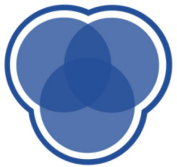
INFO 1998: Introduction to Machine Learning



CDS Education

We explore, learn, and educate big minds.

Lecture 3: Data Visualization

INFO 1998: Introduction to Machine Learning

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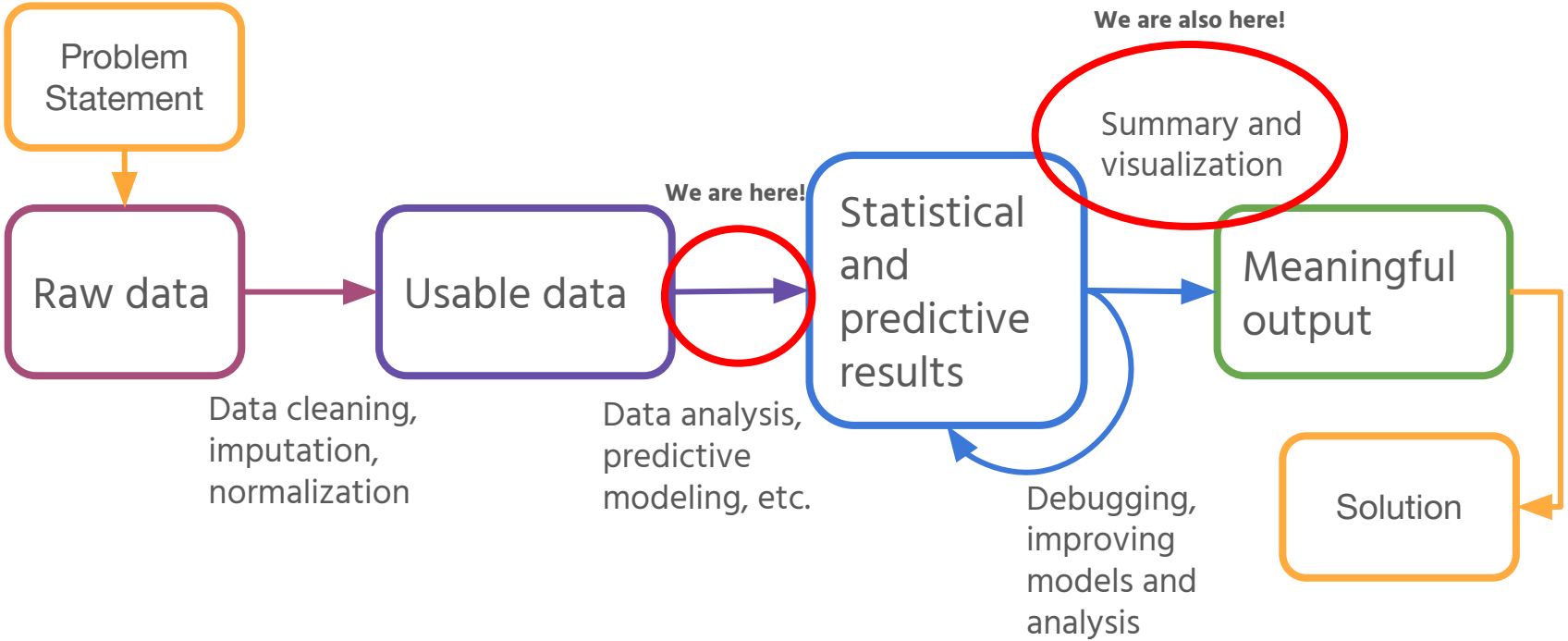
We explore, learn, and educate big minds.

Agenda

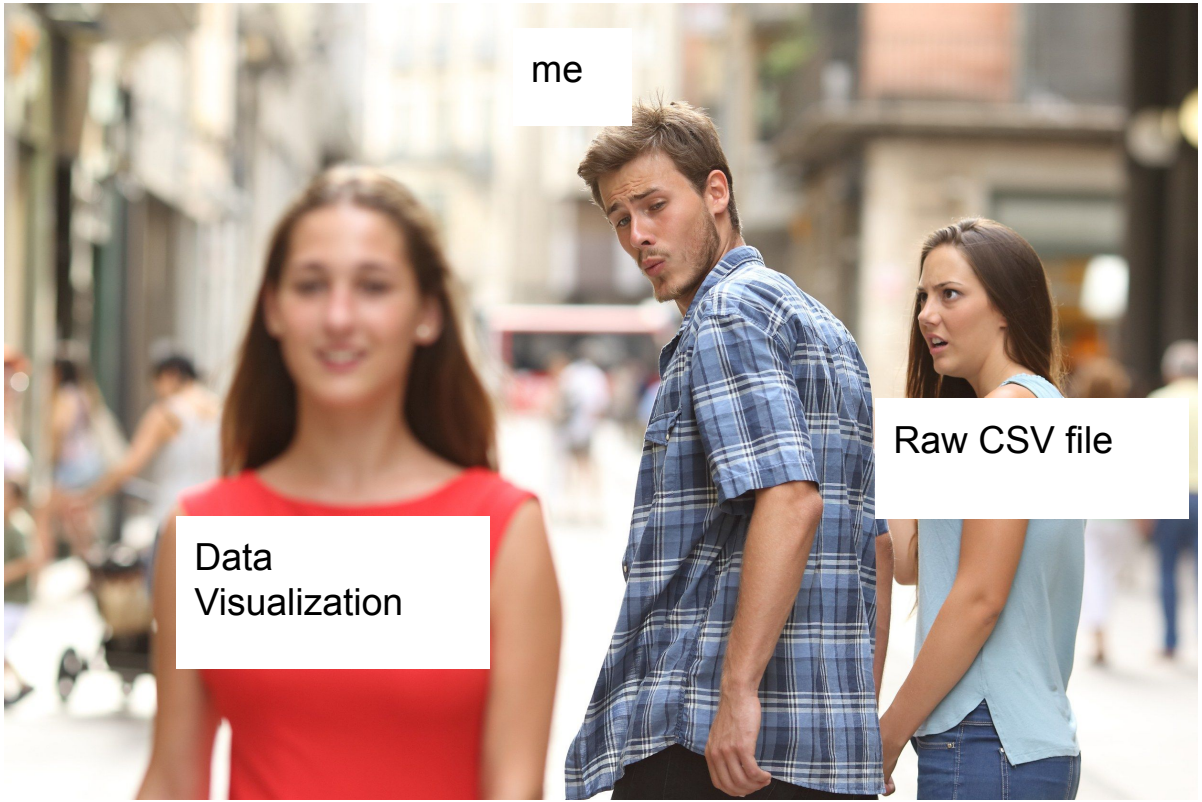
1. Why Data Visualization is Important
2. Data Visualization Libraries
3. Basic Visualizations
4. Advanced Visualizations
5. Challenges of Visualization

The Data Pipeline



https://towardsdatascience.com/5-steps-of-a-data-science-project-lifecycle-26c50372b492

Why is Data Visualization Important?



