

Predicting Health Code Violations in Boston Restaurants

Roy Wright – August 2016

Background

- Health inspections of Boston restaurants currently take place in a largely random pattern
- Inspections could be more targeted if we had a way to predict future health code violations
- More efficient use of time, and better protection of public health

Objective

Develop a means to foresee whether a health code violation would be found at a given food service establishment, if it were chosen to be inspected, without prior notice, right now.

But how can we predict the future?

Near each restaurant, we'll take a close look at environmental conditions in the city in recent weeks, based on 311 service call records.

For example, has the restaurant been near...

- ... streetlight outages?
- ... reports of “unsanitary conditions”?
- ... rodent sightings?
- ... etc.

But how can we predict the future?

Near each restaurant, we'll take a close look at environmental conditions in the city in recent weeks, based on 311 service call records.

To understand how this could help us to predict the outcome of a health inspection, let's think for a moment about just one type of environmental condition – rodent sightings.

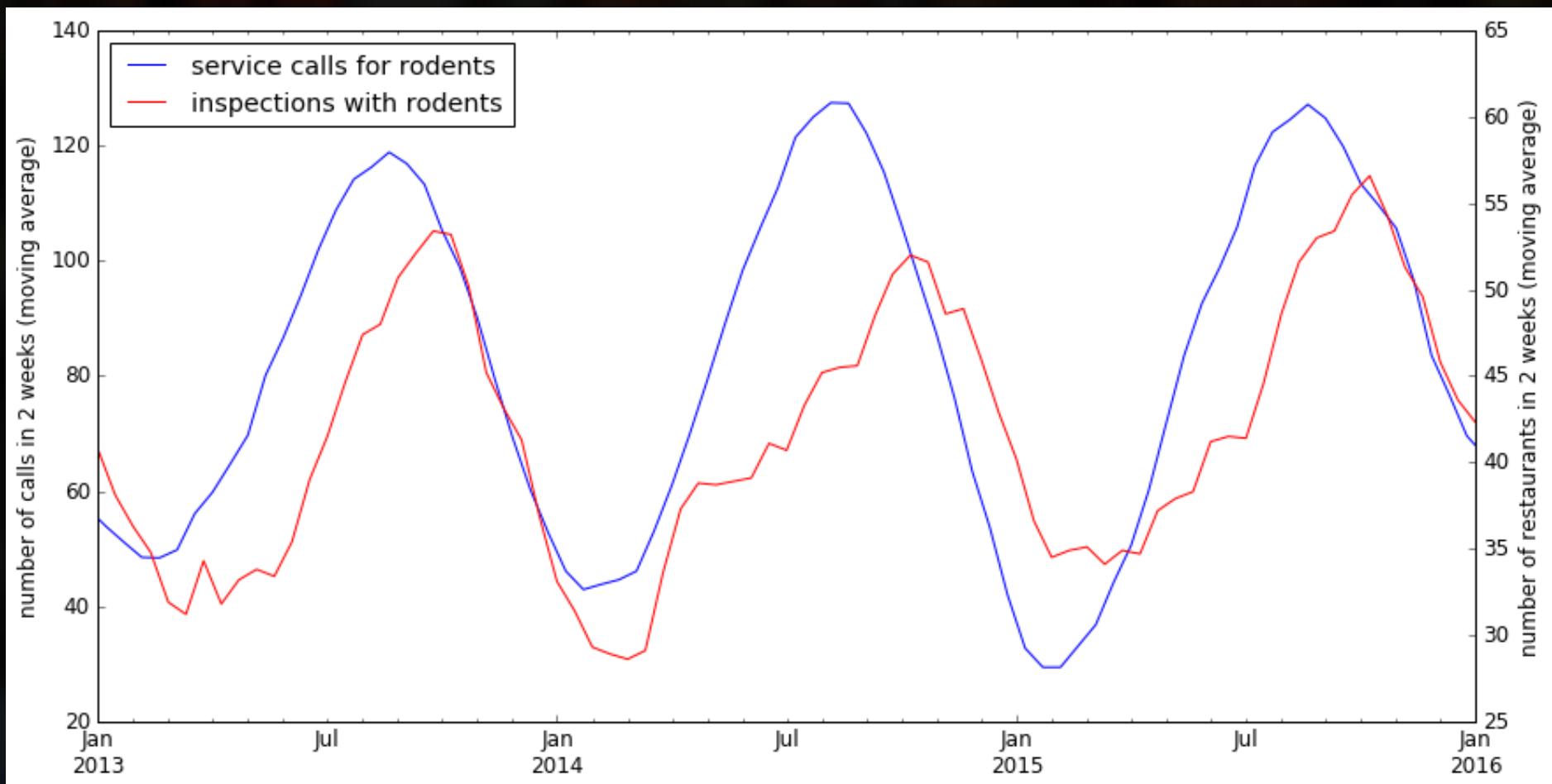
Rodent issues

- Often inspire public interest
- Over 20% of inspected businesses in our dataset have experienced inspection failures related to rodents
- If a restaurant is near a lot of 311 rodent sightings, is it more likely to have rodent-related issues during a health inspection?

Let's investigate!

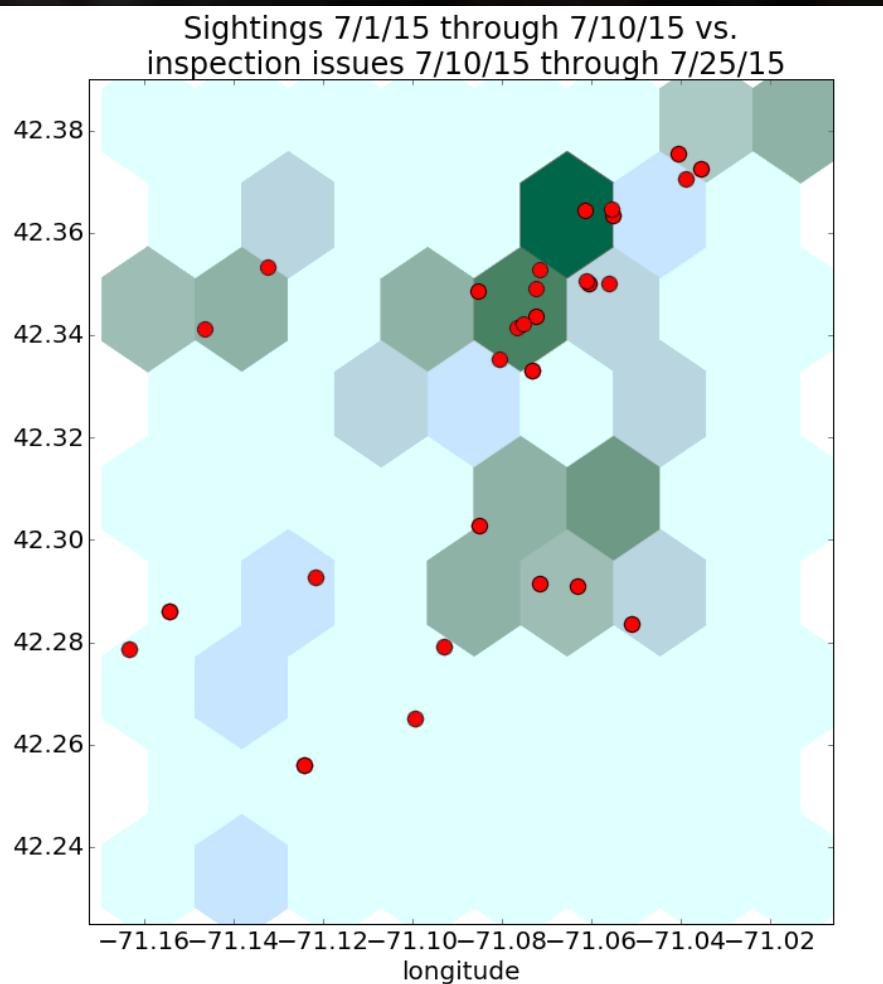
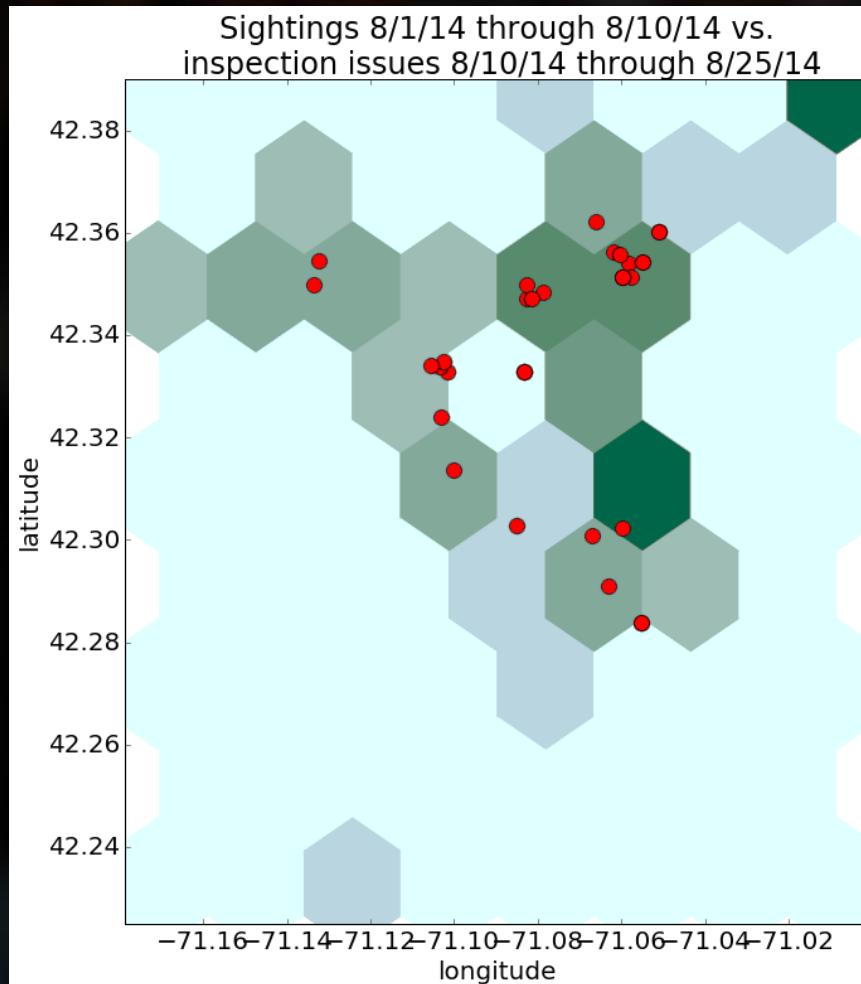
Rodent issues: patterns in time

