

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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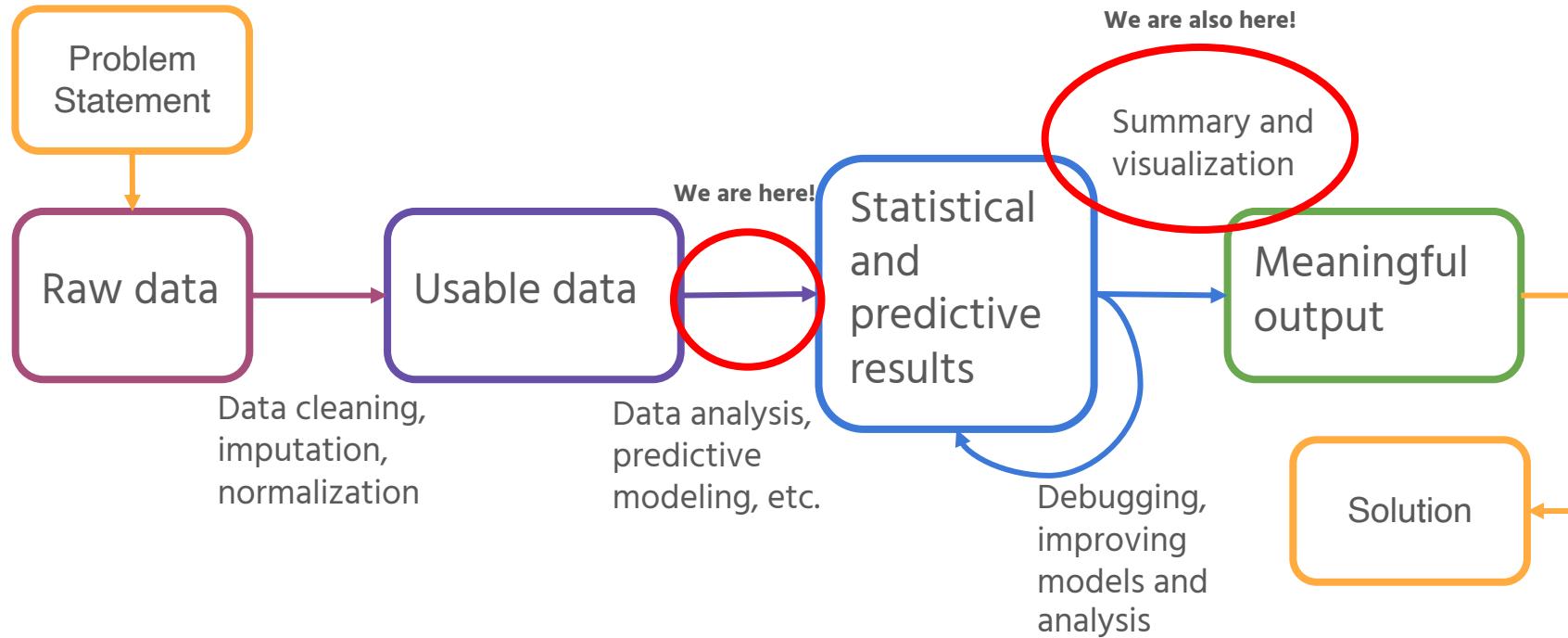
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Agenda

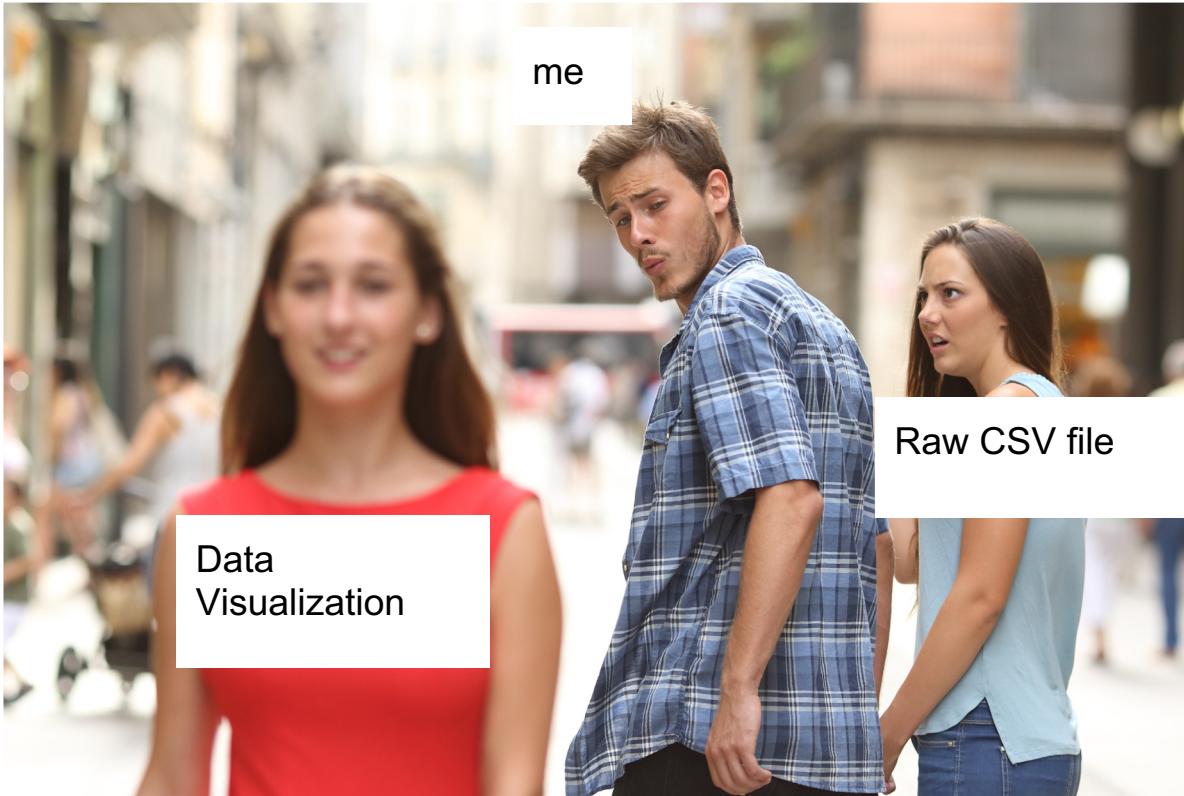
1. Why Data Visualization is Important
2. Data Visualization Libraries
3. Basic Visualizations
4. Advanced Visualizations
5. Challenges of Visualization



