Python Programming and Its Applications in Stock Chart & Moving Average (MA) Crossover

November 14, 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:

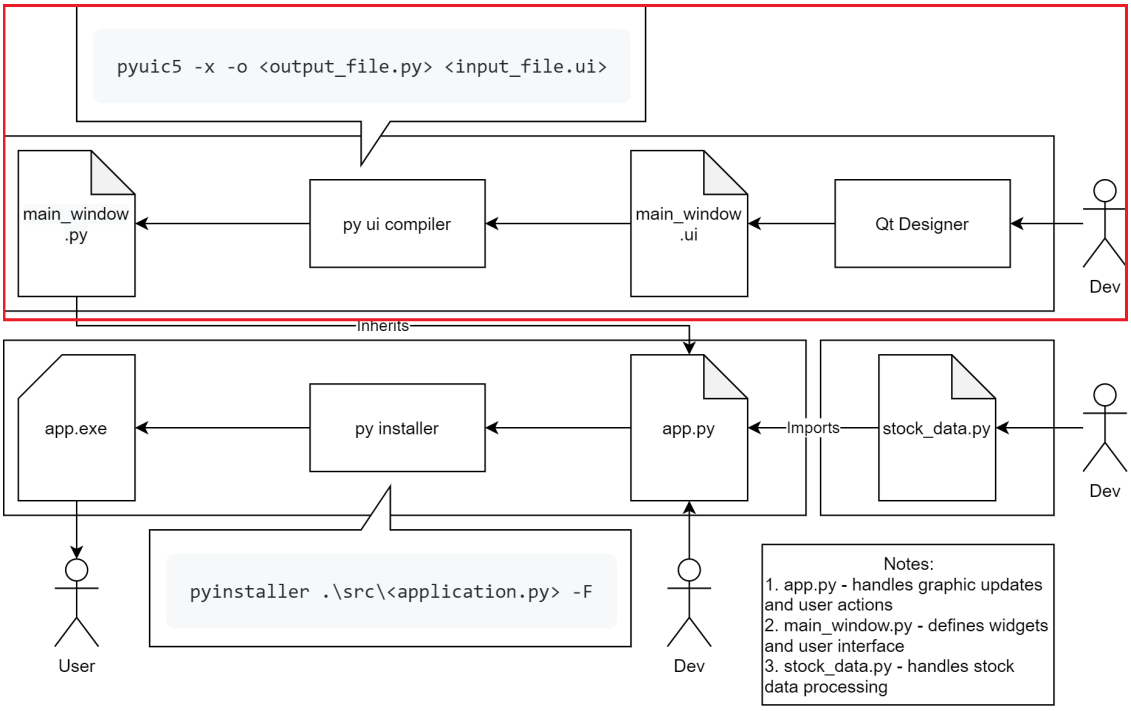
1. Defining each `Widget` objects' and their names within the GUI
2. Defining the location, size and other physical attributes of each `Widgets`

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`

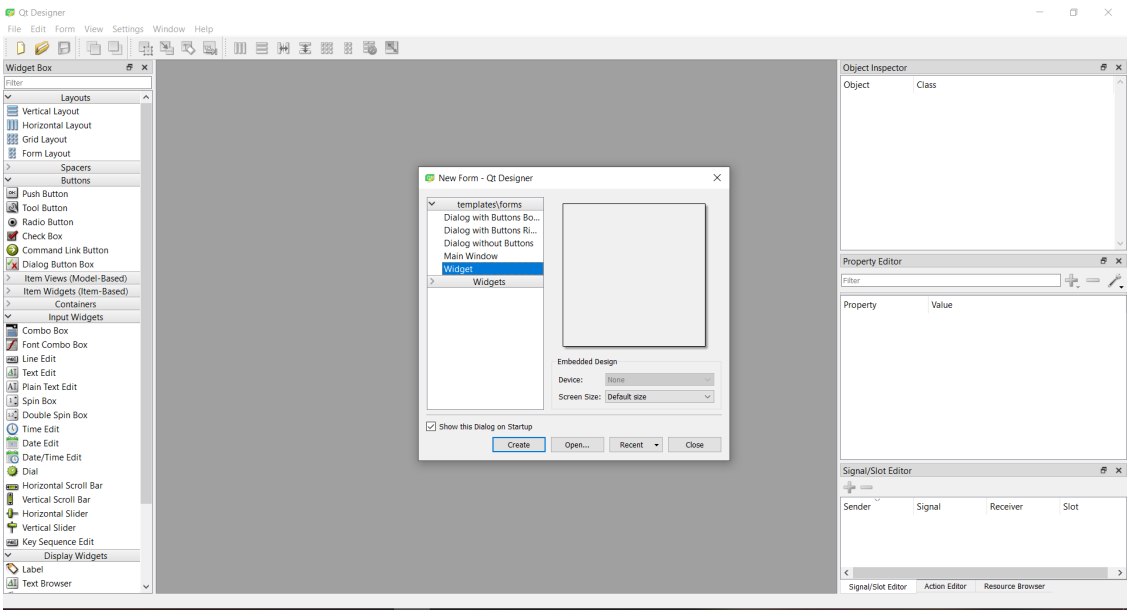
The installation process of `Qt Designer` is similar to any other application.

