

TRITON BALL

SPORTS ANALYTICS @ UCSD

Research! | Data Projects! | Consulting!

WEEK 2: GBM! (10/06)

WEEK 3: DATA VIZ WORKSHOP (10/13)

WEEK 4: MACH. LEARNING SOCCER WORKSHOP (10/20)

WEEK 4: WORLD SERIES WATCH PARTY (10/24)

WEEK 5: INDUSTRY GUEST SPEAKER W/ FOOD! (10/29)

WEEK 6: BASEBALL ANALYTICS DEMO (11/04)

...



@tritonball_ucsd



JOIN OUR DISCORD!

Upcoming due dates

Mon Oct 6th Quiz 1

Wed Oct 9th Pre-course survey

Fri Oct 10th Discussion Lab 1

#FinAid quiz on Canvas

Discussion section next week covers git +
installing Anaconda on your laptop.

Notebook drops Mon on Datahub

Data and data wrangling

Data Science in Practice

Data Structures Review

Structured data

- can be stored in database SQL
- tables with rows

Semi-structured data

- doesn't reside in a relational database

Unstructured

- non-tabular data
- 80% of the world's data
- images, text, audio,

Structured Data

Databases! An organized collection of structured information

- *Manage huge datasets*
- *Control access to data*
- *Allow users to find a subset of data with a query*
- *Run an analysis on data inside the DB and return a report*

Structured Data

Relational DB

- *SQLite*
- *MySQL*
- *Postgres*

Relational DB work using tables of data with “relationships” established between tables

Non-relational DB

- *Hadoop*
- *Hive*
- *Apache CouchBase*

NoSQL DB work with key-value pairs to lookup data, and that's exactly like JSON slides coming up.

(Semi-)Structured Data

Data that is stored in such a way that it is easy to search and work with. These data are stored in a particular format that adheres to organization principles imposed by the file format. These are the data structures data scientists work with most often.

CSVs

Each column separated
by a comma

Example CSV - Sheet1 — Notatnik

Plik Edycja Format Widok Pomoc

Email	First Name	Last Name	Company	Snippet
example1@domain.com	John	Smith	Company 1	Snippet Sentence1
example2@gmail.com	Mary	Blake	Company 2	Snippet Sentence 2
example3@outlook.com	James	Joyce	Company 3	Snippet Sentence 3

Has the extension “.csv”

Each row
is
separated
by a new
line



Example CSV



File Edit View Insert Format Data Tools Add-ons Help All changes saved in Drive

A row of icons for file operations (New, Open, Save, Print, Find, etc.), zoom (100%), number format (\$, %, .0, .00), and data type (123, Date, Text). Font (Arial), size (10), bold (B), italic (I), underline (U), and alignment (center, right, left) are also present.

fx

	A	B	C	D	E	F
1	Email	First Name	Last Name	Company	Snippet 1	
2	example1@domain.com	John	Smith	Company 1	Snippet Sentence1	
3	example2@gmail.com	Mary	Blake	Company 2	Snippet Sentence 2	
4	example3@outlook.com	James	Joyce	Company 3	Snippet Sentence 3	
5						
6	CSV file					
7						
8						

Example CSV - Sheet1 — Notatnik
Plik Edycja Format Widok Pomoc
Email,First Name,Last Name,Company,Snippet 1
example1@domain.com,John,Smith,Company 1,Snippet Sentence1
example2@gmail.com,Mary,Blake,Company 2,Snippet Sentence 2
example3@outlook.com,James,Joyce,Company 3,Snippet Sentence 3

JSON: key-value pairs

nested/hierarchical data

{"Name": "Isabela"}

The diagram illustrates a JSON object consisting of a single key-value pair. The key, 'Name', is highlighted in large black font at the top left. The value, 'Isabela', is highlighted in large black font at the top right. Two pink arrows point from the words 'key' and 'value' at the bottom left and bottom right respectively, towards their corresponding parts in the JSON object above.

key

value

JSON

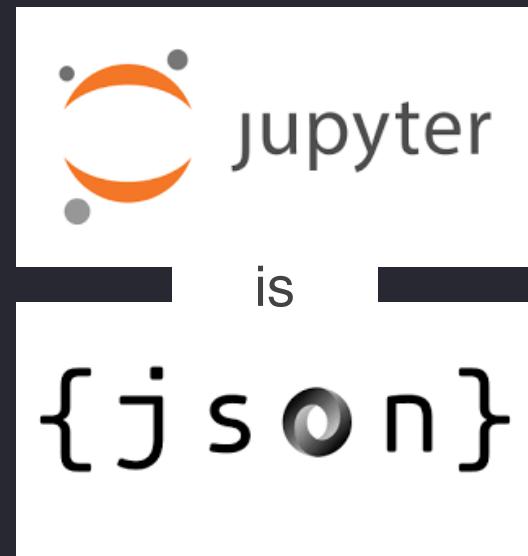
These are all
nested within
attributes

```
"attributes": {  
    "Take-out": true,  
    "Wi-Fi": "free",  
    "Drive-Thru": true,  
    "Good For": {  
        "dessert": false,  
        "latenight": false,  
        "lunch": false,  
        "dinner": false,  
        "breakfast": false,  
        "brunch": false  
    },  
},
```

These are all
nested within
"Good For"

JSON

```
{  
  "cells": [  
    {  
      "cell_type": "markdown",  
      "metadata": {},  
      "source": [  
        "This example represents the output the t-SNE dimensionality reduction algorithm on embeddings computed from Unicode emojis using Keras  
      ]  
    },  
    {  
      "cell_type": "code",  
      "execution_count": null,  
      "metadata": {},  
      "outputs": [],  
      "source": [  
        "import pandas as pd\n",  
        "import holoviews as hv\n",  
        "hv.extension('bokeh')"  
      ]  
    },  
    {  
      "cell_type": "markdown",  
      "metadata": {},  
      "source": [  
        "## Declaring data"  
      ]  
    },  
    {  
      "cell_type": "code",  
      "execution_count": null,  
      "metadata": {},  
      "outputs": [  
        {"text": "jupyter is json"}  
      ],  
      "source": [  
        "jupyter_nbformat: 3",  
        "jupyter_nbformat_minor: 0",  
        "jupyter_version": "1.0",  
        "nbformat": 4, "nbformat_minor": 2,  
        "cells": [  
          {"cell_type": "code", "execution_count": null, "metadata": {}, "outputs": [{"text": "jupyter is json"}], "source": ["jupyter_nbformat: 3", "jupyter_nbformat_minor: 0", "jupyter_version": "1.0", "nbformat": 4, "nbformat_minor": 2]}  
      ]  
    }  
  ]  
}
```



Jupyter notebooks suck to version control

<https://nextjournal.com/schmudde/how-to-version-control-jupyter>

```
{  
    "cell_type": "code",  
    "execution_count": null,  
    "metadata": {},  
    "outputs": [],  
    "source": [  
        "import pandas as pd\n",  
        "import holoviews as hv\n",  
        "hv.extension('bokeh')"  
    ]  
},
```

A graphic of a yellow arrow pointing to the right, set against a black background. The word "DETOUR" is written in large, bold, black capital letters across the center of the arrow.