The Data Pipeline



Why Data Visualization is Important?



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Why Data Visualization is Important?

Informative

Appealing

Universal

Predictive

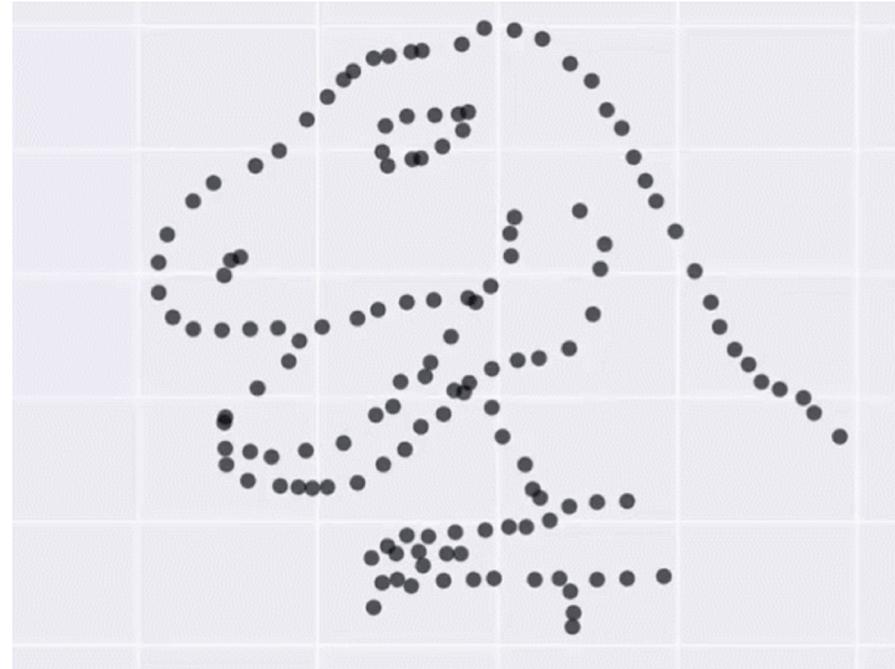


Why Data Visualization is Important?

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

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

df.describe() is not enough



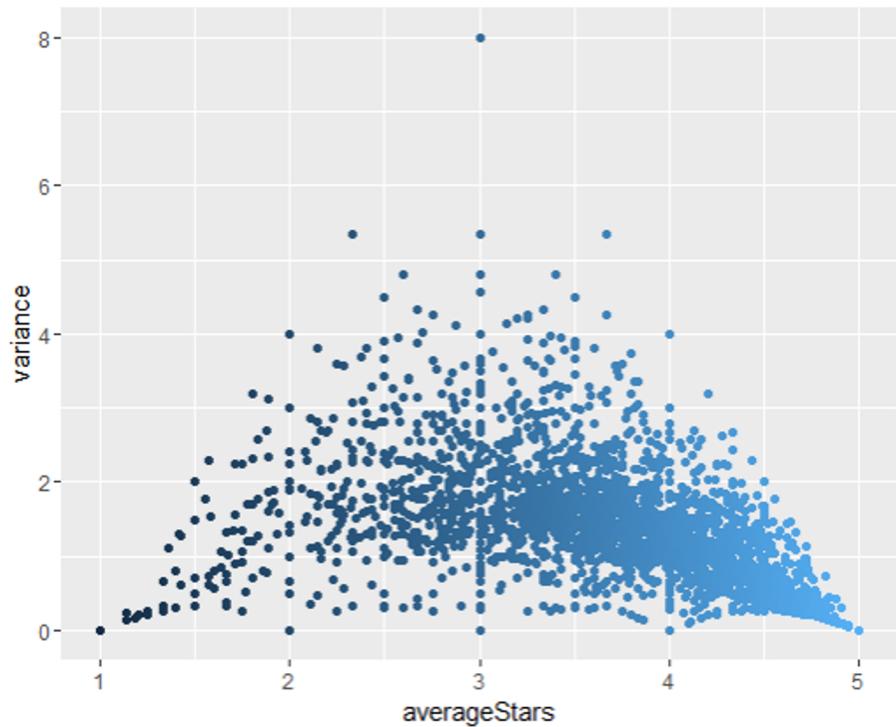
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Data Visualization Simple Example: Yelp

