Introduction to Python for Social Science

Musashi Harukawa, DPIR

1st Week Hilary 2020

Course Overview

Schedule

8-week long course will take place on Wednesdays at the IT Lab in the Manor Road Building. Each week will consist of a three-hour session divided roughly as follows:

- 1615-1715: Lecture
- 1715-1725: Break
- 1725-1825: Workshop
- 1825-1925: Clinic

Mention that class in 3rd week (5th Feb) will be moved to Monday (3rd Feb).

Lecture

- During the lectures I will discuss a mixture of theory and methods. The slides will be made available at the following:
  - https://github.com/muhark/dpir-intro-python
  - Canvas?
- Please feel free to stop me and ask questions! I have alloted time for this.

Slides are generated with `reveal.js`. Should be viewable on any device with a browser.

Workshop

- In the workshop, you will work through a number of set programming problems and discussion questions.
- Answers will be discussed as a class for the final 10 minutes.

Clinic

- Each week, there will be tasks and projects for you to try in your own time, if you wish.
- I'll be available for an hour after each session to answer questions one-to-one or in small groups.

Course Structure

1. Introduction to Python and the Development Environment
2. Data Structures and `pandas` I
3. Data Structures and `pandas` II
4. Data Visualisation
5. Machine Learning with `scikit-learn` I
6. Machine Learning with `scikit-learn` II
7. Mining the Web
8. Introduction to Natural Language Processing

Feedback

Week 1: Introduction to Python and the Development Environment

What is Python?. . .

Open-Source

- Built by a community
- Maintained by a community
- Free to use for all

General-Purpose

- If you're doing it on a computer and there's some repetitive element, then you can automate it in Python.
- Python isn't limited to Data Science, but it's very popular with data scientists!

Large community means that a larger number of people create, contribute to, and maintain the data analysis tools that we all use.

Scripting

- No strict definition for what a “script” is.
- Series of commands to automate some task.
- Like a pipeline: takes some inputs, does some things to these inputs, and gives back some outputs.

It’s good to keep the input-output framework in your head.

and what can I use Python for?

I want to…

- Clean up my messy data!
- Run analyses with (hundreds of) millions of data points
  - it won't fit into an excel spreadsheet!
- I want to automate downloading several decades of newspaper articles!
- I want to create beautiful (interactive) visuals to accompany my analyses!
- I want to uncover hidden structures linking parliamentary committees!
- … and more!

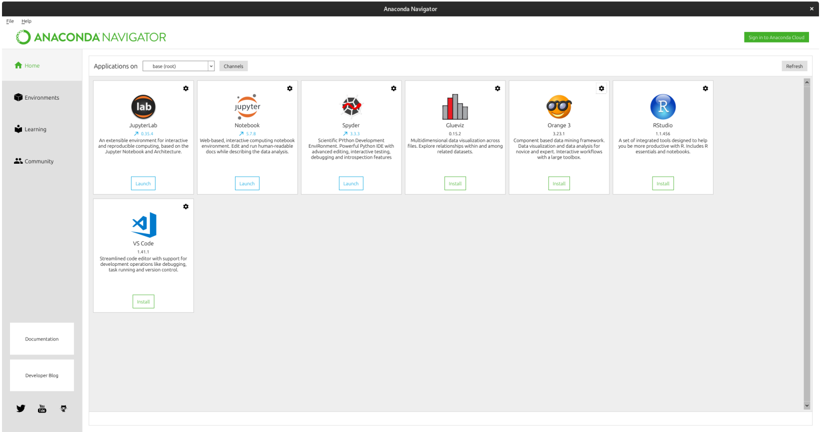
Python vs R

Basic Coding Tools

Anaconda

- Environment and software manager.
- Can be used from the command line (`cli`) or browser-like interface (anaconda-navigator).

At this point, I switch windows to open up the anaconda navigator, and go through the various relevant tabs. These include the launcher for various apps and the environment manager.



JupyterLab
↗ 0.35.4
An extensible environment for interactive and reproducible computing, based on the Jupyter Notebook and Architecture.