Year after year, rise in rodent sightings followed by rise in rodent-related inspection failures



Rodent issues: patterns in space

Rodent activity in green, and subsequent rodent-related health inspections in red...



Rodent issues

If a restaurant is near a lot of 311 rodent sightings, is it more likely to have rodent-related issues during a health inspection?

- From visualizing the data, it seems that sightings and inspection issues go hand-in-hand, both in timing and in location.
- A more objective way to answer the question...

Statistical testing

- Using data from about four years of inspection results and 311 service calls
- Businesses near at least 10 recent rodent sightings fail inspections at a rate about 20% higher than others
- Statistically, this is not a fluke – the probability of this pattern just appearing by chance is less than 1 in 1000
- Useful information for predicting failures!

More statistical tests

Rodent issues are just one particularly obvious example of how environmental conditions could be related to inspection failures.

Many other categories of 311 complaints can also be shown to have a statistically meaningful relationship with health inspection results.

Using all environmental information as a cohesive whole, we can create an accurate model for predicting inspection outcomes.

Constructing a model

- We know the outcomes of almost 10,000 previous inspections, and the types of service calls near each restaurant shortly before inspection
- We randomly select about 8,000 inspections, from which our system “learns” as well as possible whatever patterns there may be between each inspection result and the service calls preceding it

Constructing a model (cont.)

- To test our system's real predictive abilities, we show it the remaining 2,000 or so inspections, which it has never seen before, and check its predictions for their outcomes

