
|
+-----------------------------------------------------
+---------------------------------------------------------------------
+
| fiatlight.fiat_types.fiat_number_types.PositiveFlo |
fiatlight.fiat_togui.primitives_gui.FloatWithGui                     |
| at                                                 |   A highly
customizable float widget.                                           |
|   synonym for float > 0 (strictly greater than 0)  |
|
| (NewType)                                          |
|
+-----------------------------------------------------
+---------------------------------------------------------------------
+
| (dataclass) fiatlight.fiat_togui.dataclass_example |
fiatlight.fiat_togui.dataclass_gui.DataclassGui                      |
| s.ExampleDataclass                                 |   A sophisticated
GUI for a dataclass type.                                            |
|   ExampleDataclass(x: int = 0, y: str = 'Hello')   |
|
+-----------------------------------------------------
+---------------------------------------------------------------------
+
| (BaseModel) fiatlight.fiat_togui.dataclass_example |
fiatlight.fiat_togui.basemodel_gui.BaseModelGui                      |
| s.ExampleBaseModel                                 |   A sophisticated
GUI for a pydantic model.                                            |
+-----------------------------------------------------
+---------------------------------------------------------------------
+
| fiatlight.fiat_types.file_types.FilePath           |
```

```
fiatlight.fiat_togui.file_types_gui.FilePathWithGui                    |
|   synonym for str, describing a file path         |   A Gui that
enable to select a filename via a file dialog.            |
| (NewType)                                         |
|
+--------------------------------------------------
+-------------------------------------------------------------------------
+
| fiatlight.fiat_types.file_types.TextPath          |
fiatlight.fiat_togui.file_types_gui.TextPathWithGui                    |
|   synonym for str, describing a text file path    |   A Gui that
enable to select a text filename via a file dialog.       |
| (NewType)                                         |
|
+--------------------------------------------------
+-------------------------------------------------------------------------
+
| fiatlight.fiat_types.file_types.ImagePath         |
fiatlight.fiat_togui.file_types_gui.ImagePathWithGui                   |
|   synonym for str, describing an image file path  |   A Gui that
enable to select an image filename via a file dialog.     |
| (NewType)                                         |
|
+--------------------------------------------------
+-------------------------------------------------------------------------
+
| fiatlight.fiat_types.file_types.AudioPath         |
fiatlight.fiat_togui.file_types_gui.AudioPathWithGui                   |
|   synonym for str, describing an audio file path  |   A Gui that
enable to select an audio filename via a file dialog.     |
| (NewType)                                         |
|
+--------------------------------------------------
+-------------------------------------------------------------------------
+
| fiatlight.fiat_types.file_types.VideoPath         |
fiatlight.fiat_togui.file_types_gui.VideoPathWithGui                   |
|   synonym for str, describing a video file path   |   A Gui that
enable to select a video filename via a file dialog.      |
| (NewType)                                         |
|
+--------------------------------------------------
+-------------------------------------------------------------------------
+
| fiatlight.fiat_types.file_types.FilePath_Save     |
fiatlight.fiat_togui.file_types_gui.FilePathSaveWithGui                |
|   synonym for str, describing a file path for     |   A Gui that
enable to select a destination/save filename via a file   |
| saving (NewType)                                  | dialog.
|
+--------------------------------------------------
+-------------------------------------------------------------------------
```

```
+
| fiatlight.fiat_types.file_types.TextPath_Save      |
fiatlight.fiat_togui.file_types_gui.TextPathSaveWithGui                |
|   synonym for str, describing a text file path for |   A Gui that
enable to select a destination/save text filename via a   |
| saving (NewType)                                   | file dialog.
|
+----------------------------------------------------
+------------------------------------------------------------------------
+
| fiatlight.fiat_types.file_types.ImagePath_Save     |
fiatlight.fiat_togui.file_types_gui.ImagePathSaveWithGui               |
|   synonym for str, describing an image file path   |   A Gui that
enable to select a destination/save image filename via a  |
| for saving (NewType)                               | file dialog.
|
+----------------------------------------------------
+------------------------------------------------------------------------
+
| fiatlight.fiat_types.file_types.AudioPath_Save     |
fiatlight.fiat_togui.file_types_gui.AudioPathSaveWithGui               |
|   synonym for str, describing an audio file path   |   A Gui that
enable to select a destination/save audio filename via a  |
| for saving (NewType)                               | file dialog.
|
+----------------------------------------------------
+------------------------------------------------------------------------
+
| fiatlight.fiat_types.file_types.VideoPath_Save     |
fiatlight.fiat_togui.file_types_gui.VideoPathSaveWithGui               |
|   synonym for str, describing a video file path    |   A Gui that
enable to select a destination/save video filename via a  |
| for saving (NewType)                               | file dialog.
|
+----------------------------------------------------
+------------------------------------------------------------------------
+
| (BaseModel) fiatlight.fiat_kits.fiat_image.cv_colo |
fiatlight.fiat_togui.basemodel_gui.BaseModelGui                        |
| r_type.ColorConversion                             |   A sophisticated
GUI for a pydantic model.                            |
|   A color conversion from one color space to       |
|
| another (color spaces use the ColorType enum).     |
|
+----------------------------------------------------
+------------------------------------------------------------------------
+
| (BaseModel) fiatlight.fiat_kits.fiat_image.lut_typ |
fiatlight.fiat_togui.basemodel_gui.BaseModelGui                        |
| es.ColorLutParams                                  |   A sophisticated
GUI for a pydantic model.                            |
```

```
+-------------------------------------------------
+------------------------------------------------------------------------
+
| (BaseModel) fiatlight.fiat_kits.fiat_image.camera_ |
fiatlight.fiat_togui.basemodel_gui.BaseModelGui                      |
| image_provider.CameraParams                        |   A sophisticated
GUI for a pydantic model.                          |
|   Parameters for the camera image provider         |
|
+-------------------------------------------------
+------------------------------------------------------------------------
+
| None                                               |
fiatlight.fiat_kits.fiat_image.image_gui.ImageWithGui                  |
|   All types whose name starts with                 |   A highly
sophisticated GUI for displaying and analysing images.      |
| fiatlight.fiat_kits.fiat_image.image_types.Image   | Zoom/Pan, show
channels, show pixel values, sync zoom accross images,  |
|                                                    | etc.
|
+-------------------------------------------------
+------------------------------------------------------------------------
+
| None                                               |
fiatlight.fiat_kits.fiat_image.image_gui.ImageWithGui                  |
|   Union of types whose name starts with            |   A highly
sophisticated GUI for displaying and analysing images.      |
| fiatlight.fiat_kits.fiat_image.image_types.Image   | Zoom/Pan, show
channels, show pixel values, sync zoom accross images,  |
|                                                    | etc.
|
+-------------------------------------------------
+------------------------------------------------------------------------
+
| (BaseModel)                                        |
fiatlight.fiat_kits.fiat_image.lut_gui.LutParamsWithGui                |
| fiatlight.fiat_kits.fiat_image.lut_types.LutParams |   A GUI for
LutParams, allowing to visually edit a curve representing  |
|   Simple parameters to create a LUT (Look-Up       | Look-Up Table
transformation.                                          |
| Table) transformation to an image                  |
|
+-------------------------------------------------
+------------------------------------------------------------------------
+
| fiatlight.fiat_kits.fiat_implot.array_types.FloatM |
fiatlight.fiat_kits.fiat_implot.simple_plot_gui.SimplePlotGui          |
| atrix_Dim1                                         |   A GUI for
presenting 1D or 2D arrays with ImPlot. Can present the    |
|   synonym for a 1D ndarray of floats (NewType)     | array as a line,
scatter (+ stairs, or bars plot, if the array is      |
|                                                    | small enough)
```

```
|
+-------------------------------------------------------
+-----------------------------------------------------------------------------
+
| fiatlight.fiat_kits.fiat_implot.array_types.FloatM |
fiatlight.fiat_kits.fiat_implot.simple_plot_gui.SimplePlotGui          |
| atrix_Dim2                                      |   A GUI for
presenting 1D or 2D arrays with ImPlot. Can present the    |
|   synonym for a 2D ndarray of floats (NewType)     | array as a line,
scatter (+ stairs, or bars plot, if the array is      |
|                                                  | small enough)
|
+-------------------------------------------------------
+-----------------------------------------------------------------------------
+
| fiatlight.fiat_kits.fiat_ai.prompt.Prompt          |
fiatlight.fiat_kits.fiat_ai.prompt_with_gui.PromptWithGui              |
|   synonym for a string used as a prompt, used for  |   A Gui to edit a
prompt, with a Submit button, and a multiline edit   |
| AI text and image generation models (NewType)      | in a popup.
|
+-------------------------------------------------------
+-----------------------------------------------------------------------------
+
| pandas.core.frame.DataFrame                        |
fiatlight.fiat_kits.fiat_dataframe.dataframe_with_gui.DataFrameWithGui |
|                                                  |   A class to
present a pandas DataFrame in the GUI, with pagination    |
|                                                  | and other
features. Open in a pop-up for more features                |
+-------------------------------------------------------
+-----------------------------------------------------------------------------
+
| matplotlib.figure.Figure                           |
fiatlight.fiat_kits.fiat_matplotlib.figure_with_gui.FigureWithGui      |
|   The top level container for all the plot         |   A Gui that can
present a resizable matplotlib figure                |
| elements.                                          |
|
+-------------------------------------------------------
+-----------------------------------------------------------------------------
+
```

5.i. Fiat Tuning: Tune functions

Introduction:

Fiatlight provides you with powerful tools to visually debug the intermediate states of your function.

By adding a fiat_tuning attribute to a function, you can provide additional information that will be displayed in the GUI node for this function. This attribute is a dictionary and can contain named data values or descendants of AnyDataWithGui. This information can be used to fine-tune the function, debug it, or visualize intermediate states.

Moreover, this information can be updated in the GUI, even if the function is a long-running process called asynchronously.

> *Example: The image below shows a sort competition between different algorithms. The GUI nodes display in real time the evolving state of each algorithm, using "fiat_tuning".*
>
> *See "Advanced Video Tutorial: Sort Algorithm Visualizer" below for more details.*

==== Example: Measure Execution Time

In the example below, we will add a simple float into the fiat_tuning attribute of the sort_list function. This float will represent the duration of the sort operation.

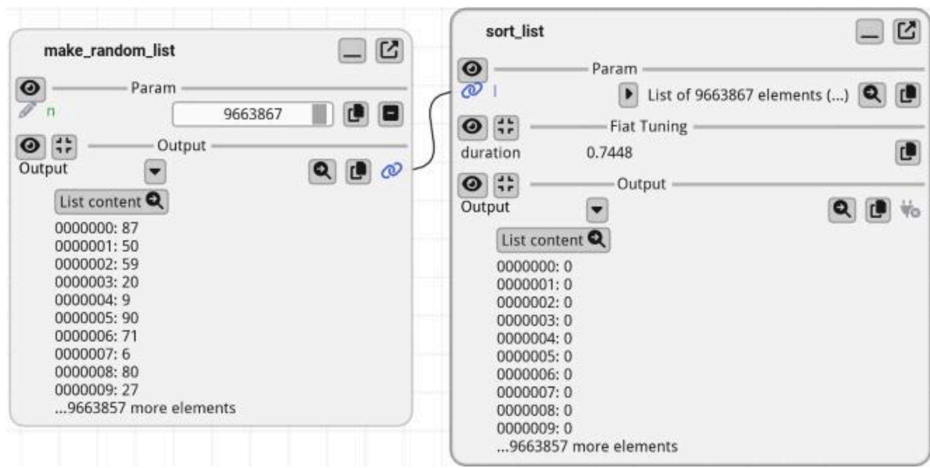
The collapsible region “Fiat Tuning” will display this duration:we can see that in this example, it takes about 0.75 seconds to sort a list of 10,000,000 elements.

```
import fiatlight as fl
import time

@fl.with_fiat_attributes(n__range=(1, 10_000_000))
def make_random_list(n: int) -> list[int]:
    import random
    return [random.randint(0, 100) for _ in range(n)]


def sort_list(l: list[int]) -> list[int]:
    start = time.time()
    r = sorted(l)
    duration = time.time() - start
    fl.add_fiat_attributes(sort_list, fiat_tuning={"duration":
duration})
    return r

fl.run([make_random_list, sort_list], app_name="Sort duration")
```



Example: Tune using an Image:

The fiat_tuning attribute can also be used to display widgets (which must be descendants of AnyDataWithGui) in the GUI node.

In the example below, we will add an image widget (ImageWithGui) into the fiat_tuning attribute.

demos/images/toon_edges.py is a good example of how to use the `fiat_tuning` attribute.

`add_toon_edges` is a complex function that adds a toon effect to an image, by adding colored edges to the image contours. The contour detection is extremely sensitive to the parameters, and the `fiat_tuning` attribute is used to display the intermediate states of the function in the GUI.

Here are some commented extracts of the function:

```
from fiatlight.fiat_kits.fiat_image import ImageU8_3, ImageU8_1

def add_toon_edges(
image: ImageU8_3,
# ... lots of parameters ...
) -> ImageU8_3:
    edges: ImageU8_1 # = ...             (compute the edges)
    dilated_edges: ImageU8_1 #  = ...    (dilate the edges)
    image_with_edges: ImageU8_3  # = ... (superimpose the edges on the
image)

    # fiat_tuning: add debug internals to ease fine-tuning the function
inside the node
    from fiatlight.fiat_kits.fiat_image import ImageWithGui

    # Add to fiat_tuning any variable you want to be able to fine-tune
or debug in the function node
    #     * Either a raw type (int, float, str, etc.): see durations
    #     * Or a descendant of AnyDataWithGui: see "canny", "dilate",
"image_with_edges"
    fl.add_fiat_attributes(add_toon_edges, fiat_tuning={
        "duration_canny": duration_canny,
        "duration_dilate": duration_dilate,
        "duration_blur": duration_blur,
        "duration_merge": duration_merge,
        "canny": ImageWithGui(edges),
        "dilate": ImageWithGui(dilated_edges),
        "image_with_edges": ImageWithGui(image_with_edges),
    })

    # return the image with edges
    return image_with_edges
```

Once these internals are set, you can see the function “Internals” in the GUI:

```
import fiatlight as fl
from fiatlight.fiat_kits.fiat_image import ImageU8_GRAY, ImageU8_3,
image_source
from fiatlight.demos.images.toon_edges import add_toon_edges

fl.run([image_source, add_toon_edges], app_name="Toon edges")
```

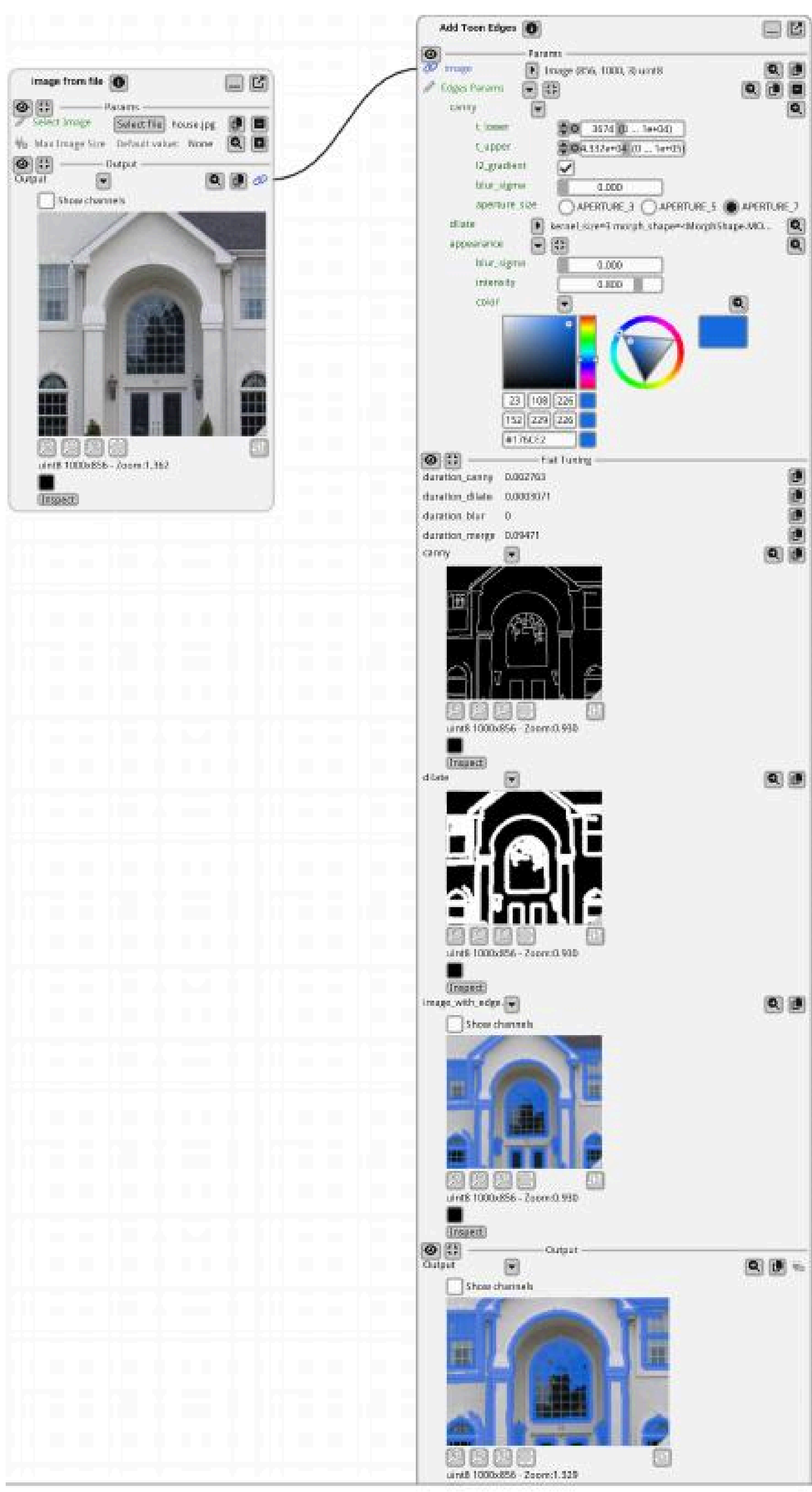


Image from file
Params
Select image
Select file
house.jpg
Max Image Size
Default value: None
Output
Show channels
Inspect
Add Toon Edges
Edges Params
canny
t_lower
t_upper
l2_gradient
blur_sigma
aperture_size
APERTURE_3
APERTURE_5
APERTURE_7
dilate
appearance
intensity
color
Fiat Tuning
duration_canny
duration_dilate
duration_blur
duration_merge
image_with_edges

> *The image above shows the GUI node for the toon_edges function, with the expanded "Fiat Tuning" section: it displays the execution time of each step, as well as an image representation of the intermediate edges and dilated edges.*

=== Debugging Functions exceptions

When a function raises an exception, Fiatlight catches and displays it without crashing the application. Instead, you will see a "Debug this exception" button that you can use to trigger the exception again.

This feature is invaluable for debugging and making your functions more robust. If you are using a debugger, you will be taken directly to the point where the exception occurred, with the correct inputs to reproduce the bug.

> _Note: this feature can be disabled with:
> `fl.get_fiat_config().run_config.catch_function_exceptions = False`

==== Example: a Math Exception

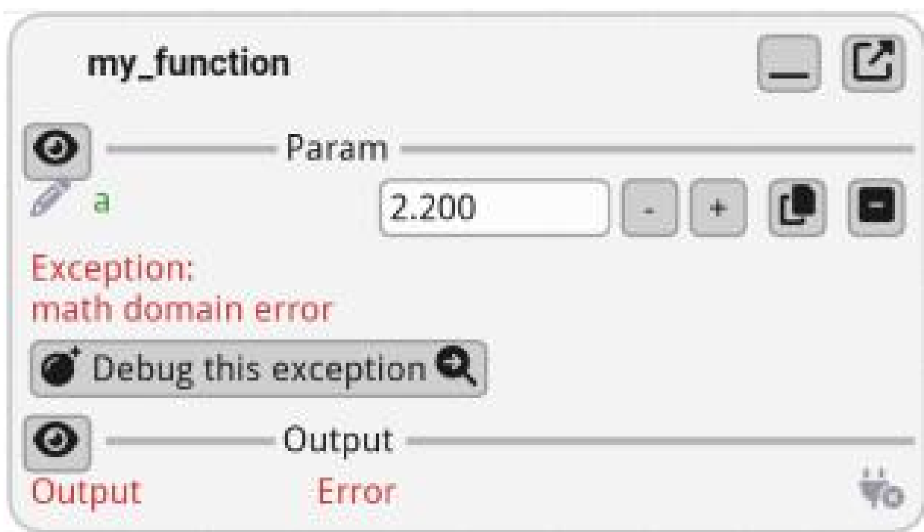
With this setup, if the input value of a causes math.log(cos_a) to produce an error (when cos_a is negative).

Fiatlight will catch and display the exception, allowing you to debug it easily.

```
import fiatlight as fl
import math

def my_function(a: float) -> float:
    cos_a = math.cos(a)
    r = math.log(cos_a)
    return r

fl.run(my_function, app_name="Math domain exception")
```



5.j. *Functions Graph*

`FunctionsGraph` is one of the core classes of FiatLight: it represents a graph of functions, where the output of one function can be linked to the input of another function.

- **Source**: see its full code online
- **API**: FunctionsGraph API

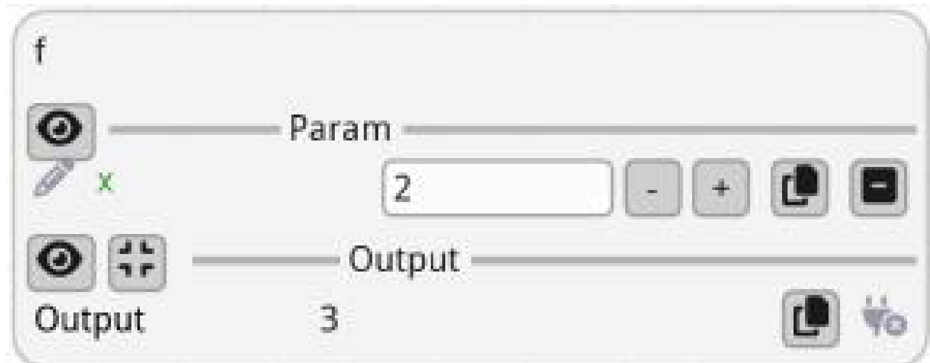
5.j.i. *Creating a FunctionsGraph:*

When a FunctionsGraph can be created automatically:

In simple cases (one function, or a list of functions that are chained together), you do not need to create a FunctionsGraph. See the examples below.

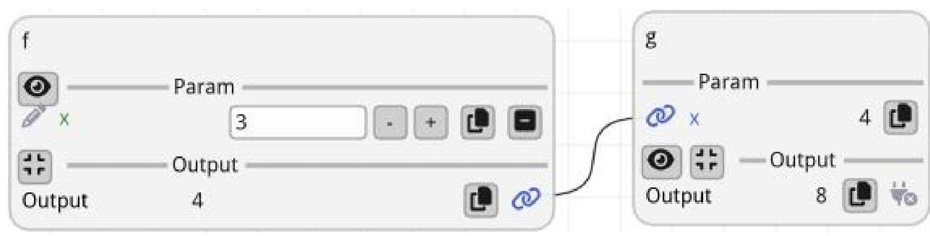
Single function:

```
import fiatlight as fl
def f(x: int) -> int:
    return x + 1
fl.run(f, app_name="Single function")
```



Chained functions:

```
import fiatlight as fl
def f(x: int) -> int:
    return x + 1
def g(x: int) -> int:
    return x * 2
fl.run([f, g], app_name="Chained functions")
```



When you need to create a FunctionsGraph:

For more complex cases, you can create a FunctionsGraph manually. This allows you to precisely control the links between the functions.

