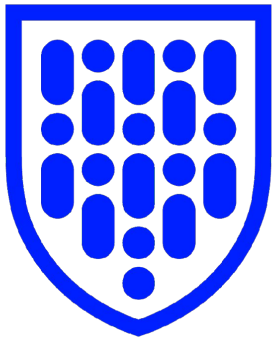

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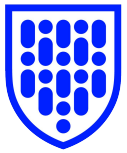
2019



Data Science and AI

Module 1
Part 2:

Python for Data Science

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Agenda: Module 1 Part 2

- Python Fundamentals
- Software Engineering Best Practices
- Using Git & GitHub for Version Control

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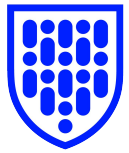
Python Fundamentals

- Programming Data Science in Python
- Developing and running Python
- Data structures in Python
- Writing functions in Python
- Iterating in Python
- numpy, pandas, scikit-learn

Programming Data Science in Python

- Programming is the **process of creating a set of instructions** that tell a computer how to perform a task.
- Python is an Interpreted, *High Level general purpose programming language*.
- Python is easy to learn and use and powerful enough to tackle the most difficult problems in any domain.
- Python has a very active community with a vast selection of libraries, especially in scientific computing, data analysis and visualisation which makes it **very suitable for Data Science**.

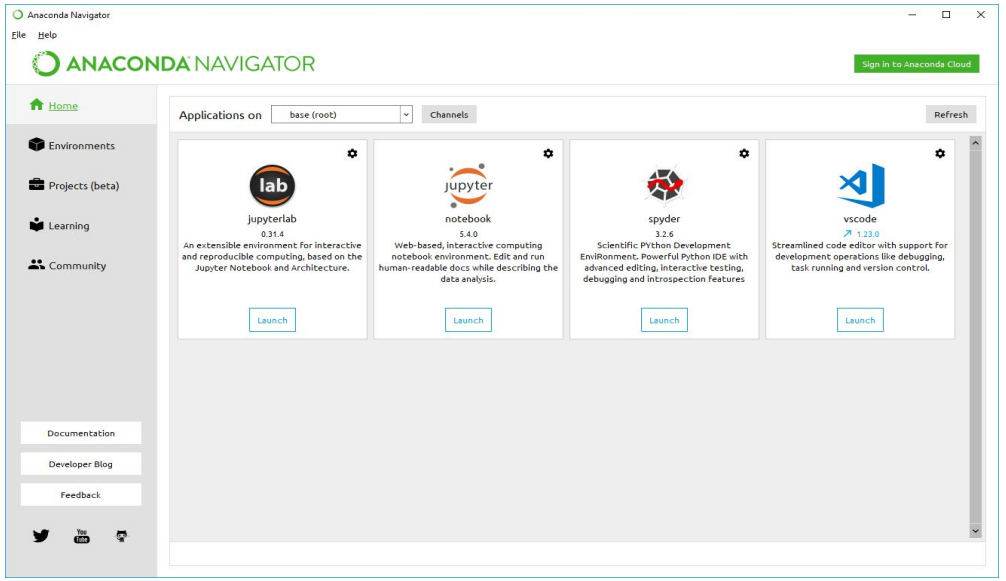


Python versions: 2.7 vs 3.x

- version 2.x
  - large code base
  - last version = 2.7 (no more releases!)
- version 3.x
  - *print* is a function
  - raising & catching exceptions
  - integer division (2.x truncates; 3.x converts to float)
  - short ⟶ long integers
  - octal constants: 0*nnn* ⟶ 0o*nnn*
  - unicode strings
  - …

Developing and running Python

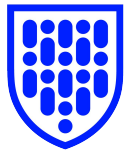
- Jupyter notebook
- Visual Studio Code (VSC)
  - VSC has now built-in Jupyter notebook support
- Jupyter Lab
- command prompt
- Anaconda
  - Anaconda Distribution is **the recommended way** to configure and manage your Python development and running environment(s).



Installing Packages with pip

- pip is the package installer for Python. You can use pip to install packages from the Python Package Index and other indexes.

- You can use pip directly in Jupyter notebook or use Anaconda to manage environment configuration (preferred).



Installing Packages with pip – cont'd

- install a package
- upgrade a package
- install a specific version
- install a set of requirements
- install from an alternate index
- install from a local archive

```
$ pip install anypkg
$ pip install --upgrade anypkg
$ pip install anypkg==1.0.4
$ pip install -r reqsfile.txt
$ pip install --index-url
http://my.package.repo/simple/ anypkg
$ pip install
./downloads/anypkg-1.0.1.tar.gz
```

Environments

What is an environment?

