NEEA Product Council

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5 / 21 / 2024

Introduction

Who am I?

Dr. Trager has been doing work and research in practical use of AI tools for 16 years. He has a Ph.D. from UC Berkeley, where his dissertation focused on using machine learning to forecast time-series data in buildings in order to facilitate automated fault detection. He's a huge nerd and loves renewable energy art.

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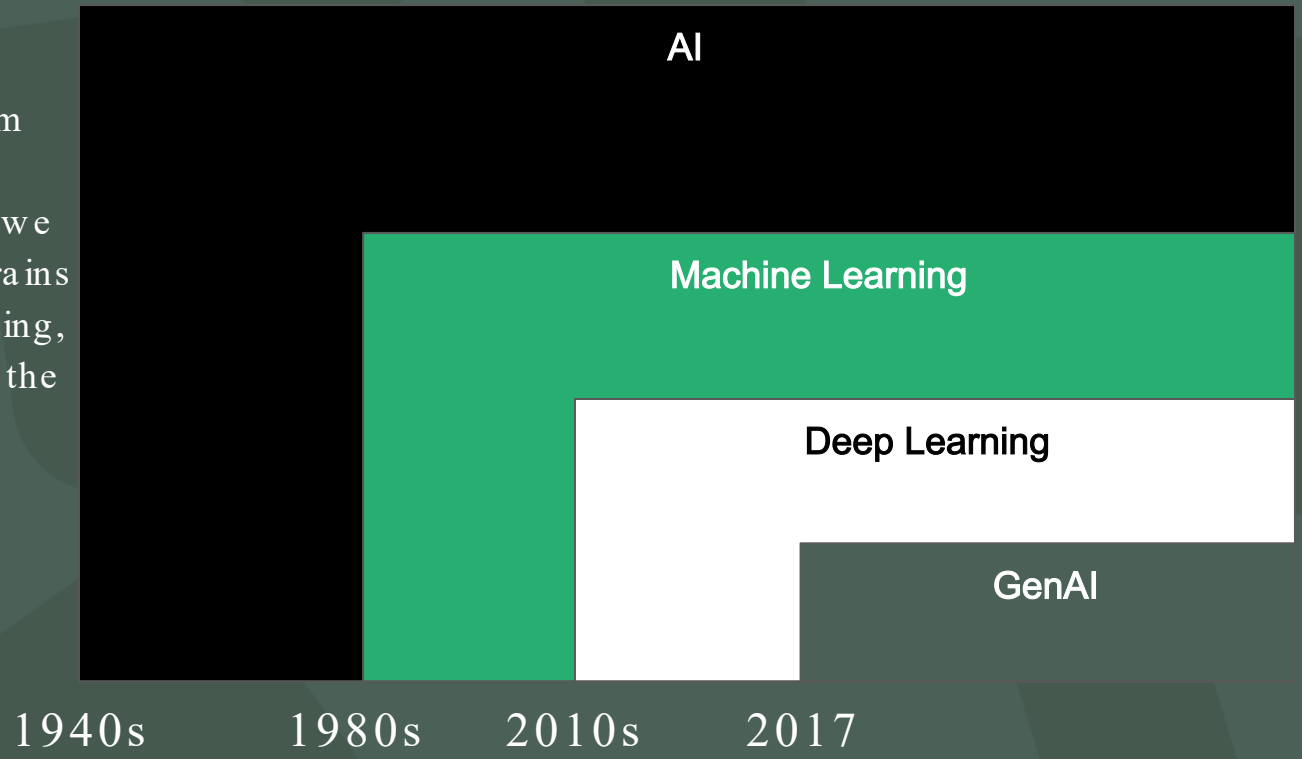
What is AI?

- AI – Mimicking behavior
- ML – AI, but we learn from data
- Deep Learning – ML, but we get inspired by human brains
- Gen AI - Like Deep Learning, but we actually architect the process in parallel like a human brain



Machine Learning Vs Traditional Programming

Traditional Programming

Write a program that follows explicit directions:

IF EMAIL_SUBJECT CONTAINS “CLICK TO CLAIM YOUR PRIZE”
THEN
MARK AS SPAM

Machine Learning

Write a program that improves based on a model

Try to classify some emails;

Change self to reduce errors;

repeat;

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Gen AI

Deep Learning

Description: A subset of ML that uses neural networks with many layers (deep neural networks) to model complex patterns in large amounts of data. It is particularly effective for tasks like image and speech recognition.

1. Collect a large dataset of labeled emails (spam and not spam).
2. Train a deep neural network (e.g., using a recurrent neural network or a transformer) to classify emails based on their content.
3. The network automatically learns to recognize patterns and features indicative of spam.
4. Evaluate the model's performance and fine-tune it to improve accuracy.
5. Use the trained network to filter incoming emails as spam or not spam.

Gen AI

Describe the output that you desire

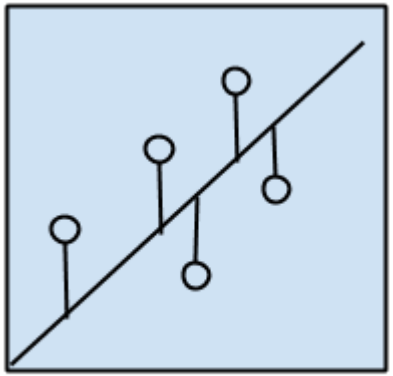
Please write me a program that will filter out common spam emails.

Some Machine Learning And AI Algorithms

Regression Algorithms

Regression is concerned with modeling the relationship between variables that is iteratively refined using a measure of error in the predictions made by the model.

Regression methods are a workhorse of statistics and have been co-opted into statistical machine learning.



Regression Algorithms

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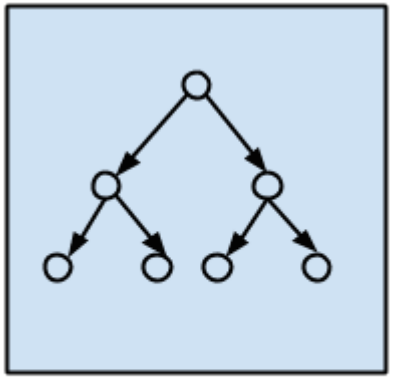
Adapted From: https://machinelearningmastery.com/a -tour-of-machine-learning-algorithms/

Some Machine Learning And AI Algorithms

DECISION TREE Algorithms

Decision tree methods construct a model of decisions made based on actual values of attributes in the data.

Decision trees are often fast and accurate and a big favorite in machine learning.



Decision Tree Algorithms

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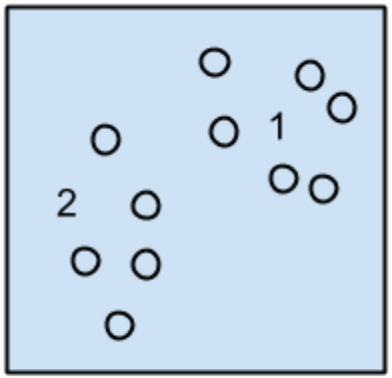
Some Machine Learning And AI Algorithms

Clustering Algorithms

Clustering, like regression, describes the class of problem and the class of methods.

Clustering methods are typically organized by the modeling approaches such as centroid -based and hierarchical. All methods are concerned with using the inherent structures in the data to best organize the data into groups of maximum commonality.



Clustering Algorithms

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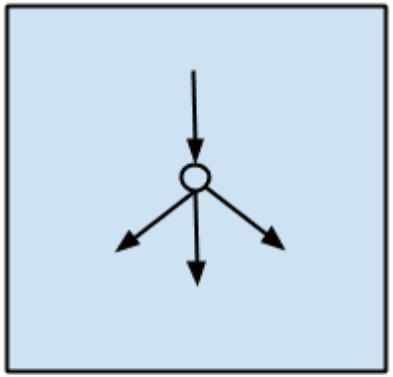
Some Machine Learning And AI Algorithms

Artificial Neural Network Algorithms

Artificial Neural Networks are models that are inspired by the structure and/or function of biological neural networks.

They are a class of pattern matching that are commonly used for regression and classification problems but are really an enormous subfield comprised of hundreds of algorithms and variations for all manner of problem types.



Artificial Neural Network Algorithms

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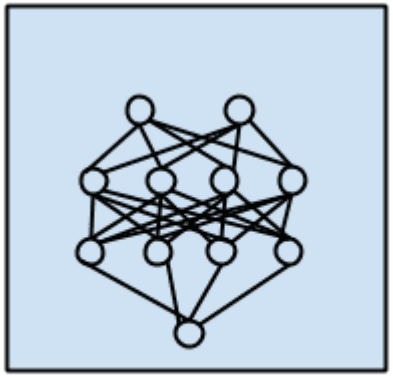
Some Machine Learning And AI Algorithms

Deep Learning Algorithms

Deep Learning methods are a modern update to Artificial Neural Networks that exploit abundant cheap computation.

