PROTRACER

DATA 520 Project

Fall 2017

Mercyhurst University

LIFE’S MOST IMPORTANT QUESTIONS

- Who?
- What?
- When?
- Where?
- Why?
- How?

WHO?

Who is responsible for this?

I DID THIS

WHAT?

What the heck is this crap?

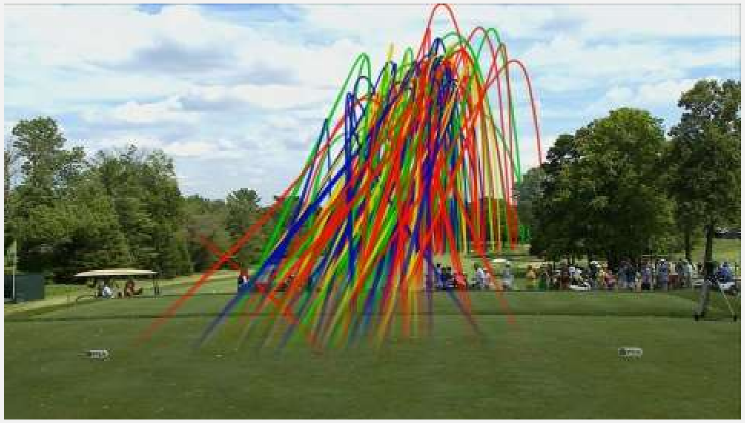
WHAT?

- An application built with Python
- To visualize golf shots from professional golfers
- Using data from the PGA Tour’s Shotlink Intelligence System
- In either 2D or 3D
- For one or more shots at a time

WHAT?

SINGLE SHOT EXAMPLE

MULTIPLE SHOT EXAMPLE



WHAT?

WHEN?

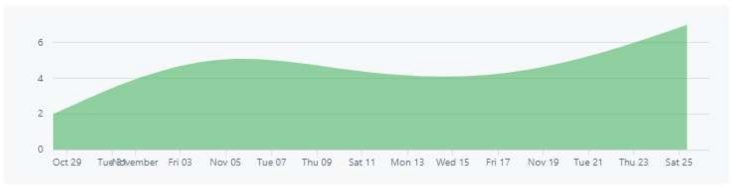
When was all this A+ worthy work completed?

WHEN?

GITHUB COMMIT LOGS

- First commit: November 2, 2017
- Last commit: December 5, 2017
- 25 commits

GITHUB ACTIVITY



WHERE?

Where did the magic happen?

WHERE?

- My house
- Mercyhurst University
- Panera Bread
- Lake View Country Club
- 408 Bar & Grille

WHY?

Why would anyone do this?

WHY?

MY REASONS

- I love golf
- Looks cool on TV
- Because I could
- Fame
- Fortune

THE REAL REASON

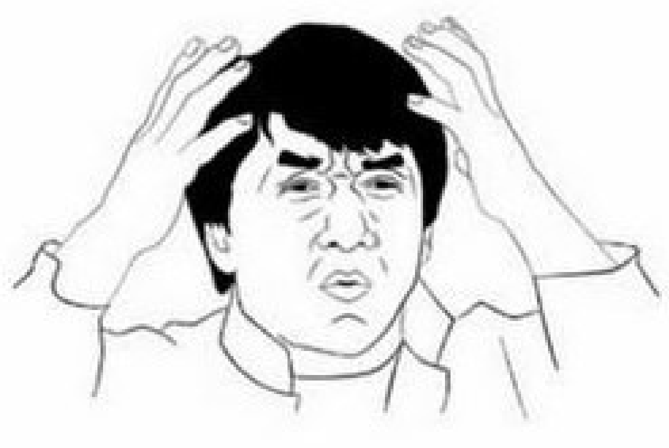
HOW?

How could this have possibly happened?

HOW?

