A Machine Learning Approach on Providing Recommendations for the Vacant Lot Problem

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Close Collaboration with City of Rochester

Vacant Lots

- What is a vacant lot?
  - An abandoned property
  - Caused by economic decline
- Why are vacant lots a problem?
  - Criminal activities
  - Poorer standard of living
  - Depressed property value

Reclaiming Vacant Lots

- Convert into community gardens
- Convert into urban farms
- Convert into Qualified Community Managed Open Spaces (QCMOS)

Current Approach

- Urban planners and community leaders select vacant lots for conversion
- Community programs provide support with data
- Decision is made by analyzing the data and selecting a vacant lot

VACANTS TO VALUE

power in dirt

GROUNDED IN PHILLY

A project of the Garden Justice Legal Initiative

Problems with Current Approach

- Decision is made by analyzing the data and selecting an optimal vacant lot
- Community leaders need to **"reinvent the wheel"** each time

Proposed Solution

- A system that would:
  - Learn from previous vacant lot conversions and,
  - Provide recommendations on which lots should be converted

Proposed Solution Benefits

- Provide a decision support system for urban planners in tackling the vacant lot problem
- Provide a recommendation tool for community members in a vacant lot

Research Objectives

- Build a generalized vacant lot model that can be applied to any city
- Develop a machine learning model to predict vacant lot conversions

The Vacant Lot Model

- We define a vacant lot as a dependency of its feature set F such that:

  F = {f1 , f2 , f3 , f4 , f5 , f6}

f1 = Utility from public services and infrastructure
f2 = Access to vacant lot
f3 = neighborhood property value indicator
f4 = vacant lot density
f5 = crime density
f6 = zoning policies