They are concerned with building much larger and more complex neural networks and many methods are concerned with very large datasets of labelled analog data, such as image, text, audio, and video.



Deep Learning Algorithms

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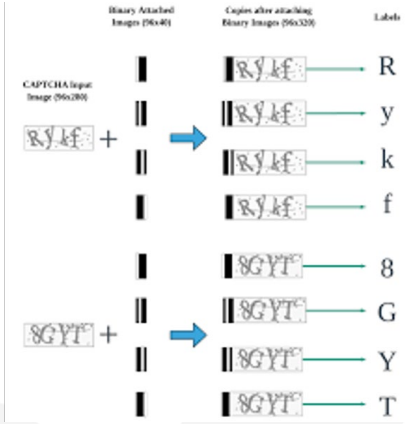
AI

ML



Deep Learning

Gen AI

Context / Why
Target

Utilities : Everyone gets the same puppy

Utilities want to give everyone the same thing.

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What can do to improve program outcomes?

From our 2021 study on maximizing minisplit performance:

- **Targeting Homes**
- Design for Displacement
- Integrated Control of Backup Heating
- Consumer Education
- Quality Assurance

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Targeting increases savings

- **Study Findings**
  - Top quartile energy users save most energy
  - Bottom quartile energy users have zero to negative savings

Targeting buys us 85% of the incremental savings in the study.

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Practical Recommendations

- **Options**
  - Utilize advanced metering infrastructure (AMI) Using air temp models

- Low Tech
  - Only 15,000 kWh/yr or more
  - Winter Season – Spring Season > 3000 kWh

- **Practical Recommendation**

- Target homes with significant electric heating loads, based on analysis of billing data

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How else to do targeting

- Geospatially
- Demographically
- Using Utility Data

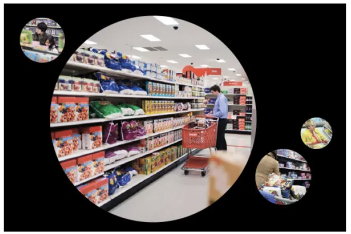
Machine Learning For Targeting - A quick history

The “Target Story” - it was the scents

The New York Times Magazine

How Companies Learn Your Secrets

Share full article 570



Antonio Bolfo/Reportage for The New York Times

By Charles Duhigg
Feb. 16, 2012

Andrew Pole had just started working as a statistician for Target in 2002, when two colleagues from the marketing department stopped by his desk to ask an odd question: “If we wanted to figure out if a customer is pregnant, even if she didn’t want us to know, can you do that? ”

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How does this apply to buildings?

Easy Example: MyHeat

If there is a lot of heat leaking,

Upgrade insulation

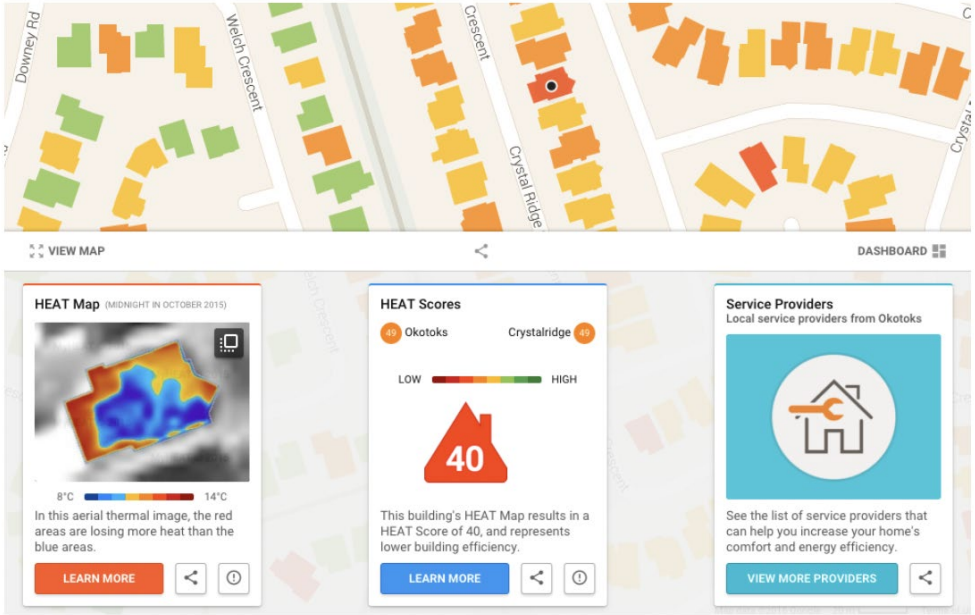

Figure 3: MyHEAT's heat map (myheat.ca/map)

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How does this apply to buildings?

Use Machine Learning.

Find Buildings Likely to adopt.

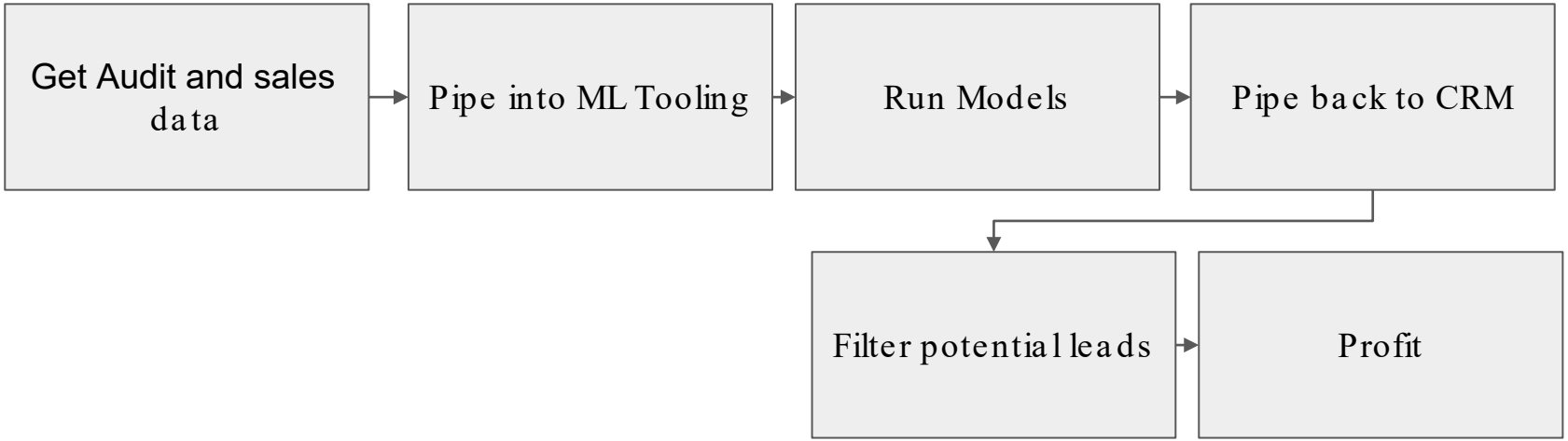
(Without seeing their heat leaking)

A case study - Direct Install (2018 - 2020)

Summary

Using geospatial machine learning, Dr. Trager helped Lime Energy significantly improve on the close rate of their direct install programs.

Practically - ML Workflow



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Conceptually - Use sales data to train ML Model

Figure 4 – A salesperson selects a portfolio of buildings to audit

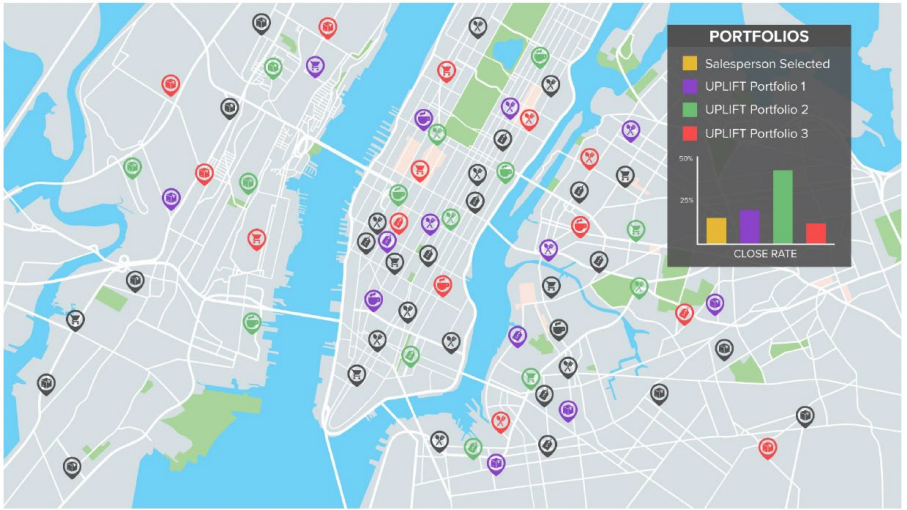

Figure 5 – the implementer uses machine learning to select a portfolio, thus maximizing sales.

