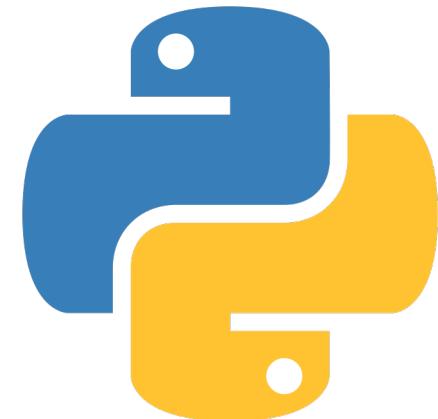


Python programming and data visualization for beginners

Dr Joel Martin

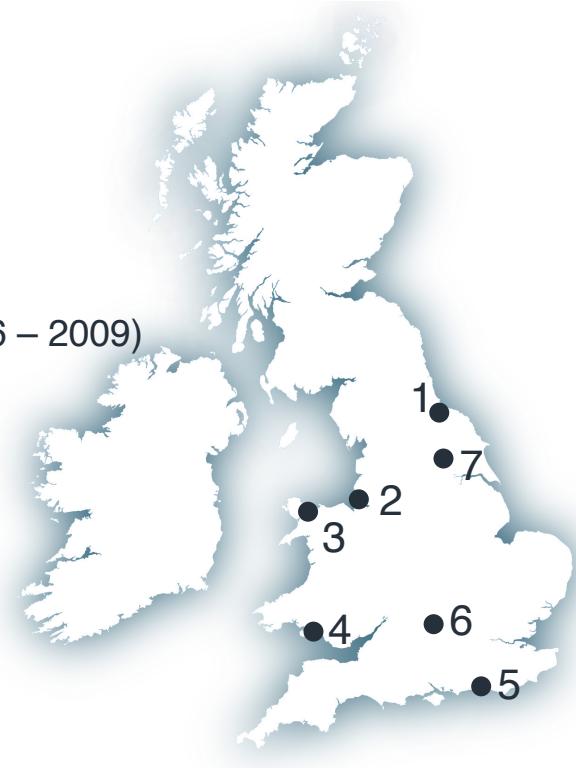


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- 1 – From Middlesbrough
- 2 – BSc Psychology and Biology (Liverpool John Moores University, 2006 – 2009)
- 3 – MSc Psychological Research (Bangor University, 2011 – 2013)
- 4 – PhD Psychology (Swansea University, 2013 – 2018)
- 5 – Research Support Specialist (Mind's Eye Research, 2018 – 2020)
- 6 – Postdoctoral Research Assistant (University of Oxford, 2020 – 2021)
- 7 – Postdoctoral Research Associate (University of York, 2021 – present)



Course outline

Week 0 – Introduction to the Python programming language

Week 1 – Syntax, data types, and built-ins

Week 2 – Logic, operators, control statements, functions

Week 3 – Imports, the standard library, third-party libraries

Week 4 – An introduction to data visualisation

Week 5 – numpy, matplotlib, pandas

Week 6 – Locating and visualising interesting data

Week 7 – Presentations and future direction

Week 0

An introduction to the Python programming language

- What is a computer?
- What is a programming language?
- What is Python?
- What can I do with Python?
- How can I install Python?
- How can I work with Python?

Computers

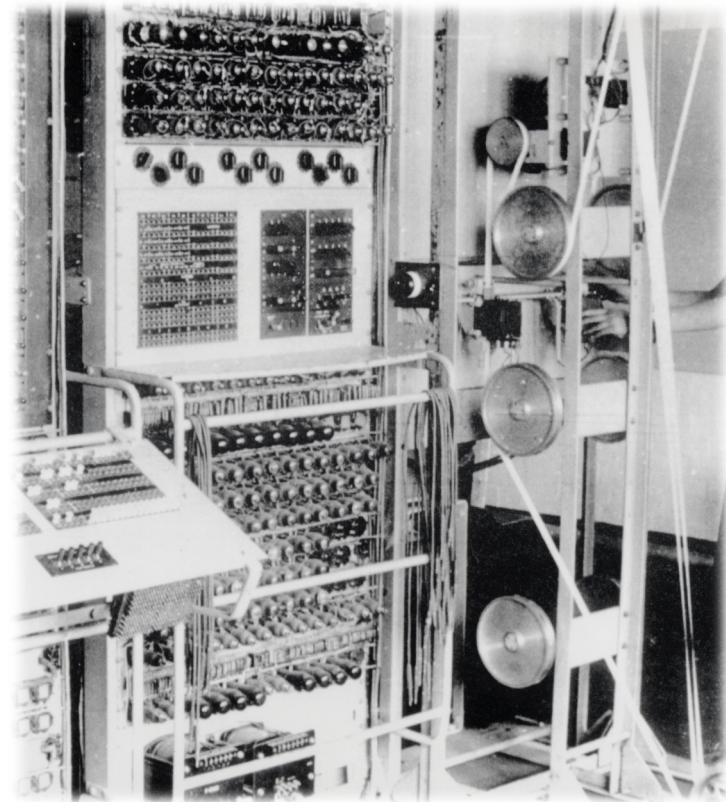
What are they?

