# Google Maps: Predicting Parking Difficulty

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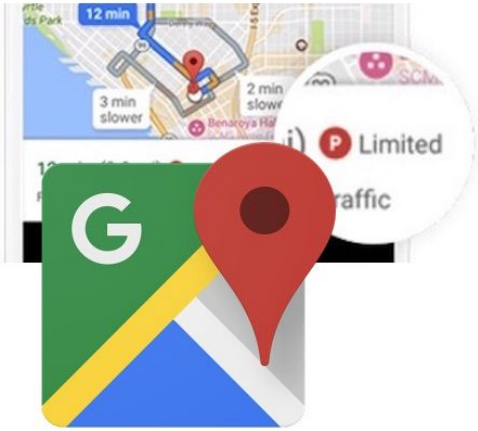
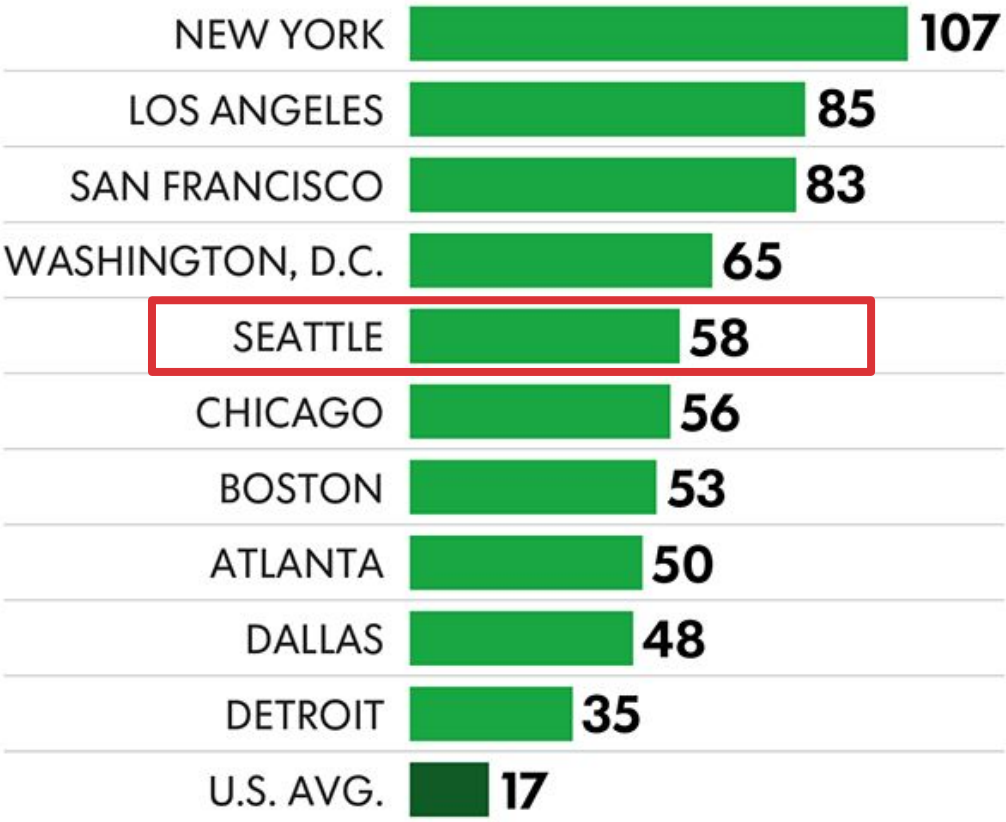
Investigation #1
July 23, 2018



Top 10 cities and U.S. average for annual search time, hours per driver:



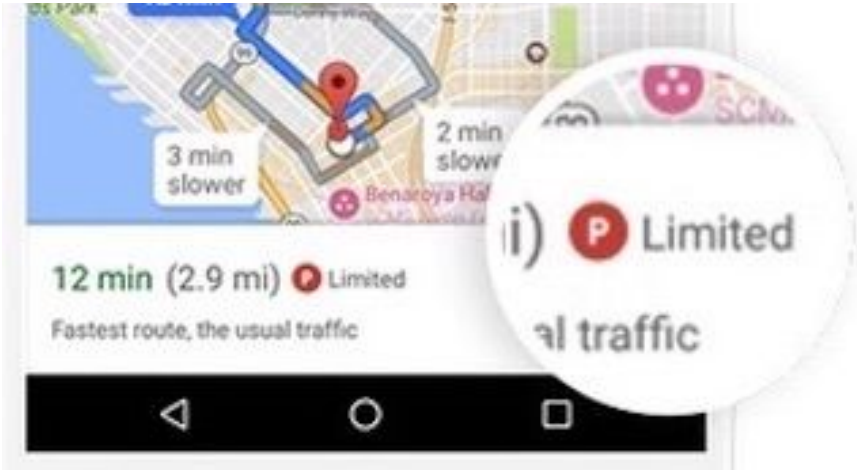


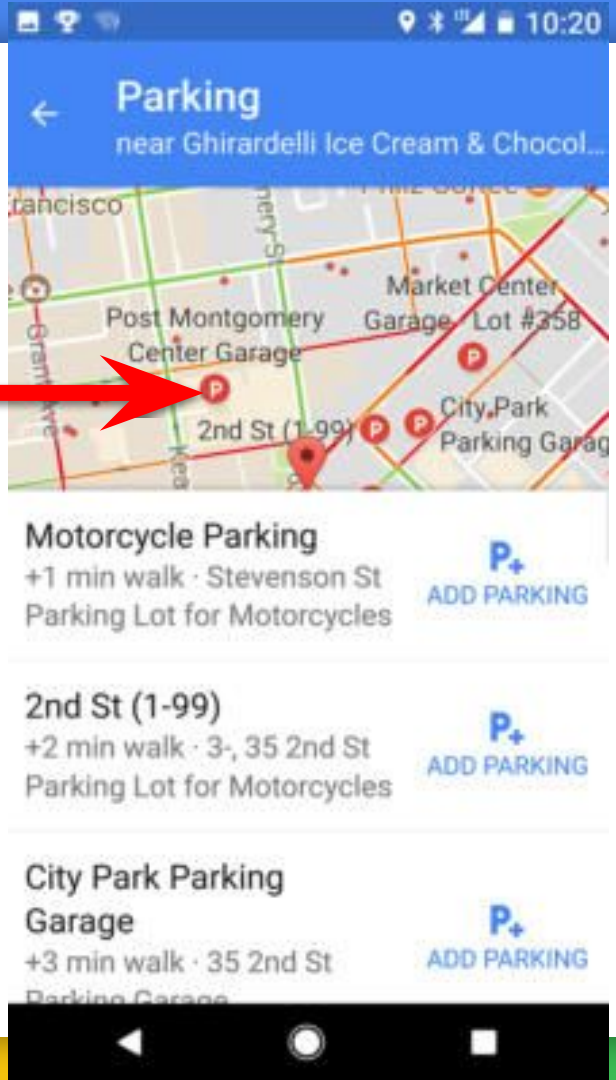
# Why this problem is hard

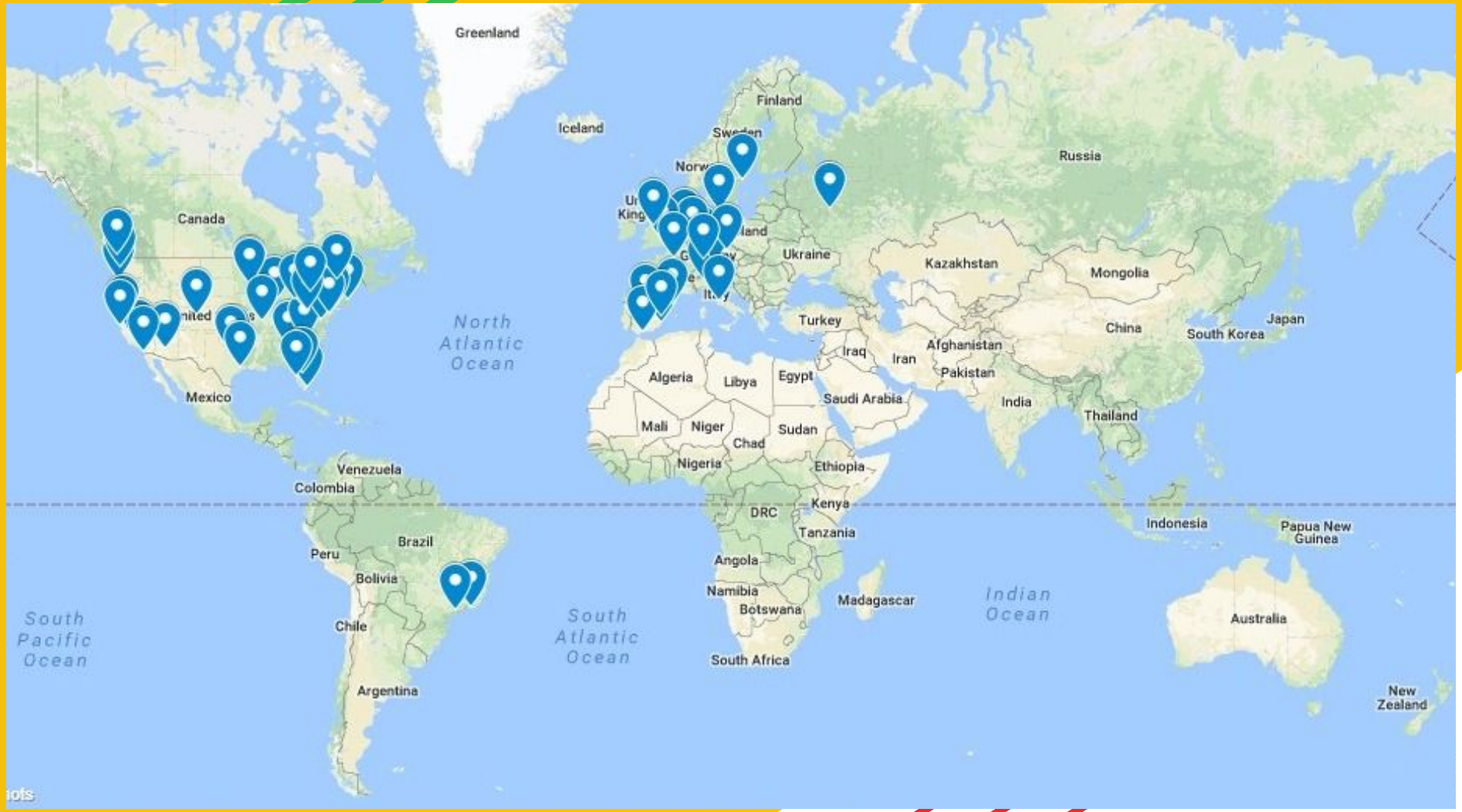
- Highly variable based on time, day of week, weather, holidays, etc.
- No real time information
  - illegal parking
  - permit parking
  - cars that leave early
- Risk being outdated as soon as it’s built since change is so rapid

# Can Google Maps help?

- Released for Android in 2017
- Classified **“Limited”**, **“Medium”**, or **“Easy”**
- Show parking spots near location and walking direction
- USA = 25 cities +  25 more globally




Greenland
Iceland
Finland
Russia
Canada
Ukraine
Kazakhstan
Mongolia
China
Japan
South Korea
North Atlantic Ocean
Turkey
Iraq
Iran
Afghanistan
Pakistan
India
Thailand
Algeria
Libya
Egypt
Saudi Arabia
Mali
Niger
Chad
Sudan
Nigeria
Ethiopia
Kenya
DRC
Tanzania
Angola
Namibia
Botswana
Madagascar
South Africa
Indonesia
Papua New Guinea
Australia
New Zealand
Indian Ocean
Mexico
Venezuela
Colombia
Brazil
Peru
Bolivia
Chile
Argentina
South Pacific Ocean
South Atlantic Ocean

# 3 Components:

Ground Truth Data

ML Model

Robust Features

# Ground Truth Data

## Where are the parking spots?

- Sidewalk Labs, Coord = APIs for data on tolls, curbs, parking, bikeshare…
- Manual process, employees are actually walking around taking photos
    - Software can map photos to a 3D map in minutes