```
import fiatlight as fl

def int_source(x : int) -> int:
    """This function will be the entry point of the graph
    Since its inputs is unlinked, fiatlight will ask the user for a
value for x
    """
    return x

def square(x: int) -> int:
    return x * x

def add(x: int, y: int) -> int:
    return x + y

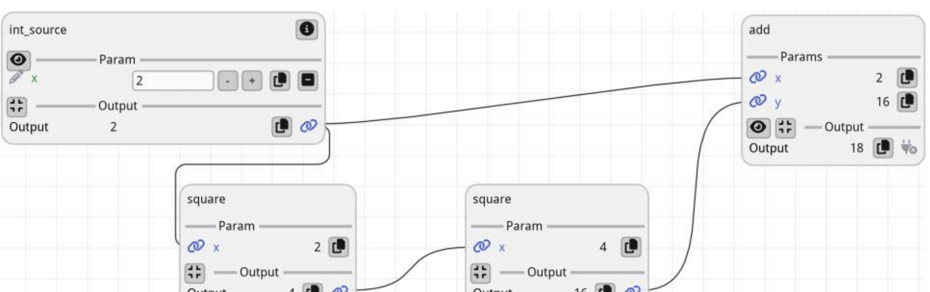
# 1. Create the graph
#
#    Notes:
#      - in this example we add the function `square` *two times*!
#          Each of them will have a different *unique name*: "square_1"
and "square_2"
#      - instead of creating a graph from a function composition, we
could also create an empty graph
#        and add the functions manually, like show in the comment below:
#             graph = fl.FunctionsGraph.create_empty()
#             graph.add_function_composition([int_source, square,
square])
#
graph = fl.FunctionsGraph.from_function_composition([int_source, square,
square])


# 2. Manually add a function
graph.add_function(add)

# 3. And link it
# First, link the output of int_source to the "x" input of add
# Note: we could also specify the source output index: src_output_idx=0
(but this is the default)
graph.add_link("int_source", "add", dst_input_name="x")

# Then, link the output of the second `square` to the "y" input of add
graph.add_link("square_2", "add", dst_input_name="y")


# 4. Run the graph
fl.run(graph, app_name="Manual graph")
```


int_source
Param
x
2
Output
Output 2
square
Param
x 2
Output
Output 4
square
Param
x 4
Output
Output 16
add
Params
x 2
y 16
Output
Output 18

5.k. Validate inputs with Fiatlight

5.k.i. *Introduction:*

Validators are functions that check the validity of a parameter value and raise a ValueError (with a nice error message), or correct the value if it is not valid. They are a powerful tool to ensure that the user enters valid values for the function parameters.

5.k.ii. *Example: Validators for function parameters:*

The code below will produce a GUI where:

- The `even_int` parameter must be an even integer. If it is not, the user will see a warning.
- The `multiple_of_5` parameter will automatically correct the input to the nearest multiple of 5.

This enhances user experience by providing immediate feedback and corrections, making the application more robust and user-friendly.

```
import fiatlight as fl

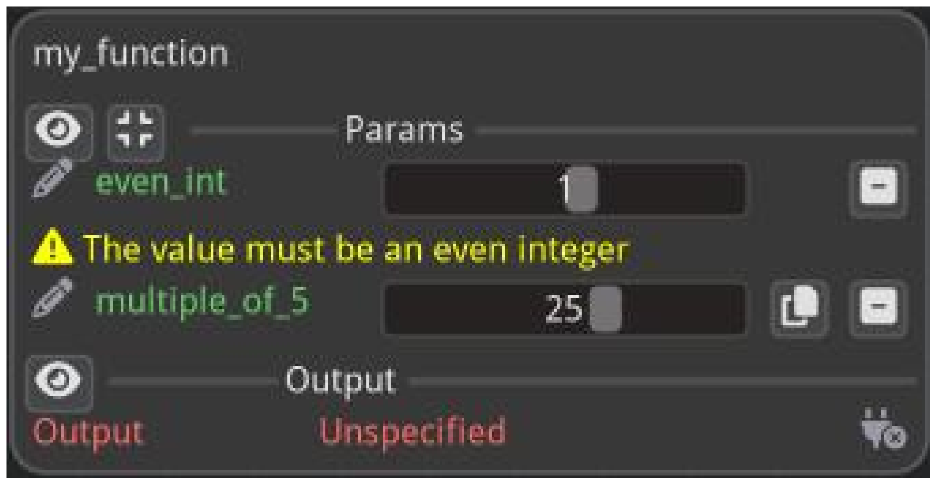
def even_int_validator(x: int) -> int:
    """This validator checks that the value is an even integer, and
warns the user if it is not."""
    if x % 2 != 0:
        raise ValueError("The value must be an even integer")
    return x


def multiple_of_5_validator(x: int) -> int:
    """This validator will correct the user input to the closest
multiple of 5."""
    return int(x / 5) * 5


def my_function(even_int: int = 0, multiple_of_5: int = 0) -> int:
    return even_int + multiple_of_5


fl.add_fiat_attributes(
    my_function,
    even_int__validator=even_int_validator,
    even_int__range=(-10, 10),
    multiple_of_5__validator=multiple_of_5_validator,
    multiple_of_5__range=(-100, 100)
)

fl.run(my_function, app_name="Validators")
```



Note: instead of using `fl.add_fiat_attributes`, you can also use the `@fl.with_fiat_attributes` decorator on top of the function to register its validators.

=== Example: Validators for Dataclass members

The code below will produce the same GUI as the previous example, but this time using a dataclass.

```
import fiatlight as fl
from dataclasses import dataclass  # optional, since fiatlight will add
the @dataclass decorator
                                   # when using the
@fl.dataclass_with_gui_registration decorator

def even_int_validator(x: int) -> int:
    """This validator checks that the value is an even integer, and
warns the user if it is not."""
    if x % 2 != 0:
        raise ValueError("The value must be an even integer")
    return x

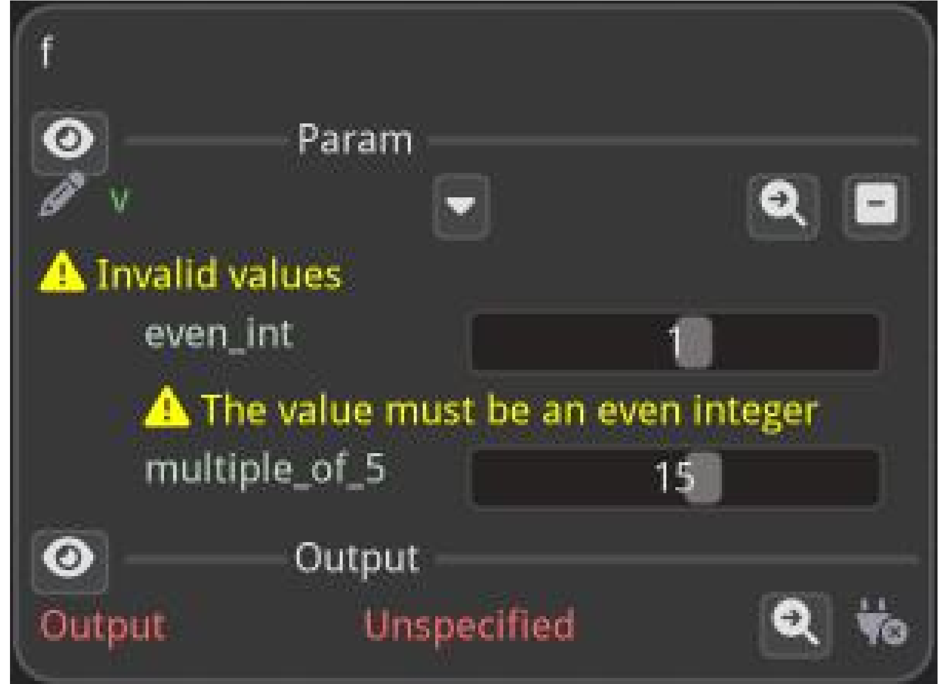

def multiple_of_5_validator(x: int) -> int:
    """This validator will correct the user input to the closest
multiple of 5."""
    return int(x / 5) * 5


# Note: the decorator @fl.dataclass_with_gui_registration will also
apply
#       the @dataclass decorator to the class
@fl.dataclass_with_gui_registration(
    even_int__validator=even_int_validator,
    even_int__range=(-10, 10),
```

```
    multiple_of_5__validator=multiple_of_5_validator,
    multiple_of_5__range=(-100, 100)
)
class MyData:
    even_int: int = 0
    multiple_of_5: int = 0


def f(v: MyData) -> MyData:
  return v

fl.run(f, app_name="Validators in a Dataclass")
```



> *Note: instead of using the decorator* `@fl.dataclass_with_gui_registration` *on top of the dataclass, you can also use the* `the functionfl.register_dataclass`` *to register the dataclass, and add fiat attributes, such as the validators.*

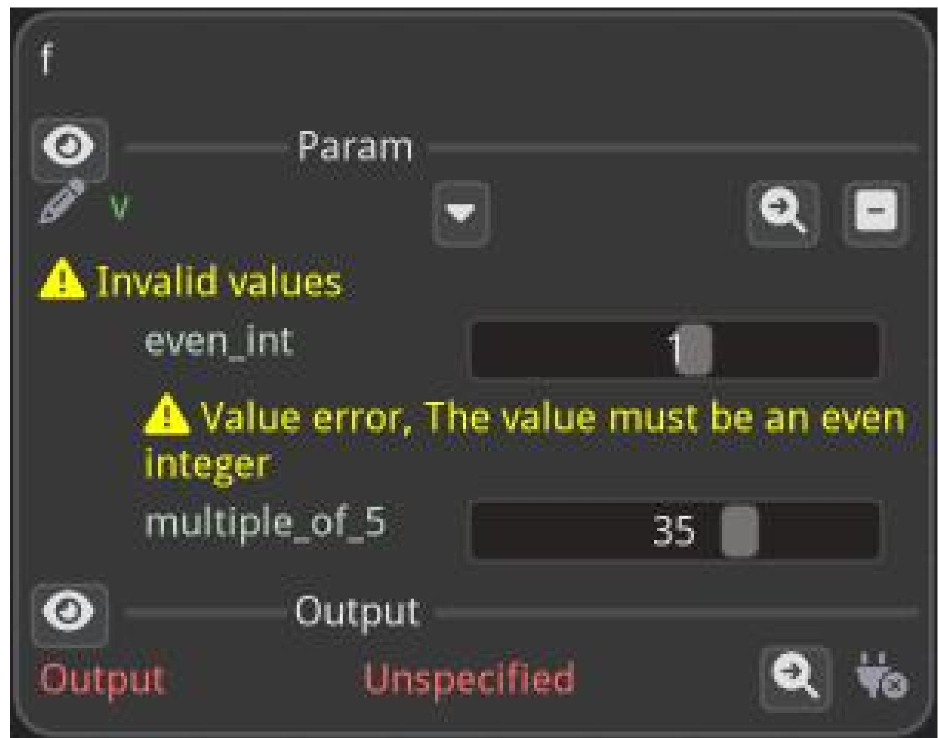
=== Example: Validators for BaseModel members

The code below will produce the same GUI as the previous example, but this time using a Pydantic model. In this case we can also use standard Pydantic validators.

> Note: Fiatlight will also interpret the range from the less than (le) and greater than (ge) constraints in the Pydantic model.

```
import fiatlight as fl
from pydantic import BaseModel, Field, field_validator
```

```python
@fl.base_model_with_gui_registration()
class MyData(BaseModel):
  even_int: int = Field(0, ge=-10, le=10)
  multiple_of_5: int = Field(0, ge=-100, le=100)

  @field_validator("even_int")
  def even_int_validator(cls, v):
    if v % 2 != 0:
      raise ValueError("The value must be an even integer")
    return v

  @field_validator("multiple_of_5")
  def multiple_of_5_validator(cls, v):
    return int(v / 5) * 5

def f(v: MyData) -> MyData:
  return v

fl.run(f, app_name="Validators in a Pydantic model")
```



Note: instead of using the decorator `@fl.base_model_with_gui_registration` *on top of the Pydantic model, you can also use the* `the functionfl.register_base_model`` *to register the Pydantic model, and add fiat attributes, such as the validators.*

Dataclasses and Pydantic models can easily be registered with their GUI.

Dataclasses:

Example: automatically create a GUI for a “Person” dataclass:

To create a GUI for a dataclass, you first need to register the dataclass with its GUI.

For this, you can use `fl.register_dataclass(dataclass_type, **fiat_attributes)` or the `@fl.dataclass_with_gui_registration(**fiat_attributes)` decorator.

In either case, you can specify GUI options for the fields using the fiat_attributes mechanism.

Option 1: using `register_dataclass`:

```
import fiatlight as fl
from dataclasses import dataclass

class Person:
    name: str
    age: int

fl.register_dataclass(Person, age__range=(0, 120))
```

Option 2: using the decorator `dataclass_with_gui_registration`:

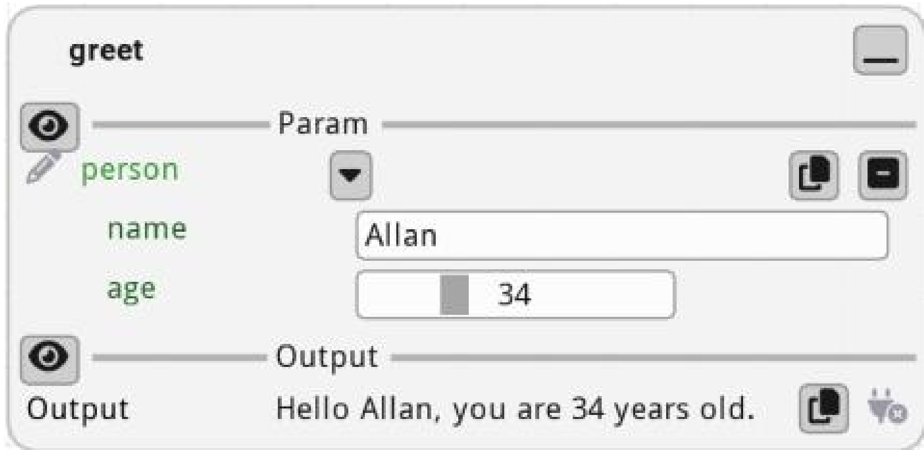
```
import fiatlight as fl
from dataclasses import dataclass

@fl.dataclass_with_gui_registration(age__range=(0, 120))
class Person:
    name: str
    age: int
```

(This option is shorter, but more intrusive, as it modifies the original class definition.)

Use the generated GUI in Fiatlight:

You can use the dataclass as a function parameter, and fiatlight will generate a GUI for it.

```
def greet(person: Person) -> str:
    return f"Hello {person.name}, you are {person.age} years old."

# Note: this app *will not* remember the values of the dataclass fields
between runs
fl.run(greet, app_name="Dataclass Person")
```



Or use the generate GUI in standalone application:

Alternatively, you can use the generated GUI in a standalone application. Below we run an application using hello_imgui. For more info, see Dear ImGui Bundle doc.

```
from imgui_bundle import hello_imgui

PERSON = Person(name="John", age=30)

def gui():
    global PERSON
    _changed, PERSON = fl.immediate_edit("Who are you?", PERSON)

hello_imgui.run(gui)
```

Who are you?
name
John
age
30

Pydantic models:

Below is a more complete example of how to use Pydantic models with fiatlight.

Example: automatically create a GUI for nested Pydantic models:

Notes:

- fiatlight will automatically generate a serialization/deserialization mechanism for Pydantic models, so that user entries can be saved and reloaded (when used as function parameters). This is not available for dataclasses.
- Pydantic models can be nested: in the example below, you will see 3 levels of nesting, and fiatlight will generate a nice GUI for those.

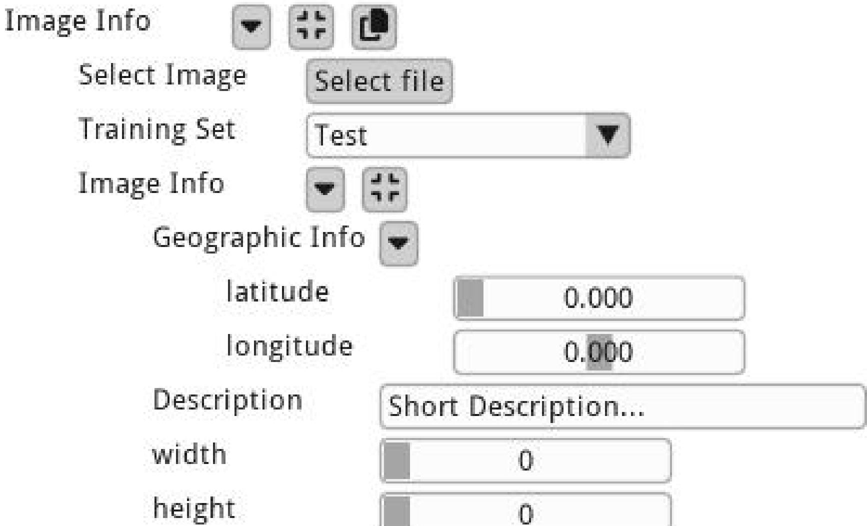
- You can use `fl.register_base_model` to register a Pydantic model with its GUI and add fiat attributes Alternatively, you can use the `@fl.base_model_with_gui_registration` decorator (but this is more intrusive, as it modifies the original class definition).
- You can specify GUI options for the fields using the fiat_attributes mechanism.
- Pydantic field validators (such as `Field(ge=0, le=90, ...)`) are supported and will be reflected in the GUI.
- Custom validators can be used, as shown in the example below.
- Validation errors will be displayed in the GUI (in yellow)

```
import fiatlight as fl
from enum import Enum
from pydantic import BaseModel, Field


# An Enum which will be associated to a Gui automatically
class TrainingDataType(Enum):
    Test = "test"
    Train = "train"
    Validation = "validation"


# GeographicInfo: a pydantic model, with validation on latitude and
longitude
# which will be reflected in the GUI
class GeographicInfo(BaseModel):
    latitude: float = Field(ge=0, le=90, default=0)
    longitude: float = Field(ge=-180, lt=180, default=0)

# We register the GeographicInfo model with its GUI
# (the sliders for lon/lat will be limited to the ranges specified in
the Fields)
fl.register_base_model(GeographicInfo)


# A custom validator, which will be used to validate the short
description
def validate_short_description(value: str) -> str:
    if len(value) > 30:
        raise ValueError("Description is too long")
    return value


# A second model, which nests the first one (GeographicInfo)
class ImageInfo(BaseModel):
    geo_info: GeographicInfo = GeographicInfo()
    description: str = "Short Description..."
    width: int = 0
    height: int = 0

# We register the ImageInfo model with its GUI, and add some fiat
```

```python
attributes
# Also, we add a custom Fiatlight validator for the description field
fl.register_base_model(
    ImageInfo,
    width__range=(0, 2000),
    height__range=(0, 2000),
    description__label="Description",
    description__validator=validate_short_description,
    geo_info__label="Geographic Info",
)



# A third model, which nests the second one (ImageInfo)
# In total, it has 3 levels: TrainingImage -> ImageInfo ->
GeographicInfo
# In this case, we use the decorator to register the model with its GUI
@fl.base_model_with_gui_registration(
    image_path__label="Select Image",
    training_type__label="Training Set",
    info__label="Image Info",
)
class TrainingImage(BaseModel):
    image_path: fl.fiat_types.ImagePath = ""  # type: ignore
    training_type: TrainingDataType = TrainingDataType.Test
    info: ImageInfo = ImageInfo(width=0, height=0)
```

Use the generated GUI in a standalone application:

```python
from imgui_bundle import hello_imgui

# We create an instance of the Pydantic model
IMAGE = TrainingImage()

def gui():
    global IMAGE
    _changed, IMAGE = fl.immediate_edit("Image Info", IMAGE)

hello_imgui.run(gui)
```



Or use the generated GUI in Fiatlight:

```
def process_image(image: TrainingImage) -> str:
    import os
    basename = os.path.basename(image.image_path)
    return basename

# Note: this app *will* remember the values of the Pydantic model fields
between runs
fl.run(process_image, app_name="Pydantic Image Model")
```

In the previous screenshot, the GUI generated by `fl.base_model_with_gui_registration` will automatically validate the data according to the model's constraints, and thus display an error message (because in this case, the description is too long).

5.l.i. *Video Tutorial:*

A short video tutorial is available for this topic.

🔗 Watch Video

5.m. Fully customize a Function Gui

5.m.i. *Introduction:*

By subclassing `FunctionWithGui`, you can fully customize the behavior of the function:

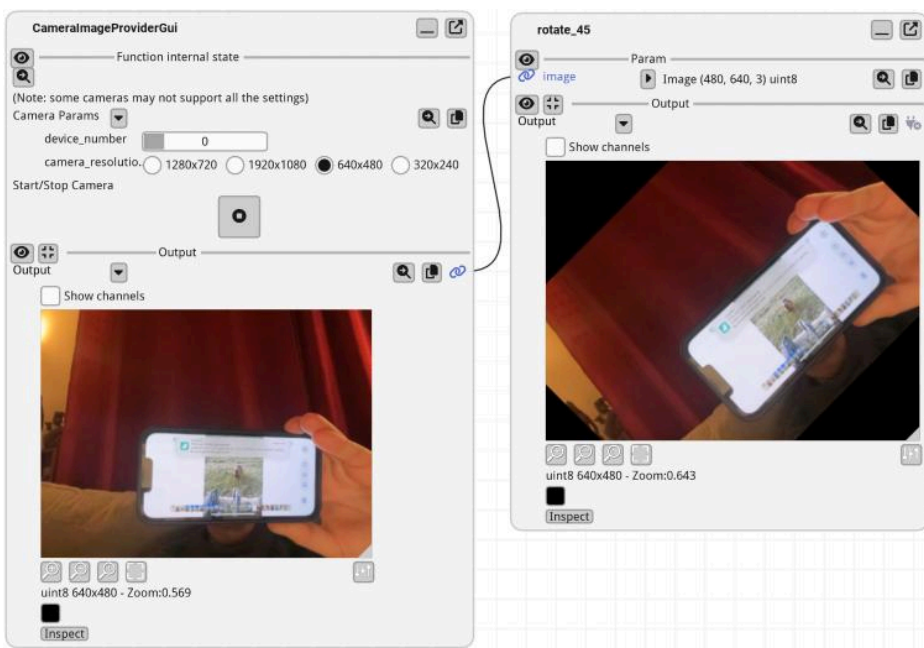
- you can add a GUI for the internal state of the function (e.g. displaying a live plot of a sound signal)
- you can add a heartbeat function that will be called at each frame (e.g. get the latest data from a sensor)
- you can save and load the internal GUI presentation options to/from a JSON file (e.g. to save the layout of a plot)

5.m.ii. *Example: Camera & Internal State:*

fiatlight.fiat_kits.fiat_image.CameraImageProviderGui is a good example of a custom FunctionWithGui class.

You can see it in action below:

```
import fiatlight as fl
from fiatlight.fiat_kits.fiat_image import CameraImageProviderGui,
ImageU8_3
import cv2

def rotate_45(image: ImageU8_3) -> ImageU8_3:
    transform = cv2.getRotationMatrix2D((image.shape[1] / 2,
image.shape[0] / 2), 45, 1)
    return cv2.warpAffine(image, transform, (image.shape[1],
image.shape[0]))  # type: ignore

camera_provider_gui = CameraImageProviderGui()
fl.run([camera_provider_gui, rotate_45], app_name="Camera provider with
rotation")
```



Commented extracts of camera_image_provider.py

Look at the `CameraImageProviderGui` class that extends `FunctionWithGui`:

Notes:

- `CameraImageProviderGui` der uses a `CameraImageProvider` class that provides images from a camera.
- `CameraParams` contains the state of the camera (device number, brightness, contrast, etc.). This state is serialized. As it is as a Pydantic model, a GUI for it is automatically created by Fiatlight, and its state is serialized.

CameraImageProviderGui (a descendant of FunctionWithGui):

```
from fiatlight.fiat_notebook import look_at_code
%look_at_python_code
fiatlight.fiat_kits.fiat_image.camera_image_provider.CameraImageProviderGui
```

CameraParams (serialized internal state):

```
import fiatlight as fl
from enum import Enum
from pydantic import BaseModel
import cv2

class CameraResolution(Enum):
    HD_1280_720 = [1280, 720]
    FULL_HD_1920_1080 = [1920, 1080]
    VGA_640_480 = [640, 480]
```

```python
@fl.base_model_with_gui_registration(device_number__range= (0, 5),
brightness__range= (0, 1), contrast__range= (0, 1))
class CameraParams(BaseModel):
    device_number: int = 0
    brightness: float = 0.5
    contrast: float = 0.5
    camera_resolution: CameraResolution = CameraResolution.VGA_640_480


class CameraImageProvider:
    '''A class that provides images from a camera'''
    camera_params: CameraParams
    cv_cap: cv2.VideoCapture | None = None
    ...
```

5.n. Custom types registration

By calling `fiatlight.register_type(DataType, DataTypeWithGui)`, it is possible to register a custom type with its GUI.

For a given type's GUI, it is possible to customize many aspects. Basically all the callbacks and options inside AnyDataGuiCallbacks can be customized.

Example 1: a customizable Normal Distribution type:

Step 1: Define the Custom Type

First, let's define a new type called NormalDistribution.

