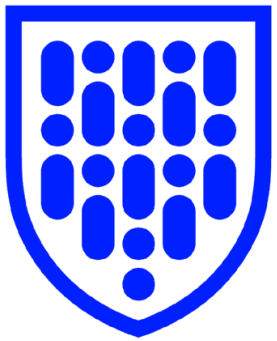

Institute of Data

2022

Introductory Python for Data Science

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Agenda

- Learning outcomes
- Course contents
- Questions

Learning outcomes

- Basic skills in programming in Python for data science including:
  - Use Jupyter Notebook to write and run Python code
  - Find and read the Python documentation for libraries and functions
  - Work with basic Python data types (string, float, integer, list, etc.)
  - Write Python expressions that involve variables, variable assignment, operators and functions
  - Use Python conditional and loop functions
  - Resolve coding errors
  - Create basic graphs
  - Read, clean and manage data

Course contents

- Overview
- Programming as a problem-solving technique
  - Lab 1
- Python environments, tools and key libraries
  - Lab 2
- Data analysis in Python and data analysis projects
  - Lab 3
- Summary and call for action

Questions

Introductory Python for Data Science

Module 1

Programming as problem-solving

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Agenda

- What is programming?
- Importance of programming for data science
- Python Fundamentals
- Developing and running Python
- Input and output function options
- Data structures in Python
- Writing functions in Python
- Iterating in Python

What is programming?

- Programming is:
  - the process of creating a set of instructions that tell a computer how to perform a task.
  - thinking systematically and critically
  - breaking a task into steps. Examples include: a recipe, directions to a destination and mathematical problem solving
- A program usually takes an input and produce an output
- You can think of programming as a way to solve a problem to generate the required output from a given input
- Difference between programming and coding?
  - Programming is the skill to specify a program independent of any programming language
  - Coding is writing the program in a specific programming language

Programming is a fundamental skill for data science

- Data science involves problem solving at many levels and in each step of a project in an implicit (conceptual) or explicit form (programs)