Computer

noun

An electronic device for storing and processing data, typically in binary form, according to instructions given to it in a variable program.

- Pictured right: The *Colossus* computer, regarded as the World's first programmable, electronic, digital computer, was designed by Tommy Flowers at Bletchley Park to decode German messages towards the end of World War II.



Computers

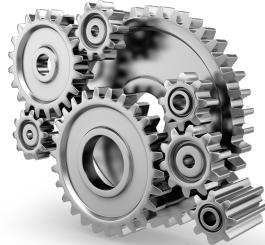
A brief history

- The abacus – a counting tool used by ancient civilizations (2700–2300 BC) prior to the Hindu-Arabic number system
- Comprised of small objects representing digits (e.g., wooden beads, seashells, pebbles) threaded onto wire or wooden rods
- Mathematical operations are performed by changing the positions of the objects

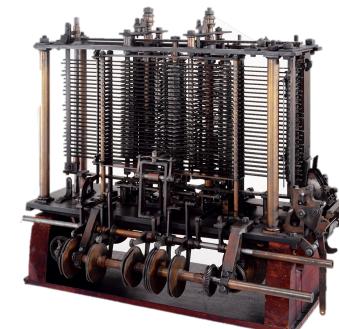
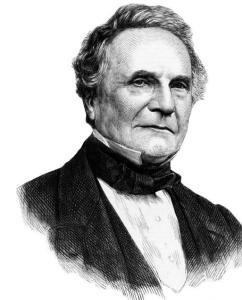
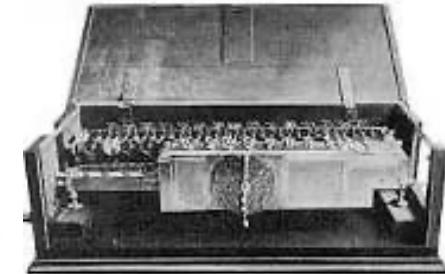
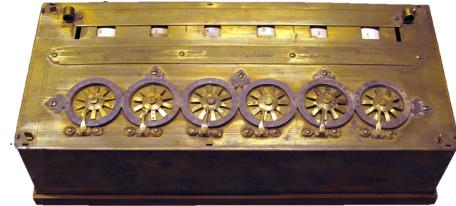


Computers

A brief history



- Gear technology led to new inventions where data are represented through gear positions
- Pictured right (top to bottom):
 - Blaise Pascal (1623-1662) and his mechanical calculator
 - Gottfried Leibniz (1646-1716) and his stepped reckoner
 - Charles Babbage (1792-1871) and his difference engine



Computers

A brief history

- **1947:** Invention of the transistor and subsequent development of integrated circuits gives rise to modern computing machines
- **1976:** Steve Jobs and Stephen Wozniak build first commercially viable home computer
- **1981:** IBM introduce first desktop computer
- **1983:** Tim Berners-Lee invents the World Wide Web
- **1990 - present:**
 - Search engines such as Google, AOL, Ask Jeeves and Duck Duck Go make the web more accessible
 - Computers become smaller, more powerful and widely available
 - Many people use computers and the internet every day



UNIVERSITY
of York



Programming languages

What are they?