> a practical way to deal with Python's packages

Issues:

- many packages have not been around long enough to be tested with other packages that you might want to use with them
- packages don't always get updated quickly in response to updated dependencies

Solution:

- Create virtual environments for hosting isolated projects using Anaconda Navigator

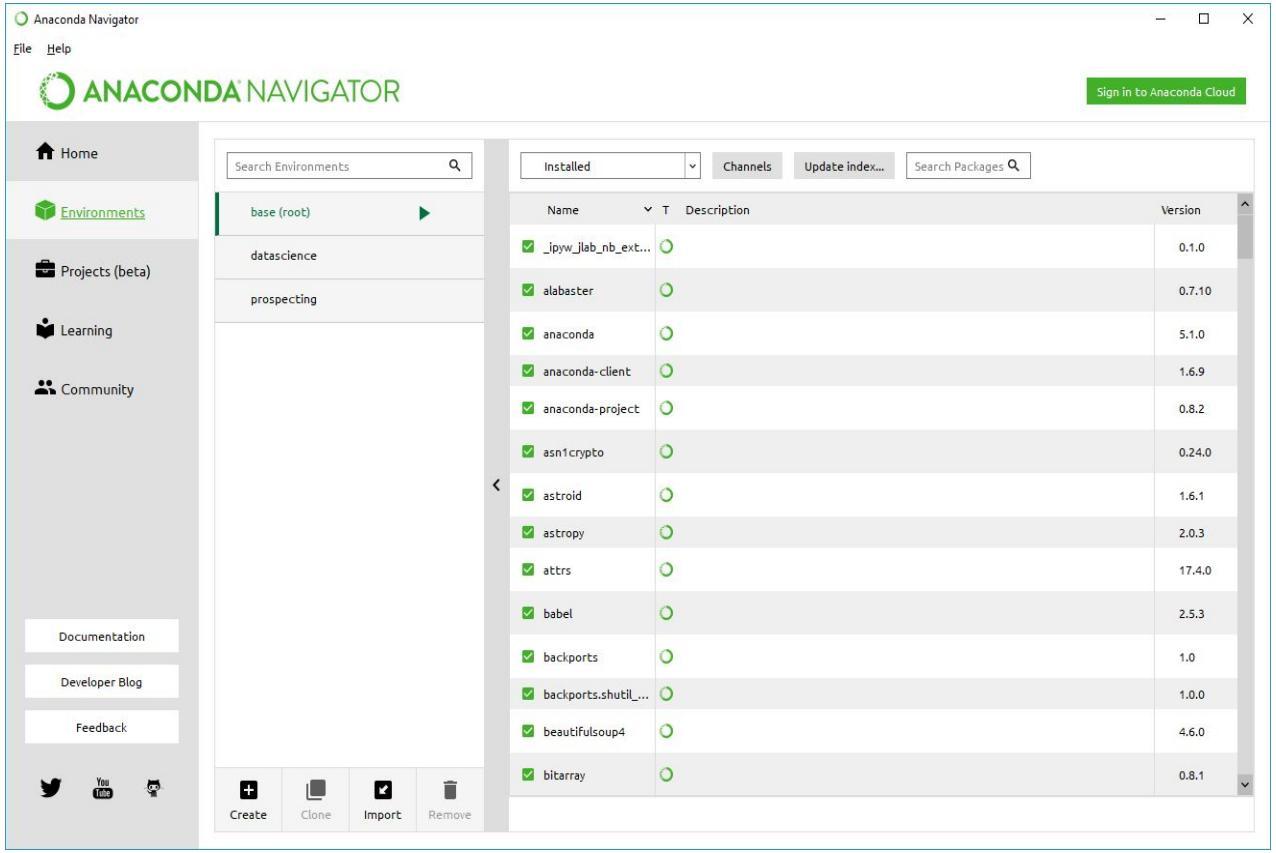
Environments – cont'd: ***conda***

- create an environment
- activate an environment
- deactivate an environment
- install python
- search for available packages
- install a package
- list installed packages

```
$ conda create --name myenv1 python
$ source activate myenv1
$ source deactivate
$ conda install python=version
$ conda search searchterm
$ conda install anypkg
$ conda list --name myenv1
```

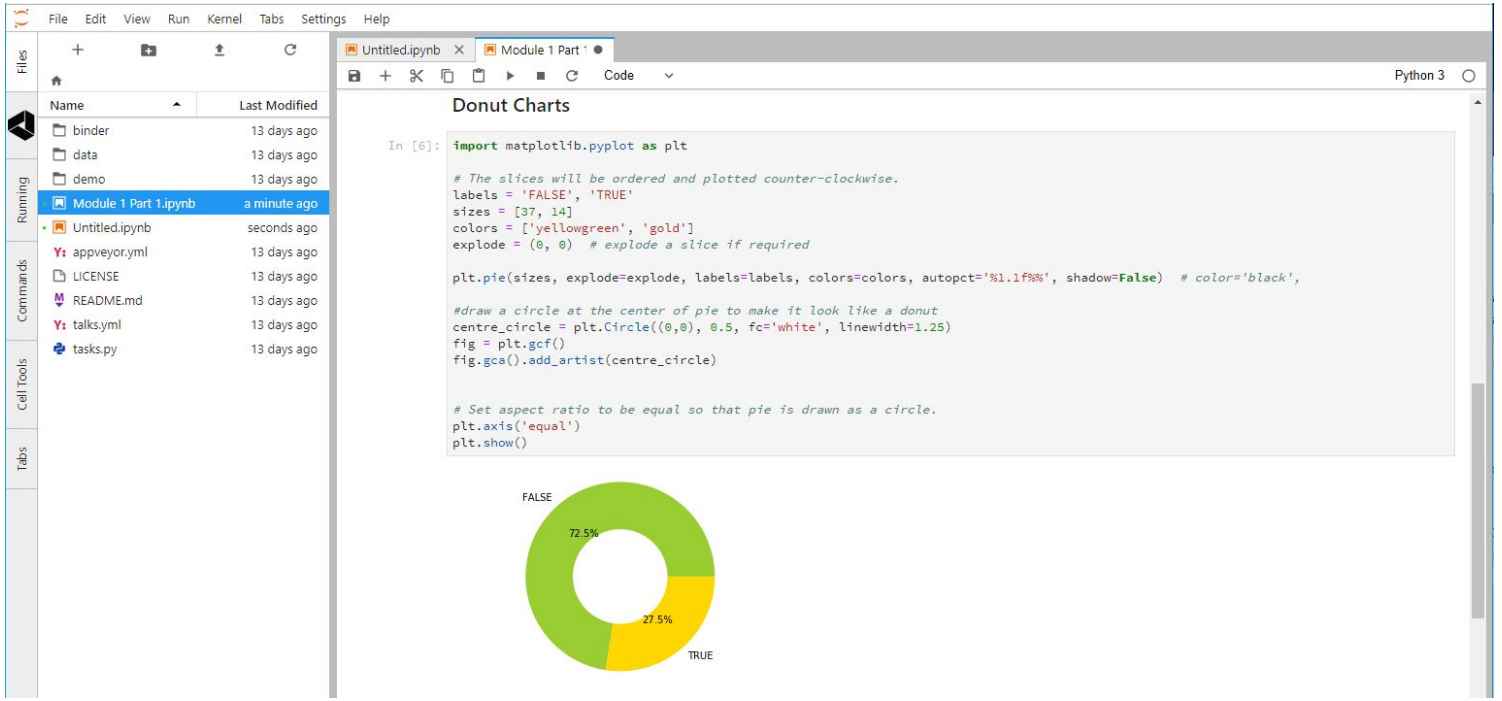
Environments – cont'd: ***Anaconda Navigator***

