EMAT10007 – Introduction to Computer Programming

Exercises – Week 10. Matplotlib

10.1 Plotting

Note: A widely-used way to import the matplotlib module is by adding the following line at the start of your code: `import matplotlib.pyplot as plt`. Any function belonging to the matplotlib module can then be accessed by writing, for example, `plt.plot()`.
All data used in these exercises can be found in the `sample_data` folder which can be downloaded as a zip file from blackboard.

Exercise 1 - Line and scatter graphs (Essential)

1. Create two lists of integers named `x` and `y` with the following values:
   `x = [0,2,4,5,8,10,13]`
   `y = [1,3,3,3,4,5,6]`
   Generate a scatter plot of `y` against `x` .
   Hint: Remember to use `plt.show()` to display the graph.
2. Modify the format string to change the appearance of the graph.
3. On the same axes, plot the graph of `f` against `x` and modify the format string to change the appearance of the graph.
   `f = [-3,0,1,0,4,6,7]`
4. Alter your graph so it has the following
   - title: `Plot of y,f vs x`
   - x axis label: `x`
   - legend indicating which line is `y` data and which is `f`
5. Save your plot as a .pdf file

Exercise 2 - Importing data (Essential)

1. Import the data in file `signal_data.csv`. Plot the data as a scatter graph where the first row in the file is the x (horizontal) data and the second row is the y (vertical) data.
2. Import the data from `hourly_cycle_count_weekend.csv`. Plot a line graph of the data in the column, 'Total' against the data in column 'Time'.
3. Import the data from `temperature_data.txt` and plot the data with the months on the horizontal axis and the temperature (° C) on the vertical axis for each city, as three line graphs on the same plot. Add a figure legend to show which data set is which and label the axes.

Exercise 3 - Importing data for Modelling (Essential)

Real data is often not in the exact form we want to plot it and some data processing is required before using the data.

1. The file `douglas_data.csv` contains a data set of recorded parameters for a sample of wooden beams. Convert the 'bend_strength' to units of Nm^{-2} (by multiplying by 10^6) and produce a scatter plot of bend strength in Nm^{-2} against 'knot_ratio'. Label the axes.
2. The file `FremontBridge.csv` contains daily recordings of traffic crossing a bridge at 1 hour intervals. Produce scatter plot of a time series of 1 hour intervals of the data in the column 'Fremont Bridge Total', for the first 2 days (the first 48 samples).

10.2 Curve Fitting and Exporting Data

Exercise 4 - Curve Fitting (Essential)

1. Fit a function of your choice to the scatter plot you generated in your answer to Ex 2.1 and show the fitted curve as a line on the graph. Save the plot as a .png file.
2. Fit a polynomial curve of degree 2 to each of the scatter plots in your answer to Ex 2.3 and show each fitted curve as a line on the graph. Save the plot as a .pdf file.

Exercise 5 - Exporting data (Essential)

1. Export the horizontal data and the raw and fitted vertical data in your answer to Ex4.1 as 3 separate rows of a .csv file.
2. Using your answer to Ex 4.2, export the months as one row, followed by the fitted temperature data for each city as the next three rows, to a .txt file. Use a space as the delimiter.

Exercise 6 - Curve Fitting for Modelling (Essential)

1. Fit 3 polynomial curves of degree 1, 2 and 3 the scatter plot in your answer to Ex 3.1 and show each fitted curve as a line on the graph.
2. Use a figure legend to show the degree of each fitted polynomial curve.
3. Find the RMSE of each fitted curve with the raw data.
4. Print the degree of the polynomial that gives the best fit.
5. Save the plot as a .pdf file.

Exercise 7 - More Curve Fitting for Modelling (Advanced)

1. Use the fitted data in your answer to Ex4.2 to a .csv file. to predict the temperature in London for the months missing from the original data set.
   Hint: Generate the fitted function for all 12 months.