DETOUR

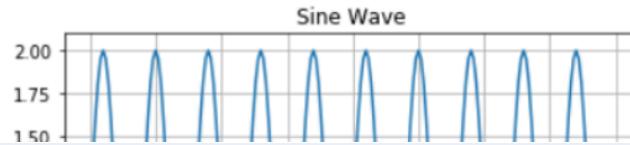
```
In [10]: import numpy as np
import matplotlib.pyplot as plt

# Data for plotting
t = np.arange(0.0, 2.0, 0.01)
s = 1 + np.sin((5 * 2)* np.pi * t)

# Note that using plt.subplots below is equivalent to using
# fig = plt.figure() and then ax = fig.add_subplot(111)
fig, ax = plt.subplots()
ax.plot(t, s)

ax.set(xlabel='time (s)', ylabel='voltage (mV)', title='Sine Wave')
ax.grid()
```

Out[10]:



```
"outputs": [
{
  "data": {
    "image/png": "iVBORw0KGgoAAAANSUhEUgAAAYwAAAECAYAAAB1xKBvAAAABHNCSVQICAgIfAhkiAAAAAlwSFzAAALEgAACxIB0t1+/AAAADl0RVh0U29mdHdhcmUAbWF0cGxvdGxpYiB2ZXJzaW9uIDIuMi4yLCBodHRwOi8vbWF0cGxvdGxpYi5vcmcvhp/UCwAAIABJREFUeJzsXmcHNd13/s9vc4+2EgABHeQEkVSXGGRFLembFNSPn7Wyy45i5UXh5ZjvcSy4xcr78WK5bwkzvKSeI1l0qaVxZKc0JLN+FHc0dxJEVxAAGQBAiCIdbDP0tPT+80fVdXdmOnl1q17ezBm/T6f+QDdXVXnVtU996z3HFFKESNGjBgxYvRDYrkHECNGjBgxVgZigREjRowYMbQQC4wYMWLEiKGFWGDEiBEjRgwtxAIjRowYMWJoIRYYMWLEiBFDC7HAiBEDEJG/JiKPL/c4YsQ4nxELjBgfGojIXSLyoojMiMg"
```

Jupyter notebooks suck to version control

<https://nextjournal.com/schmudde/how-to-version-control-jupyter>

Clear Output Manually

The simplest solution is to always clear the output before committing. **Cell → All Output → Clear → Save**. This removes any binary blobs that have been generated by the notebook. There are three main drawbacks:

- It is a manual process.
- Collaborators on other machines will need to rerun the notebook to see the output, requiring additional time and setup.

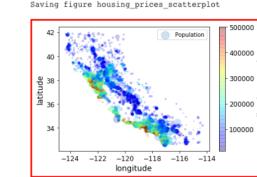
Jupyter notebooks suck to version control

<https://nextjournal.com/schmudde/how-to-version-control-jupyter>

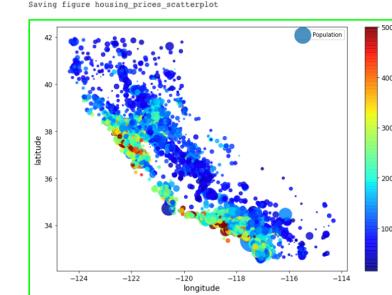
ReviewNB

[ReviewNB](#) is a GitHub app that also offers visual diffing with an interface that looks similar to the traditional Jupyter IDE. Because the outputs are visualized, problems associated with committing binary blobs disappear.

```
1 housing.plot(kind="scatter", x="longitude", y="latitude", alpha=0.2,
2   s=housing["population"]*10, label="Population", figsize=(10,7),
3   c="median_house_value", cmap=plt.get_cmap("jet"), colorbar=True,
4   sharex=False)
5 plt.legend()
6 save_fig("housing_prices_scatterplot")
```



```
1 housing.plot(kind="scatter", x="longitude", y="latitude", alpha=0.2,
2   s=housing["population"]*10, label="Population", figsize=(10,7),
3   c="median_house_value", cmap=plt.get_cmap("jet"), colorbar=True,
4   sharex=False)
5 plt.legend()
6 save_fig("housing_prices_scatterplot")
```

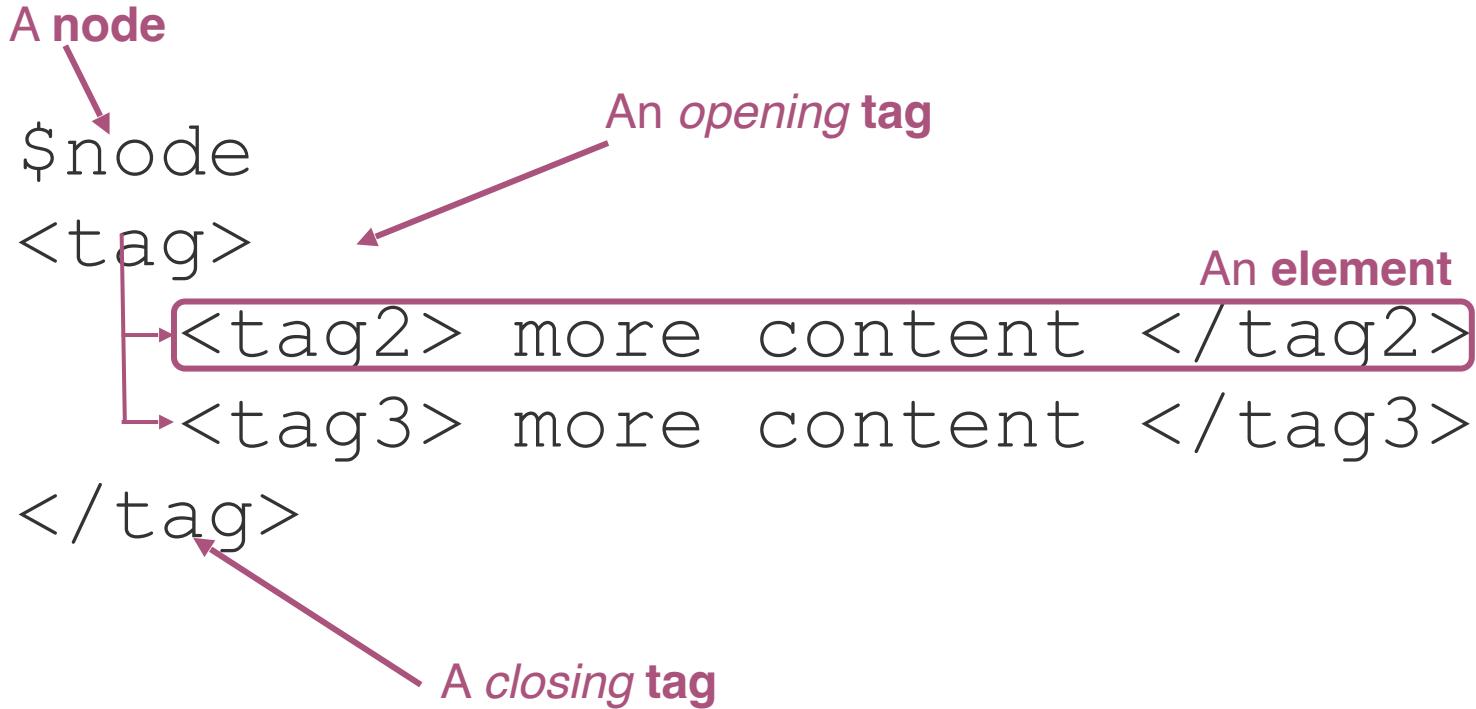


ReviewNB example courtesy of the [ReviewNB website](#)

Back to data formats...

Extensible Markup Language (XML): nodes, tags, and elements

nested/hierarchical data



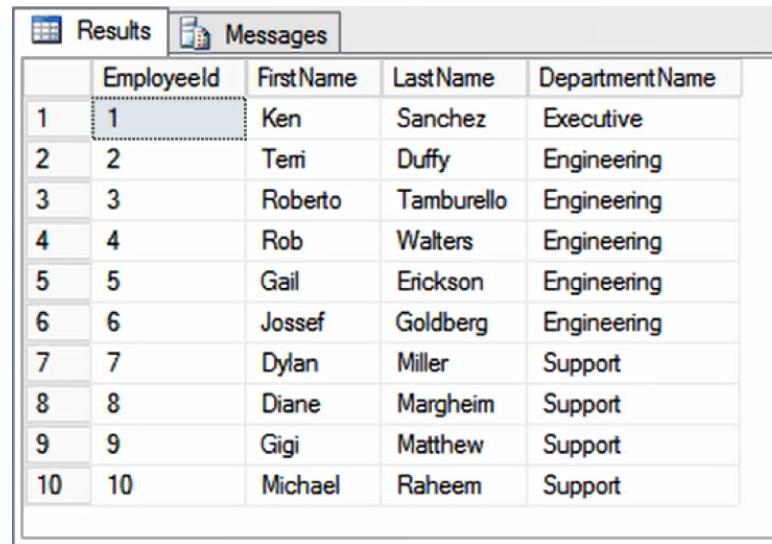
XML

```
<?xml version="1.0" encoding="UTF-8"?>
<customers>
    <customer>
        <customer_id>1</customer_id>
        <first_name>John</first_name>
        <last_name>Doe</last_name>
        <email>john.doe@example.com</email>
    </customer>
    <customer>
        <customer_id>2</customer_id>
        <first_name>Sam</first_name>
        <last_name>Smith</last_name>
        <email>sam.smith@example.com</email>
    </customer>
    <customer>
        <customer_id>3</customer_id>
        <first_name>Jane</first_name>
        <last_name>Doe</last_name>
        <email>jane.doe@example.com</email>
    </customer>
</customers>
```

