EMAT10007 – Introduction to Computer Programming

Exercises – Week 8. Reading, writing, and plotting data

Getting Started: Pycharm IDE

Open PyCharm on linux lab computers

- Scroll down to bring up log in screen and log in with your UoB user name and password.
- Click activities (top left corner) to bring up the side panel.
- Click the grid of 9 dots to bring up applications.
- Choose JetBrains PyCharm
- When prompted about the user agreement click accept and read

Create a new project and Python file

- Click New project or File >> New project >> Pure python
- Unselect 'Create a main.py welcome script'
- Note the file location:
  /home/**UoB_username**/PycharmProjects/**your_projectname**/venv
  where **UoB_username** is your UoB username and rename **your_projectname** to be a name of your choice e.g. EMAT10007_exercises
- Right click on the folder icon with project name next to it (top left of window).
- Choose new >> python file
- Give your file a name e.g. week_1_exercises.py

Write and run code

Type some code and click the green play arrow at the top to run.

Save your project

File >> Save all to save your wor

Open a project you created previously

Click File >> Open >> /home/**UoB_username**/PycharmProjects/**your_projectname**/venv, Open >> New window

Rules for naming variables

- Variable names may contain letters or numbers
- Variable names must begin with a letter
- Variable names are case sensitive (`time` is not the same as `Time`)
- Some `keywords` are reserved by the Python language and cannot be used as variable names. For a full list of keywords reserved by Python, enter the following run the following comand in the editor you are using:

  ```
  help("keywords")
  ```

- Use a consistent naming convention:
  - `snake_case`: lower case letters, words separated by underscore (_)
  - `camel_Case`: first letter of each word capitalised, excluding first word
  - `Pascal_Case`: first letter of each word capitalised

Data

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

1. Create three 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]
   f = [-3,0,1,0,4,6,7]
   ```
   Generate a scatter plot of `y` against `x` .
   Hint: Remember to use `plt.show()` to display the graph.
2. On the same axes, create a line plot of `f` against `x`.
3. Alter your figure so it has the following
   - The line for `f` vs `x` is red and has thickness 2
   - title: `Plot of y,f vs x`
   - x axis label: `x`
   - a legend
4. Save your plot as a .pdf file

Exercise 2 - Importing data

1. Import the data from `hourly_cycle_count_weekend.csv` and plot a line graph of the data with 'Time' on the horizontal axis and 'Total' on the vertical axis. Label the axes.
2. Import the data in file signal_data.csv. Plot the data as a scatter graph where the first row is the x (horizontal) data and the second row is the y (vertical) data.
3. Import the data from `temperature_data.txt` and plot the data with the months on the horizontal axis and the temperature on the vertical axis for each city, as three scatter plots on the same graph. Add a figure legend to show which data set is which and label the axes. **Hint**: this is not a CSV file so you will not be able to use the `csv` package to help with importing this data.

Exercise 3 - Importing data for Modelling

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} and produce a scatter plot of bend strength against knot ratio. Label the axes.

Exercise 4 - Exporting data

1. Consider a rectangular bar of length L and cross-sectional area A. Hooke's law states that the force needed to stretch a material by an amount λ is given by $F_H = 3EA(\lambda - 1)$. However, Hooke's law is a simplification and become inaccurate for large values of the stretch λ. The neo-Hookean model says that the force is given by $F_{nH} = EA(\lambda - 1/\lambda^2)$, whereas the Gent model for the force is

$$F_G = \frac{EA}{1 - \alpha(\lambda - 1)} \left(\lambda - \frac{1}{\lambda^2} \right), \tag{1}$$

where $\alpha \ll 1$ is a constant. Assuming that $A = 10^{-4}$ m^2, $E = 10^6$ Pa, $\alpha = 0.08$, plot F_H, F_{nH}, and F_G as a function of λ. You can assume that $1 \leq \lambda \leq 10$. All of the curves should be plotted on the same axes. Make sure the axes are labelled and the figure has a legend.

2. Save the data in a .csv file called `force_stretch.csv`. The data should be arranged in columns so that the first column are values of the stretch λ, and the second, third, and fourth columns are the forces F_H, F_{nH}, and F_G. The first row of the .csv file should be text data that describes each column.