Datasets

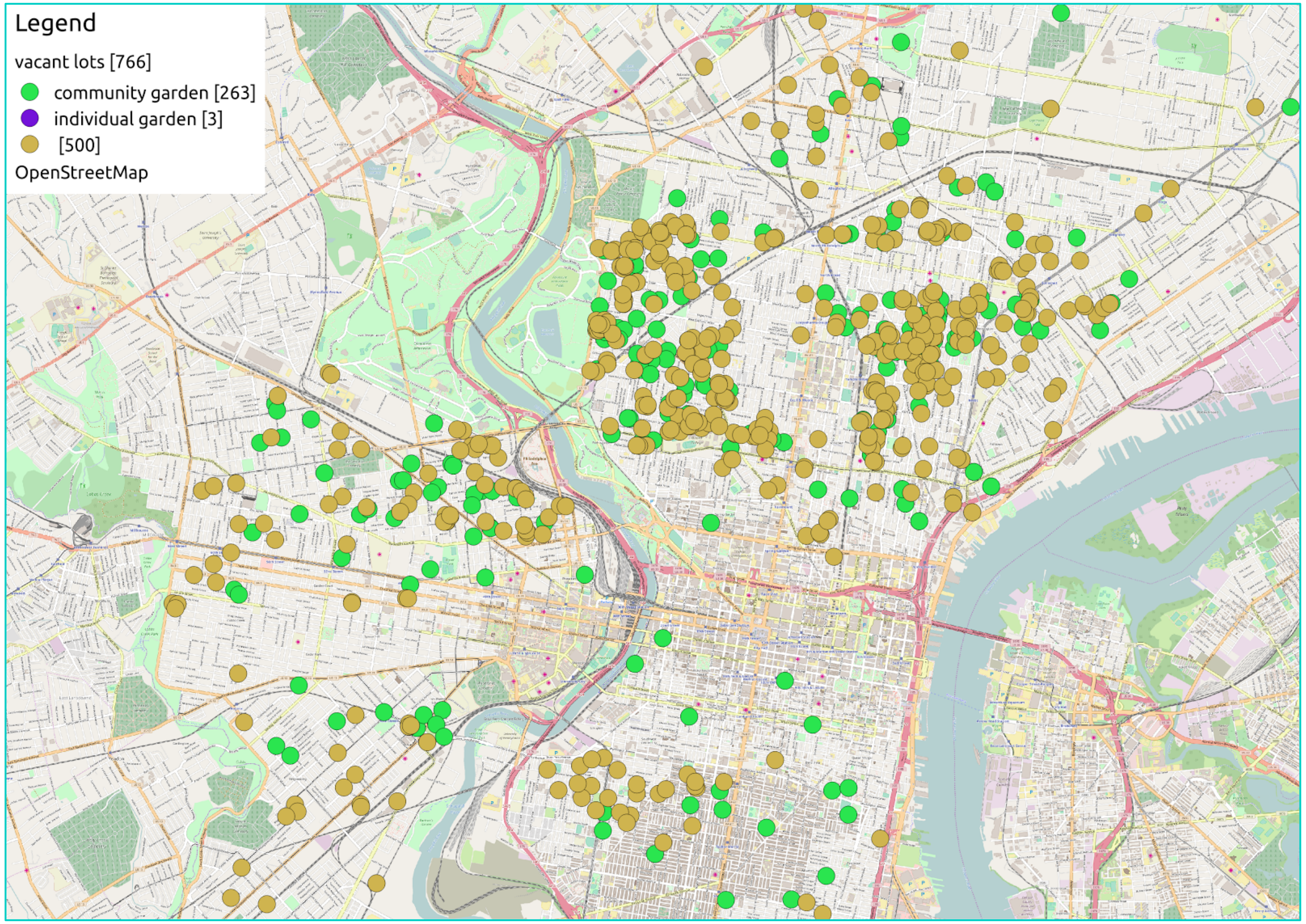
Baltimore

- Size:
  - 1907
- Vacant:
  - 1000
- Converted classes:
  - ADOPTED – 517
  - URBAN FARM – 127
  - QCMOS - 243