XML

Relational Databases: A set of interdependent tables

1. Efficient Data Storage
2. Avoid Ambiguity
3. Increase Data Privacy



	EmployeeId	FirstName	LastName	DepartmentName
1	1	Ken	Sanchez	Executive
2	2	Temi	Duffy	Engineering
3	3	Roberto	Tamburello	Engineering
4	4	Rob	Walters	Engineering
5	5	Gail	Erickson	Engineering
6	6	Jossef	Goldberg	Engineering
7	7	Dylan	Miller	Support
8	8	Diane	Margheim	Support
9	9	Gigi	Matthew	Support
10	10	Michael	Raheem	Support

relational database

Information is stored across tables

unique_identifier
AH13JK
JJ29JJ
CI21AA

unique_identifier
AH13JK
JJ29JJ
JJ29JJ
XJ11AS
CI21AA

unique_identifier
AH13JK
SE92FE
CI21AA

entries are *related* to one another by their unique identifier

relational database

restaurant

name	id	address	type
Taco Stand	AH13JK	1 Main St.	Mexican
Pho Place	JJ29JJ	192 Street Rd.	Vietnamese
Taco Stand	XJ11AS	18 W. East St.	Fusion
Pizza Heaven	CI21AA	711 K Ave.	Italian

health inspections

id	inspection_date	inspector	score
AH13JK	2018-08-21	Sheila	97
JJ29JJ	2018-03-12	D'eonte	98
JJ29JJ	2018-01-02	Monica	66
XJ11AS	2018-12-16	Mark	43
CI21AA	2018-08-21	Anh	99

rating

id	stars
AH13JK	4.9
JJ29JJ	4.8
XJ11AS	4.2
CI21AA	4.7

relational database

restaurant

name	id	address	type
Taco Stand	AH13JK	1 Main St.	Mexican
Pho Place	JJ29JJ	192 Street Rd.	Vietnamese
Taco Stand	XJ11AS	18 W. East St.	Fusion
Pizza Heaven	CI21AA	711 K Ave.	Italian

Two different restaurants with
the same name will have
different unique identifiers

health inspections

id	inspection_date	inspector	score
AH13JK	2018-08-21	Sheila	97
JJ29JJ	2018-03-12	D'eonte	98
JJ29JJ	2018-01-02	Monica	66
XJ11AS	2018-12-16	Mark	43
CI21AA	2018-08-21	Anh	99

rating

id	stars
AH13JK	4.9
JJ29JJ	4.8
XJ11AS	4.2
CI21AA	4.7

relational database

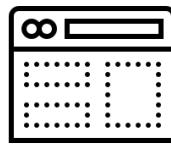
Unstructured Data

Some datasets record information about the state of the world, but in a more heterogeneous way. Perhaps it is a large text corpus with images and links like Wikipedia, or the complicated mix of notes and test results appearing in personal medical records.