ALCOHOL

HEAD SCRATCHING

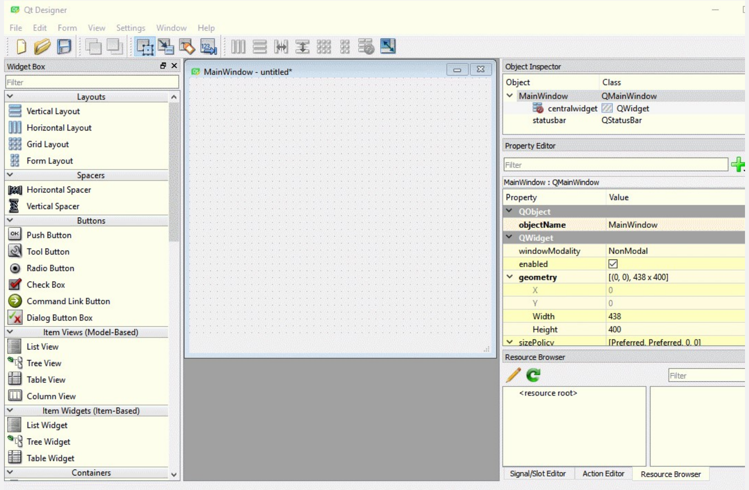


HOW?

- Python 3.6.1
- Matplotlib 2.0.2
- Numpy 1.13.3
- Pandas 0.21.0
- PyQt 5.6.2

HOW?

- QtDesigner
- Comes bundled with Anaconda3
- Drag and drop interface for building GUIs
- Generates Python code similar to Tkinter



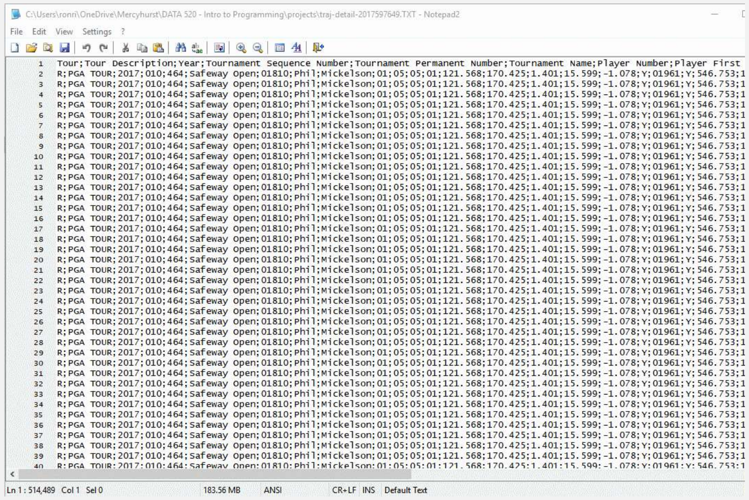
Object	Class
MainWindow	QMainWindow
centralwidget	QWidget
statusbar	QStatusBar

MainWindow : QMainWindow

Property	Value
QObject	
objectName	MainWindow
QWidget	
windowModality	NonModal
enabled	☑
geometry	[(0, 0), 438 x 400]
X	0
Y	0
Width	438
Height	400
sizePolicy	[Preferred, Preferred, 0, 0]

HOW?

- PGA Tour ShotLink Intelligence System
- Available for educational use in 2005
- Contest in 2008 created new standard in golf statistics – Strokes Gained
- Data export of trajectory data for 2017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Tour;Tour Description;Year;Tournament Sequence Number;Tournament Permanent Number;Tournament Name;Player Number;Player First
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```

HOW?

- Trackman uses doppler radar to capture the ball flight
- Calculates club head speed and ball speed
- Calculates carry distance, apex height
- Device and camera are behind the golfer, facing towards the target
- Between 30-50 data points for each shot
- Some shots are extrapolated

HOW?

