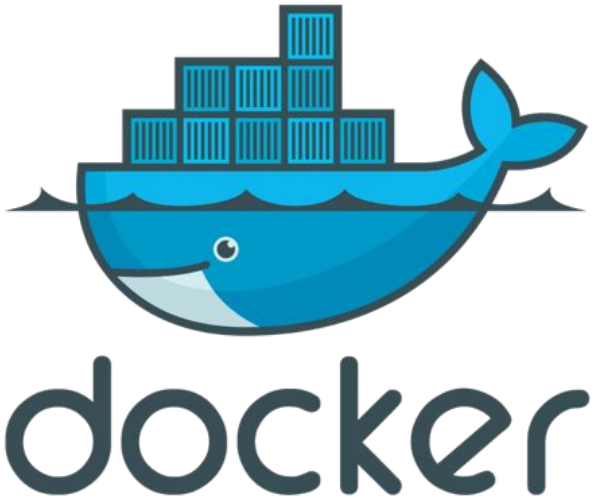
ANNOUNCEMENTS

Register on Piazza: piazza.com/umd/spring2022/cmsc320/home

- 236 have registered already ♡
- **134 still to register** 💔



If you were on Piazza, you'd know …

- Project 0 is out! It is "due" next Tuesday evening.
- Link: https://github.com/cmsc320/spring2021/tree/main/project0

We've also linked some reading for the week!

- First quiz is due Friday at 11:59pm
- Unlimited time, only need to complete 10

(A FEW) DATA SCIENCE SUCCESS STORIES & CAUTIONARY TALES

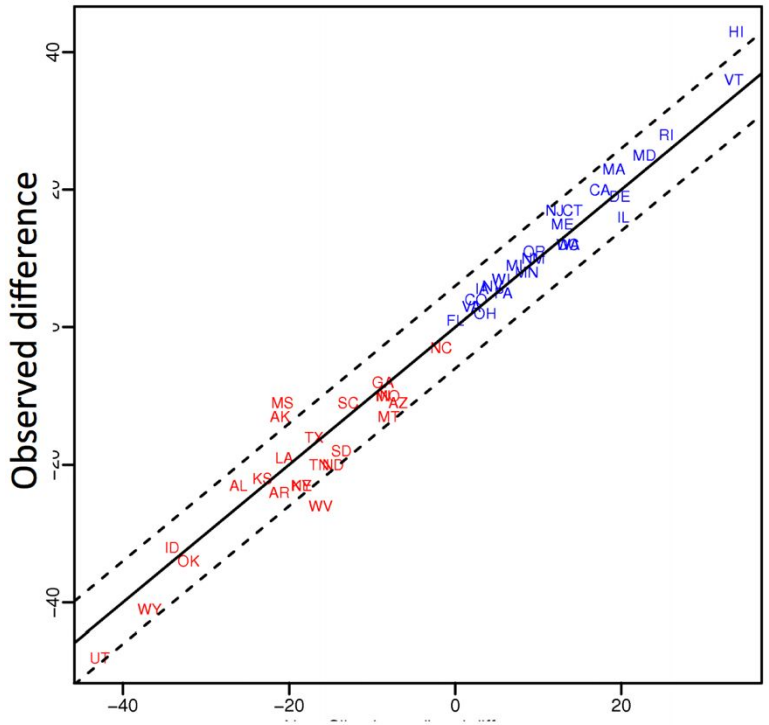
POLLING: 2008 & 2012

Nate Silver uses a simple idea – taking a principled approach to aggregating polling instead of relying on punditry – and:

- **Predicts 49/50 states in 2008**
- **Predicts 50/50 states in 2012**

- **(He is also a great case study in creating a brand.)**

https://hbr.org/2012/11/how-nate-silver-won-the-2012-p



Democrat (+) or Republican (-) in 2012

POLLING: 2016

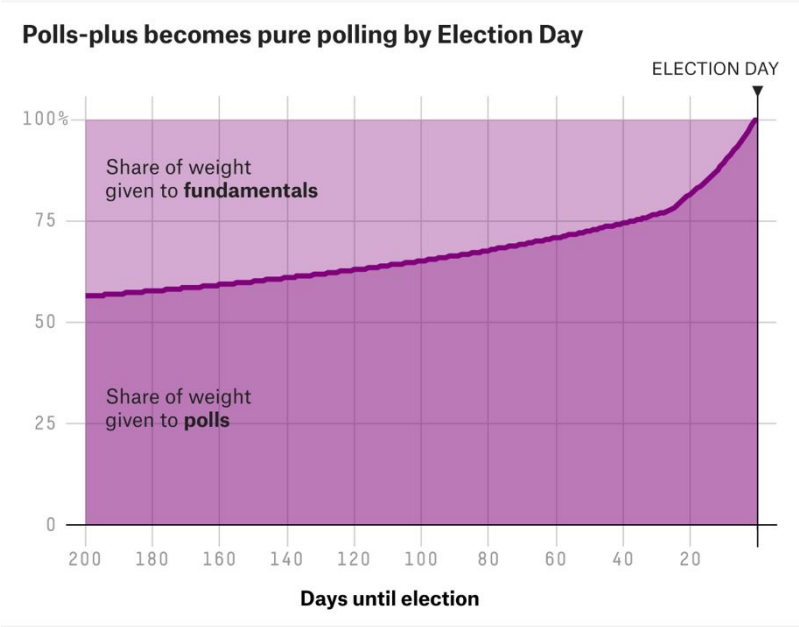
POLITICS

Nate Silver Is Unskewing Polls — All Of Them — In Trump's Direction

The vaunted 538 election forecaster is putting his thumb on the scales.

HuffPo: "He may end up being right, but he's just guessing. A "trend line adjustment" is merely political punditry dressed up as sophisticated mathematical modeling."

