Tools & Python

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CMPS3660 – Introduction to Data Science – Fall 2019

https://rebrand.ly/TUDataScience

Many Thanks
Slides based off Introduction to Data Science from John P. Dickerson -
https://cmsc320.github.io/
Some examples taken from *Data Science* by John D. Kelleher and Brendan Tierney, MIT Press.

Announcements

- Dr. Mattei's Office Hours will be:
  - Tuesday 1400 – 1500 (going possibly later)
  - Thursday 1600 – 1700 (going possibly later)
- Arie is here!

- We now have 34 People in the course.
  - If you are not formally enrolled and want to be come see me after class.

- Both Project0 and Questions1 are posted.
  - https://github.com/TulaneIntroDataScience/fall2019/tree/master/project0
  - Quick overview on how to notebook…

- Please complete Project0 before class on 9/5 – want to do in class lab work that day!

Today

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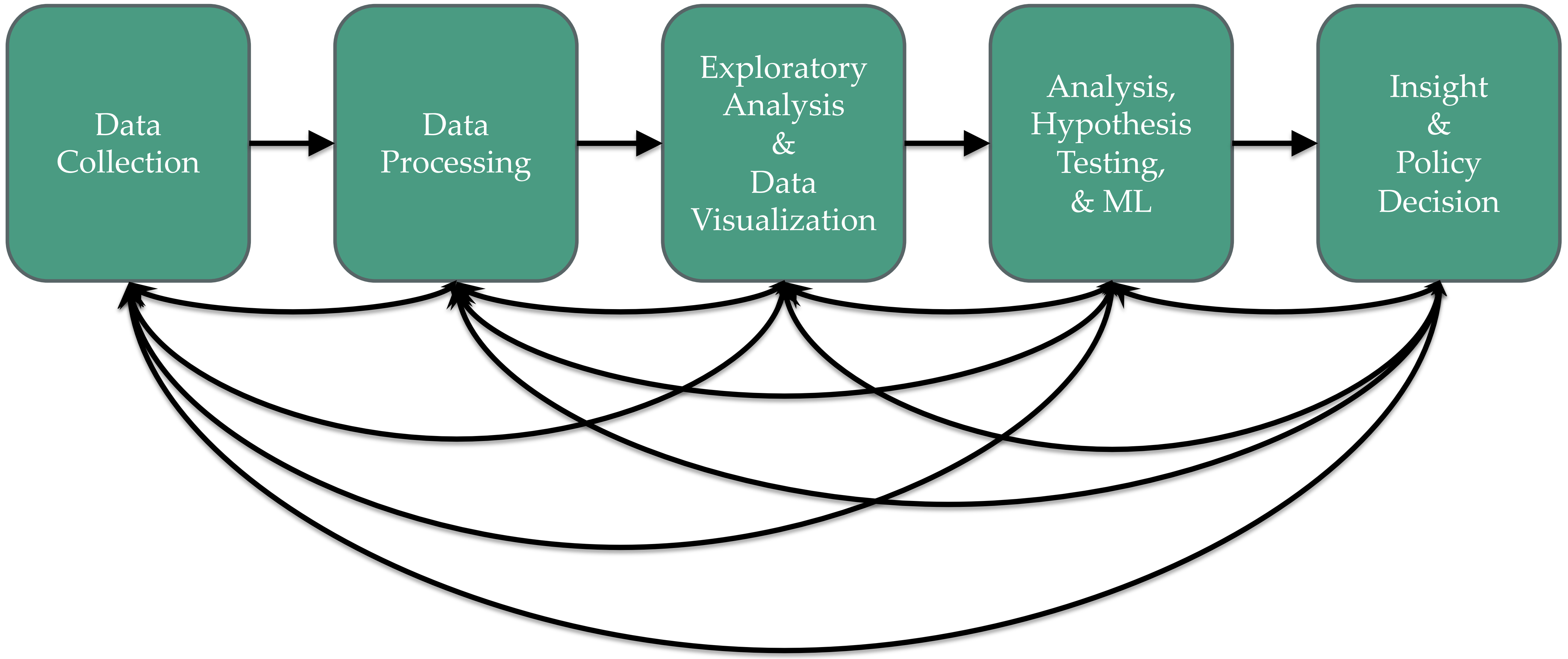
The Data LifeCycle