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

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



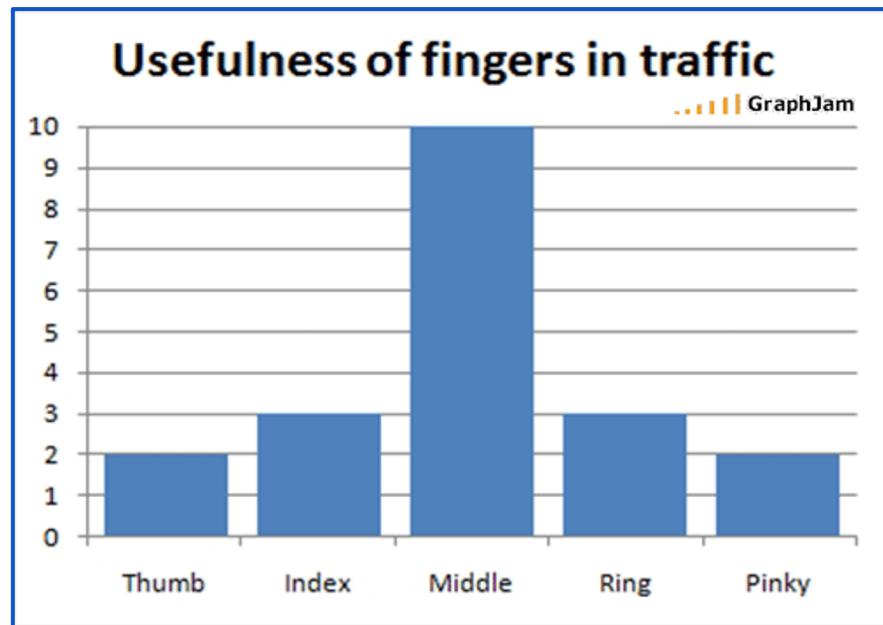
Data Visualization Libraries

- **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



Bar Graph

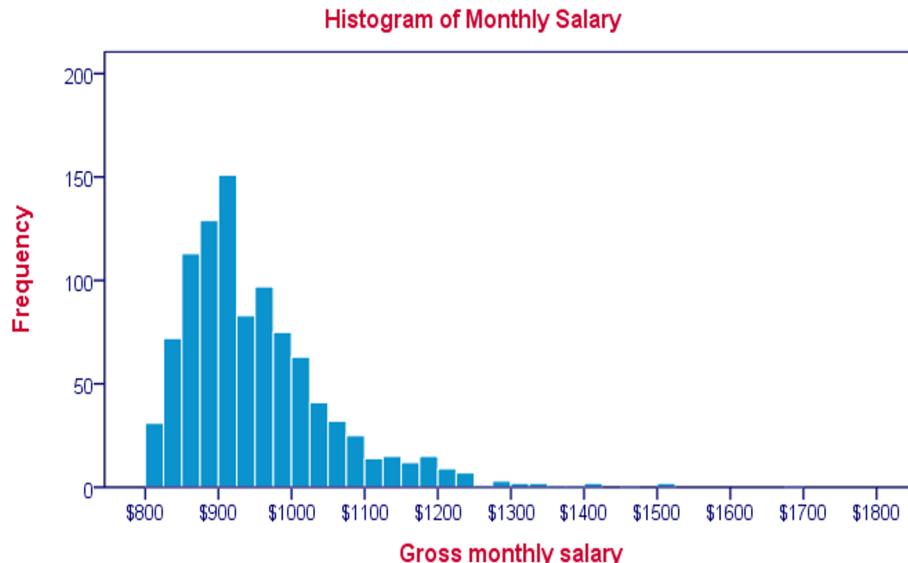
- Represent **magnitude** or **frequency** of discrete variables
- Allows us to compare features



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Histograms

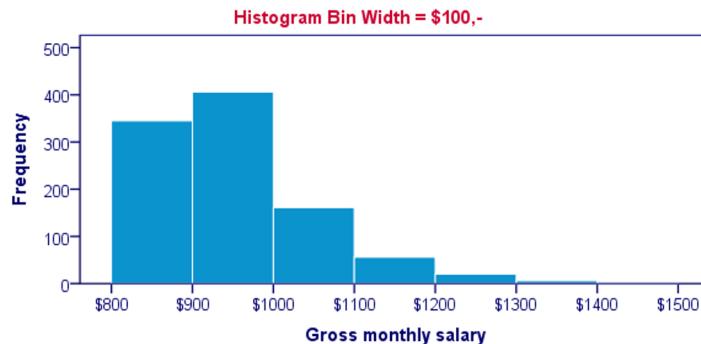


- Used to observe **frequency distribution** of continuous variables
- Data split into **bins**

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Histograms: Different Bin Sizes



