# QF205_Report

November 13, 2020

## 1 `main_window.py`

As mentioned, `main_window.py`'s main responsibility is to **define the graphic user interface (GUI) itself**. It does so by:

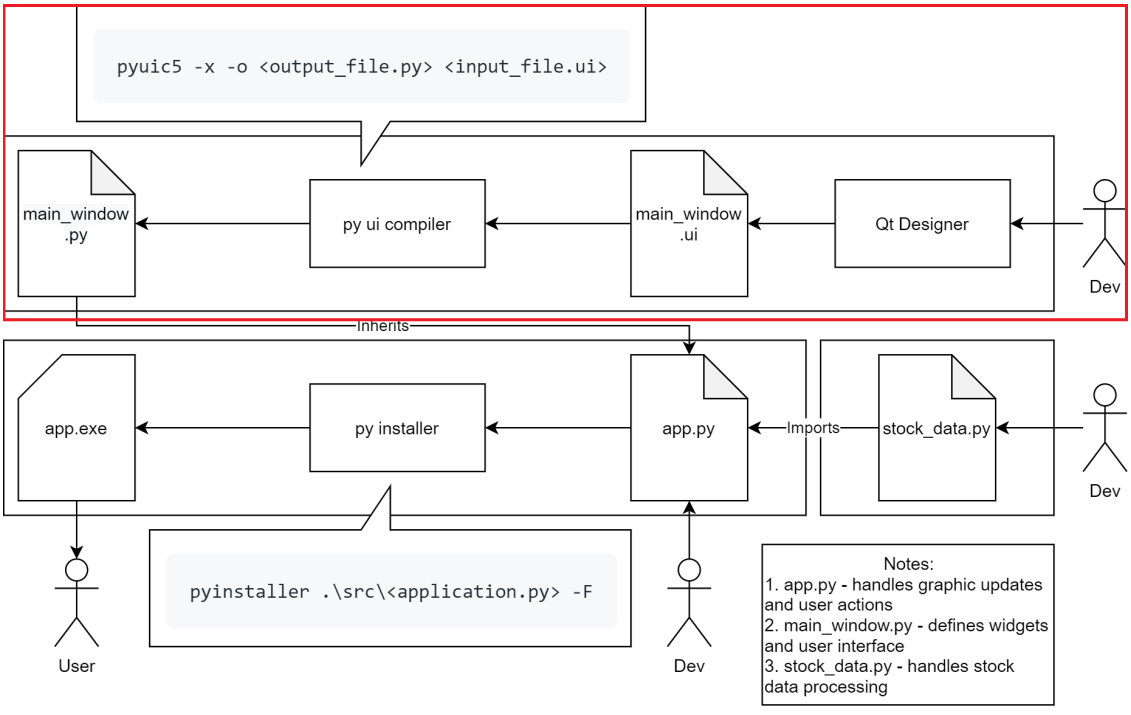
1. Defining each widget objects' and their names within the GUI
2. Defining the location, size and other physical attributes of each widgets

It does **NOT** define the functionalities of the widgets found in the GUI. That is the job of `app.py`.

While it is possible to create `main_window.py` by manually writing a python script file from scratch, it is cumbersome. Instead, the following method was used develop the Stock Chart Application:

1. Install `Qt Designer` application
2. Use `Qt Designer` to build the GUI file called: `main_window.ui`
3. Pip install `PyQt5` for python
4. Use `pyuic5` (a utility script that comes with `PyQt5`) to compile `main_window.ui` into `main_window.py`

The above-mentioned `main_window.py`'s development process is summarized in the graphics below:



This method is **recommended** because it is user-friendly and changes made can be seen visually on the `Qt Designer` itself before it is applied. Thus, not requiring the developer to run the python file after every changes or even knowing how do so at all.

This section of the report will now go through the 4 steps of developing `main_window.py` mentioned.