Notebook
↗ 5.7.8
Web-based, interactive computing notebook environment. Edit and run human-readable docs while describing the data analysis.

Spyder
↗ 3.3.3
Scientific PYthon Development EnviRonment. Powerful Python IDE with advanced editing, interactive testing, debugging and introspection features

Glueviz
0.15.2
Multidimensional data visualization across files. Explore relationships within and among related datasets.

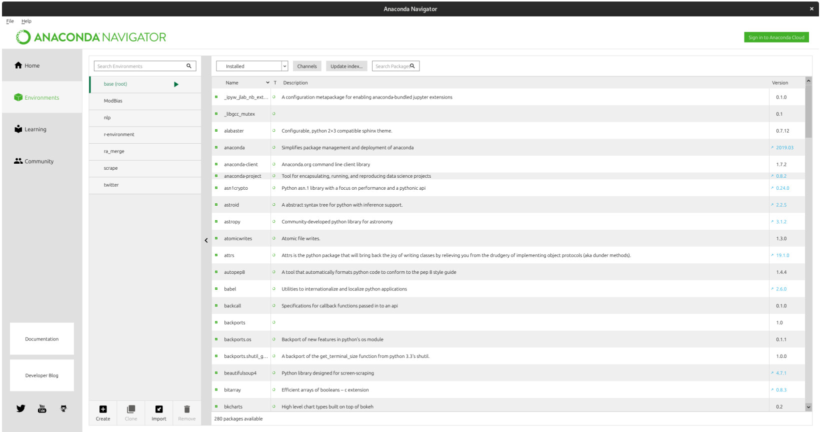
Orange 3
3.23.1
Component based data mining framework. Data visualization and data analysis for novice and expert. Interactive workflows with a large toolbox.

RStudio
1.1.456
A set of integrated tools designed to help you be more productive with R. Includes R essentials and notebooks.

VS Code
1.41.1
Streamlined code editor with support for development operations like debugging, task running and version control.

Figure 1: Anaconda Navigator

- Make sure students can find navigator, and open applications from it.



	Name	T	Description	Version
☑	_ipyw_jlab_nb_ext...	○	A configuration metapackage for enabling anaconda-bundled jupyter extensions	0.1.0
☑	_libgcc_mutex	○		0.1
☑	alabaster	○	Configurable, python 2+3 compatible sphinx theme.	0.7.12
☑	anaconda	○	Simplifies package management and deployment of anaconda	↗ 2019.03
☑	anaconda-client	○	Anaconda.org command line client library	1.7.2
☑	anaconda-project	○	Tool for encapsulating, running, and reproducing data science projects	↗ 0.8.2
☑	asn1crypto	○	Python asn.1 library with a focus on performance and a pythonic api	↗ 0.24.0
☑	astroid	○	A abstract syntax tree for python with inference support.	↗ 2.2.5
☑	astropy	○	Community-developed python library for astronomy	↗ 3.1.2
☑	atomicwrites	○	Atomic file writes.	1.3.0
☑	attrs	○	Attrs is the python package that will bring back the joy of writing classes by relieving you from the drudgery of implementing object protocols (aka dunder methods).	↗ 19.1.0
☑	autopep8	○	A tool that automatically formats python code to conform to the pep 8 style guide	1.4.4
☑	babel	○	Utilities to internationalize and localize python applications	↗ 2.6.0
☑	backcall	○	Specifications for callback functions passed in to an api	0.1.0
☑	backports	○		1.0
☑	backports.os	○	Backport of new features in python's os module	0.1.1
☑	backports.shutil_g...	○	A backport of the get_terminal_size function from python 3.3's shutil.	1.0.0
☑	beautifulsoup4	○	Python library designed for screen-scraping	↗ 4.7.1
☑	bitarray	○	Efficient arrays of booleans -- c extension	↗ 0.8.3
☑	bkcharts	○	High level chart types built on top of bokeh	0.2

