

M269 Overview

M269 Overview Prsntn 2021J

Phil Molyneux

10 October 2021

M269 Overview Tutorial

Agenda

- ▶ Introductions
- ▶ M269 Overview
- ▶ Basic Computational Components
- ▶ Course material and software: Anaconda and Jupyter Notebooks
- ▶ Learning Software Packages
- ▶ How to Program (in two slides)
- ▶ How to survive learning software packages
- ▶ *Adobe Connect* — if you or I get cut off, wait till we reconnect (or send you an email)
- ▶ Time: about 1 hour
- ▶ Do ask questions or raise points.
- ▶ Slides/Notes [M269Tutorial01Overview](#)

- ▶ *Name* Phil Molyneux
- ▶ *Background*
 - ▶ Undergraduate: Physics and Maths (Sussex)
 - ▶ Postgraduate: Physics (Sussex), Operational Research (Brunel), Computer Science (University College, London)
 - ▶ Worked in Operational Research, Business IT, Web technologies, Functional Programming
- ▶ *First programming languages* [Fortran](#), [BASIC](#), [Pascal](#)
- ▶ *Favourite Software*
 - ▶ [Haskell](#) — pure functional programming language
 - ▶ Text editors [TextMate](#), [Sublime Text](#) — previously [Emacs](#)
 - ▶ Word processing in [L^AT_EX](#) — all these slides and notes
 - ▶ [Mac OS X](#)
- ▶ *Learning style* — I read the manual before using the software

M269 Tutorial

Introductions — You

- ▶ *Name ?*
- ▶ *Favourite software/Programming language ?*
- ▶ *Favourite text editor or integrated development environment (IDE)*
- ▶ **List of text editors, Comparison of text editors and Comparison of integrated development environments**
- ▶ *Other OU courses ?*
- ▶ *Anything else ?*

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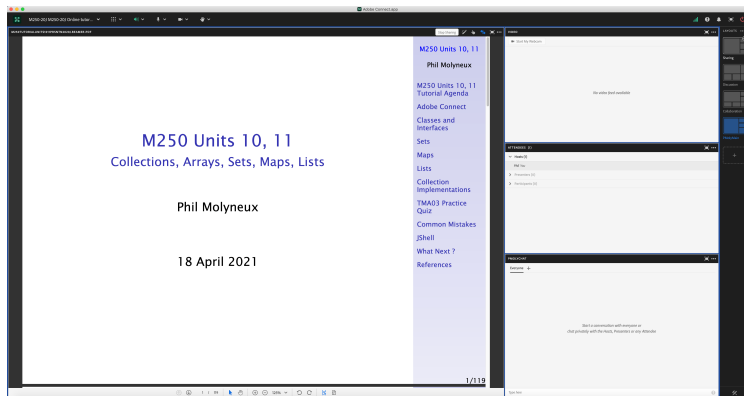
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Interface — Host View



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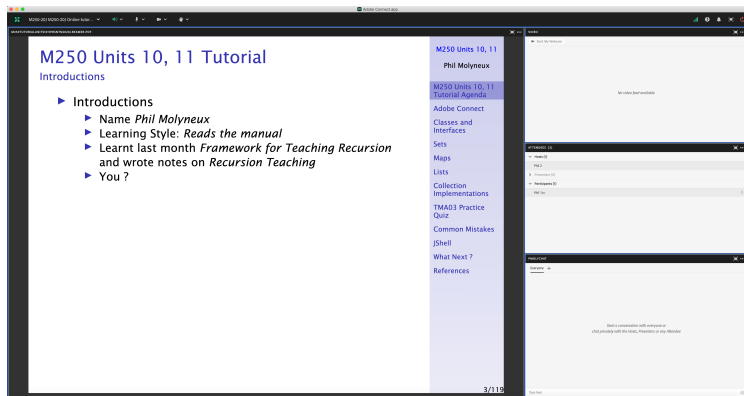
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Adobe Connect

Interface — Participant View



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Settings

- ▶ **Everybody** Menu bar Meeting Speaker & Microphone Setup
- ▶ Menu bar Microphone Allow Participants to Use Microphone ✓
- ▶ Check Participants see the entire slide **Workaround**
 - ▶ Disable Draw Share pod Menu bar Draw icon
 - ▶ Fit Width Share pod Bottom bar Fit Width icon ✓
- ▶ Meeting Preferences General **Host Cursor** Show to all attendees
- ▶ Menu bar Video Enable **Webcam** for Participants ✓
- ▶ Do not *Enable single speaker mode*
- ▶ Cancel hand tool
- ▶ Do not enable green pointer
- ▶ **Recording** Meeting Record Session ✓
- ▶ **Documents** Upload PDF with drag and drop to share pod
- ▶ Delete Meeting Manage Meeting Information Uploaded Content and check filename click on delete

Adobe Connect

Access

► Tutor Access

TutorHome > M269 Website > Tutorials

Cluster Tutorials > M269 Online tutorial room

Tutor Groups > M269 Online tutor group room

Module-wide Tutorials > M269 Online module-wide room

► Attendance

TutorHome > Students > View your tutorial timetables

► Beamer Slide Scaling 440% (422 x 563 mm)

► Clear Everyone's Status

Attendee Pod > Menu > Clear Everyone's Status

► Grant Access and send link via email

Meeting > Manage Access & Entry > Invite Participants...