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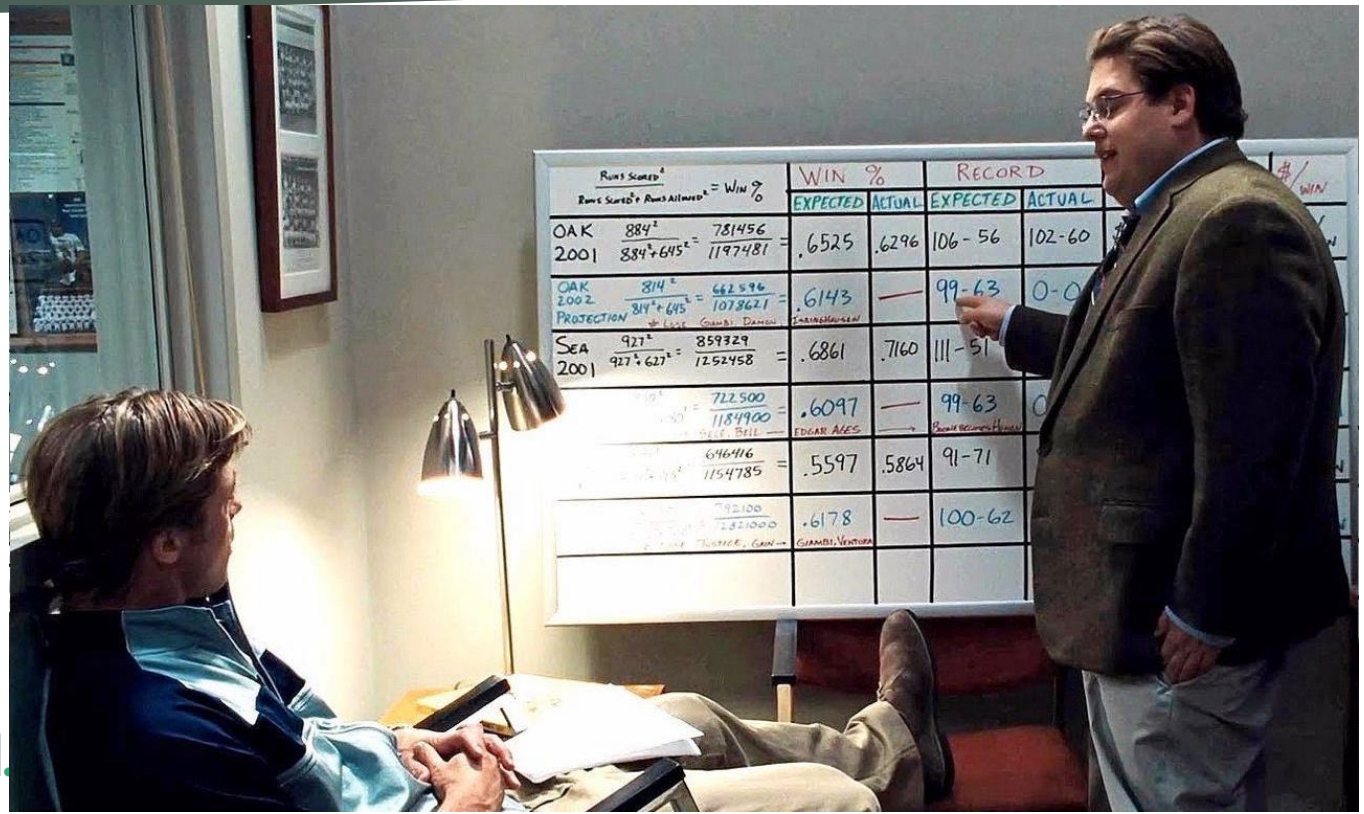
The Only Sports Movie that I like