Data Collection
Data Processing
Exploratory Analysis & Data Visualization
Analysis, Hypothesis Testing, & ML
Insight & Policy Decision

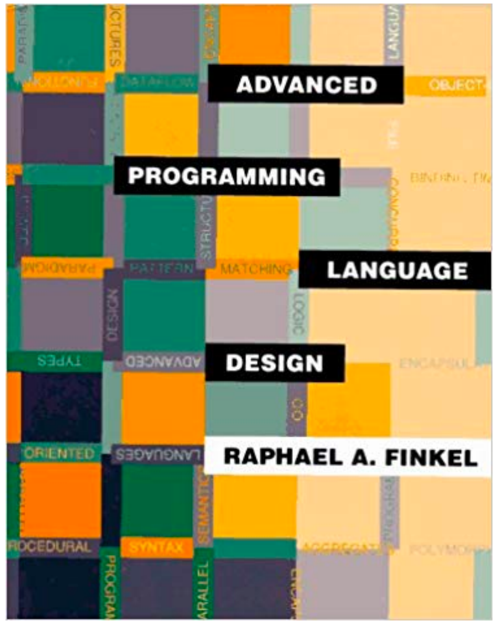
But first, snakes!

- Python is an interpreted, dynamically-typed, high-level, garbage-collected, object-oriented-functional-imperative, and widely used scripting language.
  - **Interpreted:** instructions executed without being compiled into (virtual) machine instructions*
  - **Dynamically-typed:** verifies type safety at runtime
  - **High-level:** abstracted away from the raw metal and kernel
  - **Garbage-collected:** memory management is automated
  - **OOFI:** you can do bits of OO, F, and I programming
    - OO = Object Oriented (you can make objects)
    - F = Functional (everything is a function, stateless, like LISP)
    - I = Imperative (i.e., procedural)
- Not the point of this class!
  - Python is fast (developer time), intuitive, and used in industry!

*you can compile Python source, but it's not required

The Zen of Python

- Beautiful is better than ugly.
- Explicit is better than implicit.
- Simple is better than complex.
- Complex is better than complicated.
- Flat is better than nested.
- Sparse is better than dense.
- Readability counts.
- Special cases aren't special enough to break the rules …
  - … although practicality beats purity.
- Errors should never pass silently …
  - … unless explicitly silenced.



Thanks: SDSMT ACM/LUG

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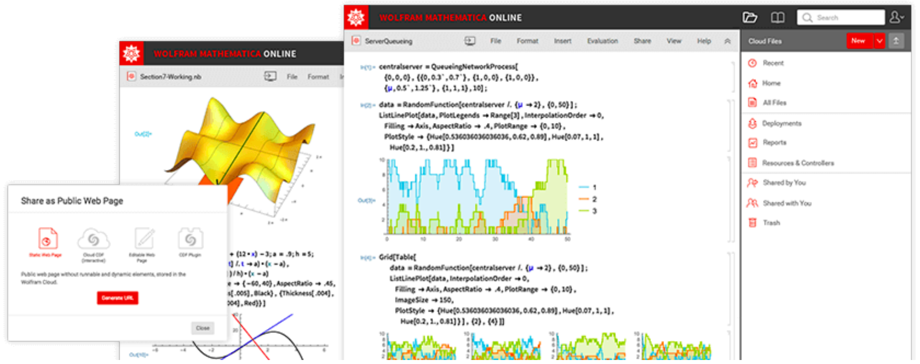
Literate Programming

- Literate code contains in **one document**:
  - the **source** code;
  - text **explanation** of the code; and
  - the **end result** of running the code.
- Basic idea: present code in the order that logic and flow of human thoughts demand, not the machine-needed ordering



- Necessary for data science!
- Many choices made need textual explanation, ditto results.
- Stuff you'll be using in Project 0 (and beyond)!