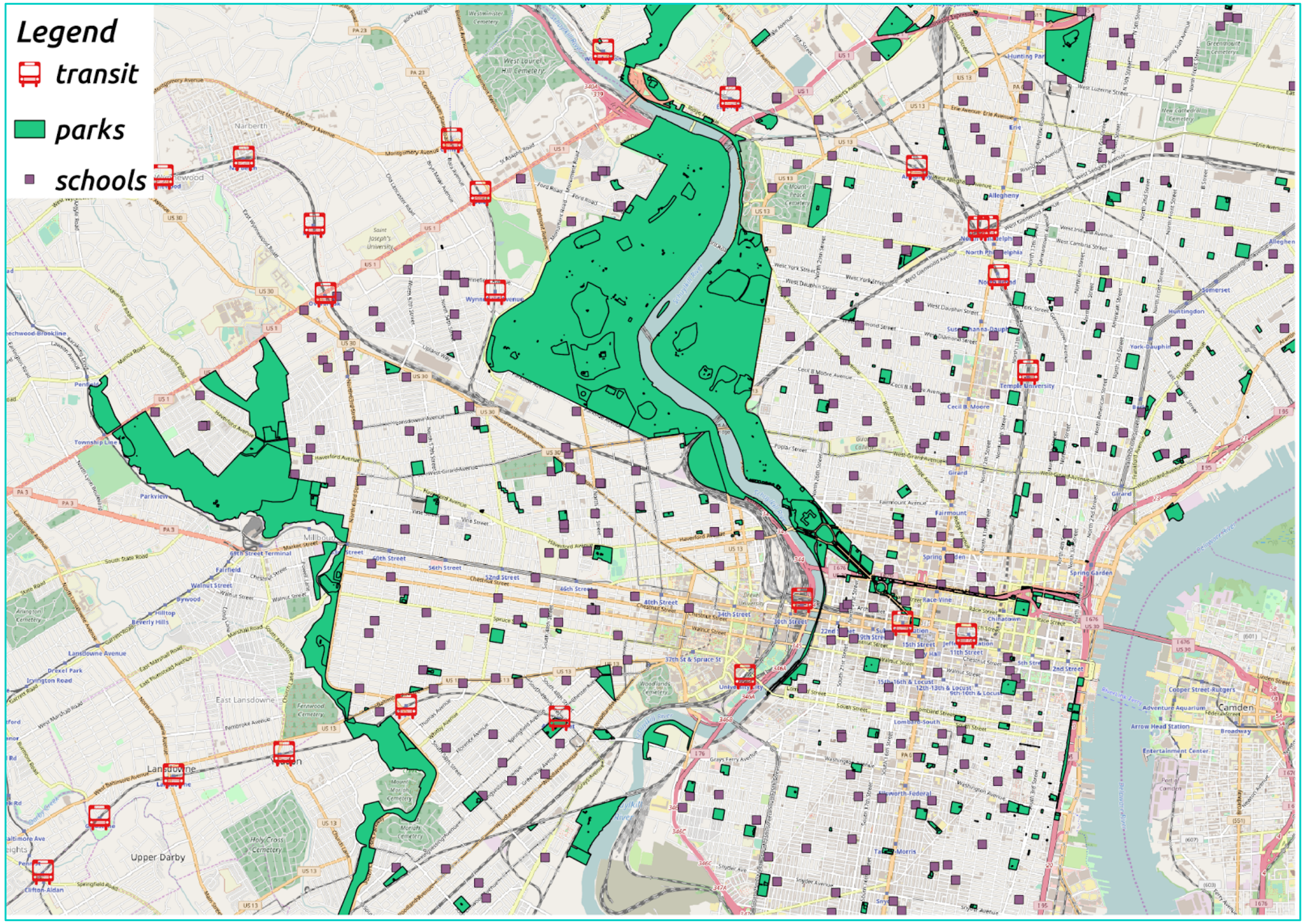
Philadelphia

- Size
  - 1101
- Vacant:
  - 500
- Converted class:
  - COMMUNITY GARDENS - 601

Vacant Lots in Philadelphia



Public Services and Transit in Philadelphia



Classification Models

- Random Forest
- Multilayer Perceptron
- K-NN
- Naïve Bayes
- SVM

Methodology

- Build datasets in conformance with our vacant lot model
- Build classification models for each city

