NYU Center for Data Science

DS-UA 112
Introduction to Data Science

Week 9: Lecture 1
Estimation – Loss Functions in Models

NYU Center for Data Science

How can we fill in the missing pieces in a description of some population?

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Introduction to Data Science

Week 9: Lecture 1
Estimation – Loss Functions in Models

Adapted from Dudoit, Nolan, Gonzalez

Announcements

- Please check Week 9 agenda on NYU Classes
  - Lab 7
    - Due on Friday March 27 at 12PM
  - Project 1
    - Due on Monday April 6 at 12PM
  - Survey

https://nyu.qualtrics.com/jfe/form/SV_3DCWUa4yc08L0wt

Announcements

- Recordings
  - Lecture
  - Section
  - Office Hours
- Media Gallery
- Zoom

Check @449 on Piazza for more information

Review

- Text as Data
  - We studied Huckleberry Finn by Mark Twain and Little Women by Louisa May Alcott
- We tried to understand aspects of the novels through numbers

Questions

- Can we make deductions about the characters or the relationships between characters by the occurrence of their name?

Review

- Text as Data
  - We studied Huckleberry Finn by Mark Twain and Little Women by Louisa May Alcott
- We tried to understand aspects of the novels through numbers

Questions

- Can we distinguish the novel by the length of sentences?
- Can we distinguish the novel by the length of words?

Review

Zipf Rule

- Text as Data
  - We studied Huckleberry Finn by Mark Twain and Little Women by Louisa May Alcott
- We tried to understand aspects of the novels through numbers

Questions

- What is the relationship between the frequency of words and the rank of a words ordered by number of occurences?

Review

- Define frequency to be the proportion of times a word appears in the text
- Define rank to be the ranking of words in descending order according to occurrence

$$Frequency = \frac{1}{Rank}$$

- Zipf Rule
  - Proposed by linguist George Kingsley Zipf to describe patterns in language
  - The rule relates frequency and rank

Review

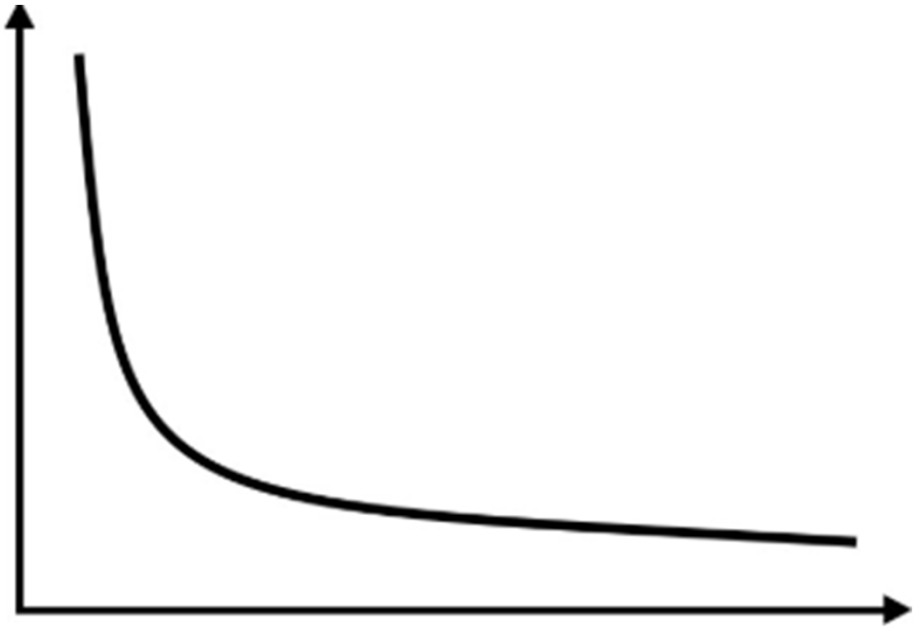
- Define frequency to be the proportion of times a word appears in the text
- Define rank to be the ranking of words in descending order according to occurrence

$$Frequency = \frac{1}{Rank}$$

- So if the most common word has frequency 0.2, then the second most common would have frequency 0.2 / 2, the third most common would have frequency 0.2 / 3, …

Review

- Zipf rule describes a power law meaning a relationship between two quantitative variables involves taking a power transformation



$$\textit{Dependent Variable} = (\textit{Independent Variable})^{\textit{power}}$$