538: Offers quantitative reasoning for re-/under-weighting older polls, & changing as election approaches

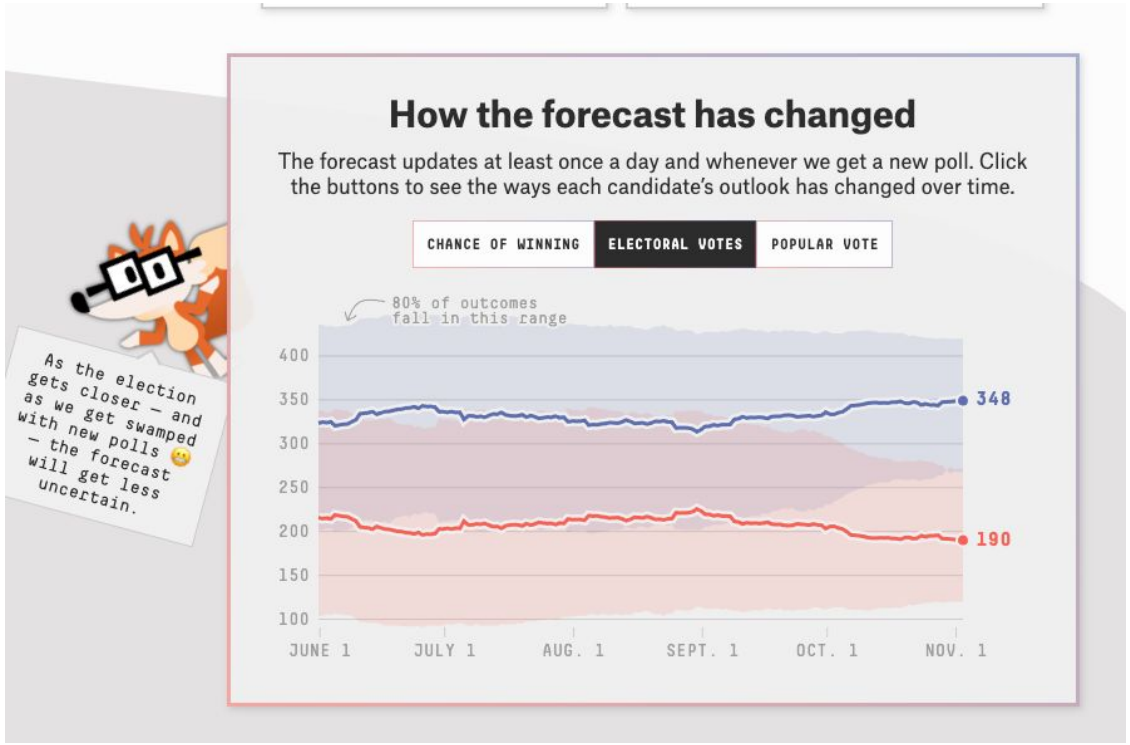


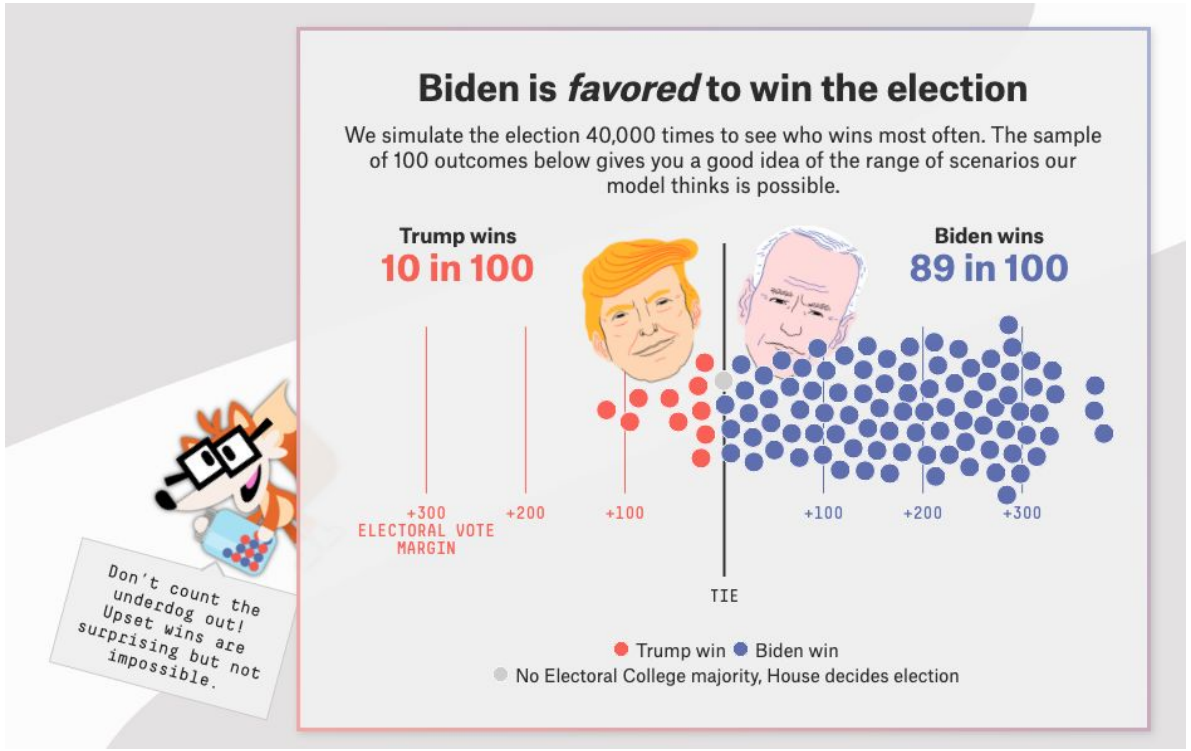
http://www.huffingtonpost.com/entry/nate-silver-election-forecast_us_581e1c33e4b0d9ce6fbc6f7f
https://fivethirtyeight.com/features/a-users-guide-to-fivethirtyeights-2016-general-election-forecast/