## 1.1 Installing `Qt Designer`

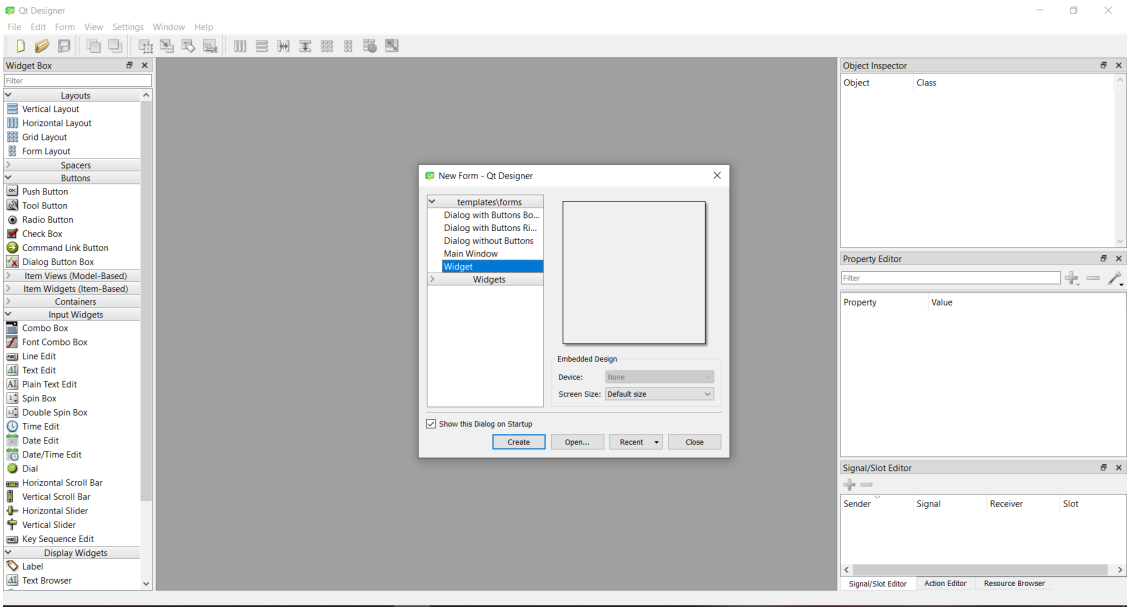
The installation process of `Qt Designer` is similar to any other application.

1. Go to: https://build-system.fman.io/qt-designer-download
2. Click either the `Windows` or `Mac` option. Depending on your computer's Operating System
3. Select a location for the Qt Setup Application `.exe` to be downloaded
4. Double click on the Qt Setup Application `.exe` and follow its installation procedure
5. Check that you have `Qt Designer` installed after the installation has completed

## 1.2 Building `main_window.ui` with `Qt Designer`

### 1.2.1 Defining the GUI

First, open `Qt Designer`. The following window and prompts will appear:



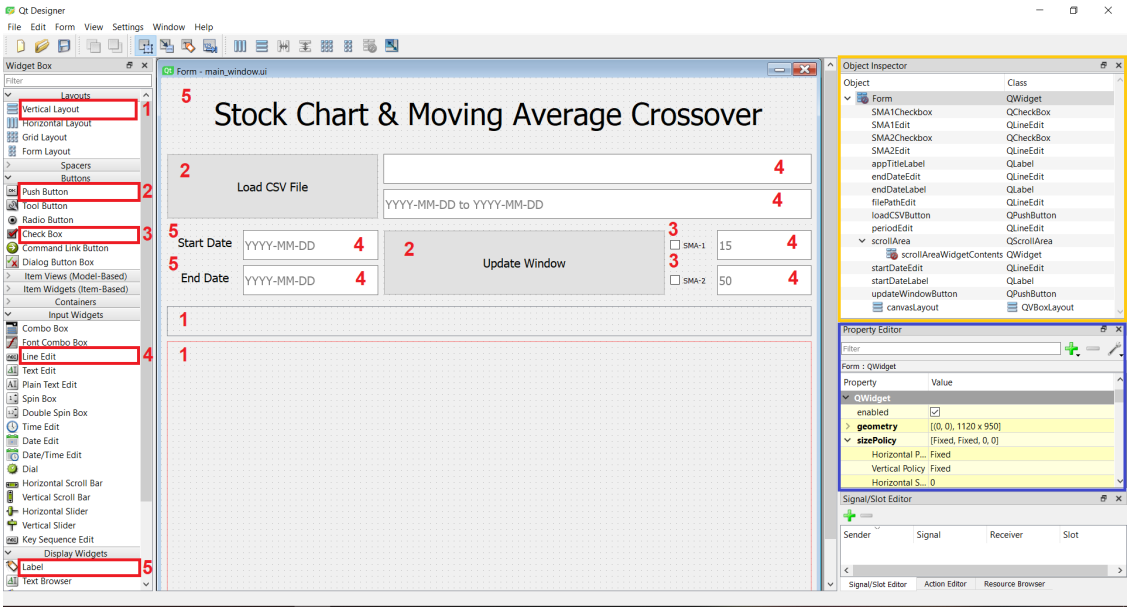

Choose `Widget` under the `template\forms` prompt and press the `Create` Button to begin designing `main_window.ui`.

This is simply a starting template of our GUI, but it is important as the `Widget` option will later be used to inform `app.py` of the type of GUI being inherited.

> *Learning Point: Qt Designer + PyQt5 Template*
>
> *The information about the template is specified when the* ***`.ui`*** *file is started. The information is important because it specifies they* ***type*** *of GUI being inherited later. In this case, the* ***`Widget`*** *called* ***`UI_Form`*** *is going to be inherited by* ***`app.py`***

### 1.2.2 Defining the `Widgets` inside the GUI

Second, start designing the `main_window.ui` GUI as shown in the image below:




To 'design' the GUI, simply **drag and drop** the appropriate **type** of `Widget` from the left side-bar called `Widget Box` into the GUI `Widget`.

This does imply that our GUI is a `Widget` (because we specify it as such in the `template\forms` option) containing `Widgets`.

For convenience, the **type** of the widget used to make the GUI shown above has ben annotated with red boxes and numbers to show where to find each **type** of `Widgets` used to build the GUI.

> *Learning Point: Qt Designer + PyQt5 Widget Types*
>
> 1. `Vertical Layout` *: a layout to mark certain area*
> 2. `Push Button` *: an interactive button*
> 3. `Check Box` *: an interactive checkbox*
> 4. `Line Edit` *: a place to enter a line of text*
> 5. `Label` *: a non-interactive label to display texts*

For each `Widget` being dragged and dropped into the GUI, remember to **name them accordingly** by editing the value of the `objectName` in the Property Box (blue box).

> *Learning Point: Qt Designer + PyQt5 Widget Attributes*
>
> *Different* `Widget` *will have different attributes. They can be found in the Property Box. Some important attributes include:* `objectName`, `geometry`, `sizePolicy`, `font`, *etc...*

Also, do refer to the Object Inspector (yellow box) in the `main_window.ui` image for a list of the **names of the widget** and their associated `Widget` **type**.

For example: name (Object): `SMA1CheckBox`, class (type): `QCheckBox`

This Stock Chart Application also has its window **fixed to a specific size**. This can be done by specifying the following properties in the Property Box of the `UI Form` (found in the Object Inspector):

1. Set `geometry` to: `[(0, 0), 1120 x 950]`
2. Set `sizePolicy` to: `[Fixed, Fixed, 0, 0]`

These actions correspond to what were meant by:

1. Defining each widget objects' and their names within the GUI
2. Defining the location, size and other physical attributes of each widgets

Finally, save the `main_window.ui` file by pressing: `File > Save As` option on the top left hand corner of the window.

