PHYS4038/MLiS and AS1/MPAGS

Scientific Programming in

python™

mpags-python.github.io

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PHYS4038/MLiS

Course Introduction

Course information and materials

- Moodle page

  https://moodle.nottingham.ac.uk/course/view.php?id=95853

→ https://mpags-python.github.io

- Slides and notebooks used in lectures
- Exercises and solutions

- 'Engage' lecture recordings available from Moodle page

Course aims

- To give you…
  - experience of using a modern scripting language
  - introduction to all essential Python syntax
  - practical advice about scientific programming
  - knowledge of the main scientific modules for Python
  - the ability to do basic data analysis tasks in Python
    (e.g. data manipulation, plotting, …)
  - knowledge of some specific tools for scientific computing
    (e.g. signal processing, optimisation, …)
  - an overview of Python's full capabilities
- Not to…
  - teach programming in general (but I will try to help!)
  - cover every aspect of Python

Course structure

- Ten sessions, every Monday this term, in George Green A13
  - 13:00 – 14:00 — lecture / workshop
    - mix of PowerPoint and Jupyter notebooks
    - have Python running and try things out as I talk
  - 14:00 – 15:00 — examples class
    - work on exercises and examples
    - ask any questions
    - make progress on coursework
    - help with debugging, etc.

Questions

- Talk to me:
  - During teaching sessions *(preferred)*
    - Specific questions, clarifications – just ask
    - Bigger issues – wait until end of lecture / start of examples class
  - Via email: steven.bamford@nottingham.ac.uk
  - Arrange a meeting
    - email me
    - office: CAPT A112b

Your backgrounds

- Your general programming experience?
  - languages
  - level
  - projects
- Your prior Python experience?
- Any particular things you want to be covered?

Provisional outline

- **Session 1**: Introduction to Python
  - Why Python is (mostly) awesome
  - Writing and running Python
  - Language basics
- **Session 2**: Introduction to Python, continued
  - More language basics
  - Good programming practice
- **Session 3**: Staying organised
  - Managing your environment with conda and pip
  - Version control with GitHub
- **Session 4**: Numerical Python
  - Numpy
  - Using arrays wisely
- **Session 5**: Plotting with Python
  - Matplotlib (and others)
- **Session 6**: Scientific Python overview
  - Scipy and other tools

Provisional outline

- **Session 7**: Scientific Python examples
  - Filtering, interpolation, optimisation
- **Session 8**: Data handling
  - Efficiently storing and processing large amounts of data
    - PyTables, Pandas, Dask
    - Multiprocessing
- **Session 9**: Robust, fast & friendly code
  - Testing and timing
  - Wrapping external libraries and creating the fastest code
    - cython, numba, etc.
  - Web applications
- **Session 10**: Python for specialists
  - Python for astronomers
    - Astropy
  - Python for theorists
    - Symbolic algebra
  - Bayesian inference and Deep Learning in Python
    - MCMC with emcee
    - ANNs with keras

Assessment

For those taking this module for University of Nottingham credits, towards a taught Masters or Undergraduate degree:

This is a 10 credit module.

- Code development – 60%
- Presentation on development – 20%
- Final report on development – 20%

All assessed work is performed individually.

You will be given a mark and feedback on each element.

Code development

- A Python program relevant to your interests
  - put course material into practice
  - opportunity to become familiar with Python
  - get feedback on your coding

- Your code should…
  - be written as an executable module (.py file) or Jupyter notebook (.ipynb)
  - do something meaningful: analyse real data or perform a simulation
  - define at least two user functions (but typically more)
  - make use of appropriate specialist modules
  - produce at least one informative plot
  - comprise >~ 50 lines of actual code
    - excluding comments, imports and other 'boilerplate'
  - contain no more than 1000 lines in total
    - if you have written more, please isolate an individual element

Code development

- Three stages – together 60% of module mark

1. hand-in by **1st November** – 5%
   - README describing what you intend your code to do
   - Rough outline of the code (classes, functions, snippets, comments, pseudocode)

2. hand-in by **15th November** – 15%
   - Rough version of your code, may be incomplete, have bugs, although try to make it reasonable and easy to understand!

3. hand-in by **13th December** – 40%
   - Complete working version of your code

Deadlines are 3pm on Fridays.

Presentation and report

- Develop your ability to communicate verbally and through writing:
  - scientific objectives
  - coding choices
  - tests and performance
  - results and implications
  - potential improvements

- Presentation – 20%
  - 5 – 10 minutes
  - In examples class on **25th November**

- Report – 20%
  - 2 – 3 sides of A4 (~1500 words plus figures)
  - hand-in by **13th December**

Feedback

- I aim to provide:
- feedback on each intermediate activity within ~ 1 week
- final feedback within ~ 2 weeks

- Code feedback will be given through GitHub
  - Introduced in Session 3

- Marks and feedback on presentation and report via Moodle

That's it for today!

Next up (with MPAGS students):

- **Session 1**: Introduction to Python
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  - Language basics

- **Session 2**: Introduction to Python, continued
  - More language basics
  - Good programming practice