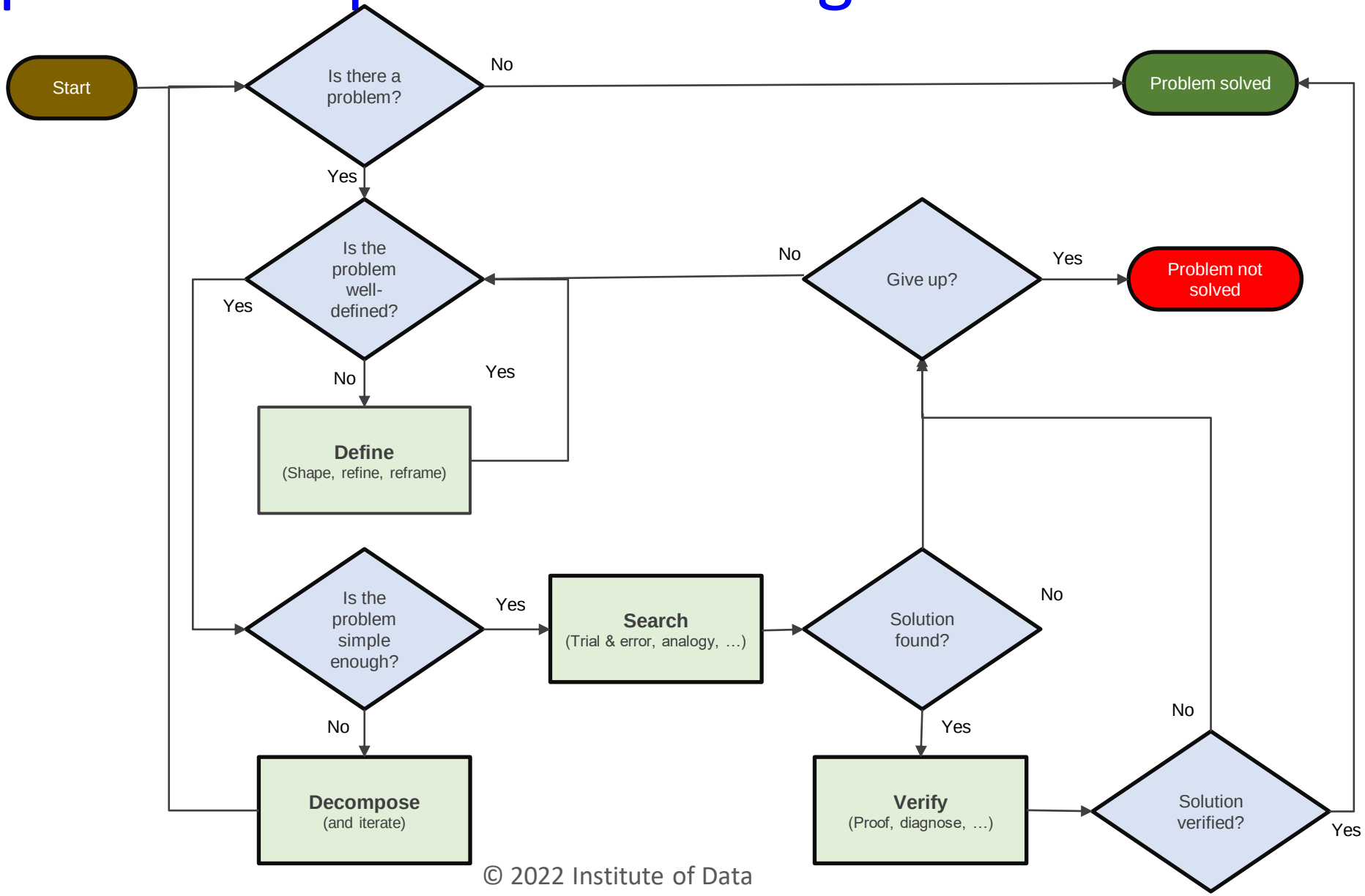
- Programming, which is the main tool for data science, can be defined in its essential form as a problem-solving technique for data-driven problems

- Python is the most popular programming language for data science

Problem solving

- Problem solving is the process of finding solutions to difficult or complex issue
- Scientific method involves stating problems in a manner that facilitate solving them *mathematically* and verify them *empirically*
- Problems can be solved using techniques that include a combination of the following actions:
  - Define
  - Decompose
  - Search
  - Validate

An approach for problem solving



Python programming language

- Python is a high-level programming language, and its core design philosophy is all about code readability and a syntax which allows programmers to express concepts in a few lines of code
- Python is used for developing many different types of computer programs including:
  - Data analysis
  - Data visualisation
  - Machine learning

Python comments

- Single line comment

```
# This is a comment
```

- Multiple line comments

```
"""
Multiple line comment
"""
```

Python input and output functions

- Input function receives an input from the user

```
Data = input('Please enter your name:')
```

- Print function prints formatted text and variables

```
A = 100
Print(f"This is a text and embedded variable {A}")
```

Python variables and data types

- Variables are used to store information to be referenced and manipulated in a computer program.
- Common data types
  - Integer <int> examples: 1, 1095, -2
  - Float <float> examples: 1.2, - 2974.074
  - String <str> examples: ‘Bob, “This is a longer string \t with special char’s”
  - Boolean <bool> examples: True, False
- Python allows you to convert variables between these types when needed
- Type command
  - type(12.65) -> <class 'float'>

Python operations

- Math operations
  - + plus - minus / divide * multiply

    < less-than > greater-than <= less-than-equal

    >= greater-than-equal
- Logic operations
  - and, or, not

If/else, for loops, while loops

- The **if/else** statement executes a block of code if a **specified condition** is true. If condition is not met, another block of code can be executed.
- Loops through a block of code a number of times
- Loops through a block of code while a specified condition is met
- continue
- break
- pass

```
var = 10
if (var >= 5):
   print('var is greater than or equal 5')
   elif (var < 0):
      print('var is negative')
   elif (var == 0):
      print('var is zero')
else:
   print('var is less than 5')
```

```
for i in range(10):
   print(i)
```

```
var = 10
while(var < 20):
   print('var is less than 20')
   var+=2
```