- implements conda via a GUI
  - create envs
  - switch between envs
  - list packages in an env
  - search for packages to add to env
- env-specific app instances
  - set env (e.g. Python27)
  - launch Jupyter notebook to run Python 2.7 code



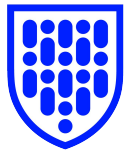
Jupyter Notebooks

- shareable
- environment-based
- interactive or batch execution
- > 40 languages
  - Python, R, Scala, …
- Big Data support
  - Spark



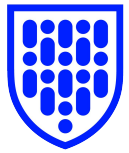
Generic Data Types

Numeric	Text	Other
integer • signed, unsigned	character • unicode	Boolean • true, false Binary • 2^n
floating-point (‘float’) • double = 2 x float	string • character array • 0-based *or* 1-based • null-terminated *or* length-encoded • usually immutable in OOP	unassigned • null • NA undefined • NA • +, − infinity
complex • 2 x double (real, imaginary)	document • key-value pairs (JSON strings)	BLOB • images, video • signals



Data Structures

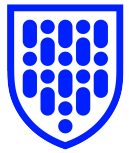
- lists
  - ordered, mixed-type, mutable
  - append, extend, insert, remove, pop, clear, index, count, sort, reverse, copy
  - comprehensions
- tuples
  - ordered, mixed-type, immutable
  - support packing, unpacking of variables
- sets
  - unordered, no duplicates
- dictionaries
  - key-value pairs (unordered)



Functions

```
def funcName(param1, param2, defArg1 = 0, defArg2 = 100):
    # code here
    return someResult
```

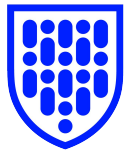
- optional parameters take default arguments if missing from function call
- arguments are assigned to parameters in defined sequence unless named in call
- return statement
  - optional
  - can return multiple items
- scope is inherited from main (but not from a calling function)



Classes

```
class phasor:
    def __init__(self, r=0, p=0):
        self.r = r
        self.p = p
    def real(self):
        return (self.r * math.cos(self.p))
    def imag(self):
        return (self.r * math.sin(self.p))

z = phasor(2.7, 0.4 * math.pi)
```

- 2 underscores before/after init
- the **self** parameter is not explicitly mapped to the function call



Iteration

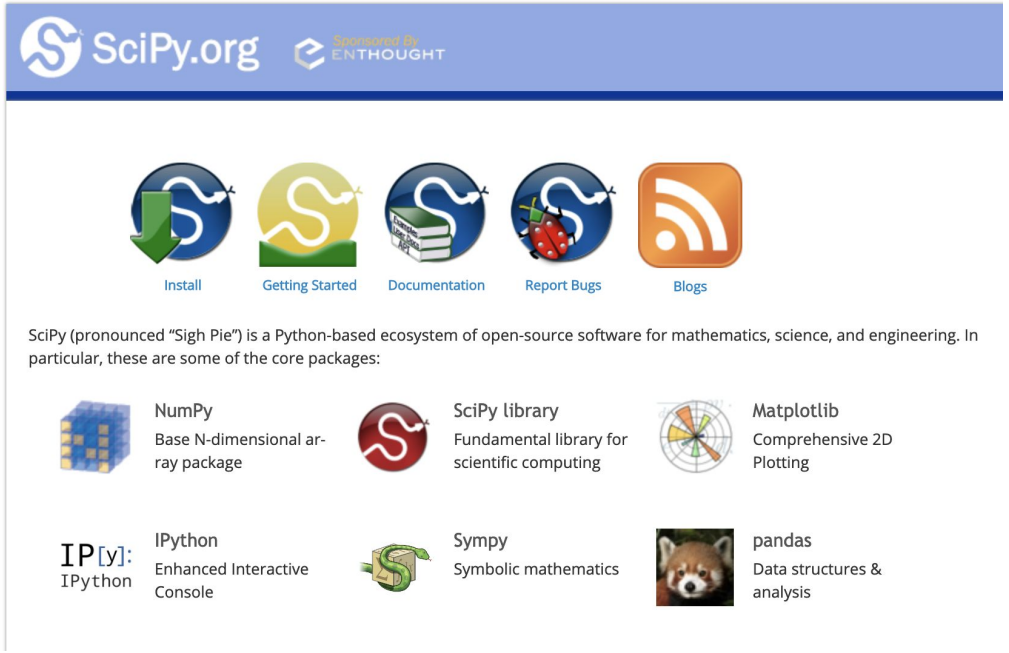
- while *condition*
- for *iterator* in *list*
- continue
- break
- pass

```
a = ['Mary', 'had', 'a', 'little', 'lamb']
for w in a:
    print(w)
for i in range(len(a)):
    print (i, a[i])

class MyClass(object):
    def meth_a(self):
        pass

    def meth_b(self):
        print (“I'm meth_b”)
```