Source

Why is Data Visualization Important?

Informative

Appealing

Universal

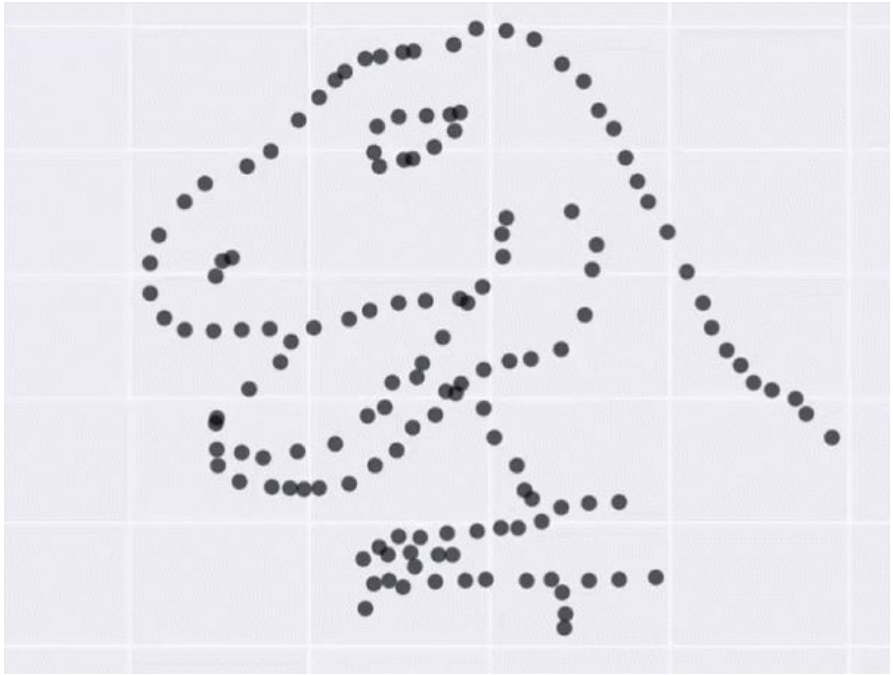
Predictive

Why is Data Visualization Important?

Same summary stats (mean, median, mode) **but different distributions!**

We need to see how the **actual** data looks!

df.describe() is not enough

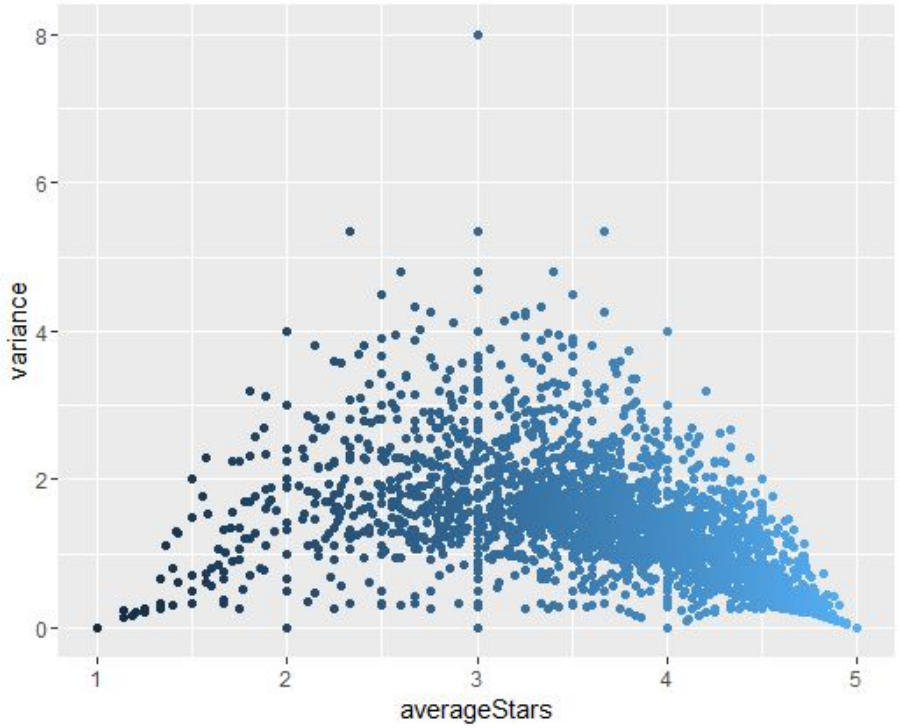


Source

Data Visualization Simple Example: *Ratings on Yelp*

	AVG(stars)	var
AVG(stars)	1.00	-0.43
var	-0.43	1.00

Question: What do you notice? What trends do you see?