### 1.3 Installing PyQt5

Installing `PyQt5` is similar to installing any other python packages using `PIP`. Simply run the following command from the computer's terminal:

```
pip install PyQt5
```

`PyQt5` is a package comprising a comprehensive set of Python bindings for `Qt Designer v5`. As part of its package, it comes with a utility script called `pyuic5` which will be used to compile `.ui` files created using `Qt Designer` into a `.py` python module file.

### 1.4 Compiling `main_window.ui` into `main_window.py`

To compile the `main_window.ui` file into `main_window.py`, simply run the following command from the computer's terminal:

```
pyuic5 -x -o .\src\main_window.py .\src\main_window.ui
```

- The two flags `-x -o` are **required** for the program to work.
- The two arguments passed are also **required** as they are the `output` file path and the `input` file path.

Note: the two file paths assume that the command is run from the `root` directory and the `main_window.ui` file is saved in a directory called `src`.

## 2 `app.py`

While `main_window.py`'s responsibility is to **define the graphics user interface**, `app.py`'s responsibility is to **define the functionalities of the GUI**. This is achieved by doing 2 things:

1. Defining `functions` to accomplish certain actions
2. Connecting `Widget` actions to these `functions`

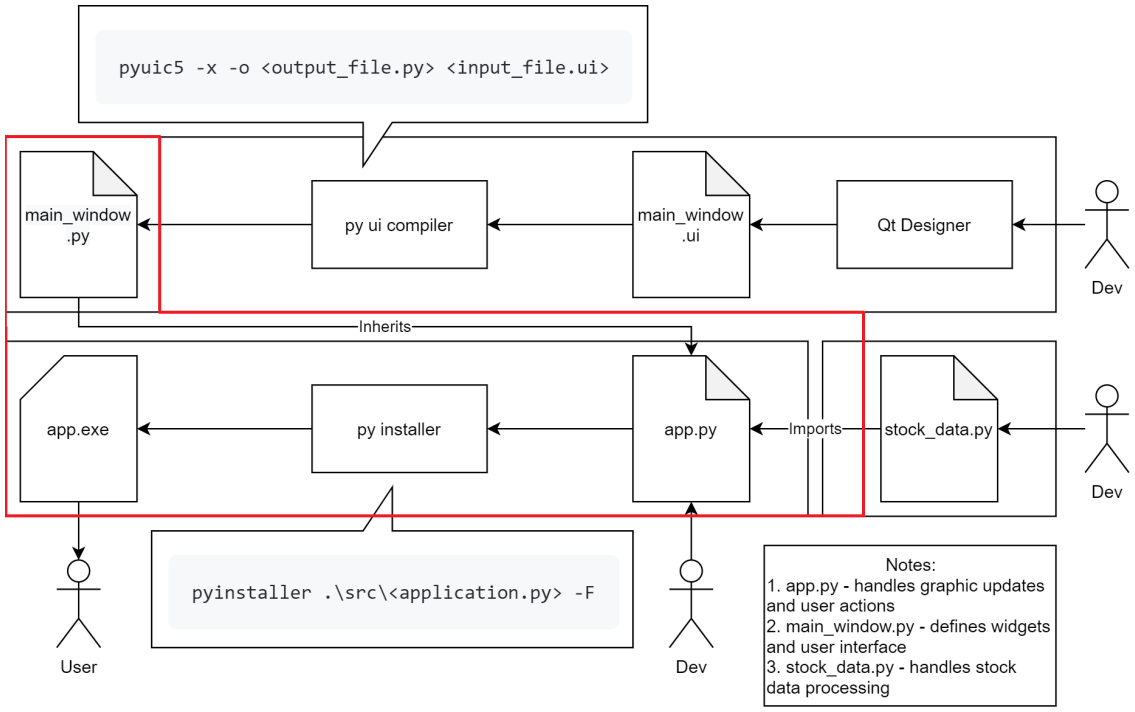
For example, if we want the `Update Window Button` to plot the stock prices in the GUI's canvas. We will have to create a `function` that plots the graph into the canvas and then connect the `Update Window Button` to this `function`.