Unstructured Data Types



Text files
and
documents



Websites
and
applications



Sensor
data



Image
files



Audio
files



Video
files



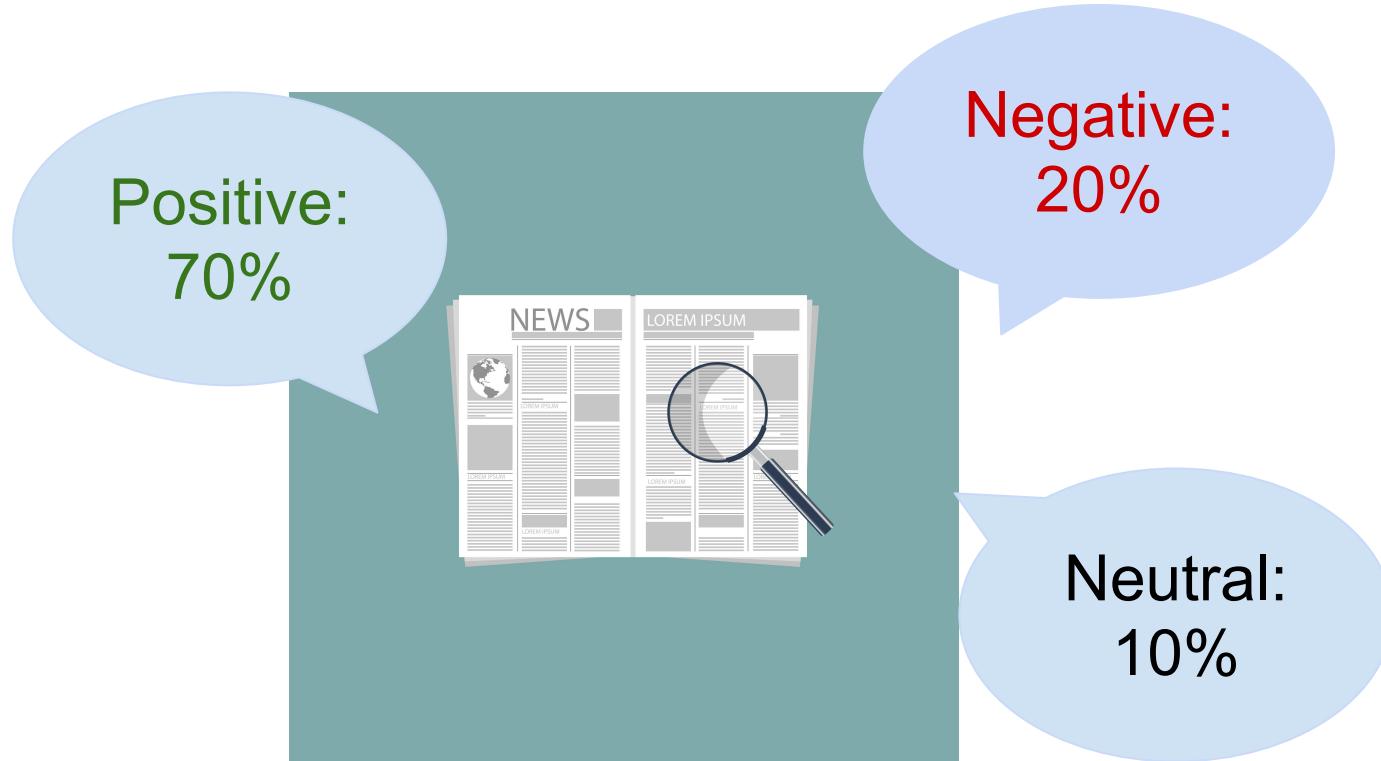
Email
data



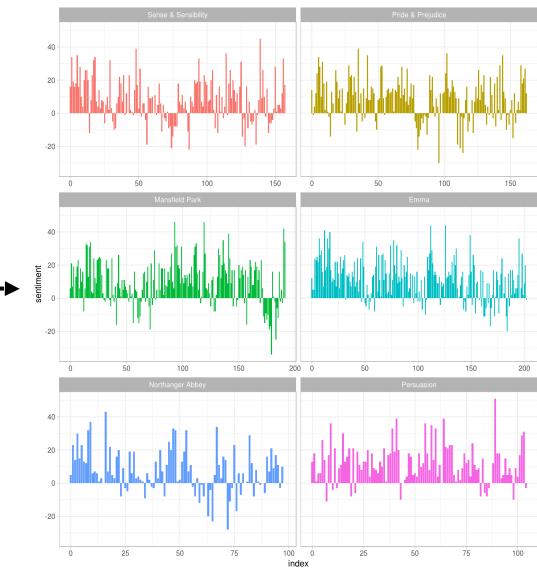
Social
media
data



Text: Sentiment Analysis

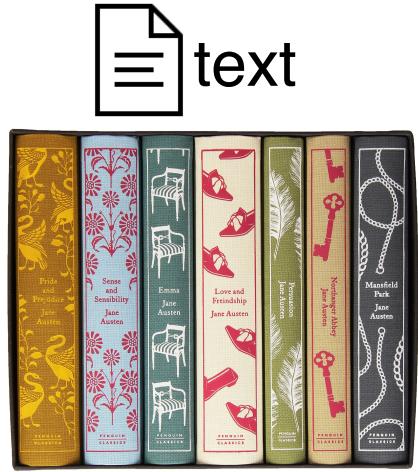


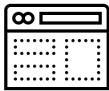
results



tidy dataset

Word	Novel	Frequency
good	Emma	359
young	Emma	192
friend	Emma	166



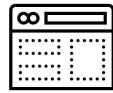


PYTHON

BEAUTIFULSOUP

WEB SCRAPING





website

JAN. 21 "I wasn't a fan of Iraq. I didn't want to go in there," he said at a press briefing last week. **JAN. 21** "A reporter for Time magazine — and I have been here twice since the election. I think we have to do more to let them know the tales of their reporters." **JAN. 21** "A reporter for Time magazine — and I have been here twice since the election. I think we have to do more to let them know the tales of their reporters." **JAN. 21** "I was a fan of Iraq. I didn't want to go in there."

JAN. 21 "Remove 2 million and 1 million illegal votes caused us to lose the popular vote." **JAN. 21** "There's no evidence of voter fraud." **JAN. 21** "Now, the audience was the biggest ever. But then we made it look like it had to be this crowd. This crowd was massive." **JAN. 21** "Official aerial photos show Obamas' 2009 inauguration are fake, never really existed." **JAN. 21** "Take a look at the Pew reports (which show voter fraud)." **JAN. 21** "The report never mentioned voter fraud." **JAN. 21** "No, that's not true."

JAN. 22 "So, look, when President Obama was here two weeks ago making a speech, very nice speech. Two people were shot and killed during his speech. You can't tell me that's not voter fraud." **JAN. 22** "When the American citizens come to the White House, they're not going to leave nothing about them. They can say whatever they want. That's what happened. There was a lot of noise. There was a lot of noise. **JAN. 22** "What's your point? What's your point? You don't care who you are here? You don't?" **JAN. 22** "I just got hundreds of millions of dollars off one particular place. Instead of billions of dollars it's a short period of time. It's a week! I bet a week, like, weeks, hours, less than hours, and more, many hundreds of millions of dollars. And the place's going to be better. **JAN. 22** "They can't even agree on who to nominate to be the next president. **JAN. 22** "It's not a surprise that the Republicans are going to argue that the Tea Party wants to be involved in deciding who the next president is. **JAN. 22** "The Coloradan who got the power of the state of Colorado is correct for this." **JAN. 22** "Only 100 people out of 32000 were detained and held for questioning. Big problems at airports were caused by Delta computer upgrade." **JAN. 22** "Only 100 people out of 32000 were detained and arrested, and the Delta computer upgrade was caused by the FBI." **JAN. 22** "Professional assholes, things and people who are not qualified to be running this country." **JAN. 22** "The first thing that Donald Trump did was to make MARY AMERICA LOOK LIKE A DICK. **JAN. 22** "I'm going to apologize for it but not because of what we're writing the election. THE FAZ NEWS goes down it all fast!" **JAN. 22** "It never concluded." **JAN. 22** "We had 300 people out of hundreds of thousands of travelers and all we did was we took those people very, very roughly." **JAN. 22** "What's your point? What's your point? You don't care who you are here?" **JAN. 22** "To make sure that little stories which are detailed in the legislation on the FSA, the FSA bill, the little bills are detailed, and the little bills are effective."

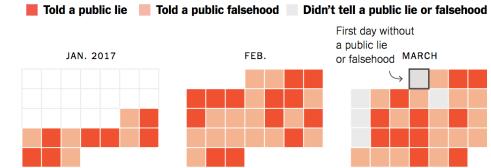
JAN. 22 "To make sure that little stories which are detailed in the legislation on the FSA, the FSA bill, the little bills are detailed, and the little bills are effective."



tidy dataset

date	lie	explanation	url
0 Jan 21, 2017	I wasn't a fan of Iraq. I didn't want to go in there...	He was for an invasion before he was against it.	https://www.buzzfeed.com/andrewkaczynski/i-hate-trump-2017
1 Jan 21, 2017	A reporter for Time magazine — and I have been here twice since the election.	Trump was on the cover 11 times and Nixon 11 times and Nixon apple ...	http://nation.time.com/2013/11/06/10-things-you-didnt-know-about-trumps-time-cover-record
2 Jan 23, 2017	Between 3 million and 5 million illegal votes ...	There's no evidence of illegal voting.	https://www.nytimes.com/2017/01/23/us/politics/trump-voter-fraud.html
3 Jan 25, 2017	Now, the audience was the biggest ever. But th...	Official aerial photos show Obamas' 2009 inaug...	https://www.nytimes.com/2017/01/21/us/politics/trump-voter-fraud.html
4 Jan 25, 2017	Take a look at the Pew reports (which show vot...	The report never mentioned voter fraud.	https://www.nytimes.com/2017/01/24/us/politics/trump-voter-fraud.html

results



Accessing data from a website

- Prefer API access
- If no API access then you can see if its possible to web scrape in a reasonable fashion
 - Be nice... don't slam the servers
 - Identify yourself as a scraper if at all possible

Application Programming Interface (API) access

- See this tutorial! <https://realpython.com/api-integration-in-python/>
- Basically:
 - Website gives you a way to authenticate (e.g. keys or OAuth)
 - You create a text string that asks for the thing you want in a particular way
 - You turn that text string into an HTTP request on the website
 - Website returns the thing you're looking for as XML or JSON or similar via HTTP

text (lyrics)

ThePudding "I'll be analyzing the repetitiveness of a dataset of 15,000 songs that charted on the Billboard Hot 100 between 1958 and 2017."



AN EXERCISE IN LANGUAGE COMPRESSION

Are Pop Lyrics Getting More Repetitive?

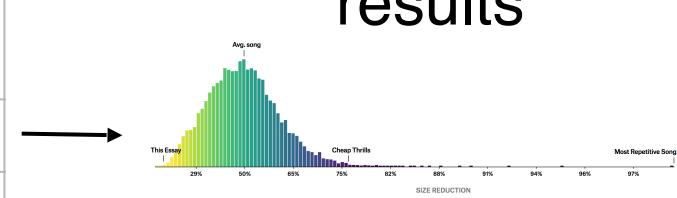
By Colin Morris

<https://pudding.cool/2017/05/song-repetition/>

tidy dataset

song	Artist	Released	Reduction
Cheap Thrills	Sia	2016	76
Around The World	Daft Punk	1997	98
Everybody Dies	J. Cole	2018	27

results



What are these uber-repetitive outliers? *Around The World* by Daft Punk gets reduced a whopping 98%. It goes from 2,610 characters to 61. Small enough to fit in a tweet - twice!

Tidy Data

"Good data scientists understand, in a deep way, that the heavy lifting of cleanup and preparation isn't something that gets in the way of solving the problem: it is the problem."