► Presenter Only Area

Meeting > Enable/Disable Presenter Only Area

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Adobe Connect

Keystroke Shortcuts

- ▶ **Keyboard shortcuts in Adobe Connect**
- ▶ **Toggle Mic**  + **M** (Mac), **Ctrl** + **M** (Win) (On/Disconnect)
- ▶ **Toggle Raise-Hand status**  + **E**
- ▶ **Close dialog box**  (Mac), **Esc** (Win)
- ▶ **End meeting**  + ****

Adobe Connect Interface

Sharing Screen & Applications

- ▶ **Share My Screen** > **Application tab** > **Terminal** for **Terminal**
- ▶ **Share menu** > **Change View** > **Zoom in** for mismatch of screen size/resolution (Participants)
- ▶ (Presenter) Change to 75% and back to 100% (solves participants with smaller screen image overlap)
- ▶ Leave the application on the original display
- ▶ Beware blue hatched rectangles — from other (hidden) windows or contextual menus
- ▶ Presenter screen pointer affects viewer display — beware of moving the pointer away from the application
- ▶ First time: **System Preferences** > **Security & Privacy** > **Privacy** > **Accessibility**

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Ending a Meeting

- ▶ *Notes for the tutor only*
- ▶ **Student:** Meeting > Exit Adobe Connect
- ▶ **Tutor:**
- ▶ **Recording** Meeting > Stop Recording ✓
- ▶ **Remove Participants** Meeting > End Meeting... ✓
 - ▶ Dialog box allows for message with default message:
 - ▶ *The host has ended this meeting. Thank you for attending.*
- ▶ **Recording availability** *In course Web site for joining the room, click on the eye icon in the list of recordings under your recording* — edit description and name
- ▶ **Meeting Information** Meeting > Manage Meeting Information — can access a range of information in Web page.
- ▶ **Attendance Report** see course Web site for joining room

Adobe Connect

Invite Attendees

- ▶ **Provide Meeting URL** Menu Meeting Manage Access & Entry
Invite Participants...
- ▶ **Allow Access without Dialog** Menu Meeting
Manage Meeting Information provides new browser window with *Meeting Information* Tab bar Edit Information
- ▶ Check *Anyone who has the URL for the meeting can enter the room*
- ▶ Default *Only registered users and accepted guests may enter the room*
- ▶ **Reverts to default next session but URL is fixed**
- ▶ Guests have blue icon top, registered participants have yellow icon top — same icon if URL is open
- ▶ See [Start, attend, and manage Adobe Connect meetings and sessions](#)

Adobe Connect

Layouts

- ▶ **Creating new layouts** example *Sharing* layout
- ▶ **Menu** > **Layouts** > **Create New Layout...** > **Create a New Layout dialog**
> **Create a new blank layout** and name it *PMolyMain*
- ▶ New layout has no Pods but does have Layouts Bar open (see Layouts menu)
- ▶ **Pods**
- ▶ **Menu** > **Pods** > **Share** > **Add New Share** and resize/position — initial name is *Share n*
- ▶ **Rename Pod** **Menu** > **Pods** > **Manage Pods...** > **Manage Pods**
> **Select** > **Rename** or **Double-click & rename**
- ▶ Add Video pod and resize/reposition
- ▶ Add Attendance pod and resize/reposition
- ▶ Add Chat pod — name it *PMolyChat* — and resize/reposition

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Adobe Connect

Layouts

- ▶ Dimensions of **Sharing** layout (on 27-inch iMac)
 - ▶ Width of Video, Attendees, Chat column 14 cm
 - ▶ Height of Video pod 9 cm
 - ▶ Height of Attendees pod 12 cm
 - ▶ Height of Chat pod 8 cm
- ▶ **Duplicating Layouts** does *not* give new instances of the Pods and is probably not a good idea (apart from local use to avoid delay in reloading Pods)

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Chat Pods

- ▶ **Format Chat text**

- ▶  menu icon 

- ▶ Choices: Red, Orange, Green, Brown, Purple, Pink, Blue, Black

- ▶ Note: Color reverts to Black if you switch layouts

- ▶  menu icon 

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Graphics Conversion

PDF to PNG/JPG

- ▶ Conversion of the screen snaps for the installation of Anaconda on 1 May 2020
- ▶ Using GraphicConverter 1.1
- ▶ 
- ▶ Select files to convert and destination folder
- ▶ Click on  or  + 

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M269 Algorithms, data structures and computability

