Introduction to Computer Programming

Week 11 – Looking ahead

Overview

- Further Python functionality to help with your studies
- Other programming languages
- Further Computer Programming EMAT10006
- Further programming opportunities
- Real-world applications of programming

SciPy

- Contains a broad range of algorithms for solving engineering problems
- Used to tackle problems that cannot be solved exactly
- Functions for optimisation, linear algebra, differential equations, interpolation, image and signal processing, statistics

Original

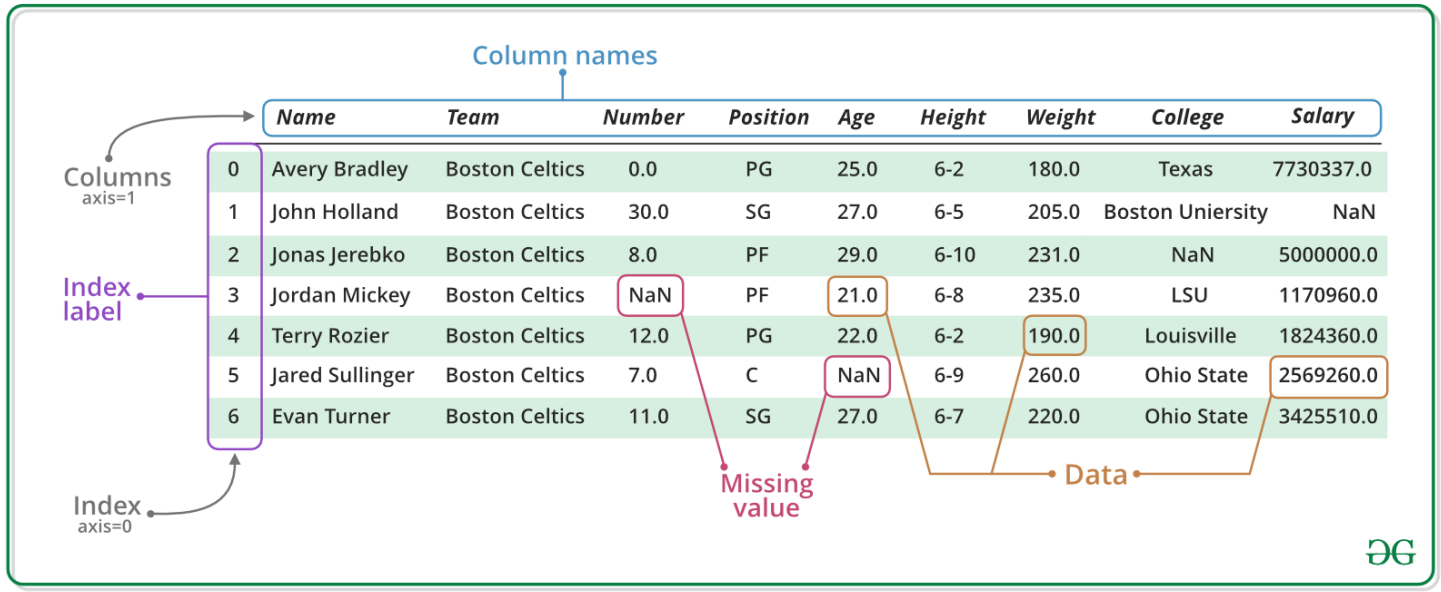
Blurred

Deblurred

scipy-lectures.org

Pandas

- A Python library for data storage, manipulation, and analysis
- Many convenient functions for working with tables of complex data
- File import/export is straightforward