Data structures

- lists
  - A list is the Python equivalent of an array, but is resizable and can contain elements of different types
  - Functions: append, extend, insert, remove, pop, clear, index, count, sort, reverse, copy
  - comprehensions
- tuples
  - A tuple is an (immutable) ordered list of values.
- sets
  - A set is an unordered collection with no duplicate elements.
- dictionaries
  - A dictionary stores (key, value) pairs

```
Tuple_x = (2, 7)

List_y = [2, 4, 6, 8]

Dictionary_z = {"id": 123,
"name": "Item 123"}
```

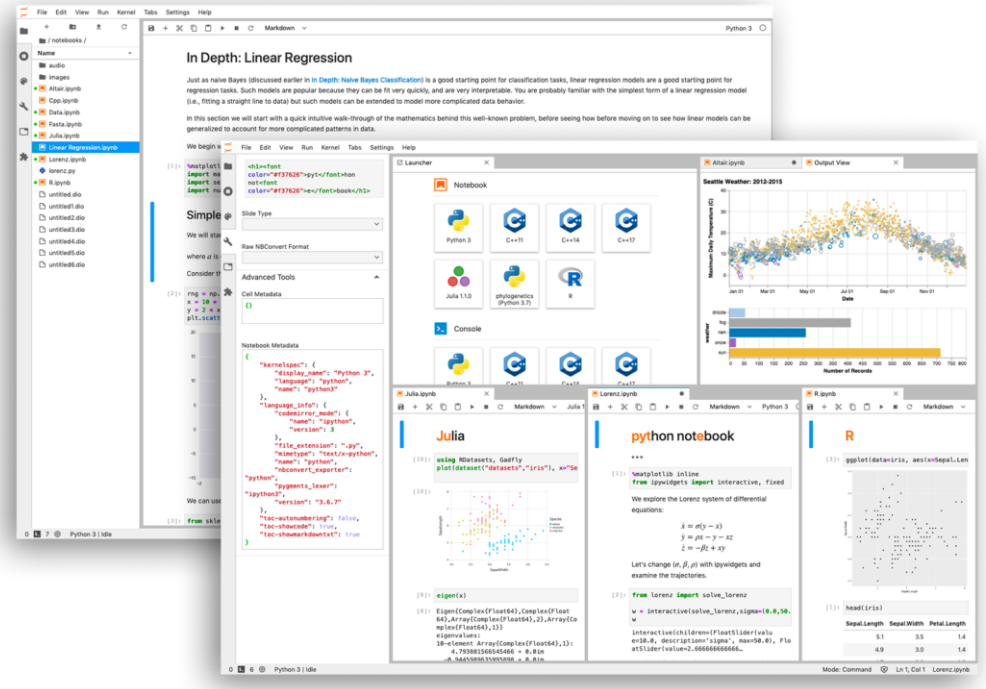
Functions

```
def funcName(param1, param2, defArg1 = 0, defArg2 = 100):
        # code here
        return someResult
```

- Optional parameters take default arguments if missing from function call
- Arguments are assigned to parameters in defined sequence unless named in call
- return statement
  - optional
  - can return multiple items
- scope is inherited from main (but not from a calling function)

Jupyter notebook

- The **Jupyter** notebook is an open-source web application that allows you to create and share documents that contain live code, equations, visualisations and narrative text
- We will use Jupyter notebooks for exercises in this course



Lab 1: First Python program

- Read and follow the instructions in the notebook

Introductory Python for Data Science

Module 2

Python environment, tools and libraries

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Agenda

- Python environment
- Python tools
- Python libraries

Environments

What is an environment?