IP[y]: IPython Interactive Computing

jupyter

10-Minute Python primer

- Define a function:

```
def my_func(x, y):
        if x > y:
                return x
        else:
                return y
```

- Define a function that returns a tuple:

```
def my_func(x, y):
        return (x-1, y+2)

(a, b) = my_func(1, 2)
```

```
a = 0; b = 4
```

Useful Build-In Functions

- `len`: returns the number of items of an enumerable object

```
len( [‘c’, ‘m’, ‘s’, ‘c’, 3, 2, 0] )
```

```
7
```

- `range`: returns an iterable object

```
list( range(10) )
```

```
[0, 1, 2, 3, 4, 5, 6, 7, 8, 9]
```

- `enumerate`: returns iterable tuple (index, element) of a list

```
enumerate( [“311”, “320”, “330”] )
```

```
[(0, “311”), (1, “320”), (2, “330”)]
```

- https://docs.python.org/3/library/functions.html

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Useful Built In Fucntions: Map and Filter

Note!

There is a problem here for Python3!

- `map`: apply a function to a sequence or iterable

```
arr = [1, 2, 3, 4, 5]
map(lambda x: x**2, arr)
```

```
[1, 4, 9, 16, 25]
```

- `filter`: returns a list of elements for which a predicate is true

```
arr = [1, 2, 3, 4, 5, 6, 7]
filter(lambda x: x % 2 == 0, arr)
```

```
[2, 4, 6]
```

- We'll go over in much greater depth with pandas/numpy as the syntax is a little different.

Pythonic Programming

- Basic iteration over an array in Java:

```
int[] arr = new int[10];
for(int idx=0; idx<arr.length; ++idx) {
      System.out.println( arr[idx] );
}
```

- Direct translation into Python:

```
idx = 0
while idx < len(arr):
      print( arr[idx] ); idx += 1
```

- A more “Pythonic” way of iterating:

```
for element in arr:
      print( element )
```

List Comprehensions

- Construct sets like a mathematician!
  - $P = \{ 1, 2, 4, 8, 16, \ldots, 2^{16} \}$
  - $E = \{ x \mid x \text{ in } \mathbb{N} \text{ and } x \text{ is odd and } x < 1000 \}$
- Construct lists like a mathematician **who codes!**

```
P = [ 2**x for x in range(17) ]
```

```
E = [ x for x in range(1000) if x % 2 != 0 ]
```

- Very similar to `map`, but:
  - You'll see these way more than `map` in the wild
  - Many people consider `map`/`filter` not "pythonic"
  - They can perform differently (`map` is "lazier")

Python 2 vs 3

- Python 3 is intentionally backwards incompatible
  - (But not *that* incompatible)
- Biggest changes that matter for us:
  - `print “statement”` → `print(“function”)`
  - `1/2 = 0` → `1/2 = 0.5` and `1//2 = 0`
  - ASCII `str` default → default Unicode

- Namespace ambiguity fixed:
- `i = 1`
- `[i for i in range(5)]`
- `print(i)   # ????????`
  - `Prints “4” in Python 2 and “1” in Python 3 (narrow scope)`

To An Curmudgeons

- I you're ing to use Python 2 anyway, u e the `_future_` module:
  - Python introduces features that will row runtime errors in P hon 2 (e.g., `with` statement
  - `_future_` m ule incrementally brings functionality into 2
  - https://docs.pyth org/2/library/__futu __.html
  - `from _future_ i ort division`
  - `from _future_ impo print_fu ction`
  - `from _future_ import lease ust_use_python_3`