280 packages available

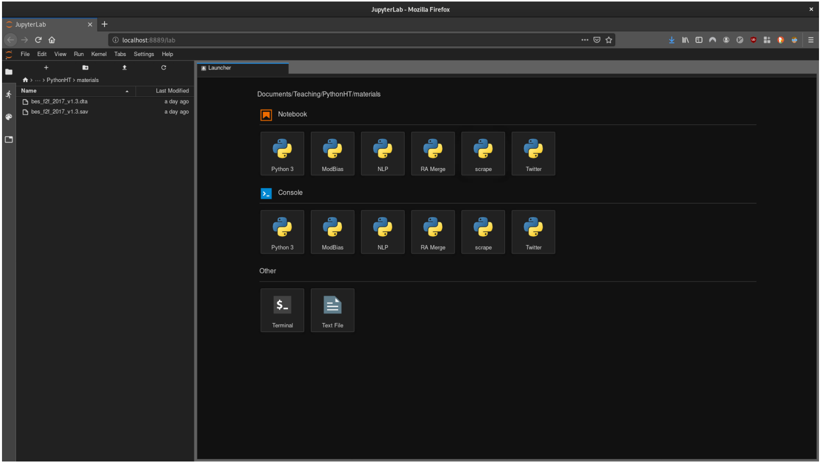
Figure 2: Environment Manager

- Show students how to install packages here. Also mention that this can be done from the command line.

Jupyter

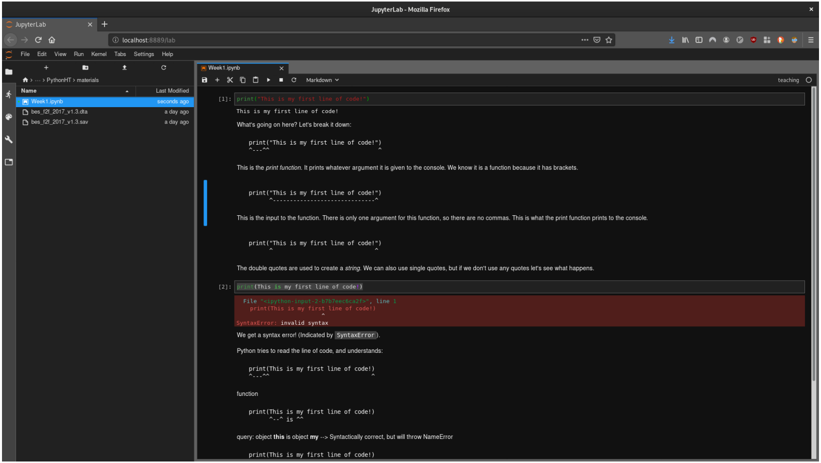
- Interactive code editor.
- Popular, but has its detractors.

- I don't use it, but I started off with it. I recommend that you give it a go.



Name	Last Modified
bes_f2f_2017_v1.3.dta	a day ago
bes_f2f_2017_v1.3.sav	a day ago

Figure 3: Jupyter Lab Launcher



JupyterLab - Mozilla Firefox
JupyterLab
localhost:8889/lab
File Edit View Run Kernel Tabs Settings Help
PythonHT > materials
Name
Last Modified
Week1.ipynb seconds ago
bes_f2f_2017_v1.3.dta a day ago
bes_f2f_2017_v1.3.sav a day ago
Week1.ipynb
Markdown
teaching

```
[1]: print("This is my first line of code!")
```

```
This is my first line of code!
```

What's going on here? Let's break it down:

```
print("This is my first line of code!")
^---^^                                ^
```

This is the *print function*. It prints whatever argument it is given to the console. We know it is a function because it has brackets.

```
print("This is my first line of code!")
      ^------------------------------^
```

This is the input to the function. There is only one argument for this function, so there are no commas. This is what the print function prints to the console.

```
print("This is my first line of code!")
      ^                              ^
```

The double quotes are used to create a *string*. We can also use single quotes, but if we don't use any quotes let's see what happens.

```
[2]: print(This is my first line of code!)
```

```
  File "<ipython-input-2-b7b7eec6ca2f>", line 1
    print(This is my first line of code!)
                        ^
SyntaxError: invalid syntax
```

We get a syntax error! (Indicated by `SyntaxError`).