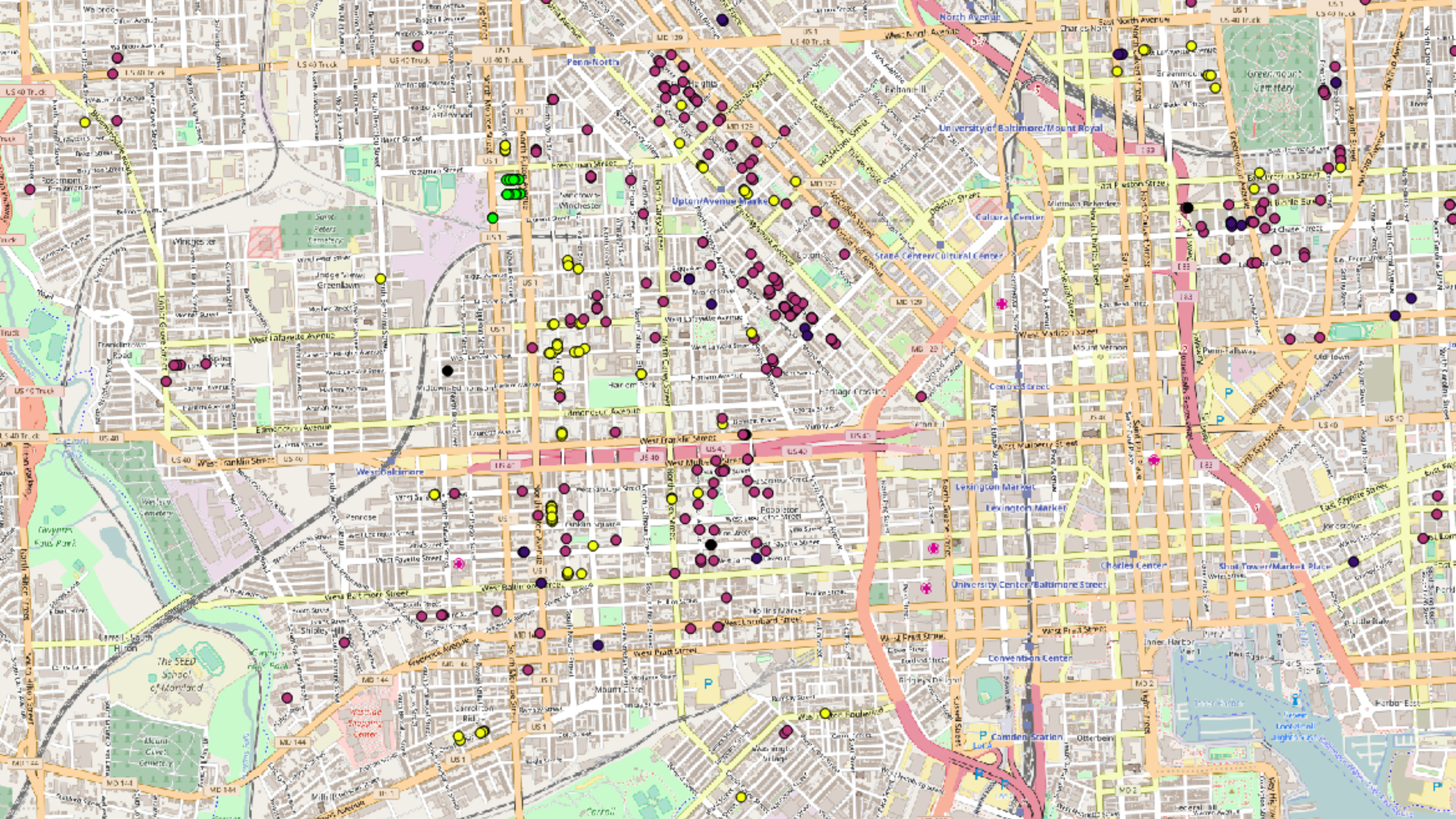
- For each city
  - Split dataset into training, testing and validation set
  - Utilize random sample of 60% of the data for training and testing
  - Utilize random sample of 40% of the data for validation

Classifier	ADOPTED			QCMOS			URBAN FARM			Overall (Mean)		
	Precision	Recall	F1	Precision	Recall	F1	Precision	Recall	F1	Precision	Recall	F1
Random Forest	0.90	0.94	0.92	0.84	0.77	0.80	1.00	0.98	0.99	0.91	0.90	0.90
k-NN	0.91	0.94	0.92	0.85	0.79	0.82	1.00	1.00	1.00	0.92	0.91	0.91
Naive Bayes	0.79	0.98	0.88	0.91	0.44	0.59	1.00	0.98	0.99	0.90	0.80	0.82
MLP	0.81	0.92	0.86	0.75	0.54	0.63	0.98	0.98	0.98	0.85	0.81	0.82
SVM	0.85	0.90	0.88	0.78	0.65	0.71	0.95	1.00	0.97	0.86	0.85	0.85