POLLING: 2020

Lessons learned: don't just communicate a binary prediction (X loses, Y wins):

- Communicate uncertainty over that prediction
- Communicate variance in the underlying model(s), modeling errors, etc





AD TARGETING

Pregnancy is an expensive & habit-forming time

- **Thus, valuable to consumer-facing firms**

2012:

- **Target identifies 25 products and subsets thereof that are commonly bought in early pregnancy**
- **Uses purchase history of patrons to predict pregnancy, targets advertising for post-natal products (cribs, etc)**
- **Good: increased revenue**
- **Bad: this can expose pregnancies – as famously happened in Minneapolis to a high schooler**

http://www.businessinsider.com/the-incredible-story-of-how-target-exposed-a-teen-girls-pregnancy-2012-2

AUTOMATED DECISIONS OF CONSEQUENCE

[Sweeney 2013, Miller 2015, Byrnes 2016, Rudin 2013, Barry-Jester et al. 2015]

textio

DOXA

zest finance

LendingClub

PREDPOL

gild

GJ GapJumpers

Kabbage

NORTHPOINTE
Advancing Justice. Embracing Community.

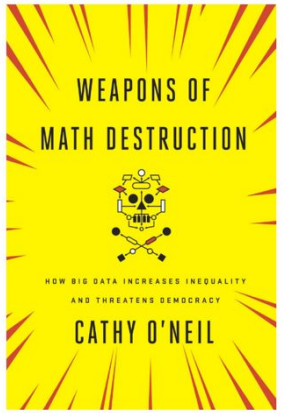
Hiring

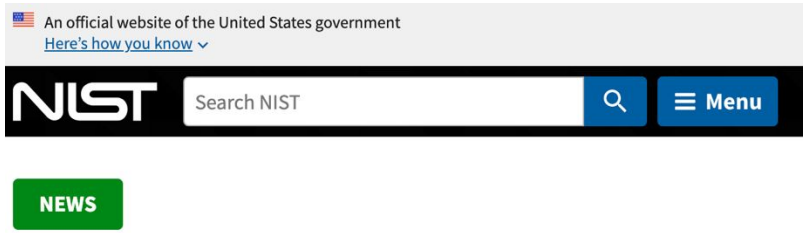
Lending

Policing/ sentencing

Search for minority names □
ads for DUI/arrest records

Female cookies □
less freq. shown professional job opening ads





NEWS

NIST Proposes Approach for Reducing Risk of Bias in Artificial Intelligence

Comments are sought on the publication, which is part of NIST's effort to develop trustworthy AI.

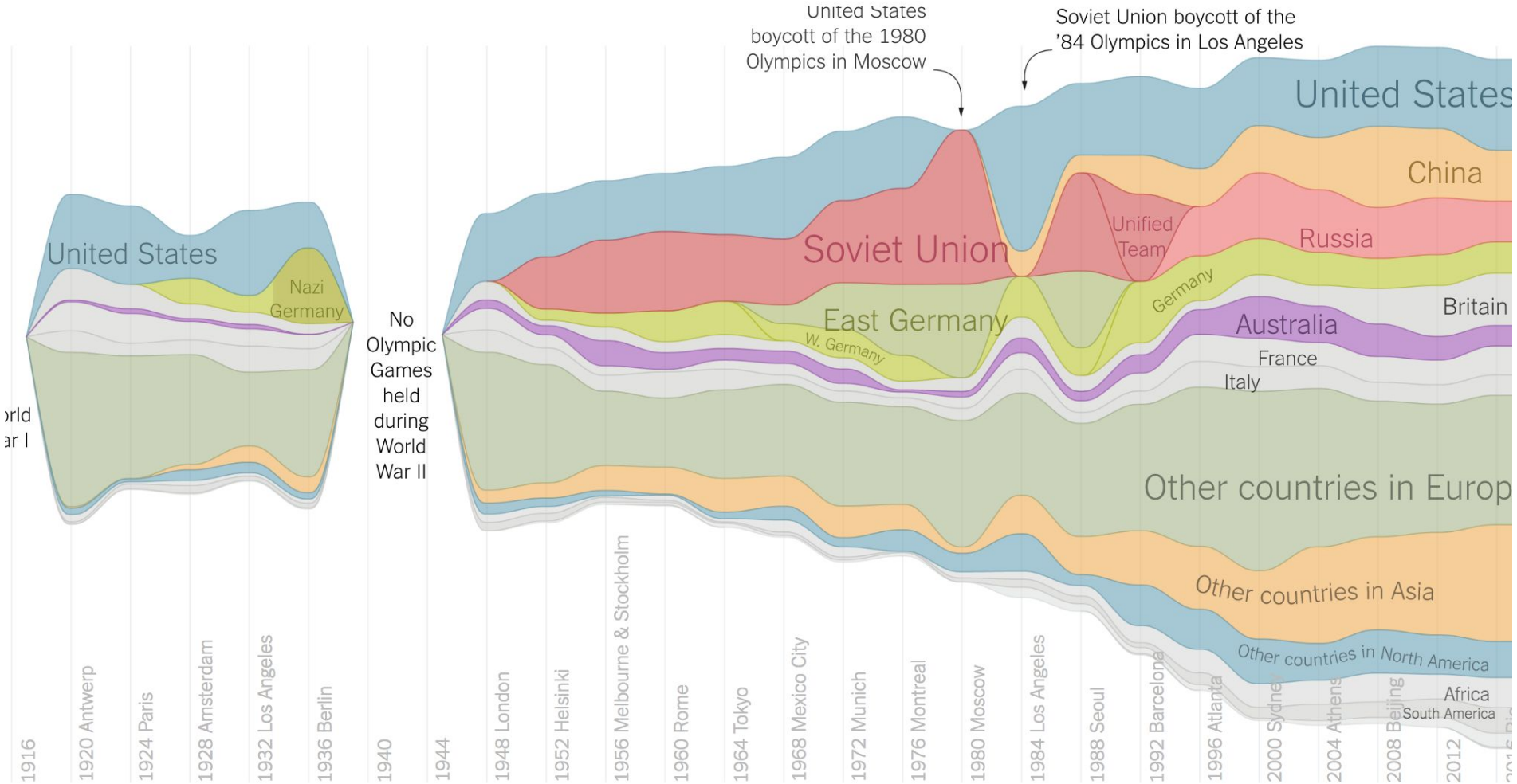
"… a lot remains unknown about how big data-driven decisions may or may not use factors that are proxies for race, sex, or other traits that U.S. laws generally prohibit from being used in a wide range of commercial decisions … What can be done to make sure these products and services–and the companies that use them treat consumers fairly and ethically?"