- DJ Patil



Australian Bureau of Statistics

1800.0 Australian Marriage Law Postal Survey, 2017

Released on 15 November 2017

Table 5 Participation by Federal Electoral Division(a), Males and Age Gender apartheid

Table junk

Yeah NA		18-19 years	20-24 years	25-29 years	30-34 years	35-39 years	40-44 years	45-49 years	50-54 years	55-59 years	60-64 years	
i22 Lingiari (c)	Total participants	292	1,058	1,465	1,653	1,515	1,516	1,710	1,730	1,753	1,574	
i23 Lingiari (c)	Eligible participants	572	2,910	3,789	3,996	3,607	3,506	3,645	3,331	2,960	2,456	
i24 Lingiari (c)	Participation rate (%)	51.0	36.4	38.7	41.4	42.0	43.2	46.9	51.9	59.2	64.1	
Primary keynotes		Communion										
Merged cells		Total participants	442	1,461	2,066	2,357	2,188	2,057	2,224	2,108	2,134	1,772
Solomon		Eligible participants	750	2,991	3,994	4,155	3,634	3,398	3,427	3,066	2,931	2,355
		Participation rate (%)	58.9	48.8	51.7	56.7	60.2	60.5	64.9	68.8	72.8	75.2
Northern Territory (Total)		Total participants	734	2,519	3,531	4,010	3,703	3,573	3,934	3,838	3,887	3,346
		Eligible participants	1,322	5,901	7,783	8,151	7,241	6,904	7,072	6,397	5,891	4,811
		Participation rate (%)	55.5	42.7	45.4	49.2	51.1	51.8	55.6	60.0	66.0	69.5
Australian Capital Territory Divisions		Covariate as Subheading										
Canberra(d)		Summary of data inside data										
		Total participants	1,764	4,789	4,817	4,973	4,626	4,453	5,074	4,826	5,169	4,394
		Eligible participants	2,260	6,471	6,448	6,509	5,983	5,805	6,302	5,902	6,044	5,057
		Participation rate (%)	78.1	74.0	74.7	76.4	77.3	76.7	80.5	81.8	85.5	86.9
Fenner(e)		Total participants	1,477	4,687	5,178	5,786	6,025	5,463	5,191	4,208	3,948	3,465
		Eligible participants	1,904	6,354	7,121	7,822	7,960	7,155	6,480	5,206	4,692	3,945
		Participation rate (%)	77.6	73.8	72.7	74.0	75.7	76.4	80.1	80.8	84.1	87.8
Australia		NA Yeah										
Australian Capital Territory (Total)		Total participants	5,241	9,476	9,993	10,739	10,051	9,310	10,205	9,034	9,117	7,659
		Eligible participants	4,164	12,825	13,569	14,331	13,943	12,960	12,782	11,108	10,736	9,002
		Participation rate (%)	77.8	73.9	73.7	75.1	76.4	76.5	80.3	81.3	84.9	87.3
Total		Total participants	151,297	438,166	441,658	460,548	462,206	479,360	524,620	517,693	543,449	506,799
		Eligible participants	201,439	635,909	646,916	665,250	656,446	660,841	693,850	659,150	664,720	597,386
		Participation rate (%)	75.1	68.9	68.3	69.2	70.4	72.5	75.6	78.5	81.8	84.8

(a) The Federal Electoral Divisions are current as at 24 August 2017

(b) Includes those whose age is unknown

(c) Includes Christmas Island and the Cocos (Keeling) Islands

(d) Includes Norfolk Island

(e) Includes Jervis Bay

Return of the table junk

untidy data

Australian Bureau of Statistics												
1800.0 Australian Marriage Law Postal Survey, 2017												
Released 15 November 2017												
Table 5 Participation by Federal Electoral Division(a) Males and Age												Table junk
Primary keynotes												
Yeah NA												
		18-19 years	20-24 years	25-29 years	30-34 years	35-39 years	40-44 years	45-49 years	50-54 years	55-59 years	60-64 years	
Lingard(c)	Total participants	292	1,058	1,460	1,653	1,515	1,516	1,710	1,730	1,753	1,574	
	Eligible participants	292	2,910	3,049	3,096	3,607	3,506	3,645	3,331	2,960	2,456	
	Participation rate (%)	51.0	36.4	38.7	41.4	42.0	43.2	46.8	51.9	58.2	64.1	
Merged cells												
Solomon	Total participants	442	1,461	2,068	2,357	2,188	2,057	2,224	2,108	2,134	1,772	
	Eligible participants	750	2,991	3,994	4,155	3,634	3,398	3,427	3,066	2,931	2,355	
	Participation rate (%)	56.9	48.8	51.7	56.7	60.2	60.5	64.9	68.8	72.8	75.2	
Northern Territory	Total participants	734	2,519	3,531	4,010	3,703	3,573	3,934	3,838	3,887	3,346	
(Total)	Eligible participants	1,322	5,901	7,783	8,151	7,241	6,904	7,072	6,397	5,891	4,811	
	Participation rate (%)	55.5	42.7	45.4	49.2	51.1	51.8	55.6	60.0	66.0	69.5	
Australian Capital Territory Divisions	Covariate as Subheading											
Canberra(d)	Summary of data inside data											
	Total participants	1,764	4,789	4,817	4,973	4,626	4,453	5,074	4,826	5,169	4,394	
	Eligible participants	2,260	6,471	6,448	6,509	5,983	5,805	6,302	5,902	6,044	5,057	
	Participation rate (%)	78.1	74.0	74.7	76.4	77.3	76.7	80.5	81.8	85.5	86.9	
Fenner(e)	Total participants	1,477	4,687	5,178	5,786	6,025	5,463	5,191	4,208	3,948	3,465	
	Eligible participants	1,904	6,354	7,121	7,822	7,960	7,155	6,480	5,206	4,692	3,945	
	Participation rate (%)	77.6	73.8	72.7	74.0	75.7	76.4	80.1	80.8	84.1	87.8	
	NA Yeah											
Australian Capital Territory (Total)	Total participants	5,542	9,416	9,895	10,155	10,054	9,219	10,205	9,034	9,141	7,659	
	Eligible participants	4,164	12,825	13,569	14,331	13,943	12,960	12,782	11,108	10,736	9,002	
	Participation rate (%)	77.8	73.9	73.7	75.1	76.4	76.5	80.3	81.3	84.9	87.3	
Australia	Total participants	151,297	438,166	441,658	460,548	462,206	479,360	524,620	517,693	543,449	506,799	
	Eligible participants	201,439	635,909	646,916	665,250	656,446	660,841	693,850	659,150	664,720	597,386	
	Participation rate (%)	75.1	68.9	68.3	69.2	70.4	72.5	75.6	78.5	81.8	84.8	
a)	The Federal Electoral Divisions are current as at 24 August 2017											
b)	Includes those whose age is unknown											
c)	Includes Christmas Island and the Cocos (Keeling) Islands											
d)	Includes Norfolk Island											
e)	Includes Jervis Bay											
	Return of the table junk											
	MS Excel or Die											

data → wrangling

tidy data

area	gender	age	State	Area (sq km)	Eligible participants	Participation rate (%)	Total participants	Total Participants
Adelaide	Female	18-19 years	SA	76	1341	83.5	1120	1120
Adelaide	Female	20-24 years	SA	76	4620	81.2	3750	3750
Adelaide	Female	25-29 years	SA	76	4897	81.8	4004	4004
Adelaide	Female	30-34 years	SA	76	4784	79.8	3820	3820
Adelaide	Female	35-39 years	SA	76	4319	79	3411	3411
Adelaide	Female	40-44 years	SA	76	4310	80.6	3472	3472
Adelaide	Female	45-49 years	SA	76	4579	81.4	3728	3728
Adelaide	Female	50-54 years	SA	76	4475	84.7	3791	3791
Adelaide	Female	55-59 years	SA	76	4622	87.3	4033	4033
Adelaide	Female	60-64 years	SA	76	4342	89.3	3879	3879
Adelaide	Female	65-69 years	SA	76	3970	90.7	3602	3602
Adelaide	Female	70-74 years	SA	76	3009	90.3	2716	2716
Adelaide	Female	75-79 years	SA	76	2156	88.5	1908	1908
Adelaide	Female	80-84 years	SA	76	1673	85.1	1423	1423