A practical way to deal with Python's packages (libraries)

Issues:

- Many packages have not been around long enough to be tested with other packages that you might want to use with them
- Packages don't always get updated quickly in response to updated dependencies

Solution:

- Create virtual environments for hosting isolated projects using Anaconda Navigator

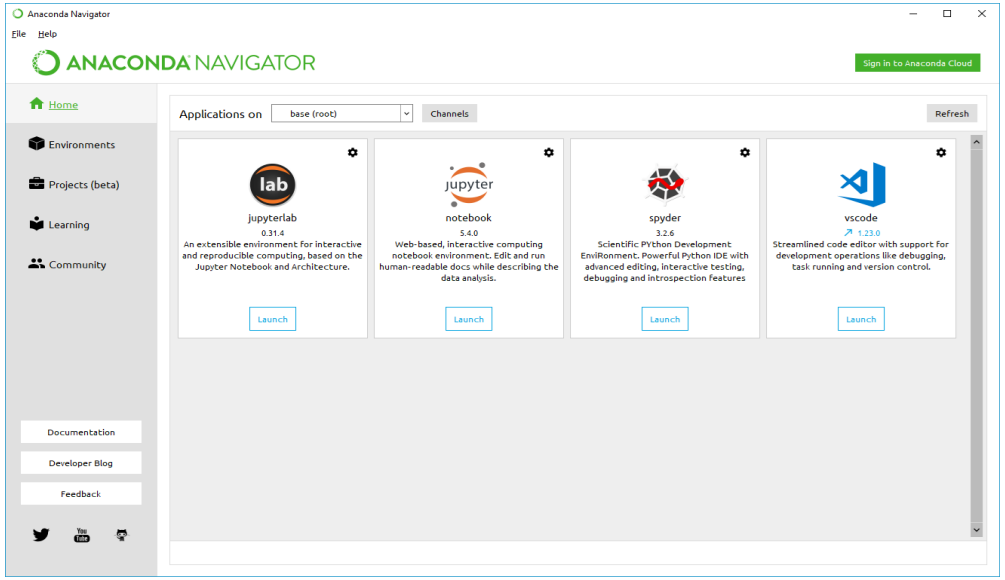
Installing Packages with pip

- install a package
- upgrade a package
- install a specific version
- install a set of requirements
- install from an alternate index
- install from a local archive

```
$ pip install anypkg
$ pip install --upgrade anypkg
$ pip install anypkg==1.0.4
$ pip install -r reqsfile.txt
$ pip install --index-url
http://my.package.repo/simple/ anypkg
$ pip install ./downloads/anypkg-
1.0.1.tar.gz
```

Anaconda

Anaconda Distribution is the recommended way to configure and manage your Python development and running environment(s).



SciPy

- SciPy (pronounced “Sigh Pie”) is a Python-based ecosystem of open-source software for mathematics, science, and engineering

- Main libraries (packages) include numpy, scipy, matplotlib, ipython, jupyter, pandas, sympy, nose

https://www.scipy.org/

Numpy

- Numpy is the fundamental package for scientific computing with Python
- A powerful N-dimensional array object
- Tools for integrating C/C++ and Fortran code
- Useful linear algebra, Fourier transform, and random number capabilities and many, many more

Numpy data types

Type	Python	Numpy	Usage
byte byte array	b‘any string’ bytearray()		• immutable • mutable
integer	int()	• 11 types	• signed, unsigned • 8, 16, 32, 64 bits, unlimited
floating-point	float()	• 3 types	• 16, 32, 64 bits
complex	complex()	• 2 types	• 64, 128 bits
unassigned	None		• object • myVar is not None
missing	nan	isnull(), notnull(), isnan()	• float, object

Visualisation libraries

matplotlib

- histograms
- bars
- curves
- surfaces
- contours
- maps
- legends
- annotations
- primitives

Seaborn

- based on matplotlib
- prettier
- more informative
- more specialised

Lab 2: Python libraries

- Read and follow the instructions in the notebook

Questions

Introductory Python for Data Science

Module 3

Data analysis in Python

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Agenda

- Introduction to data analysis
- Data sources and shapes
- Data analysis operations
- Pandas library
- Data loading
- Data visualisation
- Data statistics
- Data insights