```
class NormalDistribution:
    mean: float = 0.0
    stddev: float = 1.0

    def __init__(self, mean: float = 0.0, stddev: float = 1.0) -> None:
        self.mean = mean
        self.stddev = stddev
```

Step 2: Create a Class to Handle the Custom Type

Next, we create a class NormalDistributionWithGui that extends AnyDataWithGui and defines the custom presentation and editing logic for the NormalDistribution type.

It will handle:

- A custom GUI for editing the NormalDistribution type
- A custom GUI for presenting the NormalDistribution type (using a cached figure, which is updated when the distribution changes)
- Serialization and deserialization of the custom type
- A default value provider

```
import fiatlight as fl
from imgui_bundle import imgui, imgui_fig
import matplotlib.pyplot as plt
from matplotlib.figure import Figure
import numpy as np


class NormalDistributionWithGui(fl.AnyDataWithGui[NormalDistribution]):
    # Cached figure for the distribution plot
    figure: Figure | None = None
    # boolean to indicate if the figure image should be refreshed
    shall_refresh_figure_image: bool = True

    def __init__(self) -> None:
        super().__init__(NormalDistribution)

        # Edit and present callbacks
```

```
        self.callbacks.edit = self._edit_gui
        self.callbacks.present = self._present_gui
        self.callbacks.present_str = lambda value: f"Normal Distrib:
Mean={value.mean:.2f}, StdDev={value.stddev:.2f}"

        # Default value provider
        self.callbacks.default_value_provider = lambda:
NormalDistribution()

        # Serialization of the custom type
        # (note it would be automatic if we used a Pydantic model)
        self.callbacks.save_to_dict = lambda value: {"mean": value.mean,
"stddev": value.stddev}
        self.callbacks.load_from_dict = lambda data:
NormalDistribution(mean=data["mean"], stddev=data["stddev"])

        # Callback for handling changes: we need to subscribe to this
event
        # in order to update the self.figure when the distribution
changes
        self.callbacks.on_change = self._on_change

    def _on_change(self, value: NormalDistribution) -> None:
        # remember to close the previous figure to avoid memory leaks
        if self.figure is not None:
            plt.close(self.figure)

        # Create the figure
        x = np.linspace(value.mean - 4 * value.stddev, value.mean + 4 *
value.stddev, 100)
        y = (1 / (value.stddev * np.sqrt(2 * np.pi))) * np.exp(-0.5 *
((x - value.mean) / value.stddev) ** 2)
        figure = plt.figure(figsize=(4, 3))
        plt.plot(x, y)
        plt.title("Normal Distribution")
        plt.xlabel("x")
        plt.ylabel("Density")
        plt.grid(True)

        # Cache the figure
        self.figure = figure

        # Indicate that the figure image should be refreshed
        self.shall_refresh_figure_image = True

    @staticmethod
    def _edit_gui(value: NormalDistribution) -> tuple[bool,
NormalDistribution]:
        # Note: we receive the current value and return a tuple with
        # a boolean indicating if the value was modified
        modified = False
        imgui.text("Edit Normal Distribution:")
```

```python
        imgui.set_next_item_width(100)
        changed, new_mean = imgui.slider_float("Mean", value.mean,
-10.0, 10.0)
        if changed:
            value.mean = new_mean
            modified = True
        imgui.set_next_item_width(100)
        changed, new_stddev = imgui.slider_float("StdDev", value.stddev,
0.1, 10.0)
        if changed:
            value.stddev = new_stddev
            modified = True

        return modified, value

    def _present_gui(self, _value: NormalDistribution) -> None:
        # We do not use the value which was passed as a parameter as we
use the cached Figure
        # which was updated in the _on_change callback
        imgui_fig.fig("Normal Distribution", self.figure,
refresh_image=self.shall_refresh_figure_image)
        self.shall_refresh = False
```

Step 3: Register the type

Finally, we register the custom type with its GUI, simply by calling the register_type function.

```python
fl.register_type(NormalDistribution, NormalDistributionWithGui)
```

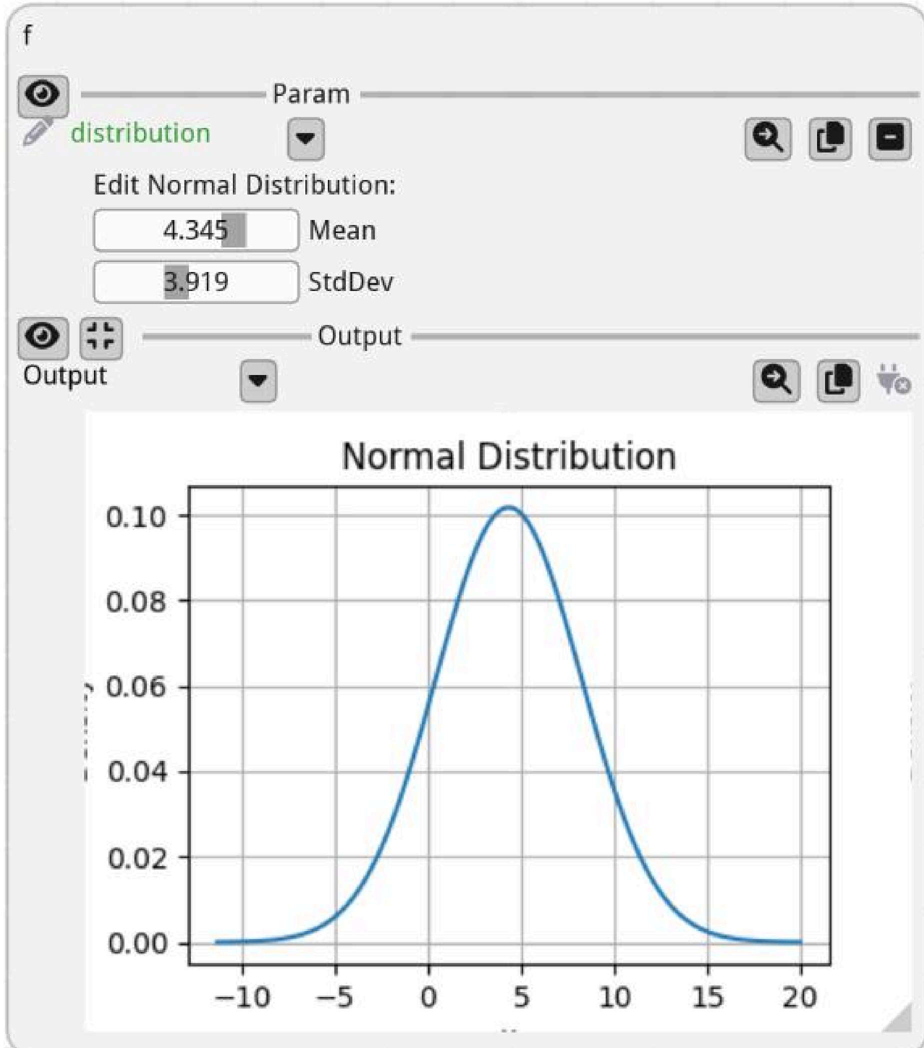
From now on, the NormalDistribution type will be associated with the NormalDistributionWithGui GUI: any function that uses NormalDistribution as a parameter or as a return type will automatically have a GUI for editing and presenting the NormalDistribution type.

Step 4: Use the custom type in a function

In this example, our function simply returns the NormalDistribution instance that was passed to it. In the screenshot, you can see the “edit” callback in action in the Param edition section, and the “present” callback in the Output section.

```python
def f(distribution: NormalDistribution) -> NormalDistribution:
    return distribution

fl.run(f, app_name="Normal Distribution")
```

```
2024-07-04 23:40:32.252 Python[68193:11625526]
ApplePersistenceIgnoreState: Existing state will not be touched. New
state will be written to /var/folders/w1/w77kvvl9613022ksfxj7v8xh0000gn/
T/org.python.python.savedState
```



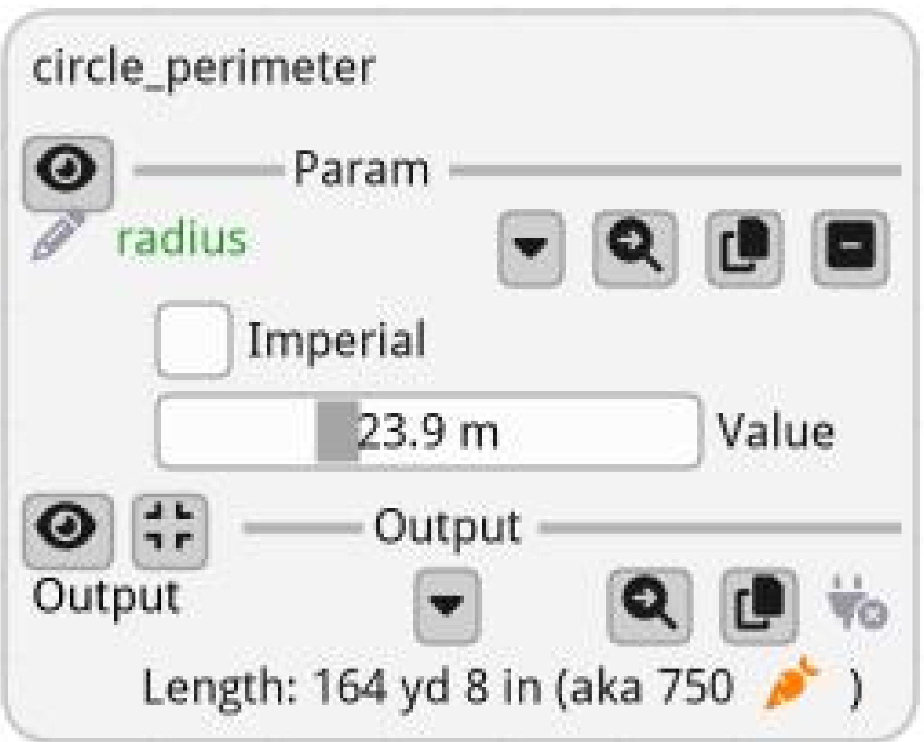
Example 2: a Length type with imperial units:

```
# Step 1: Define the custom type for which we want to create a GUI
# ==================================================================
from typing import NewType

Length = NewType("Length", float)

# Step 2: Create a class to handle the custom type
# ================================================
import fiatlight
from fiatlight import AnyDataWithGui
from fiatlight.fiat_widgets import fontawesome_6_ctx,
icons_fontawesome_6
from typing import NewType, Any, Dict
from imgui_bundle import imgui, hello_imgui, imgui_ctx, ImVec4


# The specific GUI for our custom type
```

```
class LengthWithGui(AnyDataWithGui[Length]):
    use_imperial_units: bool = False

    def __init__(self) -> None:
        super().__init__(Length)
        self.callbacks.edit = self._edit  # A custom callback for
editing the data
        self.callbacks.present = self._present  # A custom callback for
presenting the data
        self.callbacks.present_str = self._present_str  # A custom
callback for presenting the data as a short string
        self.callbacks.default_value_provider = lambda: Length(1.0)  # A
custom callback for providing a default value
        # custom callback for saving the GUI options (here, we save the
imperial units option)
        self.callbacks.save_gui_options_to_json =
self._save_gui_options_to_json
        self.callbacks.load_gui_options_from_json =
self._load_gui_options_from_json

    def _edit(self, value: Length) -> tuple[bool, Length]:
        _, self.use_imperial_units = imgui.checkbox("Imperial",
self.use_imperial_units)

        format = "%.3g m" if not self.use_imperial_units else "%.3g yd"
        value_unit = value * 1.09361 if self.use_imperial_units else
value
        imgui.set_next_item_width(hello_imgui.em_size(10))
        changed, new_value_unit = imgui.slider_float(
            "Value", value_unit, 1e-5, 1e11, format,
imgui.SliderFlags_.logarithmic.value
        )
        if changed:
            value = Length(new_value_unit / 1.09361 if
self.use_imperial_units else new_value_unit)
        return changed, value

    @staticmethod
    def _present_str(value: Length) -> str:
        return f"Length: {value:.2f} m"

    @staticmethod
    def _present(value: Length) -> None:
        with fontawesome_6_ctx():
            yd = int(Length(value * 1.09361))
            inches = int((Length(value * 1.09361 - yd) * 36))
            bananas = int(value / 0.2)
            imgui.text(f"Length: {yd} yd {inches:.0f} in (aka
{bananas}")
            imgui.same_line()
            with imgui_ctx.push_style_color(imgui.Col_.text.value,
ImVec4(1, 0.5, 0, 1)):
```

```python
                imgui.text(icons_fontawesome_6.ICON_FA_CARROT)
            imgui.same_line()
            imgui.text(")")

    def _save_gui_options_to_json(self) -> Dict[str, Any]:
        return {"use_imperial_units": self.use_imperial_units}

    def _load_gui_options_from_json(self, json: Dict[str, Any]) -> None:
        self.use_imperial_units = json.get("use_imperial_units", False)


# Step 3: Register the custom type with its GUI
# ==============================================
from fiatlight import register_type

register_type(Length, LengthWithGui)


# Step 4: Use the custom type in a function
# =========================================
# A function that uses our custom type
def circle_perimeter(radius: Length) -> Length:
    return Length(2 * 3.14159 * radius)


# Run the function with the GUI
fiatlight.run(circle_perimeter, app_name="Circle Perimeter in banana
units")
```

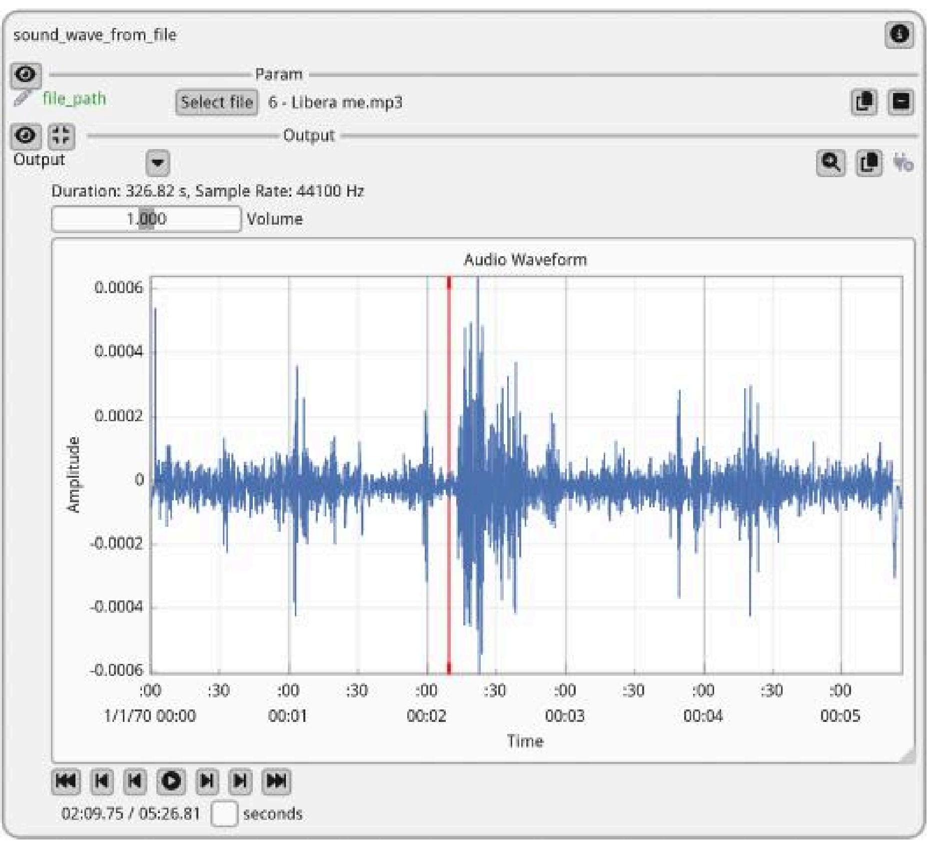
```
2024-07-04 23:40:37.134 Python[68193:11625526] WARNING: Secure coding is
not enabled for restorable state! Enable secure coding by implementing
NSApplicationDelegate.applicationSupportsSecureRestorableState: and
returning YES.
```



Example 3: a sound player:

The sound wave player also uses a custom type with a GUI.

```
from fiatlight.fiat_kits.experimental.fiat_audio_simple.demos import
demo_sound_wave_player

sound_wave_player_gui_demo.main()
```



For more info, see its source code).

5.n.i. *How to create a new "fiat kit":*

fiat_kit_skeleton:

fiatlight.fiat_kits.fiat_skeleton is a starting point for creating new widgets: it is a minimalistic kit that contains the necessary files to create a new widget.

```
fiat_kit_skeleton
├── __init__.py
├── mydata.py                    # An example data or library that you
want to present
├── mydata_presenter.py          # The presenter of the data
|                                # Also contains a derivate of
PossibleCustomAttributes
|                                # where all the custom attributes are
defined
|
└── mydata_with_gui.py           # MyDataWithGui: the widget that will
be displayed in the GUI
# (inherits from AnyDataWithGui, implements all the callbacks
#  of AnyDataGuiCallbacks, and uses MyDataPresenter for
# complex data presentation)
```

See files:

- mydata.py
- mydata_presenter.py
- mydata_with_gui.py

fiat_kit_skeleton in action:

fiatlight.fiat_kits.fiat_dataframe it was developed starting from the skeleton. It is a good example on how it can be customized.

```
fiat_dataframe
├── dataframe_presenter.py                    # The presenter of the data
(presentation code)
|                                             # Also contains a derivate
of PossibleCustomAttributes
|
├── dataframe_with_gui.py                     # The widget that will be
displayed in the GUI
|                                             # (inherits from
AnyDataWithGui, implements all the callbacks
|                                            #  of AnyDataGuiCallbacks,
and uses DataFramePresenter for
|                                            # complex data presentation)
```

See files:

- dataframe_presenter.py
- dataframe_with_gui.py

Install optional dependencies

In order to run the demos, you may need to install per domain dependencies:

- For AI demos: `pip install -r requirements-ai.txt`
- For audio demos: `pip install -r requirements-audio.txt`

Standard demos

Several demos are available in the src/python/fiatlight/demos folder:

```
%%bash
tree -I "__pycache__|fiat_settings|priv_experiments|fonts|
__init__.py" ../demos/ | grep -v directories
```

```
../demos/
├── ai
│   ├── demo_sdxl_meme.py
│   └── demo_sdxl_toon_edges.py
├── audio
│   ├── demo_audio_processing_link.py
│   ├── microphone_gui_demo_link.py
│   └── sound_wave_player_gui_demo_link.py
├── custom_graph
│   └── demo_custom_graph.py
├── hello_rosetta
│   ├── example_validation.py
│   └── hello_rosetta.py
├── images
│   ├── demo_computer_vision.py
│   ├── demo_oil_paint.py
│   ├── old_school_meme.py
│   ├── opencv_wrappers.py
│   └── toon_edges.py
├── math
│   ├── demo_binomial.py
│   ├── demo_float_functions.py
│   ├── demo_plot_array.py
│   └── demo_plot_manual_present.py
├── plots
│   └── demo_matplotlib.py
└── string
    ├── demo_word_count.py
    └── str_functions.py
```

Notebook demos

You can also run all the demos that are present in the documentation (there are a lot of interesting demos, together with screenshots)

- install Jupyter: `pip install jupyter`

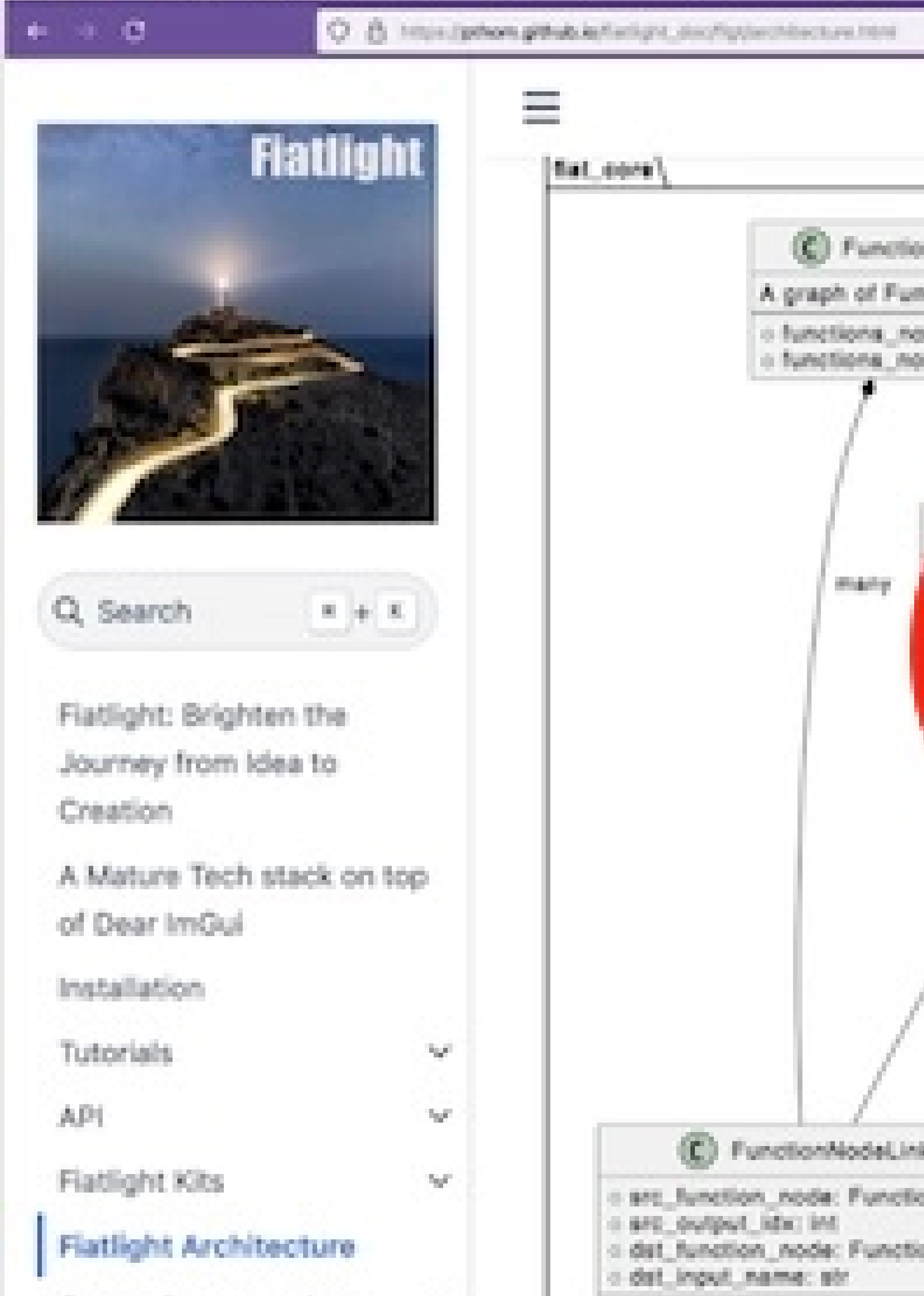
- Launch Jupyter with the following command: `jupyter lab`
- After Jupyter is launched, a browser page will open: navigate to the “src/python/fiatlight/doc” folder to find the demos.

6. API

6.a. High level overview video

The video below present a high-level overview of Fiatlight's architecture and how it automatically maps functions and data types to UI components.

🔗 Watch Video


Flatlight
Search
Flatlight: Brighten the Journey from Idea to Creation
A Mature Tech stack on top of Dear ImGui
Installation
Tutorials
API
Flatlight Kits
Flatlight Architecture
many

== Architecture

- Fiatlight Architecture: Overview of the Fiatlight architecture, including the class diagrams and folders structure.

6.b. *fiat_core*

fiat_core is the foundational package of the fiatlight framework. It focuses on wrapping data and functions with GUI elements to facilitate interaction.

Its most important classes are:

- `FunctionWithGui`: Encapsulates a function, enriching it with a GUI based on inferred input and output types. It handles function invocation and manages internal states like exceptions and execution flags.
- `AnyDataWithGui`: Wraps any type of data with a GUI. This class manages the data value and its associated callbacks, and it provides methods to serialize/deserialize the data to/from JSON.
- `AnyDataGuiCallbacks`: Stores callback functions for AnyDataWithGui, enhancing interactivity by allowing custom widgets and presentations.
- `FunctionsGraph`: Represents a graph of functions, where the output of one function can be linked to the input of another function. It allows the user to create complex workflows by chaining functions together.

6.c. Fiatlight Architecture