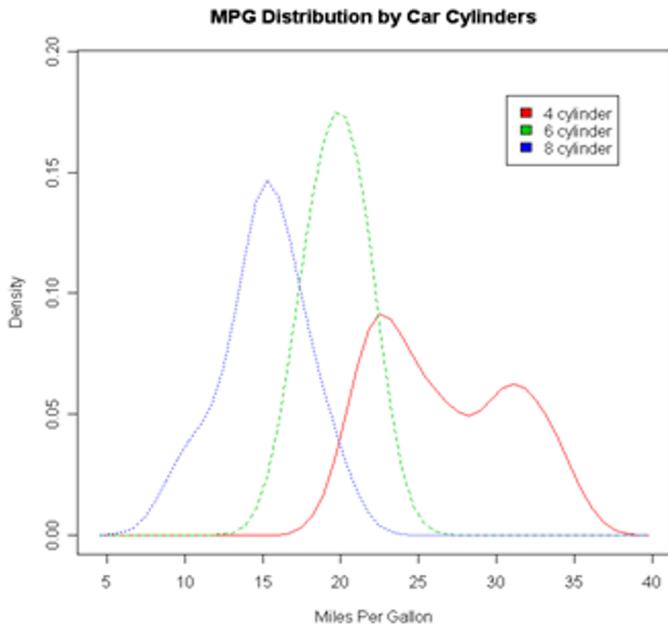
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Demo 1



Density Plot

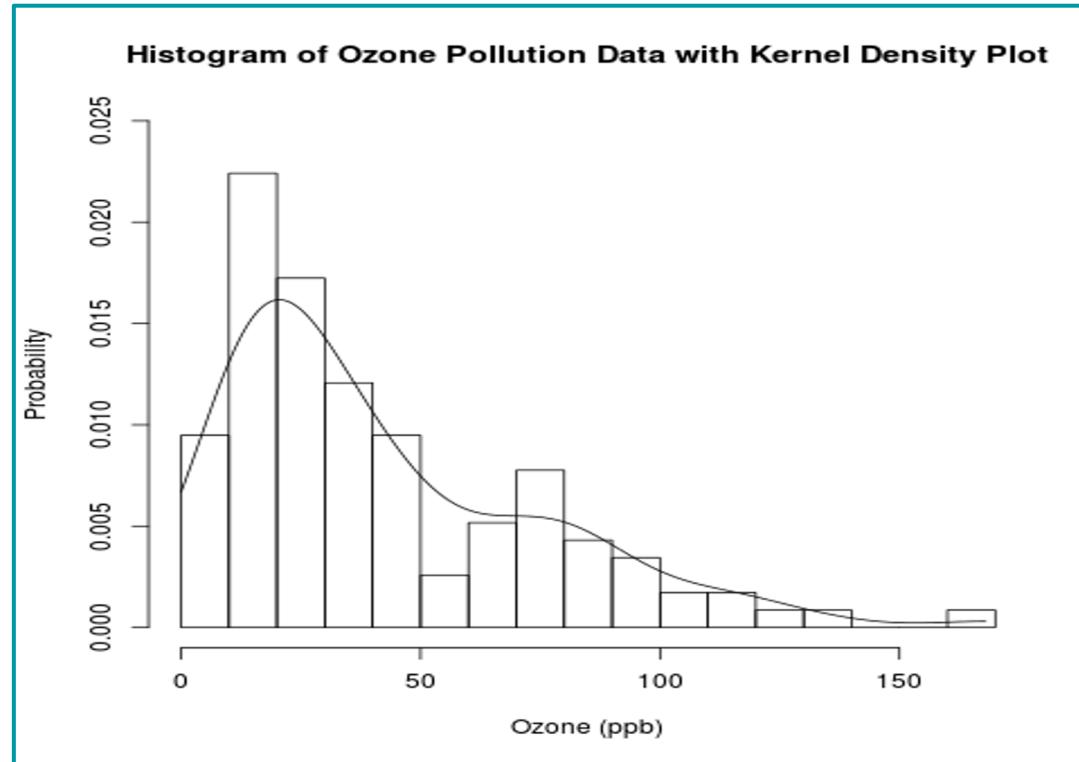


Like a histogram, but **smooths** the shape of the distribution

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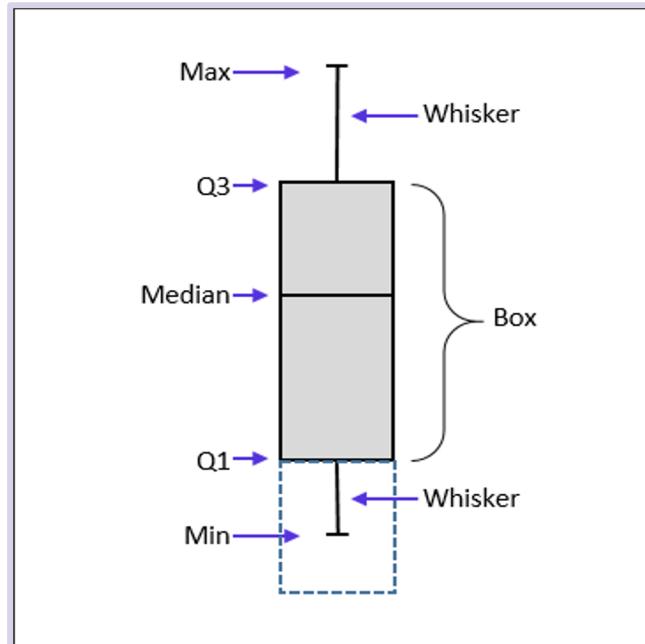
Histogram vs Density Plot