- FTC Commissioner Julie Brill [2015]

"**Hold yourself accountable – or be ready for the FTC to do it for you.** As we've noted, it's important to hold yourself accountable for your algorithm's performance. … keep in mind that if you don't hold yourself accountable, the FTC may do it for you."

- FTC official blog post, "Aiming for truth, fairness, and equity in your company's use of AI", written by Elisa Jillson [2021]

OLYMPIC MEDALS



https://www.nytimes.com/interactive/2016/08/08/sports/olympics/history-olympic-dominance-charts.html

NETFLIX PRIZE I

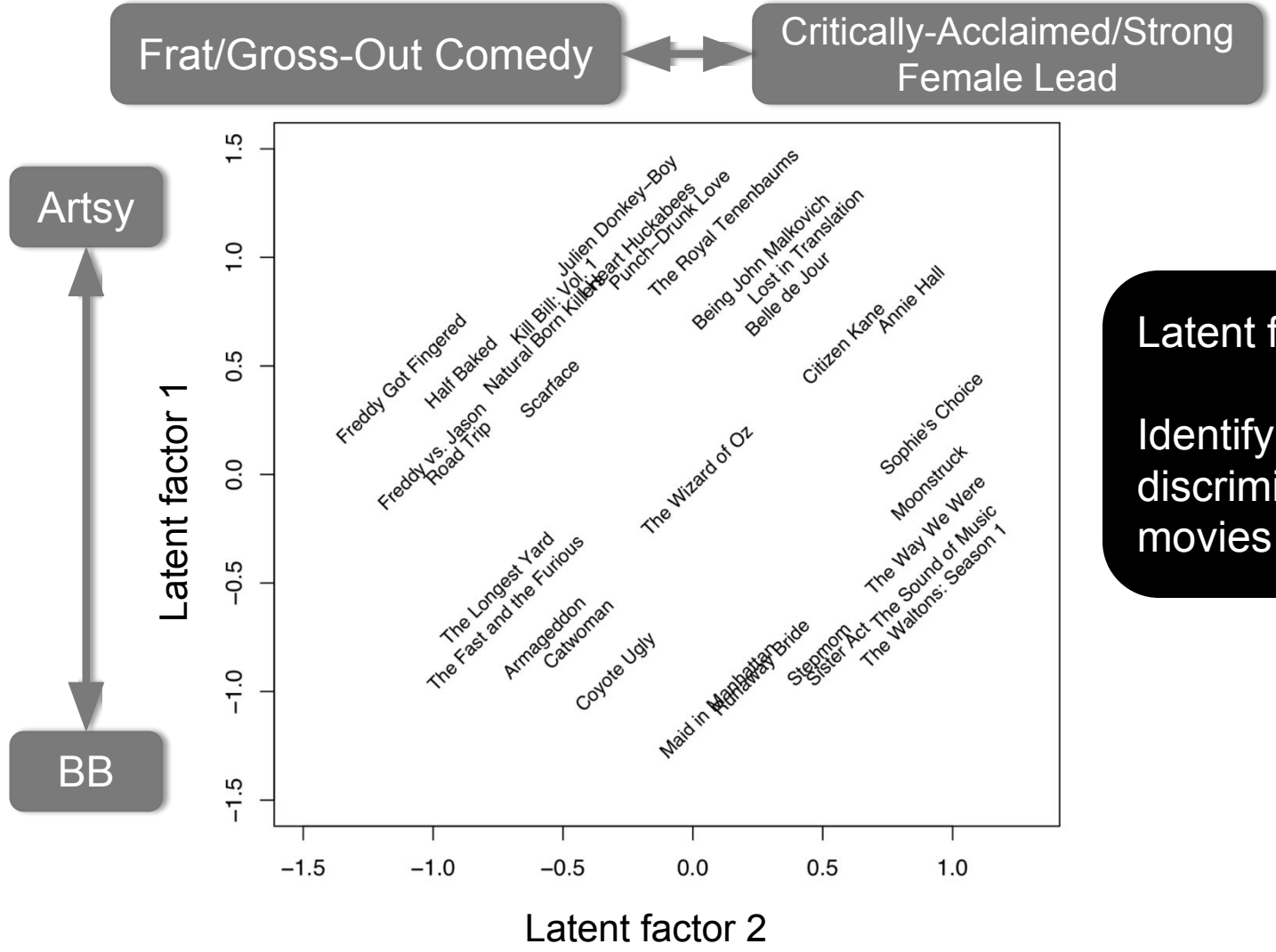
Recommender systems: predict a user's rating of an item

	Twilight	Wall-E	Twilight II	Furious 7
User 1	+1	-1	+1	?
User 2	+1	-1	?	?
User 3	-1	+1	-1	+1

Netflix Prize: $1MM to the first team that beats our in-house engine by 10%

- **Happened after about three years**
- **Model was never used by Netflix for a variety of reasons**
  - Out of date (DVDs vs streaming)
  - Too complicated / not interpretable

NETFLIX PRIZE II



Latent factors model:

Identify factors with max discrimination between movies

Image courtesy of Christopher Volinsky

NETFLIX PRIZE III

Netflix initially planned a follow-up competition

In 2007, UT Austin managed to deanonymize portions of the original released (anonymized) Netflix dataset:

- **??????????**
- **Matched rating against those made publicly on IMDb**

Why could this be bad?