```
# Necessary imports for this doc page
from fiatlight.fiat_notebook import plantuml_magic,
display_markdown_from_file
```

6.c.i. *Class diagrams:*

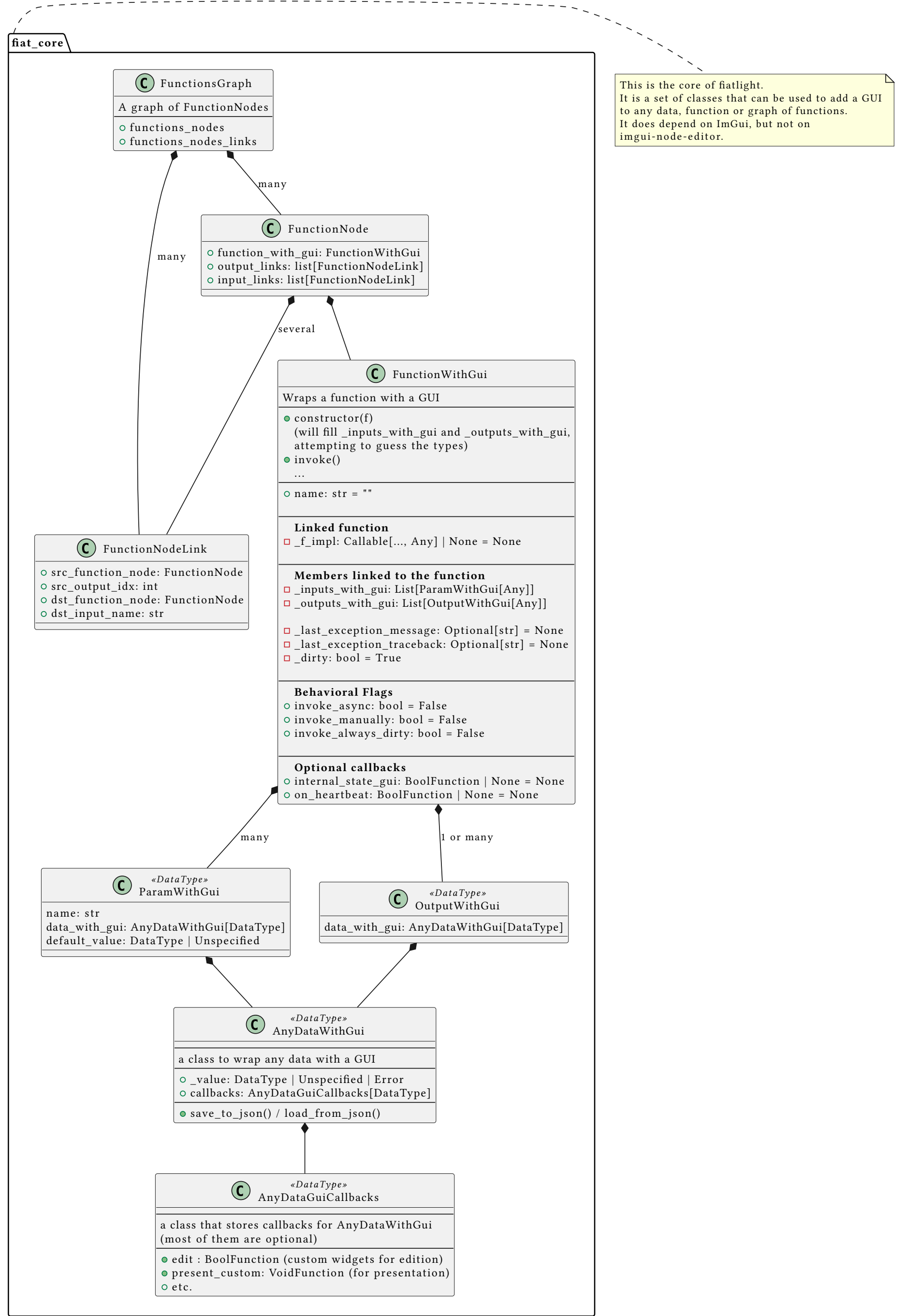
fiat_core:

This is the foundational package of the fiatlight framework. It focuses on wrapping data and functions with GUI elements to facilitate interaction.

Classes

- `AnyDataWithGui`: Wraps any type of data with a GUI. This class manages the data value and its associated callbacks, and it provides methods to serialize/deserialize the data to/from JSON.
- `AnyDataGuiCallbacks`: Stores callback functions for AnyDataWithGui, enhancing interactivity by allowing custom widgets and presentations.
- `FunctionWithGui`: Encapsulates a function, enriching it with a GUI based on inferred input and output types. It handles function invocation and manages internal states like exceptions and execution flags.
- `ParamWithGui` and `OutputWithGui`: These classes link parameters and outputs of functions to their GUI representations.
- `FunctionNode`: Represents a node in a function graph, containing links to other function nodes and managing data flow between them.
- `FunctionNodeLink`: Defines a link between outputs of one function node and inputs of another, facilitating data flow in the function graph.
- `FunctionsGraph`: Represents a graph of interconnected FunctionNode instances, effectively mapping the entire functional structure.

```
%plantuml_include class_diagrams/fiat_core.puml
```



fiat_togui:

fiat_togui provides functions to register new types (classes, dataclasses, enums) so that they are associated with a GUI.

Functions

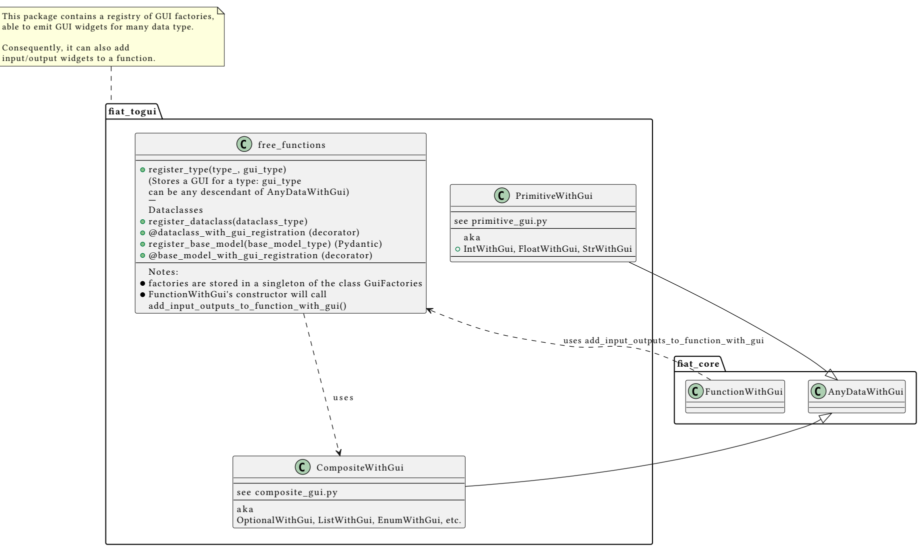
- `register_type(type_, gui_type)`: register a GUI for a given type. gui_type must be a descendant of AnyDataWithGui

- `register_enum(enum_type)` and the equivalent decorator `enum_with_gui_registration`: register an enum
- `register_dataclass` and the equivalent decorator `dataclass_with_gui_registration`: register a dataclass base model
- `register_base_model` and the equivalent decorator `base_model_with_gui_registration`: register a pydantic base model

Classes

- `IntWithGui`, `FloatWithGui`, etc.: provides GUI for primitive types (int, str, float, bool)
- `OptionalWithGui`: able to add GUI to Optional[DataType] (if DataType is registered)

```
%plantuml_include class_diagrams/fiat_togui.puml
```



fiat_runner:

fiat_runner is the package that contains the "run" functions:

Free function

`fiat_run` accepts either a standard function, a list of functions, or a graph of functions. It executes the function(s) and displays the results in a GUI.

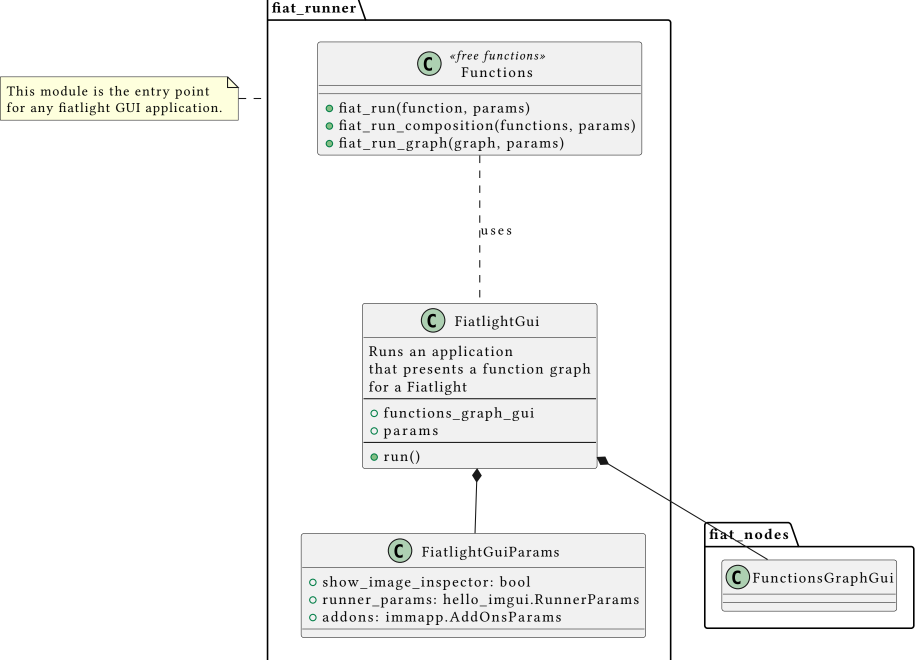
- `fiat_run(fn)` # fn is a function or a FunctionWithGui
- `fiat_run([fn1, fn2, ...])` # list of functions or FunctionWithGui
- `fiat_run(graph)` # A FunctionsGraph

Classes

- `FiatlightGui`: The main runtime class that presents a GUI for interacting with a function graph. It orchestrates the execution and user interaction.

- `FiatlightGuiParams`: Stores configuration and parameters for the GUI application, such as visibility toggles and other settings.

```
%plantuml_include class_diagrams/fiat_runner.puml
```



fiat_nodes:

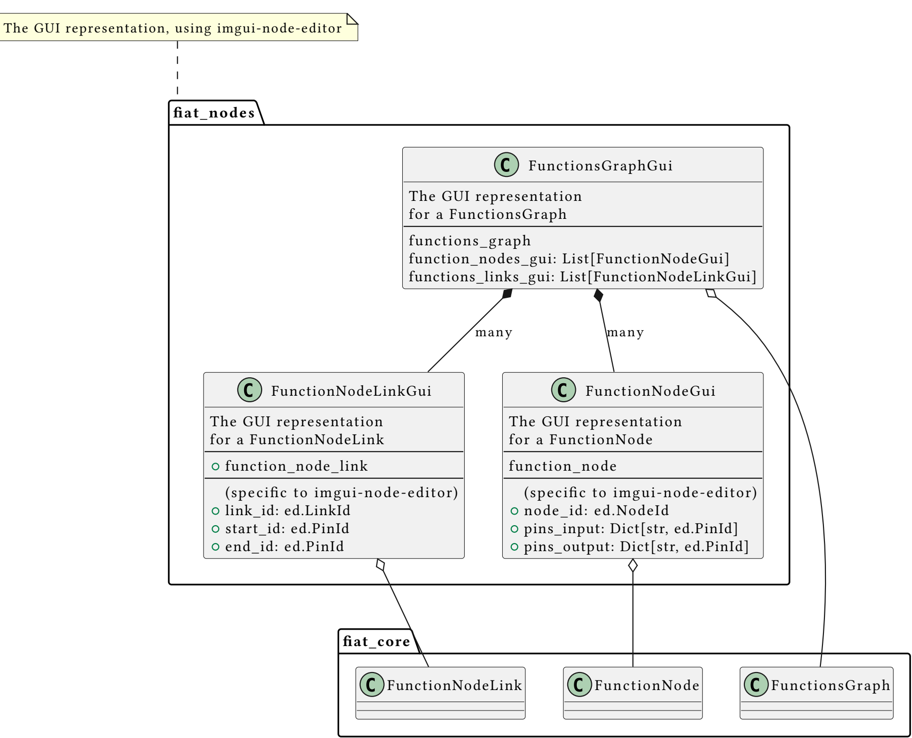
fiat_nodes is the package that is able to display a function graph in a node editor (using imgui-node-editor)

As a final user, you will probably not interact with it.

Classes

- `FunctionNodeGui`: The GUI representation of a FunctionNode
- `FunctionNodeLinkGui`: The GUI representation aspect of a FunctionNodeLink
- `FunctionsGraphGui`: The GUI representation of a FunctionsGraph

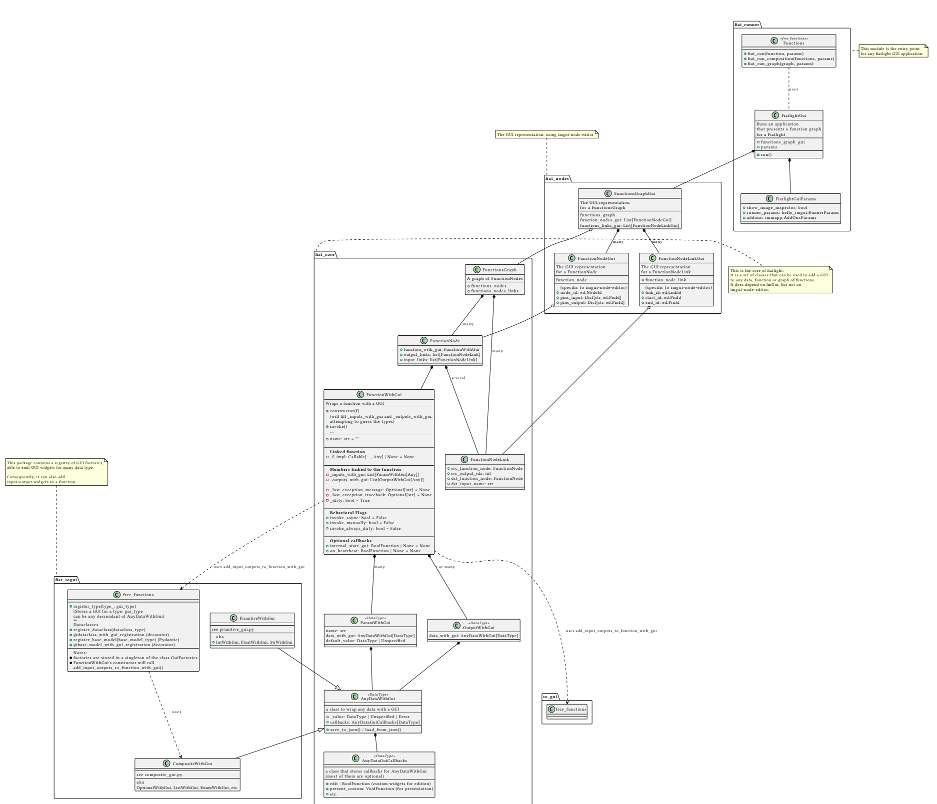
```
%plantuml_include class_diagrams/fiat_nodes.puml
```



Full diagram:

Below is the full class diagram

```
%plantuml_include class_diagrams/all.puml
```



6.c.ii. *Folder structure:*

Below is the folder structure of the fiatlight framework.

```
display_markdown_from_file("folder_structure.md")
```

<IPython.core.display.Markdown object>

6.d. *FunctionWithGui*

6.d.i. *Introduction:*

`FunctionWithGui` is one of the core classes of FiatLight: it wraps a function with a GUI that presents its inputs and outputs.

- **Manual**: Read the manual for a detailed guide on how to use it.
- **Source code**: View its full code online.

6.d.ii. *Signature:*

Below, you will find the “signature” of the `FunctionWithGui` class, with its main attributes and methods (but not their bodies)

Its full source code is available online.

```
from fiatlight.fiat_notebook import look_at_code
%look_at_class_header fiatlight.fiat_core.FunctionWithGui
```

```
class FunctionWithGui:
    """FunctionWithGui: add GUI to a function

    `FunctionWithGui` is one of the core classes of FiatLight: it wraps
a function with a GUI that presents its
    inputs and its output(s).

    Public Members
    ==============
    # the name of the function
    name: str = ""

    #
    # Behavioral Flags
    # ----------------
    # invoke_async: if true, the function shall be called asynchronously
    invoke_async: bool = False

    # invoke_manually: if true, the function will be called only if the
user clicks on the "invoke" button
    # (if inputs were changed, a "Refresh needed" label will be
displayed)
    invoke_manually: bool = False

    # invoke_always_dirty: if true, the function output will always be
considered out of date, and
    #   - if invoke_manually is true, the "Refresh needed" label will be
displayed
    #   - if invoke_manually is false, the function will be called at
each frame
    # Note: a "live" function is thus a function with
invoke_manually=False and invoke_always_dirty=True
    invoke_always_dirty: bool = False
```

```
    # Optional user documentation to be displayed in the GUI
    #     - doc_display: if True, the doc string is displayed in the GUI
(default: False)
    #     - doc_is_markdown: if True, the doc string is in Markdown
format (default: True)
    #     - doc_user: the documentation string. If not provided, the
function docstring will be used
    #     - doc_show_source: if True, the source code of the function
will be displayed in the GUI
    doc_display: bool = True
    doc_markdown: bool = True
    doc_user: str = ""
    doc_show_source: bool = False

    #
    # Internal state GUI
    # ------------------
    # internal_state_gui: optional Gui for the internal state of the
function
    # (this function may display a GUI to show the internal state of the
function,
    #  and return True if the state has changed, and the function needs
to be called)
    internal_state_gui: BoolFunction | None = None

    # internal_state_gui_node_compatible:
    # If True, the internal_state_gui function is incompatible with
being presented in a node
    # (this is due to a limitation of the node editor, which cannot
render scrollable widgets)
    # Note: instead of setting edit_node_compatible to False, you may
query
    #       `fiatlight.is_rendering_in_node()` to know if you are
rendering in a node
    #       and choose alternative widgets in this case.
    internal_state_gui_node_compatible: bool = True

    #
    # Heartbeat
    # ---------
    # on_heartbeat: optional function that will be called at each frame
    # (and return True if the function needs to be called to update the
output)
    on_heartbeat: BoolFunction | None = None

    #
    # Serialization
    # -------------
    # save/load_internal_gui_options_from_json (Optional)
    # Optional serialization and deserialization of the internal state
GUI presentation options
    # (i.e. anything that deals with how the GUI is presented, not the
```

```
data itself)
    # If provided, these functions will be used to recreate the GUI
presentation options when loading a graph,
    # so that the GUI looks the same when the application is restarted.
    save_internal_gui_options_to_json: Callable[[], JsonDict] | None =
None
    load_internal_gui_options_from_json: Callable[[JsonDict], None] |
None = None

    """
    function_name: str = ''
    label: str = ''
    invoke_async: bool = False
    invoke_manually: bool = False
    invoke_always_dirty: bool = False
    invoke_is_gui_only: bool = False
    doc_display: bool = True
    doc_markdown: bool = True
    doc_user: str = ''
    doc_show_source: bool = False
    internal_state_gui: BoolFunction | None = None
    internal_state_gui_node_compatible: bool = True
    save_internal_gui_options_to_json: Callable[[], JsonDict] | None =
None
    load_internal_gui_options_from_json: Callable[[JsonDict], None] |
None = None
    on_heartbeat: BoolFunction | None = None
    _dirty: bool = True
    _f_impl: Callable[..., Any] | None = None
    _inputs_with_gui: List[ParamWithGui[Any]]
    _outputs_with_gui: List[OutputWithGui[Any]]
    _last_exception_message: Optional[str] = None
    _last_exception_traceback: Optional[str] = None
    _accept_none_as_output: bool = False

    class _Construct_Section:
        """
        #
--------------------------------------------------------------------------------
        #        Construction
        #  input_with_gui and output_with_gui should be filled soon
after construction
        #
--------------------------------------------------------------------------------
        """
        pass

    def __init__(self, fn: Callable[..., Any] | None, fn_name: str |
None=None, *, signature_string: str | None=None, fiat_attributes:
FiatAttributes | None=None, is_dataclass_init_method: bool=False) ->
None:
        """Create a FunctionWithGui object, with the given function as
```

```
implementation

        The function signature is automatically parsed, and the inputs
and outputs are created
        with the correct GUI types.

        :param fn: the function for which we want to create a
FunctionWithGui

        Notes:
        This function will capture the locals and globals of the caller
to be able to evaluate the types.
        Make sure to call this function *from the module where the
function and its input/output types are defined*

        If the function has attributes like invoke_manually or
invoke_async, they will be taken into account:
            - if `invoke_async` is True, the function will be called
asynchronously
            - if `invoke_manually` is True, the function will be called
only if the user clicks on the "invoke" button


        Advanced parameters:
        ********************
        :param signature_string: a string representing the signature of
the function
                                 used when the function signature cannot
be retrieved automatically
        """
        pass

    class _FiatAttributes_Section:
        """
        #
------------------------------------------------------------------------------------
        #        Fiat Attributes
        #
------------------------------------------------------------------------------------
        """
        pass

    def handle_fiat_attributes(self, fiat_attributes: dict[str, Any]) ->
None:
        """Handle custom attributes for the function"""
        pass

    def set_invoke_live(self) -> None:
        """Set flags to make this a live function (called automatically
at each frame)"""
        pass
```

```
    def set_invoke_manually(self) -> None:
        """Set flags to make this a function that needs to be called
manually"""
        pass

    def set_invoke_manually_io(self) -> None:
        """Set flags to make this a IO function that needs to be called
manually
        and that is always considered dirty, because it depends on an
external device
        or state (and likely has no input)"""
        pass

    def is_invoke_manually_io(self) -> bool:
        """Return True if the function is an IO function that needs to
be called manually"""
        pass

    def set_invoke_async(self) -> None:
        """Set flags to make this a function that is called
asynchronously"""
        pass

    def is_live(self) -> bool:
        """Return True if the function is live"""
        pass

    class _Utilities_Section:
        """
        #
------------------------------------------------------------------------------
        #        Utilities
        #
------------------------------------------------------------------------------
        """
        pass

    def call_for_tests(self, **params: Any) -> Any:
        """Call the function with the given parameters, for testing
purposes"""
        pass

    def is_dirty(self) -> bool:
        """Return True if the function needs to be called, because the
inputs have changed since the last call"""
        pass

    def set_dirty(self) -> None:
        """Set the function as dirty."""
        pass

    def get_last_exception_message(self) -> str | None:
```

```
        """Return the last exception message, if any"""
        pass

    def shall_display_refresh_needed_label(self) -> bool:
        """Return True if the "Refresh needed" label should be displayed
        i.e. if the function is dirty and invoke_manually is True"""
        pass

    def __str__(self) -> str:
        pass

    class _Inputs_Section:
        """
        #
--------------------------------------------------------------------------------
        #        Inputs, aka parameters
        #
--------------------------------------------------------------------------------
        """
        pass

    def nb_inputs(self) -> int:
        """Return the number of inputs of the function"""
        pass

    def all_inputs_names(self) -> List[str]:
        """Return the names of all the inputs of the function"""
        pass

    def input(self, name: str) -> AnyDataWithGui[Any]:
        """Return the input with the given name as a AnyDataWithGui[Any]
        The inner type of the returned value is Any in this case.
        You may have to cast it to the correct type, if you rely on type
hints.

        Use input_as() if you want to get the input with the correct
type.
        """
        pass

    def input_as(self, name: str, gui_type: Type[GuiType]) -> GuiType:
        """Return the input with the given name as a GuiType

        GuiType can be any descendant of AnyDataWithGui, like
            fiatlight.fiat_core.IntWithGui,
fiatlight.fiat_core.FloatWithGui, etc.