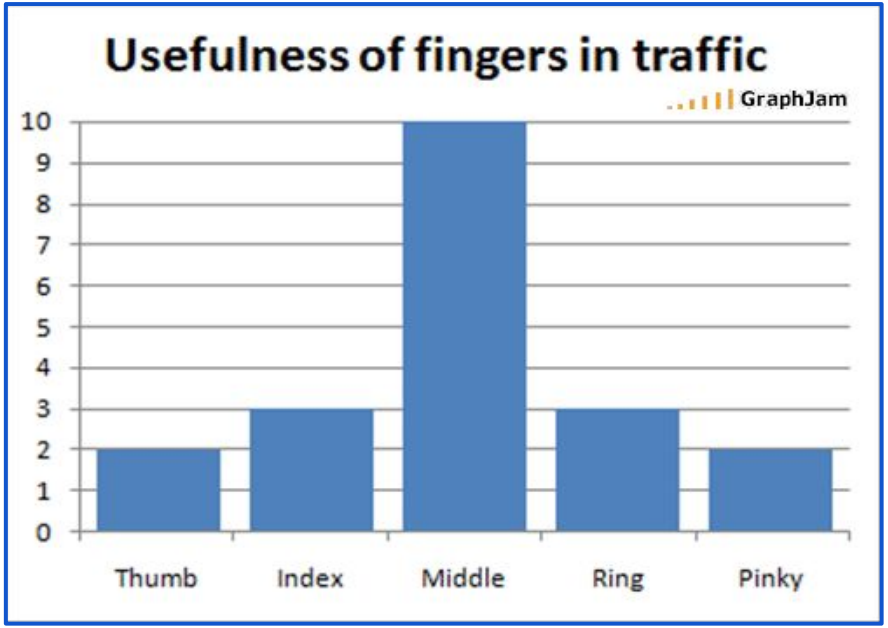
Data Visualization Libraries

- **matplotlib**
  - Python data visualization package
  - Capable of handling most data visualization needs
  - Simple object-oriented library inspired from MATLAB
  - Cheatsheet
- **seaborn**
  - Another visualization package built on matplotlib

Basic Data Visualizations

Bar Graph

- Represent **magnitude** or **frequency** of discrete variables
- Allows us to compare features



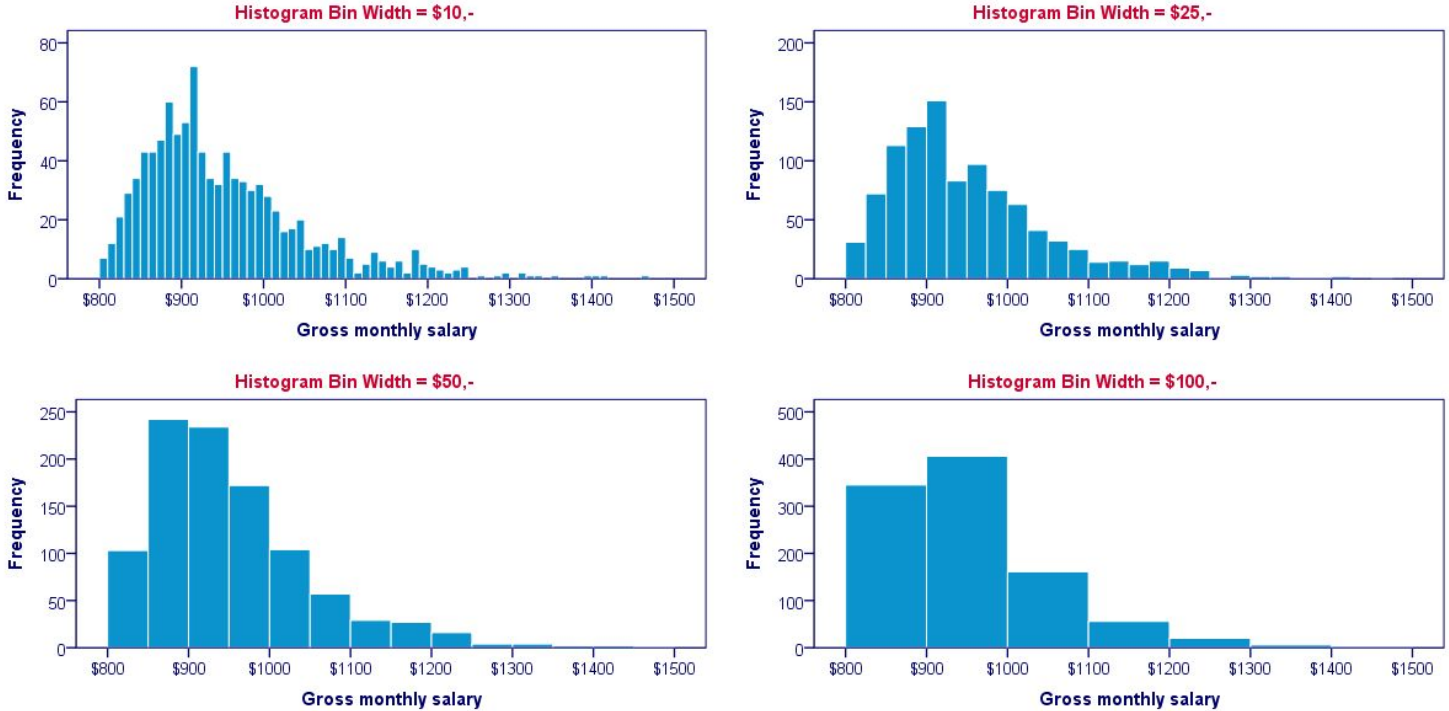
Source

Histograms

Source

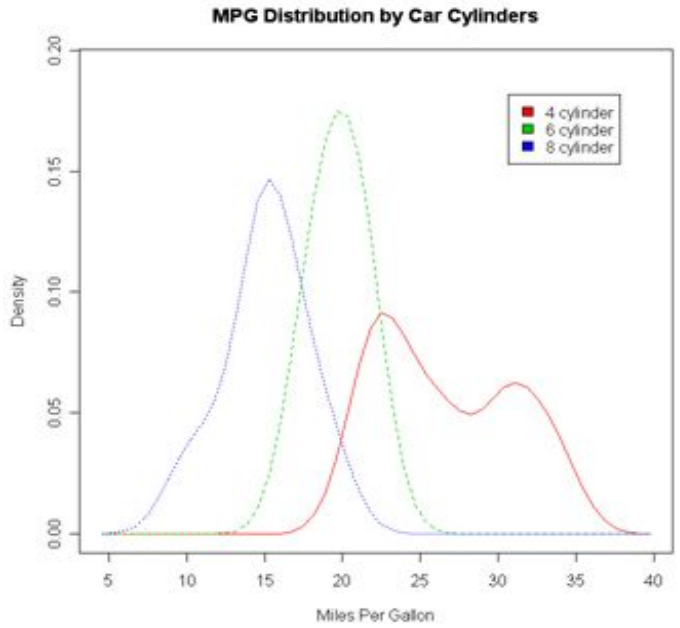
- Used to observe **frequency distribution** of continuous variables
- Data split into **bins**