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:



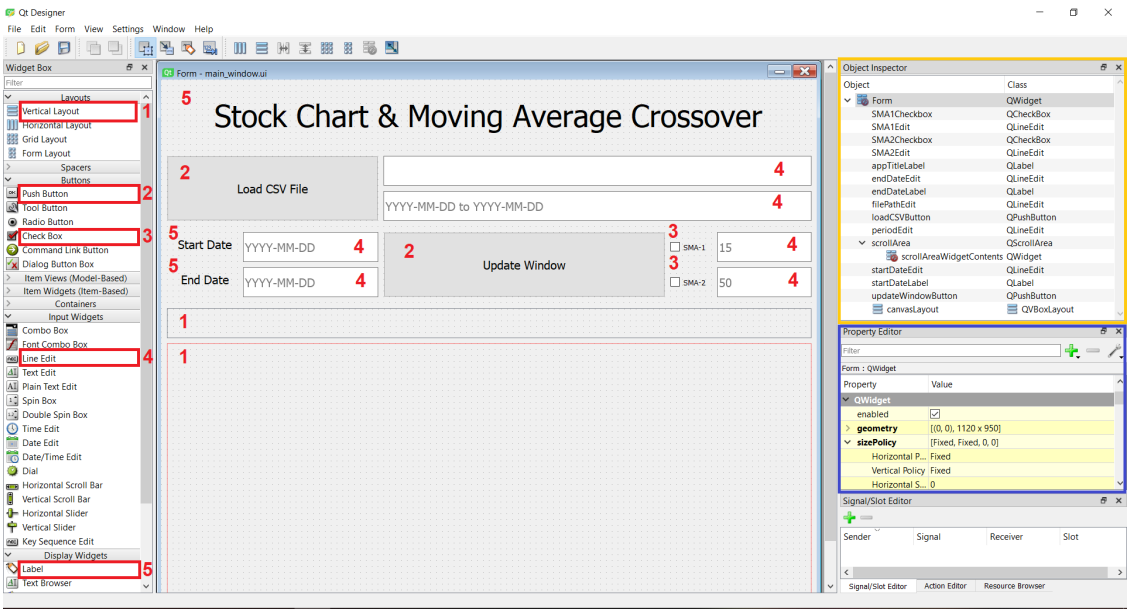
Choose `Widget` under the `template\forms` prompt and press the `Create` Button to begin designing `main_window.ui`.

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 Editor (blue box). There are also other attributes values to play with!

For instance, this Stock Chart Application has its window **fixed to a specific size**. This can be done by specifying the following properties in the Property Editor 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]`

Tips: To preview the GUI inside `Qt Designer`, press `Ctrl + R` (for Windows users only).

> *Learning Point:* ***`Qt Designer`*** *+* ***`PyQt5 Widget`*** *Attributes*
>
> *Different* ***`Widget`*** *will have different attributes. They can be found in the Property Editor. 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`.

In short, these 2 actions: **dragging and dropping `Widgets` and editing values in `Property Editor`** correspond to what were initially 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, to save the `main_window.ui` file, press: `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`

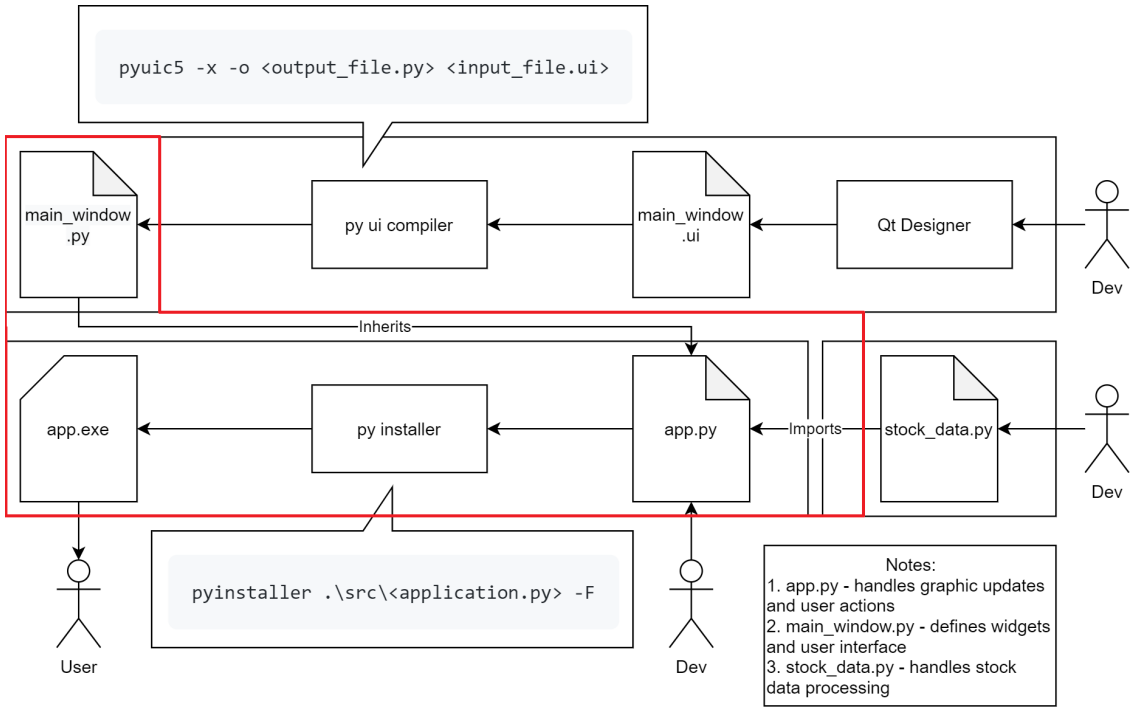
For example, if we want the `Update Window Button` to plot the stock prices in the GUI's canvas. We will have to create a `function` that plots the graph into the canvas and then connect the `Update Window Button` to this `function`.