However, before doing so, `app.py` must first know the `Widget names` defined in `main_window.py`.

For example, the `Update Window Button` is actually named: `updateWindowButton`. This name is defined on the previous step, when `main_window.ui` was designed using `Qt Designer` and the `objectName` is specified inside the Property Box!

This is why, on the previous step, it is **recommended** to name the `Widgets` **accordingly!**

This section of the report will go through the 3 steps of developing `app.py` + 1 optional step to compile `app.exe`, as summarized in the graphics below.

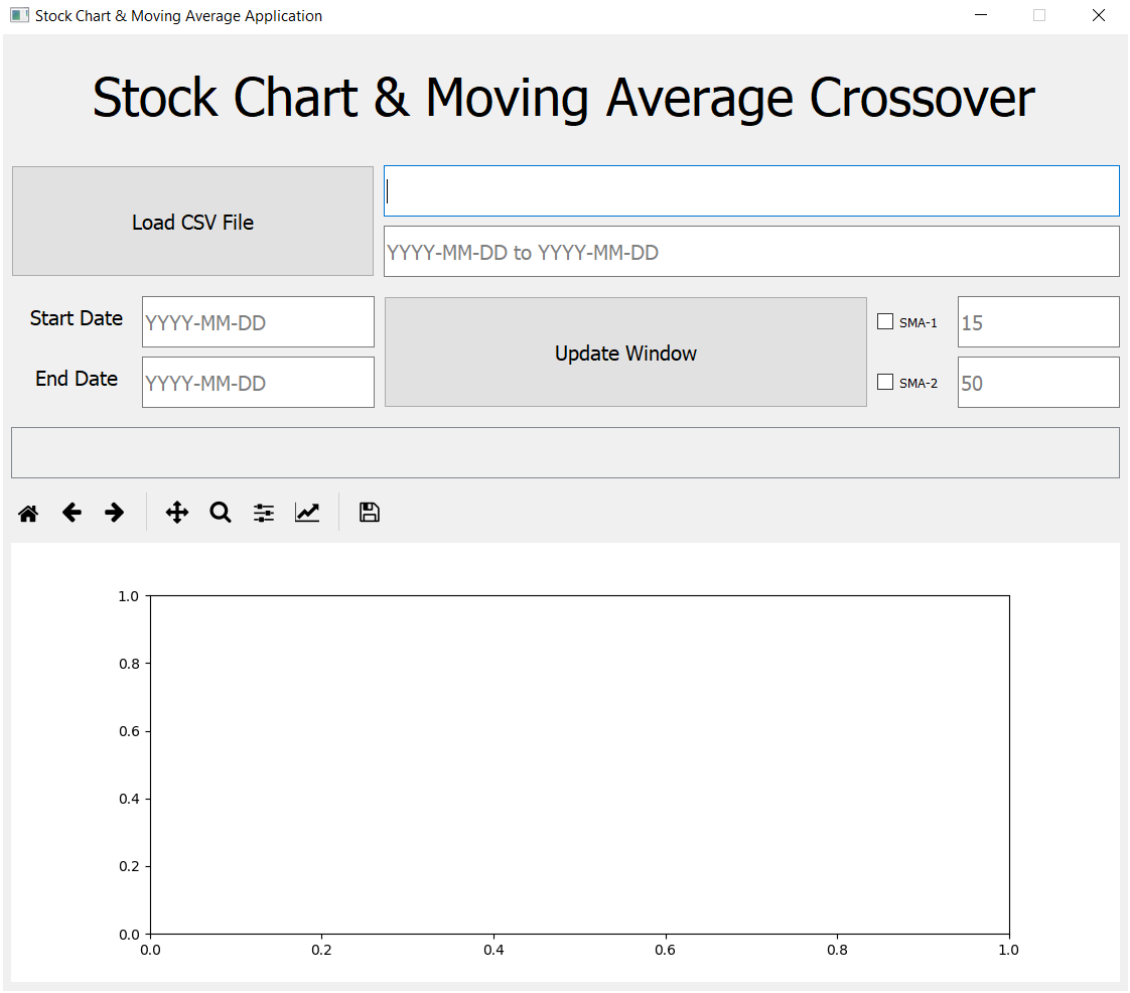



[3]:
```
import sys
sys.path.insert(1, '../src')

from app import Main
import main_window
import inspect # built-in standard library used later on in the section to get␣
↪info about the source code
```