2009—2010, four Netflix users filed a class-action lawsuit against Netflix over

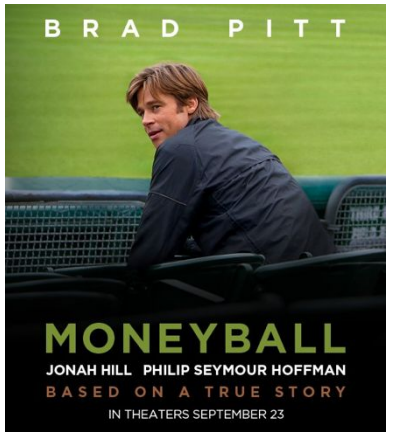
MONEYBALL

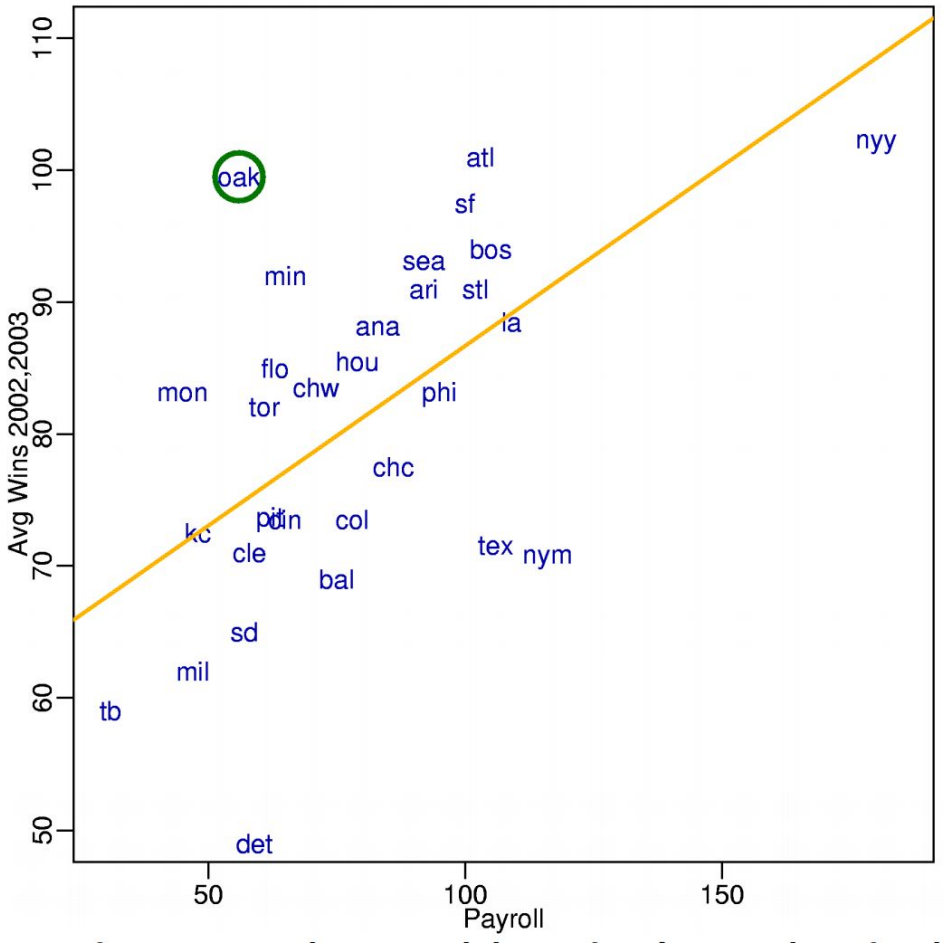
Baseball teams drafted rookie players primarily based on human scouts' opinions of their talents

Paul DePodesta, data scientist *du jour*, convinces the {bad, poor} Oakland Athletics to use a quantitative aka sabermetric approach to hiring