Aims

- ▶ Ideas of *computational thinking*
- ▶ Introduction to algorithms and data structures (using *Python*)
- ▶ Logic and the limits of computation
- ▶ Computability
- ▶ Complexity

M269 Algorithms, data structures and computability

Topics Weeks 1-10

- ▶ Numbers and sequences — functions, complexity, data types
- ▶ Booleans and selection — Abstract Data Type (ADT), Decision problems
- ▶ Sequences and iteration — control structures for iteration, lists, tuples
- ▶ Implementing sequences — arrays as primitives, lists in arrays
- ▶ Stack and queues — example ADTs
- ▶ Unordered collections — maps, dictionaries, hash tables, sets, bags

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M269 Algorithms, data structures and computability

Topics Weeks 11–20

- ▶ Exhaustive search
- ▶ Recursion — some historical context
- ▶ Divide and conquer
- ▶ Sorting
- ▶ Tree data structures
- ▶ Graph algorithms
- ▶ Greedy algorithms

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M269 Algorithms, data structures and computability

Topics Weeks 21–30

- ▶ M269 Units 6 Sets, logic and databases
- ▶ Propositional and predicate logic — first order logic
- ▶ M269 Unit 7 Computation
- ▶ Computability and complexity
- ▶ NP-completeness

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Computational Components

Imperative, Procedural Programming

Imperative or procedural programming has statements which can manipulate global memory, have explicit **control flow** and can be **organised** into procedures (or functions)

► **Sequence** of statements

```
stmnt ; stmnt
```

► **Iteration** to repeat statements

```
while expr :  
    suite  
  
for targetList in exprList :  
    suite
```

► **Selection** choosing between statements

```
if expr : suite  
elif expr : suite  
else : suite
```

Computational Components

Functional Programming

Functional programming treats computation as the evaluation of expressions and the definition of functions (in the mathematical sense)

- ▶ **Function composition** to combine the application of two or more functions — like sequence but from right to left (notation accident of history)

$$(f \circ g) x = f (g x)$$

- ▶ **Recursion** — function definition defined in terms of calls to itself (with *smaller* arguments) and base case(s) which do not call itself.
- ▶ **Conditional expressions** choosing between alternatives expressions

```
if expr then expr else expr
```

Computation

Programming, Programming Languages

- ▶ M269 is not a programming course but ...
- ▶ The course uses Python to illustrate various algorithms and data structures
- ▶ The final unit addresses the question:
- ▶ *What is an algorithm* ? What is programming ? What is a programming language ?
- ▶ So it *is* a programming course (sort of)

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Computation

Syntax and Semantics

- ▶ **Syntax and Semantics (1)**
- ▶ What is each of the following — *first reaction* !

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Syntax and Semantics

- ▶ **Syntax and Semantics (1)**
- ▶ What is each of the following — *first reaction* !
- ▶ $4 + 6$

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Syntax and Semantics

- ▶ **Syntax and Semantics (1)**
- ▶ What is each of the following — *first reaction* !
- ▶ $4 + 6$
- ▶ $4 + 6 \times 3$

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Syntax and Semantics

- ▶ **Syntax and Semantics (1)**
- ▶ What is each of the following — *first reaction* !
- ▶ $4 + 6$
- ▶ $4 + 6 \times 3$
- ▶ 4

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Syntax and Semantics

- ▶ **Syntax and Semantics (1)**
- ▶ What is each of the following — *first reaction* !
- ▶ $4 + 6$
- ▶ $4 + 6 \times 3$
- ▶ 4
- ▶ $19370721 \times 761838257287$

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What Next ?

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► Syntax and Semantics (1)

► What is each of the following — *first reaction* !

► $4 + 6$

► $4 + 6 \times 3$

► 4

► $19370721 \times 761838257287$

► The above are *expressions in arithmetic*

► Most students read *what is* as *evaluate*

► Not easy for the last one

► *But* you can say:

► *They are expressions which when evaluated, evaluate to some number*

► $19370721 \times 761838257287$

► $= 147573952589676412927 = 2^{67} - 1$

► demonstrated in a famous meeting of the New York AMS in October 1903 by [F.N.Cole](#) (Cole, 1903)

Computation

Cartesian Closed Comic — Equality



Cartesian Closed Comic: cc-by-nc/1.0

Sad fact: many math teachers do not know the difference between equality and reduction.