## 2.1 Inheriting `Widgets` from `main_window.py`

The goal of this section is to ensure that `app.py` is **runnable without any error** and shows the **exact same** GUI as if previewing `main_window.ui`.




This result shows that `app.py` has successfully inherited all the properties of `main_window.py`, which includes all the `Widgets` defined when `main_window.ui` was created! These `Widgets` include `updateWindowButton`, `SMA1Checkbox`, `filePathEdit`, etc…

To achieve this, simply start from the generic starter code for all `PyQt5` application and then add the following:

1. Import `matplotlib`, `PyQt5` and the GUI's Widget class called `UI_Form` from `main_window`
2. Pass `QWidget` and `UI_Form` as argument to `Main` class to specify inheritance from `QWidget` and `UI_Form` class
3. Call the superclass' (`UI_Form`) initializing function and setup function
4. Finally, after the inherited GUI has been initialized, add the `canvas` and `toolbar` widget to the `canvasLayout`

This is exactly shown in the code below, running them should result in the image shown above:

[ ]:
```
import sys

# Step 1
import matplotlib.pyplot as plt
```

```
import matplotlib.dates as mdates
from matplotlib.backends.backend_qt5agg import FigureCanvasQTAgg as FigureCanvas
from matplotlib.backends.backend_qt5agg import NavigationToolbar2QT as␣
↪NavigationToolbar

from PyQt5 import QtCore as qtc
from PyQt5 import QtWidgets as qtw

from main_window import Ui_Form

class Main(qtw.QWidget, Ui_Form): # Step 2
    def __init__(self):
        # Step 3
        super().__init__()
        self.setupUi(self)
        self.setWindowTitle("Stock Chart & Moving Average Application")

        # Step 4
        # sets up a new figure to plot on, then instantiates a canvas and␣
↪toolbar object
        self.figure, self.ax = plt.subplots()
        self.canvas = FigureCanvas(self.figure)
        self.toolbar = NavigationToolbar(self.canvas, self)

        # attaches the toolbar and canvas to the canvas layout
        self.canvasLayout.addWidget(self.toolbar)
        self.canvasLayout.addWidget(self.canvas)

if __name__ == "__main__":
    app = qtw.QApplication([])
    main = Main()
    main.show()
    sys.exit(app.exec_())
```

*Learning Point: Inheriting Widgets from* ***main_window.py***

*afsd*

[6]:
```
help(main_window.Ui_Form)
```

```
Help on class Ui_Form in module main_window:

class Ui_Form(builtins.object)
 |  Methods defined here:
 |
 |  retranslateUi(self, Form)
 |
 |  setupUi(self, Form)
```

```
 |
 |  ----------------------------------------------------------------------
 |  Data descriptors defined here:
 |
 |  __dict__
 |      dictionary for instance variables (if defined)
 |
 |  __weakref__
 |      list of weak references to the object (if defined)
```