Histograms: Different Bin Sizes



Source

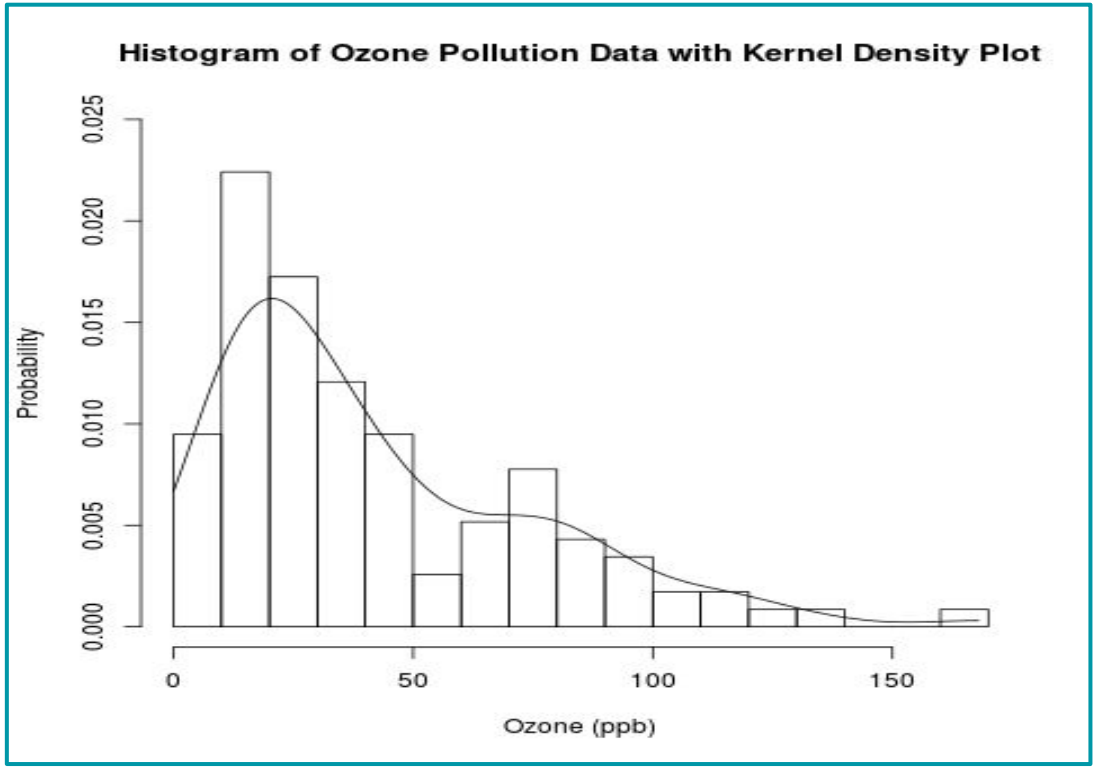
Density Plot



Like a histogram, but **smooths** the shape of the distribution

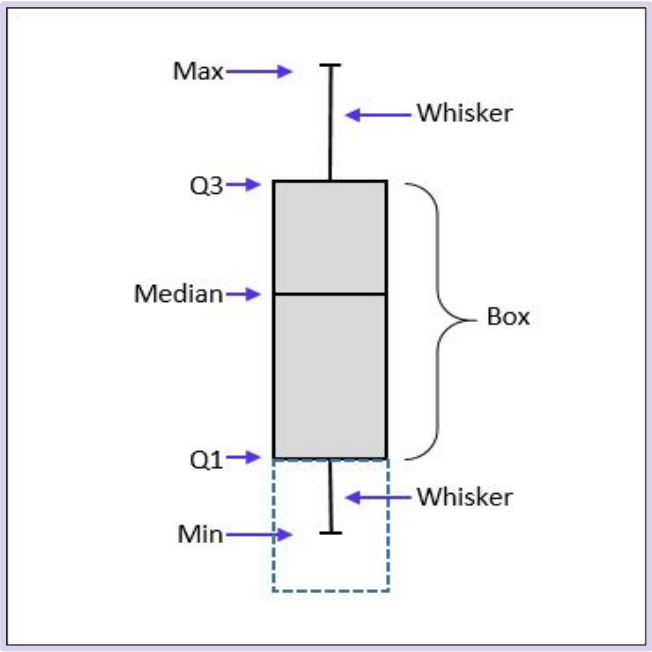
Source

Histogram vs Density Plot



Source

Boxplot (a.k.a box and whisker plot)

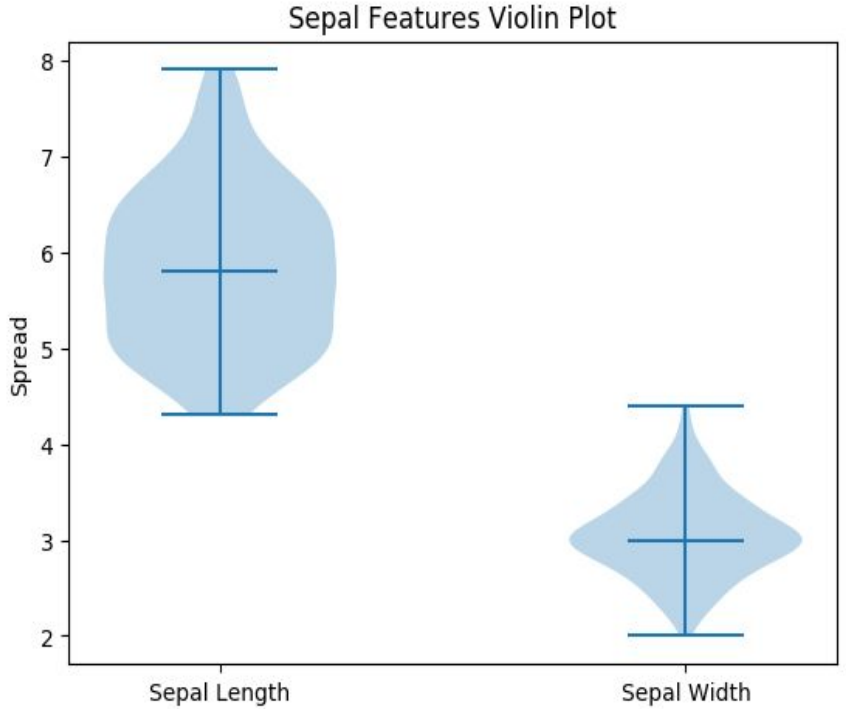


Source

- Summary of data
- Shows **spread** of data
- Gives range, interquartile range, median, and outlier information