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Syntax and Semantics

- ▶ **Syntax and Semantics (2)**
- ▶ **Evaluate**
- ▶ $6 + 4 \times 3$
- ▶ $6 - 4 - 1$
- ▶ False or True (in Python)
- ▶ $5 // 3$ (integer division in Python)
- ▶ $1 // 0$ (in Python)
- ▶ False or True or $1 // 0$ (in Python)

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Syntax and Semantics

Elementary Concepts

- ▶ An *expression* can be thought of as a program (and vice versa)
- ▶ A set of instructions to find a value.
- ▶ Operator *precedence* and *associativity* are there to get rid of some brackets
- ▶ (to make the code more *user friendly*!)
- ▶ **Precedence** — which operator to use first. This is also called *binding power* or operator *fixity*
- ▶ **Associativity** — for the same operator, whether to evaluate from left to right or right to left (or it doesn't matter)
- ▶ **Lazy Evaluation** — don't do today what you can put off til tomorrow, because you might never have to do it (useful in computation — not useful for doing TMAs)

Syntax and Semantics

Sharp Edges

- ▶ **Sharp edges**
- ▶ Evaluate (in Maths) 2^2 and 2^{2^2} and $2^{2^{2^2}}$
- ▶ In Python `2**2**2**2`
- ▶ Alternate in Python `pow(2,pow(2,pow(2,2)))`
- ▶ Microsoft Excel `=2^2^2^2`
- ▶ or use LibreOffice, Numbers, ...

Syntax and Semantics

Sharp Edges

- ▶ **Sharp edges**
- ▶ Evaluate (in Maths) 2^2 and 2^{2^2} and $2^{2^{2^2}}$
- ▶ $2^{2^2} = 16$ and $2^{2^{2^2}} = 2^{16} = 65536$ (or 64K in computing)

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Sharp Edges

- ▶ **Sharp edges**
- ▶ Evaluate (in Maths) 2^2 and 2^{2^2} and $2^{2^{2^2}}$
- ▶ $2^{2^2} = 16$ and $2^{2^{2^2}} = 2^{16} = 65536$ (or 64K in computing)
- ▶ Python `2**2**2**2 == 65536`
- ▶ Python `pow(2,pow(2,pow(2,2))) == 65536`

Syntax and Semantics

Sharp Edges

- ▶ **Sharp edges**
- ▶ Evaluate (in Maths) 2^2 and 2^{2^2} and $2^{2^{2^2}}$
- ▶ $2^{2^2} = 16$ and $2^{2^{2^2}} = 2^{16} = 65536$ (or 64K in computing)
- ▶ Python `2**2**2**2 == 65536`
- ▶ Python `pow(2,pow(2,pow(2,2))) == 65536`
- ▶ Casio fx-85GT Plus `2^2^2^2` shows 65536

Syntax and Semantics

Sharp Edges

► Sharp edges

- Evaluate (in Maths) 2^2 and 2^{2^2} and $2^{2^{2^2}}$
- $2^{2^2} = 16$ and $2^{2^{2^2}} = 2^{16} = 65536$ (or 64K in computing)
- Python `2**2**2**2 == 65536`
- Python `pow(2,pow(2,pow(2,2))) == 65536`
- Casio fx-85GT Plus `2^2^2^2` shows 65536
- Haskell `2^2^2^2 == 65536`

Syntax and Semantics

Sharp Edges

► Sharp edges

- Evaluate (in Maths) 2^2 and 2^{2^2} and $2^{2^{2^2}}$
- $2^{2^2} = 16$ and $2^{2^{2^2}} = 2^{16} = 65536$ (or 64K in computing)
- Python `2**2**2**2 == 65536`
- Python `pow(2,pow(2,pow(2,2))) == 65536`
- Casio fx-85GT Plus `2^2^2^2` shows 65536
- Haskell `2^2^2^2 == 65536`
- Microsoft Excel `=2^2^2^2 == 256`
- *Beware language semantics*

Syntax and Semantics

Sharp Edges

► Sharp edges

- Evaluate (in Maths) 2^2 and 2^{2^2} and $2^{2^{2^2}}$
- $2^{2^2} = 16$ and $2^{2^{2^2}} = 2^{16} = 65536$ (or 64K in computing)
- Python `2**2**2**2 == 65536`
- Python `pow(2,pow(2,pow(2,2))) == 65536`
- Casio fx-85GT Plus `2^2^2^2` shows 65536
- Haskell `2^2^2^2 == 65536`
- Microsoft Excel `=2^2^2^2 == 256`
- *Beware language semantics*
- Microsoft Excel `=2^2^2^2^2 == 65536`
- Haskell `length (show (2^2^2^2^2)) == 19729`
- $2^{2^{2^2}}$ has 19729 digits
- What is Excel doing differently ?

Computation

Programming Languages

- ▶ Add a tick on the slide next to languages used
- ▶ FORTRAN
- ▶ BASIC
- ▶ Pascal
- ▶ SASL
- ▶ C
- ▶ Miranda
- ▶ Prolog
- ▶ JavaScript
- ▶ Java
- ▶ Haskell
- ▶ Add names of other languages used

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Programming Languages and Coding

- ▶ Are the following programming languages ?
- ▶ Excel
- ▶ HTML
- ▶ Word
- ▶ $\text{\LaTeX}$
- ▶ SQL

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Programming Languages and Coding — Excel