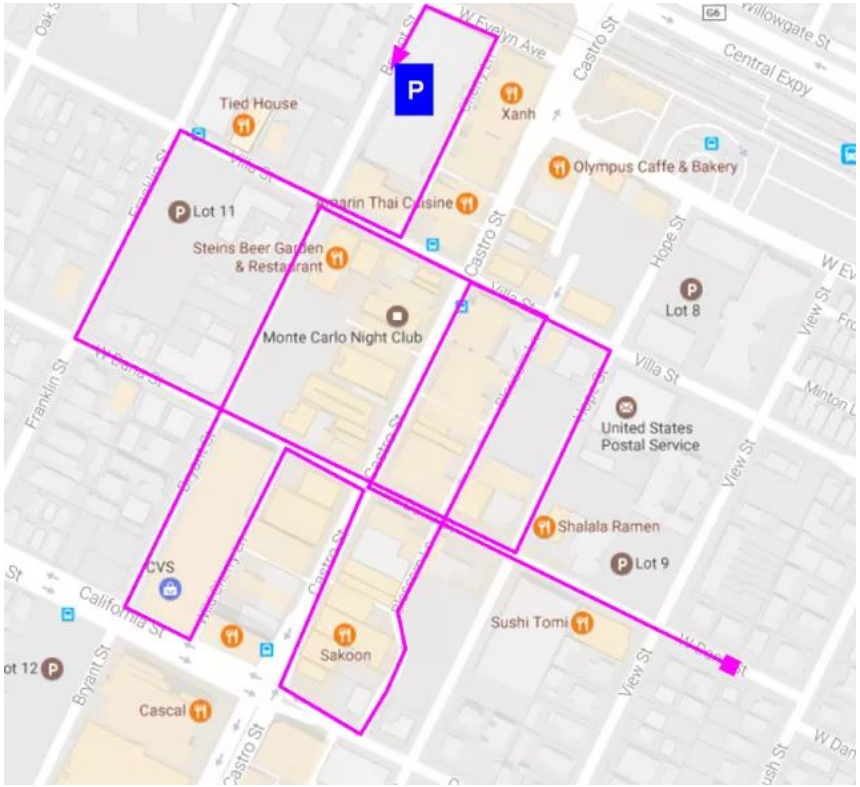
# Ground Truth Data

## How many parking spots were available?

- Asked individuals if parking was difficult
  - “How long did it take to park at 12 PM?”
  - ~ 100k responses
- Anonymous location data from users
  - Phone-based GPS
  - Drivers’ location, relative speed, itinerary
- Millions of data points

# Features

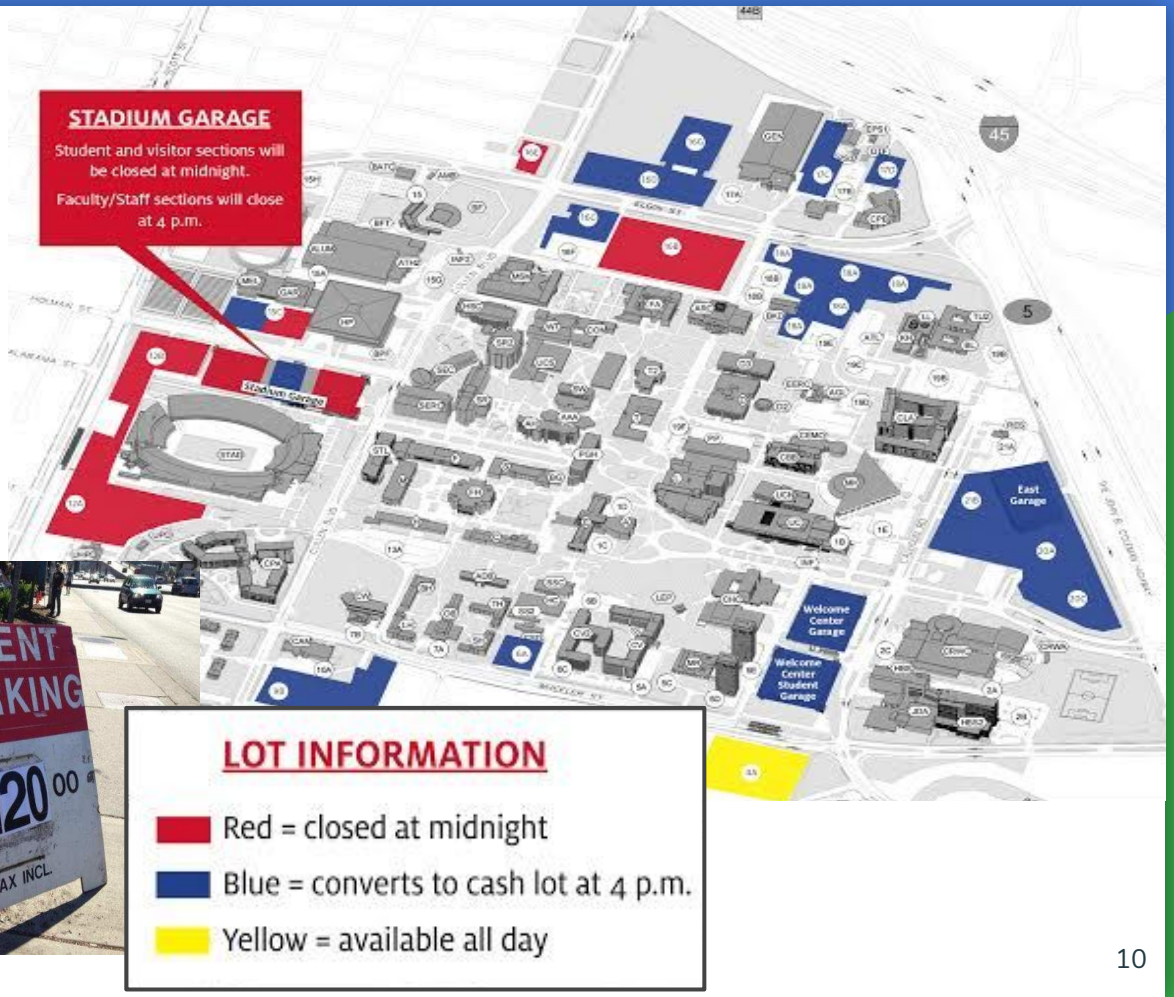
- Circling behavior indicates difficult parking
  - ⇒ Time the difference between predicted arrival and actual arrival.