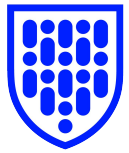
SciPy

- SciPy (pronounced “Sigh Pie”) is a Python-based ecosystem of open-source software for mathematics, science, and engineering. In particular.

- Main libraries (packages) include numpy, scipy, matplotlib, ipython, jupyter, pandas, sympy, nose



https://www.scipy.org/

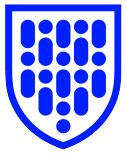


NumPy

- the fundamental package for scientific computing with Python
  - a powerful N-dimensional array object
  - sophisticated (broadcasting) functions
  - tools for integrating C/C++ and Fortran code
  - useful linear algebra, Fourier transform, and random number capabilities

```
import numpy as np
```

http://www.numpy.org/

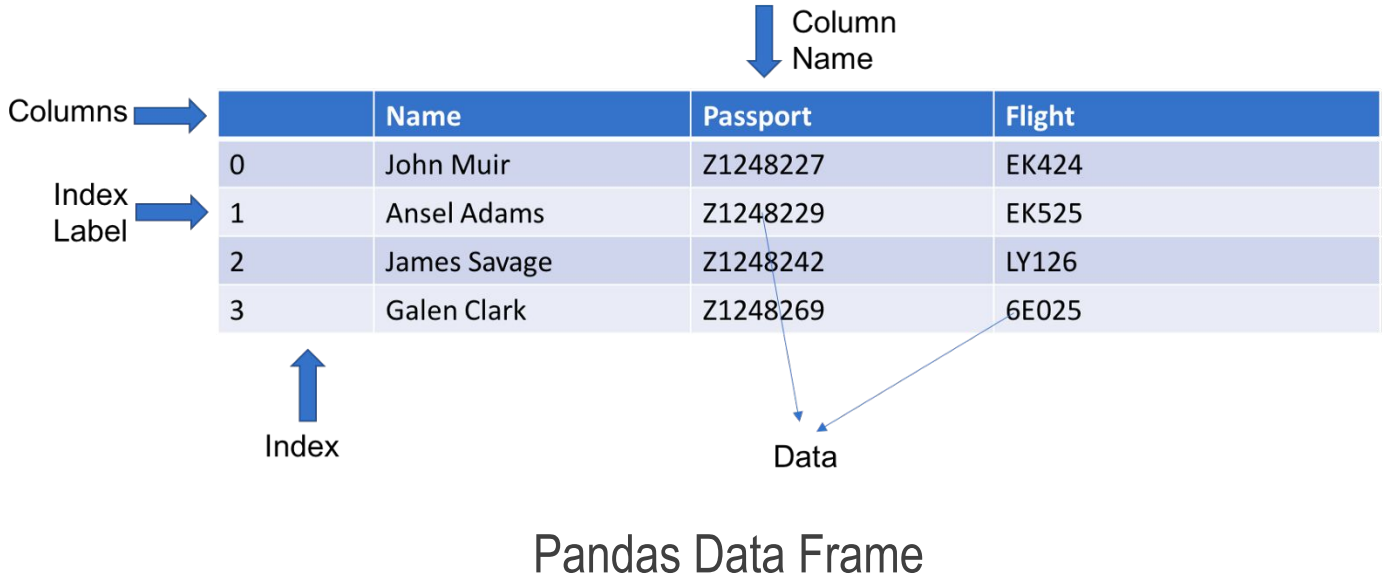


Data Types in Python and NumPy

Type	Python	Numpy	Usage
byte byte array	b‘any string’ bytearray()		• immutable • mutable
integer	int()	• 11 types	• signed, unsigned • 8, 16, 32, 64 bits, unlimited
floating-point	float()	• 3 types	• 16, 32, 64 bits
complex	complex()	• 2 types	• 64, 128 bits
unassigned	None		• object • myVar is not None
missing	nan	isnull(), notnull(), isnan()	• float, object

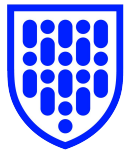
Pandas

- Rich relational data analysis tool built on top of NumPy
- Easy to use and highly performing APIs
- A foundation for data wrangling, munging, preparation, etc in Python