Review

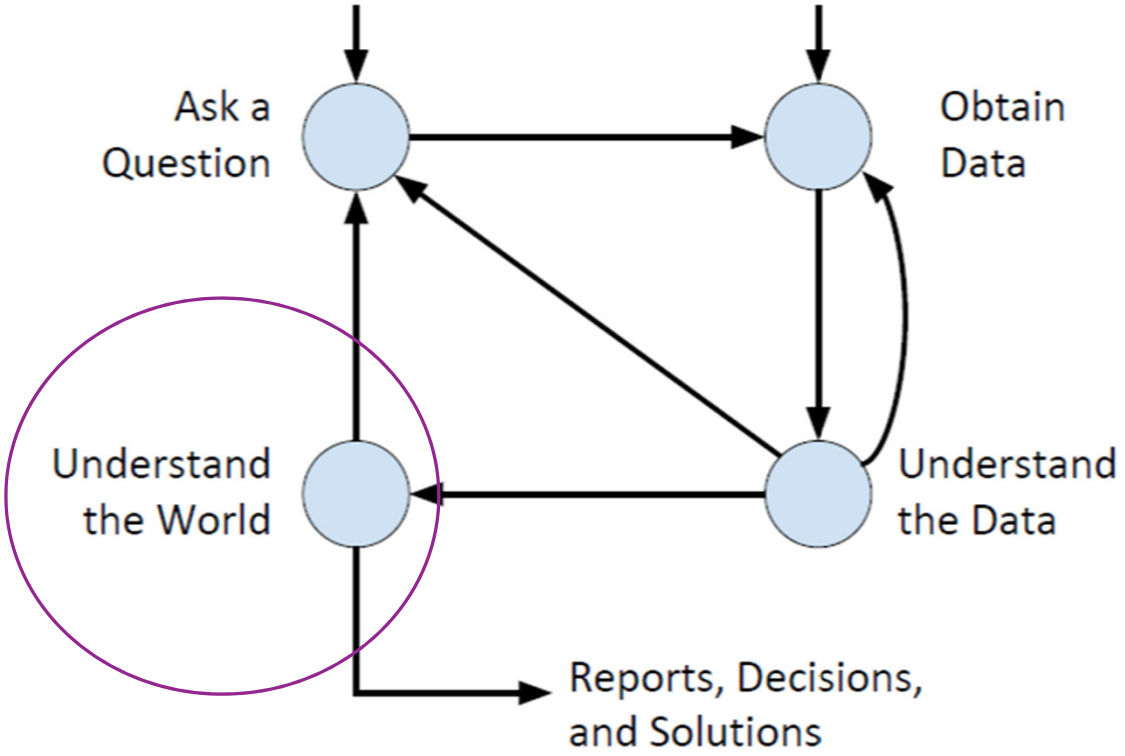
- Zipf rule describes a power law meaning a relationship between two quantitative variables involves taking a power transformation

$$\textit{Dependent Variable} = (\textit{Independent Variable})^{\textit{power}}$$

- Power laws occur in many contexts to model
  - Population of Cities
  - Distribution of Wealth
  - Size of Companies

Agenda

- Modelling
  - Estimation
  - Prediction
  - Inference



Models

15% of bill is customary amount for tip in US

	total_bill	tip	sex	smoker	day	time	size
0	16.99	1.01	Female	No	Sun	Dinner	2
1	10.34	1.66	Male	No	Sun	Dinner	3
2	21.01	3.50	Male	No	Sun	Dinner	3
...	...	...	...	...	...	...	...
241	22.67	2.00	Male	Yes	Sat	Dinner	2
242	17.82	1.75	Male	No	Sat	Dinner	2
243	18.78	3.00	Female	No	Thur	Dinner	2

- Tips for waiters and waitresses
- Estimation: Is 15% the average amount for a tip in US?
- Prediction: Could we use information like day and time to guess the tip?
- Inference: If the average is 15% then what is the chance that the tip exceeds 25%?