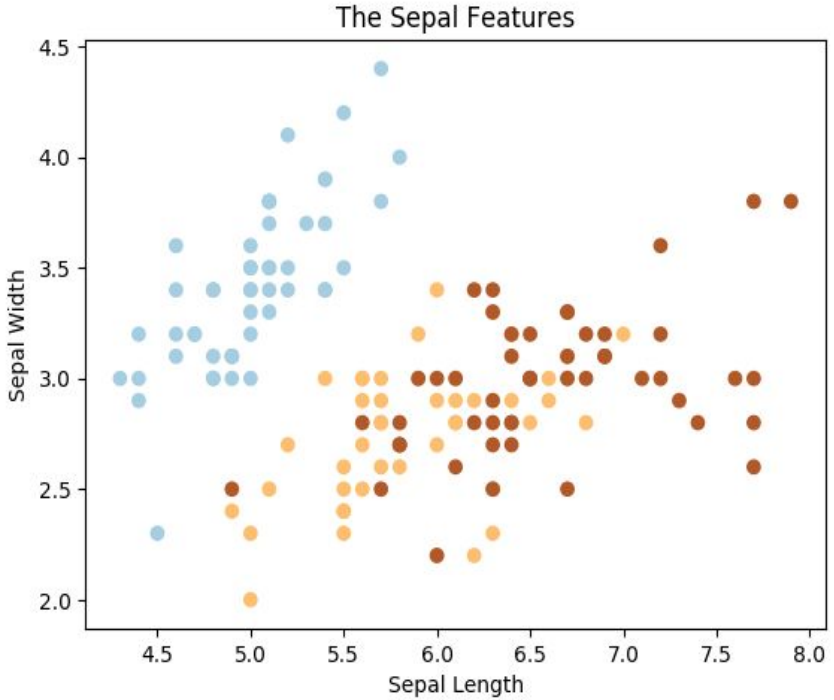
Violin Plot

- Combination of **boxplot** and **density plot** to show the **spread** and **shape** of the data
- Can show whether the data is **normal** (i.e. is distributed normally)

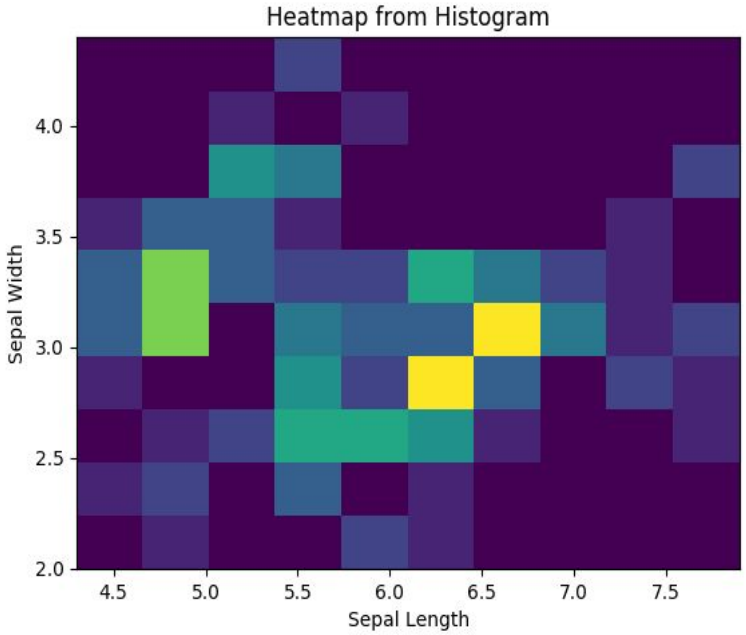


Scatterplot

- See **relationship** between two features
- Can be useful for **extrapolating** information