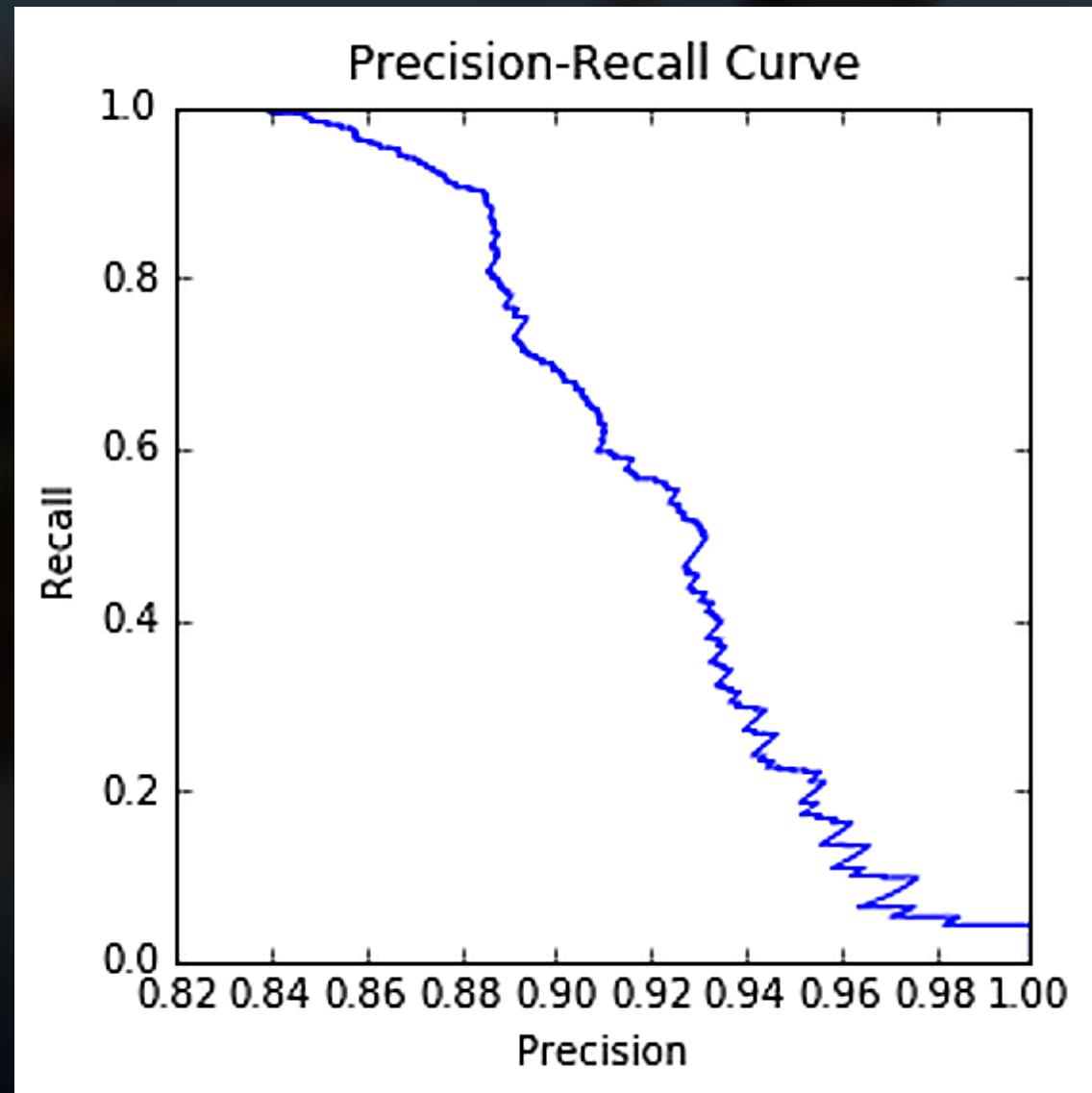
Model results

Our best system has an accuracy of about 88%, which means that 88% of its predictions for inspection outcomes are correct.

Since our aim is to target potential *violations* specifically, the best way to judge our predictor is not its accuracy, but its “precision” and “recall.”