        Raises a ValueError if the input is not found, and a TypeError
if the input is not of the correct type.
        """
        pass
```

```
    def input_of_idx(self, idx: int) -> ParamWithGui[Any]:
        """Return the input with the given index as a
ParamWithGui[Any]"""
        pass

    def input_of_idx_as(self, idx: int, gui_type: Type[GuiType]) ->
GuiType:
        """Return the input with the given index as a GuiType"""
        pass

    def inputs_guis(self) -> List[AnyDataWithGui[Any]]:
        pass

    def set_input_gui(self, name: str, gui: AnyDataWithGui[Any]) ->
None:
        """Set the GUI for the input with the given name"""
        pass

    def has_param(self, name: str) -> bool:
        """Return True if the function has a parameter with the given
name"""
        pass

    def param(self, name: str) -> ParamWithGui[Any]:
        """Return the input with the given name as a
ParamWithGui[Any]"""
        pass

    def param_gui(self, name: str) -> AnyDataWithGui[Any]:
        """Return the input with the given name as a
AnyDataWithGui[Any]"""
        pass

    def set_param_value(self, name: str, value: Any) -> None:
        """Set the value of the input with the given name
        This is useful to set the value of an input programmatically,
for example in tests.
        """
        pass

    def toggle_expand_inputs(self) -> None:
        pass

    def toggle_expand_outputs(self) -> None:
        pass

    class _Outputs_Section:
        """
        #
--------------------------------------------------------------------------------------------
        #        Outputs
        #
```

```
--------------------------------------------------------------------------------
        """
        pass

    def nb_outputs(self) -> int:
        """Return the number of outputs of the function.
        A function typically has 0 or 1 output, but it can have more if
it returns a tuple.
        """
        pass

    def output(self, output_idx: int=0) -> AnyDataWithGui[Any]:
        """Return the output with the given index as a
AnyDataWithGui[Any]
        The inner type of the returned value is Any in this case.
        You may have to cast it to the correct type, if you rely on type
hints.

        Use output_as() if you want to get the output with the correct
type.
        """
        pass

    def output_as(self, output_idx: int, gui_type: Type[GuiType]) ->
GuiType:
        """Return the output with the given index as a GuiType

        GuiType can be any descendant of AnyDataWithGui, like
            fiatlight.fiat_core.IntWithGui,
fiatlight.fiat_core.FloatWithGui, etc.

        Raises a ValueError if the output is not found, and a TypeError
if the output is not of the correct type.
        """
        pass

    def outputs_guis(self) -> List[AnyDataWithGui[Any]]:
        pass

    class _Invoke_Section:
        """
        #
--------------------------------------------------------------------------------
        #        Invoke the function
        # This is the heart of fiatlight: it calls the function with the
current inputs
        # and stores the result in the outputs, stores the exception if
any, etc.
        #
--------------------------------------------------------------------------------
        """
        pass
```

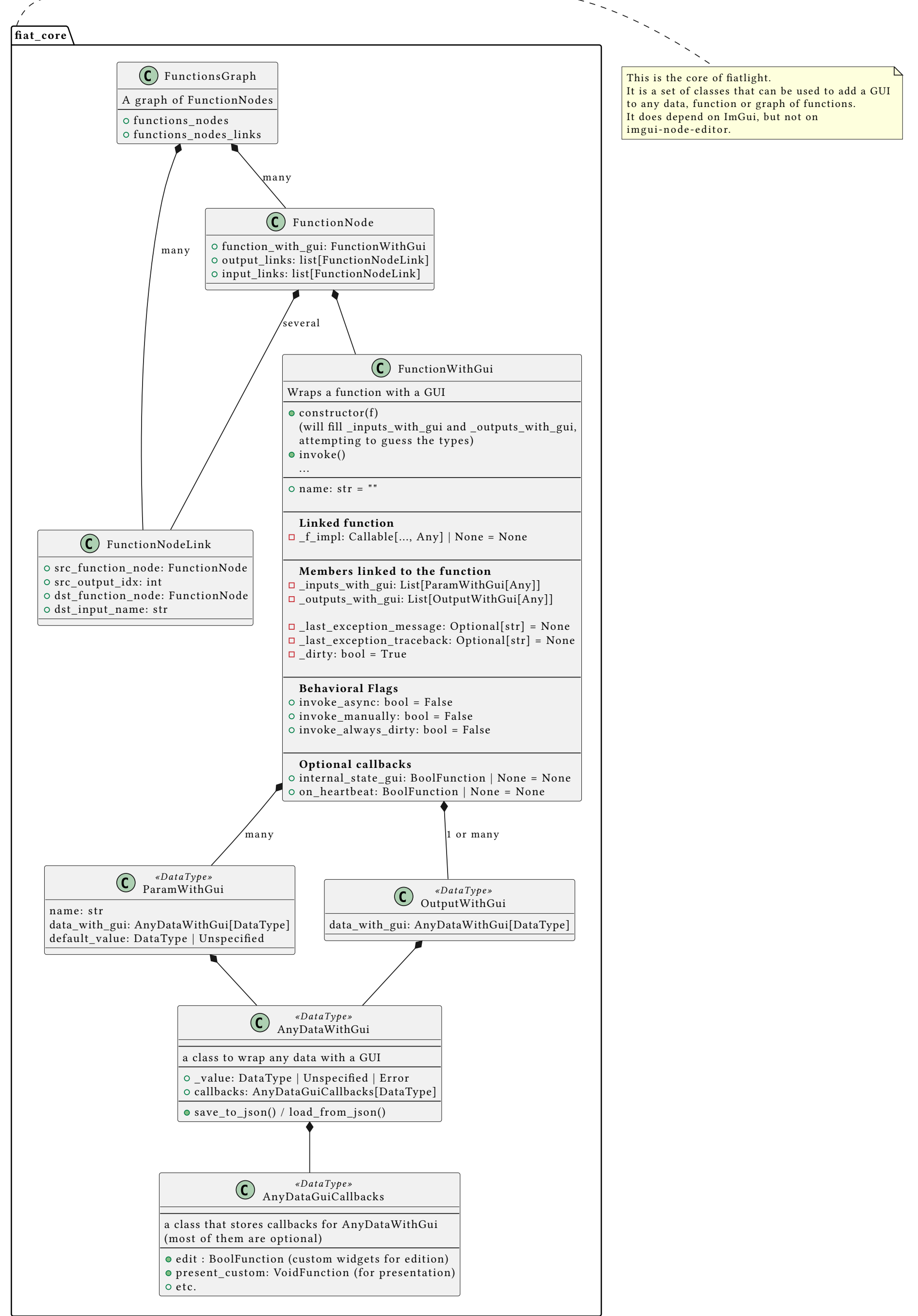
```
    @final
    def has_bad_inputs(self) -> bool:
        pass

    @final
    def invoke(self) -> None:
        """Invoke the function with the current inputs, and store the
result in the outputs.

        Will call the function if:
         - the inputs have changed since the last call
         - the function is dirty
         - none of the inputs is an error or unspecified

        If an exception is raised, the outputs will be set to
ErrorValue, and the exception will be stored.

        If the function returned None and the output is not allowed to
be None, a ValueError will be raised
        (this is inferred from the function signature)
        """
        pass

    def invoke_gui(self) -> None:
        pass

    @final
    def _invoke_impl(self) -> None:
        pass

    def on_exit(self) -> None:
        """Called when the application is exiting
        Will call the on_exit callback of all the inputs and outputs
        """
        pass

    def _can_emit_none_output(self) -> bool:
        """Return True if the function can emit None as output
        i.e.
        - either the function has no output
        - or the output can be None (i.e. the signature looks like `def
f() -> int | None:`)
        if the function has multiple outputs, we consider that it can
not emit None
        """
        pass

    class _Serialize_Section:
        """
        #
-----------------------------------------------------------------------
```

```
        #        Save and load to json
        # Here, we only save the options that the user entered manually
in the GUI:
        #    - the options of the inputs
        #    - the options of the outputs
        #
--------------------------------------------------------------------------------------------
        """
        pass

    def save_user_inputs_to_json(self) -> JsonDict:
        pass

    def load_user_inputs_from_json(self, json_data: JsonDict) -> None:
        pass

    def save_gui_options_to_json(self) -> JsonDict:
        """Save the GUI options to a JSON file
        (i.e. any presentation options of the inputs and outputs, as
well as of the internal GUI)
        """
        pass

    def load_gui_options_from_json(self, json_data: JsonDict) -> None:
        """Load the GUI options from a JSON file"""
        pass

    class _Doc_Section:
        pass

    def get_function_doc(self) -> FunctionWithGuiDoc:
        pass

    def _get_function_userdoc(self) -> str | None:
        """Return the user documentation of the function"""
        pass

    def _get_function_docstring(self) -> str | None:
        """Return the docstring of the function"""
        pass

    def _get_function_source_code(self) -> str | None:
        """Return the source code of the function"""
        pass
```

6.d.iii. *Architecture:*

Below is a PlantUML diagram showing the architecture of the `fiat_core` module. See the architecture page for the full architecture diagrams.

```
from fiatlight.fiat_notebook import plantuml_magic
%plantuml_include class_diagrams/fiat_core.puml
```


fiat_core
This is the core of fiatlight.
It is a set of classes that can be used to add a GUI
to any data, function or graph of functions.
It does depend on ImGui, but not on
imgui-node-editor.
FunctionsGraph
A graph of FunctionNodes
functions_nodes
functions_nodes_links
many
many
FunctionNode
function_with_gui: FunctionWithGui
output_links: list[FunctionNodeLink]
input_links: list[FunctionNodeLink]
several
FunctionWithGui
Wraps a function with a GUI
constructor(f)
(will fill _inputs_with_gui and _outputs_with_gui,
attempting to guess the types)
invoke()
...
name: str = ""
Linked function
_f_impl: Callable[..., Any] | None = None
Members linked to the function
_inputs_with_gui: List[ParamWithGui[Any]]
_outputs_with_gui: List[OutputWithGui[Any]]
_last_exception_message: Optional[str] = None
_last_exception_traceback: Optional[str] = None
_dirty: bool = True
Behavioral Flags
invoke_async: bool = False
invoke_manually: bool = False
invoke_always_dirty: bool = False
Optional callbacks
internal_state_gui: BoolFunction | None = None
on_heartbeat: BoolFunction | None = None
FunctionNodeLink
src_function_node: FunctionNode
src_output_idx: int
dst_function_node: FunctionNode
dst_input_name: str
many
1 or many
«DataType»
ParamWithGui
name: str
data_with_gui: AnyDataWithGui[DataType]
default_value: DataType | Unspecified
«DataType»
OutputWithGui
data_with_gui: AnyDataWithGui[DataType]
«DataType»
AnyDataWithGui
a class to wrap any data with a GUI
_value: DataType | Unspecified | Error
callbacks: AnyDataGuiCallbacks[DataType]
save_to_json() / load_from_json()
«DataType»
AnyDataGuiCallbacks
a class that stores callbacks for AnyDataWithGui
(most of them are optional)
edit : BoolFunction (custom widgets for edition)
present_custom: VoidFunction (for presentation)
etc.

6.e. AnyDataWithGui

6.e.i. *Introduction:*

AnyDataWithGui associate a GUI to any type, with associated GUI callbacks, allowing for custom rendering, editing, serialization, and event handling within the Fiatlight framework.

It uses callbacks which are stored inside AnyDataGuiCallback.

6.e.ii. *Signature:*

Below, we display the class header, i.e., the class without its methods bodies, to give a quick overview of its structure.

You can see its full code at AnyDataWithGui.

```
from fiatlight.fiat_notebook import look_at_code
%look_at_class_header fiatlight.fiat_core.AnyDataWithGui
```

```
class AnyDataWithGui(Generic[DataType]):
    """AnyDataWithGui: a GUI associated to a type.

    AnyDataWithGui[DataType]
    ========================

    This class manages data of any type with associated GUI callbacks,
allowing for custom rendering, editing,
    serialization, and event handling within the Fiatlight framework.

    Members:
    --------
    # The type of the data, e.g. int, str, typing.List[int],
typing.Tuple[int, str], typing.Optional[int], etc.
    _type: Type[DataType]

    # The value of the data - can be a DataType, Unspecified, or Error
    # It is accessed through the value property, which triggers the
on_change callback (if set)
    _value: DataType | Unspecified | Error = UnspecifiedValue

    # Callbacks for the GUI
    # This is the heart of FiatLight: the GUI is defined by the
callbacks.
    # Think of them as __dunder__ methods for the GUI.
    callbacks: AnyDataGuiCallbacks[DataType]

    # If True, the value can be None. This is useful when the data is
optional.
    # Otherwise, any None value will be considered as an Error.
    # Note: when using Optional[any registered type], this flag is
automatically set to True.
    can_be_none: bool = False
```

```
    Property:
    ---------
    # Custom attributes that can be set by the user, to give hints to
the GUI.
    # For example, with this function declaration,
    #         def f(x: int, y: int) -> int:
    #             return x + y
    #        f.x__range = (0, 10)
    # fiat_attributes["range"] will be (0, 10) for the parameter x.
    @property
    fiat_attributes -> dict[str, Any]

    """
    _type: Type[DataType] | None
    _value: DataType | Unspecified | Error | Invalid[DataType] =
UnspecifiedValue
    callbacks: AnyDataGuiCallbacks[DataType]
    can_be_none: bool = False
    _fiat_attributes: FiatAttributes
    _expanded: bool = False
    _can_set_unspecified_or_default: bool = False
    label: str | None = None
    label_color: ImVec4 | None = None
    tooltip: str | None = None
    status_tooltip: str | None = None

    class CollapseOrExpand(Enum):
        collapse = 'Collapse All'
        expand = 'Expand All'

    class PresentOrEdit(Enum):
        present = 'View'
        edit = 'Edit'

    class _Init_Section:
        """
        #
---------------------------------------------------------------------------------------
        #            Initialization
        #
---------------------------------------------------------------------------------------
        """
        pass

    def __init__(self, data_type: Type[DataType] | None) -> None:
        """Initialize the AnyDataWithGui with a type, an unspecified
value, and no callbacks."""
        pass

    class _Value_Section:
        """
```

```
        #
--------------------------------------------------------------------------------
        #           Value getter and setter + get_actual_value (which
returns a DataType or raises an exception)
        #
--------------------------------------------------------------------------------
        """
        pass

    @property
    def value(self) -> DataType | Unspecified | Error |
Invalid[DataType]:
        """The value of the data, accessed through the value property.
        Warning: it might be an instance of `Unspecified` (user did not
enter any value) or `Error` (an error was triggered)
        """
        pass

    @value.setter
    def value(self, new_value: DataType | Unspecified | Error |
Invalid[DataType]) -> None:
        """Set the value of the data. This triggers the on_change
callback (if set)"""
        pass

    def get_actual_value(self) -> DataType:
        """Returns the actual value of the data, or raises an exception
if the value is Unspecified or Error or Invalid
        When we are inside a callback, we can be sure that the value is
of the correct type, so we can call this method
        instead of accessing the value directly and checking for
Unspecified or Error.
        """
        pass

    def get_actual_or_invalid_value(self) -> DataType:
        """Returns the actual value of the data, or raises an exception
if the value is Unspecified or Error"""
        pass

    class _CustomAttributes_Section:
        """
        #
--------------------------------------------------------------------------------
        #           Custom Attributes
        #
--------------------------------------------------------------------------------
        """
        pass

    @staticmethod
    def possible_fiat_attributes() -> PossibleFiatAttributes | None:
```

```
        """Return the possible custom attributes for this type, if
available.
        Should be overridden in subclasses, when custom attributes are
available.

        It is strongly advised to return a class variable, or a global
variable
        to avoid creating a new instance each time this method is
called.
        """
        pass

    @final
    def possible_fiat_attributes_with_generic(self) ->
tuple[PossibleFiatAttributes | None, PossibleFiatAttributes]:
        pass

    @property
    def fiat_attributes(self) -> FiatAttributes:
        pass

    def merge_fiat_attributes(self, fiat_attrs: FiatAttributes) -> None:
        """Merge custom attributes with the existing ones"""
        pass

    def _handle_generic_attrs(self) -> None:
        """Handle generic custom attributes"""
        pass

    @staticmethod
    def propagate_label_and_tooltip(a: 'AnyDataWithGui[Any]', b:
'AnyDataWithGui[Any]') -> None:
        """Propagate label and tooltip from one AnyDataWithGui to
another
        Meant to be used with CompositeGui
        """
        pass

    class _Gui_Section:
        """
        #
-----------------------------------------------------------------------------------------
        #             Gui sections
        #      (Can also be used outside a function Node)
        #
-----------------------------------------------------------------------------------------
        """

    def sub_items_can_collapse(self, _present_or_edit: PresentOrEdit) ->
bool:
        """Overwrite this in derived classes if they provide multiple
sub-items that can be collapsed"""
```

```
        pass

    def sub_items_collapse_or_expand(self, _collapse_or_expand:
CollapseOrExpand) -> None:
        """Overwrite this in derived classes if they provide multiple
sub-items that can be collapsed"""
        pass

    def sub_items_will_collapse_or_expand(self, _present_or_edit:
PresentOrEdit) -> CollapseOrExpand:
        """Overwrite this in derived classes if they provide multiple
sub-items that can be collapsed"""
        pass

    def _show_collapse_sub_items_buttons(self, present_or_edit:
PresentOrEdit) -> None:
        pass

    def can_show_present_popup(self) -> bool:
        pass

    def can_show_edit_popup(self) -> bool:
        pass

    def _show_collapse_button(self) -> None:
        pass

    def _show_copy_to_clipboard_button(self) -> None:
        pass

    def can_collapse_present(self) -> bool:
        pass

    def can_collapse_edit(self) -> bool:
        pass

    def can_edit_on_header_line(self) -> bool:
        pass

    def can_present_on_header_line(self) -> bool:
        pass

    def _can_edit_on_next_lines_if_expanded(self) -> bool:
        pass

    def _can_present_on_next_lines_if_expanded(self) -> bool:
        pass

    def _is_editing_on_next_lines(self) -> bool:
        pass

    def _is_presenting_on_next_lines(self) -> bool:
```

```
        pass

    def _popup_window_name(self, params: GuiHeaderLineParams[DataType],
present_or_edit: PresentOrEdit) -> str:
        pass

    def _gui_present_header_line(self, params:
GuiHeaderLineParams[DataType]) -> None:
        """Present the value as a string in one line, or as a widget if
it fits on one line"""
        pass

    def _gui_edit_header_line(self, params:
GuiHeaderLineParams[DataType]) -> bool:
        pass

    def _show_set_unspecified_or_default_button(self) -> bool:
        pass

    def _gui_edit_next_lines(self, in_popup: bool) -> bool:
        pass

    def _gui_present_next_lines(self, in_popup: bool) -> None:
        pass

    def gui_present_customizable(self, params:
GuiHeaderLineParams[DataType]) -> None:
        """Present the value using either the present callback or the
default str conversion
        May present on one line (if possible) or on multiple lines with
an expand button
        """
        pass

    def gui_present(self) -> None:
        pass

    def gui_edit_customizable(self, params:
GuiHeaderLineParams[DataType]) -> bool:
        """Call the edit callback. Returns True if the value has changed
        May edit on one line (if possible) or on multiple lines with an
expand button
        """
        pass

    def gui_edit(self) -> bool:
        pass

    class _Callbacks_Section:
        """
        #
------------------------------------------------------------------------------
```

```
        #            Callbacks sections
        #
-----------------------------------------------------------------------------------------
        """

    def set_edit_callback(self, edit_callback:
DataEditFunction[DataType]) -> None:
        """Helper function to set the edit callback from a free
function"""
        pass

    def set_present_callback(self, present_callback:
DataPresentFunction[DataType], present_node_compatible: bool |
None=None) -> None:
        """Helper function to set the present custom callback from a
free function"""
        pass

    def add_validate_value_callback(self, cb: Callable[[DataType],
None]) -> None:
        pass

    def _Serialization_Section(self) -> None:
        """
        #
-----------------------------------------------------------------------------------------
        #            Serialization and deserialization
        #
-----------------------------------------------------------------------------------------
        """
        pass

    @final
    def call_save_to_dict(self, value: DataType | Unspecified | Error |
Invalid[DataType]) -> JsonDict:
        """Serialize the value to a dictionary

        Will call the save_to_dict callback if set, otherwise will use
the default serialization, when available.
        A default serialization is available for primitive types,
tuples, and Pydantic models.

        (This is how fiatlight saves the data to a JSON file)

        Do not override these methods in descendant classes!
        """
        pass

    @final
    def call_load_from_dict(self, json_data: JsonDict) -> DataType |
Unspecified | Error:
        """Deserialize the value from a dictionary
```

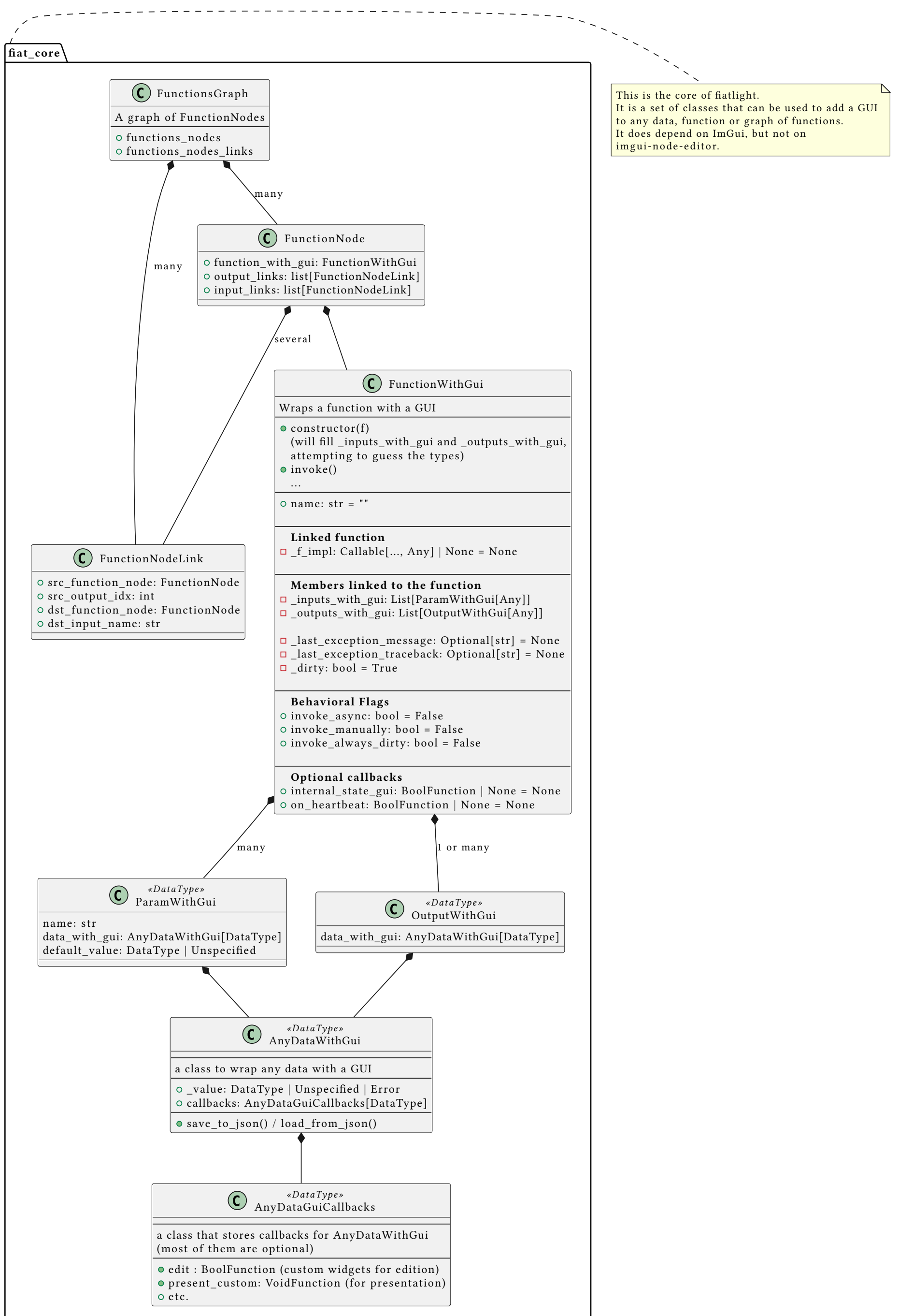
```
        Do not override these methods in descendant classes!
        """
        pass

    @final
    def call_save_gui_options_to_json(self) -> JsonDict:
        pass

    @final
    def call_load_gui_options_from_json(self, json_data: JsonDict) ->
None:
        pass

    class _Utilities_Section:
        """
        #
-----------------------------------------------------------------------------------------
        #            Utilities
        #
-----------------------------------------------------------------------------------------
        """

    def can_construct_default_value(self) -> bool:
        pass

    def construct_default_value(self) -> DataType:
        pass

    def datatype_qualified_name(self) -> str:
        pass

    def datatype_basename(self) -> str:
        pass

    def datatype_base_and_qualified_name(self) -> str:
        pass

    def datatype_value_to_str(self, value: DataType) -> str:
        """Convert the value to a string
        Uses either the present_str callback, or the default str
conversion
        """
        pass

    def datatype_value_to_clipboard_str(self, value: DataType) -> str:
        """Convert the value to a string for the clipboard
        Uses either the clipboard_copy_str callback, or the default str
conversion
        """
        pass

    def docstring_first_line(self) -> str | None:
```

```
    """Return the first line of the docstring, if available"""
    pass
```

6.e.iii. *Architecture:*

Below is a PlantUML diagram showing the architecture of the `fiat_core` module. See the architecture page for the full architecture diagrams.