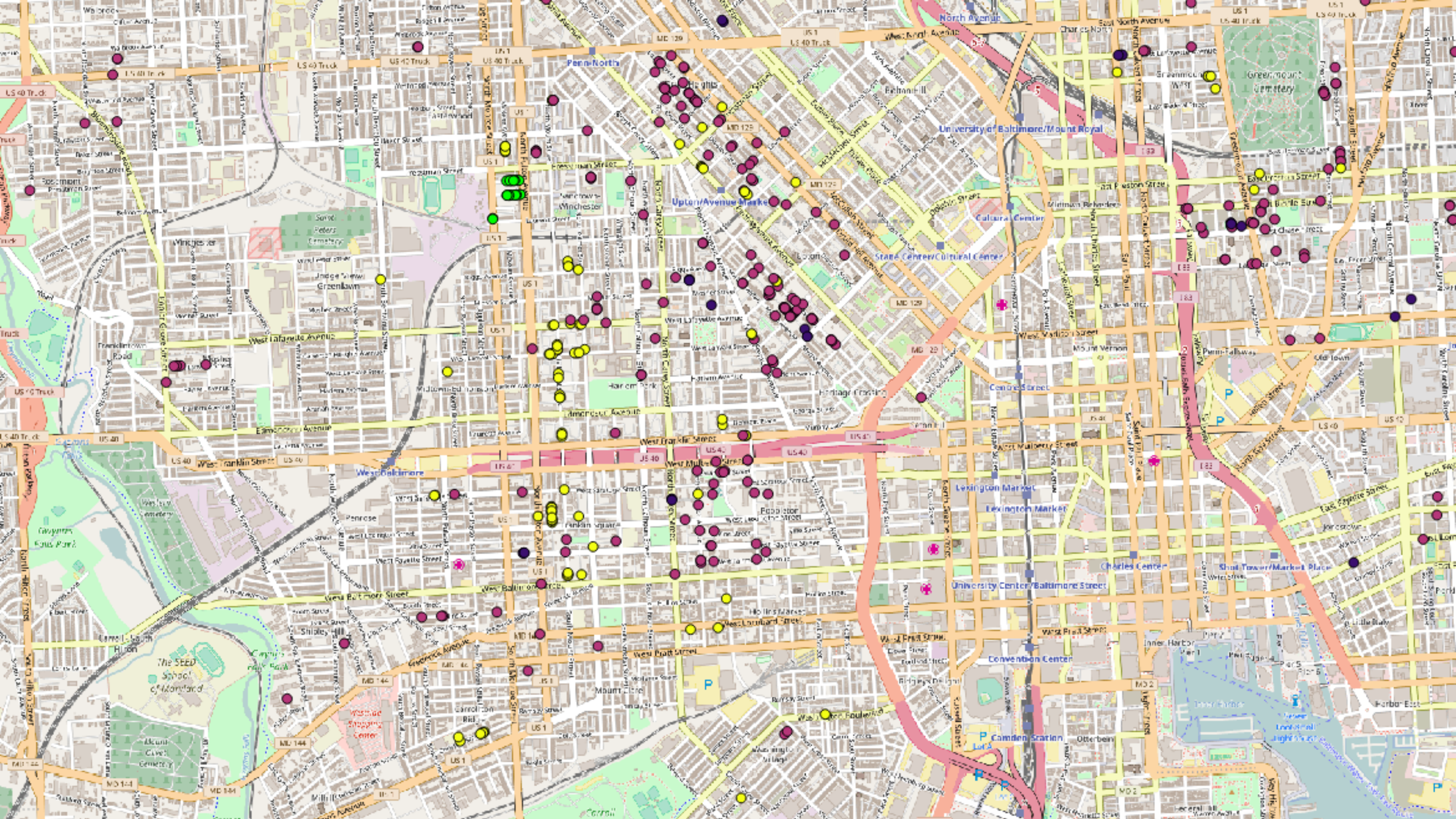
Results for Baltimore

Classifier	Adopt		
	Precision	Recall	F1
Random Forest	**0.90**	**0.93**	**0.92**
k-NN	0.85	0.84	0.84
SVM	0.67	0.72	0.69
MLP	0.63	0.79	0.70
Naive Bayes	0.76	0.72	0.74

