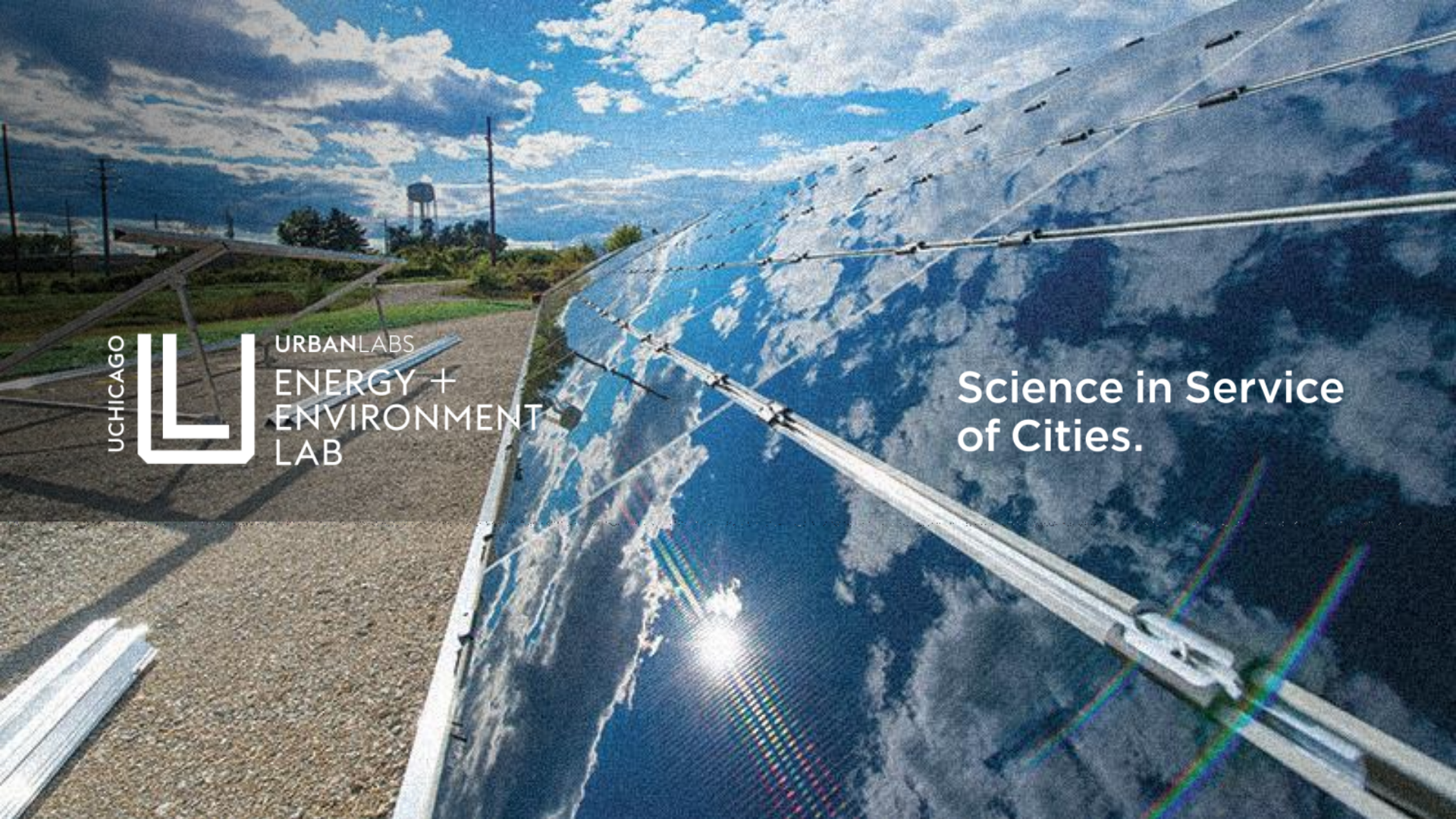
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Science in Service
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October 23, 2018

Using Predictive Analytics to Improve Inspection Targeting

Michael Greenstone
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Agenda

1) Background on UChicago Energy & Environment Lab

2) Using Predictive Analytics to Improve RCRA Inspection Targeting

3) Improving Inspection Targeting and Efficiency in Your Program

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UChicago E&E Lab Leadership

Michael Greenstone
Faculty Director

Olga Rostapshova
Executive Director

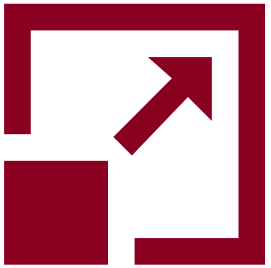
Mark Templeton
Regulatory Advisor

OUR APPROACH

WE PARTNER WITH POLICYMAKERS TO:

IDENTIFY
Promising solutions to environmental challenges

TEST
The most promising policies and programs



SCALE UP
The most effective and cost-efficient policies and programs

EPA and UChicago Partnership

OECA and the University of Chicago Energy & Environment Lab began our **partnership in early 2015**

Goal: Collaborate to develop and evaluate the effectiveness of novel techniques for supporting compliance assurance efforts

UChicago **Research Fellow** joined EPA HQ in June 2017 (embedding is part of our model)

Our Partners

We partner with policymakers at the local, state and federal levels

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Runs Scored² / Runs Scored² + Runs Allowed² = Win %
WIN %
RECORD
EXPECTED
ACTUAL
EXPECTED
ACTUAL
OAK 2001
884² / 884² + 645² = 781456 / 1197481 = .6525
.6296
106 - 56
102-60
OAK 2002 PROJECTION
814² / 814² + 645² = 662596 / 1078621 = .6143
99-63
SEA 2001
927² / 927² + 627² = 859329 / 1252458 = .6861
.7160
111-51
722500 / 1184900 = .6097
EDGAR ALES
99-63
646416 / 1154785 = .5597
.5864
91-71
792100 / 1321000 = .6178
GIAMBI, VENTURA
100-62

What is Predictive Analytics?

Predictive analytics is the practice of using data to determine patterns and predict future probabilities. Its appeal is that it can discern subtle relationships in the data.

Also known as: Machine Learning, Artificial Intelligence, Data Science, Big Data, etc.

Predictive analytics influences our daily lives

Private companies have been using predictive analytics to **inform decisions and improve performance for years**

- Detects potential credit card fraud
- Product recommendations at Amazon and Netflix

This revolution is coming to the public policy sphere, where government agencies are learning how to use data to **provide better services and increase their cost-effectiveness**

- New York Fire Department prioritizes building inspections by predicting which buildings are more likely to catch fire
- Chicago Department of Public Health predicts children at high risk for lead poisoning for screening

Transforming environmental regulation

This wave of technological change is making the world much more efficient.

Yet these methods are not yet widely applied in environmental regulation – leaving potentially substantial efficiency gains on the table.

Predictive analytics has the potential to transform inspection targeting – and enforcement and compliance more broadly – in environmental regulation by achieving greater efficiency in an increasingly resource-constrained environment.

The Challenge: How to Improve Inspection Targeting

All levels of government enforce laws that protect the environment, health, food, worker safety, and much more, by conducting inspections.

EPA has resources to inspect a small fraction of active hazardous waste facilities each year – **how can they find more violators with fewer resources?**

Proposed Solution: Identifying high-risk facilities

Use predictive analytics to identify facilities **most likely to violate** RCRA regulations

Built model based on **15 years of historical data**, including tens of thousands of variables such as:

- Facility characteristics (location, industry, etc.)
- Historical enforcement and compliance data – RCRA and other regulations such as the Clean Air Act

Proposed Solution: Identifying high-risk facilities

Use predictive analytics to identify facilities **most likely to violate** RCRA regulations

We **evaluate model performance** by:

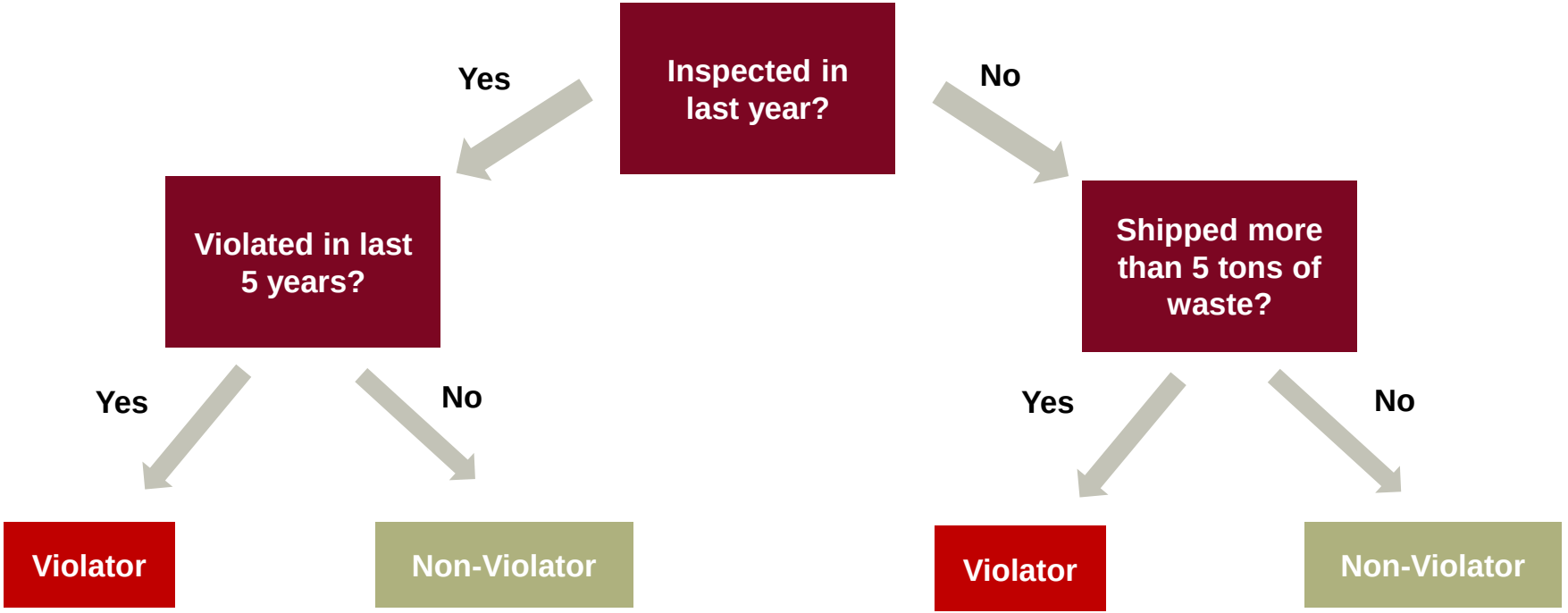
1) Training the model on historical data (2000-2013)
2) Predicting facility risk level in the recent past (2014)
3) Comparing these results to whether the facility actually violated regulations (in 2014)

Proposed Solution: Identifying high-risk facilities

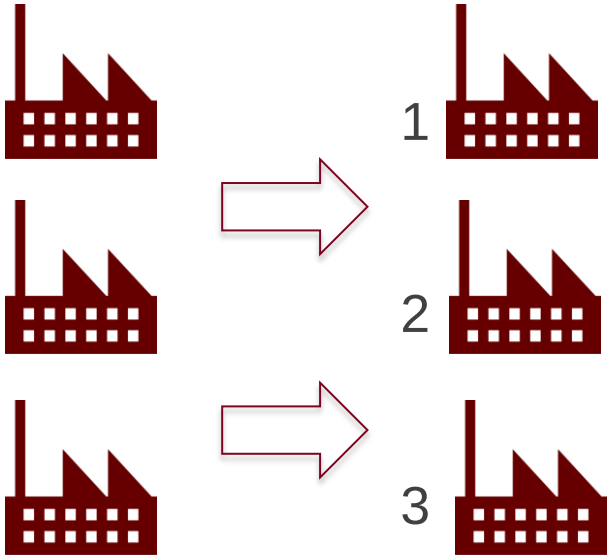
Use predictive analytics to identify facilities **most likely to violate** RCRA regulations

The model generates a **risk score** for each facility quantifying the likelihood that an inspection of the facility will find a severe violation of RCRA regulations.

Decision Trees and Random Forest Algorithms



Performance on Historical Data



The **model achieves a 50% increase in the detection of severe violations,** compared to status quo targeting

Conclusion: Predictive analytics works for inspection targeting for environmental enforcement when using historical data.