- A set of instructions for interacting with and controlling a computer
- Because computers can't speak human languages!
- Instead, they represent everything with **bits** of information:
 - 1 or 0
 - True or False
- Three levels of programming language:
 - Machine language (e.g., binary)
 - Assembly language (e.g., x86 Assembly)
 - High-level languages (e.g., Python)

0	1	0	0	1	0	0	0
0	1	1	0	0	1	0	1
0	1	1	0	1	1	0	0
0	1	1	0	1	1	0	0
0	1	1	0	1	1	1	1
0	0	1	0	0	0	0	0
0	1	0	1	0	1	1	1
0	1	1	0	1	1	1	1
0	1	1	1	0	0	1	0
0	1	1	0	1	1	0	0
0	1	1	0	0	1	0	0
0	0	1	0	0	0	0	1

H e l l o w o r l d !

```
SECTION .data
Msg: db "Hello world!", 10
Len: equ $-Msg
```

```
SECTION .text
global _start
_start:
```

```
    mov eax,4
    mov ebx,1
    mov ecx,Msg
    mov edx,Len
    int 80H
```

```
    mov eax,1
    mov ebx,0
    int 80H
```

Programming languages

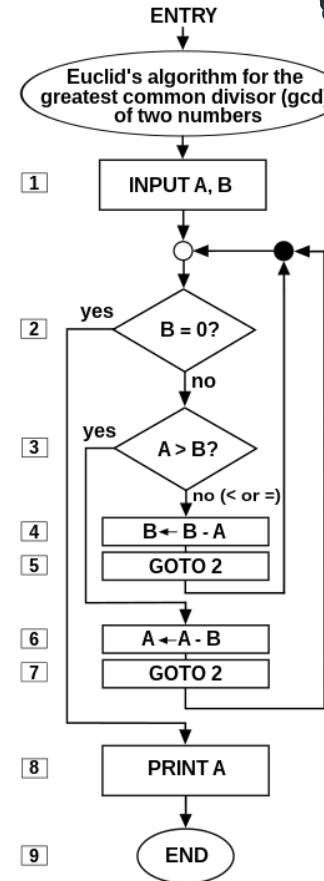
Algorithms

Algorithm

noun

A process or set of rules to be followed in calculations or other problem-solving operations, especially by a computer.

- Algorithms are a fundamental concept in computer science and computer programming
- Computer programs are representations of algorithms
- Pictured right: The Ancient Greek mathematician, Euclid (c. 300 BCE), and his algorithm for finding the greatest common divisor of two numbers



Euclid was one of the greatest mathematicians of antiquity and his algorithm is still widely used today.

Programming languages

How many are there?

- Lots!
- Various paradigms:
 - Procedural
 - Functional
 - Scripting
 - Logic
 - Object oriented
- Pictured right are the 20 most popular programming languages



Programming languages

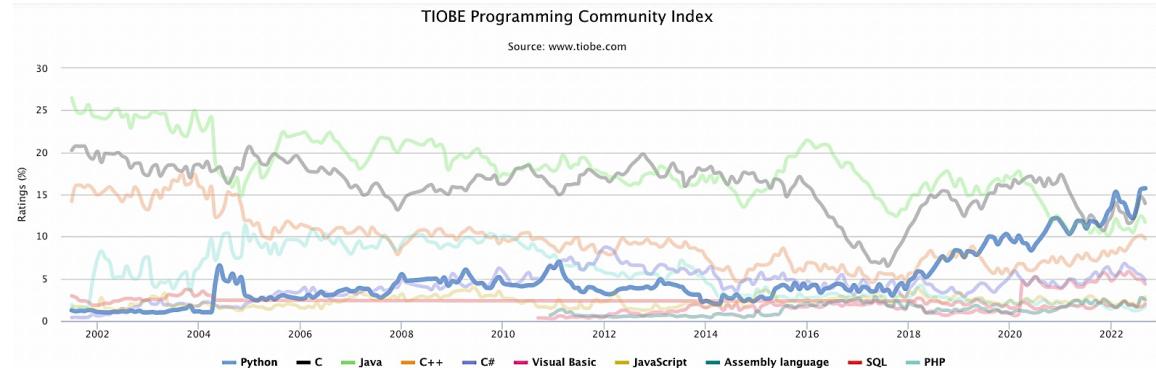
Which is best?

- There is no “best” programming language. All have their strengths and weaknesses
- TIOBE – An index of software quality and popularity
- Python’s ratings have climbed sharply since 2018
- Currently number 1



TIOBE
the software quality company

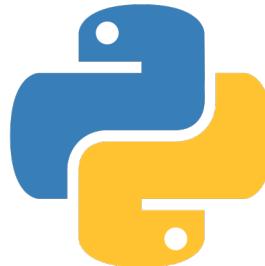
Sep 2022	Sep 2021	Change	Programming Language	Ratings	Change
1	2	▲	Python	15.74%	+4.07%
2	1	▼	C	13.96%	+2.13%
3	3		Java	11.72%	+0.60%
4	4		C++	9.76%	+2.63%
5	5		C#	4.88%	-0.89%
6	6		Visual Basic	4.39%	-0.22%
7	7		JavaScript	2.82%	+0.27%
8	8		Assembly language	2.49%	+0.07%



Python

What is it?