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



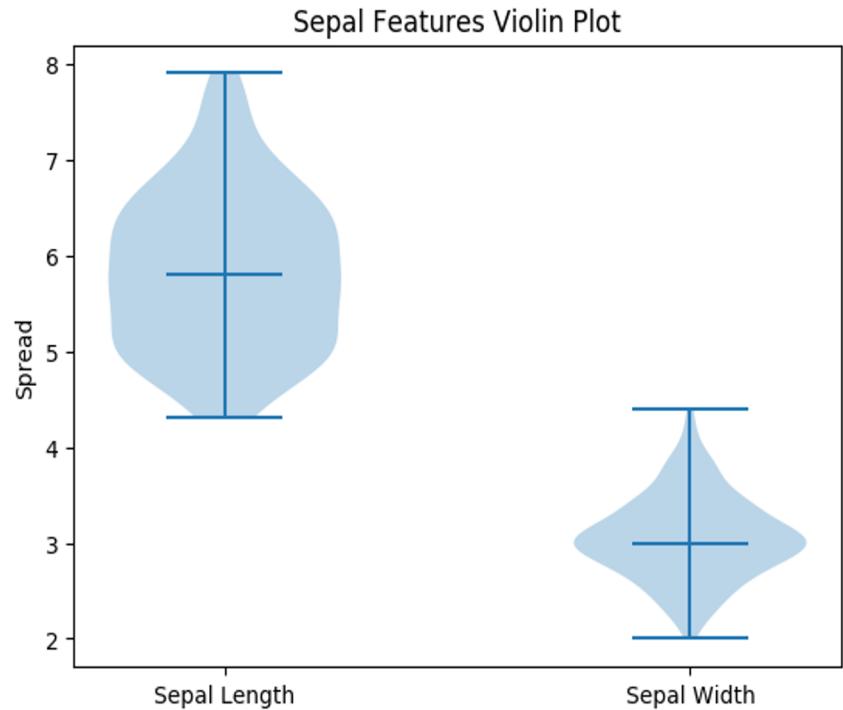
- Summary of data
- Shows **spread** of data
- Gives range, interquartile range, median, and outlier information

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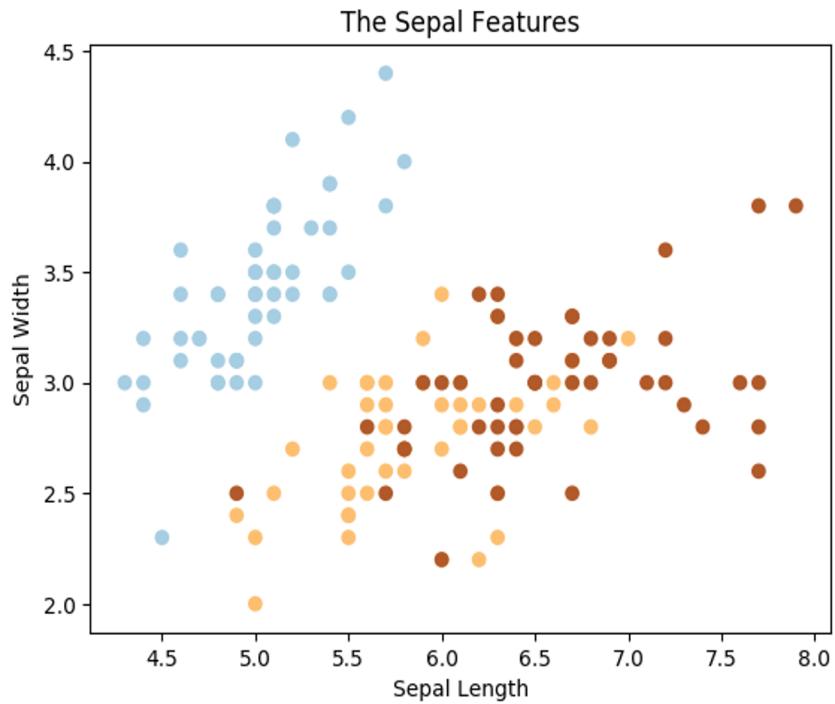
Violin Plot

- Combination of **boxplot** and **density plot** to show the **spread** and **shape** of the data
- Can show whether the data is **normal**