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RESULTS

Random Selection (Salespeople's Instinct): 32.8% Close rate

Intelligent Selection (Machine Learning): 42.1% Close rate

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Separating Distributions

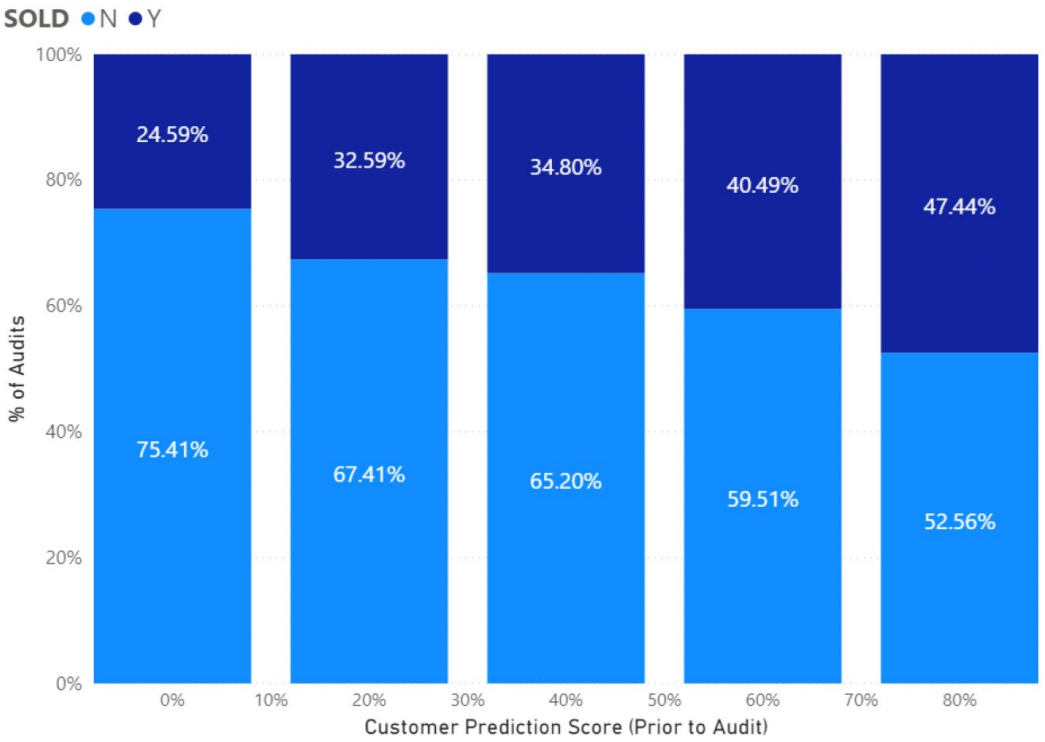

Figure 12: Deal close rate (dark blue) by customer prediction score bin

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Separating Distributions

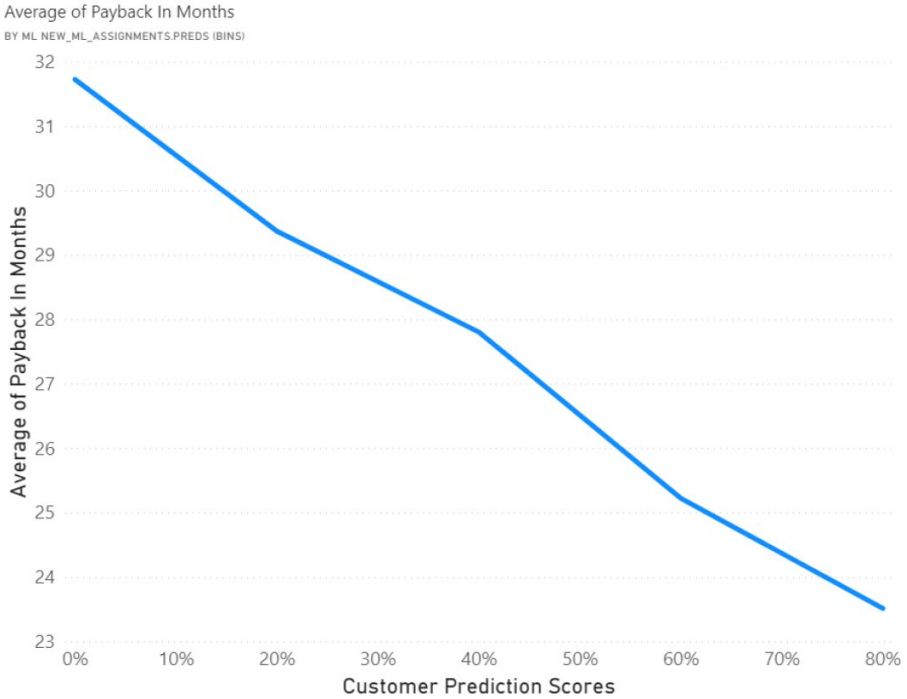

Figure 13 Payback's correlation with customer prediction score

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Separating Distributions

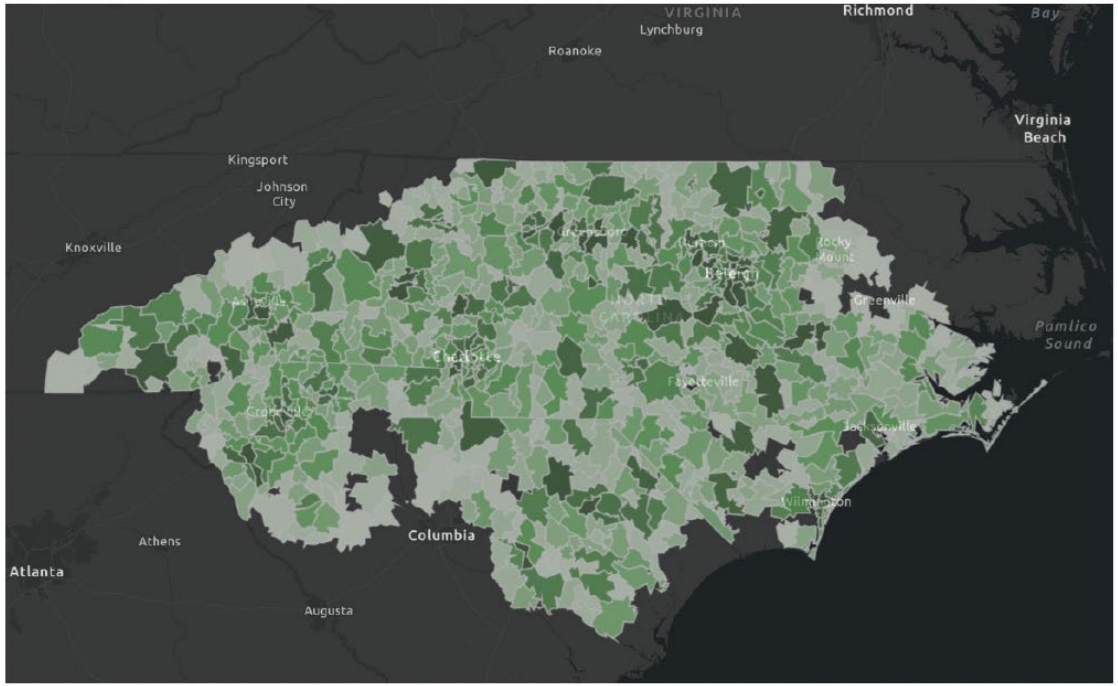


Figure 14: Distribution of top 60% of prediction scores across North Carolina zip codes

Vetting the evidence

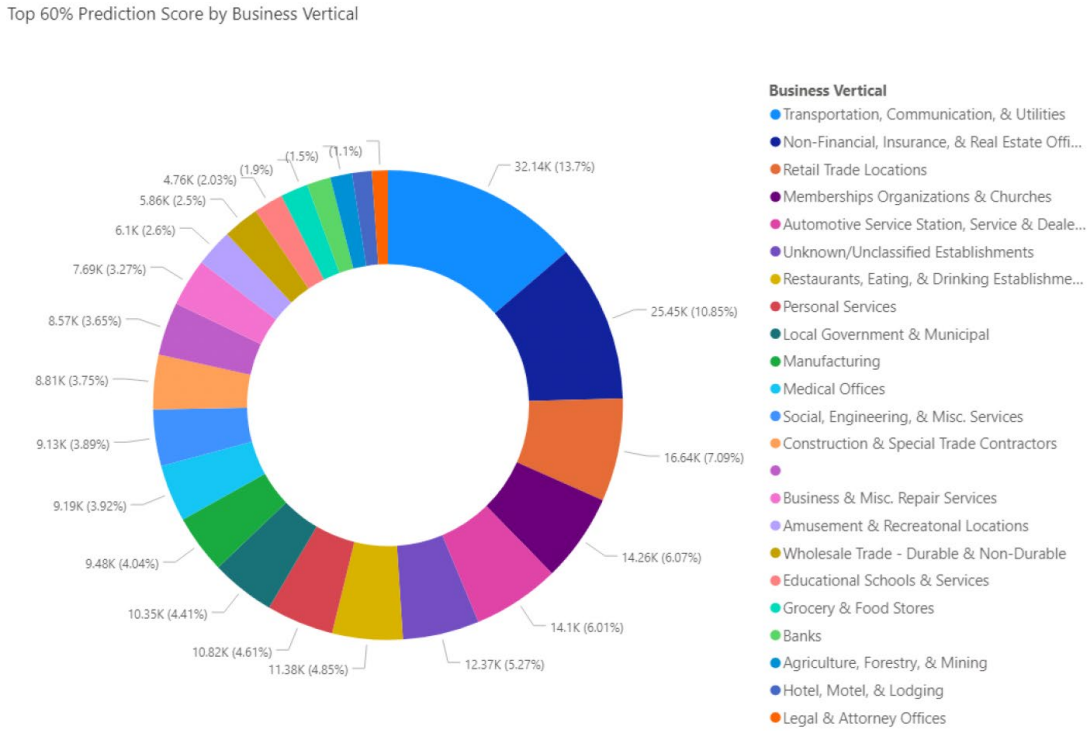


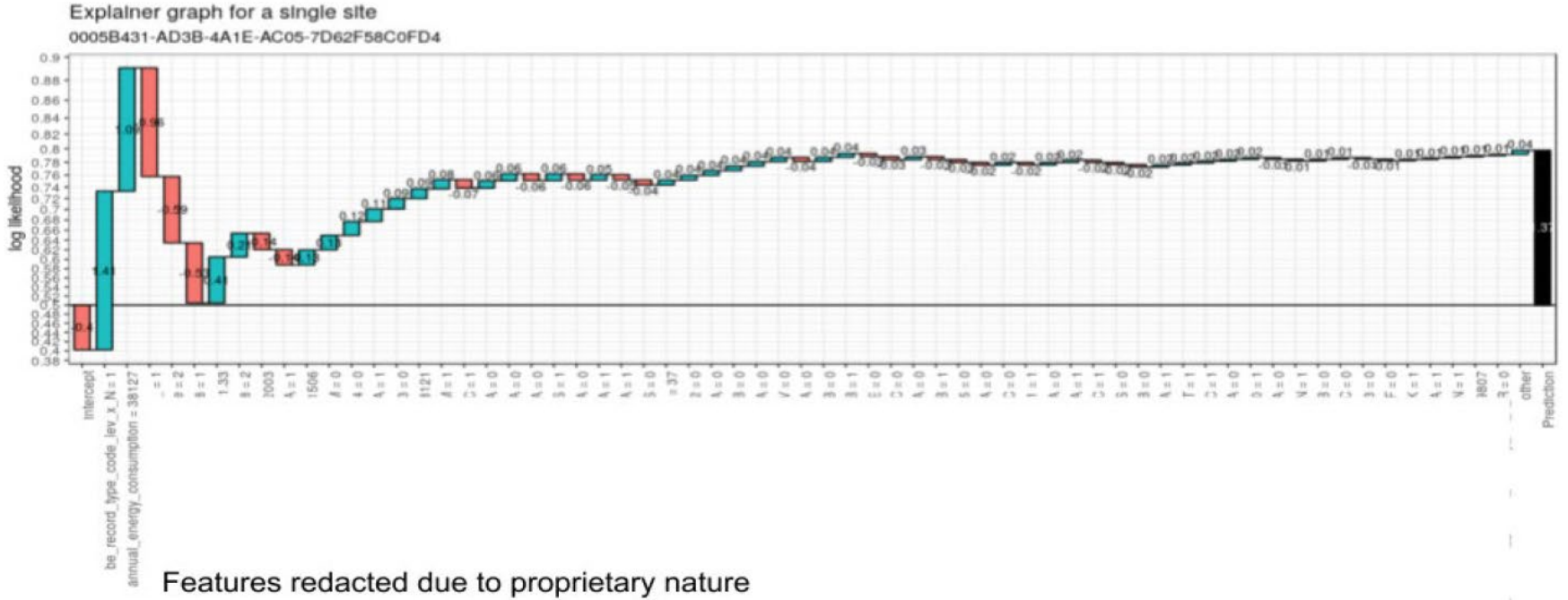
Figure 15: Distribution of top 60% of prediction scores across business verticals