- An interpreted, object-oriented, high-level programming language with dynamic semantics
- Conceived in the late 1980s by Guido van Rossum (principal author)
- Named after Monty Python's Flying Circus (Guido must have a sense of humor!)
- Current version is 3.10



[Portrait of Guido Van Rossum](#) at the Dropbox headquarters in 2014. Taken by San Francisco based photographer Dan Stroud. Licensed under [CC BY-SA 4.0](#).

Python

Example programs

- `00_fahreneit_to_celsius.py`
- Request input from user in Fahrenheit, perform Celsius conversion, report the result

```
"""Convert Fahrenheit to celsius."""

# Ask user to enter a temperature in Fahrenheit
temp = float(input("Enter temperature in Fahrenheit: "))

# Convert to celsius
celsius = (temp - 32) * (5 / 9)

print(f"{temp} degrees Fahrenheit is equal to {celsius} degrees Celsius.")
```

Python

Example programs

- `00_number_guessing_game.py`
 - Generate a random number between 1 and 100
 - Ask the user to guess the number
 - Inform the user whether their guess was too high or too low
 - Repeat process until the guess is correct

```
"""Play a number guessing game."""

import random

# Generate a random number between 0 and 100
n = random.randrange(1, 100)

# Ask the user to have a guess
guess = int(input("Enter any number: "))

# Keep asking until the guess is right
while n != guess:
    if guess < n:
        print("Too low")
        guess = int(input("Enter number again: "))
    elif guess > n:
        print("Too high!")
        guess = int(input("Enter number again: "))
    else:
        break

# Tell user they guessed right
print("you guessed it right!!")
```

Python

Example programs

- `00_check_prime_number.py`
 - Ask user to input a number
 - Check if the number has a factor other than 1 and itself
 - Report whether the number is prime

```
"""Check if a number is prime."""

# Take input from the user
num = int(input("Enter a number: "))

# Define a flag variable
flag = False

# Prime numbers are greater than 1
if num > 1:
    # Check for factors
    for i in range(2, num):
        if (num % i) == 0:
            # If factor is found, set flag to True
            flag = True
            # Break out of loop
            break

    # Check if flag is True
    if flag:
        print(num, "is not a prime number.")
    else:
        print(num, "is a prime number.")
```

Python

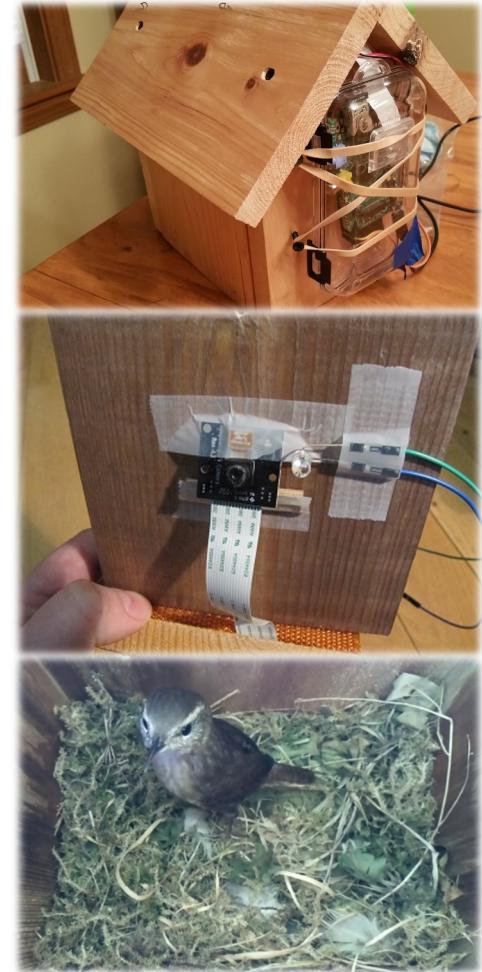
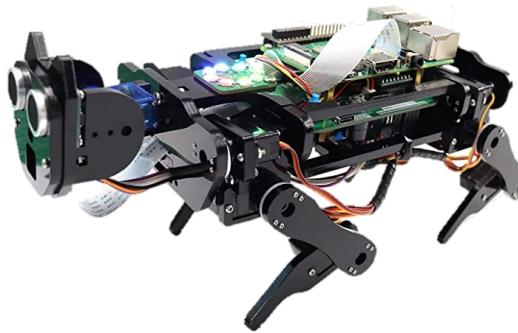
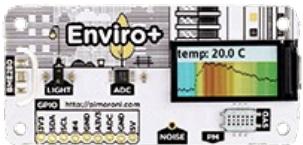
What is it used for?