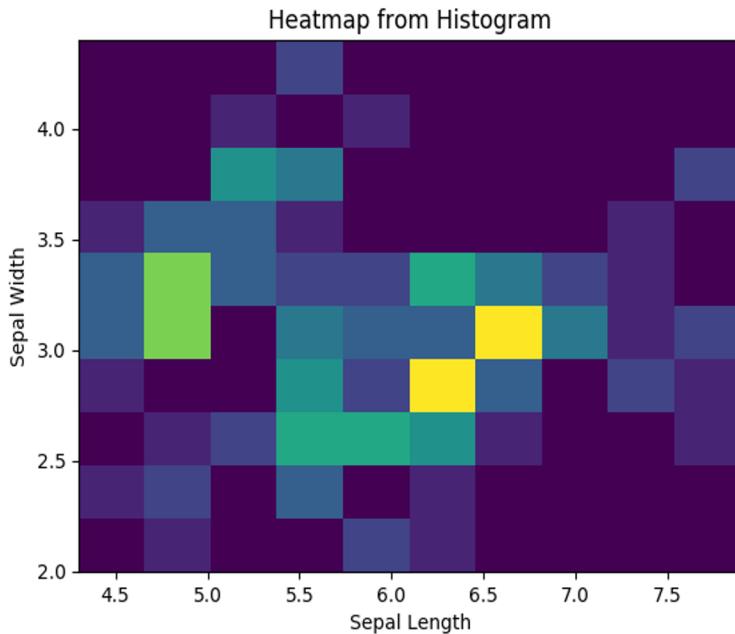


Scatterplot

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



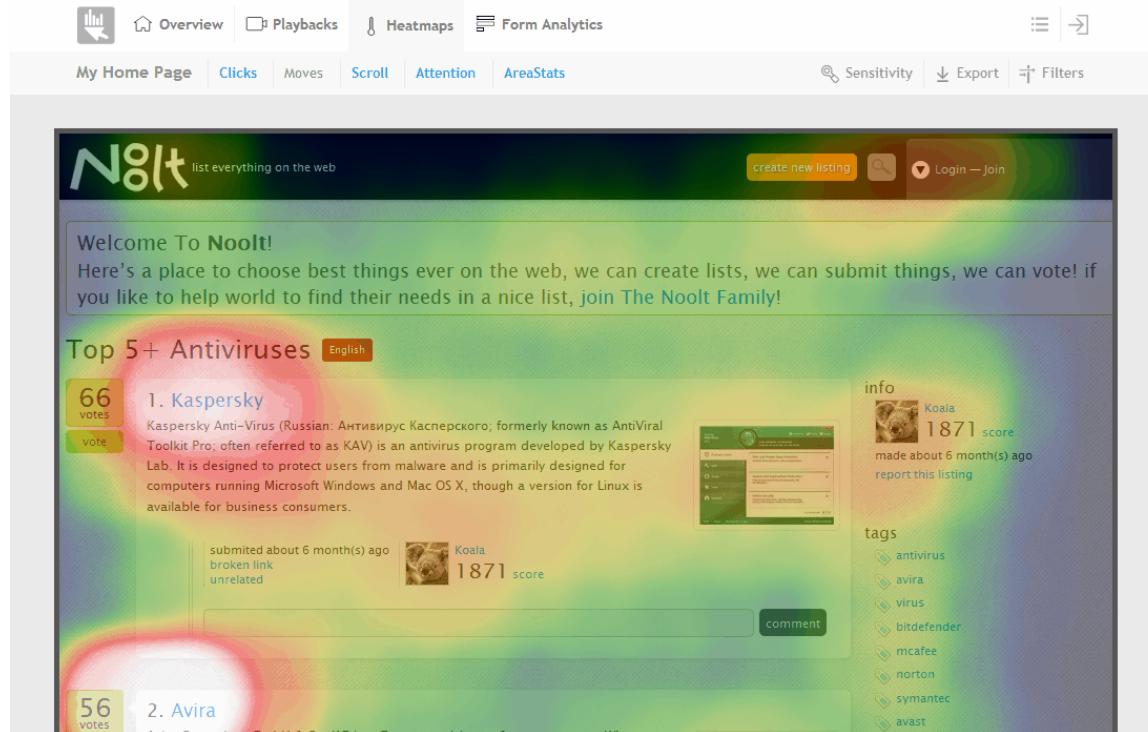
Heatmap



- 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

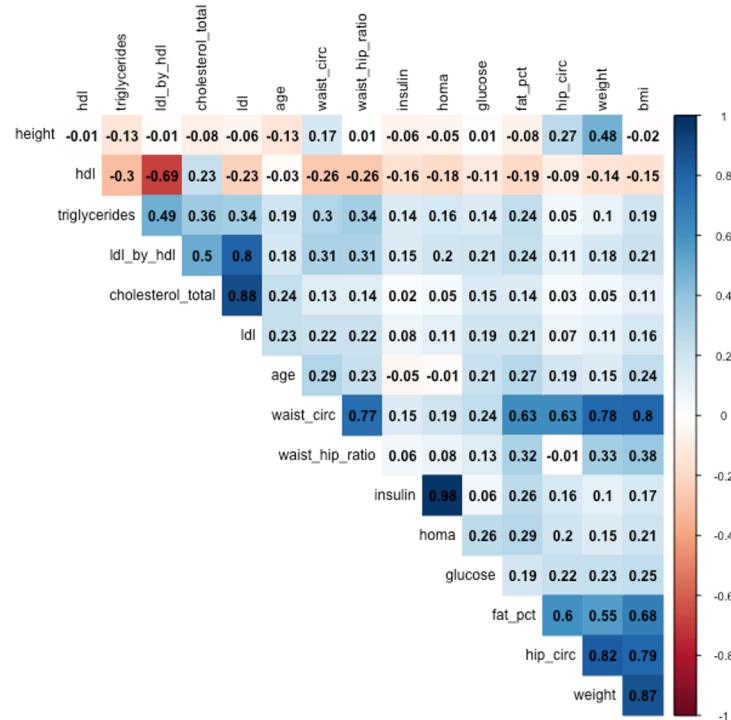


Correlation Plots

- 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



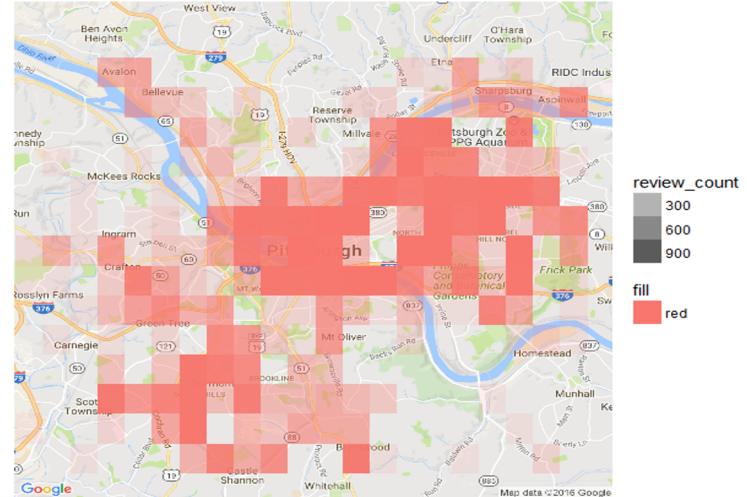
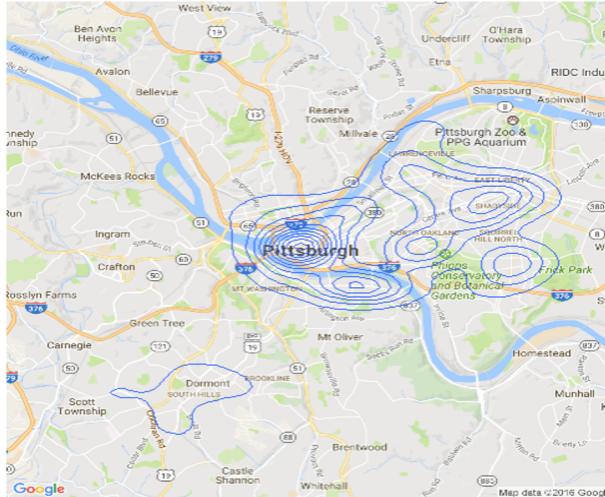
Demo 2