Features that can be used

Things that are predictive:

- Energy use
- Census political lean
- Gender of the contact person
- How many neighbors have upgraded
- …and many many others

Explainability



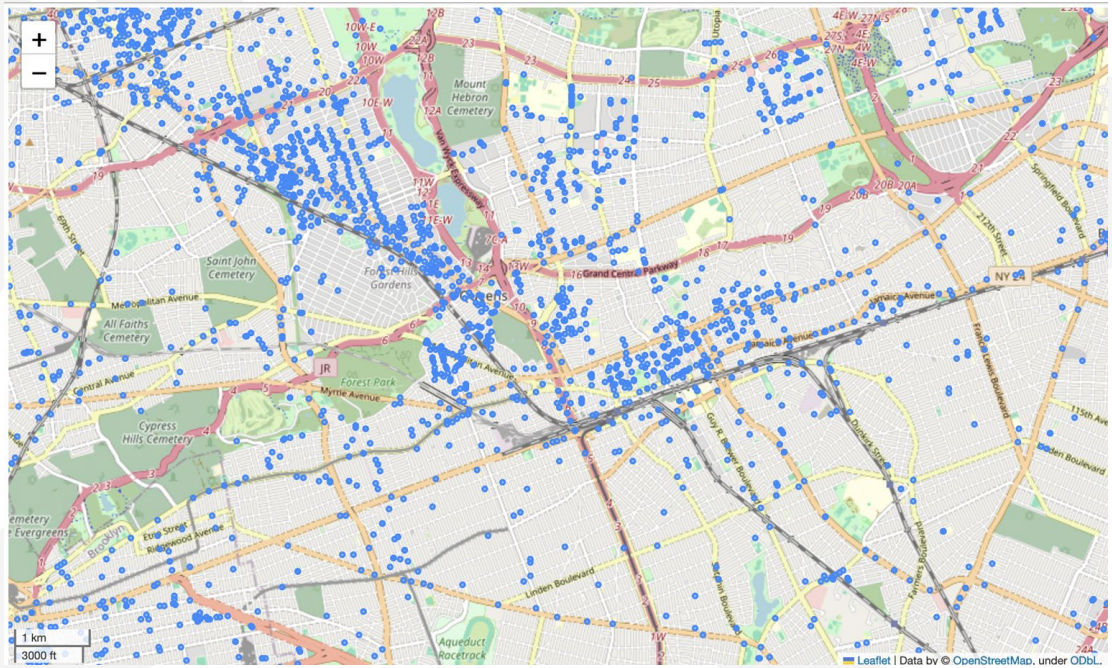
Features redacted due to proprietary nature

Figure 8: Explainer graph for a single site

Practical Applications

How does this look in practice?

Data is uploaded
and mapped



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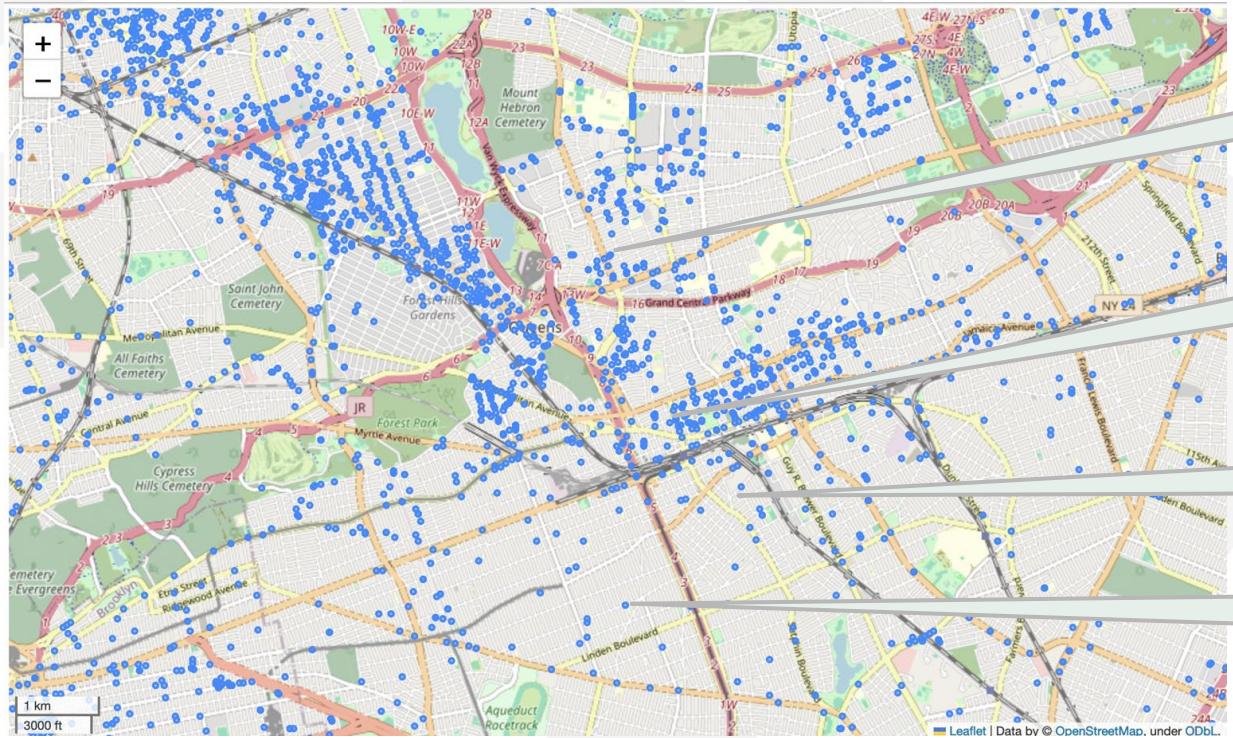
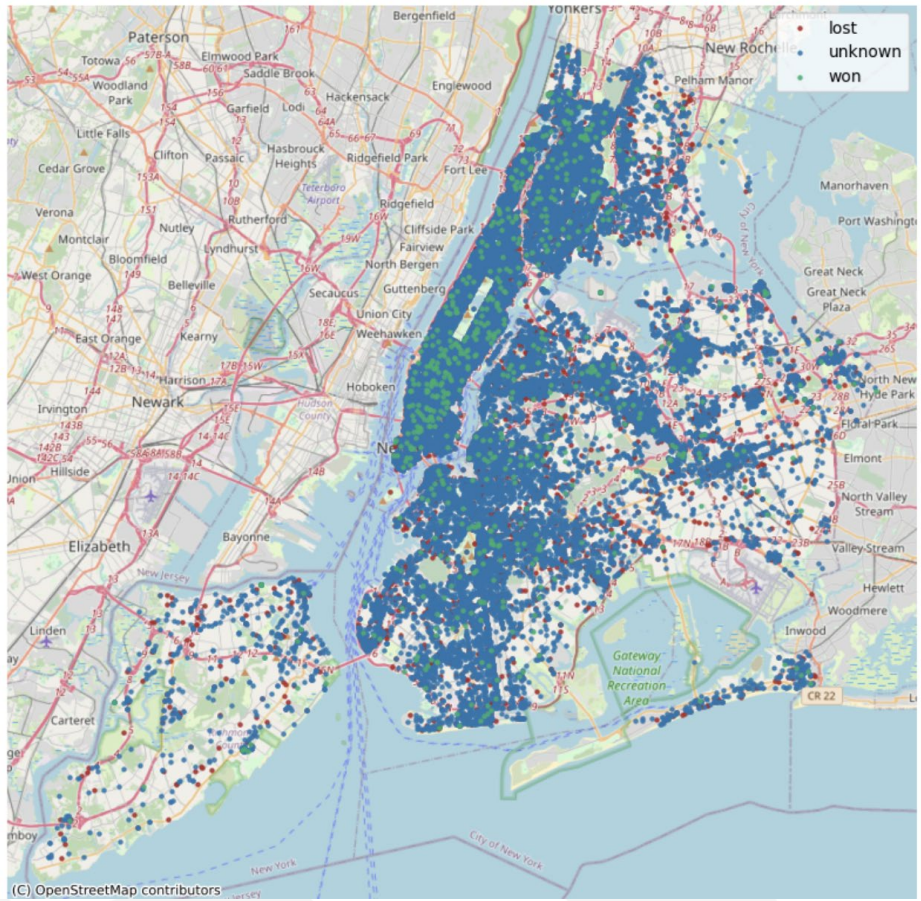
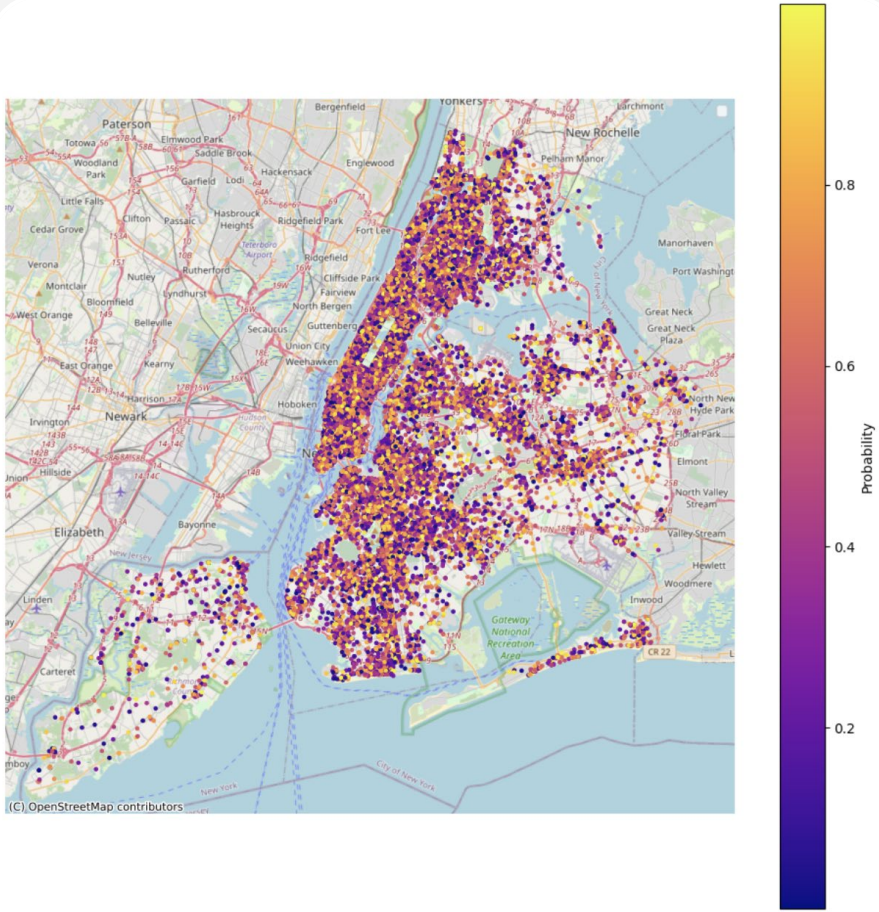