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 section, when `main_window.ui` was designed using `Qt Designer` and the `objectName` is specified inside the Property Editor!

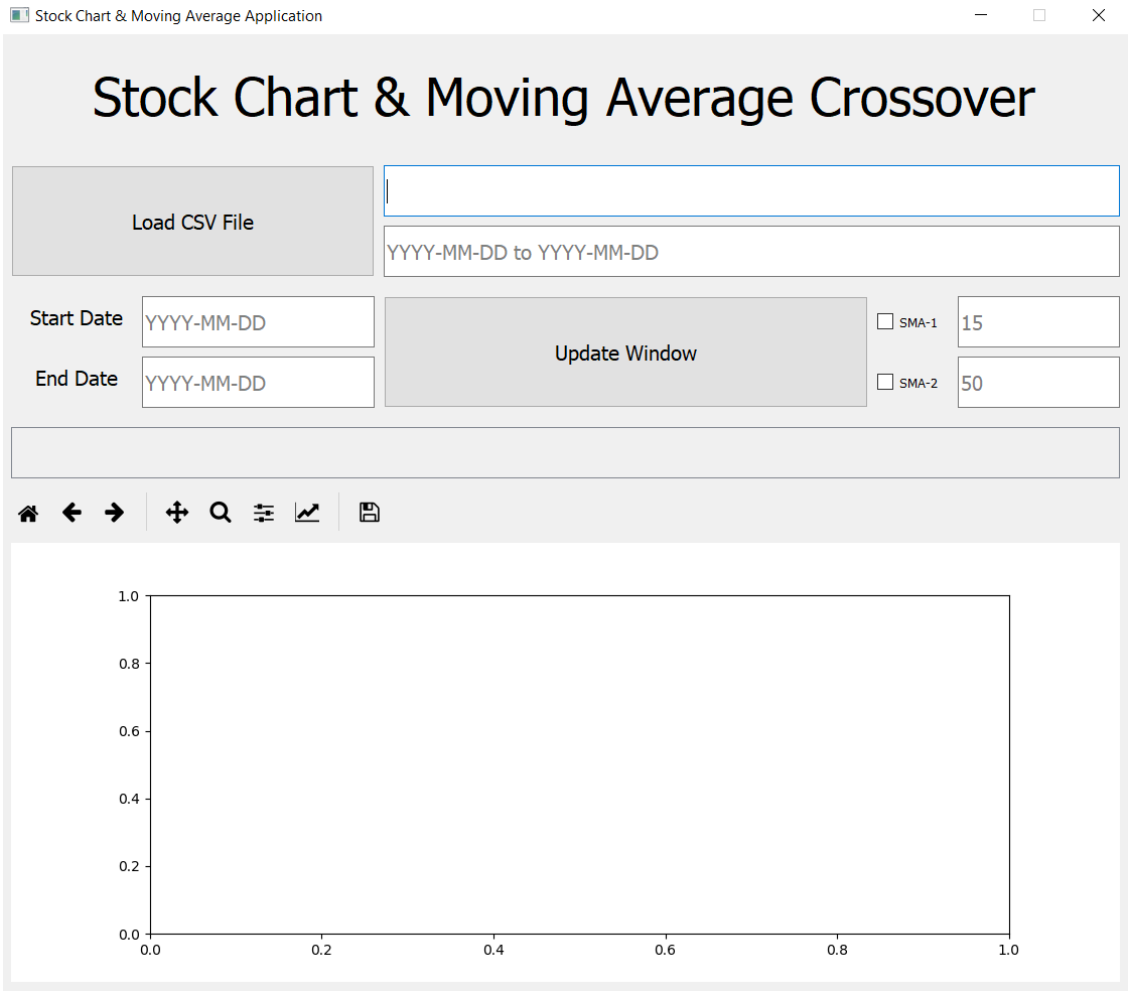
This is why, on the previous step, it is **recommended** to name the `Widgets` **accordingly!**

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.