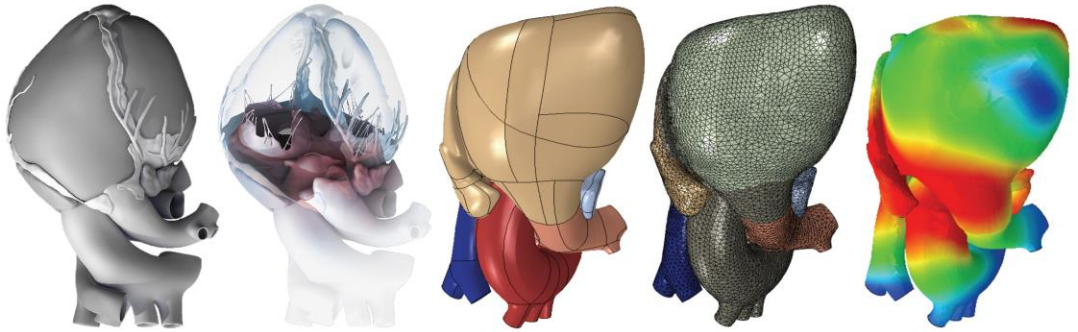


	Name	Team	Number	Position	Age	Height	Weight	College	Salary
0	Avery Bradley	Boston Celtics	0.0	PG	25.0	6-2	180.0	Texas	7730337.0
1	John Holland	Boston Celtics	30.0	SG	27.0	6-5	205.0	Boston Uniersity	NaN
2	Jonas Jerebko	Boston Celtics	8.0	PF	29.0	6-10	231.0	NaN	5000000.0
3	Jordan Mickey	Boston Celtics	NaN	PF	21.0	6-8	235.0	LSU	1170960.0
4	Terry Rozier	Boston Celtics	12.0	PG	22.0	6-2	190.0	Louisville	1824360.0
5	Jared Sullinger	Boston Celtics	7.0	C	NaN	6-9	260.0	Ohio State	2569260.0
6	Evan Turner	Boston Celtics	11.0	SG	27.0	6-7	220.0	Ohio State	3425510.0

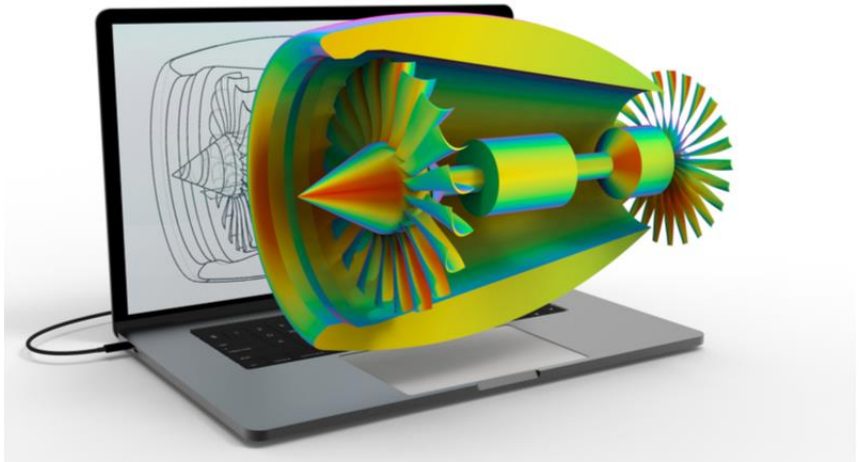
www.geeksforgeeks.org

FEniCS

- A Python library for simulating models of heat transfer, fluid flow, solid deformation, and more
- Code is *parallelized* and can run on supercomputers
- Useful for final-year projects or MSc dissertations involving modelling of physical and/or biological processes



biomechanics.stanford.edu



www.imeche.org

scikit-learn

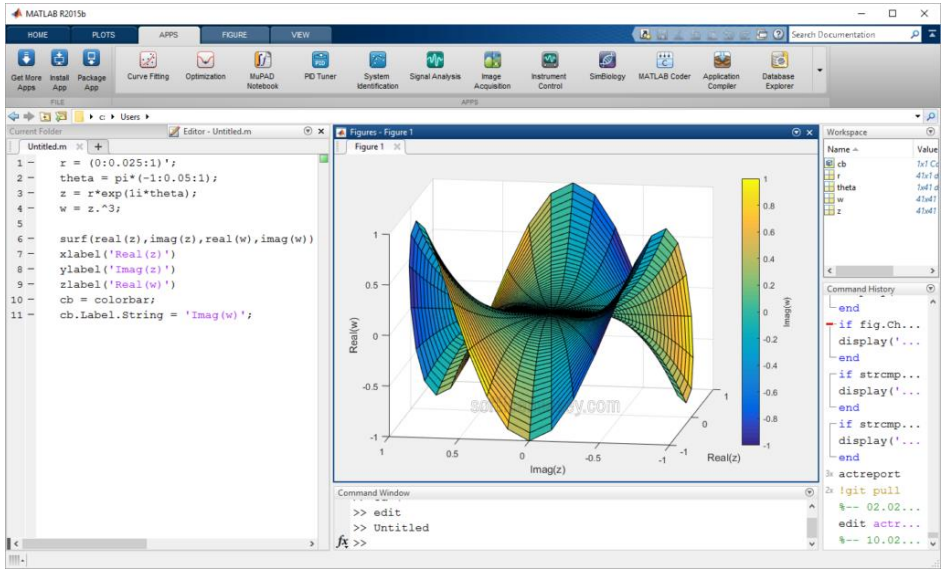
- An open-source Python library for machine learning
- Tools for predictive data analysis
- Data classification, regression, clustering, dimension reduction
- Built on SciPy, NumPy, and matplotlib

scikit-learn.org

Other programming languages

There are thousands of programming languages!