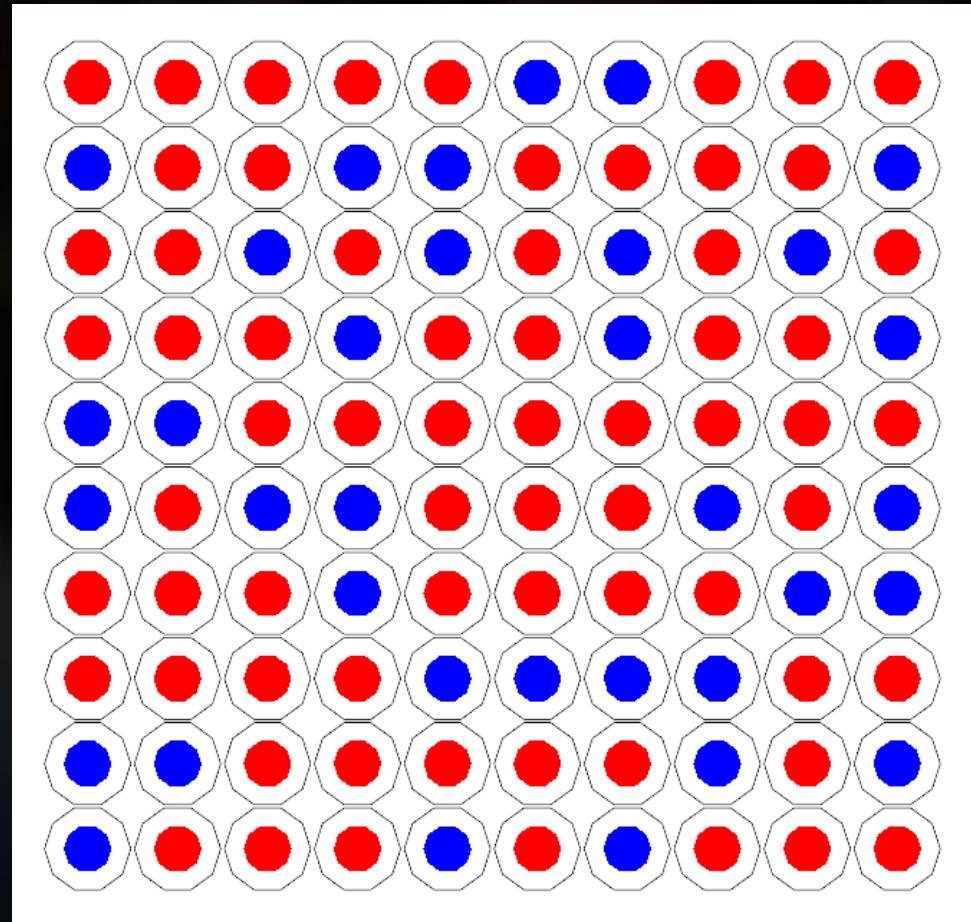
Model results: precision and recall

This curve shows the possible levels of precision and recall our predictor can achieve. Let's take a detailed look at what this means...