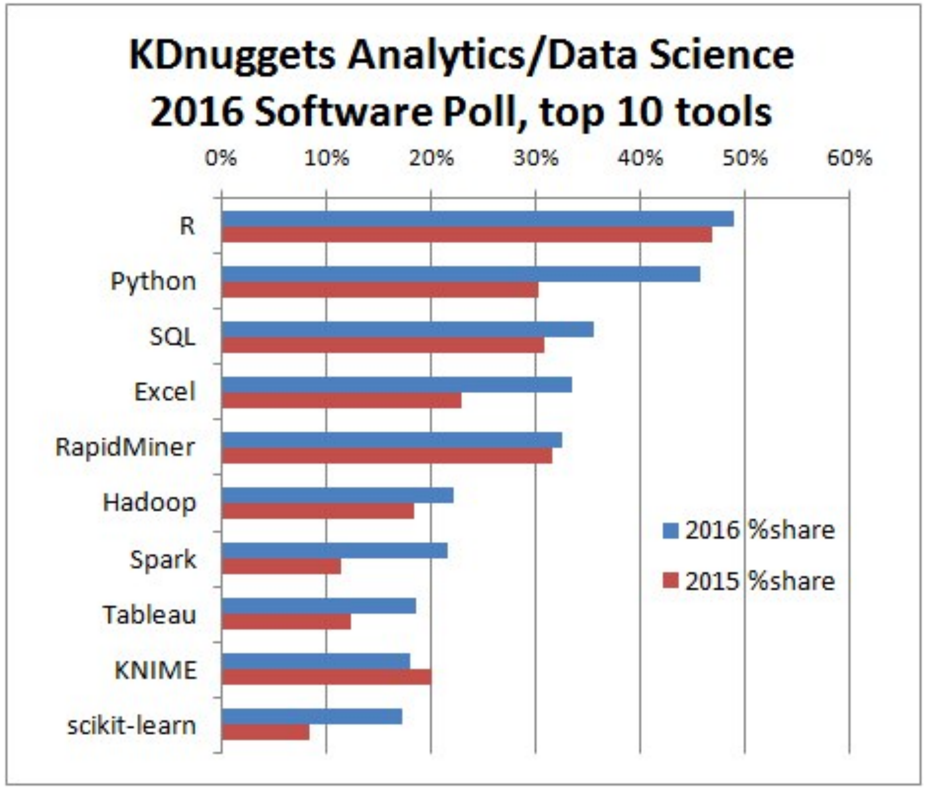
In CMPS 3660 this is wrong.

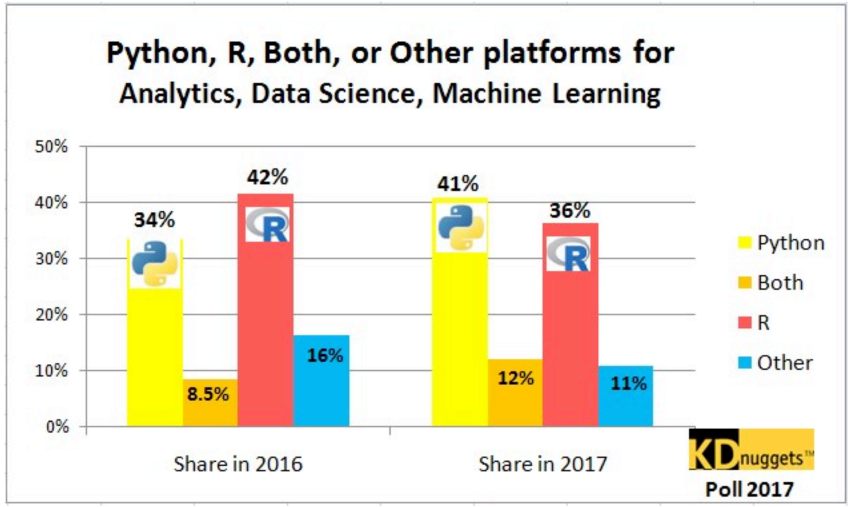
If your code does not run in Python 3, it is wrong.

I'm in charge!

Python v. R (For Data Scientists)

