Data Cleaning

February 6, 2020
Data Science CSCI 1951A
Brown University
Instructor: Ellie Pavlick
HTAs: Josh Levin, Diane Mutako, Sol Zitter

Thanks to C. Binning for some stolen slides. :)

Announcements

- Assignment 1: down! Assignment 2: up!
- Projects:
  - Let me know by today at 10:20 if you want to be N != 4
  - Being thinking about your project data…the first deliverable is not just a “ceremonial” checkpoint
  - “Will we know how to do X by in time?” —> maybe/probably/probably not but you should do it regardless!

Today

- 45 minutes—let’s just see how far we get….
- Problems with dirty data
- Cleaning and string matching heuristics
- Monday: bash commands (come with a command line…if you don’t know what that means, ask me)

ID	Name	Street	City	State	Zip	Hours
1	N Aldroubi	123 University Ave	Providence	RI	98106	42
2	Natalie Delworth	245 3rd St	Pawtucket	RI	98052-1234	30
3	Nam Do	345 Broadway	PVD	Rhode Island	98101	19
4	N Dellworth	245 Third Street	Pawtucket	NULL	98052	299
5	Do Nam	345 Broadway St	Providnce	Rhode Island	98101	19
6	Nazem Aldroubi	123 Univ Ave	PVD	Rhode Island	NULL	41
7	Minna Kimura-T	123 University Ave	Providence	Guyana	94305	NULL

…

Problems?

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Problems?

Inconsistent Representations

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Typos

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Missing Values

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- Any combination of the above

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- Fields too long (get truncated)
- Primary key violations (from data merging)

Dirty Data…

- Parsing input data (e.g., separator issues)
- Naming conventions: NYC vs New York
- Formatting issues – esp. dates
- Missing values and required fields (e.g., always use 0)
- Different representations (2 vs Two)
- Fields too long (get truncated)
- Primary key violations (from data merging)
- Redundant Records (from data merging)

Clicker Questions!

Clicker Lightening Round!

TAS

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How will the dirty data affect the results of this query?

(a) Too high

(b) Too low

(c) Unaffected

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How many TAs are there?

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SELECT COUNT(*)
FROM TAS
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Duplicates -> Double Counting

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How will the dirty data affect the results of this query?

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How many TAs have worked zero hours?

```
SELECT COUNT(*)
FROM TAS
WHERE Hours = 0
```

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NULLS arent included in the where clause

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How many hours do my commuter TAs work?

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SELECT SUM(Hours)
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WHERE City != “Providence”
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Inconsistent names, typos, and duplicates...

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FROM TAS
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```

What’s to be done?

