SmartDispatch

Melanie Costello, Priya Gupta,
Jason Harville & James Peng

What we'll cover in this presentation

- Overview problem
- Our approach
  - Predictive modeling
  - Ambulance selection
  - Ambulance positioning
- Demo
- Future improvements

Overview of the problem

Fire and ambulance services depend on technology that is **outdated**, has caused **dangerous delays**, & **cost lives**.

FDNY's 'antiquated' dispatch system blamed for delay in fatal fire, DOI commissioner says

911 Error Leads To Ga. Woman's Death

St. Louis settles lawsuit for $500,000 over 911 dispatcher's deadly mistake

Outdated technology hindering 911 dispatchers in providing emergency services

SmartDispatch will help dispatchers streamline & improve decision making

Improving the call process

There are opportunities to improve each stage of the emergency call process.

Before calls happen	During an emergency	While waiting for calls

Predictive modeling to understand call volume

Rapid identification of best crew to respond

Optimization of ambulance placement

Before calls happen

Goals:
Keep cost low
Minimize response time

Solution:
Predict demand – Where+When

Current State of Predicting

- Average population in area
- Moving average over the last 4 weeks (basic)
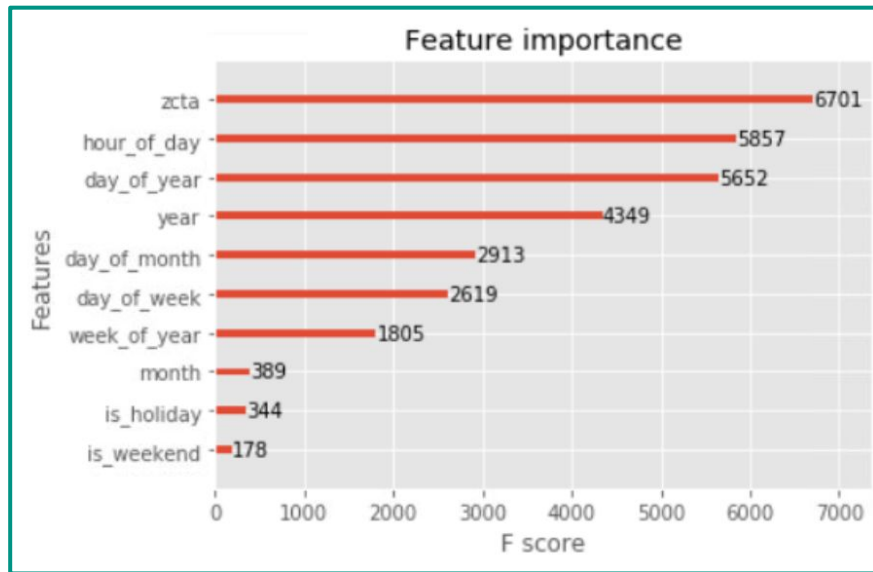- Advancement: Average over the last 4 years

Weak Points in Current System

- Averages can be biased
- Leads to wasting resources

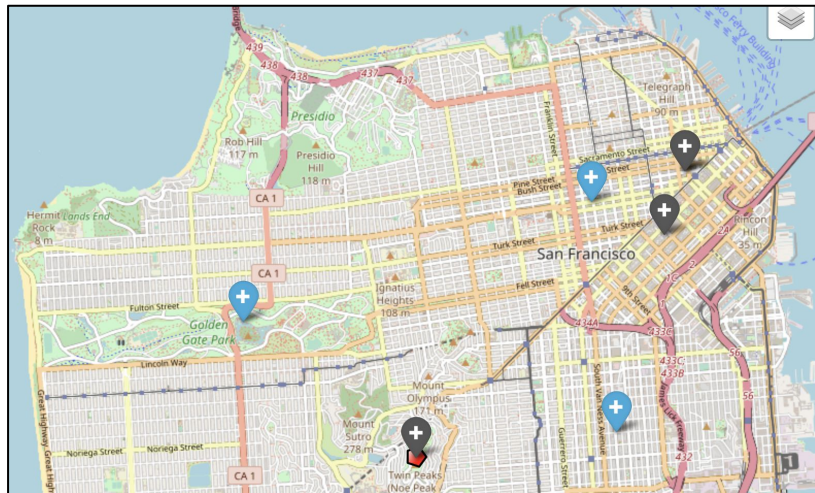# But what if we could be **more accurate**?