	Name	Passport	Flight
0	John Muir	Z1248227	EK424
1	Ansel Adams	Z1248229	EK525
2	James Savage	Z1248242	LY126
3	Galen Clark	Z1248269	6E025

Pandas Data Frame



Pandas

- high-performance, easy-to-use data structures and data analysis tools
  - DataFrame class
  - IO tools
  - data alignment
  - handling of missing data
  - manipulating data sets
    - reshaping, pivoting
    - slicing, dicing, subsetting
    - merging, joining

```
import pandas as pd
```

https://pandas.pydata.org/

Scikit-learn

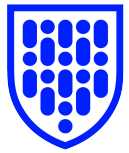
- biggest library of ML functions for Python
  - classification
  - regression
  - clustering
  - dimensional reduction
  - model selection & tuning
  - preprocessing

$ pip install -U scikit-learn

or

$ conda install scikit-learn

http://scikit-learn.org/stable/



Other Python Packages for Data Science

- statsmodels
  - statistical modelling & testing
  - R-style formulae

```
import statsmodels.api as sm
import statsmodels.formula.api as smf
```

- BeautifulSoup
  - reading & parsing XML & HTML data

```
from bs4 import BeautifulSoup
```

- Natural Language Toolkit
  - tokenising, tagging, analysing text

```
import nltk
```

Visualisation

matplotlib

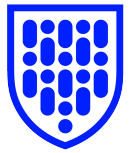
- histograms
- bars
- curves
- surfaces
- contours
- maps
- legends
- annotations
- primitives

https://matplotlib.org/gallery.html

Seaborn

- based on matplotlib
- prettier
- more informative
- more specialised

https://seaborn.pydata.org/examples/index.html



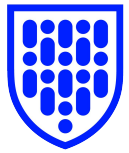
Lab 1.2.1: Numpy

1. Explain the following NumPy methods and create working examples in Jupyter notebook using the data created for you in the beginning of the Lab notebook:

2. Structure your code using functions (prepare to discuss the value of using functions).

- ndim
- shape
- Size
- itemsize
- data
- linspace
- mean
- min
- max
- cumsum
- std

. Stretch exercise. Use matplot to explore the data



Lab 1.2.2: Pandas

1. Explore and download Employee Attrition file from Kaggle (https://www.kaggle.com/HRAnalyticRepository/employee-attrition-data)
2. Explain the following Pandas methods and create working examples in the lab Jupyter notebook .
3. Structure your code using functions (prepare to discuss the value of using functions.

- read_csv
- describe
- loc
- iloc
- Index
- sort_index
- set_index
- sample

2. Stretch exercise. Use matplot to explore some of the data in the data frame

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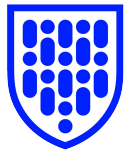
Software Engineering Best Practices

- Object-Oriented Programming
- Refactoring
- Coding for readability
- Coding for testability
- Documenting



Object-Oriented Programming

- an *object* encapsulates
  - data (*attributes*)
  - procedures (*methods*)
- a *class* is a prototype for an object
  - *instantiation*: creating an object (in memory) from a class definition

def: **encapsulation**

- attributes of the class should only be accessible by methods of the class
  - get()
  - set()

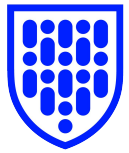
Creating and Using a Class in Python

```
class myclass:
    def __init__(self, param1, …):
        # initialise class attributes

    def method1(self, ):
        # do something
        return (method1result)
```

```
obj1 = myclass(arg1, …)
```

- define class by name
  - initialisation code
    - only **self** is mandatory
    - may use arguments passed from caller
  - define methods
    - only **self** is mandatory
    - may use arguments passed from caller
    - may use attributes
    - may return a value
- invoke class name in assignment to instantiate an object
    - omit **self**



Other OOP Concepts

def: **abstraction**

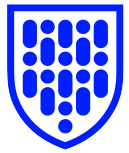
- data and procedures that do not need to be accessible to the caller should be hidden within the class

def: **inheritance**

- new classes can be based on and extend an existing class

def: **polymorphism**

- a class can implement multiple methods with the same name and function, but which operate on different parameters (type and/or number)

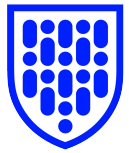


Refactoring

def: Restructuring existing code without changing its behaviour

Examples

- abstract reused code to functions
  - generalise functions (polymorphism?)
- use get, set methods
- simplify structure of nested loops, logic
- minimise use of global variables
  - in Python, this includes all variables defined in main program

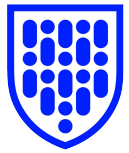


Coding for Readability (Maintainability)

Examples

- indent blocks
  - mandatory in Python
- white space
  - between groups of lines
  - between symbols
- comments: inline (to explain logic, return values, etc.)
  - sectional (to explain functional blocks)
  - header (to explain program or module)
    - purpose, authors, date
    - dependences, assumptions

- comments are for coders
  - maintaining or extending your code
- documentation is for users
  - explaining what the application is for and how to use it



Coding for Testability

Examples

- avoid side-effects in functions
- enable testing via compiler flags

```
##define TEST_MODE
#if TEST_MODE
print("test mode activated")
#endif
```

- write tests *before* functions
  - specify return type(s) supported
  - test return type(s), validity
  - pass sample data as arguments
  - print result