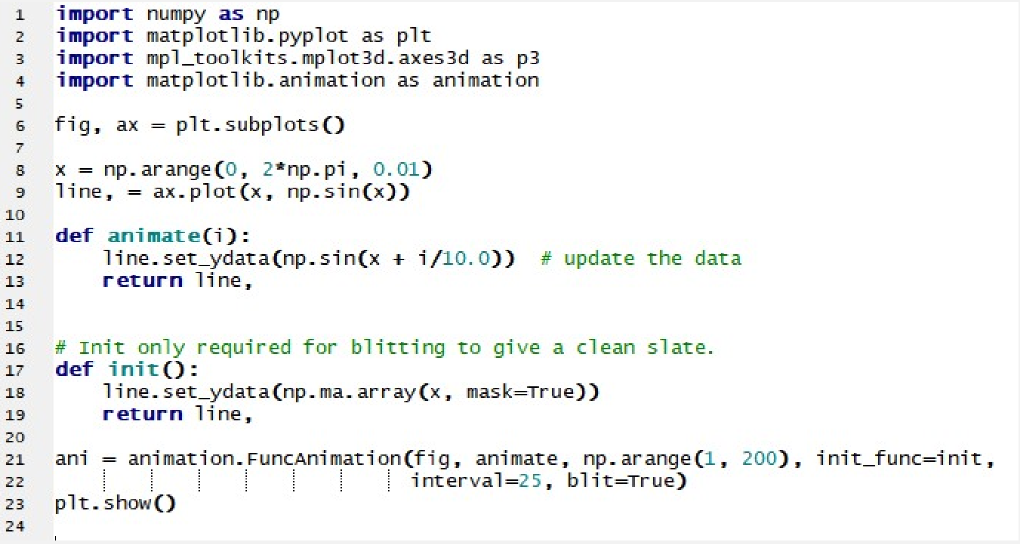
- 9 Python files
- 4 external Python modules
- 2 internal Python modules
- 3 data files
- 3 QtDesigner UI files
- 6 hard coded examples

- 7,595 total lines of code
- 459 lines of UI code from QtDesigner
- 201 lines of auto-generated Python code from QtDesigner
- 6,509 lines of auto-generated resource code (for images)
- 426 lines of hand-written code

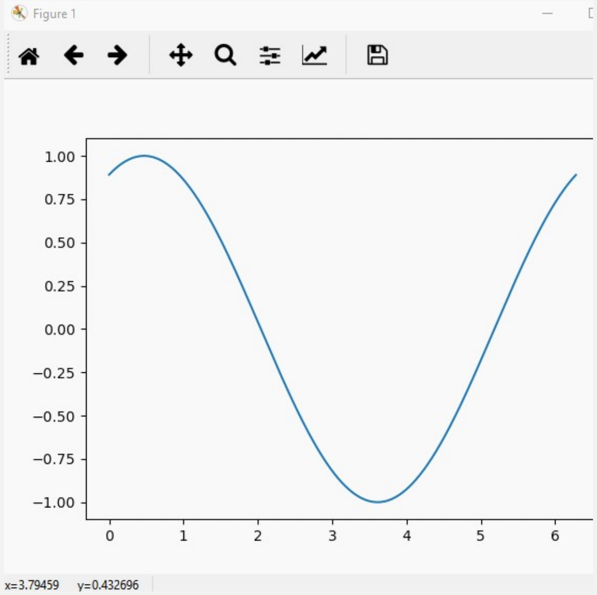
HOW?

- http://pyqt.sourceforge.net/Docs/PyQt5/index.html
- https://pythonspot.com/en/pyqt5/
- https://pythonspot.com/en/pyqt5-matplotlib/
- https://stackoverflow.com/questions/43947318/plotting-matplotlib-figure-inside-qwidget-using-qt-designer-form-and-pyqt5
- https://stackoverflow.com/questions/36222998/drawing-in-a-matplotlib-widget-in-qtdesigner
- https://stackoverflow.com/questions/12459811/how-to-embed-matplotlib-in-pyqt-for-dummies
- https://stackoverflow.com/questions/3972158/how-to-plot-on-my-gui
- https://stackoverflow.com/questions/36665850/matplotlib-animation-inside-your-own-pyqt4-gui
- https://stackoverflow.com/questions/4899176/qt4-mplot3d-of-matplotlib
- https://stackoverflow.com/questions/29357442/example-of-embedding-matplotlib-in-pyqt5
- https://stackoverflow.com/questions/42983449/python-getting-a-matplotlib-figure-to-rotate-when-embedded-in-a-gui
- https://stackoverflow.com/questions/41167196/using-matplotlib-3d-axes-how-to-drag-two-axes-at-once
- https://stackoverflow.com/questions/30330912/rotating-an-embedded-matplotlib-plot
- http://matplotlib.org/examples/user_interfaces/embedding_in_qt5.html
- https://www.mail-archive.com/matplotlib-users@lists.sourceforge.net/msg15322.html