# Other Features

- Time of day
- Date
- Historical data
- More…

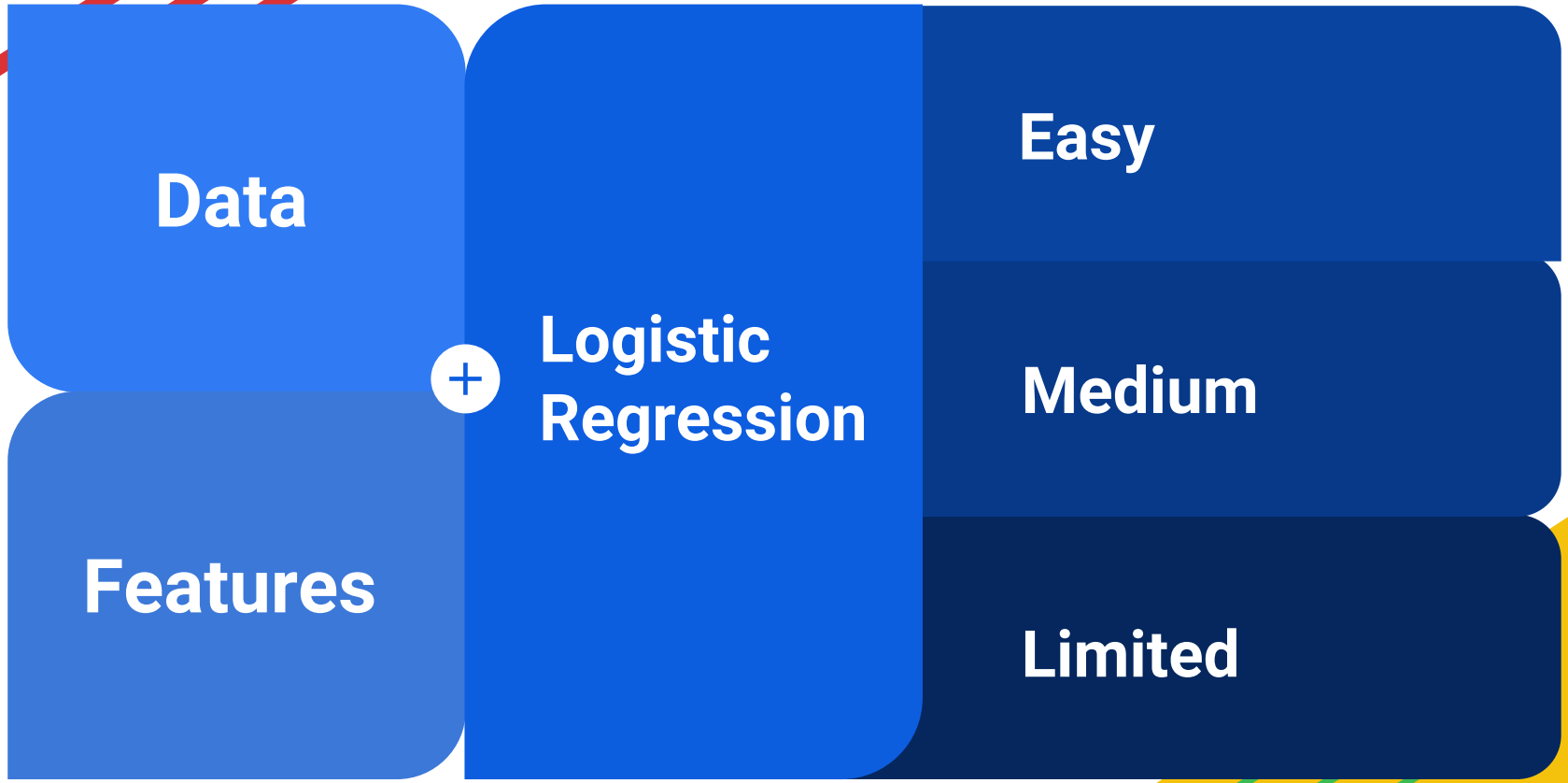
~ 20 features

# Model → Logistic Regression

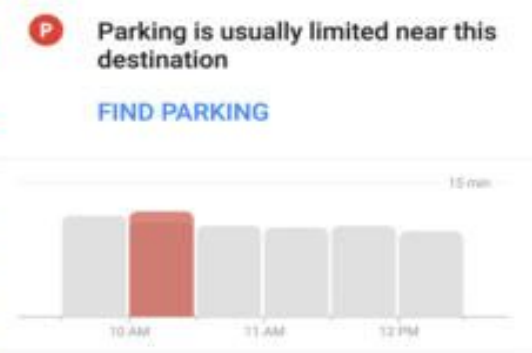
$$Y(x) = e^{x} + e^{-x}$$

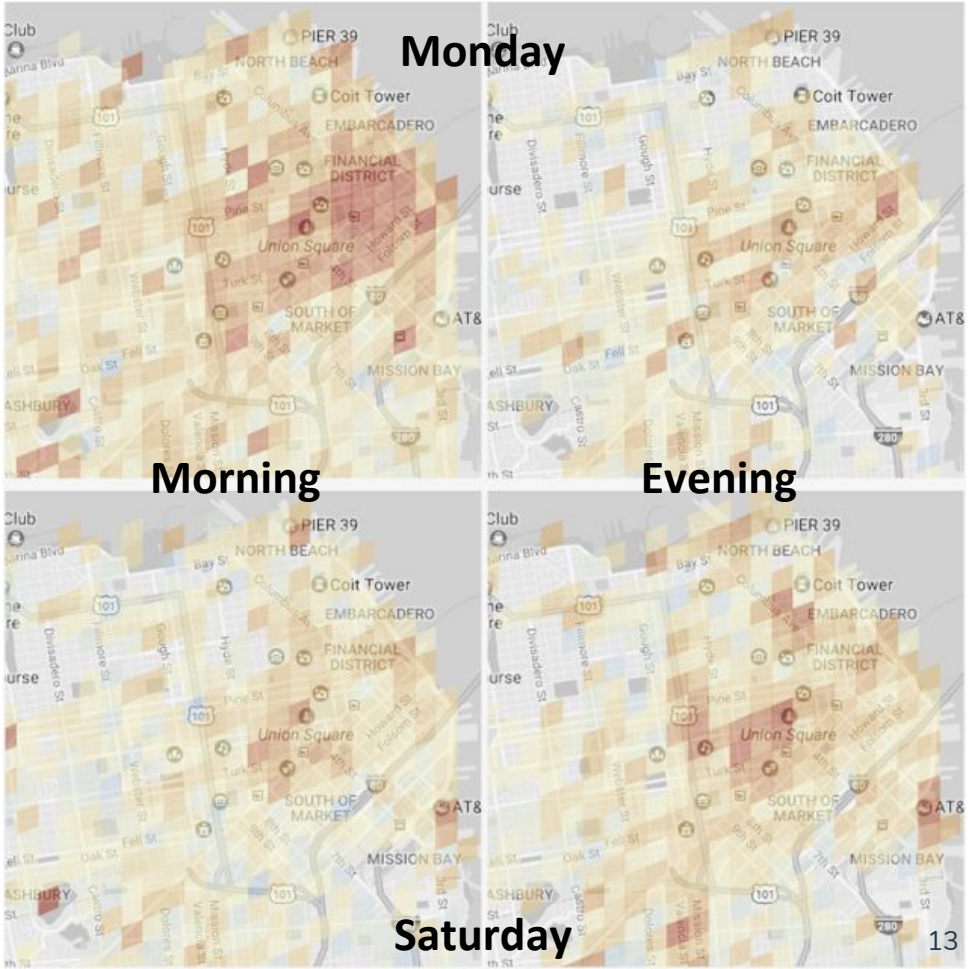
- Behavior is well understood
- Resilient to noise (good for complicated response variables)
- Easy to understand influence of each feature
- Interpret output as probability that parking is hard and map onto categories like “easy”, “medium”, “hard”


Data
Features
Logistic Regression
Easy
Medium
Limited

# Results

- Estimates for any date, time, and location
- Features based on dispersion of parking locations turned out to be most influential



# Conclusions

- Crowdsourcing + ML

- Inferred data from indirect source
- Value of simpler algorithms, don’t always need neural networks

- Pre-launch experiment showed significant increase in clicks on transit mode button