- ▶ **Excel**
- ▶ Excel has conditional expressions and indirections (so can have loops)
- ▶ An [Excel Turing Machine](#) is described in [Felienne's blog](#)
- ▶ Excel see [Improving the world's most popular functional language: user-defined functions in Excel](#)
- ▶ [Announcing LAMBDA: Turn Excel formulas into custom functions](#) (3 December 2020)

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Programming Languages and Coding — HTML

- ▶ **HTML**
- ▶ **HyperText Markup Language** is the standard markup language for Web pages — it describes the structure of the content.
- ▶ It can contain CSS (for describing appearance) and
- ▶ JavaScript (for describing behaviour)
- ▶ HTML is not a programming language
- ▶ JavaScript is a Turing complete programming language but embedded in a host environment.
- ▶ CSS could be extended to be Turing complete — see **Is CSS Turing complete**

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Computation

Programming Languages and Coding — Word

- ▶ **Word**
- ▶ [Microsoft Word](#) interface to text formatting
- ▶ Serialised with the markup language [Office Open XML](#)
- ▶ [Visual Basic for Applications](#) is embedded and is a programming language

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Computation

Programming Languages and Coding — $\LaTeX$

- ▶ $\LaTeX$
- ▶ $\LaTeX$ is a format of $\TeX$
- ▶ Markup technology for typesetting documents — oriented towards mathematics and technical documents.
- ▶ Is also a Turing complete programming language (Unit 7)
- ▶ Used in MST125 Essential Mathematics 2 Unit 2 *Mathematical typesetting*

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Programming Languages and Coding — SQL

- ▶ **SQL**
- ▶ **Structured Query Language** based on relational algebra and tuple relational calculus
- ▶ Syntactic sugar for first order logic (Unit 6)
- ▶ Originally not a **Turing complete programming language** (Unit 7)
- ▶ but extensions are Turing complete

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Programming Languages and Coding

- ▶ **Turing completeness** is not everything
- ▶ Data languages such as **XML**, **HTML**, **JSON**
- ▶ **Regular languages** for **regular expressions** in your favourite text editor (and some programming languages)
- ▶ **Pushdown automata** and **Context-free grammars** used in program compiling.
- ▶ **Total Functional Programming** requires all programs to be provably terminating.

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Anaconda

- ▶ **Anaconda** [Individual Edition](#)
- ▶ **Anaconda documentation** [Documentation](#)
- ▶ **Anaconda documentation** [Quick Start Guide](#)
- ▶ **Anaconda Troubleshooting** [Troubleshooting](#)
- ▶ You have to pay attention to your configuration:
Windows, macOS, Linux

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Anaconda

macOS

► macOS bash

- The install sets up `.bash_profile` which then bypasses `.profile` and `.bashrc`
- `/Users/molyneux/opt/anaconda3/bin` is prepended to your `PATH` (with your user name not mine, *molyneux*)
- I have the following set in `.profile` and `.bashrc`
- `.profile`

```
export PYTHONSTARTUP="$HOME/.PythonStartupRC/PythonStartupRC.py"  
# Sets the prompts for several Python distributions
```

► `.bashrc`

```
# Python aliases for alternate Python distributions  
  
alias anPython="$HOME/opt/anaconda3/bin/python"  
alias acPython="/usr/local/bin/python3"  
alias apPython="/usr/bin/python"
```

Python & Jupyter Notebook

Jupyter Notebook

- ▶ [Jupyter Notebook](#) is a Web application that allows the sharing of documents containing live code, equations and other Maths, visualisations and narrative text
- ▶ [Jupyter Notebook documentation](#)
- ▶ Launch *Jupyter Notebook*
- ▶ Navigate to the folder containing the notebooks in a command terminal (macOS Terminal)

```
jupyter notebook &
```

- ▶ Your default Web browser opens with *Notebook Dashboard*
- ▶ Navigate to a Notebook file (*.pynb) to launch a *Notebook Editor* on the Notebook file
- ▶  
- ▶  
- ▶ Halt a *Notebook Editor* with  

Jupyter Notebook

`custom.css`

- ▶ The supplied file `custom.css` (with the book files) changes some styles
- ▶ The file has to be placed at `~/.jupyter/custom/custom.css` — note the `(.)` in `.jupyter`

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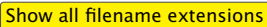
[References](#)

Jupyter Notebook

custom.css

- ▶ Some files and folders in macOS are not displayed by default in Finder or Terminal
- ▶ These are files with names starting with a dot (.), Library folders (there are several) and some system folders
- ▶ Here are several ways of making these files visible
- ▶ **Finder (1)** with Finder selected, type  +  +  — the keystroke command is a toggle so to turn viewing off just re-type the same
- ▶ **Finder (2)** to make the change permanent, type the following in Terminal

```
defaults write com.apple.Finder AppleShowAllFiles true  
killall Finder
```

- ▶ **Finder (3)** to make a permanent change without using Terminal have a look at [TinkerTool](#) (free) — the *Finder* tab first item is *Show hidden and system files*
- ▶ Also make sure you display filename extensions with    and check 