```
from fiatlight.fiat_notebook import plantuml_magic
%plantuml_include class_diagrams/fiat_core.puml
```



6.f. *AnyDataGuiCallbacks*

6.f.i. *Introduction:*

AnyDataGuiCallbacks provides a set of callbacks that define how a particular data type should be presented, edited, and managed within the Fiatlight GUI framework.

These callbacks are used by AnyDataWithGui.

6.f.ii. *Source:*

Below, is the class source, which you can also see online.

```
from fiatlight.fiat_notebook import look_at_code
%look_at_python_code fiatlight.fiat_core.AnyDataGuiCallbacks
```

```
class AnyDataGuiCallbacks(Generic[DataType]):
    """AnyDataGuiCallbacks: Collection of callbacks for a given type

    AnyDataGuiCallbacks
    ===================

    This class provides a set of callbacks that define how a particular
data type should be
    presented, edited, and managed within the Fiatlight GUI framework.

    These callbacks are used by [AnyDataWithGui](any_data_with_gui).

    """

    #                         Presentation
    #
-----------------------------------------------------------------------------------
    # present_str: (Mandatory if str() is not enough, optional
otherwise)
    # Provide a function that returns a short string info about the data
content
    # This string will be presented as a short description of the data
in the GUI
    #
    # If possible, it should be short enough to fit in a single line
inside a node (40 chars max).
    # If the result string is too long, or occupies more than one line,
it will be truncated and followed by "..."
    # (and the rest of the string will be displayed in a tooltip)
    # For example, on complex types such as images, return something
like "128x128x3 uint8"
    # If not provided, the data will be presented using str()
    present_str: Callable[[DataType], str] | None = None

    # present: (Optional)
    # a function that provides a more complex, custom GUI representation
of the data. Used for detailed views.
    # It will be presented when a function param is in "expanded" mode,
```

```
and can use imgui widgets on several lines.
    # If not provided, the data will be presented using present_str
    #
    # Note: Some widgets cannot be presented in a Node (e.g., a
multiline text input, a child window, etc.)!
    #       You can query `fiatlight.is_rendering_in_node()` to know if
you are rendering in a node.
    #       Also, when inside a Node, you may want to render a smaller
version, to save space
    #       (as opposed to rendering a larger version in a detached
window).
    present: Callable[[DataType], None] | None = None

    # present_collapsible:
    # Set this to False if your custom presentation is small and fits in
one line
    # (i.e. it does not need to be collapsible)
    # If True, the gui presentation will either:
    #     - show present_str + an expand button
    #     - show the custom presentation + a collapse button
    present_collapsible: bool = True

    # present_node_compatible: (Optional: set to False if using
input_text_multiline, combo, begin_child, etc.)
    # If True, the present function is incompatible with being presented
in a node (this is due to a limitation
    # of the node editor, which cannot render scrollable widgets)
    # Note: instead of setting edit_node_compatible to False, you may
query
    #       `fiatlight.is_rendering_in_node()` to know if you are
rendering in a node
    #       and choose alternative widgets in this case.
    present_node_compatible: bool = True

    #
---------------------------------------------------------------------------------------

    #                       Edition
    #
---------------------------------------------------------------------------------------
    # edit: (Mandatory if edition is required)
    # Provide a function that presents an editable interface for the
data, and returns
    #     (True, new_value) if changed
    #     (False, old_value) if not changed
    # If not provided, the data will be presented as read-only
    # Note: Some widgets cannot be presented in a Node (e.g., a
multiline text input, a child window, etc.)!
    #       You can query `fiatlight.is_rendering_in_node()` to know if
you are rendering in a node.
    edit: Callable[[DataType], tuple[bool, DataType]] | None = None
```

```
    # edit_collapsible:
    # Set this to False if your custom edition is small, and does not
need to be collapsible (i.e. it fits one line)
    # If True, the gui edition will either:
    #     - show present_str + an expand button
    #     - show the custom edition + a collapse button
    edit_collapsible: bool = True

    # edit_node_compatible: (Optional: set to False if using
input_text_multiline, combo, begin_child, etc.)
    # If True, the edit function is incompatible with being presented in
a node (this is due to a limitation
    # of the node editor, which cannot render scrollable widgets)
    # Note: instead of setting edit_node_compatible to False, you may
query
    #      `fiatlight.is_rendering_in_node()` to know if you are
rendering in a node
    #      and choose alternative widgets in this case.
    edit_node_compatible: bool = True

    #
-----------------------------------------------------------------------------------------

    #                        Default value
    #
-----------------------------------------------------------------------------------------
    # default value provider (Needed only for a type without default
constructor)
    # this function will be called to provide a default value if needed
    default_value_provider: Callable[[], DataType] | None = None
    #
-----------------------------------------------------------------------------------------

    #                        Events callbacks
    #
-----------------------------------------------------------------------------------------
    # on_change (Optional)
    # if provided, this function will be called when the value changes.
    # Can be used in more advanced cases,
    # for example when `present` has an internal cache that needs to be
updated,
    # or other side effects.
    on_change: Callable[[DataType], None] | None = None

    # validate_value (Optional)
    # if provided, these functions will be called when the user tries to
set a value.
    # They should return a DataValidationResult.ok() if the value is
valid,
    # or a DataValidationResult.error() with an error message.
    validate_value: list[Callable[[DataType], DataValidationResult]]
```

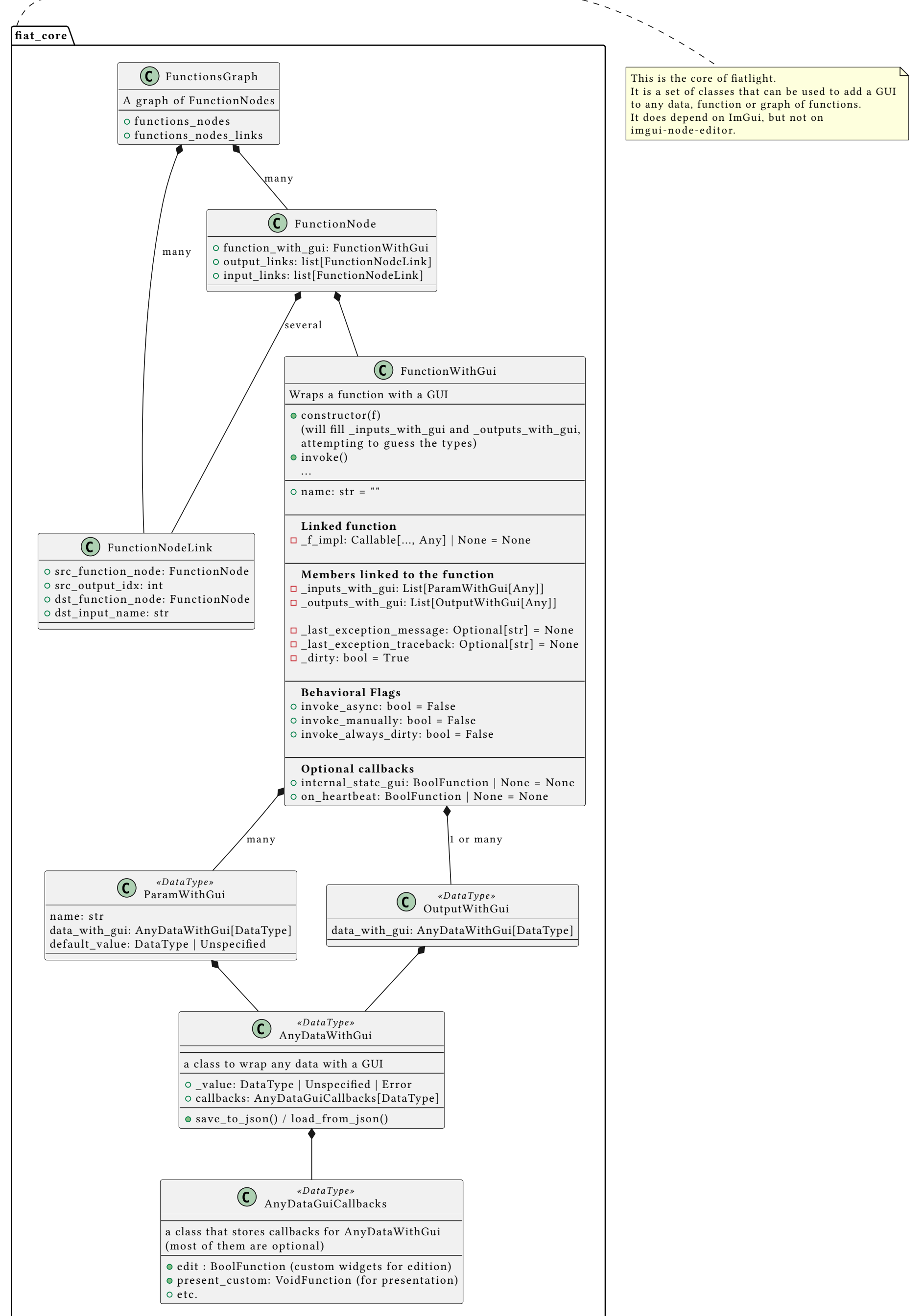
```
    # on_exit (Optional)
    # if provided, this function will be called when the application is
closed.
    # Used in more advanced cases, typically when some resources need to
be released.
    on_exit: VoidFunction | None = None

    # on_heartbeat: (Optional)
    # If provided, this function will be called at each heartbeat of the
function node.
    # (before the value is drawn). It should return True if any change
has been made to the data.
    on_heartbeat: BoolFunction | None = None

    # on_fiat_attributes_changed (Optional)
    # if provided, this function will be called when the custom
attributes of the data change.
    # Used in more advanced cases, when the data presentation depends on
custom attributes.
    on_fiat_attributes_changed: Callable[[FiatAttributes], None] | None
= None

    #
-------------------------------------------------------------------------------------

    #                        Serialization and deserialization
    #
-------------------------------------------------------------------------------------
    # Of the GUI presentation options (not the data itself)
    #
    # save/load_gui_options_from_json (Optional)
    # Optional serialization and deserialization of the GUI presentation
options
    # (i.e. anything that deals with how the data is presented in the
GUI, *not the data itself*)
    # If provided, these functions will be used to recreate the GUI
presentation options when loading a graph,
    # so that the GUI looks the same when the application is restarted.
    save_gui_options_to_json: Callable[[], JsonDict] | None = None
    load_gui_options_from_json: Callable[[JsonDict], None] | None = None

    # Of the data itself
    #
    # Optional serialization and deserialization functions for DataType
    # If provided, these functions will be used to serialize and
deserialize the data with a custom dict format.
    # If not provided, "value" will be serialized as a dict of its
__dict__ attribute,
    # or as a json string (for int, float, str, bool, and None)
    save_to_dict: Callable[[DataType], JsonDict] | None = None
    load_from_dict: Callable[[JsonDict], DataType] | None = None
    #
```

```
----------------------------------------------------------------------------
    #                        Clipboard
    #
----------------------------------------------------------------------------
    # clipboard_copy_str (Optional)
    # if provided, this function will be called when the value is copied
to the clipboard.
    # Used in more advanced cases, when the data is not a simple string,
or when present_str or str() is not enough.
    clipboard_copy_str: Callable[[DataType], str] | None = None

    # clipboard_copy_possible (Optional)
    # True by default
    # If False, the user can not copy the data to the clipboard
    clipboard_copy_possible: bool = True
    #
----------------------------------------------------------------------------

    def __init__(self) -> None:
        self.validate_value = []
```

6.f.iii. *Architecture:*

Below is a PlantUML diagram showing the architecture of the `fiat_core` module. See the architecture page for the full architecture diagrams.

```
from fiatlight.fiat_notebook import plantuml_magic
%plantuml_include class_diagrams/fiat_core.puml
```


fiat_core
This is the core of fiatlight.
It is a set of classes that can be used to add a GUI
to any data, function or graph of functions.
It does depend on ImGui, but not on
imgui-node-editor.
FunctionsGraph
A graph of FunctionNodes
functions_nodes
functions_nodes_links
many
many
FunctionNode
function_with_gui: FunctionWithGui
output_links: list[FunctionNodeLink]
input_links: list[FunctionNodeLink]
several
FunctionWithGui
Wraps a function with a GUI
constructor(f)
(will fill _inputs_with_gui and _outputs_with_gui,
attempting to guess the types)
invoke()
...
name: str = ""
Linked function
_f_impl: Callable[..., Any] | None = None
Members linked to the function
_inputs_with_gui: List[ParamWithGui[Any]]
_outputs_with_gui: List[OutputWithGui[Any]]
_last_exception_message: Optional[str] = None
_last_exception_traceback: Optional[str] = None
_dirty: bool = True
Behavioral Flags
invoke_async: bool = False
invoke_manually: bool = False
invoke_always_dirty: bool = False
Optional callbacks
internal_state_gui: BoolFunction | None = None
on_heartbeat: BoolFunction | None = None
FunctionNodeLink
src_function_node: FunctionNode
src_output_idx: int
dst_function_node: FunctionNode
dst_input_name: str
many
1 or many
«DataType»
ParamWithGui
name: str
data_with_gui: AnyDataWithGui[DataType]
default_value: DataType | Unspecified
«DataType»
OutputWithGui
data_with_gui: AnyDataWithGui[DataType]
«DataType»
AnyDataWithGui
a class to wrap any data with a GUI
_value: DataType | Unspecified | Error
callbacks: AnyDataGuiCallbacks[DataType]
save_to_json() / load_from_json()
«DataType»
AnyDataGuiCallbacks
a class that stores callbacks for AnyDataWithGui
(most of them are optional)
edit : BoolFunction (custom widgets for edition)
present_custom: VoidFunction (for presentation)
etc.

6.g. *FunctionsGraph*

`FunctionsGraph` is one of the core classes of FiatLight: it represents a graph of functions, where the output of one function can be linked to the input of another function.

- **Source**: see its full code online
- **Manual**: FunctionsGraph API

6.g.i. *Signature:*

Below, you will find the "signature" of the `FunctionsGraph` class, with its main attributes and methods (but not their bodies)

Its full source code is available online.

```
from fiatlight.fiat_notebook import look_at_code
%look_at_class_header fiatlight.fiat_core.FunctionsGraph
```

```
class FunctionsGraph:
    """A graph of FunctionNodes

     `FunctionsGraph` is one of the core classes of FiatLight: it
represents a graph of functions,
     where the output of one function can be linked to the input of
another function.

     See its [full code](../fiat_core/functions_graph.py).

    It contains a graph of FunctionNodes modeled as a list of
FunctionNode and a list of FunctionNodeLink
    (which are the links between the outputs of a FunctionNode and the
inputs of another FunctionNode)

    This class only stores the data representation of the graph, and
does not deal with its GUI representation
    (for this, see FunctionGraphGui)

    This class is not meant to be instantiated directly. Use the factory
methods instead.

    Public Members
    ==============
    # the list of FunctionNode in the graph
    functions_nodes: list[FunctionNode]
    # the list of links between the FunctionNode
    functions_nodes_links: list[FunctionNodeLink]

    """
    functions_nodes: list[FunctionNode]
    functions_nodes_links: list[FunctionNodeLink]
    _secret_key: str = 'FunctionsGraph'
```

```
    class _Construction_Section:
        """
        #
==========================================================================================
        #                                            Construction
(Empty)
        #
==========================================================================================
        """
        pass

    def __init__(self, secret_key: str='FunctionsGraph') -> None:
        """This class should not be instantiated directly. Use the
factory methods instead."""
        pass

    @staticmethod
    def create_empty() -> 'FunctionsGraph':
        """Create an empty FunctionsGraph"""
        pass

    class _Public_API_Add_Function_Section:
        """
        #
==========================================================================================
        #                                            Public API / Add
functions
        #
        #
------------------------------------------------------------------------------------------
        # Notes:
        #   You can add either Functions or FunctionWithGui
        #     - If f is a FunctionWithGui, it will be added as is
        #     - If f is a standard function:
        #         - it will be wrapped in a FunctionWithGui
        #         - the function signature *must* mention the types of
the parameters and the return type
        #
==========================================================================================
        """
        pass

    @staticmethod
    def from_function(f: Function | FunctionWithGui) ->
'FunctionsGraph':
        """Create a FunctionsGraph from a single function, either a
standard function or a FunctionWithGui"""
        pass

    @staticmethod
    def from_function_composition(functions: Sequence[Function |
FunctionWithGui]) -> 'FunctionsGraph':
```

```
        """Create a FunctionsGraph from a list of functions that will be
chained together
        i.e. the output[0] of one function will be the input[0] of the
next function
        """
        pass

    def add_function_composition(self, functions: Sequence[Function |
FunctionWithGui]) -> None:
        """Add a list of functions that will be chained together"""
        pass

    def add_function(self, f: Function | FunctionWithGui) ->
FunctionNode:
        """Add a function to the graph. It will not be linked to any
other function. Returns the FunctionNode added."""
        pass

    def add_gui_node(self, gui_function: GuiFunctionWithInputs, label:
str | None=None, gui_serializable_data: BaseModel | None=None) ->
FunctionNode:
        pass

    def add_task_node(self, task_function: GuiFunctionWithInputs, label:
str | None=None) -> FunctionNode:
        pass

    def add_markdown_node(self, md_string: str, label:
str='Documentation', text_width_em: float=20.0, unindented: bool=True) -
> FunctionNode:
        pass

    class _Private_API_Add_Function_Section:
        """
        #
===========================================================================
        #                                            Private API / Add
functions
        #
===========================================================================
        """
        pass

    def _add_function_with_gui(self, f_gui: FunctionWithGui) ->
FunctionNode:
        pass

    def _add_function(self, f: Function) -> FunctionNode:
        pass

    @staticmethod
    def _create_from_function_composition(functions: Sequence[Function |
```

```
FunctionWithGui]) -> 'FunctionsGraph':
        """Create a FunctionsGraph from a list of
PureFunctions([InputType] -> OutputType)
        * They should all be pure functions
        * The output[0] of one should be the input[0] of the next
        """
        pass

    class _Graph_Manipulation_Section:
        """
        #
====================================================================================
        #                                          Graph manipulation
        #
====================================================================================
        """
        pass

    def _can_add_link(self, src_function_node: FunctionNode,
dst_function_node: FunctionNode, dst_input_name: str, src_output_idx:
int) -> Tuple[bool, str]:
        """Check if a link can be added between two functions.
(private)"""
        pass

    def _add_link_from_function_nodes(self, src_function_node:
FunctionNode, dst_function_node: FunctionNode, dst_input_name: str |
None=None, src_output_idx: int=0) -> FunctionNodeLink:
        """Add a link between two functions nodes (private)"""
        pass

    def add_link(self, src_function: str | Function | FunctionWithGui,
dst_function: str | Function | FunctionWithGui, dst_input_name: str |
None=None, src_output_idx: int=0) -> None:
        """Add a link between two functions, which are identified by
their *unique* names

        If a graph reuses several times the same function "f",
        the unique names for this functions will be "f_1", "f_2", "f_3",
etc.
        """
        pass

    def merge_graph(self, other: 'FunctionsGraph') -> None:
        """Merge another FunctionsGraph into this one"""
        pass

    def function_with_gui_of_name(self, name: str | None=None) ->
FunctionWithGui:
        """Get the function with the given unique name"""
        pass
```

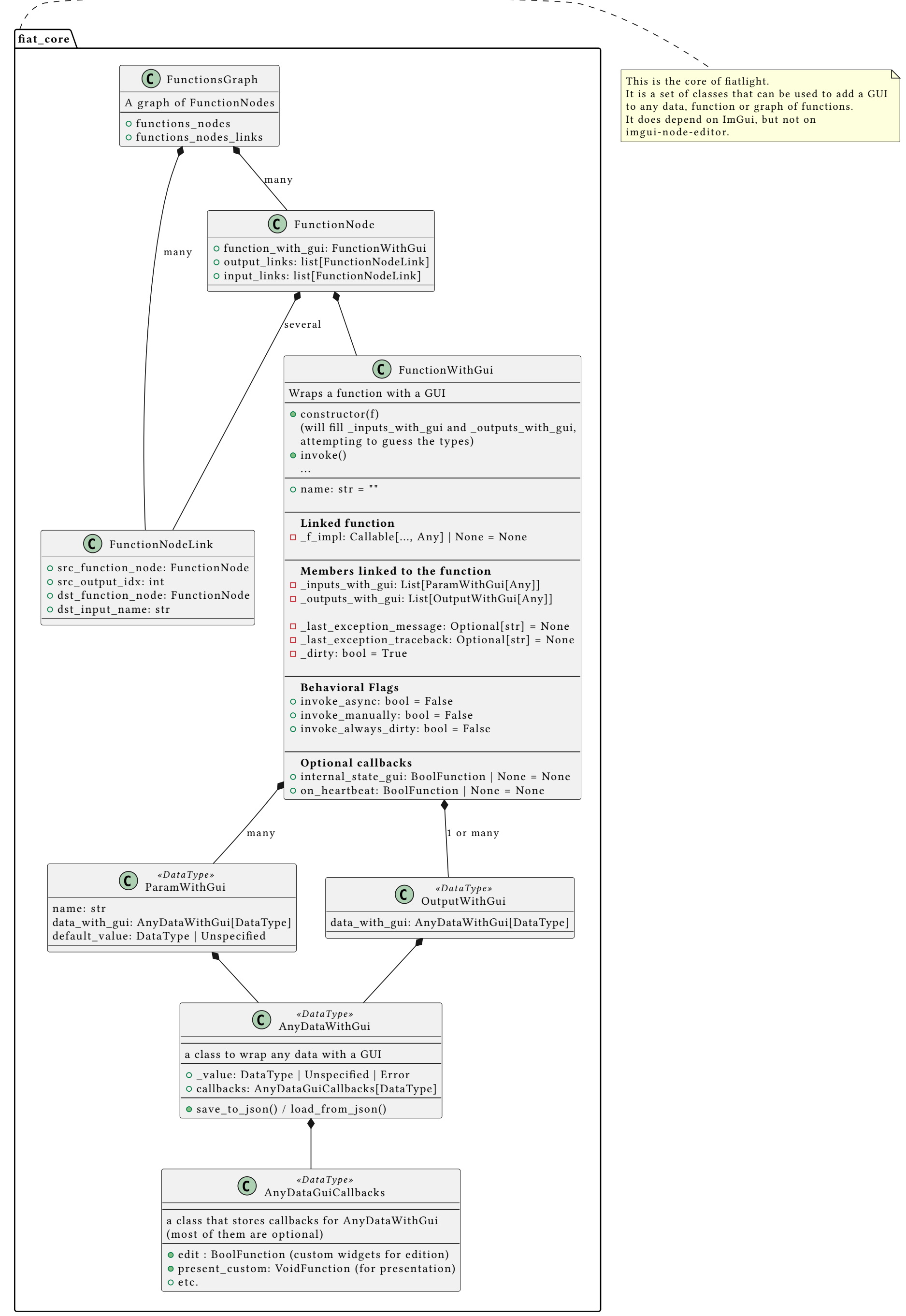
```
    def _would_add_cycle(self, new_link: FunctionNodeLink) -> bool:
        """Check if adding a link would create a cycle (private)"""
        pass

    def has_cycle(self) -> bool:
        """Returns True if the graph has a cycle"""
        pass

    def _has_cycle_from_node(self, fn: FunctionNode, path:
Set[FunctionNode] | None=None) -> bool:
        """Check if there is a cycle starting from a given node
(private)"""
        pass

    def _remove_link(self, link: FunctionNodeLink) -> None:
        """Remove a link between two functions (private)"""
        pass

    def _remove_function_node(self, function_node: FunctionNode) ->
None:
        """Remove a function node from the graph (private)"""
        pass

    class _Utilities_Section:
        """
        #
==============================================================================
        #                                            Utilities
        #
==============================================================================
        """
        pass

    def function_node_unique_name(self, function_node: FunctionNode) ->
str:
        """Return the unique name of a function node:
        If a graph reuses several times the same function "f",
        the unique names for this functions will be "f_1", "f_2", "f_3",
etc.
        """
        pass

    def _function_node_with_name_or_is_function(self, name_or_function:
str | Function | FunctionWithGui) -> FunctionNode:
        """Get the function node with the given name or function"""
        pass

    def _function_node_with_unique_name(self, function_name: str) ->
FunctionNode:
        """Get the function with the unique name"""
        pass
```

```
    def all_function_nodes_with_unique_names(self) -> Dict[str,
FunctionNode]:
        """Return a dict of all the function nodes, with their unique
names as keys (private)"""
        pass

    def shall_display_refresh_needed_label(self) -> bool:
        """Returns True if any function node shall display a "Refresh
needed" label"""
        pass

    class _Serialization_Section:
        """
        #
===========================================================================================
        #                                               Serialization
        # Note:  save_gui_options_to_json() and
load_gui_options_from_json()
        #        are intentionally not implemented here
        #        See FunctionsGraphGui (which does deals with the GUI)
        #
===========================================================================================
        """
        pass

    def save_user_inputs_to_json(self) -> JsonDict:
        """Saves the user inputs, i.e. the functions params that are
editable in the GUI
        (this excludes the params that are set by the links between the
functions)"""
        pass

    def load_user_inputs_from_json(self, json_data: JsonDict) -> None:
        """Restores the user inputs from a json dict"""
        pass

    def save_graph_composition_to_json(self) -> JsonDict:
        """Saves the graph composition to a json dict.
        Only used when the graph composition is editable.
        """
        pass

    def load_graph_composition_from_json(self, json_data: JsonDict,
function_factory: FunctionWithGuiFactoryFromName) -> None:
        """Loads the graph composition from a json dict."""
        pass
```

6.g.ii. *Architecture:*

Below is a PlantUML diagram showing the architecture of the `fiat_core` module. See the architecture page for the full architecture diagrams.