- **MATLAB** (Numerical Methods in Matlab, EMAT20920)
- **R** (for statistics)
- **C/C++** (C for Embedded Systems, EENG20004)
- **LaTeX** (used for writing technical reports)




```c
#include <stdio.h>

int main() {

  int n = 3
  float pi = 3.14

  printf("Pi is equal to %.2f\n", pi)

  return 0

}
```

Further Computer Programming EMAT10006

- Create and navigate larger codebases
- Use version control with git and GitHub
- Work collaboratively in groups in a single codebase
- Use Python for simulations and plotting and for engineering or scientific work
- Use additional intermediate-level features of Python as a programming language

master Root-finding / rootfinding.py / Jump to Go to file

hennessymatt added a function Latest commit 345390a on Oct 31, 2018 History

2 contributors

30 lines (20 sloc) 457 Bytes Raw Blame

```
1  def myfun(x):
2      return x**2+(x-2)**3-5
3
4  def myfun2(x):
5      return x**3+(x-2)**3-5
6
7
8  def mybisection(f,a,b,eps):
9
10     #initial guess
11     x=(a+b)/2.0
12     err=b-a
13
14     if f(a)*f(b) > 0:
15         raise ValueError("Possible no root in given interval")
16
17     while err > eps:
18         if f(a)*f(x) < 0:
19             b=x
20         else:
21             a=x
22         err=b-a
23         x=(a+b)/2
24     return x
25
26
27
28 x = mybisection(myfun,-3.,3.,10**(-6))
29 print(x)
30
```

Further Programming Opportunities at Bristol

Computer Science Society (https://cssbristol.co.uk/)

- Hackathons, workshops, programming activities, and social events

Bristol Data Science Society (https://www.facebook.com/BristolDSS/)

- Programming workshops, seminars, data-science competitions

ChallEng (look them up at https://www.bristolsu.org.uk/)

- Work with fellow students to solve real problems faced by small businesses and start-ups

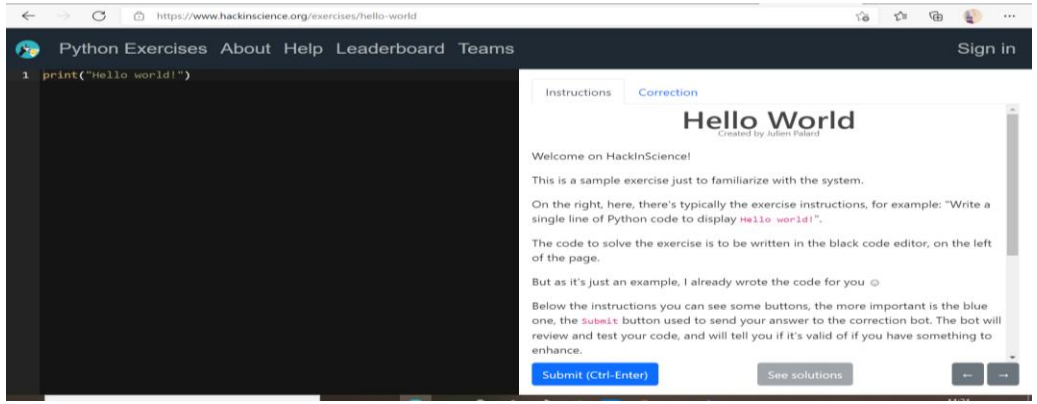
180 Degrees Consulting (https://180dc.org/branch/bristol/)

- Student-led organisation – opportunities to work with charities and NGOs on a voluntary basis providing Data Science (statistics, visualisation, NLP) and other consulting services.