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Look at your data

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FROM PEOPLE
GROUP BY Zip_Code
ORDER BY pop
```

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City	Count(*)
Schenectady	2,500
New York City	2,200
Los Angeles	1,900
Dallas	1,400

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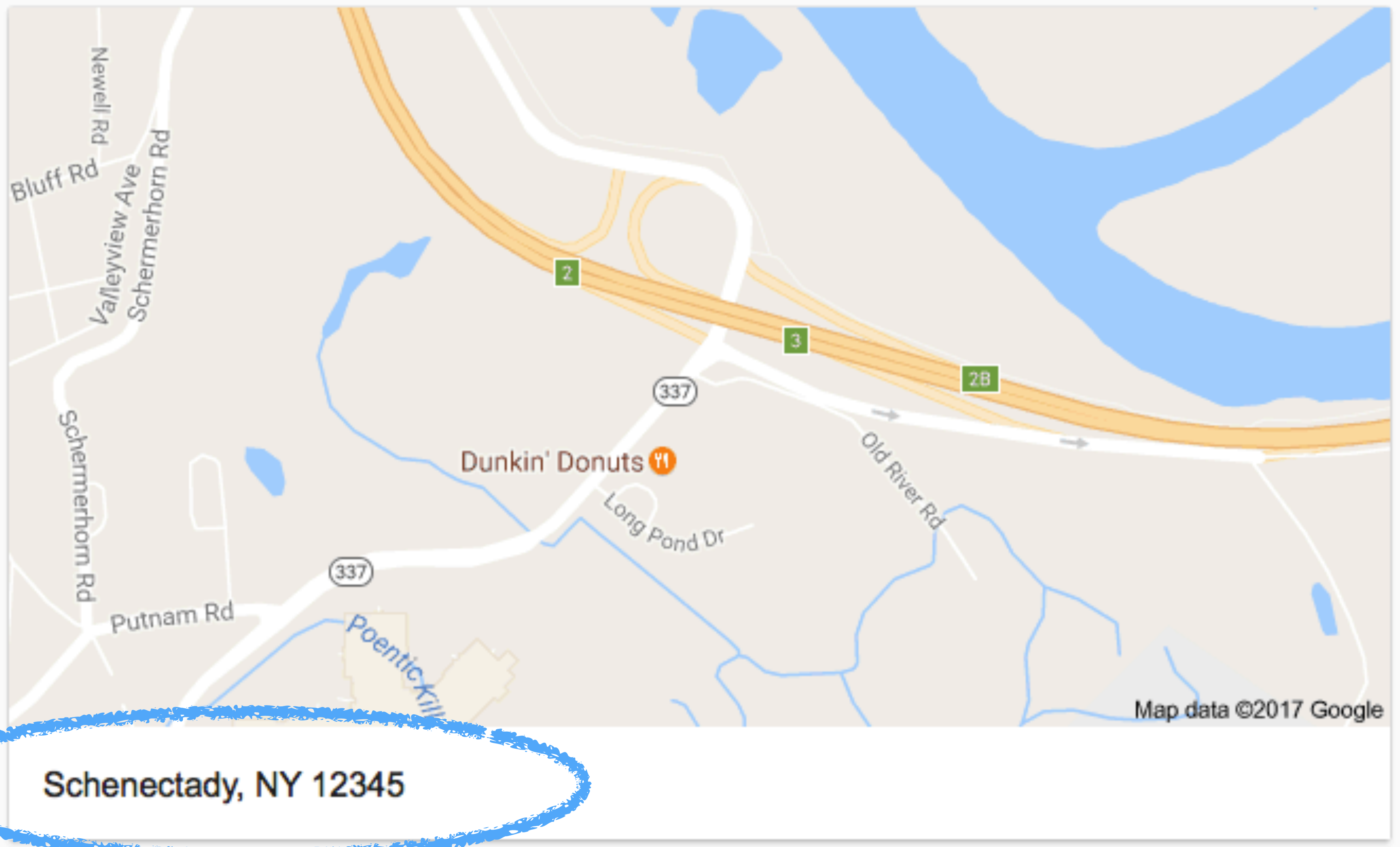
Loc

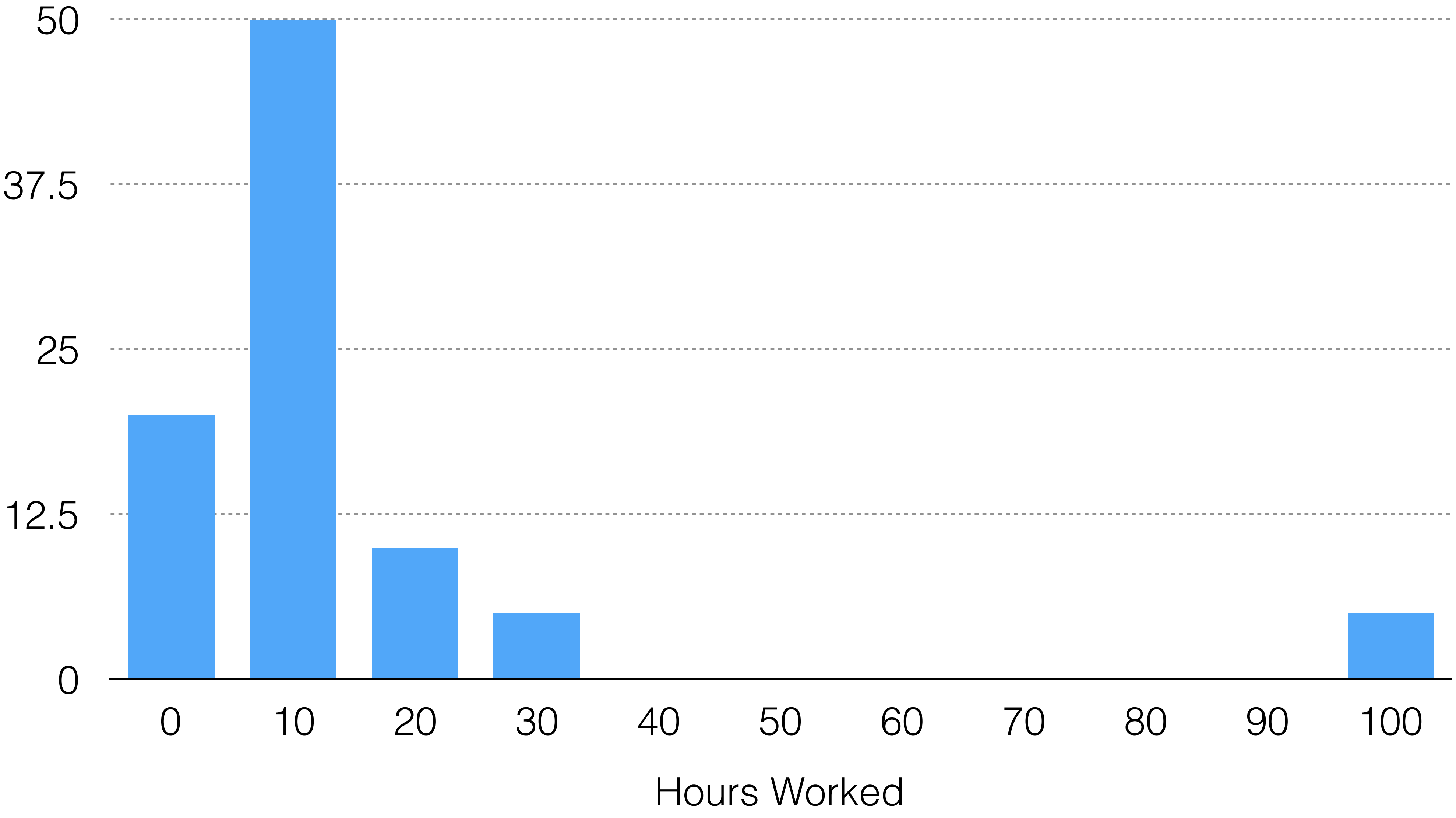
```
SELECT (
FROM PE(
GROUP B
ORDER B
```



Schenectady, NY 12345

City	Count(*)
12345	2,500
10001	2,2000
90001	1,900
75001	1,400

Set Defaults/Remove Outliers



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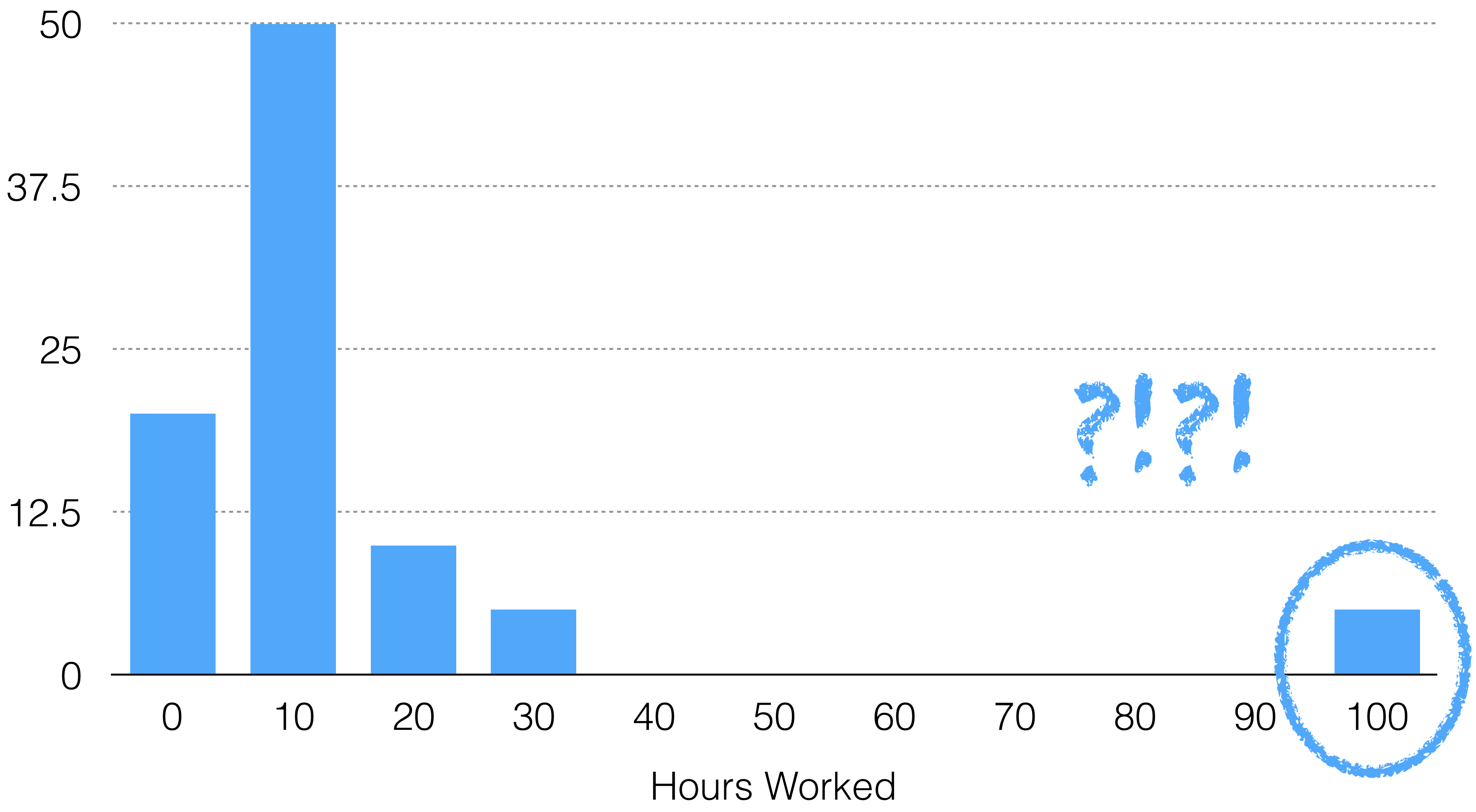

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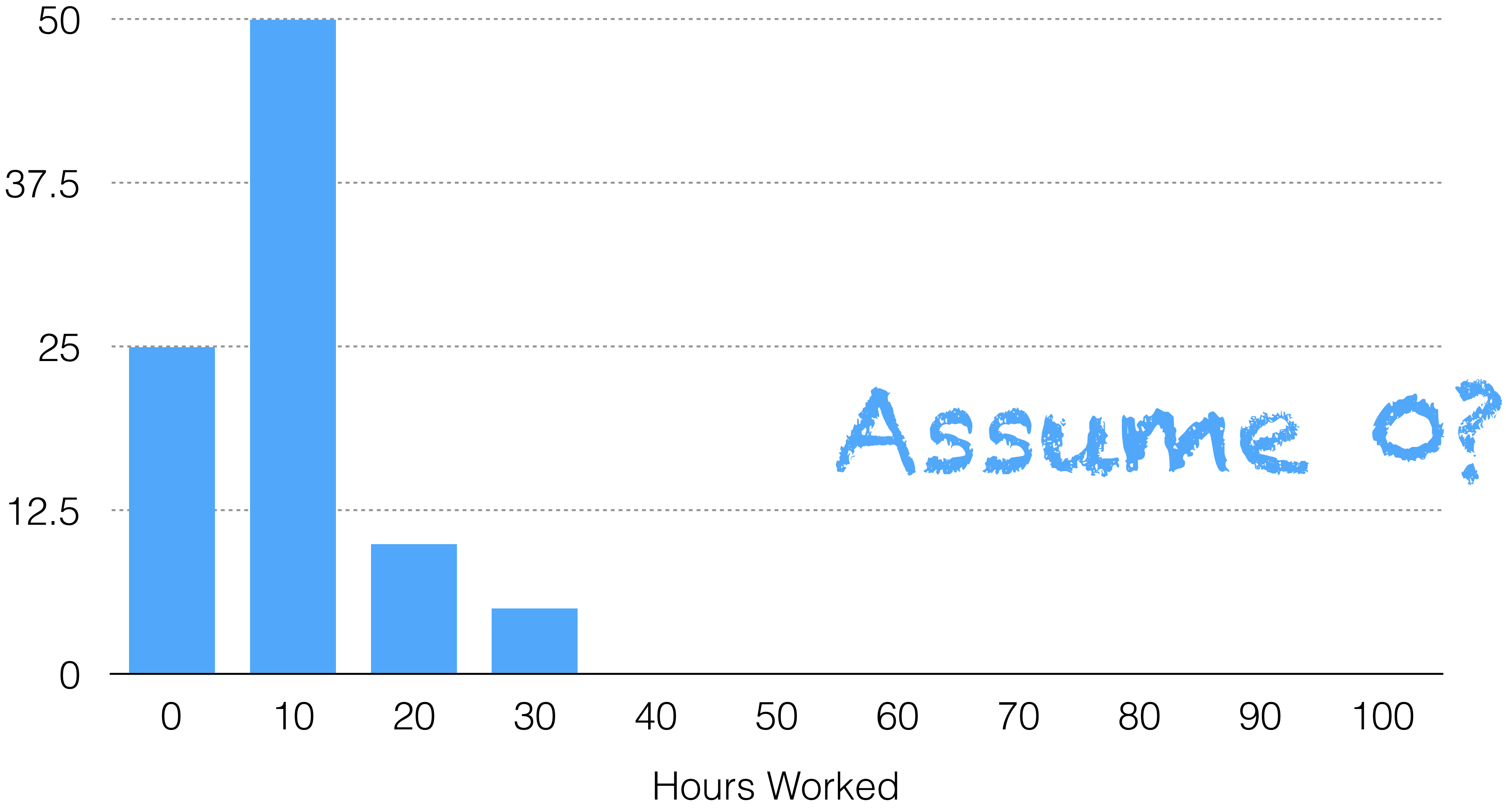

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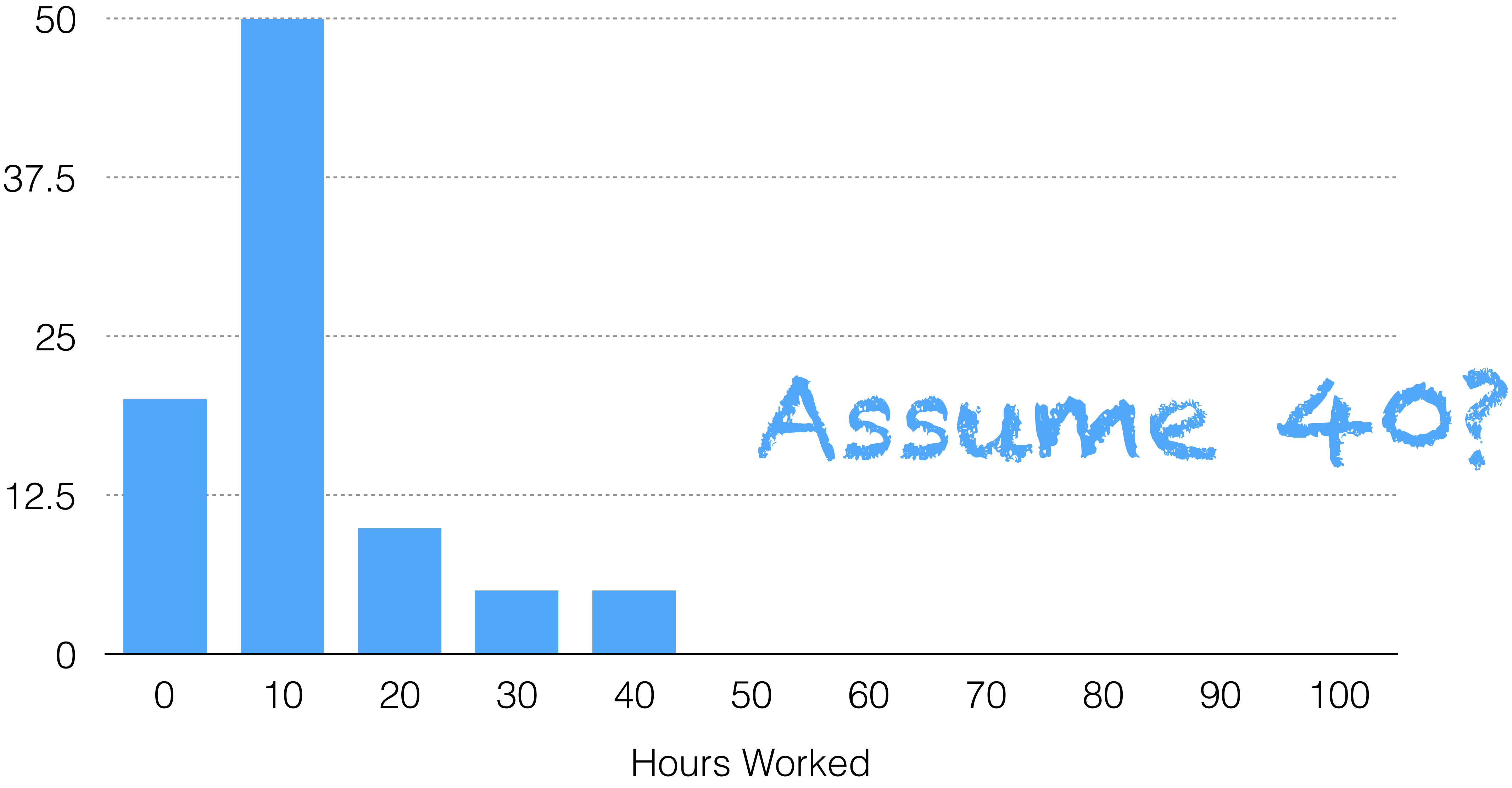

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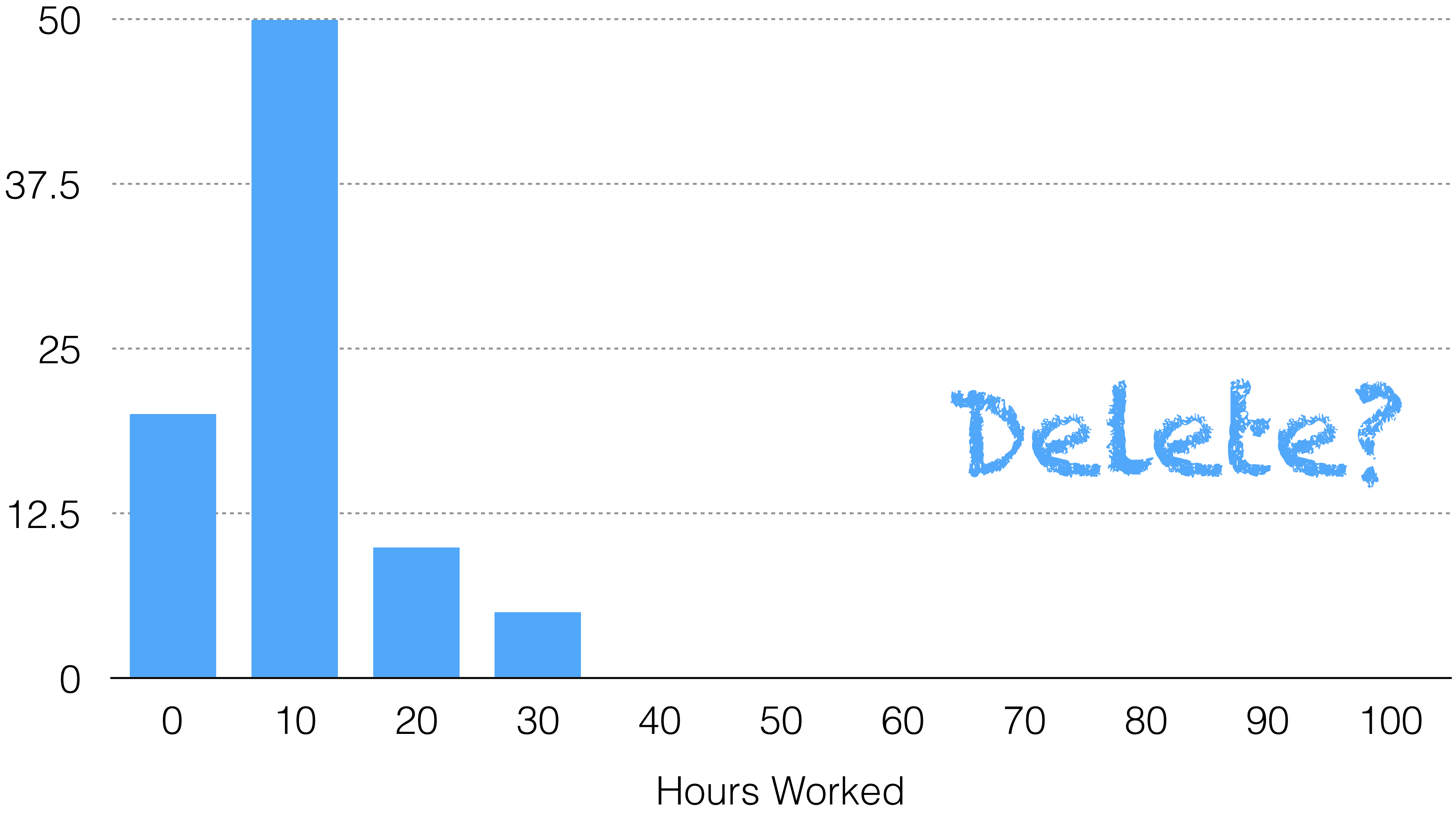

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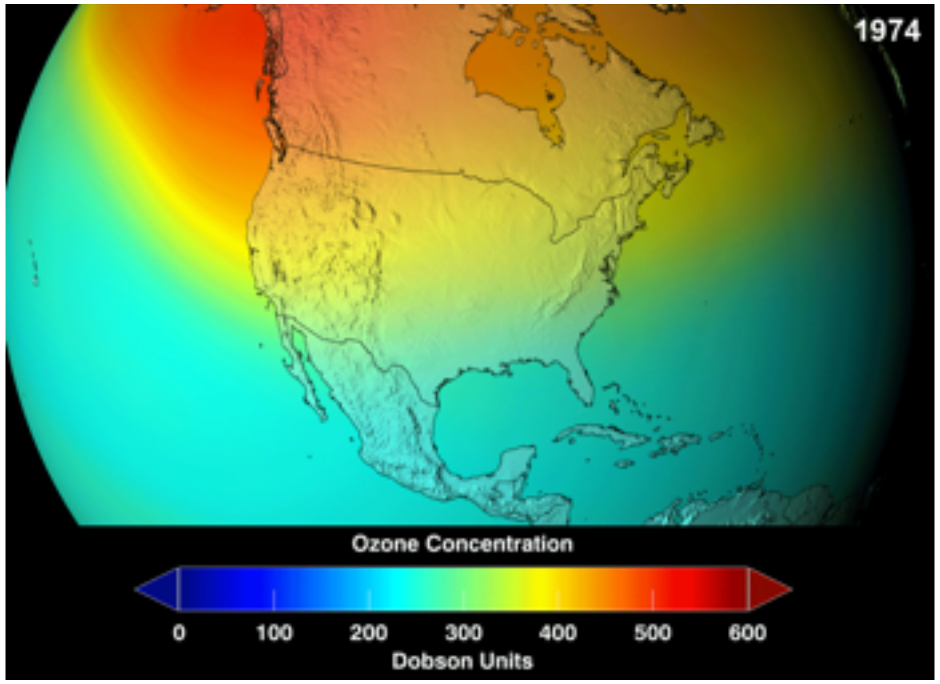