```python
from fiatlight.fiat_notebook import plantuml_magic
%plantuml_include class_diagrams/fiat_core.puml
```



7. Fiatlight Kits

Fiatlight offers several kits adapted to different domains.

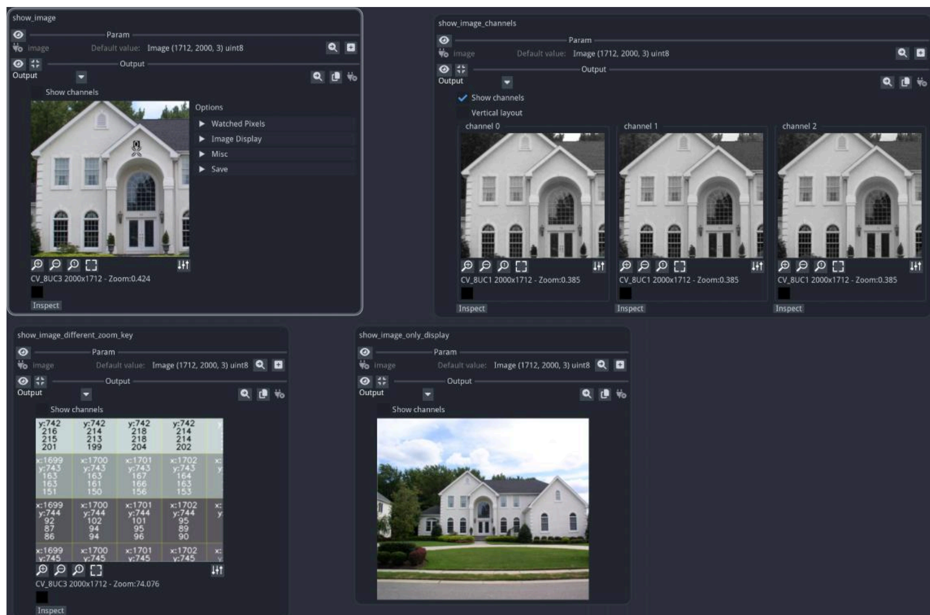
- `fiat_image`: advanced image widget
- `fiat_matplotlib`: widget to view matplotlib plots (zoomable)
- `fiat_dataframe`: widget to explore pandas dataframes
- `fiat_implot`: widget to explore 1D and 2D numpy arrays with ImPlot

7.a. *fiat_image: advanced image widget*

Fiatlight provides an advanced image viewer and analyzer which enables to zoom, pan, look at pixel values and sync the zoom across images.

7.a.i. *Example:*

```
from fiatlight.fiat_kits.fiat_image import fiat_image_attrs_demo
fiat_image_attrs_demo.main()
```



- In the "show_image" output, the options panel was opened
- The "show_image_channels" output shows the image channels, and it zoom/pan is linked to "show_image"
- The "show_image_different_zoom_key" image has a different zoom key, and the zoom/pan is not linked to "show_image". It also zoomed at a high-level, so that pixel values are displayed.
- the "show_image_only_display" image is displayed, and cannot be zoomed or panned (the widget may be resized however)

=== Fiat attributes available for the ImageWithGui widget

The image widget provided with fiat_image is extremely customizable. Here is a list of all the possible customizations options:

```
%%bash
fiatlight gui ImageWithGui
```

```
GUI type: ImageWithGui
=======================
  A highly sophisticated GUI for displaying and analysing images. Zoom/
Pan, show channels, show pixel values, sync zoom accross images, etc.
```

Available custom attributes for fiat_image.ImageWithGui:

Name	Type	Default	Explanation
			Main attributes for the image viewer
only_display	bool	False	Only display the image, no info displayed, no zoom, no pan
image_display_size	tuple[int, int]	(200, 0)	Initial size of the displayed image (width, height). One of them can be 0
zoom_key	str	z	Key to zoom in the image. All images with the same zoom key will be zoomed together
is_color_order_bgr	bool	True	Color order is BGR (default is True). OpenCV uses BGR by default, unfortunately.
can_resize	bool	True	Can resize the image by dragging the mouse at the bottom right corner
			Channels
show_channels	bool	False	Show channels
channel_layout_vertically	bool	False	Layout channels vertically

			Zoom & Pan
pan_with_mouse	bool	True	Pan with mouse
zoom_with_mouse_wheel	bool	True	Zoom with mouse wheel
			Info displayed on image
show_school_paper_background	bool	True	Show school paper background, when the image is unzoomed
show_alpha_channel_checkerboard	bool	True	Show alpha channel checkerboard
show_grid	bool	True	Show grid with the zoom level is high
draw_values_on_zoomed_pixels	bool	True	Draw values on pixels, when the zoom is high
			Info displayed under the image
show_image_info	bool	True	Show image info, i.e image size and type
show_pixel_info	bool	True	Show pixel info, i.e. show pixel value and position under the mouse
			Control buttons under the image

```
  +--------------------------------+-----------------+-----------
+--------------------------------------------+
  | show_zoom_buttons              | bool            | True      | Show
zoom buttons                          |
  +--------------------------------+-----------------+-----------
+--------------------------------------------+
  | show_options_panel             | bool            | True      | Show
options panel                         |
  +--------------------------------+-----------------+-----------
+--------------------------------------------+
  | show_options_button            | bool            | True      | Show
options button                        |
  +--------------------------------+-----------------+-----------
+--------------------------------------------+
  | show_inspect_button            | bool            | True      | Show
the inspect button, that enables to open |
  |                                |                 |           | a
large version of image in the Image        |
  |                                |                 |           |
Inspector                                  |
  +--------------------------------+-----------------+-----------
+--------------------------------------------+

  Available custom attributes for AnyDataWithGui Generic attributes:

--------------------------------------------------------------------------------
  +----------------+--------+--------------------
+----------------------------------------------+
  | Name           | Type   | Default            | Explanation
|
+================+========+====================+==========================================
  |                |        |                    | **Generic
attributes**                       |
  +----------------+--------+--------------------
+----------------------------------------------+
  | validate_value | object | None               | Function to validate
a parameter value (should |
  |                |        |                    | return
DataValidationResult.ok() .error()      |
  +----------------+--------+--------------------
+----------------------------------------------+
  | label          | str    |                    | A label for the
parameter. If empty, the       |
  |                |        |                    | function parameter
name is used                |
  +----------------+--------+--------------------
+----------------------------------------------+
  | tooltip        | str    |                    | An optional tooltip
to be displayed            |
  +----------------+--------+--------------------
+----------------------------------------------+
  | label_color    | ImVec4 | ImVec4(0.000000,   | The color of the
```

```
label (will use the default   |
  |                |        | 0.000000, 0.000000, | text color if not
provided)                    |
  |                |        | 1.000000)           |
|
  +----------------+--------+--------------------
+-----------------------------------------------+

Code to test this GUI type:
----------------------------
```python
import typing
import fiatlight

@fiatlight.with_fiat_attributes(
    #  Main attributes for the image viewer
    union_param__only_display = False,
    union_param__image_display_size = (200, 0),
    union_param__zoom_key = "z",
    union_param__is_color_order_bgr = True,
    union_param__can_resize = True,
    #  Channels
    union_param__show_channels = False,
    union_param__channel_layout_vertically = False,
    #  Zoom & Pan
    union_param__pan_with_mouse = True,
    union_param__zoom_with_mouse_wheel = True,
    #  Info displayed on image
    union_param__show_school_paper_background = True,
    union_param__show_alpha_channel_checkerboard = True,
    union_param__show_grid = True,
    union_param__draw_values_on_zoomed_pixels = True,
    #  Info displayed under the image
    union_param__show_image_info = True,
    union_param__show_pixel_info = True,
    #  Control buttons under the image
    union_param__show_zoom_buttons = True,
    union_param__show_options_panel = True,
    union_param__show_options_button = True,
    union_param__show_inspect_button = True,
    #  Generic attributes
    union_param__validate_value = None,
    union_param__label = "",
    union_param__tooltip = "",
    union_param__label_color = ImVec4(0.000000, 0.000000, 0.000000,
1.000000))
def f(union_param:
typing.Union[fiatlight.fiat_kits.fiat_image.image_types.ImageU8_1,
fiatlight.fiat_kits.fiat_image.image_types.ImageU8_2,
fiatlight.fiat_kits.fiat_image.image_types.ImageU8_3,
fiatlight.fiat_kits.fiat_image.image_types.ImageU8_4,
fiatlight.fiat_kits.fiat_image.image_types.ImageU8_RGB,
```
```

```
fiatlight.fiat_kits.fiat_image.image_types.ImageU8_RGBA,
fiatlight.fiat_kits.fiat_image.image_types.ImageU8_BGRA,
fiatlight.fiat_kits.fiat_image.image_types.ImageU8_BGR,
fiatlight.fiat_kits.fiat_image.image_types.ImageU8_GRAY,
fiatlight.fiat_kits.fiat_image.image_types.ImageFloat_1,
fiatlight.fiat_kits.fiat_image.image_types.ImageFloat_2,
fiatlight.fiat_kits.fiat_image.image_types.ImageFloat_3,
fiatlight.fiat_kits.fiat_image.image_types.ImageFloat_4]) ->
typing.Union[fiatlight.fiat_kits.fiat_image.image_types.ImageU8_1,
fiatlight.fiat_kits.fiat_image.image_types.ImageU8_2,
fiatlight.fiat_kits.fiat_image.image_types.ImageU8_3,
fiatlight.fiat_kits.fiat_image.image_types.ImageU8_4,
fiatlight.fiat_kits.fiat_image.image_types.ImageU8_RGB,
fiatlight.fiat_kits.fiat_image.image_types.ImageU8_RGBA,
fiatlight.fiat_kits.fiat_image.image_types.ImageU8_BGRA,
fiatlight.fiat_kits.fiat_image.image_types.ImageU8_BGR,
fiatlight.fiat_kits.fiat_image.image_types.ImageU8_GRAY,
fiatlight.fiat_kits.fiat_image.image_types.ImageFloat_1,
fiatlight.fiat_kits.fiat_image.image_types.ImageFloat_2,
fiatlight.fiat_kits.fiat_image.image_types.ImageFloat_3,
fiatlight.fiat_kits.fiat_image.image_types.ImageFloat_4]:
    return union_param

fiatlight.run(f)
```

7.a.ii. *Image types:*

Fiatlight provides several synonyms for Numpy arrays that denote different types of images. Each of these types will be displayed by the image widget.

```
import fiatlight
from fiatlight.fiat_notebook import look_at_code
%look_at_python_file fiat_kits/fiat_image/image_types.py
```

```
"""This module defines several types you can use to annotate your
functions.
The image types are defined as NewType instances, which are just aliases
for numpy arrays.

All those types will be displayed in the GUI as images, using the
ImmVision image viewer
(https://github.com/pthom/immvision)

Notes:
    - The easiest way to display an image is to use the `Image` type,
which is a union of all image types,
      or to use the `ImageU8` type, which is a union of all UInt8 image
types.
    - any numpy array can be used to create an `Image`, and the viewer
will try to display it
"""
```

```
from typing import Any, NewType
import numpy as np
from typing import Tuple, Union

# Define shape types for clarity
ShapeHeightWidth = Tuple[int, int]
ShapeHeightWidthChannels = Tuple[int, int, int]

# Define UInt8 as a dtype for numpy arrays
UInt8 = np.dtype[np.uint8]
AnyFloat = np.dtype[np.floating[Any]]


#
# UInt8 Images
#
# ImageU8 = NewType("ImageU8", np.ndarray[ShapeHeightWidthChannels |
ShapeHeightWidth, UInt8])
# Type definitions for UInt8 images based on channel count
ImageU8_1 = NewType("ImageU8_1", np.ndarray[ShapeHeightWidth, UInt8])
ImageU8_2 = NewType("ImageU8_2", np.ndarray[ShapeHeightWidthChannels,
UInt8])
ImageU8_3 = NewType("ImageU8_3", np.ndarray[ShapeHeightWidthChannels,
UInt8])
ImageU8_4 = NewType("ImageU8_4", np.ndarray[ShapeHeightWidthChannels,
UInt8])
ImageU8_WithNbChannels = Union[ImageU8_1, ImageU8_2, ImageU8_3,
ImageU8_4]
# Type definitions based on the roles of the channels
ImageU8_RGB = NewType("ImageU8_RGB", ImageU8_3)
ImageU8_RGBA = NewType("ImageU8_RGBA", ImageU8_4)
ImageU8_BGRA = NewType("ImageU8_BGRA", ImageU8_4)
ImageU8_BGR = NewType("ImageU8_BGR", ImageU8_3)
ImageU8_GRAY = NewType("ImageU8_GRAY", ImageU8_1)
ImageU8_WithChannelsRoles = Union[ImageU8_RGB, ImageU8_RGBA,
ImageU8_BGRA, ImageU8_BGR, ImageU8_GRAY]

# Generic type for any 8-bit image
ImageU8 = Union[ImageU8_WithNbChannels, ImageU8_WithChannelsRoles]


#
# Float Images
#
# Type definitions for float images based on channel count
ImageFloat_1 = NewType("ImageFloat_1", np.ndarray[ShapeHeightWidth,
AnyFloat])
ImageFloat_2 = NewType("ImageFloat_2",
np.ndarray[ShapeHeightWidthChannels, AnyFloat])
ImageFloat_3 = NewType("ImageFloat_3",
np.ndarray[ShapeHeightWidthChannels, AnyFloat])
```

```
ImageFloat_4 = NewType("ImageFloat_4",
np.ndarray[ShapeHeightWidthChannels, AnyFloat])

# Generic type for any float image
ImageFloat = Union[ImageFloat_1, ImageFloat_2, ImageFloat_3,
ImageFloat_4]


#
# Generic Image Type
#
# Image is a union of all image types
Image = Union[ImageU8, ImageFloat]


# ---------------------------- Register image type factories
----------------------------


def _register_image_type_factories() -> None:
    from fiatlight.fiat_togui.gui_registry import gui_factories
    from fiatlight.fiat_kits.fiat_image.image_gui import ImageWithGui

    prefix = "fiatlight.fiat_kits.fiat_image.image_types.Image"
    gui_factories().register_factory_name_start_with(prefix,
ImageWithGui)
    gui_factories().register_factory_union(prefix, ImageWithGui)
```

`

7.a.iii. *Source code for the example:*

```
%look_at_python_file fiat_kits/fiat_image/fiat_image_attrs_demo.py
```

```
"""Demo how to set custom presentation attributes for the Image Widget
(ImageWithGui)

Notes:
    - The custom attributes can be set using the decorator
fl.with_fiat_attributes
    - In these examples, we intend to set custom attributes for the
output of the
      functions, i.e. the returned value.
      As a consequence, the custom attributes are set in the return__...
      arguments of the decorator.
"""

import fiatlight as fl
from fiatlight.fiat_kits.fiat_image import ImageU8_3
import cv2


# Our demo image
```

```
demo_image: ImageU8_3 = cv2.imread(fl.demo_assets_dir() + "/images/
house.jpg")  # type: ignore


# A simple function that will use the Image Widget with its default
settings.
def show_image(image: ImageU8_3 = demo_image) -> ImageU8_3:
    return image

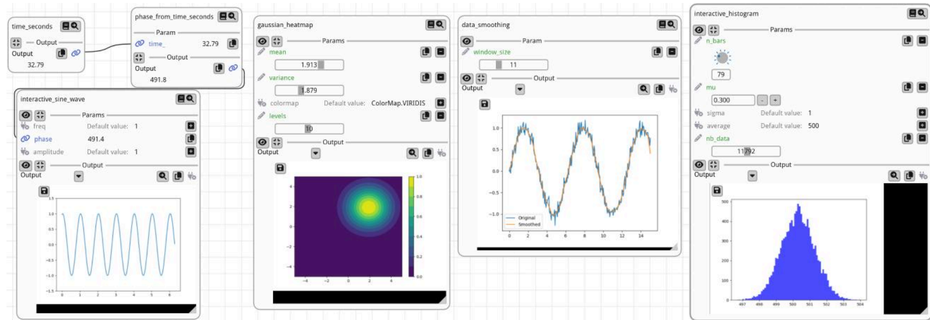

# A function whose output will initially show the channels
# Since it does not specify a zoom key,
# it will be zoomed and panned together with the image
# shown by "show_image"
@fl.with_fiat_attributes(return__show_channels=True)
def show_image_channels(image: ImageU8_3 = demo_image) -> ImageU8_3:
    return image


# A function whose output will have a different zoom key:
# it can be panned and zoomed, independently of the other images
@fl.with_fiat_attributes(return__zoom_key="other")
def show_image_different_zoom_key(image: ImageU8_3 = demo_image) ->
ImageU8_3:
    return image


# A function that will use the Image Widget with custom attributes:
# - the image is displayed only (it cannot be zoomed or panned,
#   and the pixel values are not shown)
# - the image is displayed with a height of 300 pixels
#   (the width is automatically calculated)
# - the image cannot be resized
@fl.with_fiat_attributes(
    return__only_display=True,
    return__image_display_size=(0, 300),
    return__can_resize=False,
)
def show_image_only_display(image: ImageU8_3 = demo_image) -> ImageU8_3:
    return image


def main() -> None:
    graph = fl.FunctionsGraph()
    graph.add_function(show_image)
    graph.add_function(show_image_channels)
    graph.add_function(show_image_different_zoom_key)
    graph.add_function(show_image_only_display)

    fl.run(graph, app_name="fiat_image_fiat_attrs_demo")
```

```
if __name__ == "__main__":
    main()
```

7.b. fiat_matplotlib: display matplotlib figures

Fiatlight provides `FigureWithGui`, a viewer for Matplotlib figures.

7.b.i. *Example:*

```
from fiatlight.fiat_kits.fiat_matplotlib import demo_matplotlib

demo_matplotlib.main()
```



7.b.ii. *Fiat attributes available for the FigureWithGui widget:*

The FigureWithGui widget is not customizable. However, it can be zoomed by the user and this setting will be saved.

7.b.iii. *Source code for the example:*

```
import fiatlight
from fiatlight.fiat_notebook import look_at_code  # noqa
%look_at_python_file fiat_kits/fiat_matplotlib/demo_matplotlib.py
```

```
"""Interactive Matplotlib Figures with Fiatlight

This example demonstrates several types of matplotlib figures rendered
within Fiatlight with interactive GUI elements, including a sine wave
plot, a Gaussian heatmap, data smoothing, and a histogram.
"""

import matplotlib.pyplot as plt
from matplotlib.figure import Figure
import numpy as np
from enum import Enum
import time
import fiatlight as fl


# Initialize the start time
_start_time = time.time()


def time_seconds() -> float:
    """Returns the time elapsed since the start of the application."""
    return time.time() - _start_time
```

```
def phase_from_time_seconds(time_: float) -> float:
    """Calculates the phase from the given time."""
    return time_ * 15.0


# Set the function to always update
time_seconds.invoke_always_dirty = True  # type: ignore


def interactive_sine_wave(freq: float = 1.0, phase: float = 0.0,
amplitude: float = 1.0) -> Figure:
    """Generates an interactive sine wave with adjustable frequency,
phase, and amplitude."""
    x = np.linspace(0, 2 * np.pi, 3000)
    y = amplitude * np.sin(2 * np.pi * freq * x + phase)
    fig, ax = plt.subplots()
    ax.plot(x, y)
    ax.set_ylim([-1.5, 1.5])  # Adjust the y-axis limits
    return fig


# Set ranges and edit types for the sine wave parameters
fl.add_fiat_attributes(
    interactive_sine_wave,
    freq__range=(0.1, 3),
    phase__range=(-np.pi, np.pi),
    amplitude__range=(0.1, 2),
    freq__edit_type="knob",
    phase__edit_type="knob",
    amplitude__edit_type="knob",
)


class ColorMap(Enum):
    VIRIDIS = "viridis"
    PLASMA = "plasma"
    INFERNO = "inferno"
    MAGMA = "magma"
    CIVIDIS = "cividis"