Further Programming Opportunities

- **Hackathons** – These are one off events which normally target a specific problem. There are sometimes prizes and these are great ways to learn more programming away from your studies.
- **Online practice** – There are lots of free online courses on specific parts of programming especially python.
  - Code academy – Wide range of courses in lots of programming languages
  - HackInScience — Python Exercises – HackInScience has lots of small problems for you to work on. You can compare your code to others and see how it meets industry standards.

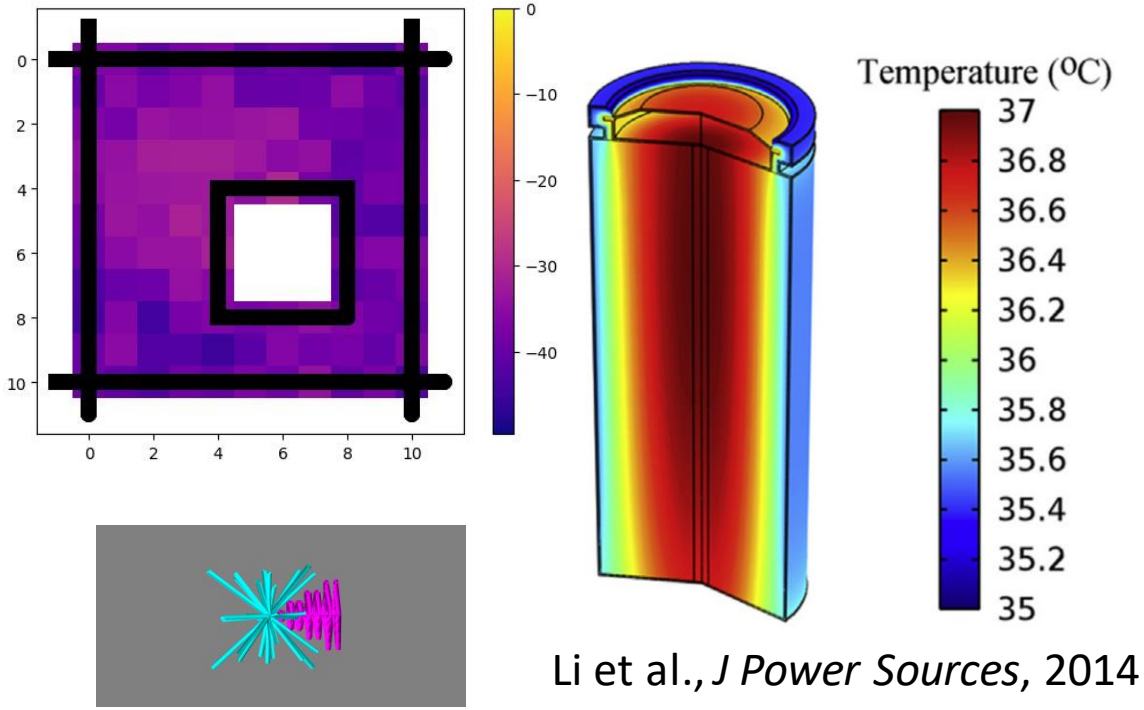
Coding may seem like an individual task but it's all about building something that works, and others can understand.
Paired programming and rubber ducking and standardized formats are common tools for improving the understanding of code.



Real-world applications

How we use programming

- Building robots and autonomous systems
- Thermal management of lithium-ion batteries; real-time detection of short circuits
- Modelling WiFi signals and 4G/5G.
- Predicting the spread of Covid-19 and deciding on lockdown strategies



Li et al., *J Power Sources*, 2014

Software and packages we use

- **PyBaMM (**Python Battery Mathematical Modelling): open-source code for solving battery models
- **OpenABM-Covid19:** Agent-based modelling of the Covid-19 pandemic, used to inform policy makers. The code consists of a mixture of Python (52%), C (30%), and R (10%).
- **PyBullet :** Physics engine

Real-world applications

Industry-led projects in EMAT30005 (Mathematical and Data Modelling 3)

Projects come from a wide range of companies including Sky, Ocado, GCHQ, Toshiba, and many more

Example problems:

- Calculating flight paths of rockets and risk assessments
- Predicting when oil and gas pipelines will fail from ultrasound images
- Automated detection of abnormal sperm from microscope images

Closing remarks

- Programming has transformed the way in which engineering (and other) problems are solved
- You will likely cross paths with programming again in your studies and possibly in your career
- All programming languages are built on the basic ideas covered in this course (variables, if/else statements, loops, etc).
- Good luck!