Data sources and shapes

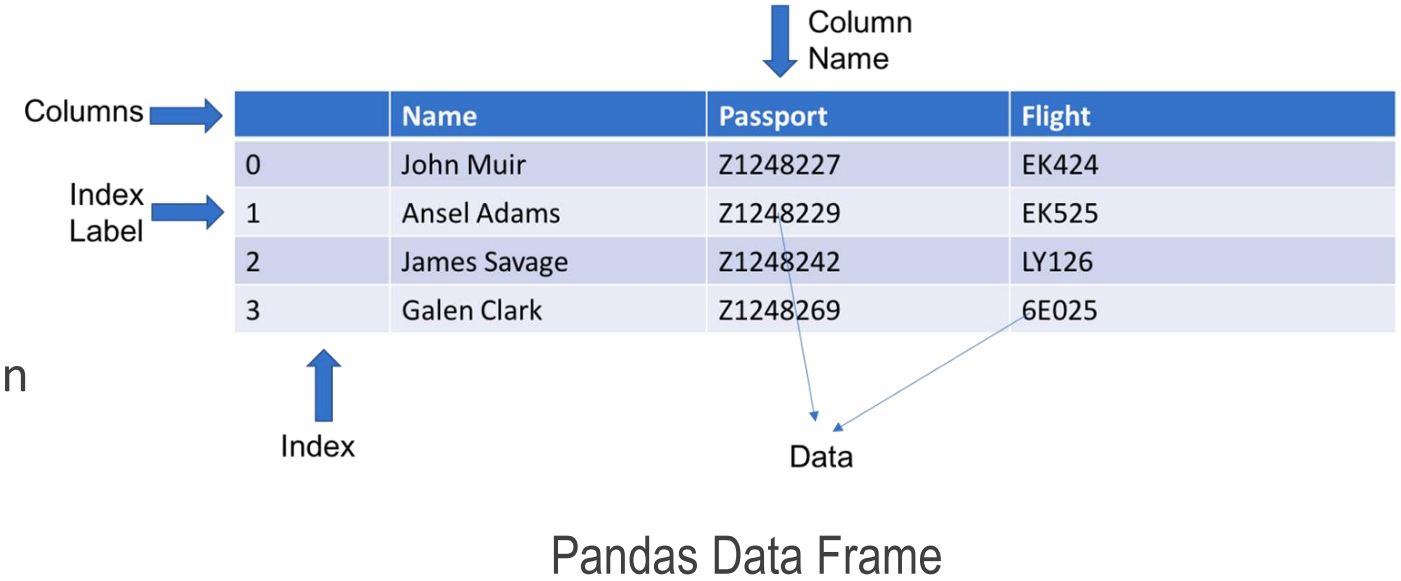
- Where does data come from?
  - Databases
  - Transaction systems
  - Websites
- What data looks like?
  - Database tables
  - Spreadsheets
  - Structured or semi-structured files

Data analysis operations

- Wrangling
  - Sourcing, loading, and precleaning the data so we can see what it really looks like
- Profiling
  - Visualising and understanding the essential characteristics of the data
- Munging
  - reshaping the data to prepare it for analysis

Pandas library

- Rich relational data analysis tool built on top of NumPy
- Easy to use and highly performing APIs
- A foundation for data wrangling, munging, preparation, etc in Python



	Name	Passport	Flight
0	John Muir	Z1248227	EK424
1	Ansel Adams	Z1248229	EK525
2	James Savage	Z1248242	LY126
3	Galen Clark	Z1248269	6E025

Pandas Data Frame

Loading and exploring data

- Pandas can load data from many sources including csv files, websites and databases
- Pandas load data into a data structure called a Data Frame which looks like a spreadsheet