Exercise

Completing the Square

- Show that the expression

$$x^2 + 6x = -2$$

is equivalent to the expression

$$(x+3)^2 = 7$$

- Suppose we have the expression

$$x^2 + bx = c$$

Find e and f such that

$$(x + e)^2 = f$$

Models

15% of bill is customary amount for tip in US

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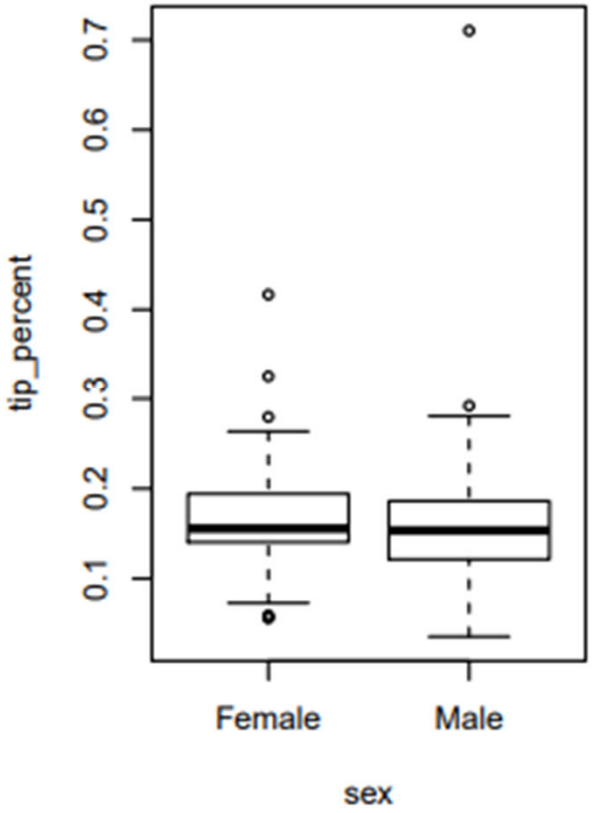
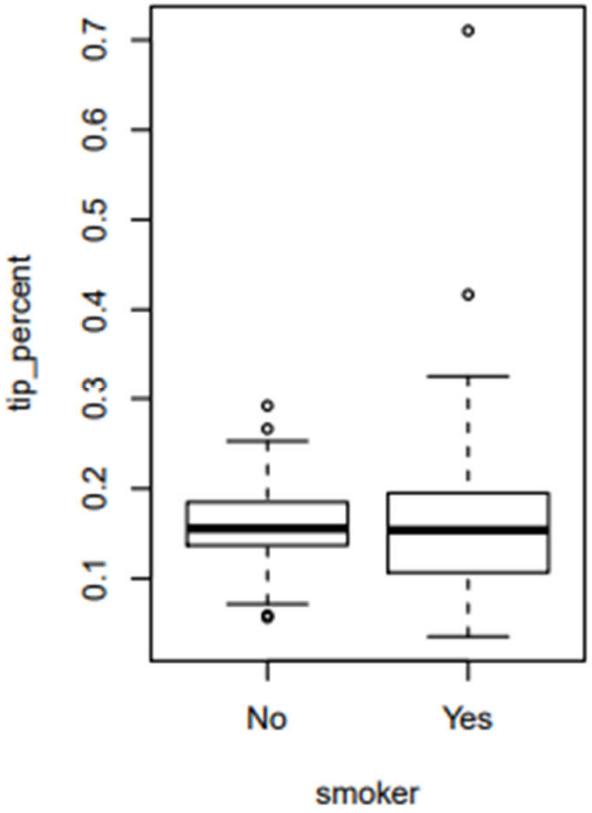
- The mean tip percentage is 16.08%
- Most tips are between 10 and 20% with a few outlying large tips. Maximum of 70%.
- The tip percentage does not appear, however, to vary much with variables such as sex, smoker, day, time, and size.