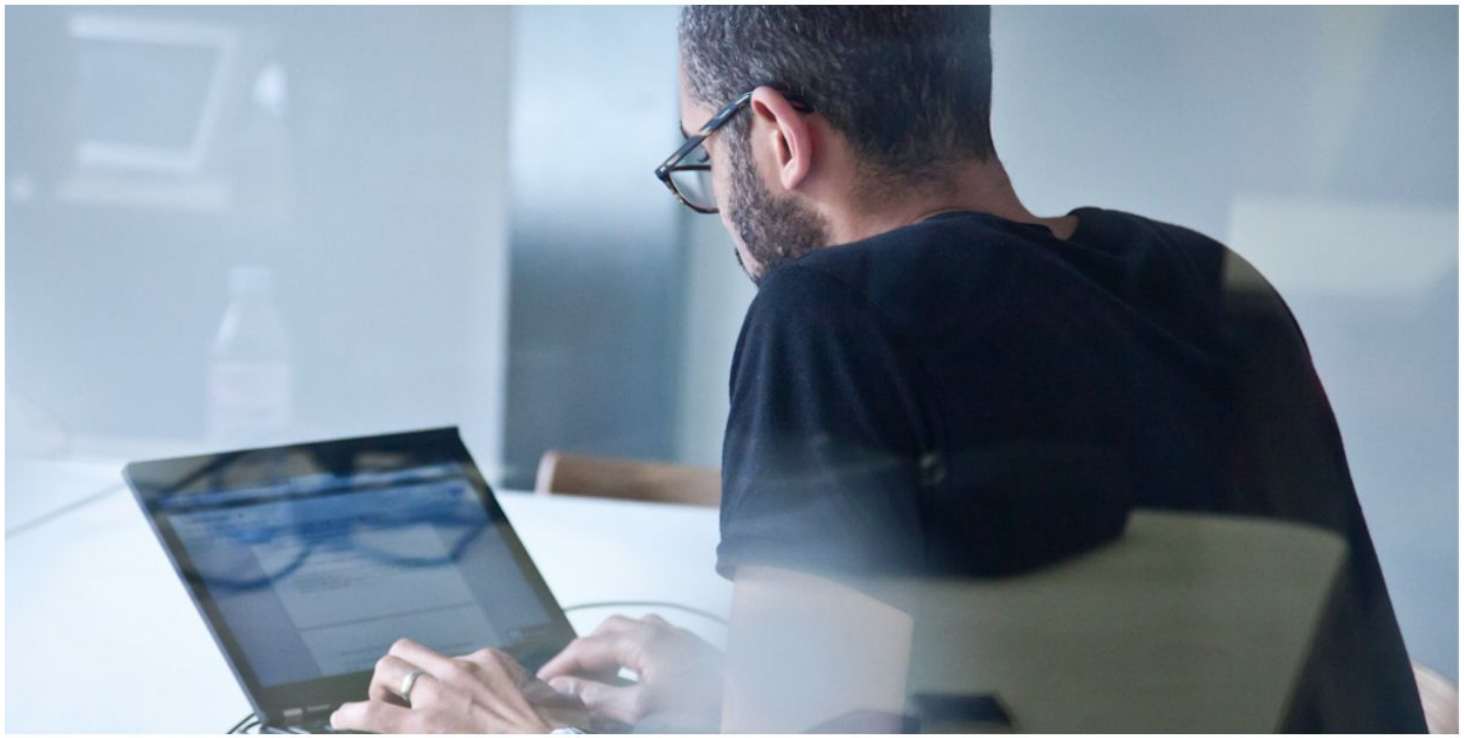
(Spoiler: Red Sox offer Brand a job, he says no, they take a sabermetric approach and win the World Series.)

(Spoiler #2: DePodesta is now Chief Strategy Officer for the Browns, and they extended his contract in 2021, so we'll see what happens!)