## 2.2 Defining functions in app.py

### 2.2.1 load_data(self)

[7]:
```
print(inspect.getsource(Main.load_data))
```

```
        def load_data(self):
                """
                loads stock data .csv from inputted filepath string on the GUI
as StockData object,
                also autocompletes all inputs using information provided by the
csv.

                Error handling
                        invalid filepath :
                                empty filepath or file could not be found or
opened.
                        invalid .csv :
                                .csv file is empty, missing date column, etc.
                """
                filepath = Path(self.filePathEdit.text())

                try:
                        self.stock_data = StockData(filepath)
                        start_date, end_date = self.stock_data.get_period()
                        period = f"{start_date} to {end_date}"

                        # auto-complete feauture
                        self.startDateEdit.setText(start_date)
                        self.endDateEdit.setText(end_date)
                        self.periodEdit.setText(period)
                        self.SMA1Edit.setText("15")
                        self.SMA2Edit.setText("50")
                        self.SMA1Checkbox.setChecked(False)
                        self.SMA2Checkbox.setChecked(False)

                        self.report(f"Data loaded from {filepath}; period auto-
```

```
selected: {start_date} to {end_date}.")
                        print(self.stock_data.data)

                except IOError as e:
                        self.report(f"Filepath provided is invalid or fail to
open .csv file. {e}")

                except TypeError as e:
                        self.report(f"The return tuple is probably (nan, nan)
because .csv is empty")
```

### 2.2.2 update_canvas(self)

[13]:
```
print(inspect.getsource(Main.update_canvas))
```

```
        def update_canvas(self):
                """
                creates a datetime object from the inputted date string of
format YYYY-MM-DD.
                uses it to slice a copy of loaded stock_data to be used to
update graphics.
                checks checkboxes first to see if SMA1, SMA2, Buya and Sell
plots need to be drawn.
                finally, updates graphic accordingly

                Error handling
                invalid date format:
                        date format inside the .csv file is not of form YYYY-MM-
DD
                non-existent stock_data :
                        the selected range results in an empty dataframe or end
date < start date
                non-existent data point :
                        data of that date does not exist, or maybe because it is
Out-Of-Bound
                raised exceptions :
                        SMA1 and SMA2 values are the same, or other exceptions
raised
                """
                self.ax.clear()
                self.date_format = '%Y-%m-%d'

                try:
                        start_date =
str(datetime.strptime(self.startDateEdit.text(), self.date_format).date())
                        end_date =
str(datetime.strptime(self.endDateEdit.text(), self.date_format).date())
```

```
                        period = f"{start_date} to {end_date}"
                        self.periodEdit.setText(period)

                        # builds a list of graphs to plot by checking the
tickboxes
                        column_headers = ['Close']
                        formats = ['k-']

                        if self.SMA1Checkbox.isChecked():
self.stock_data._calculate_SMA(int(self.SMA1Edit.text()))
column_headers.append(f"SMA{self.SMA1Edit.text()}")
                                formats.append('b-')
                        if self.SMA2Checkbox.isChecked():
self.stock_data._calculate_SMA(int(self.SMA2Edit.text()))
column_headers.append(f"SMA{self.SMA2Edit.text()}")
                                formats.append('c-')
                        if len(column_headers) == 3:
self.stock_data._calculate_crossover(column_headers[1], column_headers[2],
column_headers[1])
                                column_headers.append('Sell')
                                formats.append('rv')
                                column_headers.append('Buy')
                                formats.append('g^')

                        self.selected_stock_data =
self.stock_data.get_data(start_date, end_date)
                        self.plot_graph(column_headers, formats)

                        self.report(f"Plotting {column_headers} data from
period: {start_date} to {end_date}.")
                        print(self.selected_stock_data)

                except ValueError as e:
                        self.report(f"Time period has not been specified or does
not match YYYY-MM-DD format, {e}.")

                except AssertionError as e:
                        self.report(f"Selected range is empty, {e}")

                except KeyError as e:
                        self.report(f"Data for this date does not exist: {e}")

                except Exception as e:
                        self.report(f"Exception encountered: {e}")
```