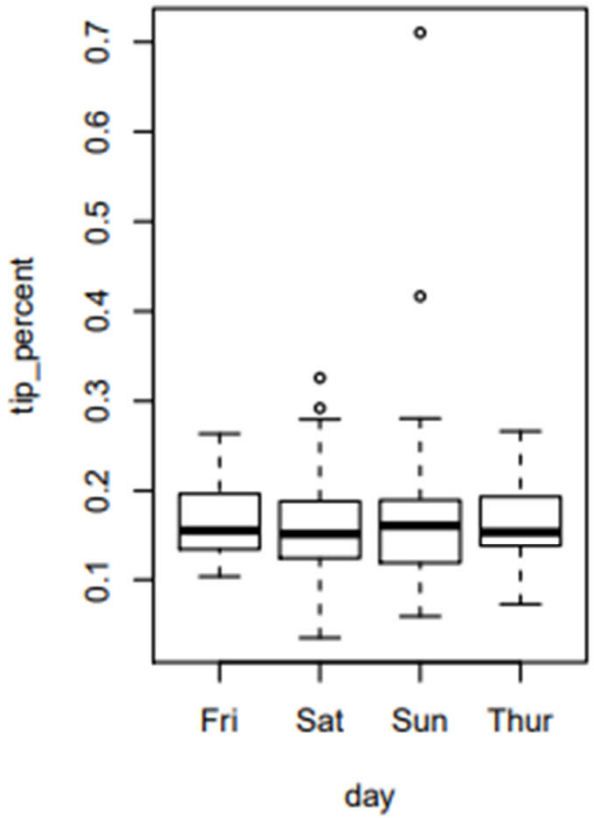
Models

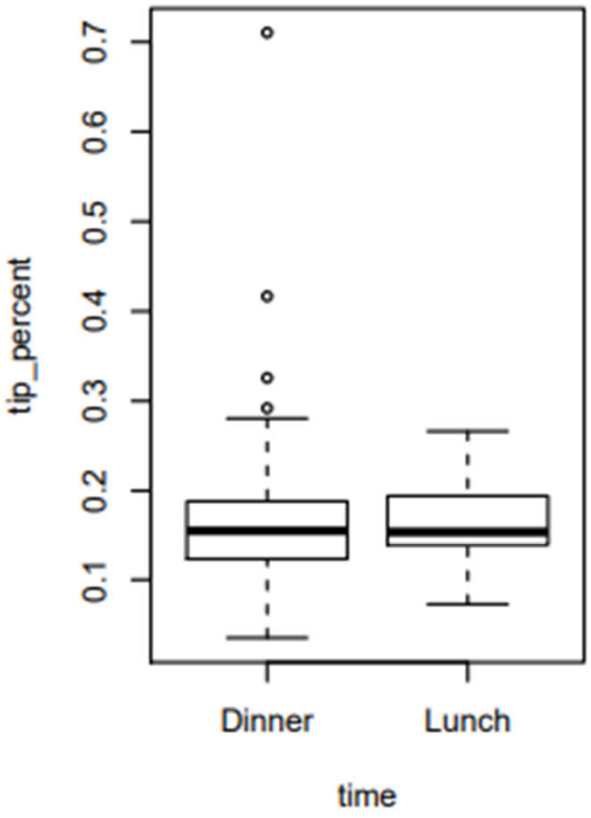
- Since sex, smoker, day, time, and size can be thought of as qualitative variables, we can produce side-by-side boxplots to investigate the relationships
- If the range of values in the tips does not significantly differ between variables, then we do not have a relationship

