PYTHON
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PYTHON FOR SCIENTISTS & ENGINEERS

Python for Scientists & Engineers

A specialist course

Audience: This is a course for scientists and engineers interested in using Python for solving computational problems and processing, analyzing, visualizing, and modelling different kinds of scientific data.

Context: In the last 15 years Python has become the go-to language for scientific and engineering computing, with a powerful ecosystem of high-level libraries for easily solving a wide range of problems.

Overview: You will gain a broad understanding of methods and tools in modern scientific computing, including simulation and machine learning. You will also come to appreciate the elegance and power of the Python language and its powerful ecosystem of packages.

Format: Live instructor-led training (online). Each topic is a mixture of expert instruction, worked examples, and hands-on exercises with help from the instructor(s).

Expert instructors: See bios below.

Duration: 5 days

Modules: You are welcome to mix and match days or split them across multiple sessions (see dates below).

Days 1–2:   Introduction to Python
Days 3–4:   Modelling and Predictive Analytics
Day 5:   Scientific Computing

Prerequisites: Days 3–5 require completion of Days 1–2 (Introduction to Python) or equivalent experience (3+ months)

Price:

Regular course (5 days): AUD $4,250 (excl GST)
Modular / partial courses: AUD $900 (excl GST) per day

Dates (February – December 2024):

18–19 March 2024 (days 1–2); 25–26 March 2024 (days 3–4)
29 April – 3 May 2024
3–7 June 2024
24–28 June 2024
12–16 August 2024
21–25 October 2024
9–13 December 2024

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Skills & Activities

Skills

Days 1–2: You will gain a solid understanding of the Python language and experience using Python for a wide range of scripting and data-manipulation tasks with data in a variety of useful formats; and creating beautiful statistical graphics and simple dashboards.

Day 3: You will learn about manipulating vector/matrix data; performing Monte Carlo simulations; transforming hierarchical data, analysing time-series data, interpolation and linear regression, and detecting outliers / anomalies.

Day 4: You will learn how to use machine learning (ML) to construct powerful predictive models using nonlinear regression and classification; and how to evaluate, refine, and deploy ML models.

Day 5: You will gain an overview of available scientific routines, including for linear algebra, curve fitting, optimization, constructing statistical models, solving ODEs, signal and image processing, easily handling scientific data formats and scientific units with uncertainties, and scaling up to handling medium-sized (sub-terabyte) data.

Activities

Exercises: There will be practical exercises throughout the training course. These will be challenging and fun, and the solutions will be discussed after each exercise and provided as source code. During the exercises, the trainer will offer help and suggestions.

Worked examples: To prepare you for the exercises, the trainer will present worked examples and demos and help you to follow along on your own computer.

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Topic outline

Day 1: Python basics

Day 1 covers how to use Python for basic scripting and automation tasks, including tips and tricks for making this easy:

- Why Python? What's possible?

- The *Jupyter* notebook for rapid prototyping

- Modules and packages

- Python concepts: an introduction through examples

- Essential data types: strings, tuples, lists, dicts, file paths

- Worked example: retrieving real-time data from a REST web API

- Raising and handling exceptions

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Topic outline

Day 2: Handling, analyzing, and presenting data

Python offers amazingly productive tools like Pandas for working with different kinds of data. Day 2 gives a thorough introduction to analyzing and visualizing data easily:

- Reading and writing essential data formats:
    CSV, Excel, SQL, time-series (others on request)

- Indexing and selecting data in *Pandas*

- Data fusion: joining & merging datasets

- Summarization with "group by" operations; pivot tables

- Visualization and statistical graphics with *Plotly Express*

- Worked example: creating automated reports

- Creating interactive dashboards with *Streamlit*

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Topic outline
Day 3: Further data analytics

Day 3 shows you how to manipulate matrix/vector data, hierarchical data, and time-series. It also demonstrates the powerful tools of Monte Carlo simulation, interpolation, and outlier / anomaly detection:

• Introduction to *NumPy* for manipulating vector and matrix data: data types, powerful indexing, reshaping, *ufuncs*

• Monte Carlo simulation and applications

• Data transformations: stack, unstack, melt, transform

• Time-series analysis: parsing dates; resampling; interpolation

• Interpolation and linear regression

• Outlier and anomaly detection with *pyod*; applications to time-series

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Topic outline
Day 4: Machine learning

Day 4 gives you a practical and comprehensive introduction to supervised machine learning in Python for powerfully inferring complex models from data, with examples selected from a range of industries, including time-series and spatial datasets:

- Intuition behind ML; overview of the ML package ecosystem in Python

- Nonlinear regression; application to time-series forecasting

- Classification; application to diagnosis, AI systems, satellite imagery, ...

- Validation and model selection; diagnostic tools; *yellowbrick*

- Feature engineering and selection; *eli5*

- Deploying machine learning models in production

Topic outline

Day 5: Scientific computing with Python

Day 5 teaches you specialized tools in Python for scientific and engineering computing. It gives you a comprehensive introduction to *SciPy* and related packages, and other specialized topics on request, such as scaling up numerical code to larger datasets.

