



# Residential Fire Risk in Boston

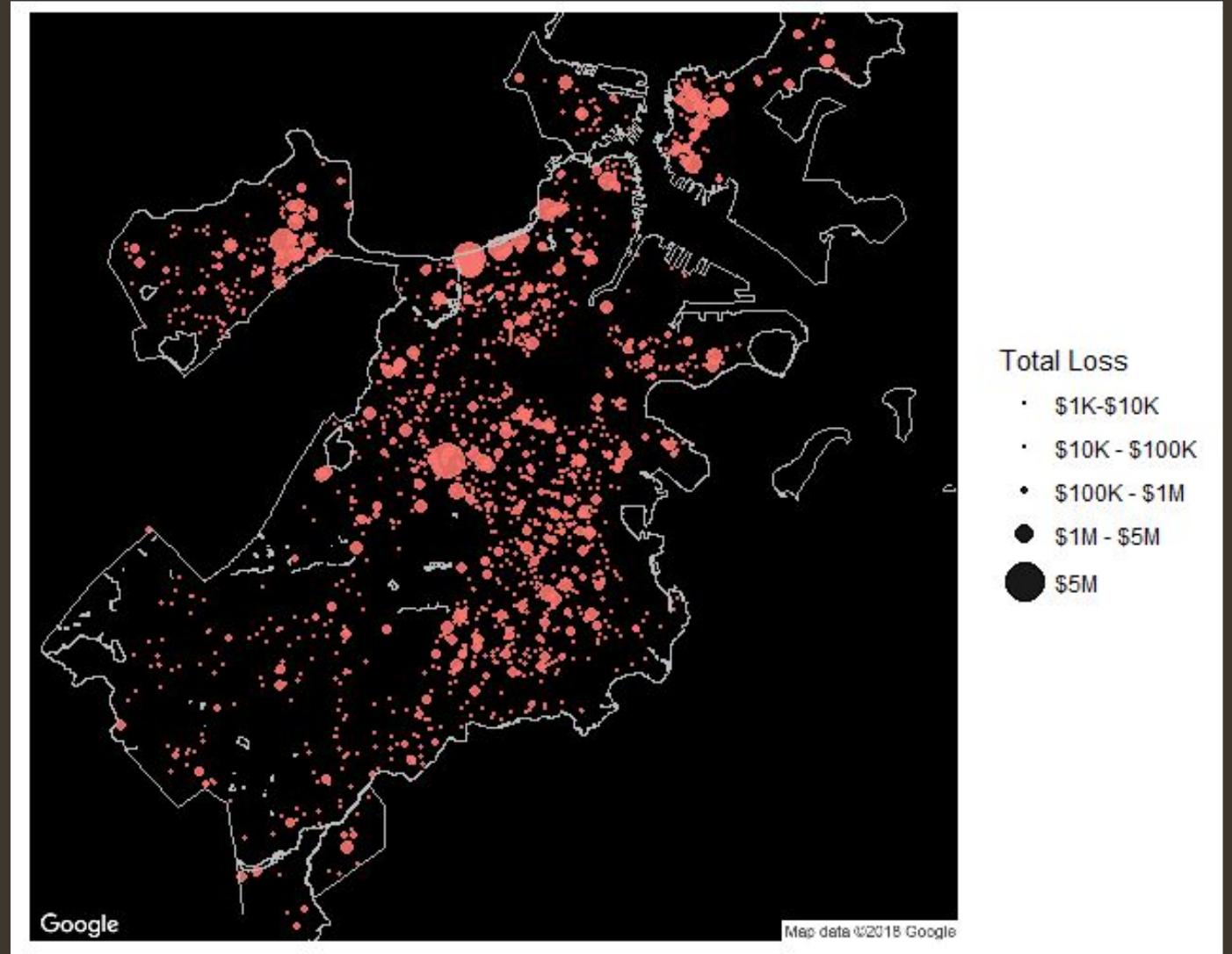
Kit Miller



# Residential Fires in Boston 2010 - 2014

2,208 Fires

- 8 Resident Deaths
- 2 Firefighter deaths
- 84 injuries
- > \$110 Million in Damage



# Mission

Can we predict where residential  
fires will occur in Boston?