- test *frequently*
  - avoid marathon coding sessions
- code top-down
  - create wireframe code to test logic, structures
  - fill in the details later

pytest

https://docs.pytest.org/en/latest/

Homework

1. Create a GitHub account (if you don't already have one).
2. Optional: Install GitHub Desktop

    url: https://desktop.github.com

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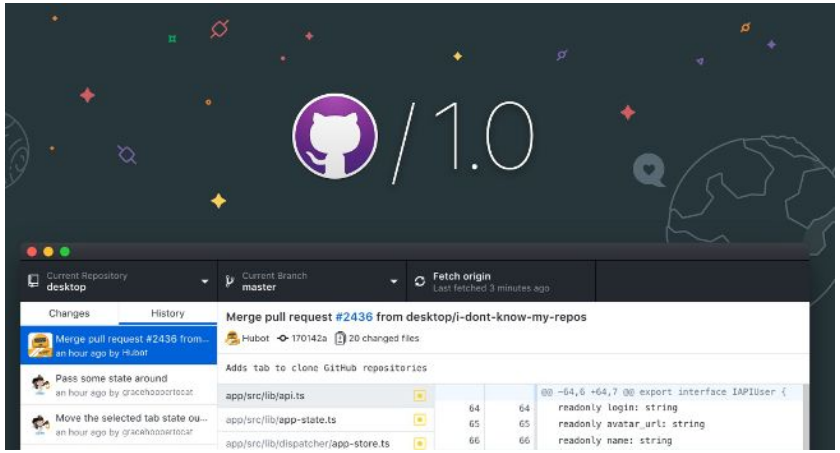
Version Control with Git & GitHub

- Forking
- Cloning
- Communicating issues
- Managing notifications
- Creating branches
- Making commits
- Introducing changes with Pull Requests

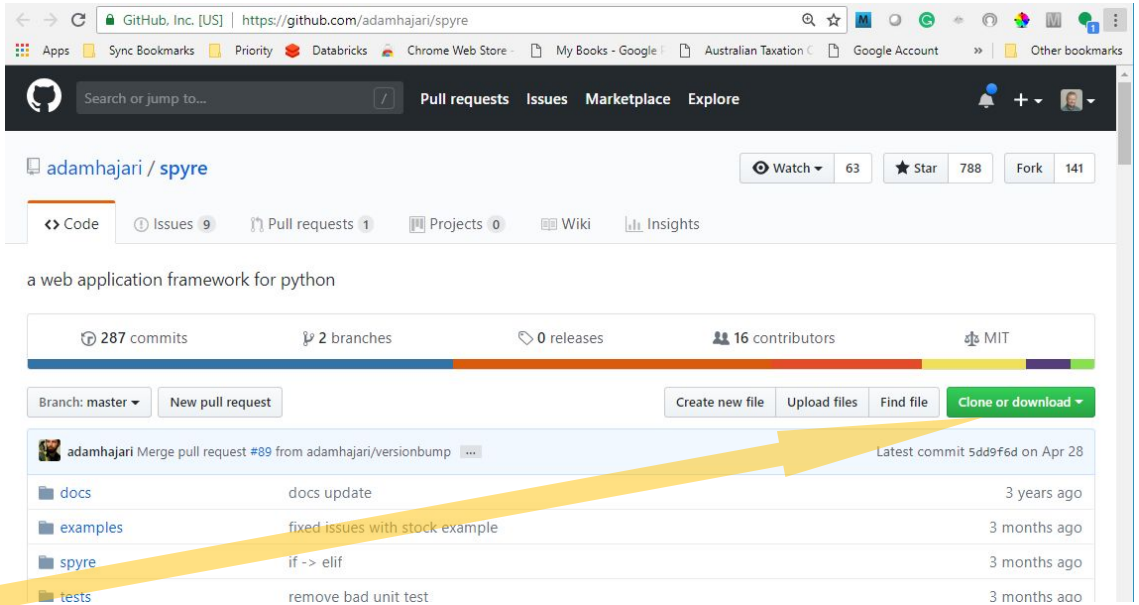
Git & GitHub

- web-based, API
- host code, data, resources
- version control
  - integrates with open-source and commercial IDE tools
- share, collaborate
  - branching
- showcase achievements
- command line & desktop versions



GitHub: Forking & Cloning a Repo

- *fork:* make your own copy of someone else's repo, on GitHub
  1. click <Fork>
- *clone:* create a (working) copy of the repo on your computer

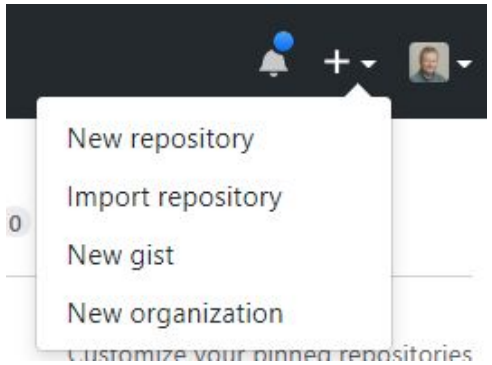


- GitHub Desktop procedure:
  1. click <Clone or download>
  2. click <Open in Desktop>
  3. navigate to target (local) folder
  4. click <Clone>

- command-line procedure:
  1. $ cd yourpath
  2. $ git clone https://github.com/yourgithubname/yourgithubrepo