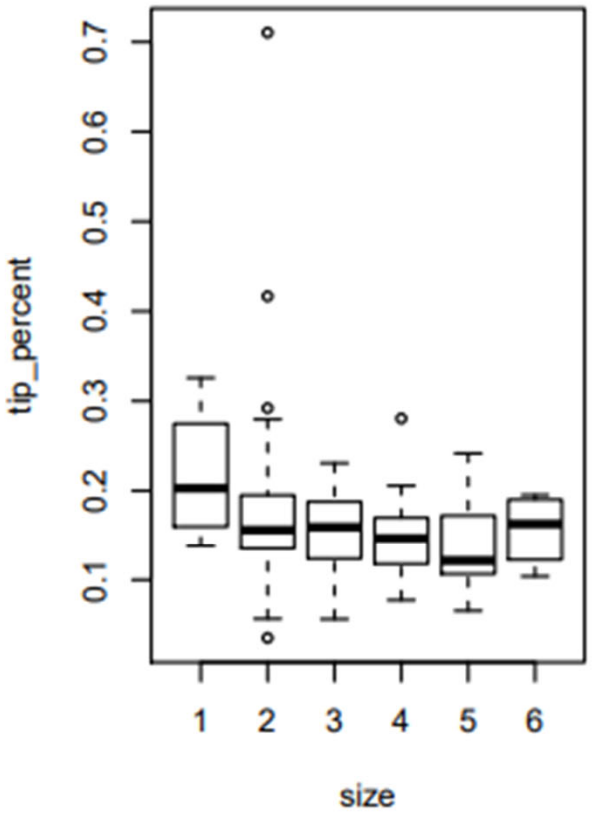




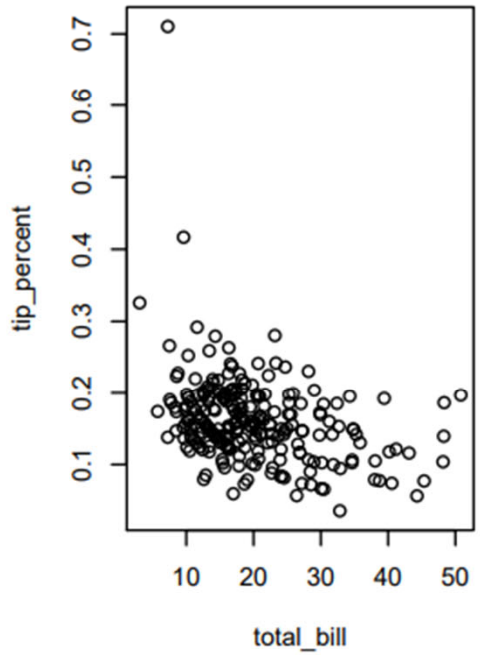
Models


tip_percent
0.1
0.2
0.3
0.4
0.5
0.6
0.7
Fri
Sat
Sun
Thur
day

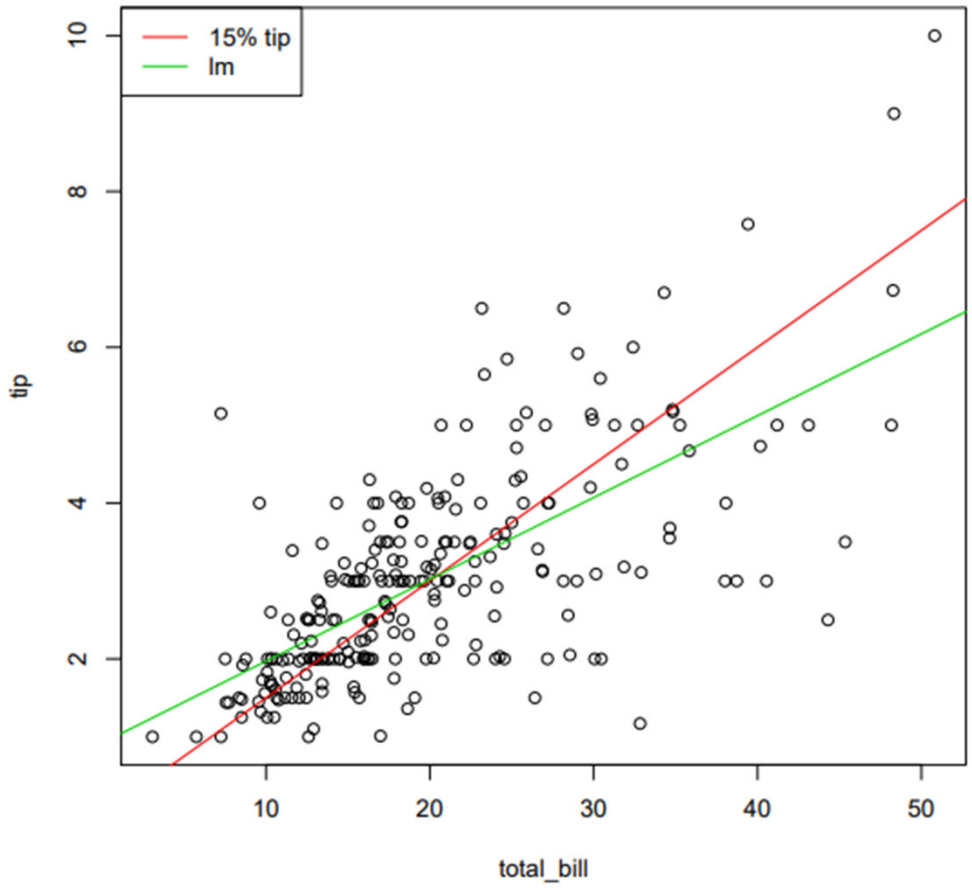

tip_percent
0.1
0.2
0.3
0.4
0.5
0.6
0.7
Dinner
Lunch
time


tip_percent
0.1
0.2
0.3
0.4
0.5
0.6
0.7
1
2
3
4
5
6
size

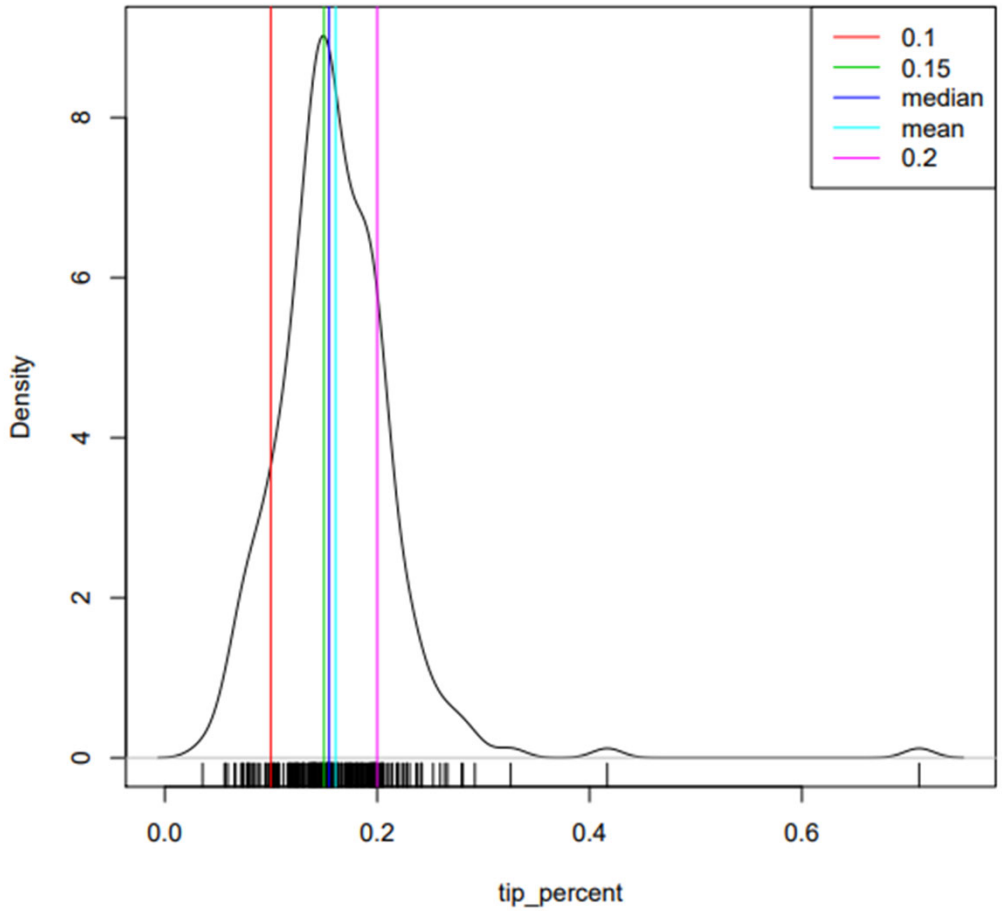
Models



- Removing outlier leads to a linear trend
- The slope estimates the percent tip