1. Data scientist



Shutterstock

Overall job score (out of 5.0): 4.8

Job satisfaction rating (out of 5.0): 4.4

Number of job openings: 4,184

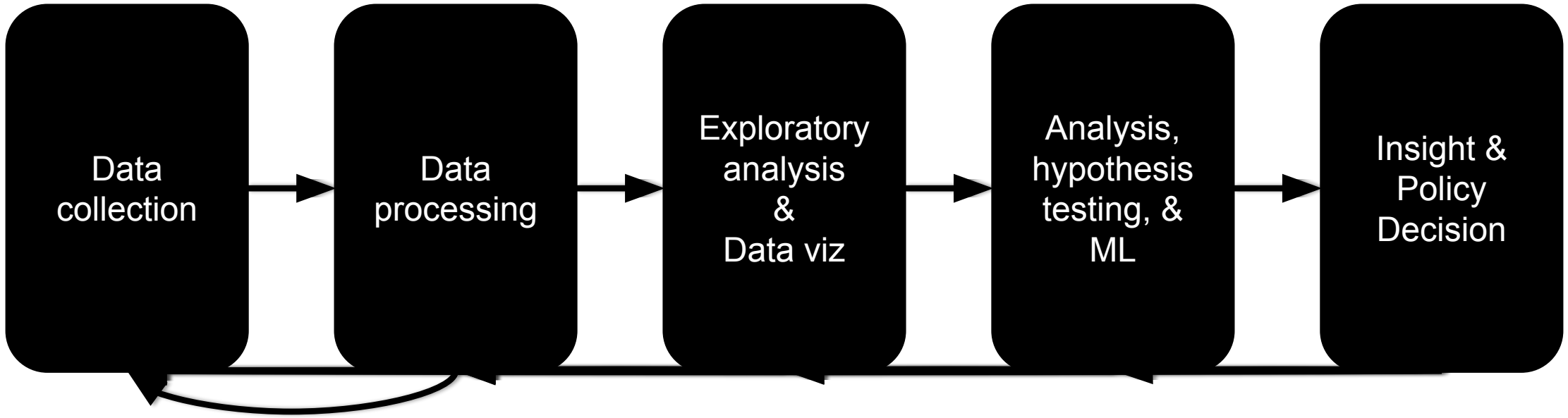
Median base pay: $110,000

http://www.businessinsider.com/best-jobs-in-america-in-2017-2017-1/

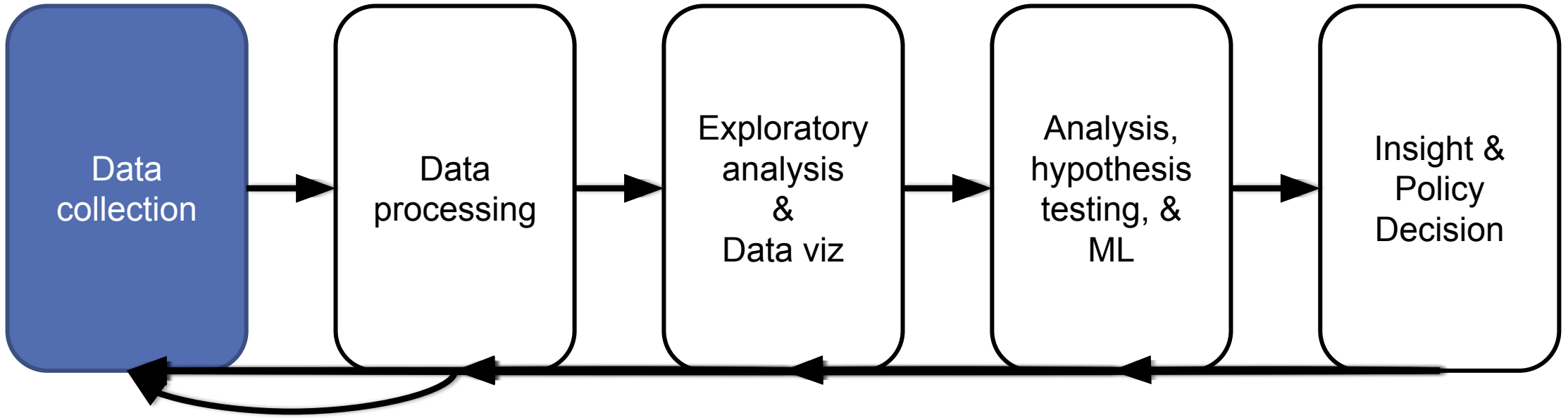
NEXT (AKA THE REST OF THIS) CLASS:

SCRAPING DATA WITH PYTHON

THE DATA LIFECYCLE



(THE REST OF) TODAY'S LECTURE



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

Not the point of this class!

- Python is fast (developer time), intuitive, and used in industry!

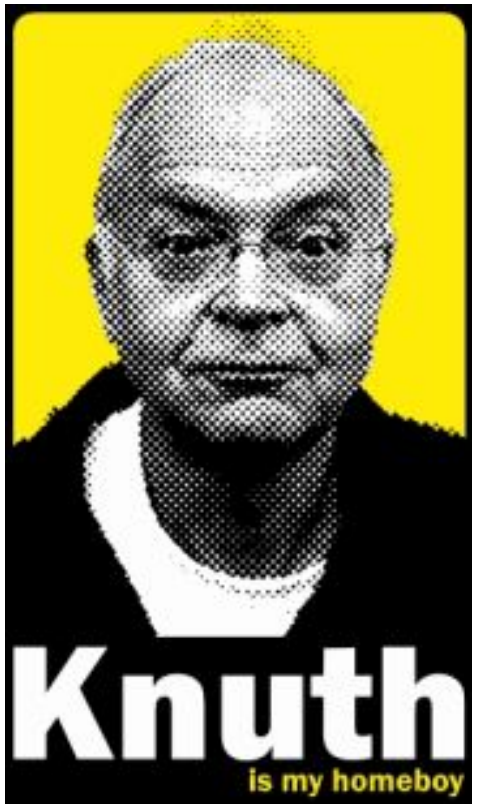
*you can compile Python source, but it's not required

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

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

JUPYTER PROJECT

Started as iPython Notebooks, a web-based frontend to the iPython Shell

- The “notebook” functionality separated out years ago
- Now supports over 40 languages/kernels
- Notebooks can be shared easily
- Can leverage big data tools like Spark

Apache Zeppelin:

- https://www.linkedin.com/pulse/comprehensive-comparison-jupyter-vs-zeppelin-hoc-q-phan-mba-

Several others, e.g., RStudio (specific to R) – can run R via Jupyter, too (IMO, worse!)

GOOGLE COLAB

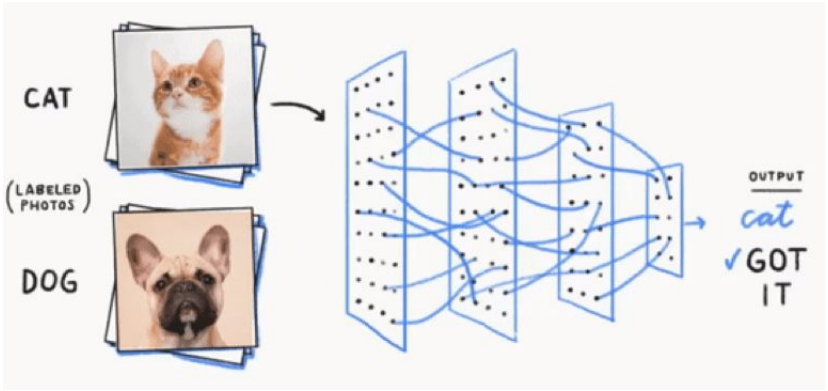
Recall: Jupyter Notebooks are web-based frontends that let you execute arbitrary Python in your browser

- What if you want to run some heavy computation (e.g., train a deep net from scratch, or even just do inference on a pre-trained net)?

Google Colab(oratory) lets you use Google's GPUs and TPUs to do heavy lifting, generally for free

- Notebooks hosted on Google Drive or Github
- Share them with other people with no install needed
- Here's an example CMSC320 tutorial from Fall 2020 that is available on Colab: https://colab.research.google.com/drive/1co_-qwtCmwl_0hCU5Vrz0Lcnp-Qvy_4_

You'll see and use this, and similar cloud services, in ML / data science land.