The discovery of the Antarctic "ozone hole" by British Antarctic Survey scientists Farman, Gardiner and Shanklin…came as a shock to the scientific community…[The data] were initially rejected as unreasonable by data quality control algorithms (they were filtered out as errors since the values were unexpectedly low); the ozone hole was detected only in satellite data when the raw data was reprocessed following evidence of ozone depletion in in situ observations. When the software was rerun without the flags, the ozone hole was seen as far back as 1976.

https://en.wikipedia.org/wiki/Ozone_depletion#Antarctic_ozone_hole

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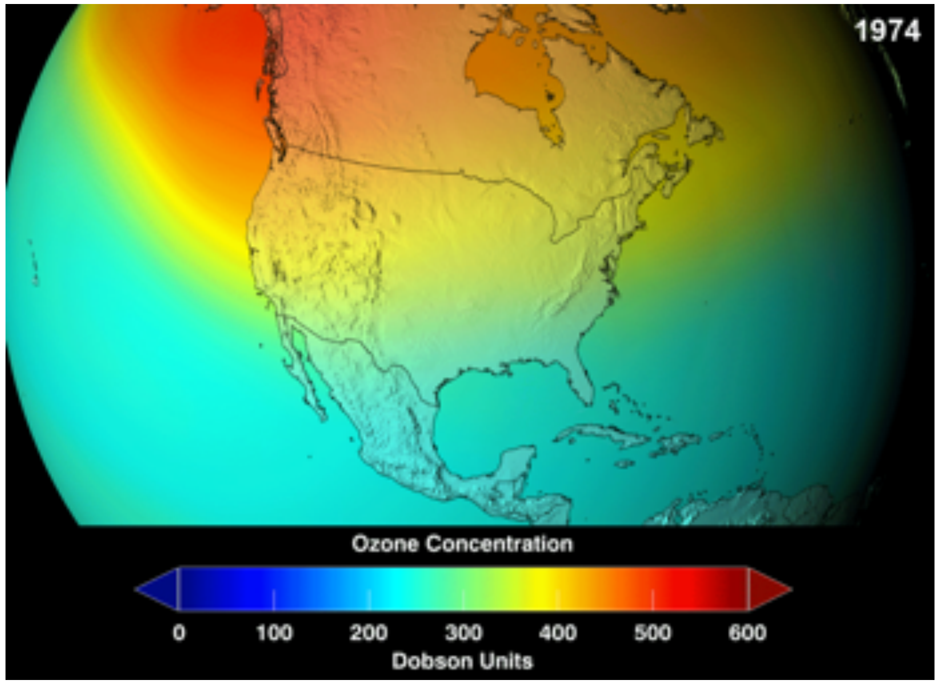

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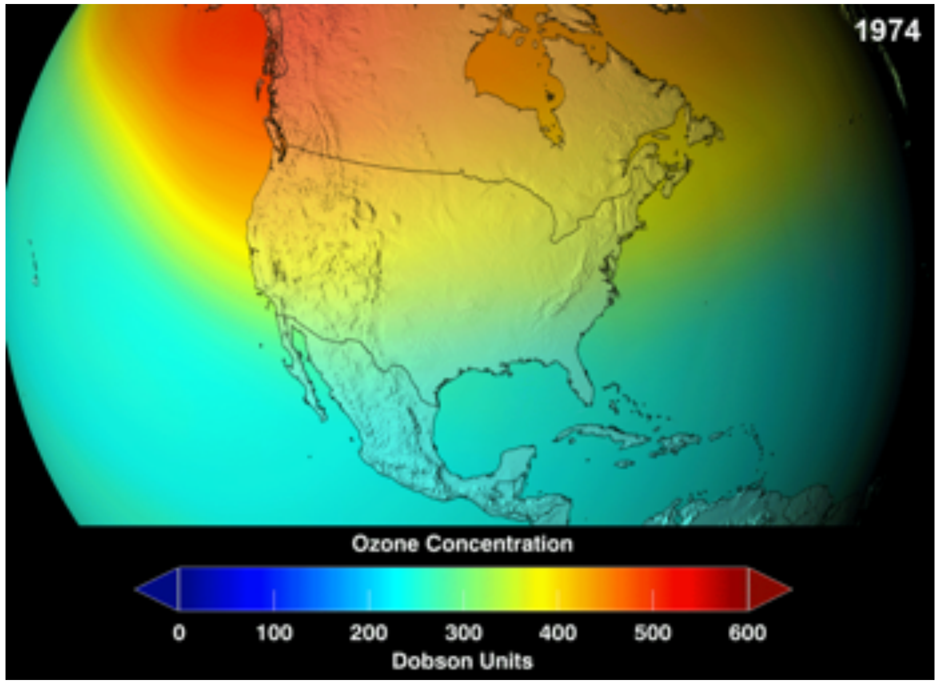

Always always always! Look at the data!

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String Similarity

String Similarity: Edit Distance

Minimal number of edits (inserts, deletes, substitutions) needed to transform A into B.

https://en.wikipedia.org/wiki/Levenshtein_distance

String Similarity: Edit Distance

$$
\begin{aligned}