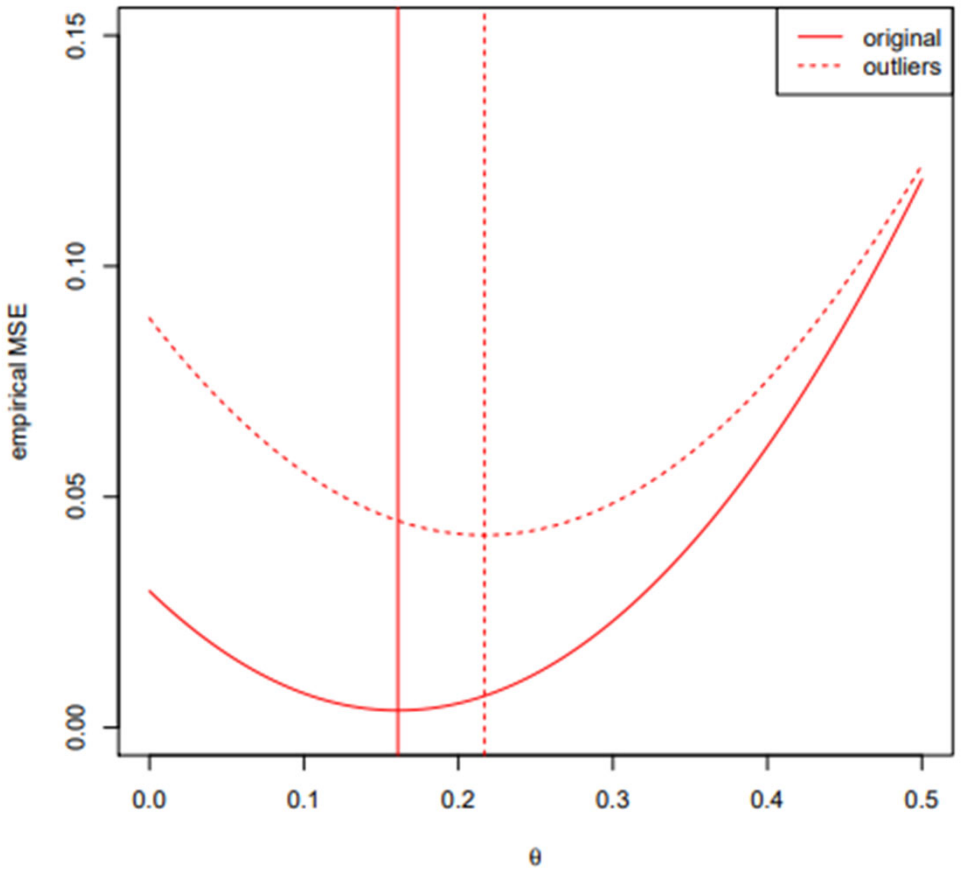


Models



- We have different approaches to summarizing the tip as a percentage of the bill
- The mean captures the average value among the tips
- The median captures the middle value among the tips

Models



- MSE stands for Mean Square Error
- MAE stands for Mean Absolute Error
- Note that MSE involves squaring numbers. Since we are squaring numbers between 0 and 1 in the tips dataset, MSE lies below MAE

Summary

- Power Law