Jupyter Notebook

macOS File Paths

- ▶ Obtaining a folder or file path in Finder:
- ▶ (1) Drag the folder or file into a Terminal window
the file path is displayed at the command prompt
most often used with `cd` to change to a new folder
- ▶ (2) Ensure you have the *Path Bar* visible

View Show Path Bar

Right-click on the folder in the Path Bar and go

Copy Folder as Pathname

- ▶ (3) In Terminal use the `pwd` command
- ▶ **Question** What folders are represented by

`(.)`

`(..)`

`./SomeFolder`

`/SomeFolder`

`../SomeFolder`

Jupyter Notebook

Notebook File Format (1) — Optional

- ▶ Optional topic from [Notebook file format](#)
- ▶ This is not part of the course for may be of interest
- ▶ **Top-level structure**
- ▶ metadat (dict)
- ▶ nbformat (int)
- ▶ nbformat_minor (int)
- ▶ cells (list)

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Jupyter Notebook

Notebook File Format (2)

► Top-level structure

```
1 {
2   "metadata" : {
3     "kernel_info": {
4       # if kernel_info is defined, its name field is required.
5       "name" : "the_name_of_the_kernel"
6     },
7     "language_info": {
8       # if language_info is defined, its name field is required.
9       "name" : "the_programming_language_of_the_kernel",
10      "version": "the_version_of_the_language",
11      "codemirror_mode": "The_name_of_the_codemirror_mode_to_use[optional]"
12    }
13  },
14  "nbformat": 4,
15  "nbformat_minor": 0,
16  "cells" : [
17    # list of cell dictionaries, see below
18  ],
19 }
```

Jupyter Notebook

Notebook File Format (3)

- ▶ **Cell Types**
- ▶ Basic structure

```
1 {  
2   "cell_type" : "type",  
3   "metadata" : {},  
4   "source" : "single_string_or_[list,of,strings]",  
5 }
```

- ▶ Several basic cell types
- ▶ Markdown cells
- ▶ Code cells
- ▶ Raw NBConvert cells

Jupyter Notebook

Notebook File Format (4)

► Markdown Cells

- Markdown cells are used for body-text, and contain markdown, as defined in [GitHub-flavored markdown](#), and implemented in [marked](#).

```
1 {  
2   "cell_type" : "markdown",  
3   "metadata" : {},  
4   "source" : "[multi-line_*markdown*]",  
5 }
```

- It would be useful to learn some Markdown — and HTML, CSS
- [Mastering Markdown](#)
- [Daring Fireball: Markdown](#) the original reference
- [MultiMarkdown](#) there are lots of extensions
- [Markdown Guide](#) and references
- [Python Markdown](#) see [Fenced Code Blocks](#)

Jupyter Notebook

Notebook File Format (5)

► Code Cells

```
1 {
2   "cell_type" : "code",
3   "execution_count": 1, # integer or null
4   "metadata" : {
5     "collapsed" : True, # whether the output of the cell is collapsed
6     "scrolled": False, # any of true, false or "auto"
7   },
8   "source" : "[some_multi-line_code]",
9   "outputs": [{
10     # list of output dicts (described below)
11     "output_type": "stream",
12     ...
13   }],
14 }
```

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Jupyter Notebook

Notebook File Format (6)

- ▶ **Code Cell Outputs**
- ▶ The `output_type` field defines the output
- ▶ **stream** output for text
- ▶ **display_data** data keyed by mime-type
- ▶ **execute_result** gives results of executing a cell
- ▶ **error** messages and traceback

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Jupyter Notebook

Notebook File Format (7)

- ▶ **Raw NBConvert Cells**
- ▶ content that should be included unmodified in nbconvert output

```
1 {  
2   "cell_type" : "raw",  
3   "metadata" : {  
4     # the mime-type of the target nbconvert format.  
5     # nbconvert to formats other than this will exclude this cell.  
6     "format" : "mime/type"  
7   },  
8   "source" : "[some_nbformat_output_text]"  
9 }
```

Jupyter Notebook

Notebook File Format (8)

- ▶ There are a lot more features than can be covered here
- ▶ The main usage here will be adding effects to a cell
- ▶ this will require some Markdown, HTML and CSS knowledge (but not much)
- ▶ See the documentation

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Learning Software Packages

Key questions

1. Where is the package source ?
2. What version are you using ?
3. What documentation is available ?
4. What are the *names* for the parts of the interface ?
5. How do you leave the package ? How do you enter the package ?
6. Is there any on-line help and, if so, how is it used ?
7. Are there any initialisation files, configuration or preferences and how are they used ?
8. How do you import and export data from the package ?
9. *When all else fails*, how can you obtain advice ?

Jupyter Notebook — Exercise

Key Questions (1)

- ▶ Answer the *Key Questions* for Jupyter Notebook
- ▶ Where is the package source ?
- ▶ What version are you using ?

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Jupyter Notebook — Exercise

Key Questions (1a)

- Where is the package source ?