d_{i0} &= \sum_{k=1}^{i} w_{\mathrm{del}}(b_k), & \text{for } 1 \leq i \leq m \\
d_{0j} &= \sum_{k=1}^{j} w_{\mathrm{ins}}(a_k), & \text{for } 1 \leq j \leq n \\
d_{ij} &= \begin{cases} d_{i-1,j-1} & \text{for } a_j = b_i \\ \min \begin{cases} d_{i-1,j} + w_{\mathrm{del}}(b_i) \\ d_{i,j-1} + w_{\mathrm{ins}}(a_j) \\ d_{i-1,j-1} + w_{\mathrm{sub}}(a_j, b_i) \end{cases} & \text{for } a_j \neq b_i \end{cases} & \text{for } 1 \leq i \leq m, 1 \leq j \leq n.
\end{aligned}
$$

https://en.wikipedia.org/wiki/Levenshtein_distance

String Similarity: Edit Distance

115th Waterman St., Providence, RI

110th Waterman St., Providence, RI

EditDistance = 1

String Similarity: Edit Distance

Waterman Street, Providence, RI

Waterman St, Providence, RI

EditDistance = 4

String Similarity: Edit Distance

Problems?

String Similarity:
Edit Distance

148th Ave NE, Redmond, WA

148th Ave NE, Redmond, WA

String Similarity: Edit Distance

Edit Distance = 0

148th Ave NE, Redmond, WA

148th Ave NE, Redmond, WA

String Similarity: Edit Distance

Edit Distance = 0

148th Ave NE, Redmond, WA

148th Ave NE, Redmond, WA

148th Ave NE, Redmond, WA

NE 148th Ave, Redmond, WA