GitHub: Creating a New Repo

- from your GitHub home page
  1. <New repository>
  2. clone the repo to your local drive
  3. copy files, folders into it
  4. commit changes
  5. generate a *pull* request

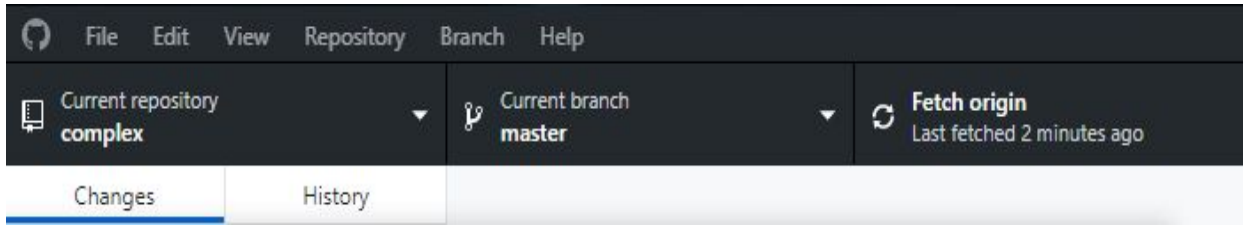


- Creating a branch
  - to allow development in isolation from source repo
    - protects your changes from changes to source
    - rejoin main branch when ready

GitHub: Refreshing Local Repo from Source

Desktop

- <Fetch origin>



Command-line

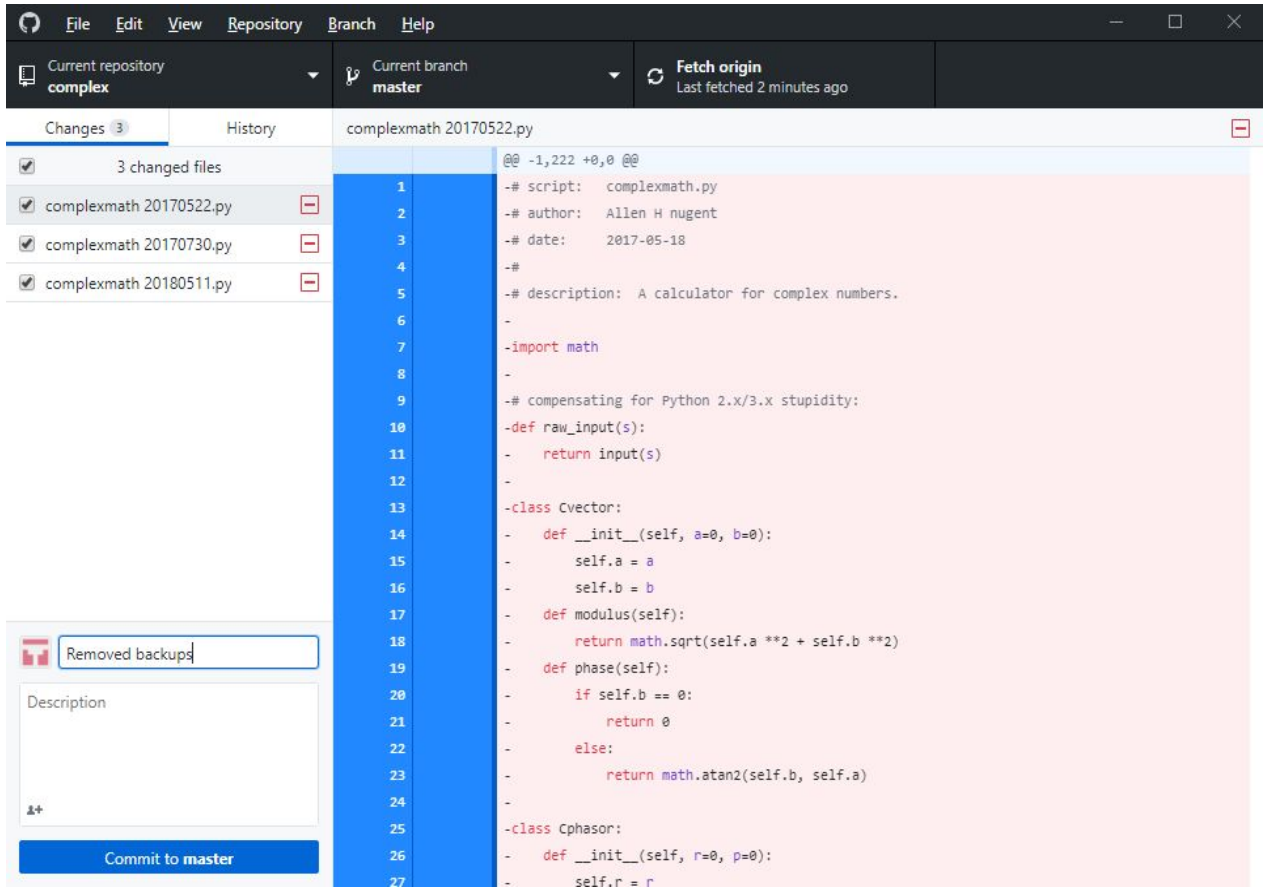
```
$ git checkout master
$ git fetch upstream
$ git merge upstream/master
```

- Ensure you're in the master branch
- Grab the latest changes from the master
- Merge the master changes with your repo