10-MINUTE PYTHON PRIMER

Define a function:

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

Python is whitespace-delimited

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
```

```
def interview(n):

    if n % 3 == 0 and n % 5 == 0:
        return 'FizzBuzz'
    elif n % 3 == 0:
        return 'Fizz'
    elif n % 5 == 0:
        return 'Buzz'
    else:
        return str(n)

print( "\n".join(interview(n) for n
in xrange(1, 101)) )
```

USEFUL BUILT-IN FUNCTIONS: COUNTING AND ITERATING

`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://doc

USEFUL BUILT-IN FUNCTIONS: MAP AND FILTER

`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.

**in Python 3, returns Iterable*

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")**

EXCEPTIONS

Syntactically correct statement throws an exception:

- `tweepy` (Python Twitter API) returns “Rate limit exceeded”
- sqlite (a file-based database) returns `IntegrityError`

```
print('Python', python_version())

try:
   cause_a_NameError
except NameError as err:
   print(err, '-> some extra text')
```

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)    # ????????
```

Python 2: prints "4"; Python 3: prints "1" (narrow scope)

TO ANY CURMUDGEONS …

If you're going to use Python 2 anyway, use the `_future_` module:

- Python 3 introduces features that will throw runtime errors in Python 2 (e.g., `with` statements)
- `_future_` module incrementally brings 3 functionality into 2
- https://docs.python.org/2/library/__future__.html

```
from _future_ import division
from _future_ import print_function
from _future_ import please_just_use_python_3
```

SO, HOW DOES IMPORT WORK?

Python code is stored in module – simply put, a file full of Python code

A package is a directory (tree) full of modules that also contains a file called `__init.py__`

- Packages let you structure Python's module namespace
- E.g., `X.Y` is a submodule `Y` in a package named `X`

For one module to gain access to code in another module, it must import it

```
sound/                          Top-level package
      __init__.py               Initialize the sound package
      formats/                  Subpackage for file format conversions
              __init__.py
              wavread.py
              wavwrite.py
              aiffread.py
              aiffwrite.py
              auread.py
              auwrite.py
              ...
      effects/                  Subpackage for sound effects
              __init__.py
              echo.py
              surround.py
              reverse.py
              ...
      filters/                  Subpackage for filters
              __init__.py
              equalizer.py
              vocoder.py
              karaoke.py
              ...
```

```
# Load (sub)module sound.effects.echo
import sound.effects.echo
# Must use full name to reference echo functions
sound.effects.echo.echofilter(input, output, delay=0.7)
```

https://docs.python.org/2/tutorial/modules.html

EXAMPLE

```
# Load (sub)module sound.effects.echo
import sound.effects.echo
# Must use full name to reference echo functions
sound.effects.echo.echofilter(input, output, delay=0.7)
```

```
# Load (sub)module sound.effects.echo
from sound.effects import echo
# No longer need the package prefix for functions in echo
echo.echofilter(input, output, delay=0.7)
```

```
# Load a specific function directly
from sound.effects.echo import echofilter
# Can now use that function with no prefix
echofilter(input, output, delay=0.7)
```

https://docs.python.org/2/tutorial/modules.html

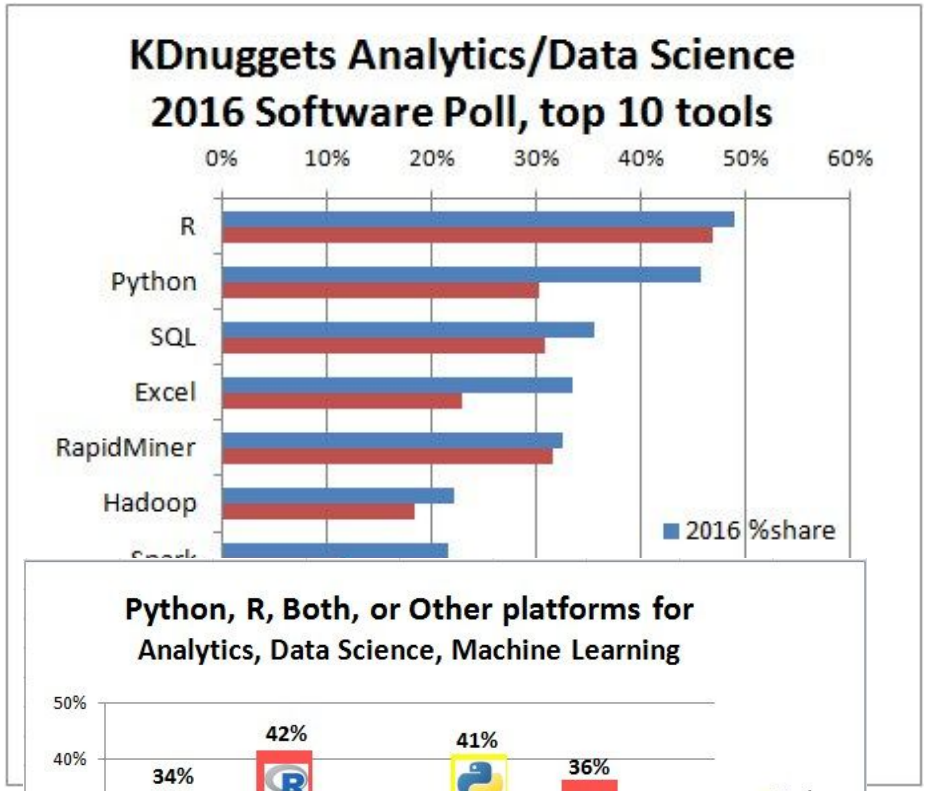
PYTHON VS R (FOR DATA SCIENTISTS)

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.

- https://insights.stackoverflow.com/survey/2021



EXTRA RESOURCES

Plenty of tutorials on the web:

- https://www.learnpython.org/

Work through Project 0, which will take you through some baby steps with Python and the Pandas library:

- (We'll also post some more readings soon.)

Come (virtually!) hang out at office hours:

- All office hours will be on the website/Piazza by early next week.
- Will have coverage MTWThF.