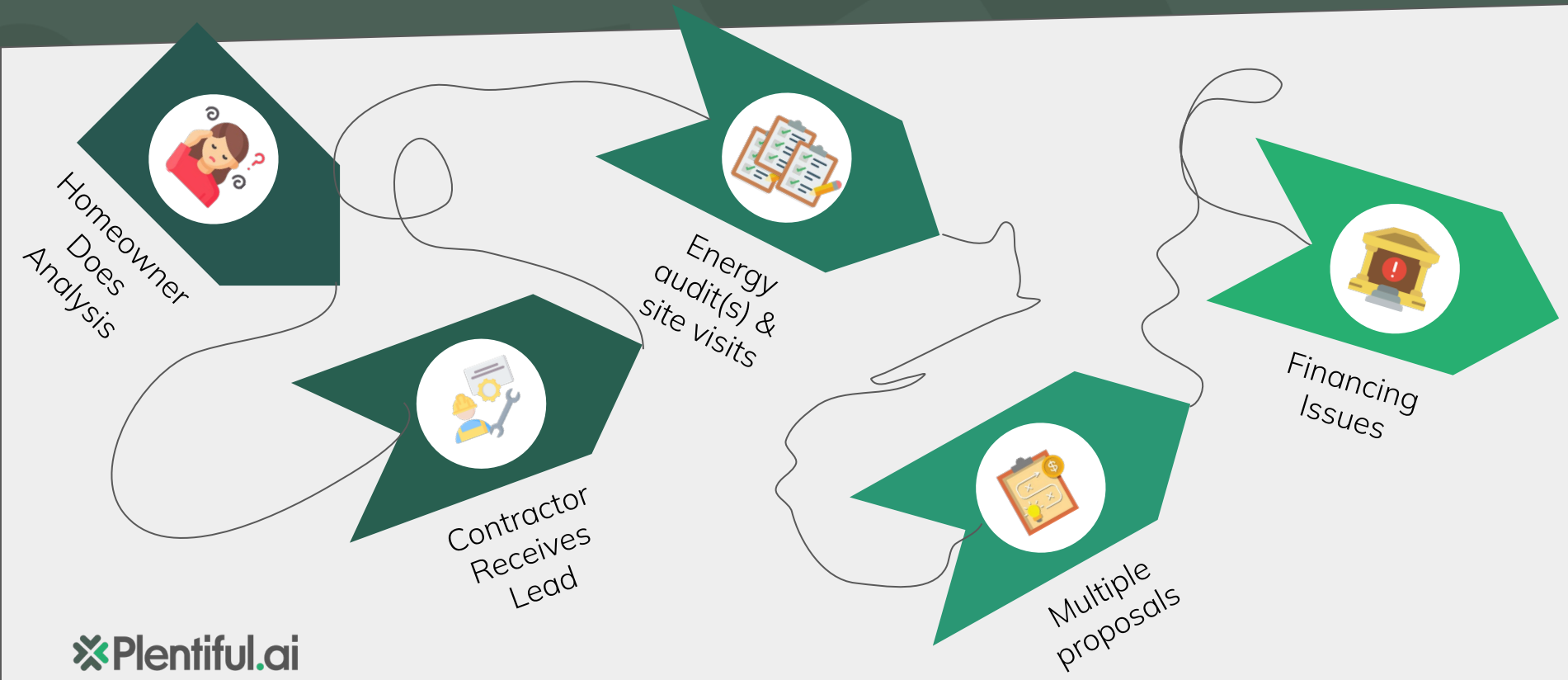
Model is trained on won leads, lost leads

Unknown points are predicted on



Ok, so what?

Even if homeowners are reached, decarbonization is messy



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Fixing parts of a process can yield huge results

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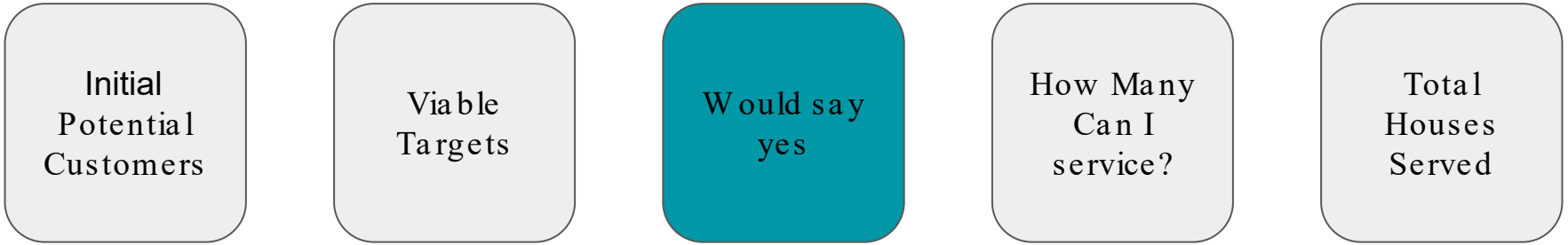
Fixing parts of a process can yield huge results