Results for Philadelphia



North Avenue
Penn-North
University of Baltimore/Mount Royal
Upton/Avenue Market
Cultural Center
State Center/Cultural Center
Greenmount Cemetery
West Lafayette Avenue
West Franklin Street
West Mulberry Street
Edmondson Avenue
West Baltimore
Lexington Market
Centre Street
Charles Center
Shot Tower/Market Place
University Center/Baltimore Street
West Baltimore Street
West Lombard Street
West Pratt Street
Convention Center
Camden Station
Inner Harbor
Harbor East
Hollins Market
Heritage Crossing
Harlem Park
Franklin Square
Gwynns Falls Park
The SEED School of Maryland
Mount Clare
Washington Village
Westside Shopping Center
Penrose
Greenlawn
Rosemont
Winchester
Otterbein
Old Town
Mount Vernon
Pratt Street
US 40
US 1
MD 129
MD 144
I 83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Pigtown
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Mount Clare
Carrollton Ridge
Shipley Hill
Carroll-South Hilton
The SEED School of Maryland
Mount Olivet Cemetery
Westside Shopping Center
Gwynns Falls Park
Gwynns Falls
Western Cemetery
Penrose
West Baltimore
Midtown-Edmondson
Franklintown Road
Greenlawn
Rosemont
Winchester
Sandtown-Winchester
Saint Peters Cemetery
Penn North
Druid Heights
Old Town
Jonestown
Little Italy
Pleasant View Gardens
Oliver
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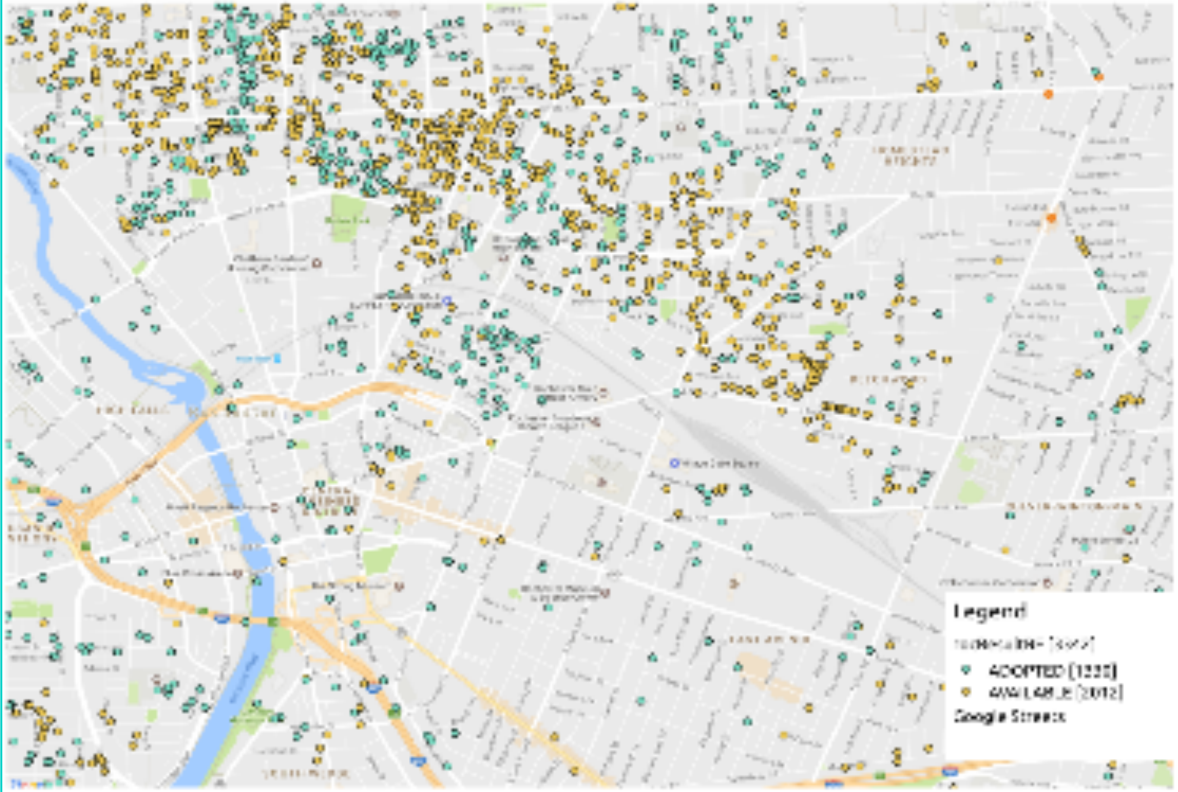