1	area	gender	age	State	Area (sq km)	Eligible participants	Participation rate (%)	Total participants	Total Participants		
2	Adelaide	Female	18-19 years	SA	76	1341	83.5	1120	1120		
3	Adelaide	Female	20-24 years	SA	76	4620	81.2	3750	3750		
4	Adelaide	Female	25-29 years	SA	76	4897	81.8	4004	4004		
5	Adelaide	Female	30-34 years	SA	76	4784	79.8	3820	3820		
6	Adelaide	Female	35-39 years	SA	76	4319	79	3411	3411		
7	Adelaide	Female	40-44 years	SA	76	4310	80.6	3472	3472		
8	Adelaide	Female	45-49 years	SA	76	4579	81.4	3728	3728		
9	Adelaide	Female	50-54 years	SA	76	4475	84.7	3791	3791		
10	Adelaide	Female	55-59 years	SA	76	4622	87.3	4033	4033		
A	B	C	D	E	F	G	H	I	J		
Australian Bureau of Statistics	Table junk										
1800.0 Australian Marriage Law Postal Survey, 2017											
Released on 31 November 2017											
Table 5 Participation by Federal Electoral Division (a) Males and Age Gender apartheid											
Yeah NA	18-19 years	20-24 years	25-29 years	30-34 years	35-39 years	40-44 years	45-49 years	50-54 years	55-59 years	60-64 years	
Total participants	292	1,059	3,409	1,063	3,115	1,516	1,710	1,720	1,753	1,574	
Living in SA	97	370	1,309	380	3,007	1,500	1,710	1,720	1,753	1,574	
Eligible participants	97.0	37.0	130.9	38.0	300.7	150.0	171.0	172.0	175.3	157.4	
Participation rate (%)	51.0	36.4	37.2	51.4	42.0	43.2	46.9	51.9	59.2	44.1	
Primary keyperson											
Merged cells											
Solomon	443	1,461	2,065	2,367	2,188	2,087	2,234	2,108	2,334	1,771	
Total participants	750	2,991	3,994	4,155	3,634	3,398	3,427	3,068	2,931	2,355	
Eligible participants	750.0	2,991.0	3,994.0	4,155.0	3,634.0	3,398.0	3,427.0	3,068.0	2,931.0	2,355.0	
Participation rate (%)	58.9	48.8	51.7	56.7	60.2	60.5	64.9	68.8	72.8	75.2	
Northern Territory (Total)	734	2,539	3,551	4,010	3,703	3,573	3,504	3,853	3,887	3,346	
Total participants	1,232	4,059	7,038	8,321	5,241	5,898	4,879	5,297	5,909	4,621	
Eligible participants	1,232.0	4,059.0	7,038.0	8,321.0	5,241.0	5,898.0	4,879.0	5,297.0	5,909.0	4,621.0	
Participation rate (%)	55.5	42.7	45.4	49.2	51.1	51.8	55.6	60.0	68.0	69.5	
Administrative Capital Territory Divisions											
Coverariate as Subheading											
Summary of territory inside data											
Yeah NA	18-19 years	20-24 years	25-29 years	30-34 years	35-39 years	40-44 years	45-49 years	50-54 years	55-59 years	60-64 years	
Total participants	2,920	9,096	31,059	30,051	9,920	20,050	20,050	21,051	21,051	17,051	
Eligible participants	2,920	9,096	31,059	30,051	9,920	20,050	20,050	21,051	21,051	17,051	
Participation rate (%)	51.0	36.4	37.2	51.4	42.0	43.2	46.9	51.9	59.2	44.1	
Cairns	784	4,793	6,817	4,973	4,626	4,453	5,074	4,826	5,369	4,294	
Total participants	2,260	4,471	6,448	6,509	5,983	6,905	6,902	5,962	6,044	5,067	
Eligible participants	2,260.0	4,471.0	6,448.0	6,509.0	5,983.0	6,905.0	6,902.0	5,962.0	6,044.0	5,067.0	
Participation rate (%)	78.1	74.0	74.7	75.4	77.3	76.7	80.5	81.8	85.5	88.9	
Perth	1,477	4,687	5,178	5,786	6,025	5,463	5,191	4,296	3,948	3,465	
Total participants	1,477	4,687	5,178	5,786	6,025	5,463	5,191	4,296	3,948	3,465	
Eligible participants	1,477.0	4,687.0	5,178.0	5,786.0	6,025.0	5,463.0	5,191.0	4,296.0	3,948.0	3,465.0	
Participation rate (%)	77.4	72.7	73.4	74.1	75.3	76.4	80.4	81.7	85.4	87.0	
2	Yeah NA	18-19 years	20-24 years	25-29 years	30-34 years	35-39 years	40-44 years	45-49 years	50-54 years	55-59 years	60-64 years
Australian Capital Territory (Total)	2,920	9,096	31,059	30,051	9,920	20,050	20,050	21,051	21,051	17,051	
Total participants	4,164	13,925	13,569	14,331	13,943	12,960	12,762	11,108	10,736	9,002	
Eligible participants	77.8	73.9	73.7	75.1	78.4	76.5	80.3	81.3	84.9	87.3	
Australia	151,297	438,165	441,168	460,549	462,206	479,360	524,850	517,893	545,449	506,759	
Total participants	201,439	638,909	646,516	665,250	658,446	660,841	681,850	659,150	664,720	597,386	
Eligible participants	78.1	68.9	68.3	69.2	70.4	72.5	75.6	78.5	81.8	84.8	
Participation rate (%)	75.1	77.8	77.6	78.4	79.2	80.0	81.8	83.6	85.4	87.5	

Survey-data-with-r-5d35cea07962

MS Excel or Die

a) The Federal Electoral Divisions are current as at 24 August 2017

b) Includes those aged 16 and over

c) Includes Tasmania and the Cocos (Keeling) Islands

d) Includes Norfolk Island

e) Includes Jervis Bay

Tidy Data

1. Each **variable** you measure should be in a single column

	A	B	C	D	E	F	G
1	ID	LastName	FirstName	Sex	City	State	Occupation
2	1004	Smith	Jane	female	Frederick	MD	Welder
3	4587	Nayef	Mohammed	male	Upper Darby	PA	Nurse
4	1727	Doe	Janice	female	San Diego	CA	Doctor
5	6879	Jordan	Alex	male	Birmingham	AL	Teacher

2. Every **observation** of a variable should be in a different row

	A	B	C	D	E	F	G
1	ID	LastName	FirstName	Sex	City	State	Occupation
2	1004	Smith	Jane	female	Frederick	MD	Welder
3	4587	Nayef	Mohammed	male	Upper Darby	PA	Nurse
4	1727	Doe	Janice	female	San Diego	CA	Doctor
5	6879	Jordan	Alex	male	Birmingham	AL	Teacher

3. There should be one table for each type of data

Demographic Survey Data

	A	B	C	D	E	F	G
1	ID	LastName	FirstName	Sex	City	State	Occupation
2		1004	Smith	Jane	female	Frederick	MD
3		4587	Nayef	Mohammed	male	Upper Darby	PA
4		1727	Doe	Janice	female	San Diego	CA
5		6879	Jordan	Alex	male	Birmingham	AL
							Teacher

Doctor's Office Measurements Data

	A	D	E	F	G
1	ID	Height_inches	Weight_lbs	Insulin	Glucose
2		1004	65	180	0.60
3		4587	75	215	1.46
4		1727	62	124	0.72
5		6879	77	160	1.23
					205

4. If you have multiple tables, they should include a column in each *with the same column label* that allows them to be joined or merged

	A	B	C	D	E	F	G
1	ID	LastName	FirstName	Sex	City	State	Occupation
2	1004	Smith	Jane	female	Frederick	MD	Welder
3	4587	Nayef	Mohammed	male	Upper Darby	PA	Nurse
4	1727	Doe	Janice	female	San Diego	CA	Doctor
5	6879	Jordan	Alex	male	Birmingham	AL	Teacher

	A	D	E	F	G
1	ID	Height_inches	Weight_lbs	Insulin	Glucose
2	1004	65	180	0.60	163
3	4587	75	215	1.46	150
4	1727	62	124	0.72	177
5	6879	77	160	1.23	205