# Mission

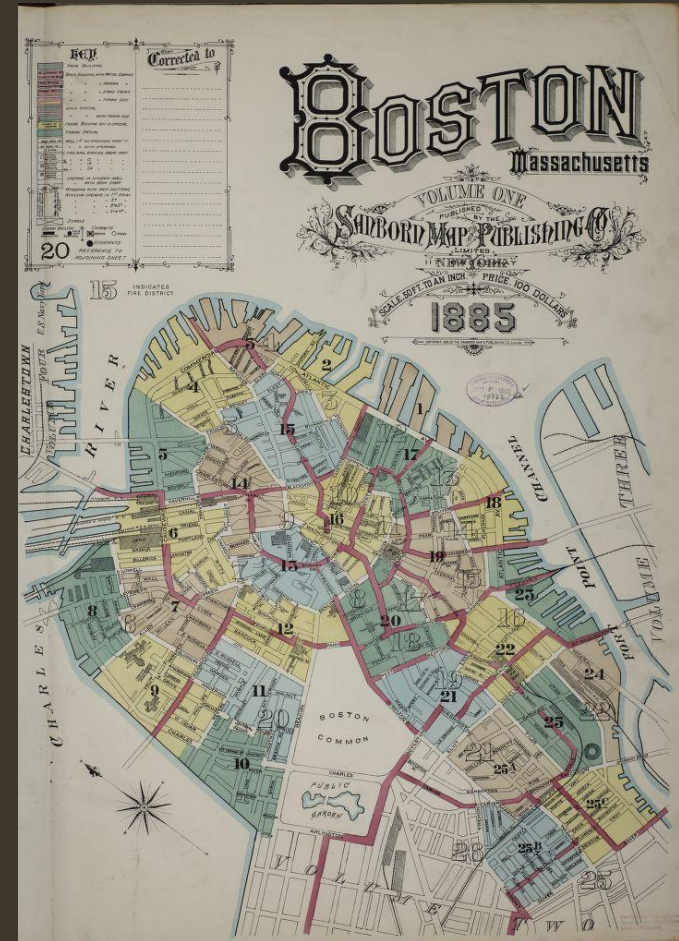
Can we at least identify  
high-risk areas or buildings  
with some accuracy?

# Where do you Assess Fire Risk?

- Fire Districts ?
- Neighborhoods / Census Tracts ?
- Blocks ?
- Streets ?
- Buildings ?

# 1860s Insurance Company Assessments

- Sanborn Map Company
- Where are fire hydrants?
- Which buildings are wood?
- French roofs?
- Iron doors?





# 1970s – First Social-based Studies

- Census Tract Level
  - Poverty
  - Population Density
  - Parental Presence / Female Headed Households
  - Home Ownership
  - African American Population

What Do We Know Now?



# Neighborhoods Matter

Highest Fire Rates 2010 - 2014

Tract Number	Neighborhood	Fires per 1000
918	South Dorchester	6.82
1003	Mattapan	6.45
922	South Dorchester	6.34
916	South Dorchester	5.37
903	Roxbury	4.93
917	South Dorchester	4.74
506	East Boston	4.61
1002	Mattapan	4.40
906	Roxbury	4.29
911	North Dorchester	4.15

# Buildings Matter Too

Fire Probabilities for 5-Year Span by Building Type (2010 – 2014)

Building Type	Probability of Fire
Apartment	6.4 %
Tax-Exempt 121A	5.6 %
4-6 Unit House	4.1 %
3-Unit House	3.6 %
Condominium	2.9 %
2-Unit House	2.0%
1-Unit House	1%

\* Controlling for number of units and owner-occupied status.