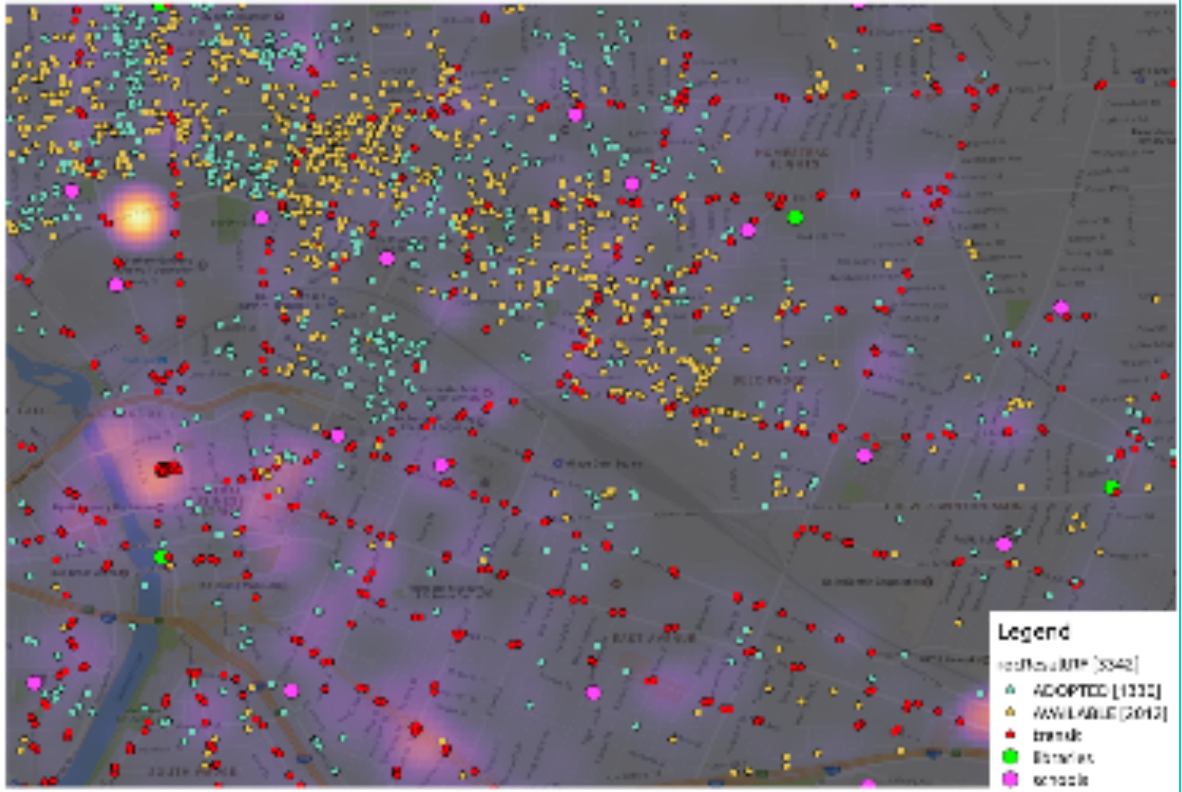

Rochester Visual Predictions

Applications

- Integrated in a decision support system for city planning
- Integrated into vacant lot toolkit, recommending vacant lot selections for community members

Future Work

- Further research on the field can focus on:
  - Applications on more cities
  - Optimize with the use of geospatial attributes such as:
    - Satellite Imagery
    - Geographically weighted regression model etc.

Conclusion

- The objectives of this research were:
  - Design and development of a vacant lot model
  - Building several prediction models for sample datasets
  - Evaluating each prediction model and analyzing their results
- The findings were:
  - Machine learning models are feasible for predicting vacant lots
  - For our experiments, Random Forest classifier provided the best result
  - Further validation with expert urban planners will provide a better evaluation