Anaconda Individual Edition

See also [Installing the Jupyter Software](#)

- What version are you using ?

```
<~><107> jupyter --version
jupyter core      : 4.6.1
jupyter-notebook  : 6.0.3
qtconsole         : 4.6.0
ipython           : 7.12.0
ipykernel         : 5.1.4
jupyter client    : 5.3.4
jupyter lab       : 1.2.6
nbconvert         : 5.6.1
ipywidgets        : 7.5.1
nbformat          : 5.0.4
traitlets         : 4.3.3
<~><108>
```

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Jupyter Notebook — Exercise

Key Questions (1b)

► What version are you using ? Conda information

```
<~><111> conda info
  active environment : base
  active env location : /Users/molyneux/opt/anaconda3
    shell level      : 1
  user config file   : /Users/molyneux/.condarc
  populated config files : /Users/molyneux/.condarc
    conda version    : 4.8.2
  conda-build version : 3.18.11
    python version   : 3.7.6.final.0
  virtual packages   : __osx=10.14.6
  base environment   : /Users/molyneux/opt/anaconda3 (writable)
    channel URLs    : https://repo.anaconda.com/pkgs/main/osx-64
                    https://repo.anaconda.com/pkgs/main/noarch
                    https://repo.anaconda.com/pkgs/r/osx-64
                    https://repo.anaconda.com/pkgs/r/noarch
  package cache      : /Users/molyneux/opt/anaconda3/pkgs
                    /Users/molyneux/.conda/pkgs
  envs directories   : /Users/molyneux/opt/anaconda3/envs
                    /Users/molyneux/.conda/envs
    platform        : osx-64
  user-agent         : conda/4.8.2 requests/2.22.0 CPython/3.7.6 Darwin/18.7.0 OS
  UID:GID           : 501:20
  netrc file         : None
  offline mode       : False

<~><112>
```

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Jupyter Notebook — Exercise

Key Questions (2)

- ▶ Answer the *Key Questions* for Jupyter Notebook
- ▶ What documentation is available ?

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Jupyter Notebook — Exercise

Key Questions (2a)

- ▶ Answer the *Key Questions* for Jupyter Notebook
- ▶ What documentation is available ?

Jupyter Documentation

Jupyter Notebook Documentation [The Jupyter Notebook](#)

- ▶ [Anaconda Product Documentation](#)
- ▶ [Anaconda User Guide](#)
- ▶ [Conda documentation](#) package manager
- ▶ [Jupyter Notebook Format](#)
- ▶ [The JSON Data Interchange Standard](#)

Jupyter Notebook — Exercise

Key Questions (3)

- ▶ Answer the *Key Questions* for Jupyter Notebook
- ▶ What are the *names* for the parts of the interface ?

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Jupyter Notebook — Exercise

Key Questions (3a)

- ▶ Answer the *Key Questions* for Jupyter Notebook
- ▶ What are the *names* for the parts of the interface ?
User interface components
- ▶ *Notebook Dashboard* and *Notebook Editor*
- ▶ *Command mode* and *Edit mode*

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Jupyter Notebook — Exercise

Key Questions (4)

- ▶ Answer the *Key Questions* for Jupyter Notebook
- ▶ How do you leave the package ? How do you enter the package ?

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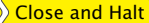
[References](#)

Jupyter Notebook — Exercise

Key Questions (4a)

- ▶ Answer the *Key Questions* for Jupyter Notebook
- ▶ How do you leave the package ? How do you enter the package ?
- ▶ **Enter**
- ▶ **Command line**

```
cd whateverFolder  
jupyter notebook &
```

- ▶ **GUI** see [Anaconda Navigator](#) but beware slow launch and having to navigate folders a lot
- ▶ **Leave**
- ▶ **Notebook Editor**  
- ▶ **Notebook Dashboard** 
- ▶ Note  does something else and will lead to an odd request to login

Jupyter Notebook — Exercise

Key Questions (5)

- ▶ Answer the *Key Questions* for Jupyter Notebook
- ▶ Is there any on-line help and, if so, how is it used ?

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Jupyter Notebook — Exercise

Key Questions (5a)

- ▶ Answer the *Key Questions* for Jupyter Notebook
- ▶ Is there any on-line help and, if so, how is it used ?

```
jupyter --help
```

but you will have to read the documentation

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Jupyter Notebook — Exercise

Key Questions (6)

- ▶ Answer the *Key Questions* for Jupyter Notebook
- ▶ Are there any initialisation files, configuration or preferences and how are they used ?

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Jupyter Notebook — Exercise

Key Questions (6a)

- ▶ Answer the *Key Questions* for Jupyter Notebook
- ▶ Are there any initialisation files, configuration or preferences and how are they used ?
- ▶ See [Config file and command line options](#)
- ▶ Set in `jupyter_notebook_config.py` in `~/.jupyter` (see earlier)
- ▶ See also

```
jupyter notebook --help
```

Jupyter Notebook — Exercise

Key Questions (7)

- ▶ Answer the *Key Questions* for Jupyter Notebook
- ▶ How do you import and export data from the package ?