# Building Conditions Matter

## 311 Reports

- Housing issues
  - Poor maintenance by landlords
    - Poor heating
    - Chronic dampness
  - Pests
    - bedbugs
- Uncivil use of space
  - illegal rooming house
  - poor condition of property
  - abandoned building

# Resident Health Matters

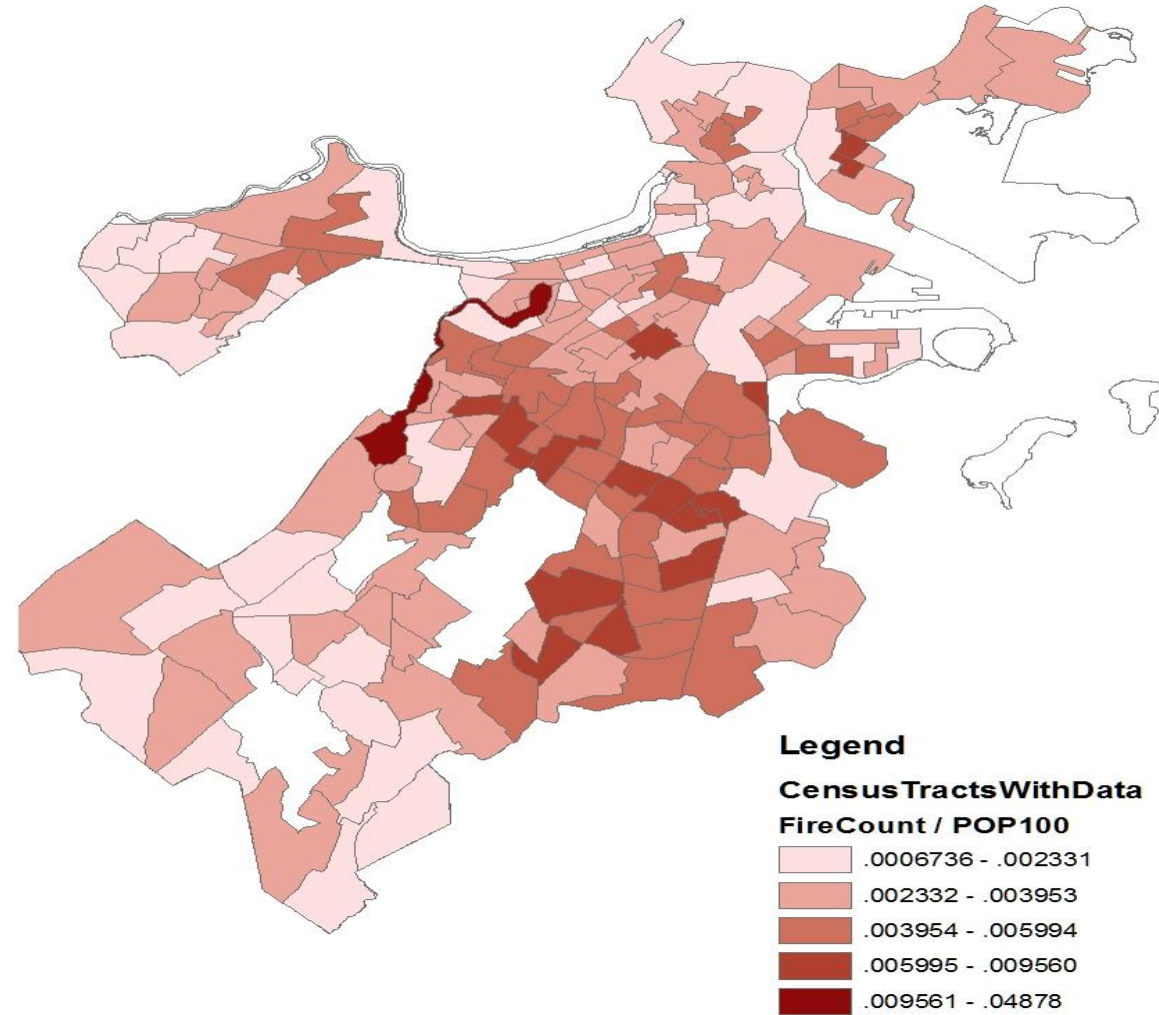
## 911 Calls

A higher volume of 911 calls at a building  
correlates with greater fire risk.