- Web development
 - e.g., Dropbox, Google, Spotify, Instagram, Netflix, Uber, Reddit
- AI and machine learning
 - e.g., Google, Facebook, AstraZeneca, Exscientia
- Data analytics and visualization
 - e.g., Universities, businesses, tech startups
- Game development
 - e.g., World of Tanks, Sims 4, Battlefield II, Civilization IV
- Finance
 - e.g., OpenBB, cryptocurrency, banking software

Python

What is it used for?

- Hobbies
 - Raspberry Pi microcomputer
 - Robots and robotic arms
 - Wildlife cameras
 - Environmental sensors
 - Home automation



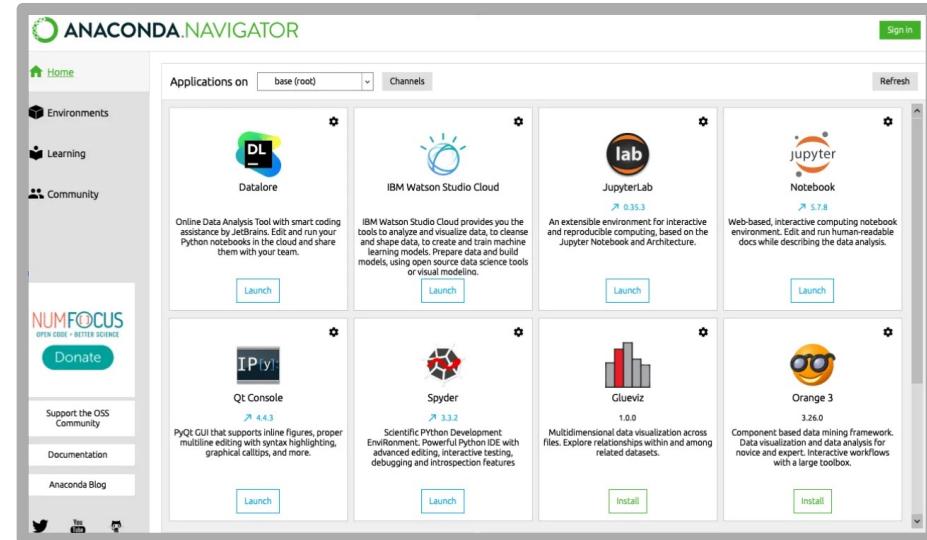
Python

How do we install it?

- There are many options
 - Download an official distribution from [python.org](https://www.python.org)
 - Install from a package manager (apt, homebrew, etc.)
 - Build from source code
 - Install from the Microsoft store
- We will complete installation using the **Anaconda distribution**
- Anaconda is a popular platform for doing scientific computing and data science with Python



A free and open-source data science platform for Python.



Python

How will we work with it?

- Software installed via **Anaconda**
- **Jupyter** is a web-based interactive development environment for creating and sharing computational documents
- **Spyder** is a free and open-source scientific environment written in Python, for Python, and designed by and for scientists, engineers and data analysts

A screenshot of a Jupyter Notebook interface. The top cell (In [1]) contains code to import numpy, pandas, seaborn, and matplotlib.pyplot, and then runs a histogram command. The bottom cell (In [2]) shows the resulting histograms. One histogram is titled 'stepfilled' and the other 'unequal bins'. Both have density axes ranging from 0.0075 to 0.00175.A screenshot of the Spyder IDE. The code editor shows a file named 'plugin.py' with code related to Spyder's plugin system. The variable explorer shows variables like 'x', 'y', and 'z' with their respective values. A 3D surface plot is displayed in the bottom right corner.

Let's go!

Open this file

- notebooks/00_introduction_to_the_python_programming_language.pdf