Python tries to read the line of code, and understands:

```
print(This is my first line of code!)
^---^^                              ^
```

function

```
print(This is my first line of code!)
      ^--^ is ^^
```

query: object **this** is object **my** --> Syntactically correct, but will throw NameError

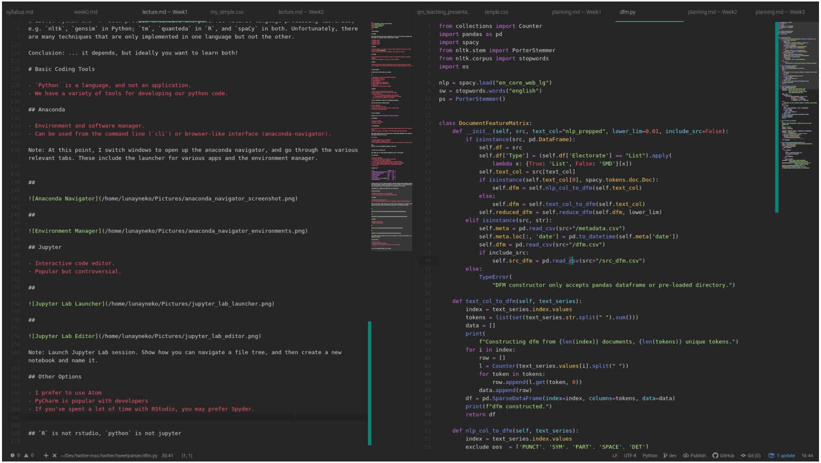
```
print(This is my first line of code!)
```

Figure 4: Jupyter Lab Editor

Launch Jupyter Lab session. Show how you can navigate a file tree, and then create a new notebook and name it.

Other Options

- I prefer to use Atom with Hydrogen
- PyCharm is popular with developers
- If you've spent a lot of time with RStudio, you may prefer Spyder.



```
e.g. `nltk`, `gensim` in Python; `tm`, `quanteda` in `R`, and `spaCy` in both. Unfortunately, there
are many techniques that are only implemented in one language but not the other.

Conclusion: ... it depends, but ideally you want to learn both!

# Basic Coding Tools

- `Python` is a language, and not an application.
- We have a variety of tools for developing our python code.

## Anaconda

- Environment and software manager.
- Can be used from the command line (`cli`) or browser-like interface (anaconda-navigator).

Note: At this point, I switch windows to open up the anaconda navigator, and go through the various
relevant tabs. These include the launcher for various apps and the environment manager.


##

![Anaconda Navigator](/home/lunayneko/Pictures/anaconda_navigator_screenshot.png)

##

![Environment Manager](/home/lunayneko/Pictures/anaconda_navigator_environments.png)

## Jupyter

- Interactive code editor.
- Popular but controversial.

##

![Jupyter Lab Launcher](/home/lunayneko/Pictures/jupyter_lab_launcher.png)

##

![Jupyter Lab Editor](/home/lunayneko/Pictures/jupyter_lab_editor.png)

Note: Launch Jupyter Lab session. Show how you can navigate a file tree, and then create a new
notebook and name it.

## Other Options

- I prefer to use Atom
- PyCharm is popular with developers
- If you've spent a lot of time with RStudio, you may prefer Spyder.


## `R` is not rstudio, `python` is not jupyter