Bell Street Pier Garage
Pacific Place Garage
Meridian Garage East
Union Square Garage
West Edge Garage
City Centre Public Parking Garage
Public Market Parking Garage
Parking Garage
Cabrini To
30-064 Hillclimb Garage
Olympic Garage
Questions?
30-063 Watermark Garage
Fourth & Madison Garage
Waterfront Place
SP+ Parking @ 1st & Columbia
Butler Garage
Seattle - Bainbridge Ferry
PIONEER SQUARE
Yesler Way
E Pike St
E Union St
Olive
Lenora St
1st Ave
Alaskan Way
Pike St
Terry Ave
University St
Seneca St
Summit Ave
Spring St
Madison
7th Ave
8th Ave
9th Ave
Columbia St
Cherry St
5th Ave
99
305
304
5

# Sources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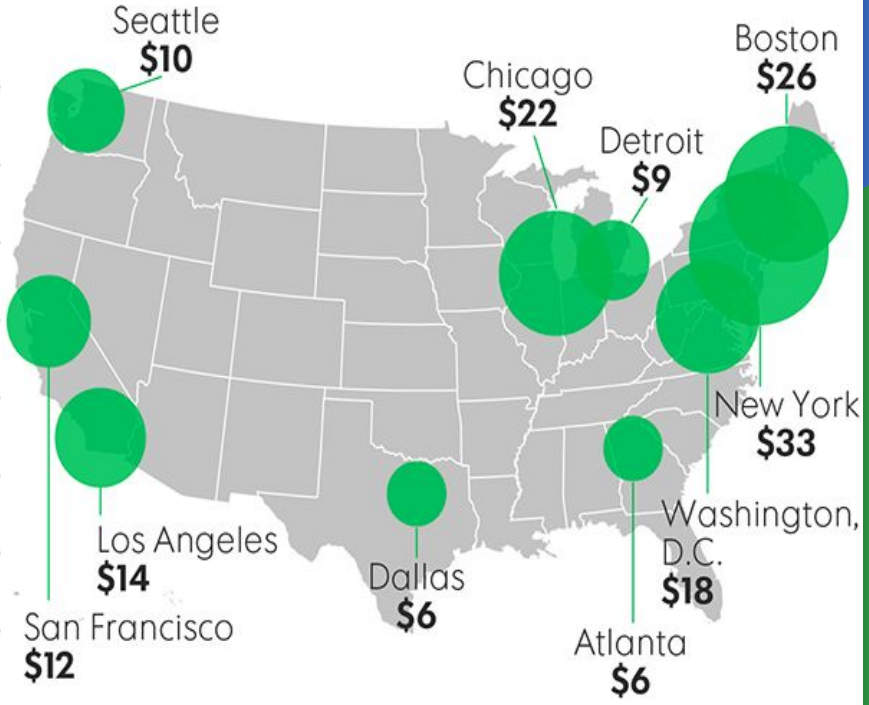
Top 10 cities and U.S. average for annual search time, total cost per city, in billions:

| | |
|---|---|
| NEW YORK | $4.3 |
| LOS ANGELES | $3.7 |
| SAN FRANCISCO | $0.66 |
| WASHINGTON, D.C. | $0.33 |
| SEATTLE | $0.49 |
| CHICAGO | $1.3 |
| BOSTON | $0.26 |
| ATLANTA | $0.25 |
| DALLAS | $0.73 |
| DETROIT | $0.21 |
| U.S. AVG. | $72.7 |

Top 10 cities for average parking cost, at two-hour rate:



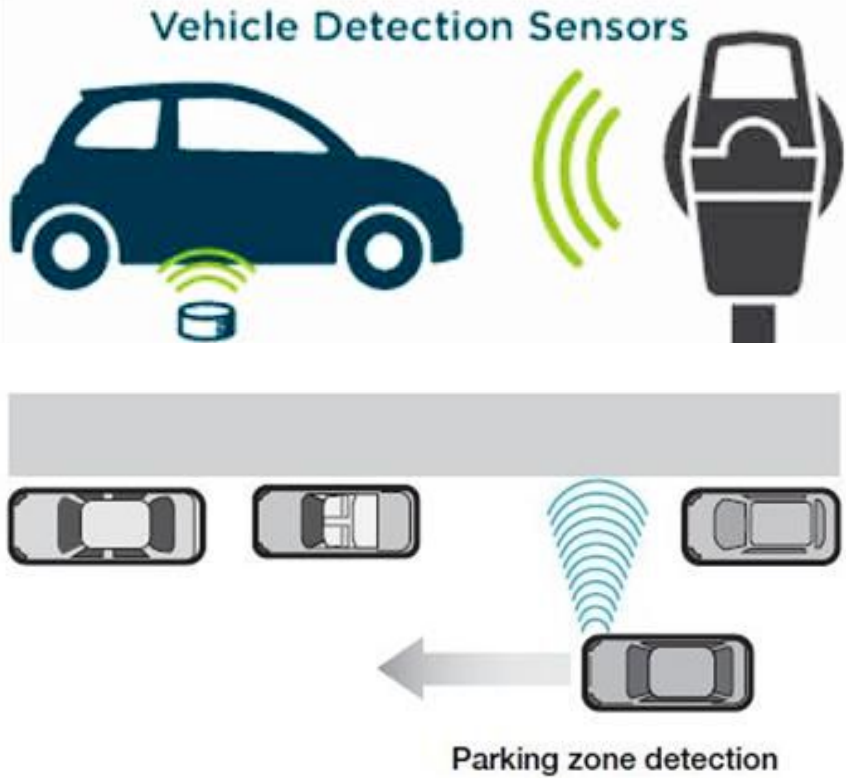
# Parking in largest U.S. cities

A new study ranked Seattle No. 5 for most time it takes drivers to find a parking spot.


| RANK | CITY | SEARCH TIME (mins/trip) ON-STREET | SEARCH TIME (mins/trip) OFF-STREET | ANNUAL SEARCH TIME Hours/driver/year | AVERAGE 2-HOUR PARKING COST One mileof city center |
|---|---|---|---|---|---|
| 1 | New York | 15 | 13 | 107 | $33 |
| 2 | Los Angeles | 12 | 11 | 85 | $14 |
| 3 | San Francisco | 12 | 11 | 83 | $12 |
| 4 | Washington, D.C. | 10 | 9 | 65 | $18 |
| 5 | **Seattle** | 9 | 8 | 58 | $10 |

# Solutions?

- Sensors for each parking spot
  - who pays and maintains them?
- Car sensors, ex. built-in cameras
  - not enough cars yet
  - merge data from car brands… if they are willing to share



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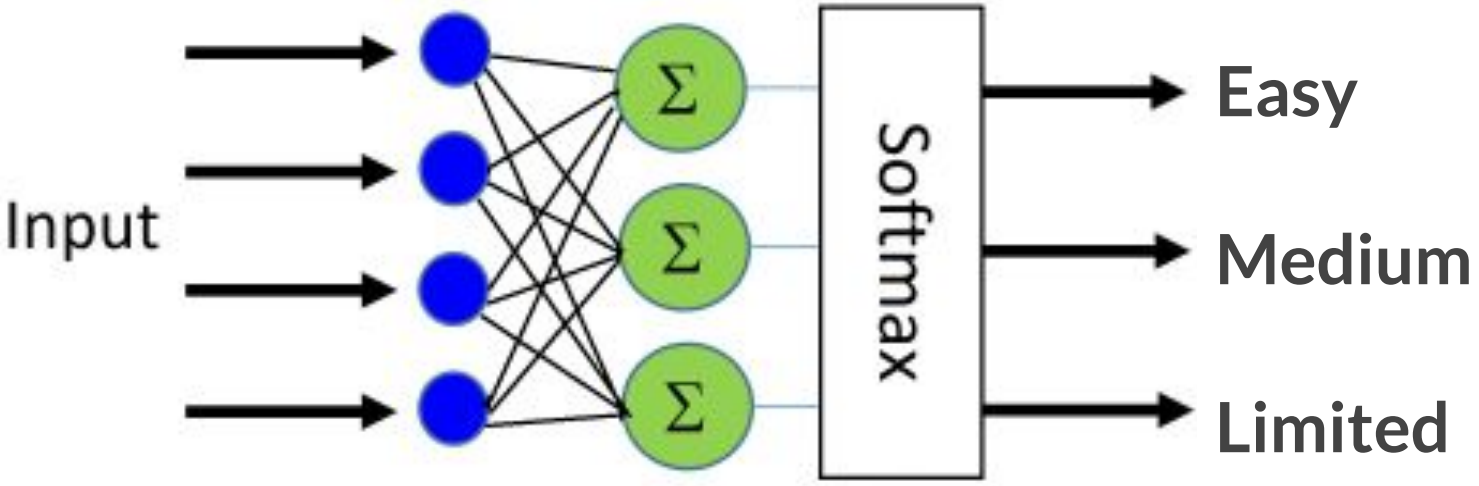


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