Tidy data == rectangular data

A

	A	B	C	D	E
1	id	sex	glucose	insulin	triglyc
2	101	Male	134.1	0.60	273.4
3	102	Female	120.0	1.18	243.6
4	103	Male	124.8	1.23	297.6
5	104	Male	83.1	1.16	142.4
6	105	Male	105.2	0.73	215.7

Tidy Data Benefits

1. consistent data structure
2. foster tool development
3. require only a small set of tools to be learned
4. allow for datasets to be combined

TIDY data is **NOT** the same as **CLEAN** data

Clean Data

Data cleaning is the process of detecting and correcting/ removing data records that are

- incomplete,
- incorrect,
- inaccurate, or
- irrelevant

and often includes making sure missing data is correctly marked and that duplicate records and other errors are removed

Data that is **TIDY** and **CLEAN** is ready for use



A

ID	Last	First	height_m	height_f
1004	Smith	Jane	NA	65
4587	Nayef	Mohammed	72	NA
1727	Doe	Janice	NA	60
6879	Jordan	Alex	55	NA

B

ID	Last	First	height_m	height_f
1004	Smith	Jane		65
4587	Nayef	Mohammed	72	
1727	Doe	Janice		60
6879	Jordan	Alex	55	

C

ID	Last	First	sex	height
1004	Smith	Jane	female	65
4587	Nayef	Mohammed	male	72
1727	Doe	Janice	fem	60
6879	Jordan	Alex	male	55

D

ID	Last	First	sex	height
1004	Smith	Jane	F	65
4587	Nayef	Mohammed	M	72
1727	Doe	Janice	F	60
6879	Jordan	Alex	M	55

Which of these tables stores data best?



A



B



C



D



Clean

ID	Last	First	height_m	height_f
1004	Smith	Jane	NA	65
4587	Nayef	Mohammed	72	NA
1727	Doe	Janice	NA	60
6879	Jordan	Alex	55	NA

Tidy

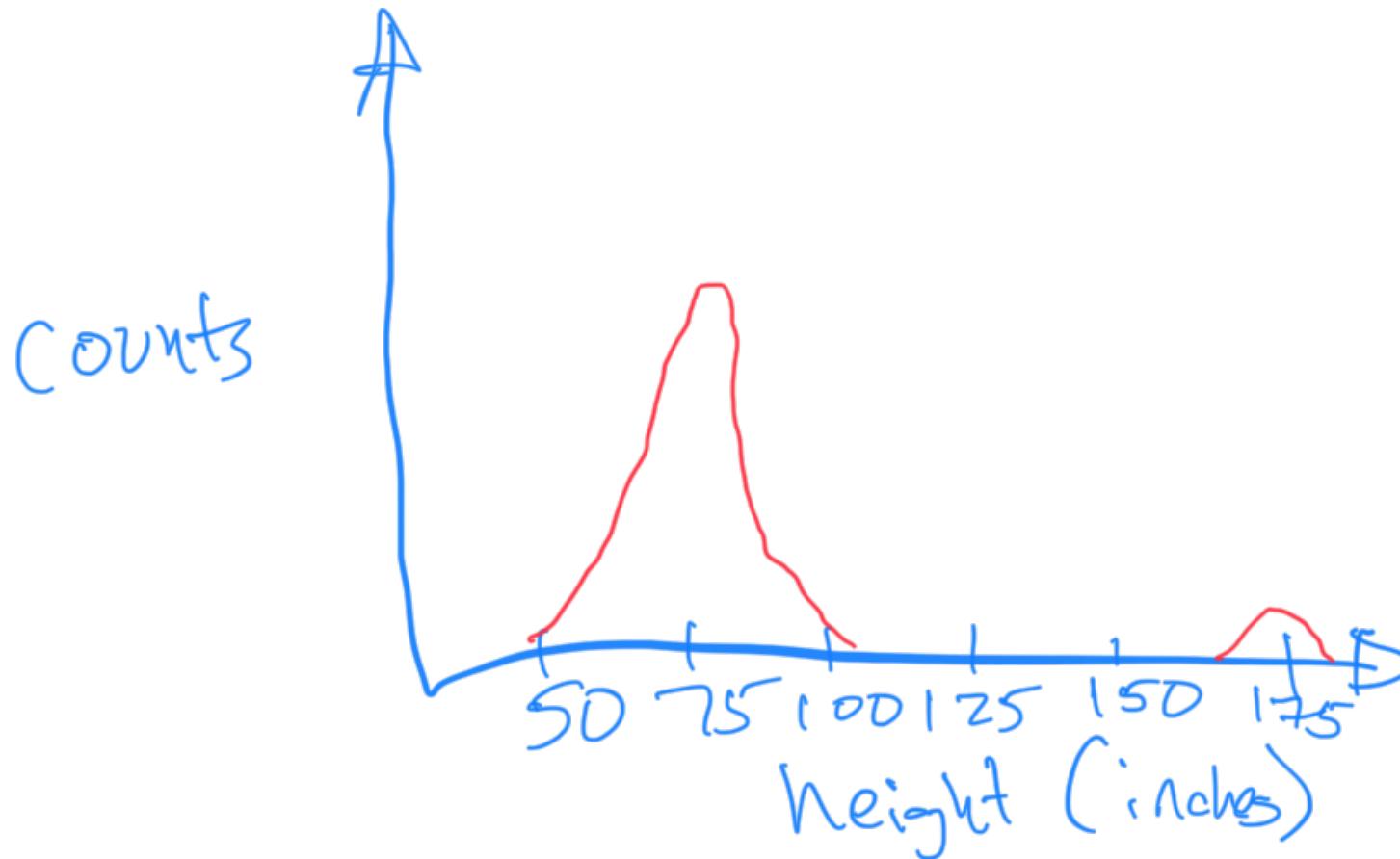
ID	Last	First	sex	height
1004	Smith	Jane	female	65
4587	Nayef	Mohammed	male	72
1727	Doe	Janice	fem	60
6879	Jordan	Alex	male	55

Tidy + Clean

ID	Last	First	sex	height
1004	Smith	Jane	F	65
4587	Nayef	Mohammed	M	72
1727	Doe	Janice	F	60
6879	Jordan	Alex	M	55

Data Intuition

Why do you need intuition?

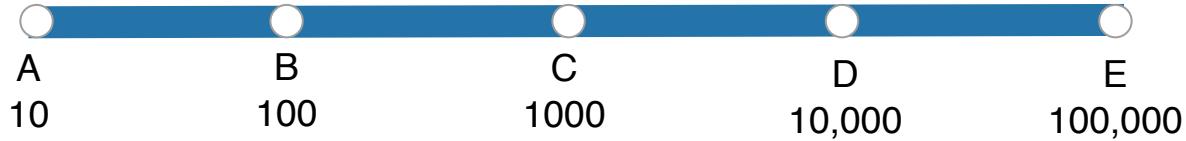




Fermi Estimation

<https://forms.gle/C982naWtU9RvHqAb7>

Approximately how many piano tuners do you think there are
in the city of Chicago?





<https://www.youtube.com/watch?v=0YzvupOX8ls>



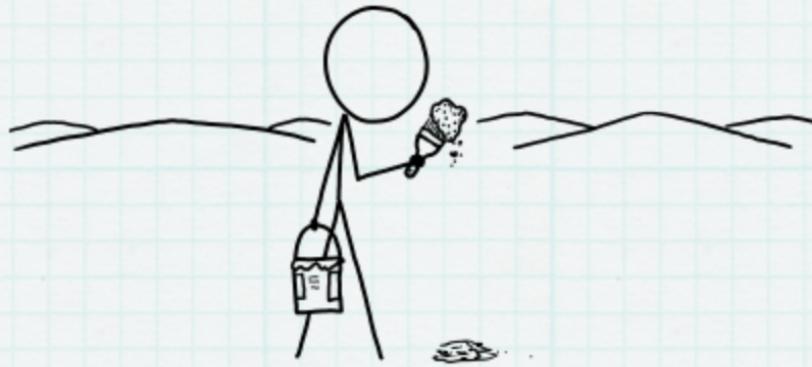


Fermi Estimation

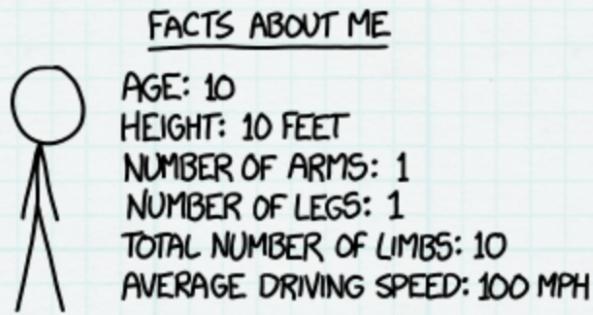
Has humanity produced enough paint to cover the entire land area of the Earth?