SmartDispatch approach

- Utilize 17 years of historical ambulance data with a **Linear Regression Neural Net model**
- Extracted features:
  - ZCTA, hour_of_day, day_of_year, day_of_month, day_of_week, and .. so on.
  - Resampling to hourly interval
- Create predictions grid that overlays a city

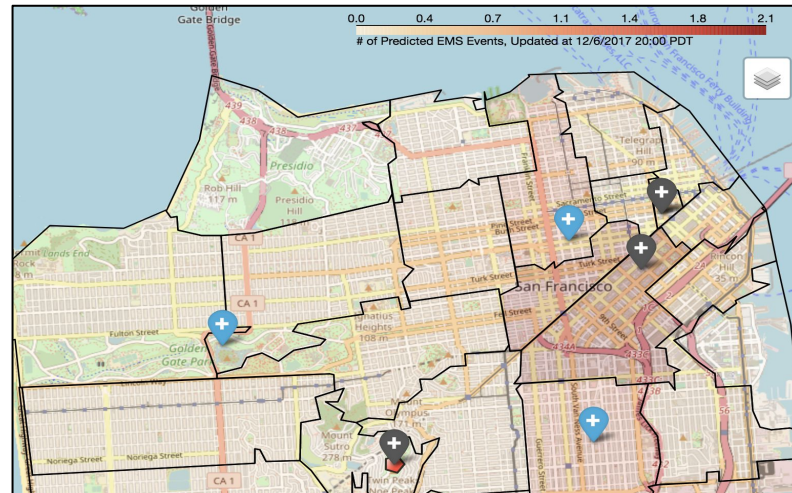- The best part: Predictions are updated every hour (real time)!

Feature importance

Features	F score
zcta	6701
hour_of_day	5857
day_of_year	5652
year	4349
day_of_month	2913
day_of_week	2619
week_of_year	1805
month	389
is_holiday	344
is_weekend	178

SmartDispatch user experience

No Predictive Events

With Predictive Events

# of Predicted EMS Events, Updated at 12/6/2017 20:00 PDT

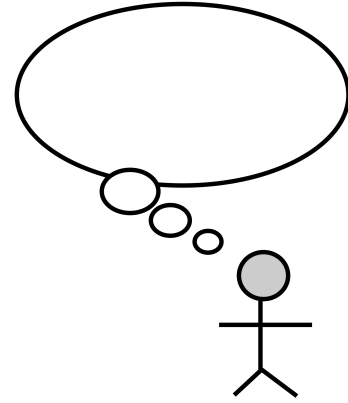0.0   0.4   0.7   1.1   1.4   1.8   2.1

During an emergency

"Effective emergency medical dispatching has the goal of sending the right EMS resources to the right person, at the right time, in the right way"

– National Academies of Emergency Dispatch (NAED)

Current State of Dispatching

- Dispatcher uses knowledge of geographic region to dispatch closest ambulance

Weak Points in Current System

- Vulnerable to human error
- Does not take into account traffic/other variables

But the **Google API** does!