String Similarity: Edit Distance

Edit Distance = 0

148th Ave NE, Redmond, WA

148th Ave NE, Redmond, WA

148th Ave NE, Redmond, WA

NE 148th Ave, Redmond, WA

Edit Distance = 4

String Similarity:
Jaccard Similarity

$$J(A, B) = \frac{|A \cap B|}{|A \cup B|}$$

https://en.wikipedia.org/wiki/Jaccard_index

String Similarity: Jaccard Similarity

148th Ave NE, Redmond, WA

140th Ave NE, Redmond, WA

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String Similarity: Jaccard Similarity

148th Ave NE, Redmond, WA

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String Similarity: Jaccard Similarity

148th Ave NE, Redmond, WA

140th Ave NE, Redmond, WA

Jaccard = 4 / 6 = .67

https://en.wikipedia.org/wiki/Jaccard_index

String Similarity: Jaccard Similarity

148th Ave NE, Redmond, WA

NE 148th Ave, Redmond, WA

Jaccard = ???

https://en.wikipedia.org/wiki/Jaccard_index

String Similarity: Jaccard Similarity

148th Ave NE, Redmond, WA

NE 148th Ave, Redmond, WA

Jaccard = 1

https://en.wikipedia.org/wiki/Jaccard_index

Clicker Question!

Clicker Question!

iPad Two 16GB WiFi White

iPad 2nd generation 16GB WiFi White