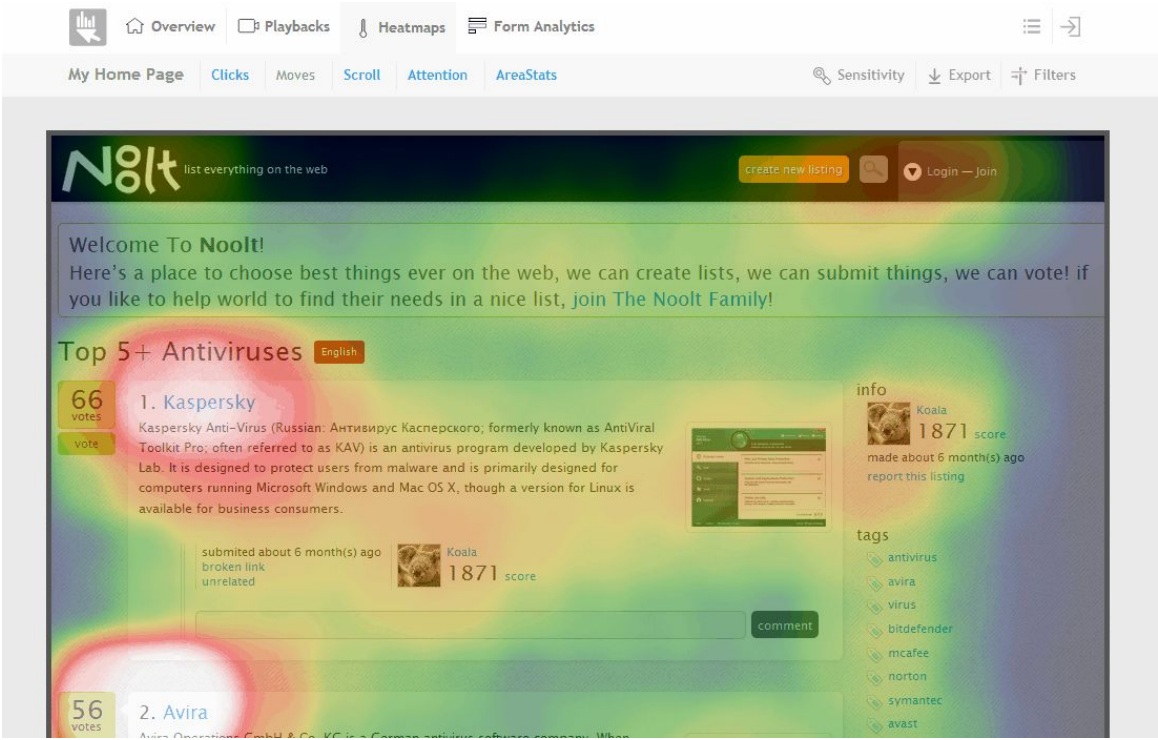


Heatmap



- Varying degrees of one metric are represented using **color**
- Especially useful in the context of **maps** to show geographical variation

Heatmap: Click Density / Website Heatmaps

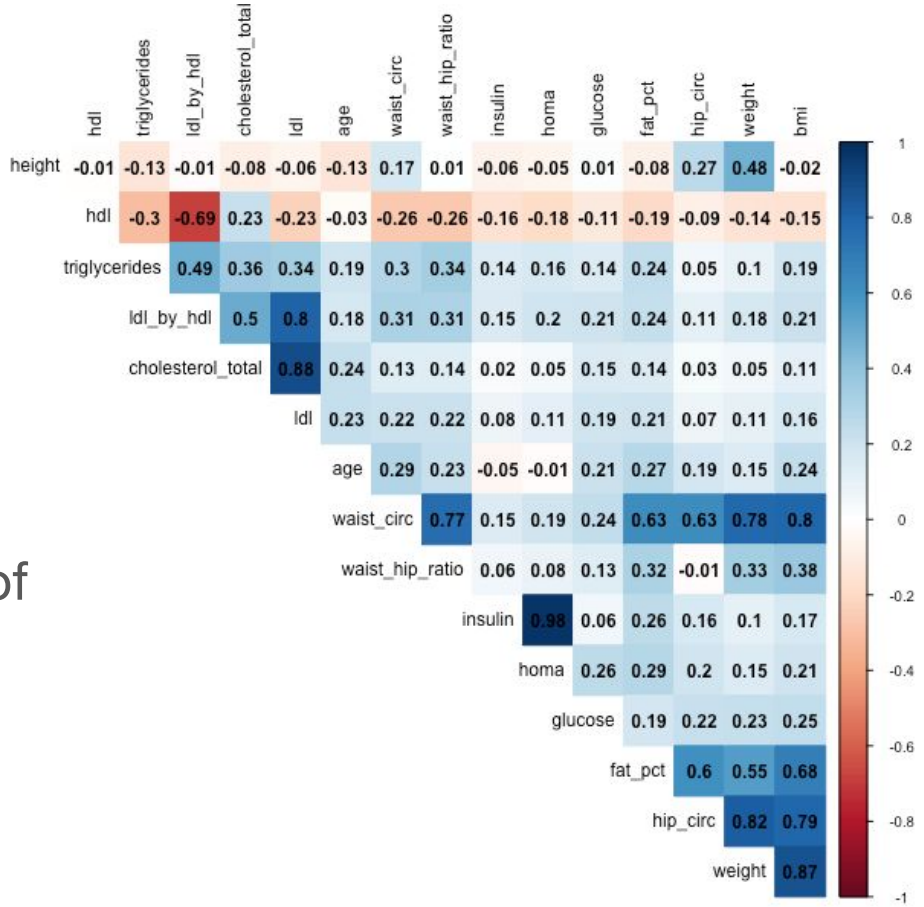


Correlation Plots

- 2D matrix with all variables on each axis
- Entries represent the **correlation coefficients** between each pair of variables

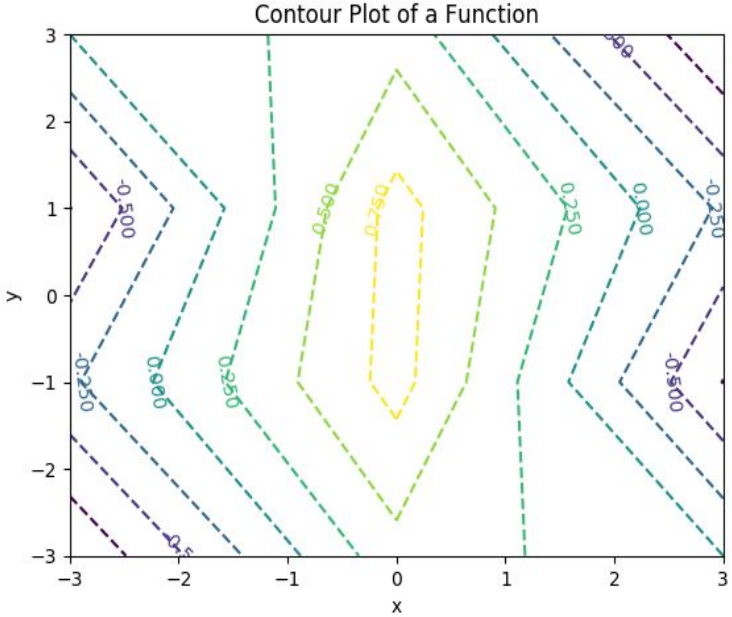
```
[[ 1.          -0.10936925  0.87175416  0.81795363]
 [-0.10936925  1.          -0.4205161  -0.35654409]
 [ 0.87175416 -0.4205161   1.           0.9627571 ]
 [ 0.81795363 -0.35654409  0.9627571    1.        ]]
```

Why are all entries on the diagonal '1'?