- Handling scientific data formats

- Handling scientific units and uncertainties

- Dense & sparse linear algebra

- Clustering and dimensionality reduction

- Statistical modelling and density estimation

- Optimization and curve fitting

- Other topics on request, such as:
  - Integration / ODEs
  - Signal & image processing
  - Speeding up numerical code
  - Parallel and distributed computing with *dask*

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Personal help

We are happy to offer on-the-spot problem-solving after each day of the training for you to ask one-on-one questions — whether about the course content and exercises or about specific problems you face in your work and how to solve them. If you would like us to prepare for this in advance, you are welcome to send us background info before the course.

Other information

Format: Courses are conducted online via live video meeting and using Python Charmers' cloud notebook server for coding and sharing code with the trainer(s).

Computer:
- **Hardware**: we recommend ≥ 8 GB of RAM and a webcam.
  Preferably also multiple screens and a quiet room (or headset mic).
- **Software**: a modern browser: *Chrome*, *Firefox*, or *Safari* (not *IE* or *Edge*); and *Zoom*

Timing: Most courses will run from 9:00 to roughly 17:00 (AEST/AEDT) each day, with breaks of 50 minutes for lunch and 20 minutes each for morning and afternoon tea.

Certificate of completion: We will provide you a certificate if you complete the course and successfully answer the majority of the exercise questions.

Materials: You will have access to all the course materials online. We will also mail you cheat sheets and a USB stick with all the materials for reference.

Instructor bio

Dr Edward Schofield

Ed has consulted to or trained over 3000 people from dozens of organisations in data analytics using Python, including Atlassian, Barclays, Cisco, CSIRO, Dolby, Harvard University, IMC, Singtel Optus, Oracle, Shell, Telstra, Toyota, Verizon, and Westpac. He is well-known in the Python community as a former release manager of *SciPy* and the author of the widely used *future* package. He regularly presents at conferences in data science and Python in Australia and internationally.

Ed holds a PhD in machine learning from Imperial College London. He also holds BA and MA (Hons) degrees in mathematics and computer science from Trinity College, University of Cambridge. He has 20+ years of experience in programming, teaching, and public speaking.

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Instructor bio

Dr Robert Layton

Robert is the author of the book "Data Mining in Python", published by Packt. He provides analysis, consultancy, research and development work to businesses, primarily using Python. Robert has worked with government, financial and security sectors, in both a consultancy and academic role. He is also a Research Fellow at the Internet Commerce Security Laboratory, investigating cybercrime analytics and data-mining algorithms for attribution and profiling.

Robert is a contributor to the Python-based *scikit-learn* open source project for machine learning and writes regularly on data mining for a number of outlets. He was the author of the website "LearningTensorflow.com", sold to DataBricks. He has presented at a number of international conferences in Python, data analysis, and its applications.

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Instructor bio

Henry Walshaw

Henry has almost 15 years of experience in Python application development and has trained hundreds of people in how to use Python from organisations including AGL, the Bureau of Meteorology, ESRI, the NSW Department of Finance, National Australia Bank, and Telstra.

Henry's core technical expertise relates to the development and analysis of large scale spatial datasets (primarily using Python), and communicating this understanding to both subject matter experts and the general public.

Before joining Python Charmers, Henry worked in both government and industry — at Geoscience Australia, the Victorian Department of Sustainability and Environment, and the Environmental Protection Agency (EPA); as a consultant with Sinclair Knight Merz (SKM), a manager at we-do-IT, and as CTO of a startup. He holds a Bachelors in Computational Science.

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Instructor bio

Errol Lloyd

Errol's background is in computational neuroscience. He has been using Python for modelling neurological systems, digital signal processing, data analysis, and empirical research for 7 years.

Prior to joining Python Charmers in 2020, Errol trained fellow researchers from both the sciences and the humanities in a variety of software solutions to research problems, including data and natural language analysis in python, data visualisation, interactive dashboards with front-end javascript, and version control and collaboration with git and GitHub.

Errol is an advocate for open source software and reproducible research in science, and is passionate about empowering others to use code in enhancing their productivity. He is currently completing doctoral studies on visual processing in the brain at the University of Melbourne.

About Python Charmers®

Python Charmers is a leading global provider of training in data science and software development, based in Australia and Singapore. Since 2010, Python Charmers has given over 600 training courses and bootcamps to over 6,000 delighted people from organizations such as AGL, Atlassian, Barclays, CSIRO, Cisco, Deloitte, Dolby, IMC, pwc, Singtel Optus, Shell, Sportsbet, Telstra, Toyota, Verizon, Westpac, and Woolworths. Python Charmers specializes in teaching programming and data science to scientists, engineers, data analysts, quants, and computer scientists.

Python Charmers' trainers boast years of experience with data science, data analytics, statistical modelling, and programming, and deep roots in the open source community, as both speakers at events and contributors to well-known open source projects for data science, including *NumPy*, *SciPy*, *Scikit-Learn*, *Pandas*, *Matplotlib, NetworkX, Dash*, and *Future*.

Testimonials: Testimonials from past participants of similar bootcamps and training courses are available at:

https://pythoncharmers.com/testimonials/

Questions: We are happy to customise this program further on request. Please let us know if you would like to discuss this or have any other questions.

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