PG TECH WEEKEND

WnCC

Debriefing Data

IIT BOMBAY

Session Objectives

GET STARTED WITH EXPLORATORY DATA ANALYSIS

See how we can extract valuable information from data and use it to infer stuff

LEARN LIBRARIES FOR DATA HANDLING

Numpy and Pandas to filter and manage huge repositories of data

VISUALISE EXTRACTED DATA

Using libraries like **matplotlib** to plot and find visual correlations between data samples

NUMPY

WHY SHOULD I USE NUMPY? AM I NOT DOING WELL ENOUGH WITH LOOPS AND LISTS?

NO.

Vectorisation over loops.
Numpy arrays over lists.

Data analysis is computation-heavy. Using libraries like numpy optimises a lot of operations - for example matrix multiplication. Numpy arrays also take less memory than python lists.

Installation

We'll be using these Libraries

```
pip install numpy
```

```
pip install scipy
```

```
pip install pandas
```

```
pip install matplotlib
```

Getting started with numpy

with help from our trusty friend, python lists!

- `numpy.array(object)`

Where object is array-like (a python list, tuple, a nested python list or tuple) returns a numpy array constructed from this object

We can represent matrices using numpy arrays, where the object is a list of lists, like [[1, 2], [3, 4]]. The array formed is a 2D array, and we can make arrays of n dimensions similarly. These arrays are of the type <numpy.ndarray>

arange() and linspace()

Similar to the range(start, stop, step) in python

np.arange() returns a numpy array of evenly spaced values in the given interval [start, stop). Precision over the step

When the step sizes are non-integer, such as 0.1, it is best to use **linspace** instead of arange.

np.linspace(start, stop, num) returns a numpy array of evenly spaced numbers over a specified interval, [start, stop]. Precision over the end values

ones and zeros - shapes

np.zeros(shape) returns an array of specified shape, filled with zeros.

np.ones(shape) returns an array of specified shape, filled with ones.

np.reshape(array, newshape) or array.reshape(newshape) changes the shape of an array without changing its data.

This gives us good matrix, or an N-dimensional numpy array of a shape of choice to play and experiment with.

Random Numbers

np.random.rand(shape): returns an array of specified shape, filled with random numbers in [0, 1).

np.random.randint(low, high=None, size=None, dtype=int): Only **low** is a compulsory parameter. Returns an array of size = **size** filled with random integer in range [low, high). If high is not given then returns in the range [0, low).

Indexing and Selection

We use the **square bracket** to select a part of the ndarray object.

```
arr[8] # gives the element at index 8
arr[:5] # returns the array from the start to one before the end index
arr[3:] # returns the array from the start index (included) to the last one
```

INDEXING FOR 2D ARRAYS

Square brackets again. This time, the elements might be arrays themselves

```
matrix[i] # returns the ith row of the 2D matrix
matrix[i][j] #returns the element at row i, column j
matrix[i:] #returns all the rows after and including the ith row

matrix[1:5, 3:6] # returns a 4x3 submatrix, with elements from the 1st to
                 the 4th row and 3rd to the 5th column
matrix[:i, :j] #similar, the ixj submatrix in the top left, with elements
               whose rows < i and columns < j
```

CONDITIONAL SELECTION

myarray <operator> value* returns a boolean array of shape similar to myarray whose elements are the condition applied to every element in myarray

```
>>> bool_arr =
np.array([1, 2, 3], [4, 5, 6]) > 3
>>> bool_arr
array([False, False, False], [True, True,
True])
```

*VALUE CAN BE ARRAY-LIKE, SEE BROADCASTING

ndarray[boolean array] returns the elements of the array for which the corresponding element in the boolean array is true.

```
>>> arr = np.array([1, 2, 3, 4, 5],
[6, 7, 8, 9, 10])
>>> arr[arr%2==0]
[2, 4, 6, 8, 10]
```

Arithmetic Operations

You can add two arrays if they are of the same shape using just +

Matrix Multiplication:
If a and b are arrays, their matrix multiplication is done by a@b

Elementwise Product:
Done using *

Broadcasting

With numpy you can apply functions for a single element for the entire array very efficiently.
Numpy does this automatically.

```
def addOne(a):
  return a+1

x = numpy.ones(15, 40)
y = addOne(x)
```