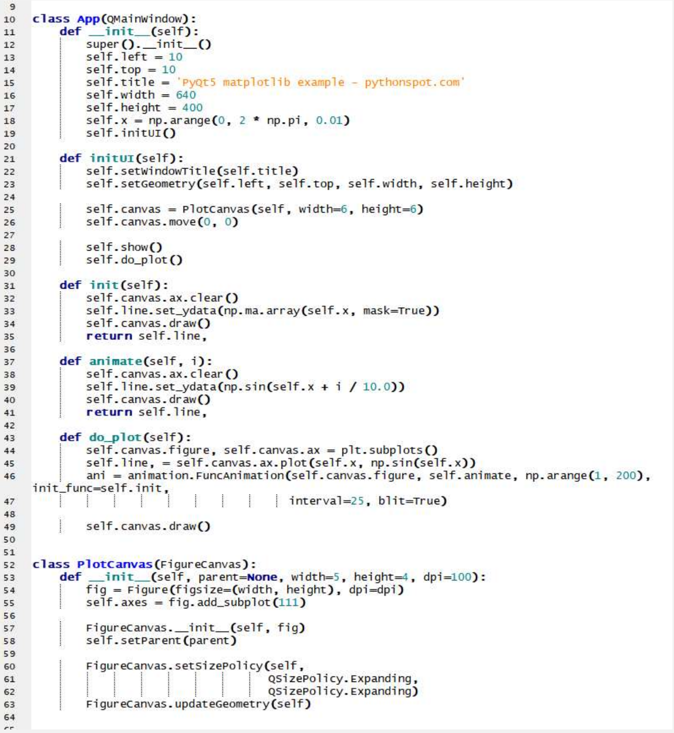
HOW?



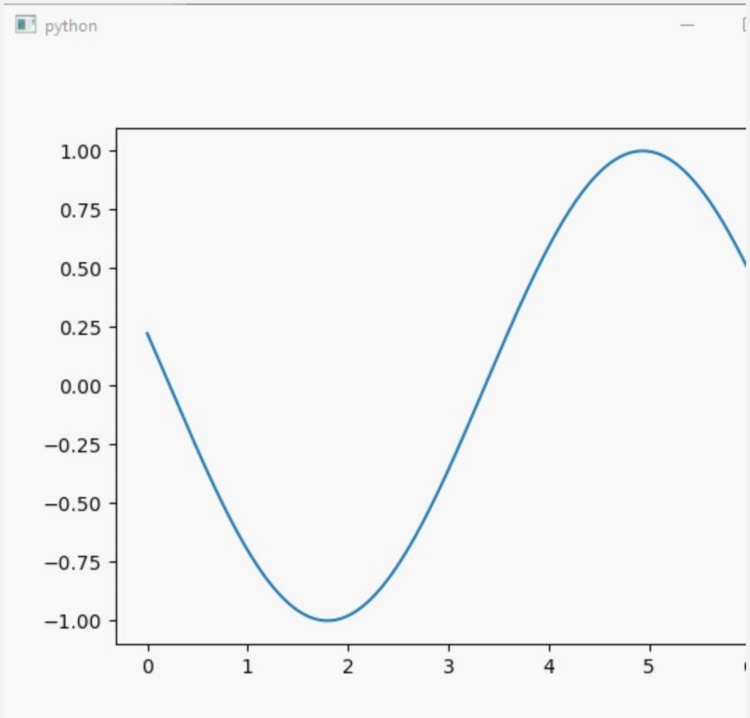
```python
import numpy as np
import matplotlib.pyplot as plt
import mpl_toolkits.mplot3d.axes3d as p3
import matplotlib.animation as animation

fig, ax = plt.subplots()

x = np.arange(0, 2*np.pi, 0.01)
line, = ax.plot(x, np.sin(x))

def animate(i):
    line.set_ydata(np.sin(x + i/10.0))  # update the data
    return line,


# Init only required for blitting to give a clean slate.
def init():
    line.set_ydata(np.ma.array(x, mask=True))
    return line,

ani = animation.FuncAnimation(fig, animate, np.arange(1, 200), init_func=init,
                              interval=25, blit=True)
plt.show()
```