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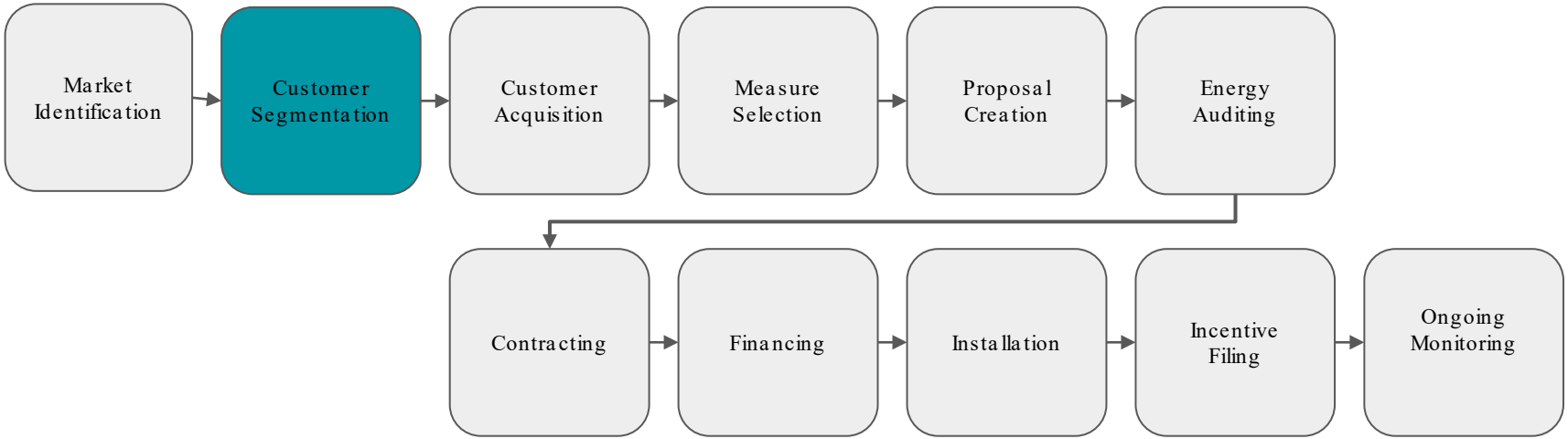
There are many steps to decarbonization

And we need to automate as many of them as possible.



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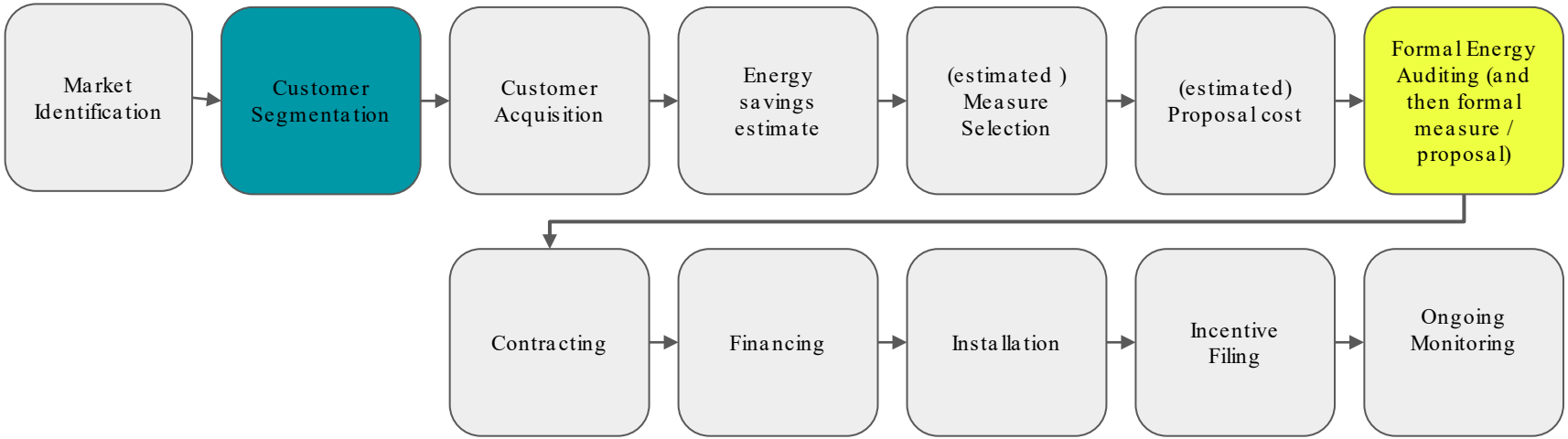

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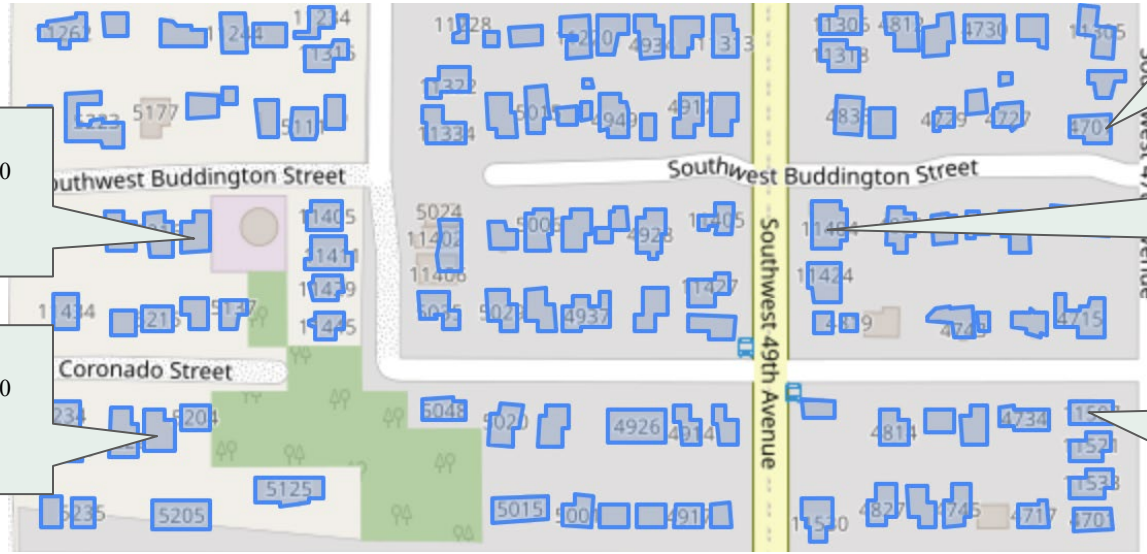
How do we Focus our efforts?

-Propensity: 82%
-Cost To Electrify: $17,000
-Incentives: $7,500
-Savings: $7000
-Lifetime Cost: $2,500

-Propensity: 75%
-Cost To Electrify: $10,000
-Incentives: $8,000
-Savings: $4000
-Lifetime Cost: $-2,000



-Propensity: 85%
-Cost To Electrify: $48,000
-Incentives: $12,000
-Savings: $8,000
-Lifetime Cost: $28,000

-Propensity: 36%
-Cost To Electrify: $55,000
-Incentives: $14,000
-Savings: $8000
-Lifetime Cost: $33,000

-Propensity: 49%
-Cost To Electrify: $20000
-Incentives: $4000
-Savings: $4000
-Lifetime Cost: $12,000

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And now, a Guest Appearance by CPR

CPR's Virtual Energy Audit

Tom Hoff – Founder and Chief Research Officer
and
Brittany Farrell – Senior Researcher
brittanyf@cleanpower.com

May 21, 2024

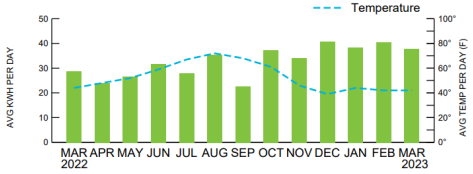
Clean Power Research

The Virtual Energy Audit

Uses historical customer energy use and outdoor temperature to create energy models for the home

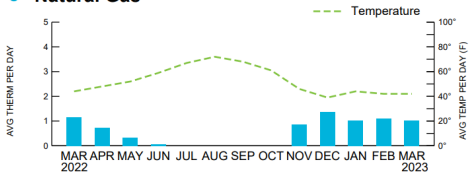
Your Usage Information

Electric

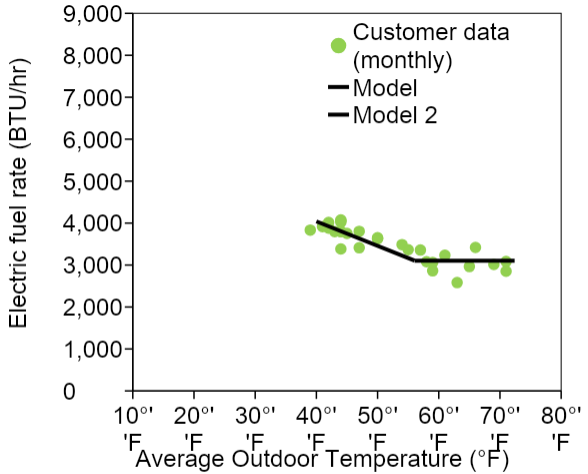


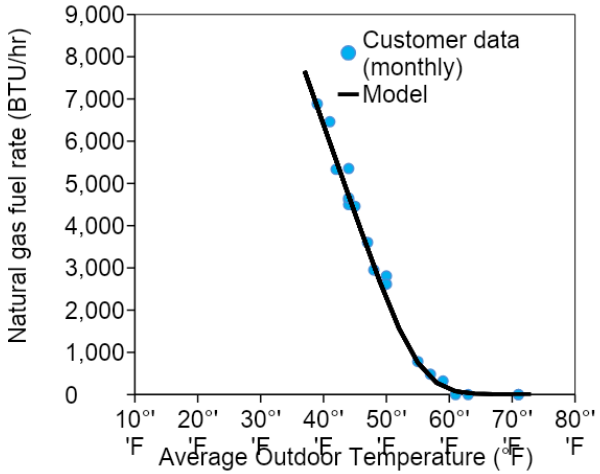
	Last Year	This Year
Average daily kilowatt hours	28.67	**37.66**
Average daily cost	$3.60	**$5.27**
Days in billing cycle	33	**32**
Average temperature	44°F	**42°F**