SmartDispatch Process

- Call Google Maps Distance API

- Compute travel times for all available ambulances

- Select ambulance based on minimum travel time, including traffic conditions as factors
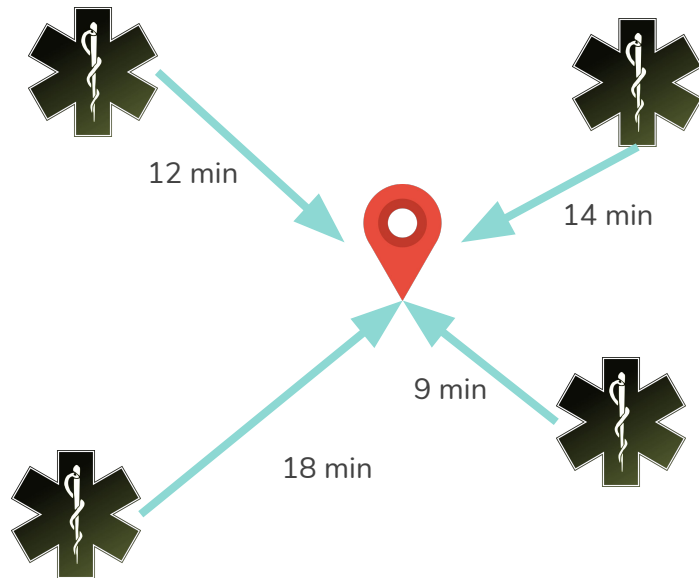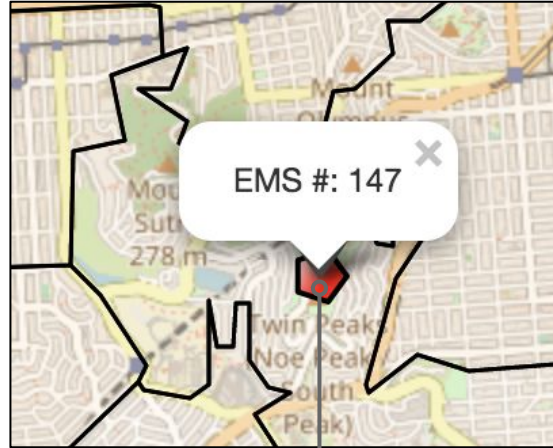

12 min

14 min

9 min

18 min

SmartDispatch user experience
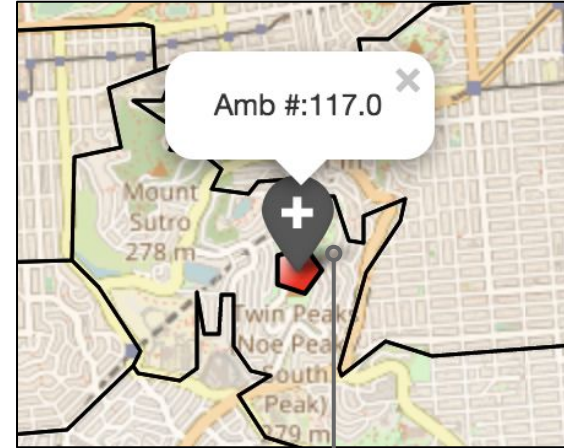

Input location of event
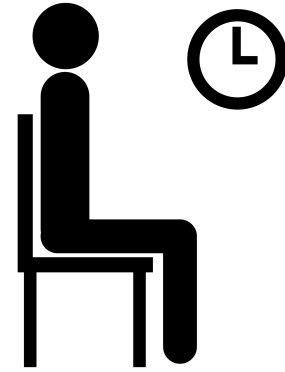
Marker for event will appear

Dispatched ambulance marker will update to event location

While waiting for calls

Ambulances do not have fixed stations to wait at when not in use

Current Placement Strategies

- Based only on geography and historical call averages
- Updated infrequently, maybe not for years at a time
- Rely on subjective dispatcher experience

Weak Points in Current System

- Not standardized
- Old data points
- Response times not optimal

But what if we could **predict** optimal locations!

SmartDispatch approach

- Utilizes predictions that change through time
- Automatically chooses locations to minimize response time
- Provides dispatcher with optimal locations in real time