So...

We know fire  
rates vary by  
neighborhood.

2010 – 2014 Residential  
Fires per 100 persons



And...

And we know fire rates  
vary by type of building.



# Interesting Question

How much of the variance in neighborhood fire rates is due to variations in housing stock across neighborhoods?

And how much is due to the neighborhood demographics?



# Neighborhoods and Buildings

## Multilevel Modeling

### Neighborhood-level effects

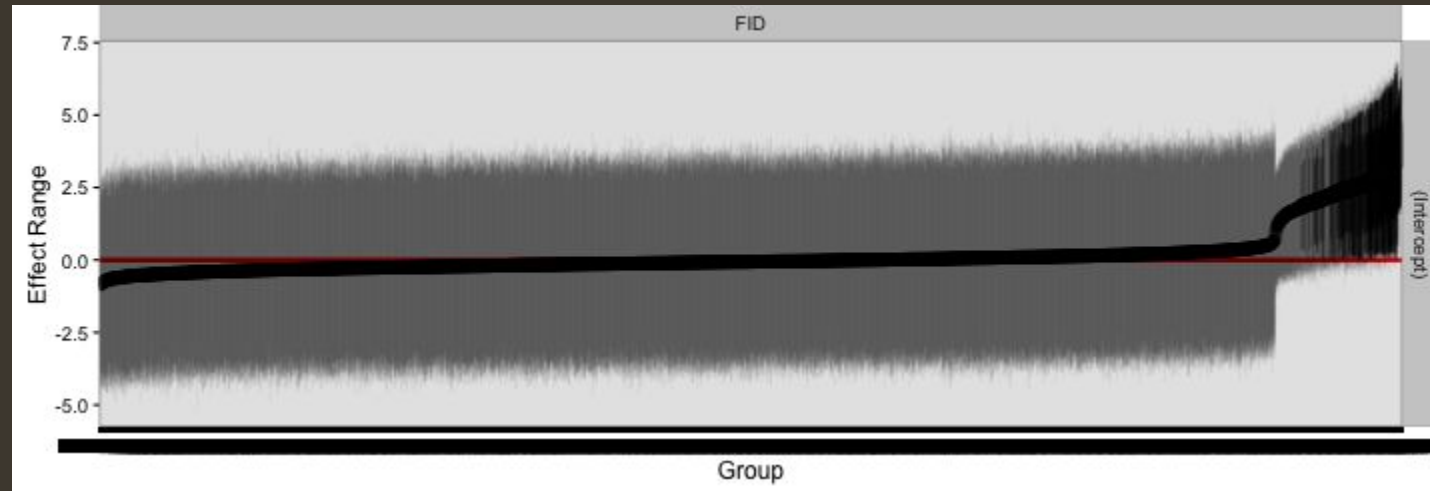
- Poverty
- Race
- Immigrant status

### Building-level effects

- # Units
- Type
- Owner Occupancy
- 311 Calls
- 911 Calls
- Assessed Value

# Methodology

Probability of Fire 2010 – 2014 Variance Across Census Tracts



# What Multilevel Models Tell Us

## Buildings Really Matter

- Building-Level factors account for 71% of the variance in fire probabilities across Census Tracts
- Building Type alone accounts for over half of the variance
- 911 Calls and 311 Private Neglect account for a small additional percentage

# Neighborhood Demographics Matters Less Than We Thought

- Accounts for an additional 12% of variance
- Significant Variables:
  - Percentage white population or percentage black population
  - Percentage foreign born

# Practical Policy Implications

- So can we identify high risk residential buildings with some accuracy?
- Can we assign scores to properties based on their fire probabilities?
- What would that look like?