Natural Gas



	Last Year	This Year
Average daily therms	1.12	**0.98**
Average daily cost	$1.56	**$1.66**
Days in billing cycle	33	**32**
Average temperature	44°F	**42°F**

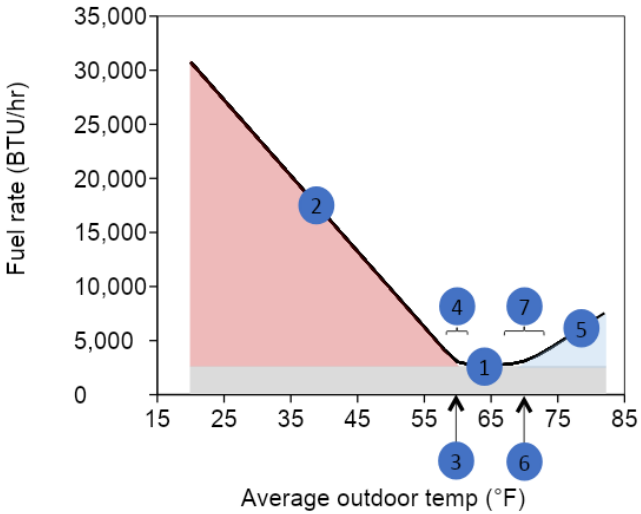




Clean Power Research

US Patent 10,797,639. System and method for performing power utility remote consumer energy auditing with the aid of a digital computer. https://patents.google.com/patent/US10797639.

The energy model

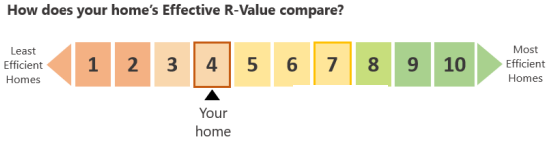


Model components

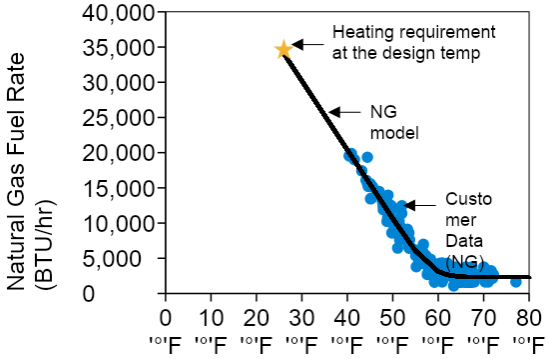
1. Other fuel rate
2. Heating fuel rate
3. Winter balance point temperature mean
4. Winter balance point temperature standard deviation
5. Cooling fuel rate
6. Summer balance point temperature mean
7. Summer balance point temperature standard deviation

Virtual Energy Audit Model Uses – Individual Buildings

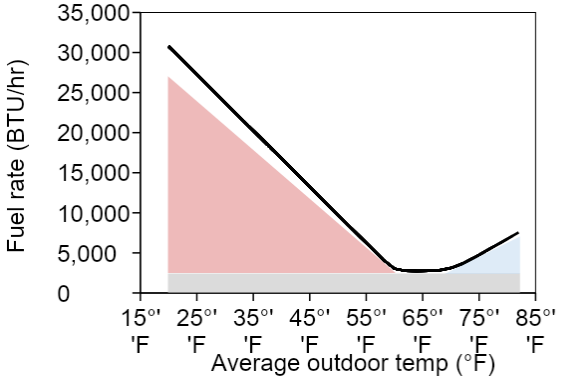
Determine overall home thermal energy efficiency



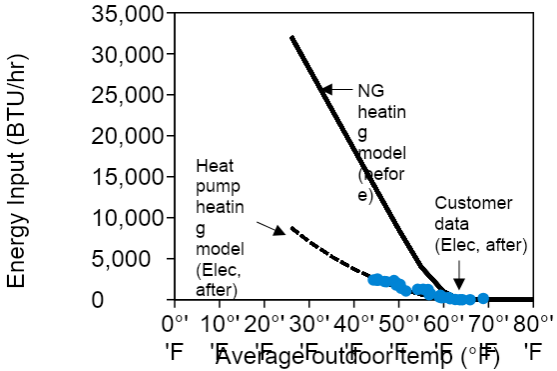
Size new heating and cooling systems



Calculate heating and cooling load

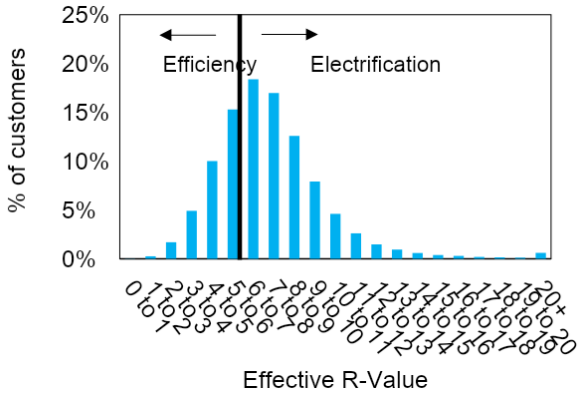


Validate energy savings



Virtual Energy Audit Model Uses – Bulk Audits

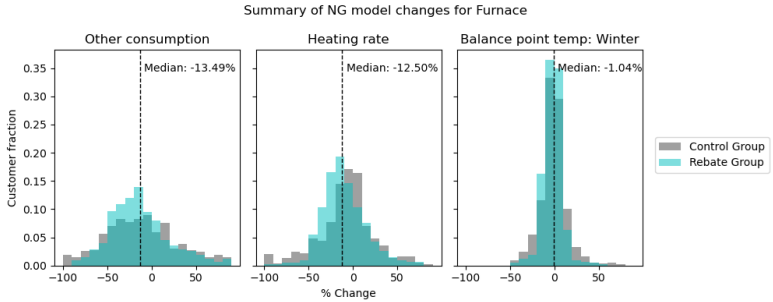
Prioritize customers for programs



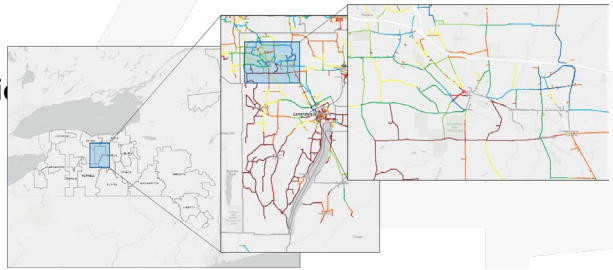
Plan program funding

R-Value Range	Gas and Electric Customers – Single Family Homes				
	Customers		Average Square Footage per home		
	#	%	Conditioned Area	Est Roof	Est Walls
0 to 1	21	0.0%	1,838	1,057	1,804
1 to 2	323	0.3%	1,688	1,042	1,674
2 to 3	2,130	1.7%	1,787	1,064	1,753
3 to 4	6,171	4.9%	1,821	1,081	1,772
4 to 5	12,561	10.0%	1,806	1,074	1,768
5 to 6	19,204	15.3%	1,799	1,076	1,763
6 to 7	23,104	18.4%	1,811	1,098	1,758
7 to 8	21,332	17.0%	1,826	1,125	1,752
...					

Track program efficacy



Plan electrificati infrastructure



DIGITIZING DECARBONIZATION SUMMIT LIST

THANK YOU!

Jason S. Trager, Ph.D.

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