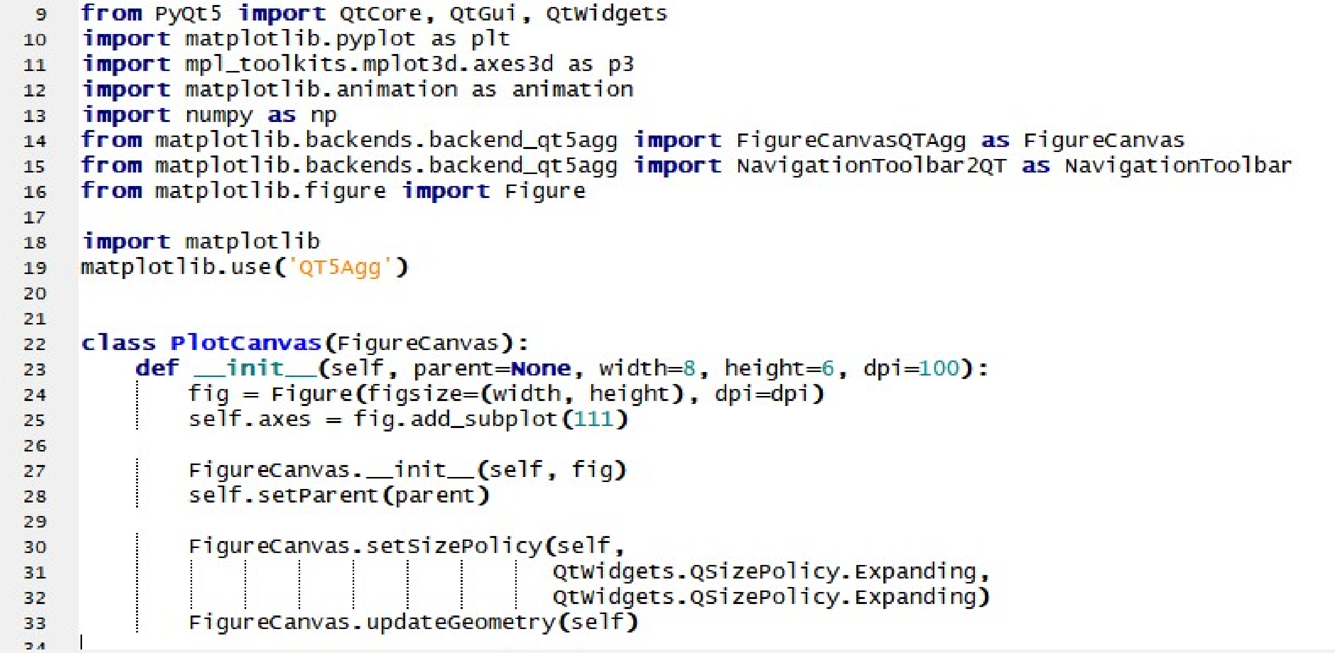
HOW?



```
class App(QMainWindow):
    def __init__(self):
        super().__init__()
        self.left = 10
        self.top = 10
        self.title = 'PyQt5 matplotlib example - pythonspot.com'
        self.width = 640
        self.height = 400
        self.x = np.arange(0, 2 * np.pi, 0.01)
        self.initUI()

    def initUI(self):
        self.setWindowTitle(self.title)
        self.setGeometry(self.left, self.top, self.width, self.height)

        self.canvas = PlotCanvas(self, width=6, height=6)
        self.canvas.move(0, 0)

        self.show()
        self.do_plot()

    def init(self):
        self.canvas.ax.clear()
        self.line.set_ydata(np.ma.array(self.x, mask=True))
        self.canvas.draw()
        return self.line,

    def animate(self, i):
        self.canvas.ax.clear()
        self.line.set_ydata(np.sin(self.x + i / 10.0))
        self.canvas.draw()
        return self.line,

    def do_plot(self):
        self.canvas.figure, self.canvas.ax = plt.subplots()
        self.line, = self.canvas.ax.plot(self.x, np.sin(self.x))
        ani = animation.FuncAnimation(self.canvas.figure, self.animate, np.arange(1, 200),
init_func=self.init,
                                      interval=25, blit=True)

        self.canvas.draw()


class PlotCanvas(FigureCanvas):
    def __init__(self, parent=None, width=5, height=4, dpi=100):
        fig = Figure(figsize=(width, height), dpi=dpi)
        self.axes = fig.add_subplot(111)

        FigureCanvas.__init__(self, fig)
        self.setParent(parent)

        FigureCanvas.setSizePolicy(self,
                                   QSizePolicy.Expanding,
                                   QSizePolicy.Expanding)
        FigureCanvas.updateGeometry(self)
```