### 2.2.3 plot_graph(self, column_headers, formats)

[14]:
```
print(inspect.getsource(Main.plot_graph))
```

```
        def plot_graph(self, column_headers, formats):
                """
                plots graphs specified under columnd_headers using the formats
specified

                Parameters
                column_headers : [str, str, …]
                        a list containing column header names whose data are to
be plotted
                formats : [str, str, …]
                        a list of matplotlib built-in style strings to indicate
whether to plot line or scatterplot
                        and the colours corresponding to each value in
col_headers (hence, must be same length)

                Error handling
                empty dataframe :
                        selected dataframe is empty
                """
                self.ax.clear()
                assert not self.selected_stock_data.empty

                # matplotlib has its own internal representation of datetime
                # date2num converts datetime.datetime to this internal
representation
                x_data = list(mdates.date2num(
                                                [datetime.strptime(dates,
self.date_format).date()
                                                for dates in
self.selected_stock_data.index.values]
                                                ))

                colors = ['black', 'blue', 'orange', 'red', 'green']
                for i in range(len(column_headers)):
                        if column_headers[i] in
self.selected_stock_data.columns:
                                y_data =
list(self.selected_stock_data[column_headers[i]])
                                self.ax.plot(x_data, y_data, formats[i],
label=column_headers[i], color=colors[i])
                                self.report(f"{column_headers[i]} data is being
plotted.")
                        else: self.report(f"{column_headers[i]} data does not
exist.")
```

```
                # formatting
                months_locator = mdates.MonthLocator()
                months_format = mdates.DateFormatter('%b %Y')
                self.ax.xaxis.set_major_locator(months_locator)
                self.ax.xaxis.set_major_formatter(months_format)
                self.ax.format_xdata = mdates.DateFormatter(self.date_format)
                self.ax.format_ydata = lambda y: '$%1.2f' % y
                self.ax.grid(True)
                self.figure.autofmt_xdate()
                self.figure.legend()
                self.figure.tight_layout()
                self.canvas.draw()
```

#### 2.2.4 report(self, string)

[15]:
```
print(inspect.getsource(Main.report))
```

```
        def report(self, string):
                """
                given a report (string), update the scroll area with this report

                Parameters
                string : str
                        string of the report, usually the error message itself.
                """
                report_text = qtw.QLabel(string)
                self.scrollLayout.addWidget(report_text)
                print(string)
```

#### 2.2.5 center(self)

[16]:
```
print(inspect.getsource(Main.center))
```

```
        def center(self):
                """
                centers the fixed main window size according to user screen size
                """
                screen = qtw.QDesktopWidget().screenGeometry()
                main_window = self.geometry()
                x = (screen.width() - main_window.width()) / 2
                y = (screen.height() - main_window.height()) / 2 - 50   # pulls
the window up slightly (arbitrary)
                self.setFixedSize(main_window.width(), main_window.height())
                self.move(x, y)
```

### 2.3 Connecting `Widget` actions to `functions`

blabla

[11]:
```
print(inspect.getsource(Main.__init__))
```

```
        def __init__(self):
                """
                initializes and sets up GUI widgets and its connections
                """
                super().__init__()
                self.setupUi(self)
                self.setWindowTitle("Stock Chart & Moving Average Application")

                # sets up a new figure to plot on, then instantiates a canvas
and toolbar object
                self.figure, self.ax = plt.subplots()
                self.canvas = FigureCanvas(self.figure)
                self.toolbar = NavigationToolbar(self.canvas, self)

                # attaches the toolbar and canvas to the canvas layout
                self.canvasLayout.addWidget(self.toolbar)
                self.canvasLayout.addWidget(self.canvas)

                # sets up a scroll area to display GUI statuses
                self.scrollWidget = qtw.QWidget()
                self.scrollLayout = qtw.QVBoxLayout()
                self.scrollWidget.setLayout(self.scrollLayout)
                self.scrollArea.setWidget(self.scrollWidget)

                # button & checkbox connections
                self.loadCSVButton.clicked.connect(self.load_data)
                self.updateWindowButton.clicked.connect(self.update_canvas)
                self.SMA1Checkbox.stateChanged.connect(self.update_canvas)
                self.SMA2Checkbox.stateChanged.connect(self.update_canvas)

                # auto-complete feauture
                self.filePathEdit.setText("../data/GOOG.csv")
```

### 2.4 (Optional) Compiling `app.exe`