Source

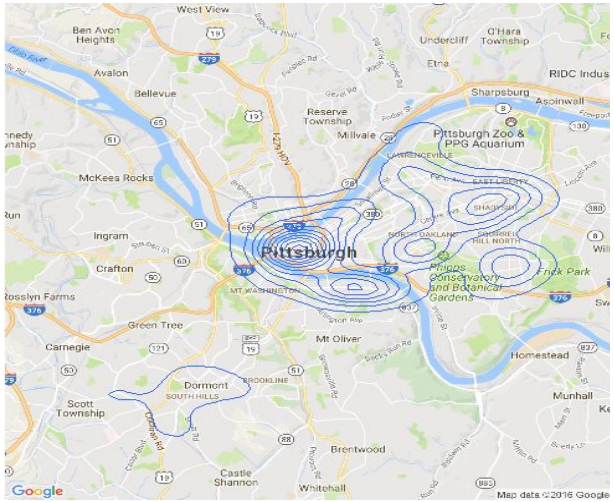
Contours

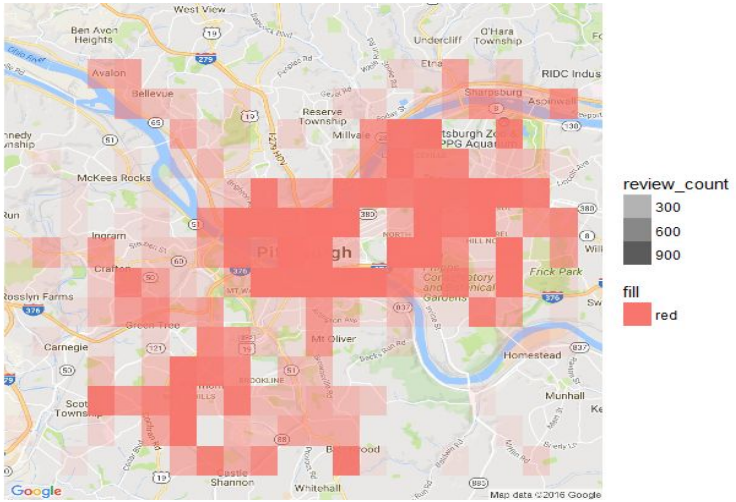


- Used to show **distribution** of the data or a function
- Observe variation among portions of data
- In maps, they indicate the shape of the land

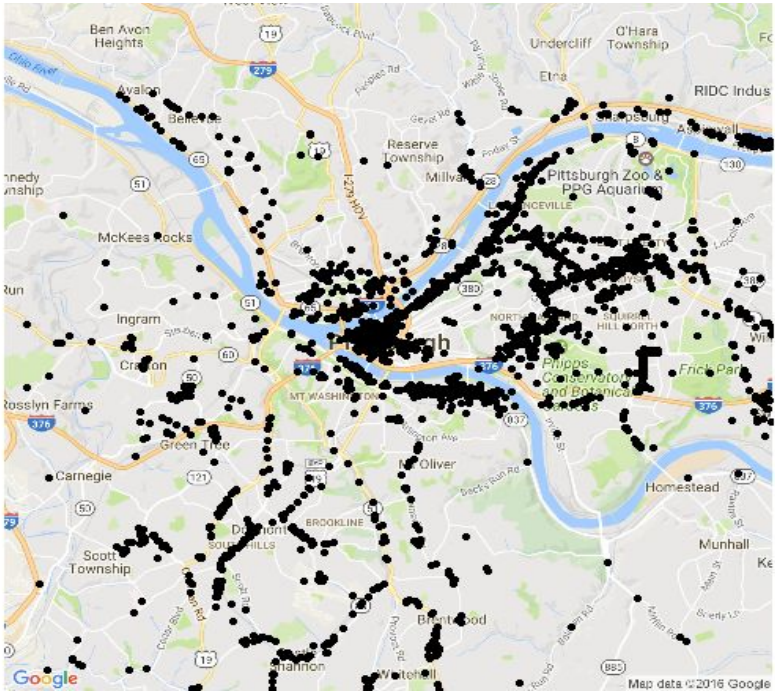
Using Maps

- **Map visualization** → **contextual information**
  - **Trends are not always apparent in the data itself**
  - Ex) Longitudes + Latitudes → *Geographical Map*