Each element in y would be 1 + the corresponding element in x

Pandas

SERIES DATA TYPE

The series data type is quite similar to a numpy array. The difference is that a **Series** object can have axis labels, meaning it can be indexed by a label, instead of just a number.

pandas.Series(data, index)

data is array-like and contains the data stored in the series
index is array-like, of same length as data and contains the labels for the data values

Eg. **data = [10, 20, 30]**
index = ['A', 'B', 'C']

Thus the elements in data can be indexed by their corresponding labels too.

```
>>> my_series = pandas.Series(data=[1, 2, 3], index=['A', 'B', 'C'])
>>> my_series['A']
1
```

DATAFRAMES

DataFrames are a crucial data type in the Pandas library. They can be thought of as a bunch of Series objects put together to share the same **index**.

pandas.DataFrame(data, index, columns)
data is an ndarray or some other iterable and contains the data stored in the DataFrame
index is array-like, and specifies the indexing for the DataFrame
columns specifies the column labels for the data

Eg. data = [[90, 80], ['A', 'B']]
index = ['Marks', 'Grade']
columns = ['Alice', 'Bob']

Here columns are a labelled Series object which share the same indices, namely 'Marks' and 'Grade'

SELECTION OF ELEMENTS

To select a Series object, use **square brackets []** with the label of the column.

```
>>> my_dataFrame[labels] # labels can be a list of column names
```

To remove a row or a column, we use the **drop(labels, axis) function**, where labels is the list of labels to remove, and axis specifies whether these labels are indices or of columns.

To select **rows**, we use the **.loc[labels]** syntax.

```
df.loc['Marks'] # the row with index 'Marks', returned as a Series object with column labels as indices
df.loc['Marks', 'Alice'] # labels specifying both the row and the column
df.loc[index-list, label-list] # part of the DataFrame, like indexing a 2D array
```

MISSING DATA

We can drop the rows or columns entirely which have a missing value.
dropna(axis, how, thresh) can be used.
Look at the Jupyter Notebook for parameter info.

CONDITIONAL SELECTION

Look at the Jupyter Notebook

INPUT AND OUTPUT

Pandas can read a variety of file types using its pandas.read_ methods.

CSV FILES

```
my_dataFrame = pandas.read_csv(Input_Filepath)
my_dataFrame.to_csv(Output_Filepath)
```

EXCEL SHEETS

```
my_dataFrame = pandas.read_excel(Input_Filepath, sheet_name)
my_dataFrame.to_excel(Output_Filepath, sheet_name)
```

Matplotlib

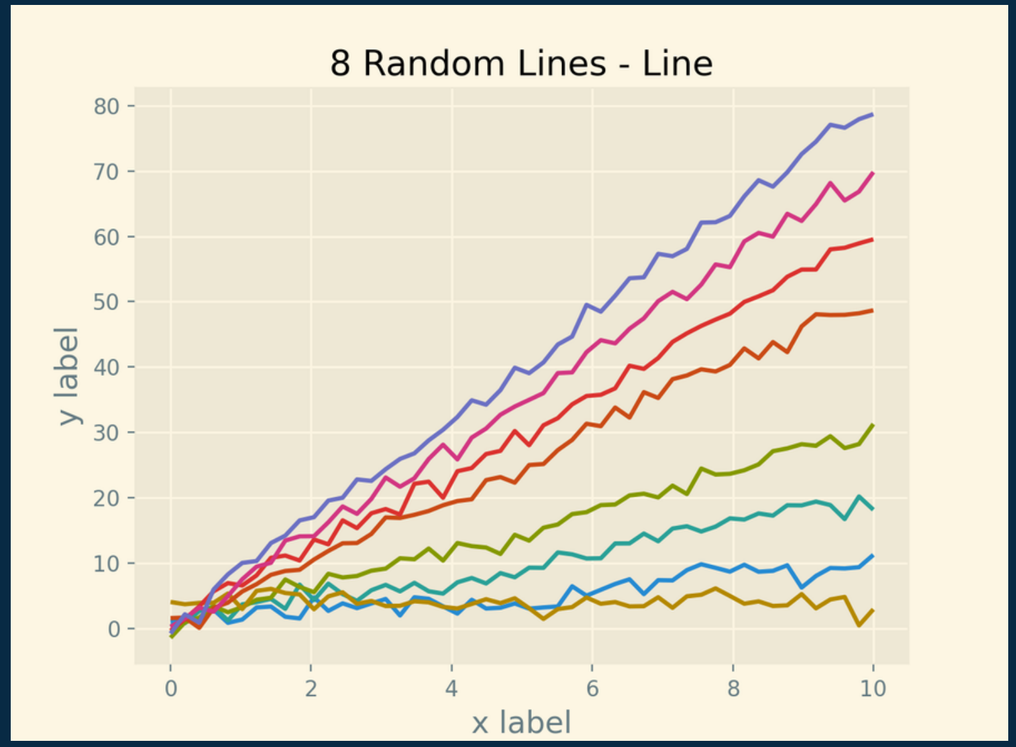
Make beautiful graphs to display your data

```
import matplotlib.pyplot as plt
```