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
from pathlib import Path
from datetime import datetime

```

```
# Step 1
# standard matplotlib import statements
import matplotlib.pyplot as plt
import matplotlib.dates as mdates

# import matplotlib backend for Qt5
from matplotlib.backends.backend_qt5agg import FigureCanvasQTAgg as FigureCanvas
from matplotlib.backends.backend_qt5agg import NavigationToolbar2QT as␣
 ↪NavigationToolbar

# standard PyQt5 import statements
from PyQt5 import QtCore as qtc
from PyQt5 import QtWidgets as qtw

# importing the class to be inherited from
from main_window import Ui_Form

# importing StockData processing module
from stock_data import StockData

class Main(qtw.QWidget, Ui_Form): # Step 2
    def __init__(self):
        # Step 3
        # calling Ui_Form's initializing and setup function
        super().__init__()
        self.setupUi(self)
        self.setWindowTitle("Stock Chart & Moving Average Application")

        # Step 4
        # sets up figure to plot on, instantiates canvas and toolbar
        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`

When `main_window.ui` is converted into `main_window.py` using `pyuic5`, the `Widget` class called `Ui_Form` is created. This `Ui_Form` class has access to all the `Widgets`

previously defined inside `main_window.ui` *using* `Qt Designer!` *They're accessible to* `Ui_Form` *as regular python* `Attributes`*. e.g:* `self.updateWindowButton`*, etc… Thus, by inheriting from* `Ui_Form`*,* `app.py`*'s* `Main` *class can also access these* `Widgets` *through its* `Attributes`*. LIkewise,* `functions` *defined in* `Ui_Form` *are also inherited and accessible to* `Main`*.*

Learning Point: Defining & Adding `Widgets` *programmatically*

Sometimes, it is more convenient to define `Widgets` *programmatically then through* `Qt Designer`*. As shown from the code snippet above, this is also possible and uses the* ***exact same core principles*** *as in* `main_window.py` 1. *Defining each* `Widget` *objects' and their names within the GUI. Exemplified with lines such as:* `self.canvas = FigureCanvas(self.figure)` *or similar instantiation line:* `button = QPushButton('Button Name', self)` 2. *Defining the location, size and other physical attributes of each* `Widgets`*. Exemplified with lines such as:* `self.canvasLayout.addWidget(self.canvas)`

Now that `app.py` is able to access the `Widgets` defined in `main_window.py` by means of Python inheritance. It is now possible to implement `app.py`'s main responsibility:

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

2.2 Defining `functions` in `app.py`

Before defining the `functions` in `app.py`, it is important to first be aware of the scope of each `functions` needed to execute the app's entire process. By referring to the User Manual's 5-step guide, it is possible to breakdown the entire app's functionalities into 3 major functions + 2 minor functions:

1. `load_data(self)` : invoked when `Load CSV File Button` is pressed

   loads stock data .csv from inputted filepath string on the GUI as StockData object, also autocompletes all inputs using information provided by the csv. (Handles the actions from Step 1-2 of User Manual).

2. `update_canvas(self)` : invoked when `Load Update Window Button` is pressed

   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, Buy and Sell plots need to be drawn. finally, updates graphic accordingly. (Handles the actions from Step 3-5 of User Manual).

3. `plot_graph(self, column_headers, formats)` : invoked when `update_canvas function` is called

   plots graphs specified under columnd_headers using the formats specified (Helps to handle the action from Step 5 of User Manual).

4. `report(self, string)` : invoked when any of the 3 major functions are called

   given a report (string), update the scroll area with this report

5. `center(self)` : invoked `__init__(self)` is called (i.e. during the startup of app)

centers the fixed main window size according to user screen size

The following part of the report will attempt to explain each of these 5 functions in detail. However, due to space limitation and the need for conciseness, only **parts of the code with its line number will be referenced!** We highly recommend that readers refer to the **full code in the Appendix or the python file itself should it become necessary**.

2.2.1 `load_data(self)`

First, this function attempts to parse the `text` for a `filepath` specified by user in the `Line Edit Widget` called `filePathEdit`.

```
102 filepath = Path(self.filePathEdit.text())
```

Next, it will attempt to instantiate a `StockData` data object using this `filepath`. However, to prevent crashes due to invalid `filepath` or `.csv` file, it is important to wrap the previous instantiation line with a `try... except...`.

```
104 try:
105     self.stock_data = StockData(filepath)
...
121 except IOError as e:
122     self.report(f"Filepath provided is invalid or fail to open .csv file. {e}")
123
124 except TypeError as e:
125     self.report(f"The return tuple is probably (nan, nan) because .csv is empty")
```

Each of this `except` corresponds to the the errors mentioned in the function's docstring line 96 to 100.