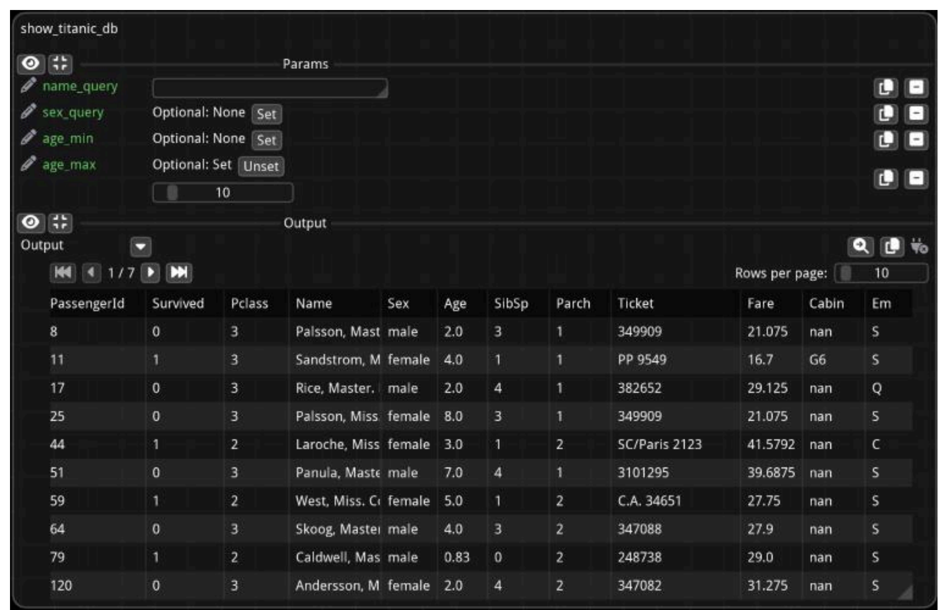
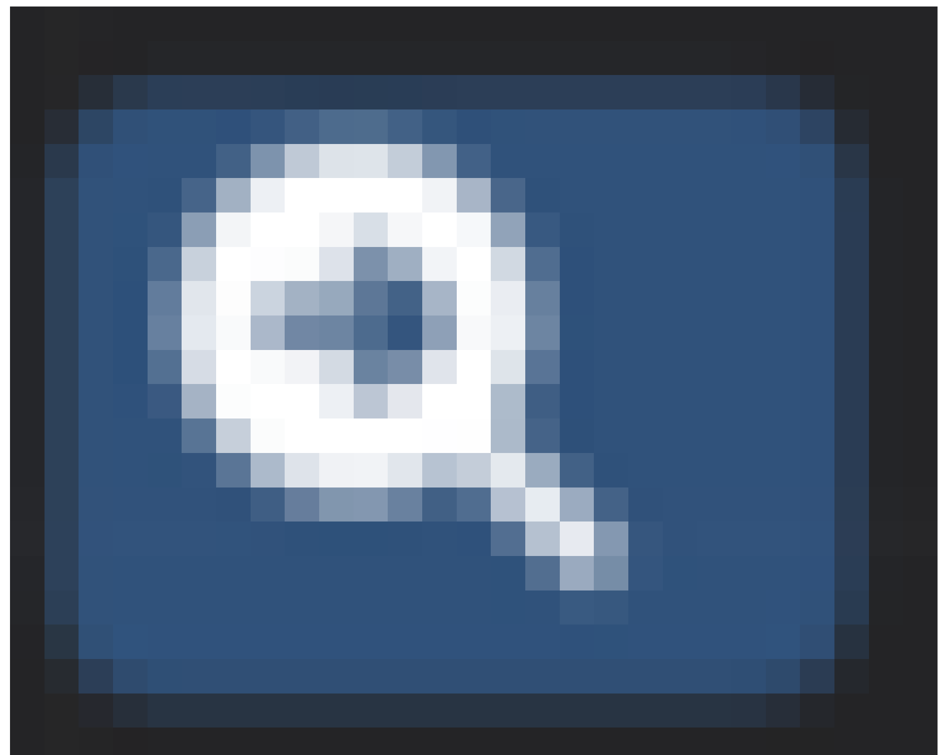
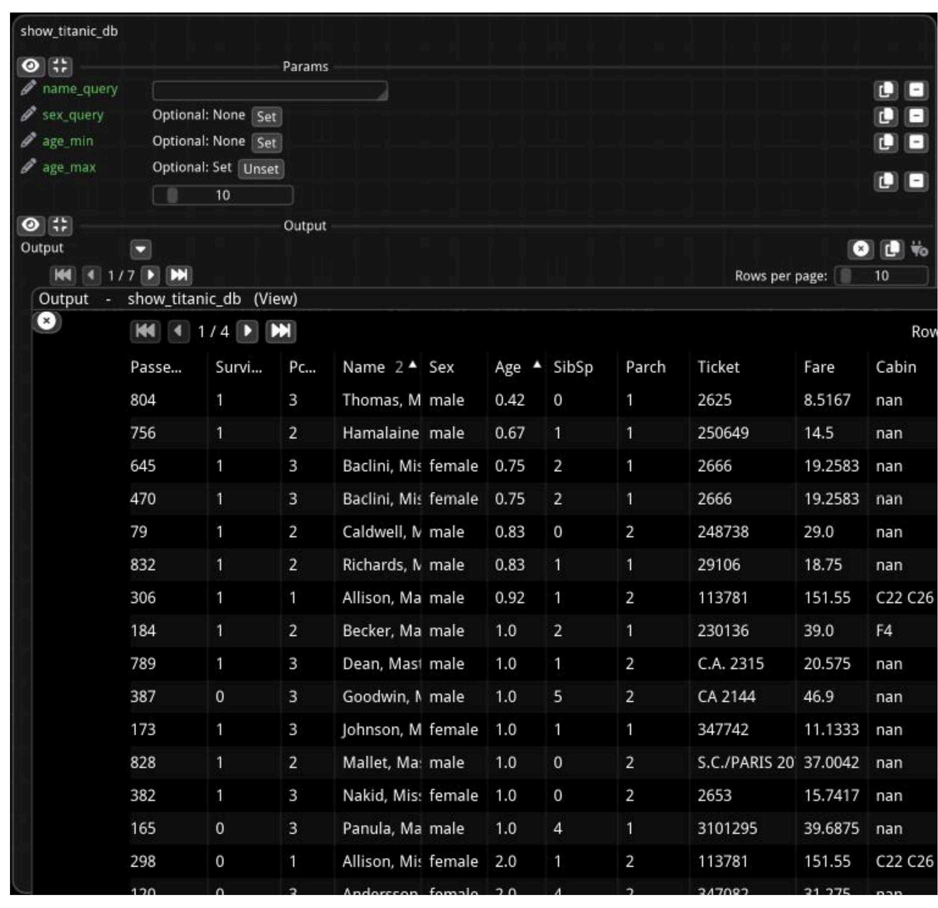

@fl.with_fiat_attributes(
    mean__range=(-5, 5),
    variance__range=(0.1, 5),
    levels__range=(1, 20),
)
def gaussian_heatmap(
    mean: float = 0, variance: float = 1, colormap: ColorMap =
ColorMap.VIRIDIS, levels: int = 10
) -> Figure:
    """Generates a Gaussian heatmap with adjustable mean, variance,
```

```
colormap, and number of contour levels."""
    x = y = np.linspace(-5, 5, 100)
    X, Y = np.meshgrid(x, y)
    Z = np.exp(-((X - mean) ** 2 + (Y - mean) ** 2) / (2 * variance))
    fig, ax = plt.subplots()
    contour = ax.contourf(X, Y, Z, levels, cmap=colormap.value)
    fig.colorbar(contour, ax=ax)
    return fig


@fl.with_fiat_attributes(window_size__range=(1, 40))
def data_smoothing(window_size: int = 5) -> Figure:
    """Demonstrates data smoothing using a moving average filter."""
    x = np.linspace(0, 15, 300)
    y = np.sin(x) + np.random.normal(0, 0.1, 300)  # Noisy sine wave
    y_smooth = np.convolve(y, np.ones(window_size) / window_size,
mode="same")
    fig, ax = plt.subplots()
    ax.plot(x, y, label="Original")
    ax.plot(x, y_smooth, label="Smoothed")
    ax.legend()
    return fig


def interactive_histogram(
    n_bars: int = 10, mu: float = 0, sigma: float = 1, average: float =
500, nb_data: int = 1000
) -> Figure:
    """Generates an interactive histogram with adjustable number of
bars, mean, and standard deviation."""
    data = np.random.normal(mu, sigma, int(nb_data)) + average
    bins = np.linspace(np.min(data), np.max(data), n_bars)
    fig, ax = plt.subplots()
    ax.hist(data, bins=bins, color="blue", alpha=0.7)
    return fig


# Set interactive parameters for the histogram
fl.add_fiat_attributes(
    interactive_histogram,
    n_bars__edit_type="knob",
    n_bars__range=(1, 300),
    mu__edit_type="input",
    mu__range=(-5, 5),
    sigma__edit_type="drag",
    sigma__range=(0.1, 5),
    average__edit_type="slider_float_any_range",
    nb_data__edit_type="slider",
    nb_data__range=(100, 1_000_000),
    nb_data__slider_logarithmic=True,
    nb_data__slider_no_input=True,
)
```

```
def main() -> None:
    """Main function to run the Fiatlight application with interactive
matplotlib figures."""
    import fiatlight

    # Create a graph to manage functions and their links
    graph = fiatlight.FunctionsGraph()
    graph.add_function(interactive_sine_wave)
    graph.add_function(gaussian_heatmap)
    graph.add_function(data_smoothing)
    graph.add_function(interactive_histogram)
    graph.add_function(time_seconds)
    graph.add_function(phase_from_time_seconds)
    graph.add_link("time_seconds", "phase_from_time_seconds", "time_")
    graph.add_link("phase_from_time_seconds", "interactive_sine_wave",
"phase")
    fiatlight.run(graph, app_name="figure_with_gui_demo")


if __name__ == "__main__":
    main()
```

7.c. *fiat_dataframe: pandas DataFrame explorer*

Fiatlight provides `DataFrameWithGui`, a viewer for pandas dataframes that allows to sort, and visualize the data. Composed with the advanced GUI creation capabilities of fiatlight, it can also filter data.

7.c.i. *Example:*

```
from fiatlight.fiat_kits.fiat_dataframe import
dataframe_with_gui_demo_titanic
dataframe_with_gui_demo_titanic.main()
```



By clicking on the magnifier button



on top of the dataframe, you can open it in a popup where sorting options are available. Click on one column (or shift-click on multiple columns) to sort the data.

```
dataframe_with_gui_demo_titanic.main()
```



7.c.ii. *Fiat attributes available for DataFrameWithGui:*

Here is a list of all the possible customizations options:

```
%%bash
fiatlight gui DataFrameWithGui
```

```
GUI type: DataFrameWithGui
===========================
  A class to present a pandas DataFrame in the GUI, with pagination and
other features. Open in a pop-up for more features

  Available custom attributes for DataFrameWithGui:

--------------------------------------------------------------------------------
  +------------------------+---------------------+--------------
+-----------------------------------------------+
  | Name                   | Type                | Default      |
Explanation                                  |

+========================+=====================+==============+======================
  | widget_size_em         | tuple[float, float] | (50.0, 15.0) | Widget
size in em units                           |
  +------------------------+---------------------+--------------
+-----------------------------------------------+
  | column_widths_em       | dict                | {}           |
```

```
Dictionary to specify custom widths for       |
  |                        |                     |              |
individual columns, identified by column name |
  +------------------------+---------------------+--------------
+---------------------------------------------+
  | rows_per_page_node     | int                 | 10           | Number
of rows to display per page (when      |
  |                        |                     |              |
displayed in a function node)                 |
  +------------------------+---------------------+--------------
+---------------------------------------------+
  | rows_per_page_classic  | int                 | 20           | Number
of rows to display per page (when      |
  |                        |                     |              |
displayed in a pop-up)                        |
  +------------------------+---------------------+--------------
+---------------------------------------------+
  | current_page_start_idx | int                 | 0            | Index
of the first row on the current page,   |
  |                        |                     |              | used
for pagination                         |
  +------------------------+---------------------+--------------
+---------------------------------------------+

  Available custom attributes for AnyDataWithGui Generic attributes:

--------------------------------------------------------------------------------
  +----------------+--------+--------------------
+---------------------------------------------+
  | Name           | Type   | Default             | Explanation
|
+================+========+====================+===================================
  |                |        |                     | **Generic
attributes**                        |
  +----------------+--------+--------------------
+---------------------------------------------+
  | validate_value | object | None                | Function to validate
a parameter value (should |
  |                |        |                     | return
DataValidationResult.ok() .error()      |
  +----------------+--------+--------------------
+---------------------------------------------+
  | label          | str    |                     | A label for the
parameter. If empty, the       |
  |                |        |                     | function parameter
name is used                |
  +----------------+--------+--------------------
+---------------------------------------------+
  | tooltip        | str    |                     | An optional tooltip
to be displayed            |
  +----------------+--------+--------------------
+---------------------------------------------+
```

```
  | label_color    | ImVec4 | ImVec4(0.000000,    | The color of the
label (will use the default   |
  |                |        | 0.000000, 0.000000, | text color if not
provided)                    |
  |                |        | 1.000000)           |
|
  +----------------+--------+--------------------
+---------------------------------------------+

Code to test this GUI type:
----------------------------
```python
import typing
import fiatlight

@fiatlight.with_fiat_attributes(
    dataframe_param__widget_size_em = (50.0, 15.0),
    dataframe_param__column_widths_em = {},
    dataframe_param__rows_per_page_node = 10,
    dataframe_param__rows_per_page_classic = 20,
    dataframe_param__current_page_start_idx = 0,
    #  Generic attributes
    dataframe_param__validate_value = None,
    dataframe_param__label = "",
    dataframe_param__tooltip = "",
    dataframe_param__label_color = ImVec4(0.000000, 0.000000, 0.000000,
1.000000))
def f(dataframe_param: pandas.core.frame.DataFrame) ->
pandas.core.frame.DataFrame:
    return dataframe_param

fiatlight.run(f)
```
```

7.c.iii. *Source code for the example:*

```
import fiatlight
from fiatlight.fiat_notebook import look_at_code  # noqa
%look_at_python_file fiat_kits/fiat_dataframe/
dataframe_with_gui_demo_titanic.py
```

```
import fiatlight as fl
import pandas as pd
from enum import Enum


def make_titanic_df() -> pd.DataFrame:
    # Here, we provide an example data frame to the user,
    # using the Titanic dataset from the Data Science Dojo repository.
    # (widely used in data science tutorials)
    url = "https://raw.githubusercontent.com/datasciencedojo/datasets/
master/titanic.csv"
```

```
    try:
        df = pd.read_csv(url)
    except Exception as e:
        print(f"Error loading sample dataset: {e}")
        df = pd.DataFrame()  # Return an empty DataFrame in case of
failure
    return df


class Sex(Enum):
    Man = "male"
    Woman = "female"


@fl.with_fiat_attributes(
    # define the custom attributes for the function parameters
    age_min__range=(0, 100),
    age_max__range=(0, 100),
    # define custom attributes for the function output
    # (i.e. the presentation options for the DataFrame)
    return__widget_size_em=(55.0, 15.0),
    return__rows_per_page_node=10,
    return__rows_per_page_popup=20,
    return__column_widths_em={"Name": 5},
)
def show_titanic_db(
    name_query: str = "", sex_query: Sex | None = None, age_min: int |
None = None, age_max: int | None = None
) -> pd.DataFrame:
    dataframe = make_titanic_df()
    if dataframe.empty:
        return dataframe

    # filter dataframe
    if name_query:
        dataframe = dataframe[dataframe["Name"].str.contains(name_query,
case=False)]
    if sex_query:
        dataframe = dataframe[dataframe["Sex"] == sex_query.value]
    if age_min is not None:
        dataframe = dataframe[dataframe["Age"] >= age_min]
    if age_max is not None:
        dataframe = dataframe[dataframe["Age"] <= age_max]

    return dataframe


def main() -> None:
    fl.run(show_titanic_db, app_name="dataframe_with_gui_demo_titanic")
```

```
if __name__ == "__main__":
    main()
```

7.d. *fiat_implot: widget for 1D and 2D numpy arrays*

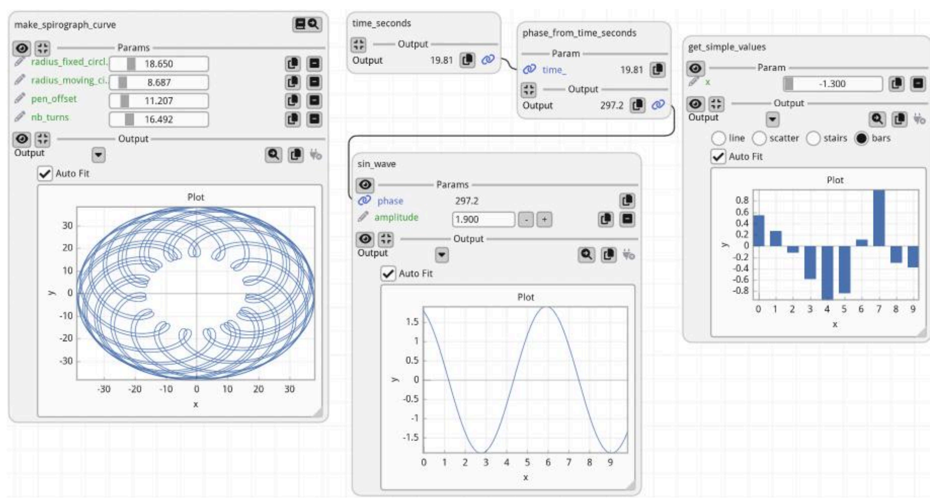
Fiatlight provides `SimplePlotGui`, a viewer for numpy arrays that allows to plot 1D and 2D arrays with ImPlot

- ImPlot is a very capable and fast plotting library, not limited to simple 1D and 2D plots. It is available with Fiatlight and ImGui Bundle (on which Fiatlight is based). See online demo of ImPlot for more examples.
- It is faster than Matplotlib within Fiatlight, and well adapted for real time plots (can refresh at 120FPS +)

=== Example

```
from fiatlight.fiat_kits.fiat_implot import demo_implot

demo_implot.main()
```



7.d.i. *Fiat attributes available for SimplePlotGui:*

Here is a list of all the type handled by SimplePlotGui:

```
%%bash
fiatlight types FloatMatrix_Dim

+----------------------------------------------------
+-------------------------------------------------------------------+
| Data Type                                          | Gui Type
|
+====================================================+===============================
| fiatlight.fiat_kits.fiat_implot.array_types.FloatM |
fiatlight.fiat_kits.fiat_implot.simple_plot_gui.SimplePlotGui       |
| atrix_Dim1                                         |   A GUI for
presenting 1D or 2D arrays with ImPlot. Can present the |
|   synonym for a 1D ndarray of floats (NewType)     | array as a line,
scatter (+ stairs, or bars plot, if the array is    |
|                                                    | small enough)
```

```
|
+-------------------------------------------------
+-----------------------------------------------------------------+
| fiatlight.fiat_kits.fiat_implot.array_types.FloatM |
fiatlight.fiat_kits.fiat_implot.simple_plot_gui.SimplePlotGui       |
| atrix_Dim2                                         |   A GUI for
presenting 1D or 2D arrays with ImPlot. Can present the |
|   synonym for a 2D ndarray of floats (NewType)     | array as a line,
scatter (+ stairs, or bars plot, if the array is   |
|                                                    | small enough)
|
+-------------------------------------------------
+-----------------------------------------------------------------+
```

Here is a list of all the possible customizations options:

```
%%bash
fiatlight gui SimplePlotGui
```

```
GUI type: SimplePlotGui
========================
  A GUI for presenting 1D or 2D arrays with ImPlot. Can present the
array as a line, scatter (+ stairs, or bars plot, if the array is small
enough)

  Available custom attributes for SimplePlotGui:

--------------------------------------------------------------------------------
  +----------------------+--------------------+-------------
+---------------------------------------------+
  | Name                 | Type               | Default      |
Explanation                                 |

+======================+====================+==============+=========================
  | plot_type            | str                | line         | The
type of presentation to use. Choose from   |
  |                      |                    |              | line,
scatter, stairs, or bars.               |
  +----------------------+--------------------+-------------
+---------------------------------------------+
  | plot_size_em         | tuple[float, float] | (35.0, 20.0) | Size in
em units (i.e. multiples of the font   |
  |                      |                    |              | height)
|
  +----------------------+--------------------+-------------
+---------------------------------------------+
  | auto_fit             | bool               | True         | Auto-
scale the plot axes                      |
  +----------------------+--------------------+-------------
+---------------------------------------------+
  | small_array_threshold | int               | 100          | The
threshold for the array size to be able to |
  |                      |                    |              | present
scatter, bars, and stairs plots        |
```

```
  +----------------------+--------------------+-------------
+---------------------------------------------+

  Available custom attributes for AnyDataWithGui Generic attributes:

--------------------------------------------------------------------------------
  +----------------+--------+--------------------
+---------------------------------------------+
  | Name           | Type   | Default            | Explanation
|

+================+========+====================+====================================
  |                |        |                    | **Generic
attributes**                       |
  +----------------+--------+--------------------
+---------------------------------------------+
  | validate_value | object | None               | Function to validate
a parameter value (should |
  |                |        |                    | return
DataValidationResult.ok() .error()      |
  +----------------+--------+--------------------
+---------------------------------------------+
  | label          | str    |                    | A label for the
parameter. If empty, the       |
  |                |        |                    | function parameter
name is used                |
  +----------------+--------+--------------------
+---------------------------------------------+
  | tooltip        | str    |                    | An optional tooltip
to be displayed            |
  +----------------+--------+--------------------
+---------------------------------------------+
  | label_color    | ImVec4 | ImVec4(0.000000,   | The color of the
label (will use the default   |
  |                |        | 0.000000, 0.000000, | text color if not
provided)                    |
  |                |        | 1.000000)          |
|
  +----------------+--------+--------------------
+---------------------------------------------+

Code to test this GUI type:
----------------------------
```

```python
import typing
import fiatlight

@fiatlight.with_fiat_attributes(
    floatmatrix_param__plot_type = "line",
    floatmatrix_param__plot_size_em = (35.0, 20.0),
    floatmatrix_param__auto_fit = True,
    floatmatrix_param__small_array_threshold = 100,
    #  Generic attributes
```

```
    floatmatrix_param__validate_value = None,
    floatmatrix_param__label = "",
    floatmatrix_param__tooltip = "",
    floatmatrix_param__label_color = ImVec4(0.000000, 0.000000,
0.000000, 1.000000))
def f(floatmatrix_param:
fiatlight.fiat_kits.fiat_implot.array_types.FloatMatrix) ->
fiatlight.fiat_kits.fiat_implot.array_types.FloatMatrix:
    return floatmatrix_param

fiatlight.run(f)
```

7.d.ii. *Source code for the example:*

```
import fiatlight
from fiatlight.fiat_notebook import look_at_code  # noqa
%look_at_python_file fiat_kits/fiat_implot/demo_implot.py
```

```
"""Demonstrates plots generated using ImPlot (https://github.com/
epezent/implot). ImPlot is an immediate mode plotting library for Dear
ImGui, whose rendering is often faster than MatPlotLib.

This example demonstrates
- how to create a live sine wave plot with adjustable frequency, phase,
and amplitude using ImPlot.
  The frequency, phase, and amplitude can be adjusted interactively
using knobs.
- how to create a spirograph-like curve using ImPlot.
"""

from fiatlight import fiat_implot
import fiatlight as fl
import numpy as np
import math
import time

_start_time = time.time()


def time_seconds() -> float:
    return time.time() - _start_time


def phase_from_time_seconds(time_: float) -> float:
    return time_ * 15.0


time_seconds.invoke_always_dirty = True  # type: ignore


def sin_wave(phase: float, amplitude: float = 1.0) ->
```

```
fiat_implot.FloatMatrix_Dim2:
    x = np.arange(0, 10, 0.1)
    y = np.sin(x + phase) * amplitude
    r = np.stack((x, y))
    return r  # type: ignore


@fl.with_fiat_attributes(
    radius_fixed_circle__range=(0.0, 100.0),
    radius_moving_circle__range=(0.0, 100.0),
    pen_offset__range=(0.0, 100.0),
    nb_turns__range=(0.0, 100.0),
)
def make_spirograph_curve(
    radius_fixed_circle: float = 10.84,
    radius_moving_circle: float = 3.48,
    pen_offset: float = 6.0,
    nb_turns: float = 23.0,
) -> fiat_implot.FloatMatrix_Dim2:
    """a spirograph-like curve"""
    import numpy as np

    t = np.linspace(0, 2 * np.pi * nb_turns, int(500 * nb_turns))
    x = (radius_fixed_circle + radius_moving_circle) * np.cos(t) -
pen_offset * np.cos(
        (radius_fixed_circle + radius_moving_circle) /
radius_moving_circle * t
    )
    y = (radius_fixed_circle + radius_moving_circle) * np.sin(t) -
pen_offset * np.sin(
        (radius_fixed_circle + radius_moving_circle) /
radius_moving_circle * t
    )
    return np.array([x, y])  # type: ignore


@fl.with_fiat_attributes(
    x__range=(0.0, 10.0),
    return__plot_type="bars",
    return__auto_fit=False,
    return__plot_size_em=(20, 10),
)
def get_simple_values(x: float) -> fiat_implot.FloatMatrix_Dim1:
    r = []
    for i in range(10):
        r.append(math.cos(x**i))
    return np.array(r)  # type: ignore


def main() -> None:
    graph = fl.FunctionsGraph()
    graph.add_function(make_spirograph_curve)
```

```python
    graph.add_function(get_simple_values)

    graph.add_function(time_seconds)
    graph.add_function(phase_from_time_seconds)
    graph.add_function(sin_wave)
    graph.add_link("time_seconds", "phase_from_time_seconds")
    graph.add_link("phase_from_time_seconds", "sin_wave")

    fl.run(graph, app_name="Demo ImPlot")


if __name__ == "__main__":
    main()
```