  - Zipf Rule
- Models
  - Estimation
  - Prediction
  - Inference
- Loss Functions

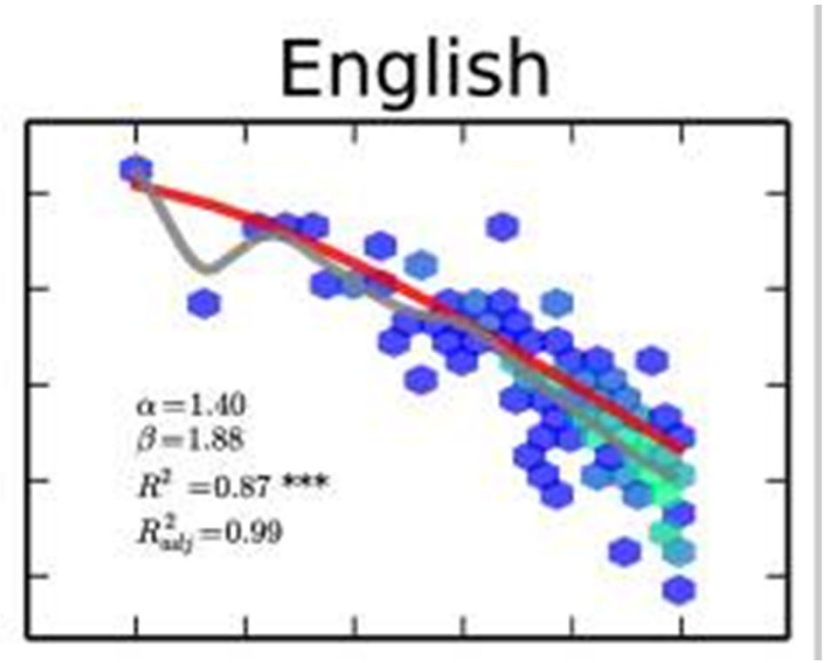
Goals

- What is square loss and absolute loss?
- How can derivatives help use to determine the parameters in loss functions?

Questions

- Questions on Piazza?
  - Please provide your feedback along with questions
- Question for You!

Where else can you find the Zipf Rule?



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