Once `StockData` has been initialized, we attempt to get the `start_date` and `end_date` of the `stock_data` by `StockData`'s method called `get_period()`.

```
106     start_date, end_date = self.stock_data.get_period()
107     period = f"{start_date} to {end_date}"
```

Finally, the function will attempt to 'auto-complete' the various `Widgets` using information such as the `start_date` and `end_date`.

```
109     # auto-complete feauture
110     self.startDateEdit.setText(start_date)
111     self.endDateEdit.setText(end_date)
112     self.periodEdit.setText(period)
113     self.SMA1Edit.setText("15")
114     self.SMA2Edit.setText("50")
115     self.SMA1Checkbox.setChecked(False)
116     self.SMA2Checkbox.setChecked(False)
```

Learning Point: Getting `Line Edit Widget` Value

Learning Point: Preventing Crashes with `try... except...`

Learning Point: Setting `Widget` Values Programmatically

2.2.2 update_canvas(self)

2.2.3 plot_graph(self, column_headers, formats)

2.2.4 report(self, string)

2.2.5 center(self)

2.3 Connecting Widget actions to functions

blabla

2.4 (Optional) Compiling app.exe

3 Appendix

3.1 Code Reference

[16]:
```
import sys
sys.path.insert(1, '../src')

from app import Main
from stock_data import StockData
import inspect # standard library used later to get info about the source code

def print_code(code): # prints '{line} {code}' with 2 less indent and without␣
 ↪the def header
    codeline = lambda code, start : [(start + 1 + i, code[i]) for i in␣
 ↪range(len(code))]
    print("".join([f"{line} {text[2:]}" if len(text) > 1 else f"{line} {text}"␣
 ↪for line, text in codeline(code[0][1:], code[1])]))
```

3.1.1 app.py

___ init ___(self)

[19]:
```
print_code(inspect.getsourcelines(Main.__init__))
```

```
59 """
60 initializes and sets up GUI widgets and its connections
61 """
62 super().__init__()
63 self.setupUi(self)
64 self.setWindowTitle("Stock Chart & Moving Average Application")
65
66 # sets up figure to plot on, instantiates canvas and toolbar
67 self.figure, self.ax = plt.subplots()
68 self.canvas = FigureCanvas(self.figure)
69 self.toolbar = NavigationToolbar(self.canvas, self)
70
71 # attaches the toolbar and canvas to the canvas layout
```

```
72 self.canvasLayout.addWidget(self.toolbar)
73 self.canvasLayout.addWidget(self.canvas)
74
75 # sets up a scroll area to display GUI statuses
76 self.scrollWidget = qtw.QWidget()
77 self.scrollLayout = qtw.QVBoxLayout()
78 self.scrollWidget.setLayout(self.scrollLayout)
79 self.scrollArea.setWidget(self.scrollWidget)
80
81 # button & checkbox connections
82 self.loadCSVButton.clicked.connect(self.load_data)
83 self.updateWindowButton.clicked.connect(self.update_canvas)
84 self.SMA1Checkbox.stateChanged.connect(self.update_canvas)
85 self.SMA2Checkbox.stateChanged.connect(self.update_canvas)
86
87 # auto-complete feauture
88 self.filePathEdit.setText("../data/GOOG.csv")
```

load_data(self)

[13]:
```
print_code(inspect.getsourcelines(Main.load_data))
```

```
91 """
92 loads stock data .csv from inputted filepath string on the GUI
93 as StockData object, also autocompletes all inputs
94 using information provided by the csv.
95
96 Error handling
97      invalid filepath :
98              empty filepath or file could not be found.
99      invalid .csv :
100             .csv file is empty, missing date column, etc.
101 """
102 filepath = Path(self.filePathEdit.text())
103
104 try:
105     self.stock_data = StockData(filepath)
106     start_date, end_date = self.stock_data.get_period()
107     period = f"{start_date} to {end_date}"
108
109     # auto-complete feauture
110     self.startDateEdit.setText(start_date)
111     self.endDateEdit.setText(end_date)
112     self.periodEdit.setText(period)
113     self.SMA1Edit.setText("15")
114     self.SMA2Edit.setText("50")
115     self.SMA1Checkbox.setChecked(False)
```

```
116     self.SMA2Checkbox.setChecked(False)
117
118     self.report(f"Data loaded from {filepath}; period auto-selected:
{start_date} to {end_date}.")
119     print(self.stock_data.data)
120
121 except IOError as e:
122     self.report(f"Filepath provided is invalid or fail to open .csv file.
{e}")
123
124 except TypeError as e:
125     self.report(f"The return tuple is probably (nan, nan) because .csv is
empty")
```

update_canvas(self)