What's the Jaccard Similarity?

(a) 3/8

(b) 4/11

(c) 4/7

Clicker Question!

iPad Two 16GB WiFi White

iPad 2nd generation 16GB WiFi White

What's the Jaccard Similarity?

(a) 3/8

(b) 4/11

[✓ (c)] 4/7

$$\frac{\#(\text{iPad, 16GB, Wifi, White})}{\#(\text{iPad, Two, 2nd, generation, 16GB, Wifi, White})}$$

String Similarity: Jaccard Similarity

Michigan State University

Michigan State Univ.

Michigan State University

Ohio State University

https://en.wikipedia.org/wiki/Jaccard_index

String Similarity:
Jaccard Similarity

Jaccard = 0.5

Michigan State University

Michigan State Univ.

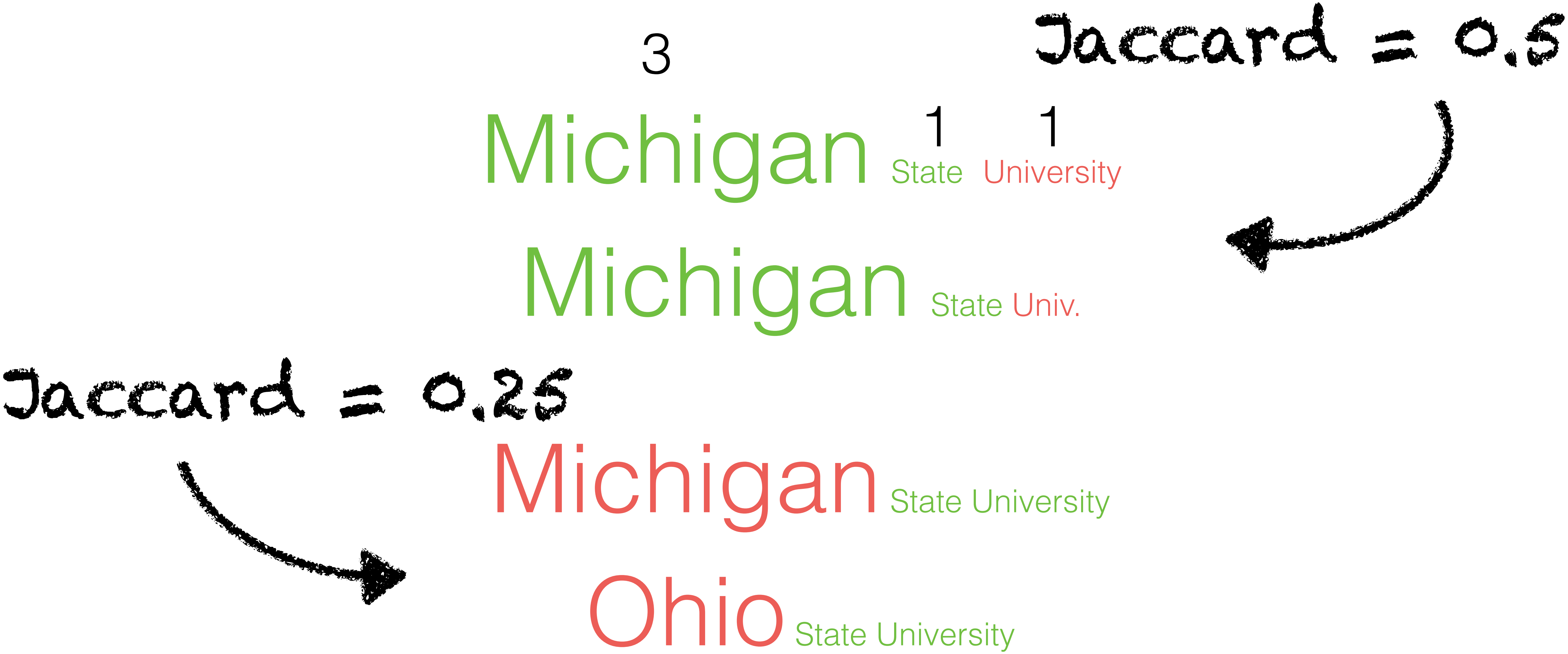
Jaccard = 0.5

Michigan State University

Ohio State University

https://en.wikipedia.org/wiki/Jaccard_index

String Similarity:
(Weighted) Jaccard Similarity



Jaccard = 0.5

3 1 1

Michigan State University

Michigan State Univ.

Jaccard = 0.25

Michigan State University

Ohio State University

https://en.wikipedia.org/wiki/Jaccard_index

String Similarity: (Weighted) Jaccard Similarity

3 1 1

Jaccard = 0.5

Michigan State University

Michigan State Univ.

Jaccard = 0.5

Michigan State University