GitHub: Commit & Pull Request

Desktop

- enter comments in text box
- <Commit to master>
- Repository > Push
  or
  <Push origin>



GitHub: Commit & Pull Request

Command-line

- commit

```
$ git status
$ git add filename
$ git add .
$ git commit -m your_comments
$ git status
```

- pull request

```
$ git push origin master
```

- show changes
- stage one file
- stage all change
- commit file(s), with comments

- origin = your GitHub repo (forked from source repo)
- master = source repo

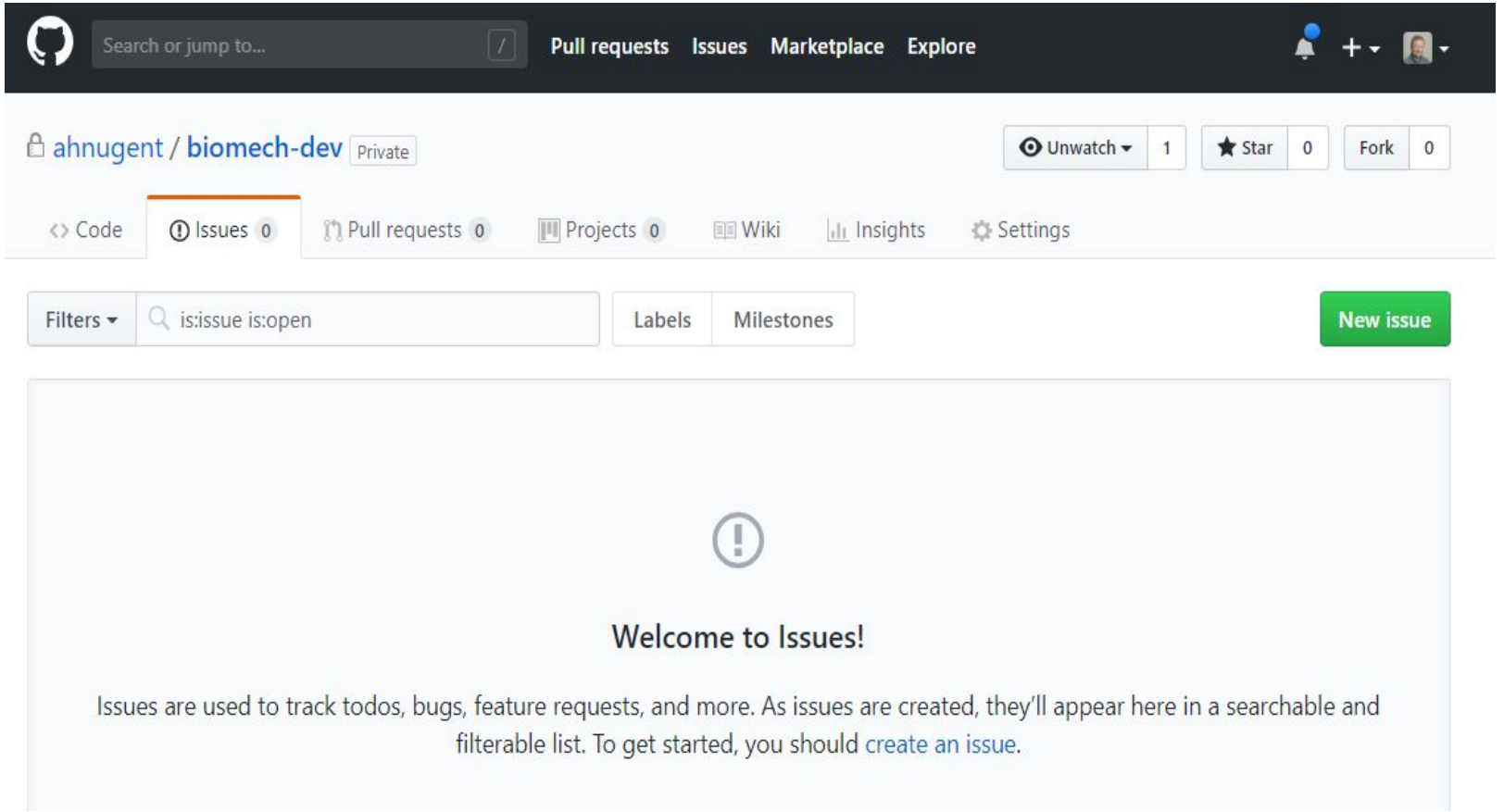
GitHub: For labs, mini projects & capstone

Workflow

- Please refer to “GIT Workflow.pdf” under “Module X”

GitHub: Issues

- track
  - issues / bugs
  - to-do items
  - feature requests
- search
- filter



GitHub: Notifications

Triggers

- you, a team member, or a parent team are mentioned
- you're assigned to an issue or pull request
- a comment is added in a conversation you're subscribed to
- a commit is made to a pull request you're subscribed to
- you open, comment on, or close an issue or pull request
- a review is submitted that approves or requests changes to a pull request you're subscribed to
- you or a team member are requested to review a pull request
- you or a team member are the designated owner of a file affected by a pull request
- you create or reply to a team discussion

Lab 1.2.3: Setting Up GitHub

Purpose:

- To establish a GitHub repo and develop basic skills for collaborating and maintaining projects.

Tools & Resources:

- GitHub / GitHub Desktop

Materials:

- ‘Lab 1.2.3.docx’

Questions?

End of Presentation!