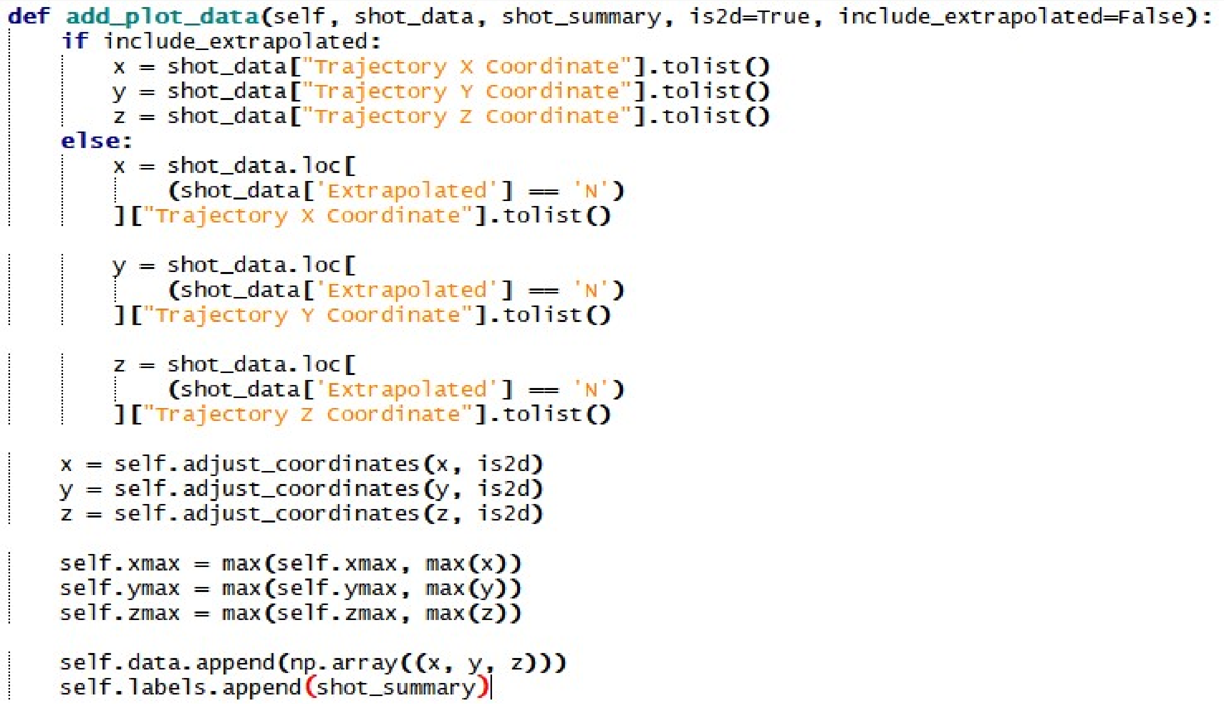


HOW?