```

```python
from collections import Counter
import pandas as pd
import spacy
from nltk.stem import PorterStemmer
from nltk.corpus import stopwords
import os

nlp = spacy.load("en_core_web_lg")
sw = stopwords.words("english")
ps = PorterStemmer()


class DocumentFeatureMatrix:
    def __init__(self, src, text_col="nlp_prepped", lower_lim=0.01, include_src=False):
        if isinstance(src, pd.DataFrame):
            self.df = src
            self.df['Type'] = (self.df['Electorate'] == "List").apply(
                lambda x: {True: 'List', False: 'SMD'}[x])
            self.text_col = src[text_col]
            if isinstance(self.text_col[0], spacy.tokens.doc.Doc):
                self.dfm = self.nlp_col_to_dfm(self.text_col)
            else:
                self.dfm = self.text_col_to_dfm(self.text_col)
            self.reduced_dfm = self.reduce_dfm(self.dfm, lower_lim)
        elif isinstance(src, str):
            self.meta = pd.read_csv(src+"/metadata.csv")
            self.meta.loc[:, 'date'] = pd.to_datetime(self.meta['date'])
            self.dfm = pd.read_csv(src+"/dfm.csv")
            if include_src:
                self.src_dfm = pd.read_csv(src+"/src_dfm.csv")
        else:
            TypeError(
                "DFM constructor only accepts pandas dataframe or pre-loaded directory.")

    def text_col_to_dfm(self, text_series):
        index = text_series.index.values
        tokens = list(set(text_series.str.split(" ").sum()))
        data = []
        print(
            f"Constructing dfm from {len(index)} documents, {len(tokens)} unique tokens.")
        for i in index:
            row = []
            l = Counter(text_series.values[i].split(" "))
            for token in tokens:
                row.append(l.get(token, 0))
            data.append(row)
        df = pd.SparseDataFrame(index=index, columns=tokens, data=data)
        print(f"dfm constructed.")
        return df

    def nlp_col_to_dfm(self, text_series):
        index = text_series.index.values
        exclude_pos  = ['PUNCT', 'SYM', 'PART', 'SPACE', 'DET']
```

Figure 5: Atom

Basic Workflow

Motivation for Today’s Coding Lesson

Why Automate?

- In general, as social scientists using computational methods, our goal is to automate some component of our analysis.
- The advantage of automation is cost, scale, and scope.
- But in order to harness these methods, we need to structure our information in a way that algorithms and programs can utilise.
  - This process of quantifying and structuring our observations usually entails the loss of some information.

- Some qualitative scholars I speak to contend that the validity of the quantitative endeavour ends there.
  - Are there unquantifiable things?
- I'm more optimistic about what is possible, and think that the key to having valid quantitative inferences is to be extremely clear on the connection between the data in your analysis and the actual events you are measuring.

Bridging the Gap between Qualitative and Quantitative Methods

- Choosing a representation of your information that retains relevant properties is key.
- To read more about this particular debate, a good starting point is Stevens (1946).
- I would love to discuss this further, but this isn't really that kind of methods class.

Data Types

Some (statistical) data types:

- Numerical
  - Interval
  - Ratio
  - Count
- Text
- Date and time
- Logical
- Categorical

(*Before points*) - What do I mean when I talk about different “types” of data? - Small exercise: what are instances of each of these?

Representing Data on a Computer

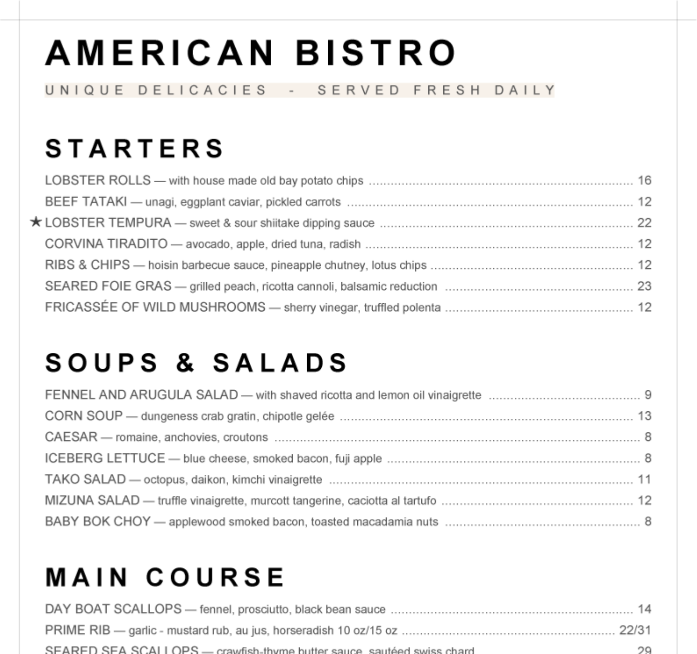
- *Good news:*
  - Python, like most modern programming languages, has ways to represent each of the data types listed above.
- *Bad news:*
  - At a fundamental level, this is being stored as 0's and 1's.
- *Take away:*
  - Take the time to understand the relationship between:
    - your empirical observations,
    - the abstracted representation of them in your mathematical model,
    - the approximation of this in your computational model.