PLOTTING DATA

Given two arrays for x and y coordinates,

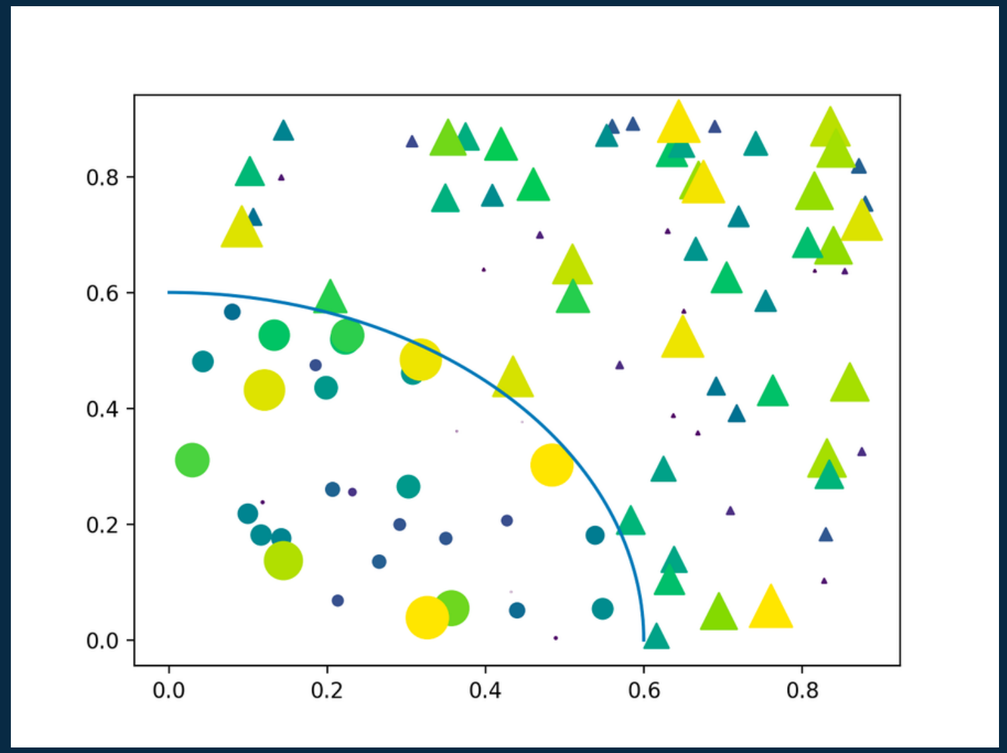
```
plt.plot(x, y)
plt.show()
```



SCATTER PLOTS

plt.scatter(x, y)

Some better properties than plt.plot if you just want to plot some points



src = https://matplotlib.org/stable/gallery/lines_bars_and_markers/scatter_masked.html

HISTOGRAMS

Use the **plt.hist()** function to plot a histogram

plt.hist(x, bins, range, density)
x is the the data in form of an array
bins specifies the number of bins to divide the data into
range specifies the lower and upper range of the bins, can be used to narrow down data points
density when True, will draw and return the probability density : the histogram will be normalised such that the areas add to 1

Tell me and I forget, teach me and I may remember, involve me and I learn.

- Benjamin Franklin


Fin.
Until Next Time.
GO THROUGH THE EXAMPLES IN THE NOTEBOOK, AND SUPPLEMENT THEM WITH THE DOCS. YOU'LL GET THE HANG OF IT IN NO TIME!