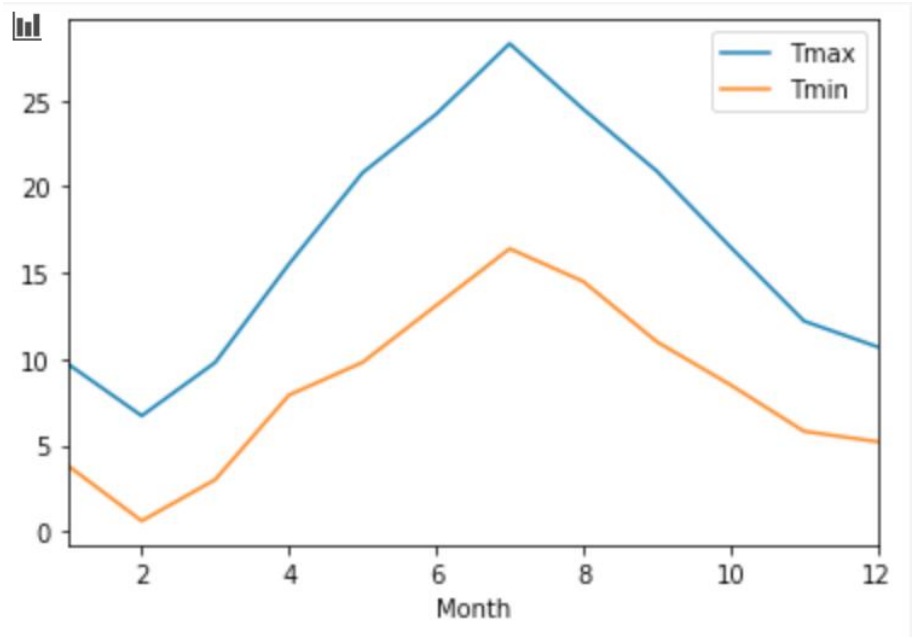
```
import numpy as np
import pandas as pd
import matplotlib.pyplot as plt
weather =
pd.read_csv('https://raw.githubusercontent.com
/alanjones2/dataviz/master/london2018.csv')
print(weather.head())
```

```
   Year  Month  Tmax  Tmin  Rain    Sun
0  2018      1   9.7   3.8  58.0   46.5
1  2018      2   6.7   0.6  29.0   92.0
2  2018      3   9.8   3.0  81.2   70.3
3  2018      4  15.5   7.9  65.2  113.4
4  2018      5  20.8   9.8  58.4  248.3
```

Data visualisation

- Data can be plotted directly from pandas' data frames using matplotlib
- There are many plot types available including:
  - Line chart
  - Bar chart
  - Scatter plot
  - Pie chart
  - Histograms
  - etc

```
weather.plot(y=['Tmax','Tmin'], x='Month')
```



Data statistics

- Pandas provides many functions that allow you to explore statistics of the data including:
  - Count
  - Mean
  - Standard deviation
  - Minimum
  - Maximum