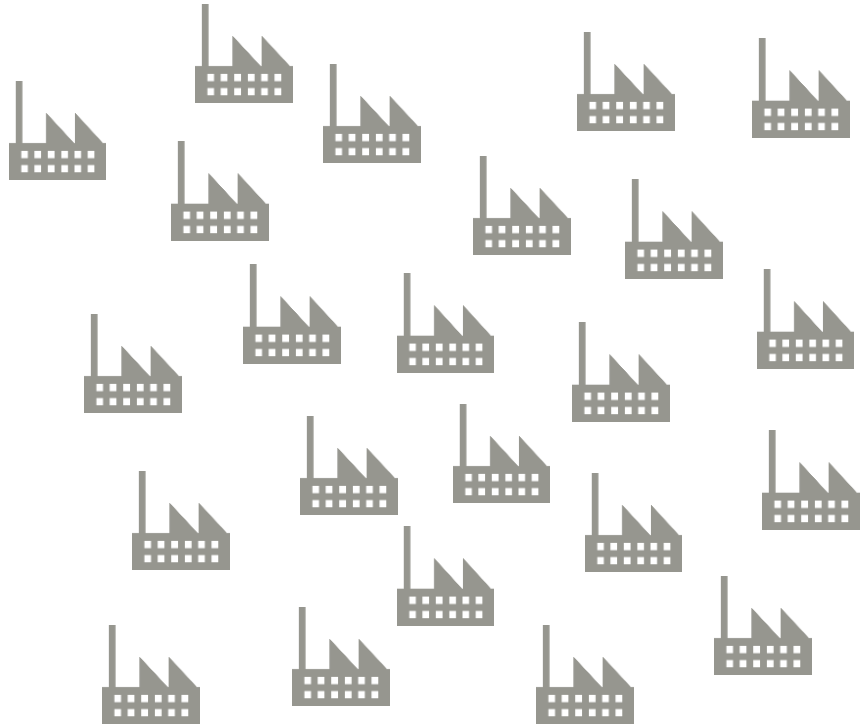
Field Testing the Model

Before incorporating the model into a targeting tool to be used by inspectors, we worked with Regional offices to conduct additional testing of the model in the field.

This on-the-ground testing serves **to demonstrate** the model's performance in the real world.

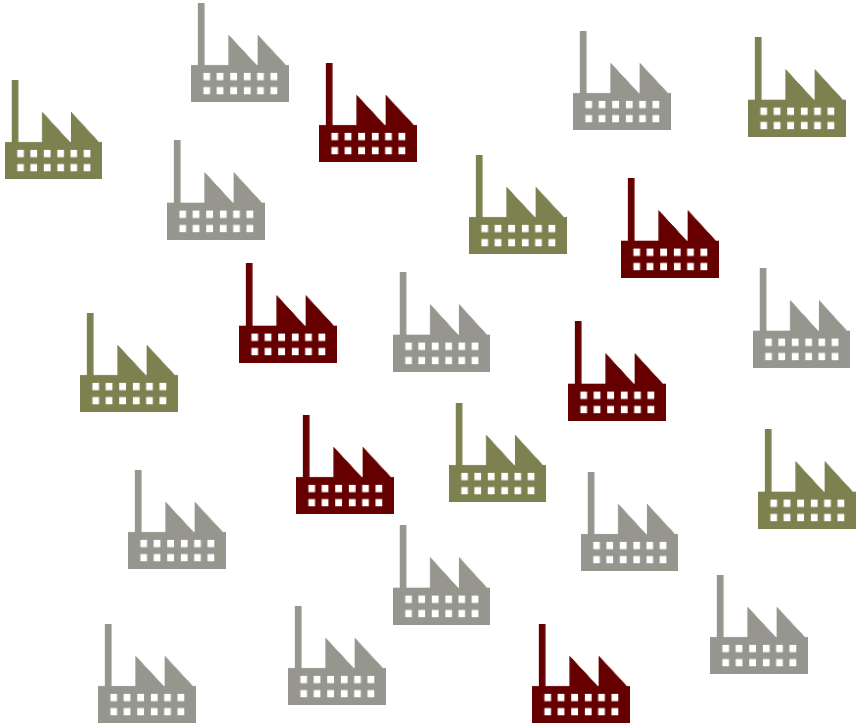
The field test also helps **build inspector confidence** in the targeting tool before it is rolled out nationwide.

Testing a Model in the Real World



All large quantity generators (LQGs) eligible to be inspected in a given year

Testing a Model in the Real World



Both the model and the EPA choose their top facilities to inspect

- Chosen to inspect by EPA
- Chosen to inspect by model

Results

Preliminary results indicate that detection rate for:

1. EPA chosen inspections is 22%

2. Model chosen inspection is 40%

→ That is an **80% increase over the current hit rate for severe violations**

→ Field evidence also indicates that predictive analytics can substantially improve efficiency of environmental inspections programs.