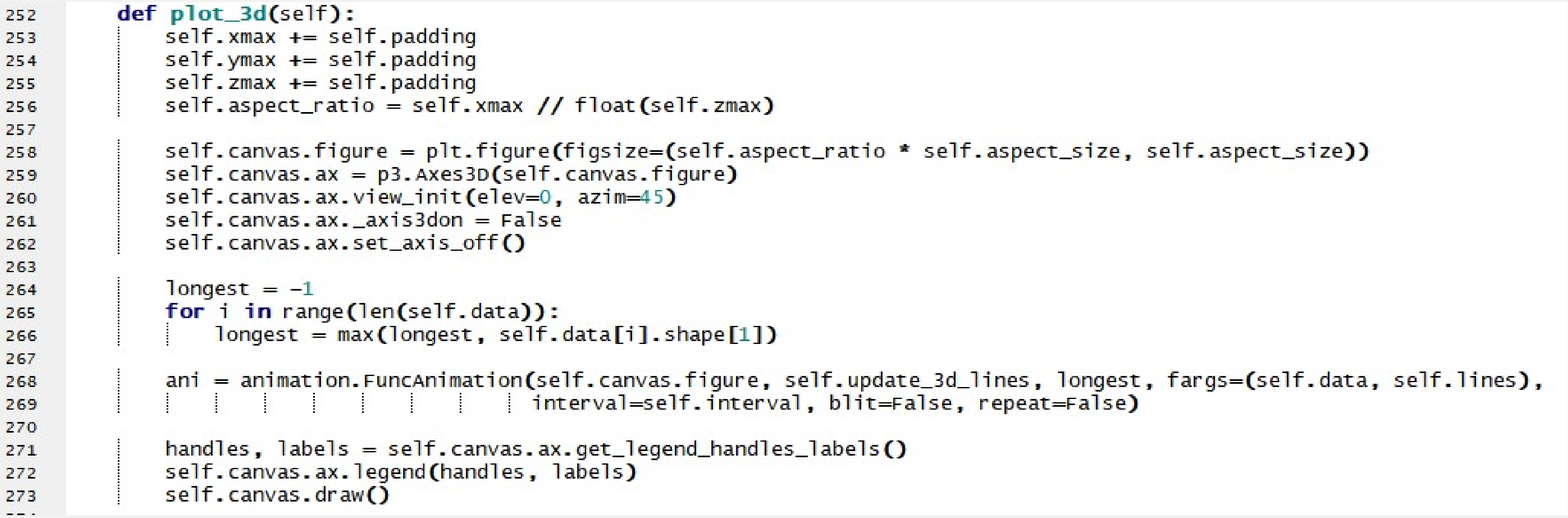
```python
from PyQt5 import QtCore, QtGui, QtWidgets
import matplotlib.pyplot as plt
import mpl_toolkits.mplot3d.axes3d as p3
import matplotlib.animation as animation
import numpy as np
from matplotlib.backends.backend_qt5agg import FigureCanvasQTAgg as FigureCanvas
from matplotlib.backends.backend_qt5agg import NavigationToolbar2QT as NavigationToolbar
from matplotlib.figure import Figure

import matplotlib
matplotlib.use('QT5Agg')


class PlotCanvas(FigureCanvas):
    def __init__(self, parent=None, width=8, height=6, dpi=100):
        fig = Figure(figsize=(width, height), dpi=dpi)
        self.axes = fig.add_subplot(111)

        FigureCanvas.__init__(self, fig)
        self.setParent(parent)

        FigureCanvas.setSizePolicy(self,
                                   QtWidgets.QSizePolicy.Expanding,
                                   QtWidgets.QSizePolicy.Expanding)
        FigureCanvas.updateGeometry(self)
```

HOW?