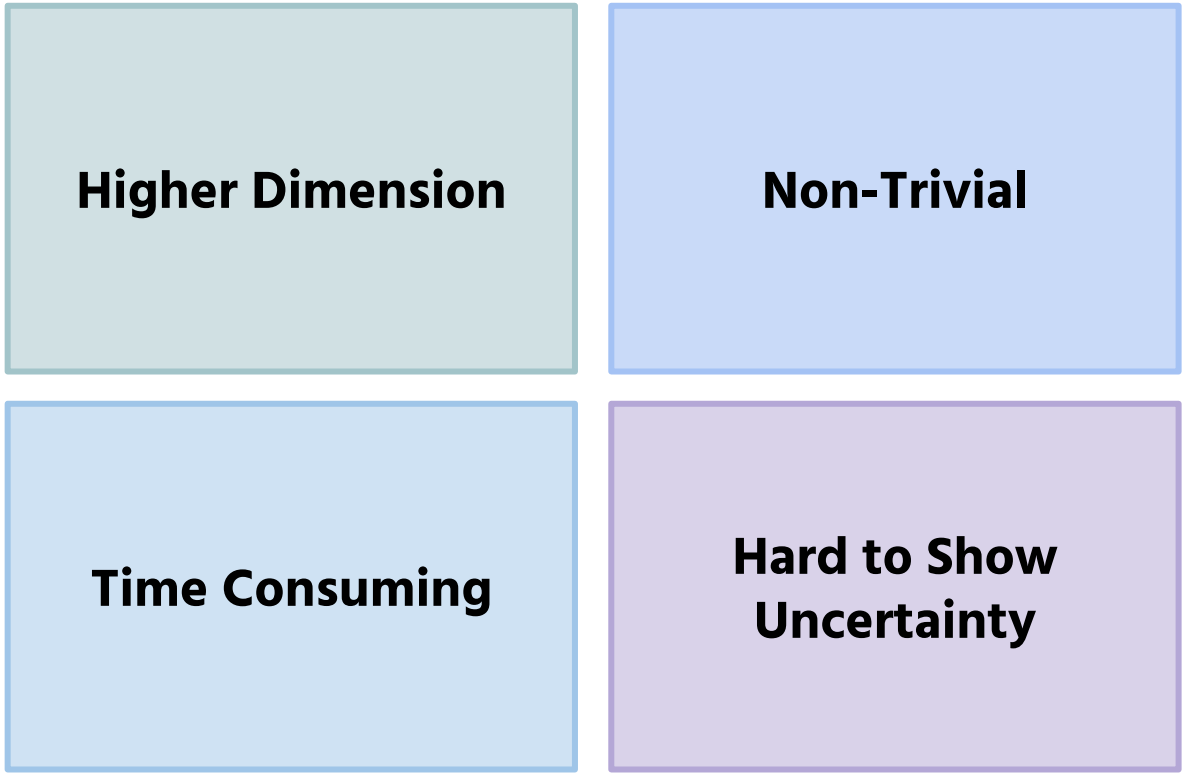


Example: Pittsburgh Data

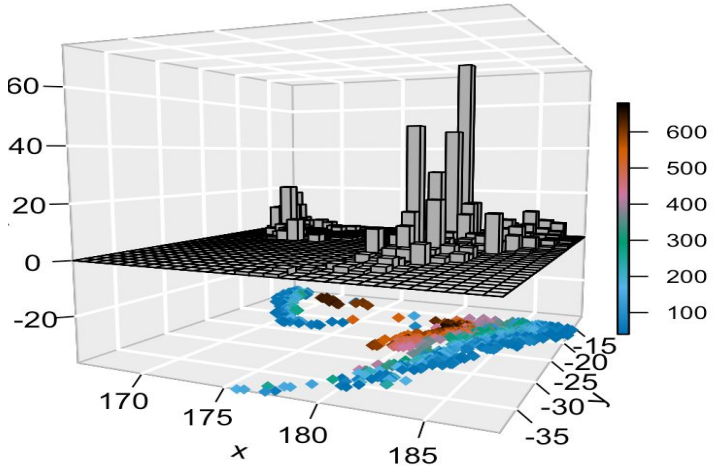


Demo

Challenges of Visualization

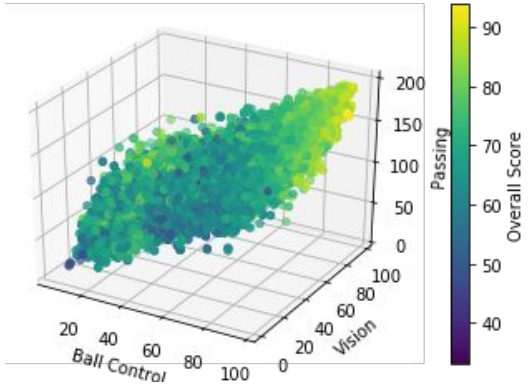


High Dimensional Data



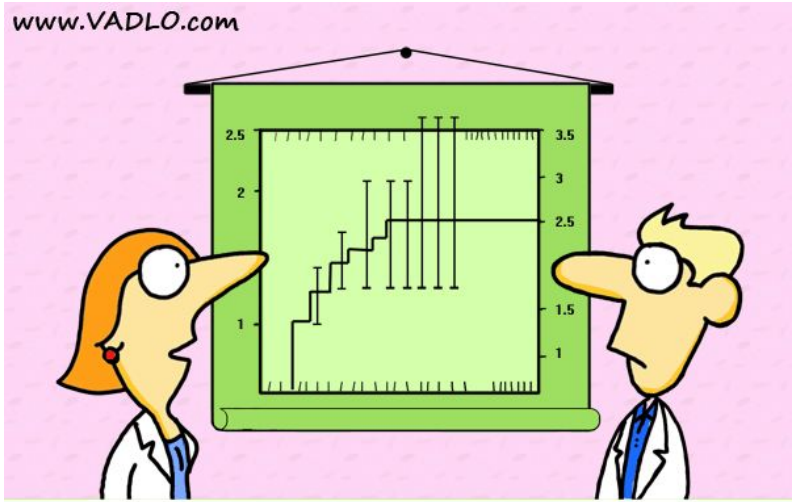
4D Plot For Earthquake Data

- Color, time animations, or point shape can be used for higher dimensions
- There is a limit to the number of features that can be displayed

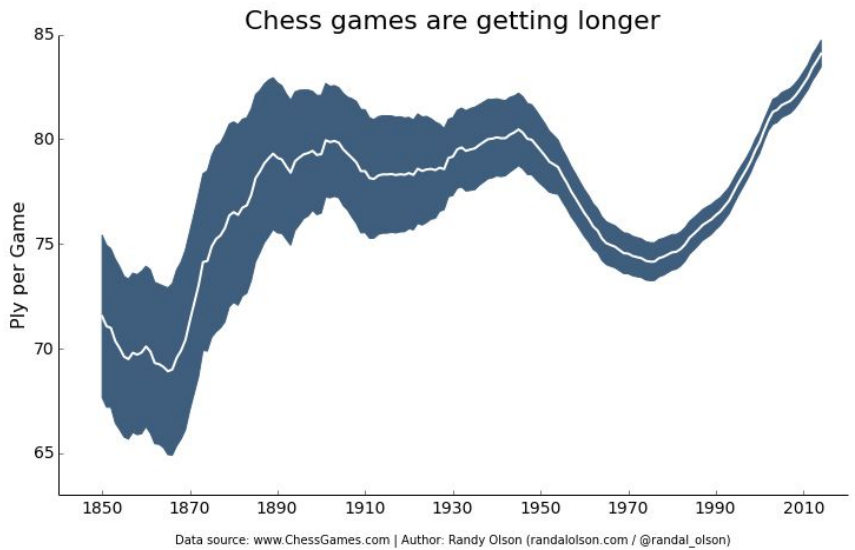


Error Bars

- Used to show uncertainty
- Usually display 95 percent confidence interval



"Did you really have to show the error bars?"



Coming Up

- **Assignment 3**: Due at 4:30pm (ET) on October 13, 2021
- **Next Lecture**: Fundamentals of Machine Learning
- **Enjoy your Fall Break!**
- **Data Scraping Workshop October 16th (timing + room TBD)**

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