Increased Efficiency

In FY17, the EPA conducted ~1,190 RCRA inspections

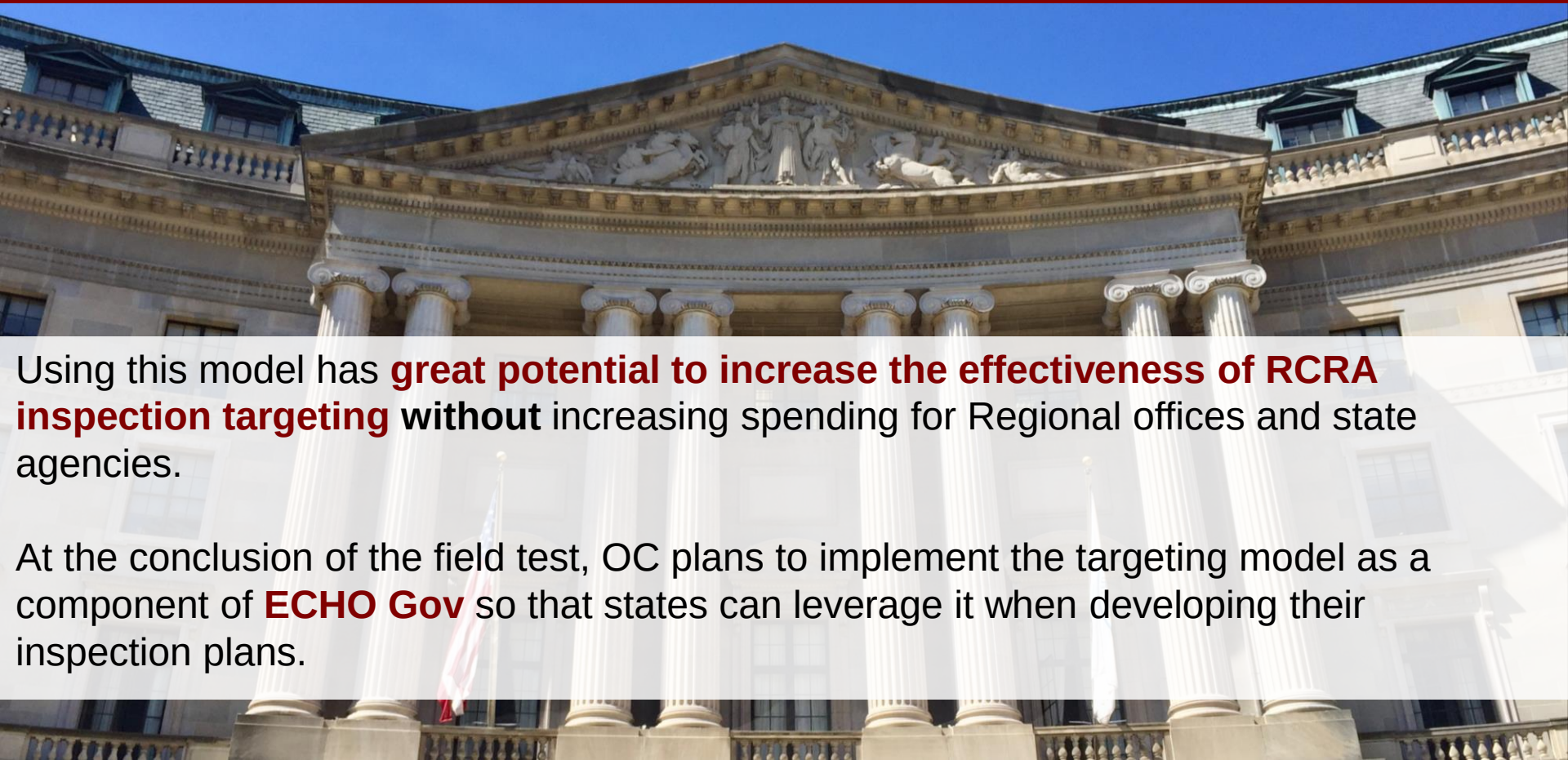
If the RCRA predictive analytics model was used nationwide, the EPA:

- Could have **found 214 additional severe violators** with the same inspection resources

-OR-

- Could have **conducted 535 fewer inspections** while finding the same number of severe violators

Taking Predictive Analytics to Scale



Using this model has **great potential to increase the effectiveness of RCRA inspection targeting** **without** increasing spending for Regional offices and state agencies.

At the conclusion of the field test, OC plans to implement the targeting model as a component of **ECHO Gov** so that states can leverage it when developing their inspection plans.

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Opportunities for leveraging predictive analytics

Other possible applications could include:

- Inspection targeting for other areas such as Clean Water Act, Clean Air Act, etc.
- Identifying high-risk facilities to help prioritize compliance assistance
- Identifying potentially un-permitted or otherwise non-compliant facilities (e.g., utilizing satellite data and image classification)

What else do we do?

The UChicago Energy & Environment Lab also:

- Provides **technical assistance** to regulators and state agencies

- Conducts **impact evaluations** to determine causal impact of programs and policies using
  - Randomized control trials (RCTs)
  - Quasi-experimental methods

Please reach out to us to discuss how we can help you design and test effective and efficient policies, regulations and enforcement strategies.

Interested in working with us?

Contact us!

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Thank you.