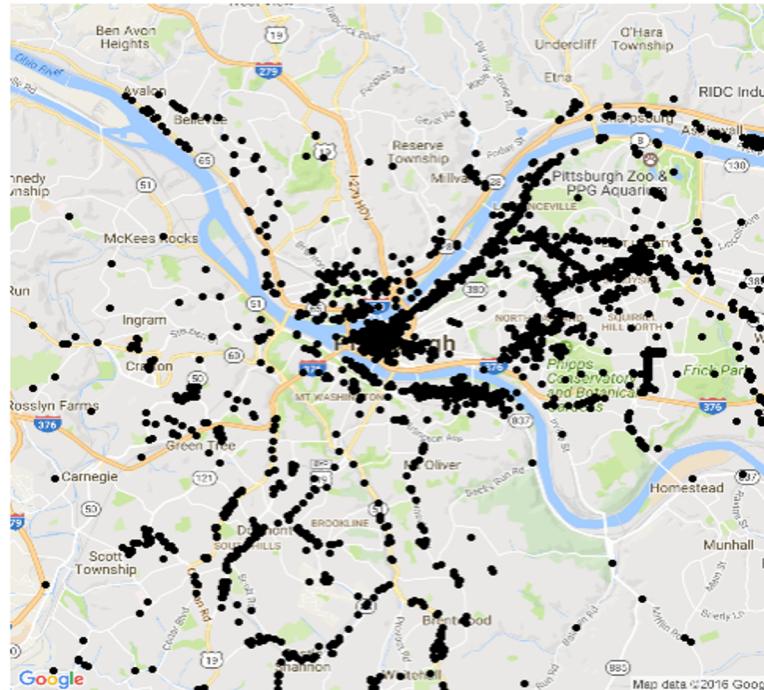
Using Maps

➤ Map visualization → contextual information

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



Example: Pittsburgh Data



Challenges of Visualization

Higher Dimension

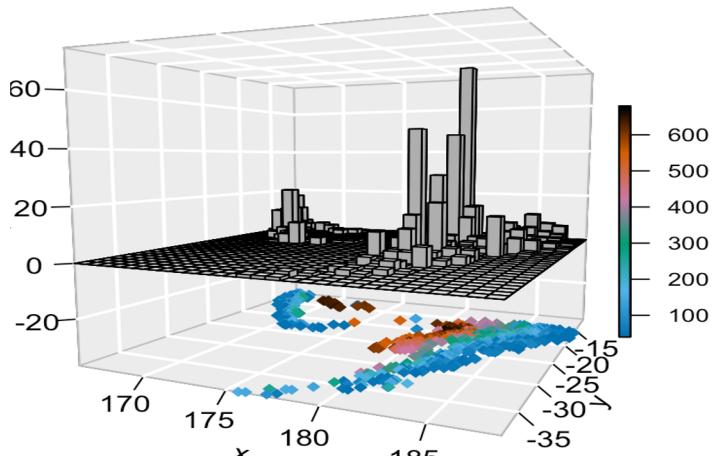
Non-Trivial

Time Consuming

**Hard to Show
Uncertainty**

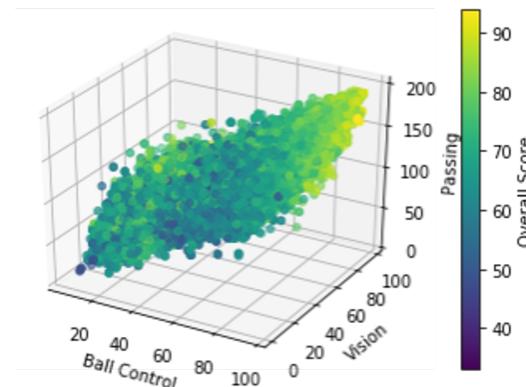


High Dimensional Data



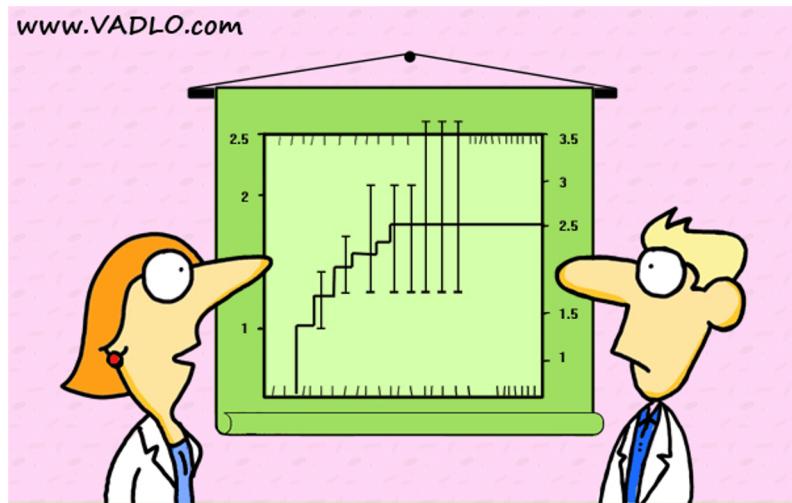
4D Plot For Earthquake Data

- 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

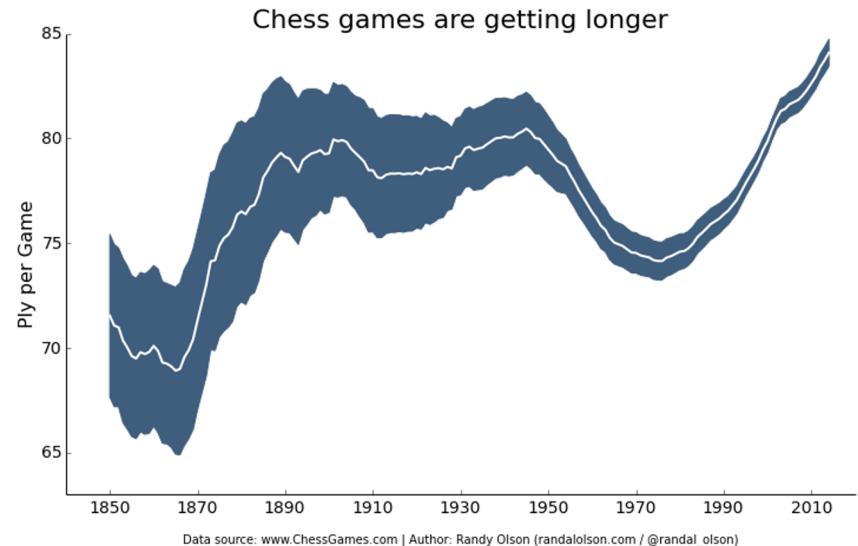