# What May be Possible

## Cross Validation of the Model

- Train the model on a random sample of data
- Make predictions on the remainder of the data set
- Establish a threshold that will signify a predicted fire

# Cross Validation of the Model Suggests Precision of Near 25%

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	Predicted	True	False	False	
Test Sample	Positives	Positives	Positives	Negatives	Precision
71,405	186	46	140	1252	0.25



# Problem Properties

- 300 Problem Properties investigated since 2011
- Double the fire risk of all other buildings.
- Designated Problem Properties have 2.5x the fire risk.

# Problem Properties

ADDRESS	Neighborhood	Status_As_Of_March_9_2018	Predicted	Fire?
961 Blue Hill AVE, Boston, MA 02124, USA	Mattapan	2b. Removed Designation Not Warranted	0.126541387	
270-280 Huntington AVE, Boston, MA 02115, USA	Back Bay	2b. Removed Designation Not Warranted	0.117312565	
194 Callender St, Boston, MA 02124, USA	Dorchester	2c. Watch List	0.116329156	TRUE
200 Hancock St, Boston, MA 02125, USA	Dorchester	5a. Designated Problem Property - Issues Successfully Resolved	0.112367442	
42 Lyon St, Boston, MA 02122, USA	Dorchester	2b. Removed Designation Not Warranted	0.109274159	
120 Humboldt AVE, Boston, MA 02121, USA	Roxbury	2b. Removed Designation Not Warranted	0.102695744	
11 Royce Rd, Boston, MA 02134, USA	Allston/Brighton	2b. Removed Designation Not Warranted	0.089352311	
14 Gardner St, Boston, MA 02134, USA	Allston/Brighton	2b. Removed Designation Not Warranted	0.088678888	
267-267R Fuller St, Boston, MA 02124, USA	Dorchester	5a. Designated Problem Property - Issues Successfully Resolved	0.087057474	
8 Montana St, Boston, MA 02121, USA	Roxbury	2b. Removed Designation Not Warranted	0.085851426	
54 Bellevue St, Boston, MA 02125, USA	Dorchester	2b. Removed Designation Not Warranted	0.085195603	TRUE
20 Pleasant St, Boston, MA 02129, USA	Charlestown	2d. Removed - Issues Successfully Resolved w/o Designation	0.084214165	
49 Gardner St, Boston, MA 02134, USA	Allston/Brighton	2b. Removed Designation Not Warranted	0.081521643	
108 Adams St, Boston, MA 02122, USA	Dorchester	5a. Designated Problem Property - Issues Successfully Resolved	0.081323762	
1 Ernst St, Boston, MA 02119, USA	Jamaica Plain	2b. Removed Designation Not Warranted	0.080885145	
882 Cummins HW, Boston, MA 02126, USA	Dorchester	2b. Removed Designation Not Warranted	0.079374581	TRUE
880 Cummins HW, Boston, MA 02126, USA	Dorchester	2b. Removed Designation Not Warranted	0.077841994	TRUE
876-886 Cummins HW, Boston, MA 02126, USA	Dorchester	2b. Removed Designation Not Warranted	0.077727023	
3 Howland St, Boston, MA 02121, USA	Roxbury	5a. Designated Problem Property - Issues Successfully Resolved	0.077426785	
164 Intervale St, Boston, MA 02121, USA	Dorchester	2d. Removed - Issues Successfully Resolved w/o Designation	0.075714898	TRUE

# Problem Properties

<u>Address</u>	<u>Cause</u>	<u>Damage</u>
194 Callender St, 02124	Smoking	\$1000
54 Bellevue St, 02125	Other Heat, Children	\$5000
882 Cummins HW, 02126	Open Flame	\$0
880 Cummins HW, 02126	Unknown	\$0
164 Intervale St, 02121	Unknown	\$0