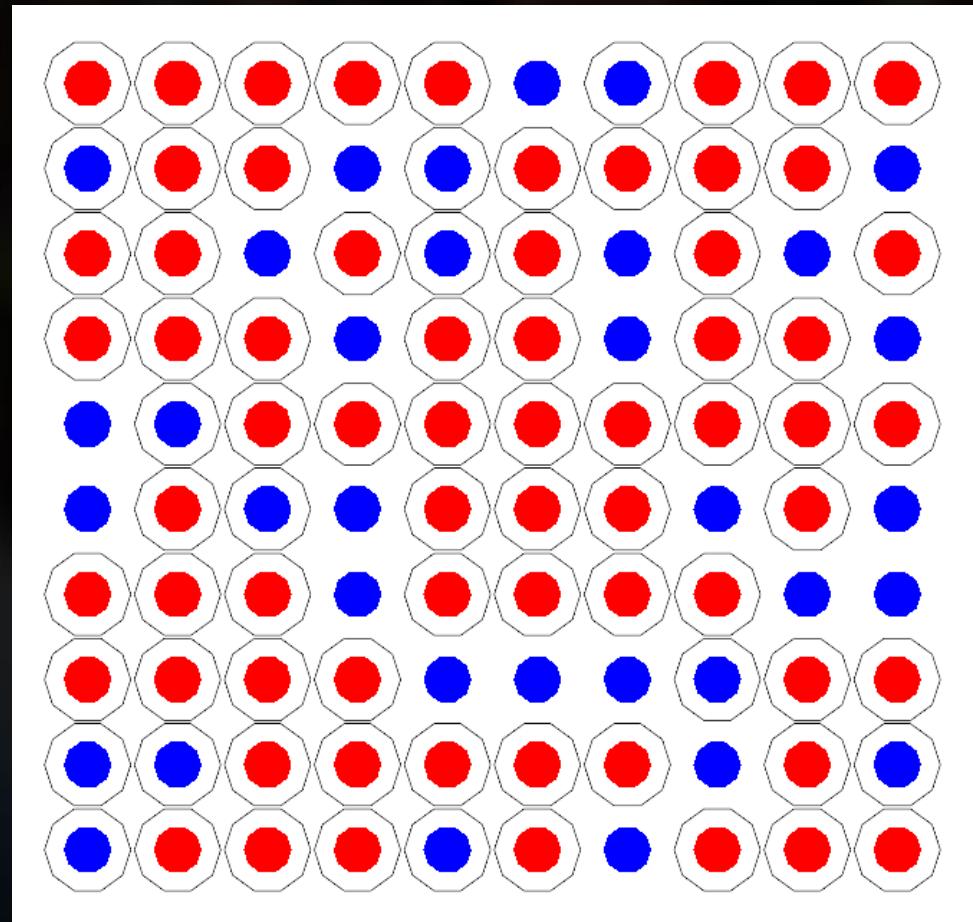
Precision and recall explained

Historically, about 2/3 of restaurant inspections result in failure. So when we randomly select a large group of restaurants to inspect, the results will look like this. (Restaurants chosen for inspection circled in black, with red dots representing failed inspections.)



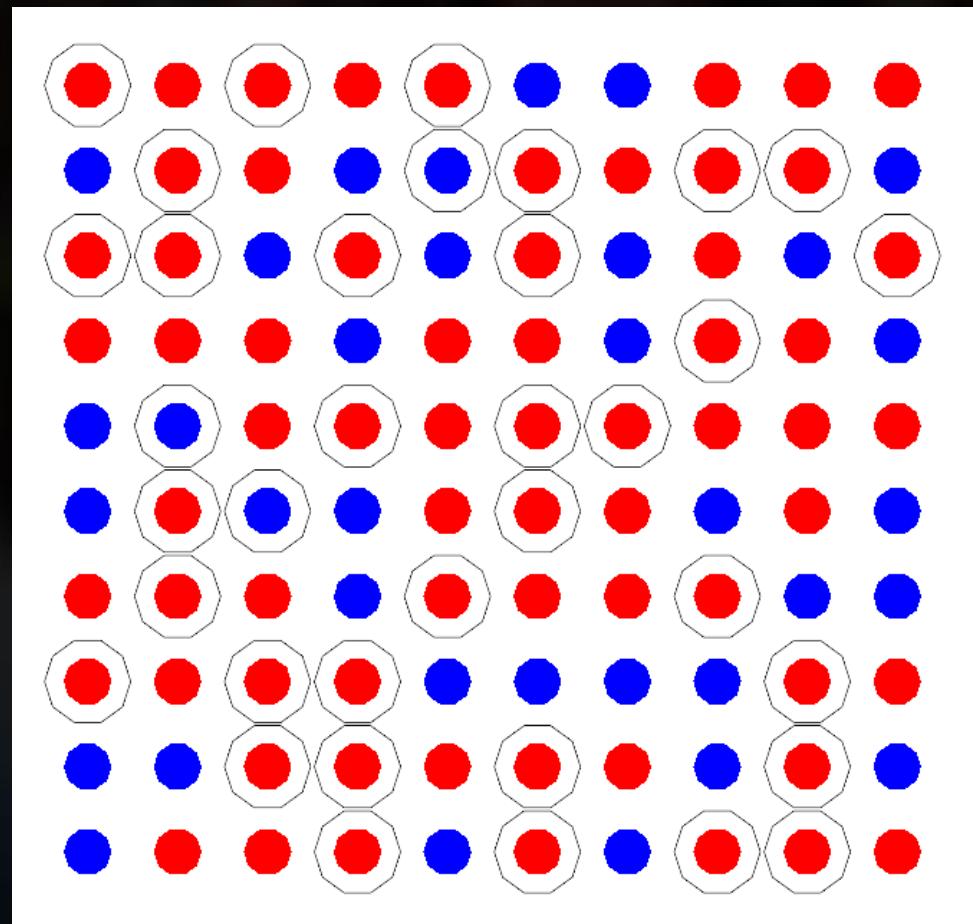
Precision and recall explained (cont.)

The precision-recall curve indicates that our system can achieve about 84% precision with 100% recall. This means that 84% of the predicted failures (circled in black) will actually be failures, and 100% of all failures will be predicted.



Precision and recall explained (cont.)

Precision can be increased, at a price. For example, based on our curve, precision could reach 93%, at the cost of decreasing recall to 50%. This would mean that only 50% of failed inspections are foreseen, but 93% of the predicted failures will come true.



Recommendations

- The City of Boston should make use of a predictor like the one developed here to help plan upcoming inspections, in order to more efficiently utilize inspectors' time.
- The trade-off between the precision and recall of the predictor should be set in consultation with the Inspectional Services Department.

These slides, the technical report, and accompanying code are all available at:

<https://github.com/roywright/springboard/tree/master/capstone>