This answer is pretty straightforward. We can look up the size of the world's paint industry, extrapolate backward to figure out the total amount of paint produced. We'd also need to make some assumptions about how we're painting the ground. Note: When we get to the Sahara desert, I recommend not using a brush.



But first, let's think about different ways we might come up with a guess for what the answer will be. In this kind of thinking—often called **Fermi estimation**—all that matters is getting in the right ballpark; that is, the answer should have about the right number of digits. In Fermi estimation, you can round [1] all your answers to the nearest order of magnitude:



Let's suppose that, on average, everyone in the world is responsible for the existence of two rooms, and they're both painted. My living room has about 50 square meters of paintable area, and two of those would be 100 square meters. 7.15 billion people times 100 square meters per person is a little under a trillion square meters —an area smaller than Egypt.

NOT ENOUGH	EXACTLY ENOUGH	MORE THAN ENOUGH
/		

Let's make a wild guess that, on average, one person out of every thousand spends their working life painting things. If I assume it would take me three hours to paint the room I'm in, [2] and 100 billion people have ever lived, and each of them spent 30 years painting things for 8 hours a day, we come up with 150 trillion square meters ... just about exactly the land area of the Earth.

NOT ENOUGH	EXACTLY ENOUGH	MORE THAN ENOUGH
/	/	

How much paint does it take to paint a house? I'm not enough of an adult to have any idea, so let's take another Fermi guess.

Based on my impressions from walking down the aisles, home improvement stores stock about as many light bulbs as cans of paint. A normal house might have about 20 light bulbs, so let's assume a house needs about 20 gallons of paint.^[3] Sure, that sounds about right.

The average US home costs about \$200,000. Assuming each gallon of paint covers about 300 square feet, that's a square meter of paint per \$300 of real estate. I vaguely remember that the world's real estate has a combined value of something like \$100 trillion, [4] which suggests there's about 300 billion square meters of paint on the world's real estate. That's about one New Mexico.

NOT ENOUGH	EXACTLY ENOUGH	MORE THAN ENOUGH
//	/	

Of course, both of the building-related guesses could be overestimates (lots of buildings are not painted) or underestimates (lots of things that are not buildings [5] are painted) But from these wild Fermi estimates, my guess would be that there probably isn't enough paint to cover all the land.

So, how did Fermi do?

According to the report [**The State of the Global Coatings Industry**](#), the world produced 34 billion liters of paints and coatings in 2012.

There's a neat trick that can help us here. If some quantity—say, the world economy—has been growing for a while at an annual rate of n —say, 3% (0.03)—then the most recent year's share of the whole total so far is $1 - \frac{1}{1+n}$, and the whole total so far is the most recent year's amount times $1 + \frac{1}{n}$.

If we assume paint production has, in recent decades, followed the economy and grown at about 3% per year, that means the total amount of paint produced equals the current yearly production times 34.^[6] That comes out to a little over a trillion liters of paint. At 30 square meters per gallon,^[7] that's enough to cover 9 trillion square meters—about the area of the United States.

So the answer is no; there's not enough paint to cover the Earth's land, and—at this rate—probably won't be enough until the year 2100.

Data Intuition

1. Think about your question and your expectations
2. Do some Fermi calculations (back of the envelope calculations)
3. Write code & look at outputs <- think about those outputs
4. Use your gut instinct / background knowledge to guide you
5. Review code & fix bugs

<https://forms.gle/CREcpMkYDLYTUp2s6>

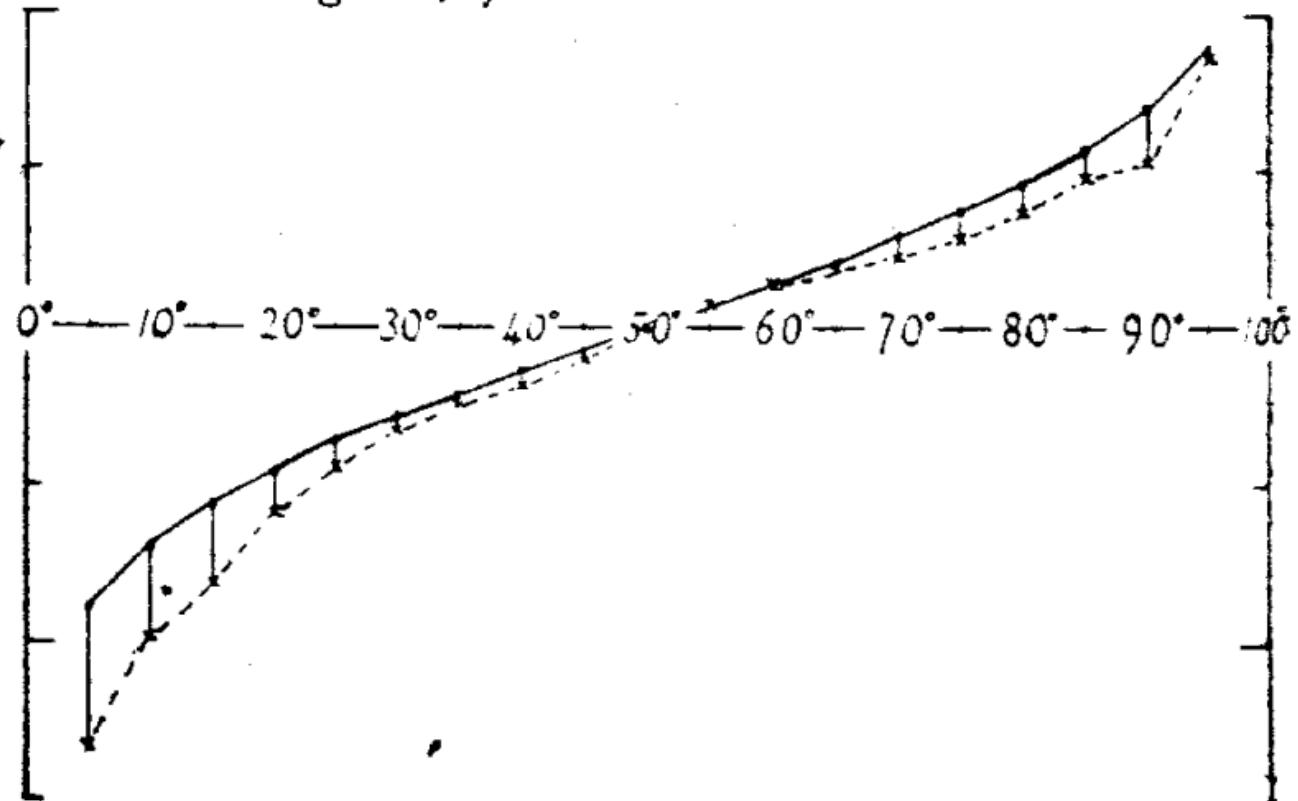


6 min think
6 min pair
6 share

Other kinds of
guessing and
intuitions

Diagram, from the tabular values.

Vox Populi



The Wisdom of the Crowds

- Diversity of opinion: Each person should have private information....even if it's just an eccentric interpretation of the known facts
- Independence: People's opinions aren't determined by the opinions of those around them
- Decentralization: People are able to specialize and draw on local knowledge
- Aggregation: Some mechanism exists for turning private judgements into a collective decision