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Jupyter Notebook — Exercise

Key Questions (7a)

- ▶ Answer the *Key Questions* for Jupyter Notebook
- ▶ How do you import and export data from the package ?
- ▶ **Export**
- ▶ See [nbconvert — Using as a command line tool](#)

```
jupyter nbconvert --to FORMAT myNotebook.ipynb
```

- ▶ Output formats — HTML, LaTeX, PDF, Markdown, WebPDF, Reveal.js HTML slideshow and others
- ▶ **Import**
- ▶ Embedding images — use Markdown syntax

```
![title][Images/myPicture.png]
```

- ▶ Convert notebook to slides

```
jupyter nbconvert --to slides --post serve myNotebook.ipynb
```

- ▶ Convert slide [myNotebook.slides.html](#) to PDF version — replace <#> at end of URL to [?print-pdf](#)

Jupyter Notebook — Exercise

Key Questions (8)

- ▶ Answer the *Key Questions* for Jupyter Notebook
- ▶ *When all else fails*, how can you obtain advice ?

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Jupyter Notebook — Exercise

Key Questions (8a)

- ▶ Answer the *Key Questions* for Jupyter Notebook
- ▶ *When all else fails*, how can you obtain advice ?

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[StackOverflow: Questions tagged \[jupyter\]](#)

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Writing Programs & Thinking

The Steps

1. Invent a *name* for the program (or function)
2. What is the *type* of the function ? What sort of *input* does it take and what sort of *output* does it produce ? In Python a type is implicit; in other languages such as Haskell a type signature can be explicit.
3. Invent *names* for the input(s) to the function (*formal parameters*) — this can involve thinking about possible *patterns* or *data structures*
4. What restrictions are there on the input — state the preconditions.
5. What must be true of the output — state the postconditions.
6. *Think* of the definition of the function body.

Writing Programs & Thinking

The *Think* Step

► How to Think

1. Think of an example or two — what should the program/function do ?
2. Break the inputs into separate cases.
3. Deal with simple cases.
4. Think about the result — try your examples again.

► Thinking Strategies

1. Don't think too much at one go — break the problem down. Top down design, step-wise refinement.
2. What are the inputs — describe all the cases.
3. Investigate choices. What data structures ? What algorithms ?
4. Use common tools — bottom up synthesis.
5. Spot common function application patterns — generalise & then specialise.
6. Look for good *glue* — to combine functions together.

What Next ?

Programming, Debugging, Psychology

Although programming techniques have improved immensely since the early days, the process of finding and correcting errors in programming — known graphically if inelegantly as *debugging* — still remains a most difficult, confused and unsatisfactory operation. The chief impact of this state of affairs is psychological. Although we are happy to pay lip-service to the adage that to err is human, most of us like to make a small private reservation about our own performance on special occasions when we really try. It is somewhat deflating to be shown publicly and incontrovertibly by a machine that even when we do try, we in fact make just as many mistakes as other people. If your pride cannot recover from this blow, you will never make a programmer.

Christopher Strachey, Scientific American 1966 vol 215 (3) September pp112-124

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What Next ?

To err is human ?

- ▶ To err is human, to really foul things up requires a computer.
- ▶ Attributed to [Paul R. Ehrlich](#) in [101 Great Programming Quotes](#)
- ▶ Attributed to [Bill Vaughn](#) in [Quote Investigator](#)
- ▶ Derived from [Alexander Pope](#) (1711, [An Essay on Criticism](#))
- ▶ *To Err is Humane; to Forgive, Divine*
- ▶ This also contains
 - A little learning is a dangerous thing;
Drink deep, or taste not the [Pierian Spring](#)*
- ▶ In programming, this means you have to *read the fabulous manual* ([RTFM](#))

What Next ?

Overview B and Unit 2

- ▶ Basic Python — selection and iteration
- ▶ Basic data types — arrays, sequences, lists, tuples
- ▶ Example Algorithm Design
- ▶ Writing Programs & Thinking — *The Steps*
- ▶ Abstract Data Types
- ▶ Tutorial online (PM) 10:00 Sunday 28 November 2021

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Web Links & References

Historical notes

- ▶ The *offside rule* (using layout to determine the start and end of code blocks) comes originally from Landin (1966) *The next 700 programming languages* — see https://en.wikipedia.org/wiki/Off-side_rule for other programming languages that use this.
- ▶ The *step-by-step* approach to writing programs is described in Glaser et al (2000) *Programming by numbers: a programming method for complete novices*
- ▶ The difficulty in learning programming is described in many articles — see, for example, Dehnadi and Bornat (2006) *The camel has two humps*
- ▶ **UTF-8** is Unicode (or Universal Coded Character Set) Transformation Format — 8-bit — one of the character encodings for the Unicode characters or code points