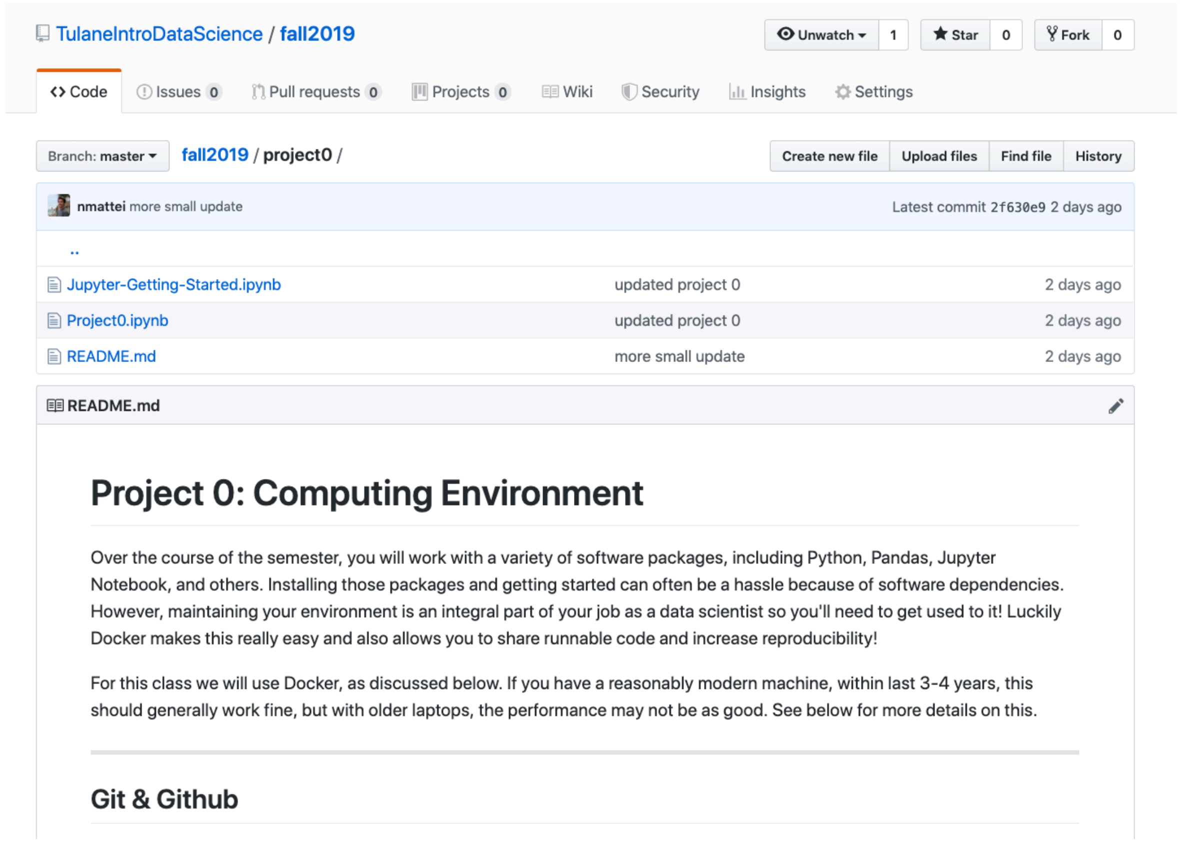
- There is no right answer here!
  - Python is a "full" programming language – easier to integrate with systems in the field
  - R has a more mature set of pure stats libraries …
  - … but Python is catching up quickly …
  - … and is already ahead **specifically for ML.**
- You will see Python more in the tech industry.





Extra resources

- Plenty of tutorials on the web:
  - https://www.learnpython.org/
- Go look at the Notebook that we made for class today!
  - Link TBD.
- Work through Project 0, which will take you through some baby steps with Python and Docker.
  - https://github.com/TulaneIntroDataScience/fall2019/tree/master/project0



nmattei more small update — Latest commit 2f630e9 2 days ago

..		
Jupyter-Getting-Started.ipynb	updated project 0	2 days ago
Project0.ipynb	updated project 0	2 days ago
README.md	more small update	2 days ago

README.md

Project 0: Computing Environment

Over the course of the semester, you will work with a variety of software packages, including Python, Pandas, Jupyter Notebook, and others. Installing those packages and getting started can often be a hassle because of software dependencies. However, maintaining your environment is an integral part of your job as a data scientist so you'll need to get used to it! Luckily Docker makes this really easy and also allows you to share runnable code and increase reproducibility!

For this class we will use Docker, as discussed below. If you have a reasonably modern machine, within last 3-4 years, this should generally work fine, but with older laptops, the performance may not be as good. See below for more details on this.

Git & Github