[14]:
```
print_code(inspect.getsourcelines(Main.update_canvas))
```

```
128 """
129 creates a datetime object from the inputted date string
130 of format YYYY-MM-DD. uses it to slice a copy of loaded
131 stock_data to be used to update graphics. checks
132 checkboxes first to see if SMA1, SMA2, Buy and Sell plots
133 need to be drawn. finally, updates graphic accordingly.
134
135 Error handling
136 invalid date format:
137     date format inside the .csv file is not YYYY-MM-DD
138 non-existent stock_data :
139     the selected range results in an empty dataframe
140     or end date < start date
141 non-existent data point :
142     data of that date does not exist,
143     or maybe because it is Out-Of-Bound
144 raised exceptions :
145     SMA1 and SMA2 values are the same,
146     or other exceptions raised
147 """
148 self.ax.clear()
149 self.date_format = '%Y-%m-%d'
150
151 try:
152     start_date = str(datetime.strptime(self.startDateEdit.text(),
self.date_format).date())
153     end_date = str(datetime.strptime(self.endDateEdit.text(),
self.date_format).date())
154     period = f"{start_date} to {end_date}"
```

```
155     self.periodEdit.setText(period)
156
157     # builds a list of graphs to plot by checking the tickboxes
158     column_headers = ['Close']
159     formats = ['k-']
160
161     if self.SMA1Checkbox.isChecked():
162             self.stock_data._calculate_SMA(int(self.SMA1Edit.text()))
163             column_headers.append(f"SMA{self.SMA1Edit.text()}")
164             formats.append('b-')
165     if self.SMA2Checkbox.isChecked():
166             self.stock_data._calculate_SMA(int(self.SMA2Edit.text()))
167             column_headers.append(f"SMA{self.SMA2Edit.text()}")
168             formats.append('c-')
169     if len(column_headers) == 3:
170             self.stock_data._calculate_crossover(column_headers[1],
column_headers[2], column_headers[1])
171             column_headers.append('Sell')
172             formats.append('rv')
173             column_headers.append('Buy')
174             formats.append('g^')
175
176     self.selected_stock_data = self.stock_data.get_data(start_date,
end_date)
177     self.plot_graph(column_headers, formats)
178
179     self.report(f"Plotting {column_headers} data from period: {start_date}
to {end_date}.")
180     print(self.selected_stock_data)
181
182 except ValueError as e:
183     self.report(f"Time period has not been specified or does not match YYYY-
MM-DD format, {e}.")
184
185 except AssertionError as e:
186     self.report(f"Selected range is empty, {e}")
187
188 except KeyError as e:
189     self.report(f"Data for this date does not exist: {e}")
190
191 except Exception as e:
192     self.report(f"Exception encountered: {e}")
```

plot_graph(self, column_headers, formats)

[15]:
```
print_code(inspect.getsourcelines(Main.plot_graph))
```

```
195 """
196 plots graphs specified under columnd_headers using the formats
197
198 Parameters
199 column_headers : [str, str, …]
200     a list containing column header names with data to be plotted
201 formats : [str, str, …]
202     a list of matplotlib built-in style strings to indicate
203     whether to plot line or scatterplot and the colours
204     corresponding to each value in col_headers
205     (hence, must be same length)
206
207 Error handling
208 empty dataframe :
209     selected dataframe is empty
210 """
211 self.ax.clear()
212 assert not self.selected_stock_data.empty
213
214 # matplotlib has its own internal representation of datetime
215 # date2num converts datetime.datetime to this internal representation
216 x_data = list(mdates.date2num(
217                                [datetime.strptime(dates,
self.date_format).date()
218                                for dates in
self.selected_stock_data.index.values]
219                                ))
220
221 colors = ['black', 'blue', 'orange', 'red', 'green']
222 for i in range(len(column_headers)):
223     if column_headers[i] in self.selected_stock_data.columns:
224             y_data = list(self.selected_stock_data[column_headers[i]])
225             self.ax.plot(x_data, y_data, formats[i],
label=column_headers[i], color=colors[i])
226             self.report(f"{column_headers[i]} data is being plotted.")
227     else: self.report(f"{column_headers[i]} data does not exist.")
228
229 # formatting
230 months_locator = mdates.MonthLocator()
231 months_format = mdates.DateFormatter('%b %Y')
232 self.ax.xaxis.set_major_locator(months_locator)
233 self.ax.xaxis.set_major_formatter(months_format)
234 self.ax.format_xdata = mdates.DateFormatter(self.date_format)
235 self.ax.format_ydata = lambda y: '$%1.2f' % y
236 self.ax.grid(True)
237 self.figure.autofmt_xdate()
238 self.figure.legend()
239 self.figure.tight_layout()
```

```
240 self.canvas.draw()
```

report(self, string)

[17]:
```
print_code(inspect.getsourcelines(Main.report))
```

```
243 """
244 given a report (string), update the scroll area with this report
245
246 Parameters
247 string : str
248     string of the report, usually the error message itself.
249 """
250 report_text = qtw.QLabel(string)
251 self.scrollLayout.addWidget(report_text)
252 print(string)
```

center(self)

[18]:
```
print_code(inspect.getsourcelines(Main.center))
```

```
255 """
256 centers the fixed main window size according to user screen size
257 """
258 screen = qtw.QDesktopWidget().screenGeometry()
259 main_window = self.geometry()
260 x = (screen.width() - main_window.width()) / 2
261
262 # pulls the window up slightly (arbitrary)
263 y = (screen.height() - main_window.height()) / 2 - 50
264 self.setFixedSize(main_window.width(), main_window.height())
265 self.move(x, y)
```

3.1.2 stock_data.py

___ init ___(self)

[20]:
```
print_code(inspect.getsourcelines(StockData.__init__))
```

```
18 """
19 initializes StockData object by parsing stock data .csv file into a dataframe
20 (assumes 'Date' column exists and uses it for index), also checks and handles
missing data
21
22 Parameters
23 filepath : str
24     filepath to the stock data .csv file, can be relative or absolute
```

```
25
26 Raises
27 IOError :
28      failed I/O operation, e.g: invalid filepath, fail to open .csv
29 """
30 self.filepath = filepath
31 self.data = pd.read_csv(filepath).set_index('Date')
32 self.check_data()
```

check_data(self, overwrite=True)