Error Bars

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



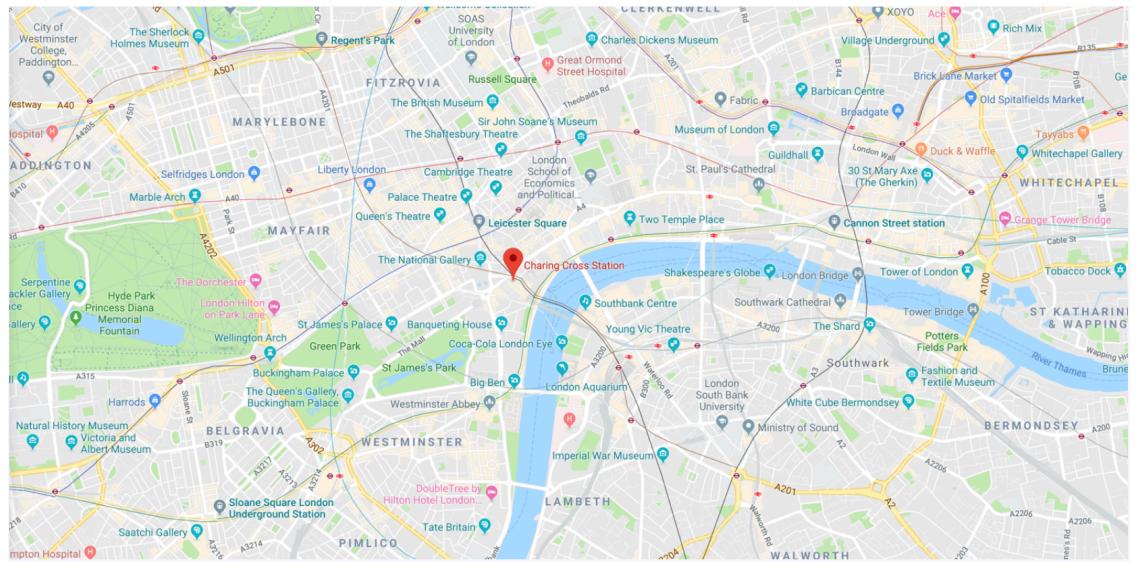
"Did you really have to show the error bars?"



What Makes a Visualization “Good”

- Data : Ink ratio
- Wagner’s Law: Effort of Writer + Effort Reader = Constant

“Easy reading is damned hard writing.” ~ Nathaniel Hawthorne



Coming Up

- **Assignment 3:** Due at 5:30pm on Oct 14, 2020
- **Next Lecture:** Fundamentals of Machine Learning
- **Data Scraping Workshop:** Sometime from Oct 7-21



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