- I'm making a bit of an assumption here about the theory-generating workflow, in that a stylised mathematical model is usually prior to a computational/empirical approach.

Data Structures

- Data types are concerned with the representation of individual data points, or observations.
- Data structures are concerned with the relations between observations.
    - Are the data points members of the same set?
    - Are the data points members of the same sequence?
    - Are the data points different features of single empirical unit?

Exercise



AMERICAN BISTRO

UNIQUE DELICACIES - SERVED FRESH DAILY

STARTERS

LOBSTER ROLLS — with house made old bay potato chips	16
BEEF TATAKI — unagi, eggplant caviar, pickled carrots	12
★ LOBSTER TEMPURA — sweet & sour shiitake dipping sauce	22
CORVINA TIRADITO — avocado, apple, dried tuna, radish	12
RIBS & CHIPS — hoisin barbecue sauce, pineapple chutney, lotus chips	12
SEARED FOIE GRAS — grilled peach, ricotta cannoli, balsamic reduction	23
FRICASSÉE OF WILD MUSHROOMS — sherry vinegar, truffled polenta	12

SOUPS & SALADS

FENNEL AND ARUGULA SALAD — with shaved ricotta and lemon oil vinaigrette	9
CORN SOUP — dungeness crab gratin, chipotle gelée	13
CAESAR — romaine, anchovies, croutons	8
ICEBERG LETTUCE — blue cheese, smoked bacon, fuji apple	8
TAKO SALAD — octopus, daikon, kimchi vinaigrette	11
MIZUNA SALAD — truffle vinaigrette, murcott tangerine, caciotta al tartufo	12
BABY BOK CHOY — applewood smoked bacon, toasted macadamia nuts	8

MAIN COURSE

DAY BOAT SCALLOPS — fennel, prosciutto, black bean sauce	14
PRIME RIB — garlic - mustard rub, au jus, horseradish 10 oz/15 oz	22/31
SEARED SEA SCALLOPS — crawfish-thyme butter sauce, sautéed swiss chard	29

And now. . .

Let’s get to coding!

Coding Recap

Variable Assignment

Variables can be assigned with =.

Four Basic Data Types

There are four basic data types in Python. These are:

- String
- Integer
- Float
- Boolean

String

- *A sequence of characters*.
- Behaves like a sequence; can be indexed with `[index]`

Integer

- Whole numbers.
- Can be positive or negative.

Float

- Decimal numbers.
- Behave unexpectedly. Remember: `0.1*3==0.3` returns `False`.

Boolean

- True/False
- Behaves similarly to integers 0 and 1.

Two basic data structures

We learned about two basic data structures:

- Lists
- Dictionaries

Lists

- Lists are an ordered sequence of values.
- Created by writing a sequence of comma-separated values between square brackets:
  - i.e. `[1, 2, 5, "some string"]`
- Lists are mutable; values can be changed in place without creating a new variable.
- Lists can be indexed the same way as strings:
  - `[n]` to get the n+1th element.
  - `[m:n]` to get all elements from m+1 to n.

Dictionaries

- Unordered mapping of *keys* to *values*.
    - Cannot be indexed numerically, and if iterated over, will not return values in the same order.
- Created by writing a list of `key:value` pairs separated by commas between curly braces.
    - i.e. `{"cat": "meow", "dog": "bork"}`
- `some_dict[some_key]` returns the corresponding value for `some_key` in `some_dict`
- To see all of the keys, use the `.keys()` method of the dict, i.e. `some_dict.keys()`
- To see all of the values, use the `.values()` method of the dict, i.e. `some_dict.values()`

Next Week: Data Structures and `pandas` I