[21]:
```
print_code(inspect.getsourcelines(StockData.check_data))
```

```
35 """
36 checks and handles missing data by filling in missing values by interpolation
37
38 Parameters
39 overwrite : bool (True)
40      if True, overwrites original source stock data .csv file
41
42 Returns
43 self : StockData
44 """
45 # function to fill in missing values with average with previous data and
after (interpolation)
46 self.data = self.data.interpolate()
47 self.data.to_csv(self.filepath, index=overwrite)
48 return self
```

get_data(self, start_date, end_date)

[22]:
```
print_code(inspect.getsourcelines(StockData.get_data))
```

```
51 """
52 returns a subset of the stock data ranging from start_date to end_date
inclusive
53
54 Parameters
55 start_date : str
56      start date of stock data range, must be of format YYYY-MM-DD
57 end_date : str
58      end date of stokc data range, must be of format YYYY-MM-DD
59
60 Returns:
61 selected_data : DataFrame
62      stock data dataframe indexed from specified start to end date inclusive
63
```

```
64 Raises
65 KeyError :
66      data for this date does not exist
67 AssertionError :
68      selected range is empty
69 """
70 self.selected_data = self.data[str(start_date):str(end_date)]
71 return self.selected_data
```

get_period(self)

[23]:
```
print_code(inspect.getsourcelines(StockData.get_period))
```

```
74 """
75 returns a string tuple of the first and last index which make up the maximum
period of StockData
76
77 Returns
78 period : (str, str)
79
80 Raises
81 TypeError :
82      the return tuple is probably (nan, nan) because .csv is empty
83 """
84 index = list(self.data.index)
85 (first, last) = (index[0], index[-1])
86 return (first, last)
```

_calculate_SMA(self, n, col='Close')

[24]:
```
print_code(inspect.getsourcelines(StockData._calculate_SMA))
```

```
89 """
90 calculates simple moving average (SMA) and augments the stock dataframe with
this SMA(n) data as a new column
91
92 Parameters
93 n : int
94      the amount of stock data to use to calculate average
95 col : str ('Close')
96      the column head title of the values to use to calculate average
97
98 Returns
99 self : StockData
100 """
101 col_head = f'SMA{n}'
102 if col_head not in self.data.columns:
```

```
103     sma = self.data[col].rolling(n).mean()
104     self.data[f'SMA{n}'] = np.round(sma, 4)
105     self.data.to_csv(self.filepath, index=True)
106 return self
```

_calculate_crossover(self, SMA1, SMA2, col='Close')

[25]:
```
print_code(inspect.getsourcelines(StockData._calculate_crossover))
```

```
109 """
110 calculates the crossover positions and values, augments the stock dataframe
with 2 new columns
111 'Sell' and 'Buy' containing the value at which SMA crossover happens
112
113 Parameters
114 SMA1 : str
115     the first column head title containing the SMA values
116 SMA2 : str
117     the second column head title containing the SMA values
118 col : str ('Close')
119     the column head title whose values will copied into 'Buy' and 'Sell'
columns
120     to indicate crossovers had happen on that index
121
122 Returns
123 self : StockData
124
125 Raises
126 Exception :
127     SMA1 and SMA2 provided are the same, they must be different
128 """
129 if SMA1 < SMA2: signal = self.data[SMA1] - self.data[SMA2]
130 elif SMA1 > SMA2: signal = self.data[SMA2] - self.data[SMA1]
131 else: raise Exception(f"{SMA1} & {SMA2} provided are the same. They must be
different SMA.")
132
133 signal[signal > 0] = 1
134 signal[signal <= 0] = 0
135 diff = signal.diff()
136
137 self.data['Sell'] = np.nan
138 self.data['Buy'] = np.nan
139 self.data.loc[diff.index[diff < 0], 'Sell'] = self.data.loc[diff.index[diff
< 0], col]
140 self.data.loc[diff.index[diff > 0], 'Buy'] = self.data.loc[diff.index[diff >
0], col]
141
```

```
142 self.data.to_csv(self.filepath, index=True)
143 return self
```

plot_graph(self, col_headers, style, ax, show=True)

[26]:
```
print_code(inspect.getsourcelines(StockData.plot_graph))
```

```
146 """
147 plots columns of selected values as line plot and/or columns of values as
scatter plot
148 as specified by style to an Axes object
149
150 Parameters
151 col_headers : [str, str, …]
152     a list containing column header names whose data are to be plotted
153 style : [str, str, …]
154     a list of matplotlib built-in style strings to indicate whether to plot
line or scatterplot
155     and the colours corresponding to each value in col_headers (hence, must
be same length)
156 ax : Axes
157     matplotlib axes object on which the plot will be drawn
158
159 Raises
160 AttributeError :
161     self.selected_data has not been specified, call
StockData.get_data(start, end) before plotting
162 AssertionError :
163     self.selected_data is empty, perhaps due to OOB or invalid range
164 """
165 assert not self.selected_data.empty
166 self.selected_data[col_headers].plot(style=style,
167                                      ax=ax,
168                                      grid=True,
169                                      x_compat=True,
170                                      linewidth=1)
171 if show: plt.show()
```

calculate_SMA(self, n)