Algorithm Details

1. Transform probability densities into point densities for each region.
2. Apply K-Means clustering for the number of available ambulances.
3. Assign cluster centroids as new placement locations.
4. Dispatch available ambulances to the closest centroid.
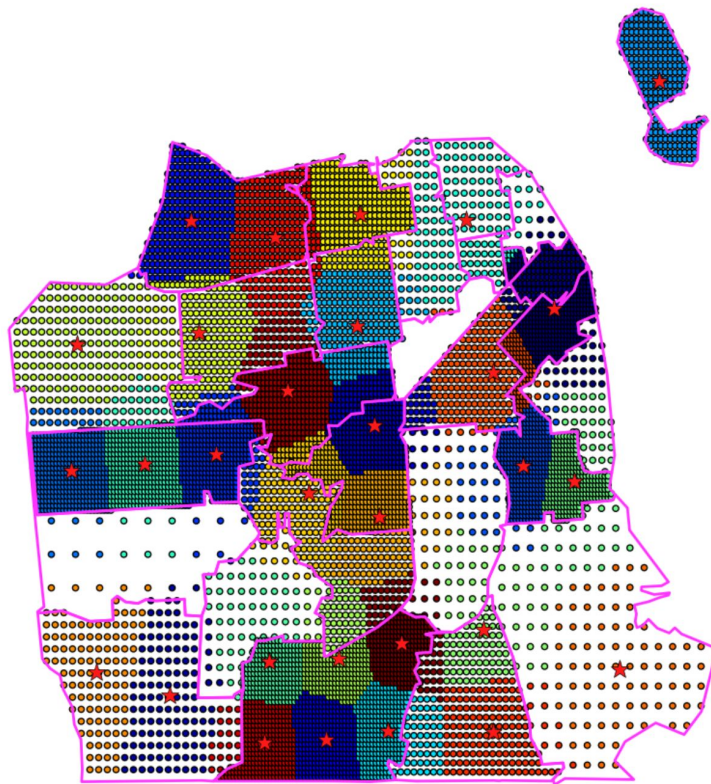
SmartDispatch user experience

Placement when call is received
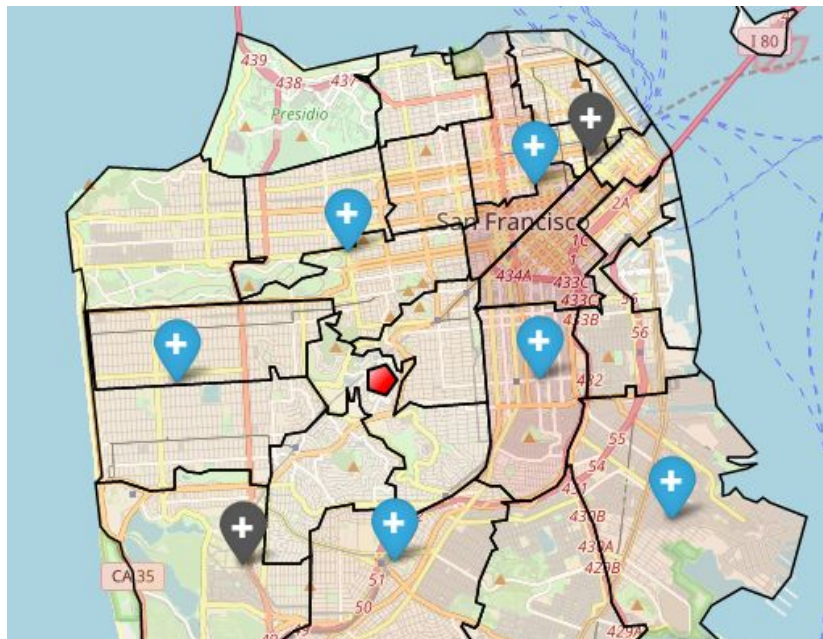
Placement after dispatch and rebalance

Demonstration

Link to Demo

datadrivendispatch.com

Future improvements

Product Roadmap

Enhancement	Description	Priority
Location validation	Only enter address in SF	HIGH
Initialize dynamic number of active ambulances	Number of active ambulances could differentiate each day	HIGH
Override ambulance status and dispatch	Ambulance personnel on break. Override dispatch and dispatch another ambulance.	HIGH
Multi-ambulance dispatching	Event needing more than one ambulance	HIGH
Predictive Model Improvement	Hyper-parameter tuning, NN Pooling layer, DNN	MEDIUM
Coordinate between different types of ambulance	Basic Life support, advanced life support, patient transport, mortuary transport	LOW
Add more features into predictive model	Weather, Census	LOW
Add in scheduled ambulance calls	Scheduled transportation between health facilities	LOW

Thank you!

GitHub: https://github.com/jamesypeng/Smarter-Emergency-Dispatch

Contact us:

Melanie Costello: melanie.costello@berkeley.edu
Priya Gupta: priyagupta@berkeley.edu
Jason Harville: jlharville@berkeley.edu
James Peng: james.peng@berkeley.edu