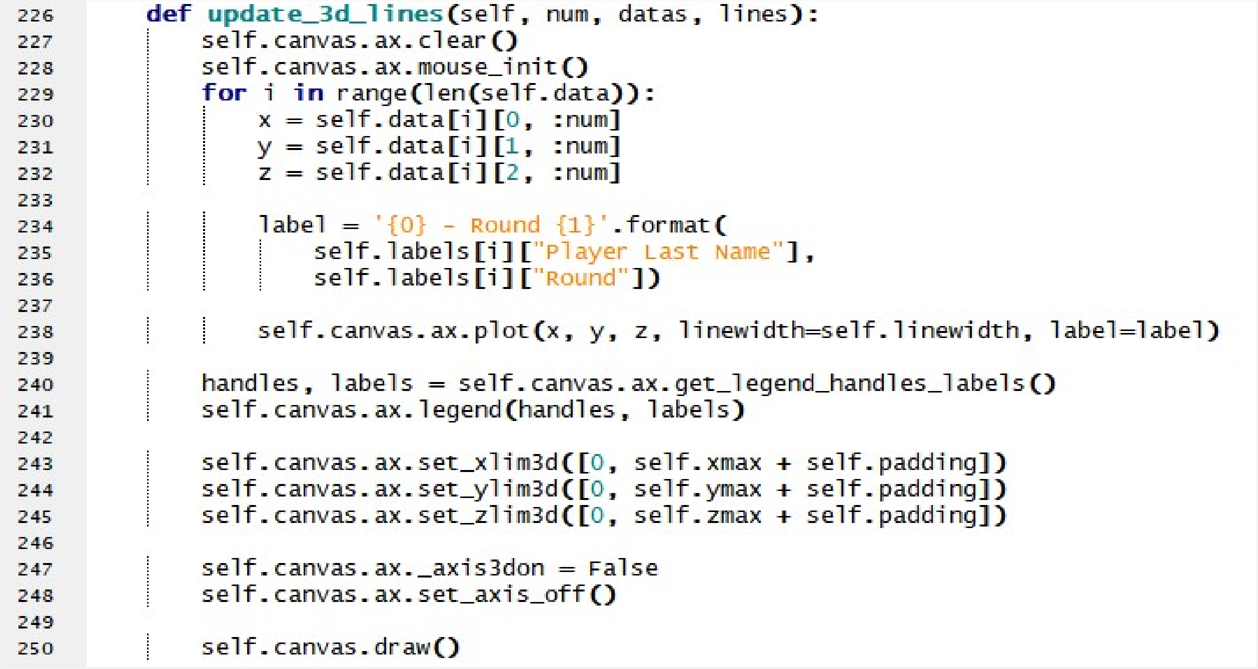
```python
def add_plot_data(self, shot_data, shot_summary, is2d=True, include_extrapolated=False):
    if include_extrapolated:
        x = shot_data["Trajectory X Coordinate"].tolist()
        y = shot_data["Trajectory Y Coordinate"].tolist()
        z = shot_data["Trajectory Z Coordinate"].tolist()
    else:
        x = shot_data.loc[
            (shot_data['Extrapolated'] == 'N')
        ]["Trajectory X Coordinate"].tolist()

        y = shot_data.loc[
            (shot_data['Extrapolated'] == 'N')
        ]["Trajectory Y Coordinate"].tolist()

        z = shot_data.loc[
            (shot_data['Extrapolated'] == 'N')
        ]["Trajectory Z Coordinate"].tolist()

    x = self.adjust_coordinates(x, is2d)
    y = self.adjust_coordinates(y, is2d)
    z = self.adjust_coordinates(z, is2d)

    self.xmax = max(self.xmax, max(x))
    self.ymax = max(self.ymax, max(y))
    self.zmax = max(self.zmax, max(z))

    self.data.append(np.array((x, y, z)))
    self.labels.append(shot_summary)
```

HOW?



```python
    def plot_3d(self):
        self.xmax += self.padding
        self.ymax += self.padding
        self.zmax += self.padding
        self.aspect_ratio = self.xmax // float(self.zmax)

        self.canvas.figure = plt.figure(figsize=(self.aspect_ratio * self.aspect_size, self.aspect_size))
        self.canvas.ax = p3.Axes3D(self.canvas.figure)
        self.canvas.ax.view_init(elev=0, azim=45)
        self.canvas.ax._axis3don = False
        self.canvas.ax.set_axis_off()

        longest = -1
        for i in range(len(self.data)):
            longest = max(longest, self.data[i].shape[1])

        ani = animation.FuncAnimation(self.canvas.figure, self.update_3d_lines, longest, fargs=(self.data, self.lines),
                                      interval=self.interval, blit=False, repeat=False)

        handles, labels = self.canvas.ax.get_legend_handles_labels()
        self.canvas.ax.legend(handles, labels)
        self.canvas.draw()
```

HOW?



```python
def update_3d_lines(self, num, datas, lines):
    self.canvas.ax.clear()
    self.canvas.ax.mouse_init()
    for i in range(len(self.data)):
        x = self.data[i][0, :num]
        y = self.data[i][1, :num]
        z = self.data[i][2, :num]

        label = '{0} - Round {1}'.format(
            self.labels[i]["Player Last Name"],
            self.labels[i]["Round"])

        self.canvas.ax.plot(x, y, z, linewidth=self.linewidth, label=label)

    handles, labels = self.canvas.ax.get_legend_handles_labels()
    self.canvas.ax.legend(handles, labels)

    self.canvas.ax.set_xlim3d([0, self.xmax + self.padding])
    self.canvas.ax.set_ylim3d([0, self.ymax + self.padding])
    self.canvas.ax.set_zlim3d([0, self.zmax + self.padding])

    self.canvas.ax._axis3don = False
    self.canvas.ax.set_axis_off()

    self.canvas.draw()
```

DEMONSTRATION

I hope this works.