[27]:
```
print_code(inspect.getsourcelines(StockData.calculate_SMA))
```

```
174 """
175 calculates simple moving average (SMA) and augments the stock dataframe with
this SMA(n) data as a new column
176
177 Parameters
```

```
n : int
    the amount of stock data to use to calculate average
col : str ('Close')
    the column head title of the values to use to calculate average

Returns
self : StockData
"""
col_head = 'SMA' + str(n)
df = self.data.reset_index()

if col_head not in df.columns:
    #Extract full dataframe from the actual data(to check if there is enough
data for sma)
    dateList = self.data.index.values.tolist() #List of data in self
dataframe
    returnList = []
    for date in dateList: #for date in dateList
            dateIndex = df[df["Date"]==date].index.values[0] # find the
index of date in the full data
            if dateIndex < n: # if date index is less than n: append None
                    returnList.append(np.nan)
            else:
                    sum = 0
                    for i in range(n):
                            sum += df.iloc[dateIndex-i]["Adj Close"]
                            # else sum of data from dateIndex to
dateIndex-i(0,1,2…n)
                    returnList.append(sum/n)  #append the SMA for each day
to a list

    self.data[col_head] = returnList
    print(self.data)
    self.data.to_csv(self.filepath, index=True)

return self
```

calculate_crossover(self, SMAa, SMAb)

[28]:
```
print_code(inspect.getsourcelines(StockData.calculate_crossover))
```

```
"""
calculates the crossover positions and values, augments the stock dataframe
with 2 new columns
'Sell' and 'Buy' containing the value at which SMA crossover happens

Parameters
```

```
216 SMA1 : str
217     the first column head title containing the SMA values
218 SMA2 : str
219     the second column head title containing the SMA values
220 col : str ('Close')
221     the column head title whose values will copied into 'Buy' and 'Sell'
columns
222     to indicate crossovers had happen on that index
223
224 Returns
225 self : StockData
226
227 Raises
228 Exception :
229     SMA1 and SMA2 provided are the same, they must be different
230 """
231 col_head1 = 'Position'
232 col_head2 = 'Signal'
233 col_head3 = 'Buy'
234 col_head4 = 'Sell'
235 df = self.data
236
237 SMAlist = self.data.index.values.tolist() # to ensure the correct number of
elements in the loop
238 if SMAa < SMAb: # extracts the SMA from the specific column in self.data
where SMA data will be
239     SMA1 = df[SMAa].tolist()
240     SMA2 = df[SMAb].tolist()
241 elif SMAa > SMAb:
242     SMA1 = df[SMAb].tolist()
243     SMA2 = df[SMAa].tolist()
244 else: # SMAa == SMAb
245     raise ValueError(f"Given {SMAa} & {SMAb} are the same. Must be different
SMA.")
246
247 stockPosition = []  # which SMA line is on top
248 stockSignal = []    # the buy/sell signal --> the 1s and -1s
249 buySignal = []              # filtered out location of buy signals
250 sellSignal = []             # filtered out location of sell signals
251
252 for i in range(len(SMAlist)):  # goes through every element in the SMA
values
253     if SMA1[i] > SMA2[i]: stockPosition.append(1)           # SMA1 above
SMA2
254     elif SMA1[i] < SMA2[i]: stockPosition.append(0)         # SMA2 above
SMA1
255     elif SMA1[i] == SMA2[i]: stockPosition.append(stockPosition[i-1]) # if
the SMAs are equal, repeat the previous entry because no crossover has occured
```

```
yet
256     else: stockPosition.append(np.nan) #if no data, leave blank
257
258 for j in range(len(stockPosition)):                          # find the
places where crossover occurs
259     if j == 0: stockSignal.append(np.nan)   # 'shifts' the data one period
to the right to ensure crossovers are reflected on the correct date
260     else: stockSignal.append(stockPosition[j] - stockPosition[j-1]) #
calculation for the crossover signals
261
262 for k in range(len(stockSignal)): # finding location of buy signals
263     if stockSignal[k] == 1:
264             value = (self.data[SMAa].tolist()[k] +
self.data[SMAb].tolist()[k]) / 2
265             buySignal.append(value) # adds '1' at the location of buy
signals in a separate column
266     else: buySignal.append(np.nan) # if no signal leave blank
267
268 for k in range(len(stockSignal)): #finding location of sell signals
269     if stockSignal[k] == -1:
270             value = (self.data[SMAa].tolist()[k] +
self.data[SMAb].tolist()[k]) / 2
271             sellSignal.append(value) # adds '-1' at the location of sell
signals in a separate column
272     else: sellSignal.append(np.nan) # if no signal leave blank
273
274 self.data[col_head3] = buySignal
275 self.data[col_head4] = sellSignal
276
277 print(self.data)
278 self.data.to_csv(self.filepath, index=True)
279 return self
```