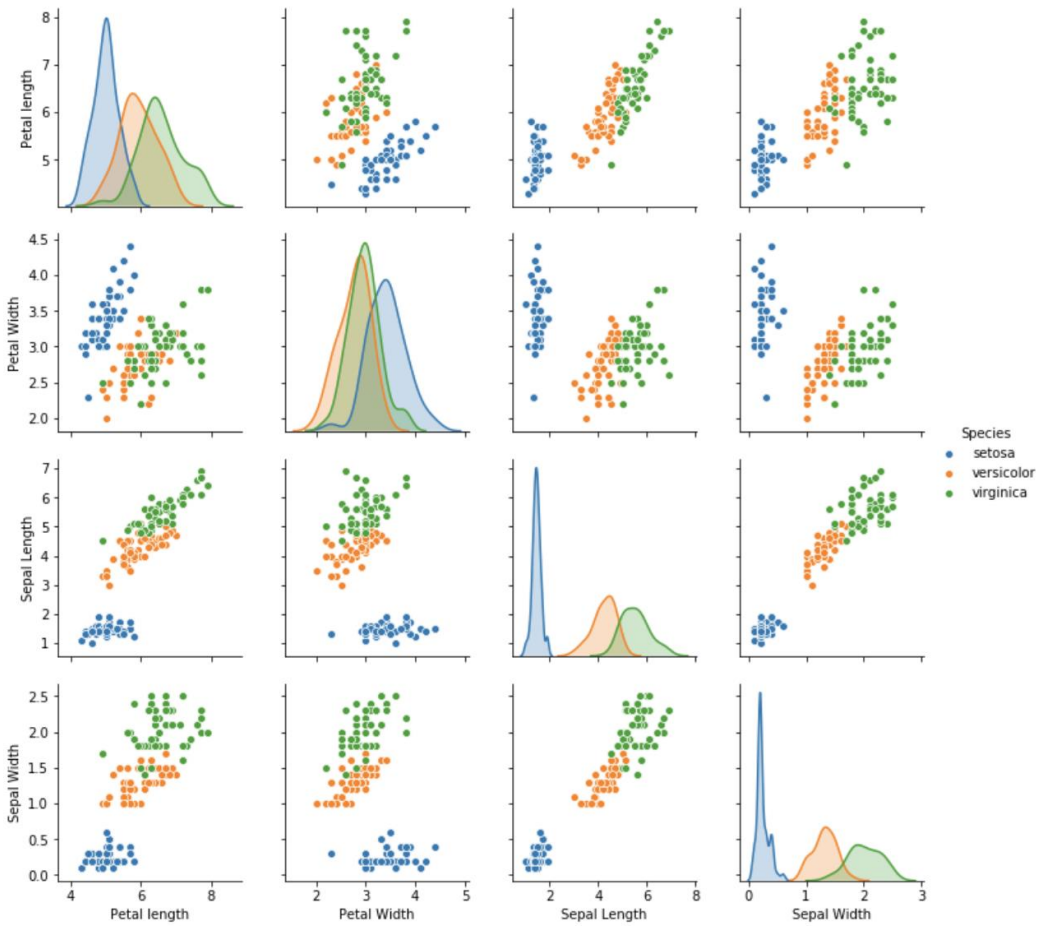
```
from sklearn.datasets import load_iris
dataset=load_iris()
data=pd.DataFrame(dataset["data"],columns=["Petal length","Petal Width","Sepal Length","Sepal Width"])
data["Species"]=dataset["target"]
data["Species"]=data["Species"].apply(lambda x: dataset["target_names"][x])
print(data.head())
print(data.describe())
```

```
Petal length  Petal Width  Sepal Length  Sepal Width Species
0           5.1          3.5           1.4          0.2  setosa
1           4.9          3.0           1.4          0.2  setosa
2           4.7          3.2           1.3          0.2  setosa
3           4.6          3.1           1.5          0.2  setosa
4           5.0          3.6           1.4          0.2  setosa
       Petal length  Petal Width  Sepal Length  Sepal Width
count    150.000000   150.000000    150.000000   150.000000
mean       5.843333     3.057333      3.758000     1.199333
std        0.828066     0.435866      1.765298     0.762238
min        4.300000     2.000000      1.000000     0.100000
25%        5.100000     2.800000      1.600000     0.300000
50%        5.800000     3.000000      4.350000     1.300000
75%        6.400000     3.300000      5.100000     1.800000
max        7.900000     4.400000      6.900000     2.500000
```

Analytical insights

- Using pandas, numpy and matplotlib you can not just describe and visualise the data. You can obtain insights that show deeper relationships between various data elements.

```
sns.pairplot(data, hue="Species")
```



Lab 3: Data analysis in Python

- Read and follow the instructions in the notebook

Questions

Introductory Python for Data Science

Module 4

Summary and call for action

Summary and call for action

- We explored what is programming and how it can be viewed as a problem-solving technique.
- We introduced Python as a suitable programming language for implementing data science projects
- We applied programming and data analysis techniques in a number of lab exercises that hopefully gave you a flavour of how data analysts, scientists and engineers use Python to perform data-driven projects.

Questions

End of presentation