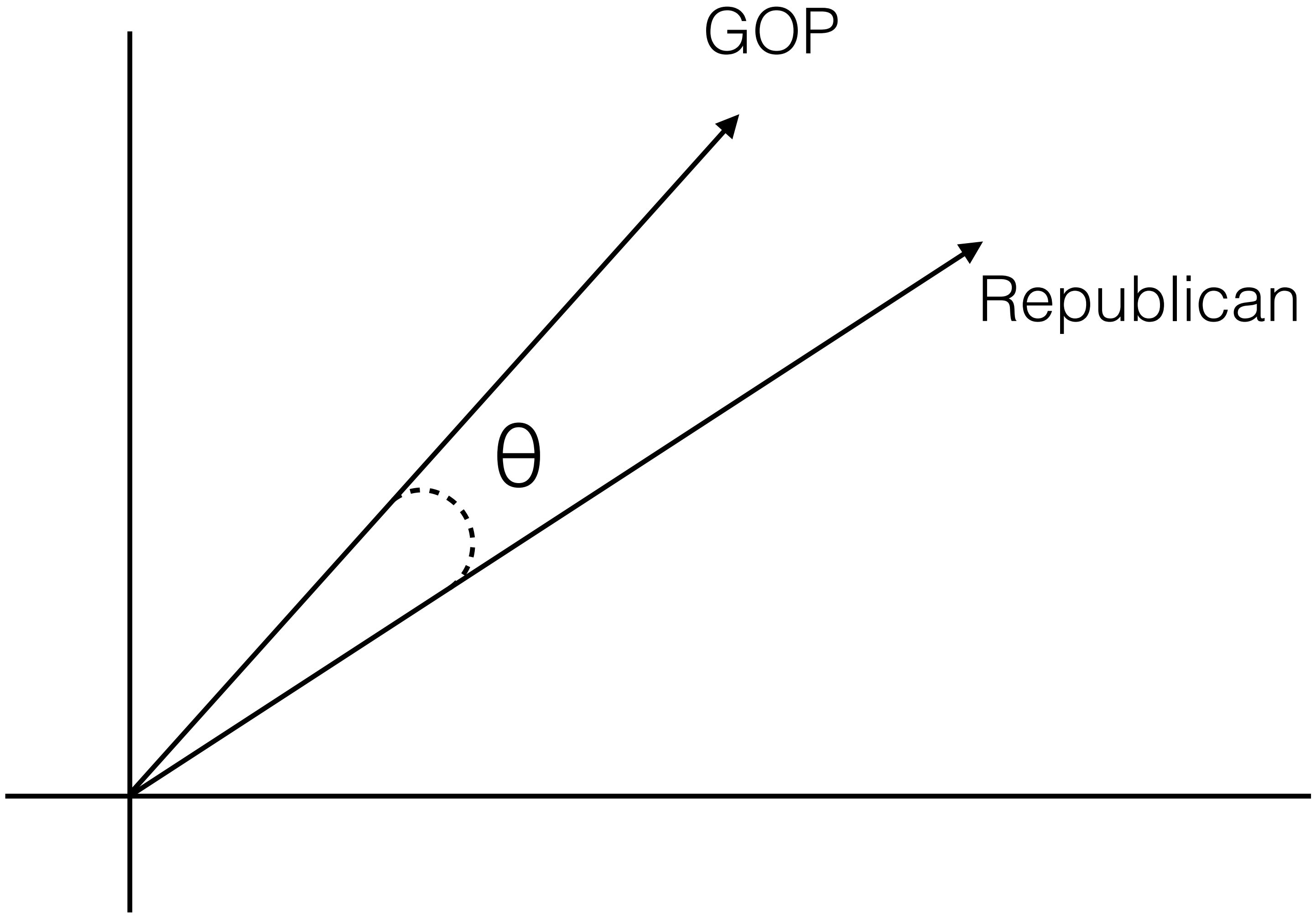
University of Michigan

https://en.wikipedia.org/wiki/Jaccard_index

String Similarity: Cosine Similarity

	Senator	Washington	announced	party	primary	chairman
GOP	1002	41	502	700	400	3
Republican	800	35	521	698	423	10

String Similarity: Cosine Similarity



Clicker Question!

Clicker Question!

Brown
Brown Uni.

Which metric would (likely) consider the above words more similar?

(a) Jaccard
(b) Cosine

Clicker Question!

Brown
Brown Uni.

Which metric would (likely) consider the above words more similar?

[✓ (a)] Jaccard
(b) Cosine

Clicker Question!

Motown
Detroit

Which metric would (likely) consider the above words more similar?

(a) Jaccard
(b) Cosine

Clicker Question!

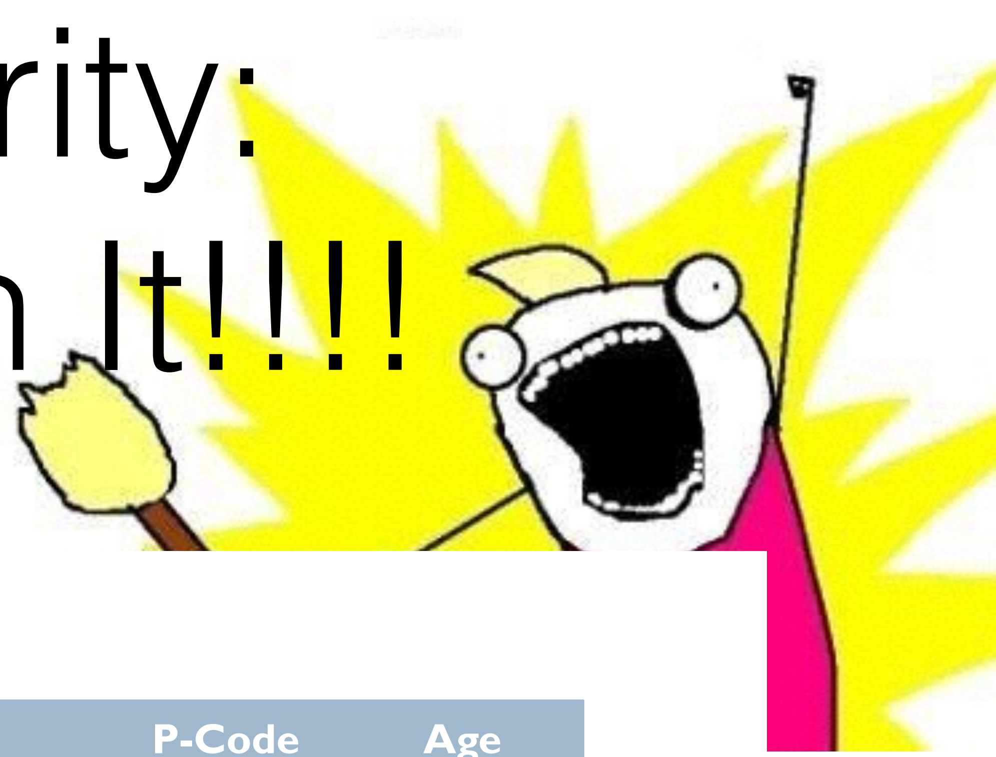
Motown
Detroit

Which metric would (likely) consider the above words more similar?

(a) Jaccard
[✓ (b)] Cosine

String Similarity: Machine Learn It!!!!

String Similarity: Machine Learn It!!!!

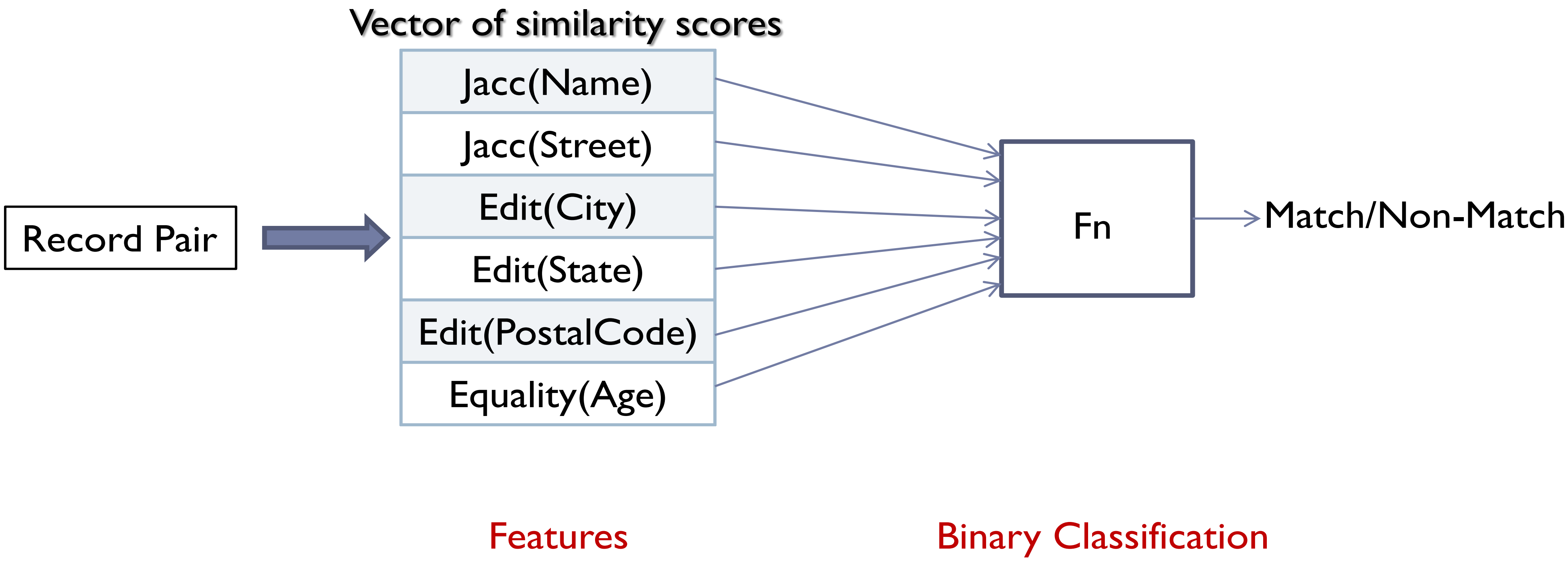


Customer

Id	Name	Street	City	State	P-Code	Age
1	J Smith	123 University Ave	Seattle	Washington	98106	42
2	Mary Jones	245 3rd St	Redmond	WA	98052-1234	30
3	Bob Wilson	345 Broadway	Seattle	Washington	98101	19
4	M Jones	245 Third Street	Redmond	NULL	98052	299
5	Robert Wilson	345 Broadway St	Seattle	WA	98101	19
6	James Smith	123 Univ Ave	Seatle	WA	NULL	41
7	J Widom	123 University Ave	Palo Alto	CA	94305	NULL
…	…	…	…	…	…	…

$WtJaccard =$ 0.57 0.91 1.0 0.0 1.0 1.0

String Similarity: Machine Learn It!!!!



String Similarity: Machine Learn It!!!!

Bob Wilson	345 Broadway	Seattle	Washington	98101	19
Robert Wilson	345 Broadway St	Seattle	WA	98101	19

Match

B Wilson	123 Broadway	Boise	Idaho	83712	19
Robert Wilson	345 Broadway St	Seattle	WA	98101	19

Non-Match

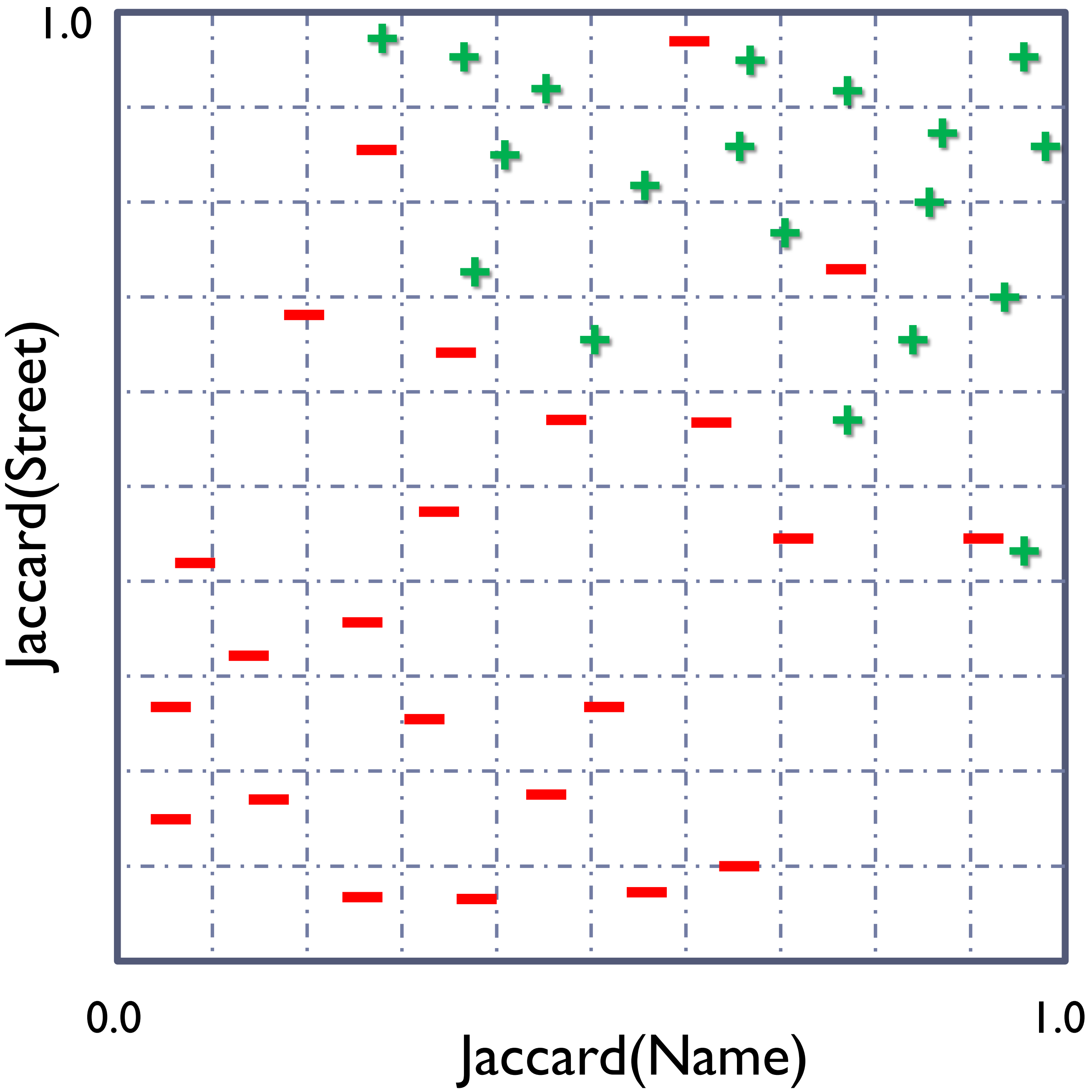
Mary Jones	245 3rd St	Redmond	WA	98052-1234	30
M Jones	245 Third Street	Redmond	NULL	98052	299

Match

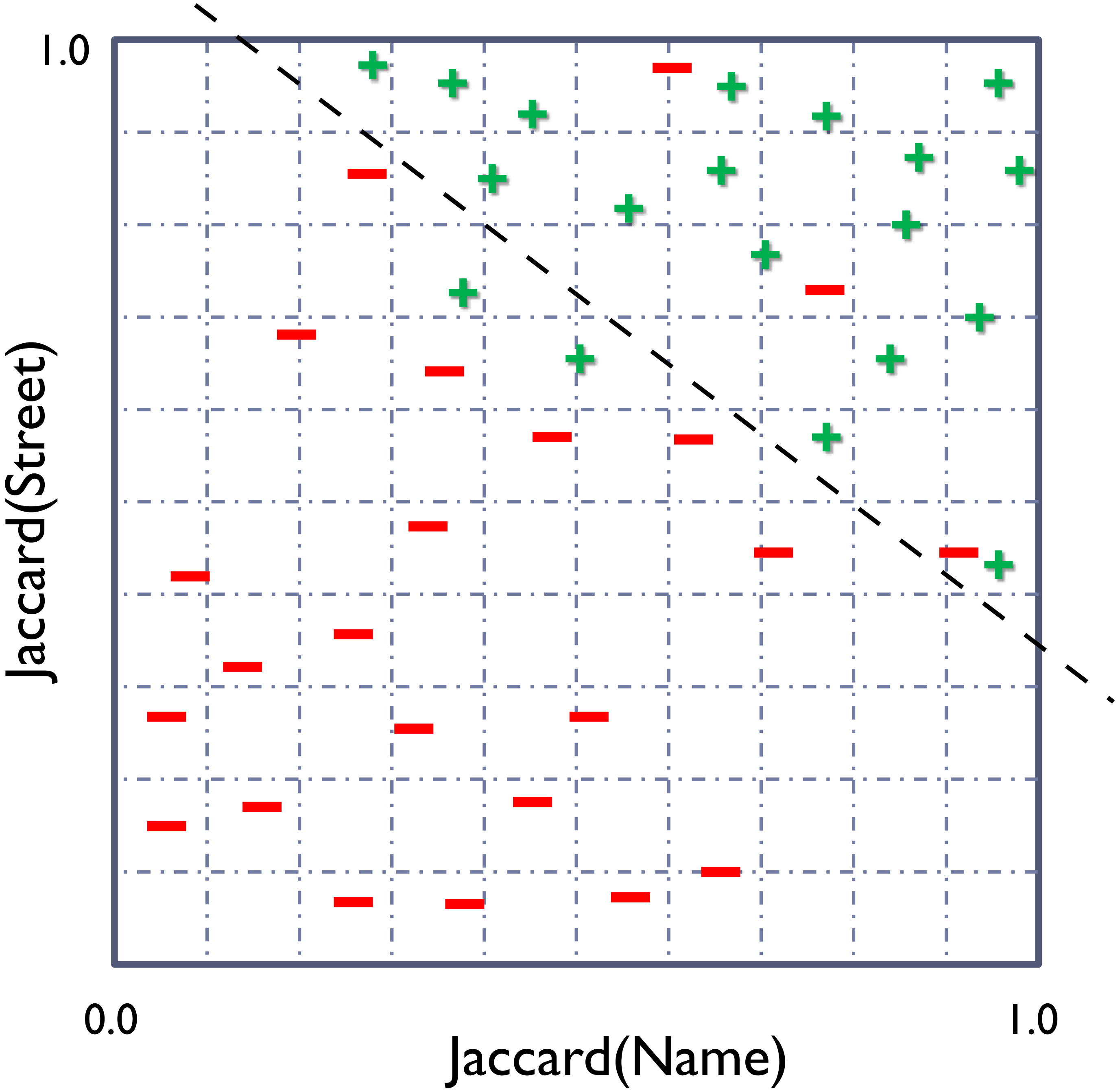
Mary Jones	245 3rd St	Redmond	WA	98052-1234	30
Robert Wilson	345 Broadway St	Seattle	WA	98101	19

Non-Match

String Similarity: Machine Learn It!!!!



String Similarity: Machine Learn It!!!!



And now….a word from your HTAs

(Meanwhile: I HAVE TO GO I’M GONNA MISS MY TRAIN EMAIL ME YOUR QUESTIONS HAVE A GOOD WEEKEND BYEEEEE)