Weather-Related Power Outage Prediction

An Application of Machine-Learning and Impact Modeling

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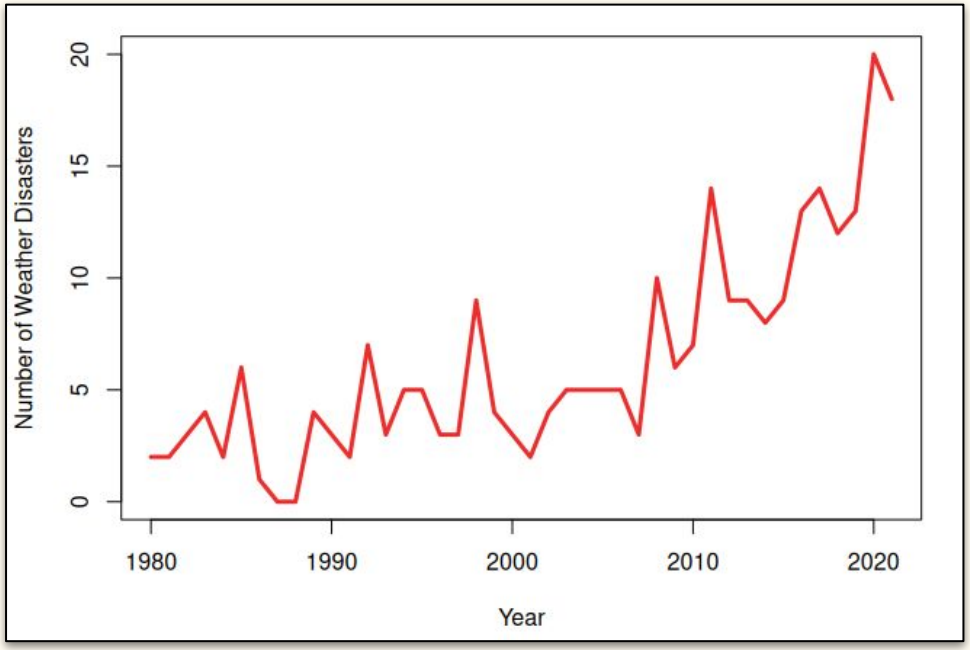
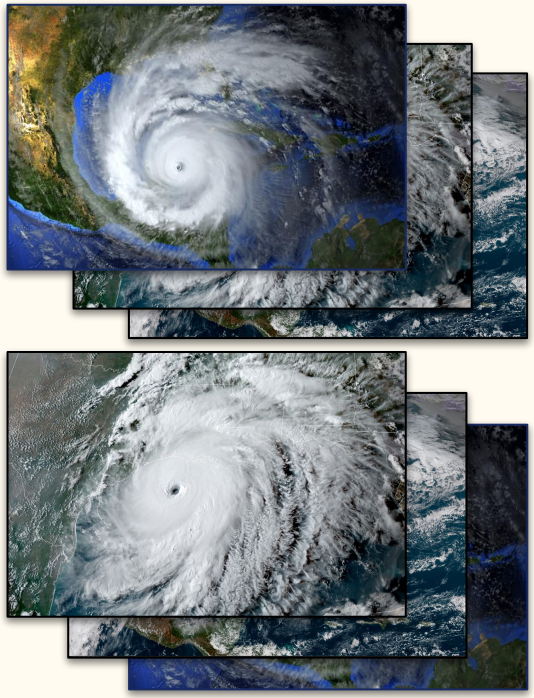
Background

Frequency of Disastrous* Weather Events in the USA

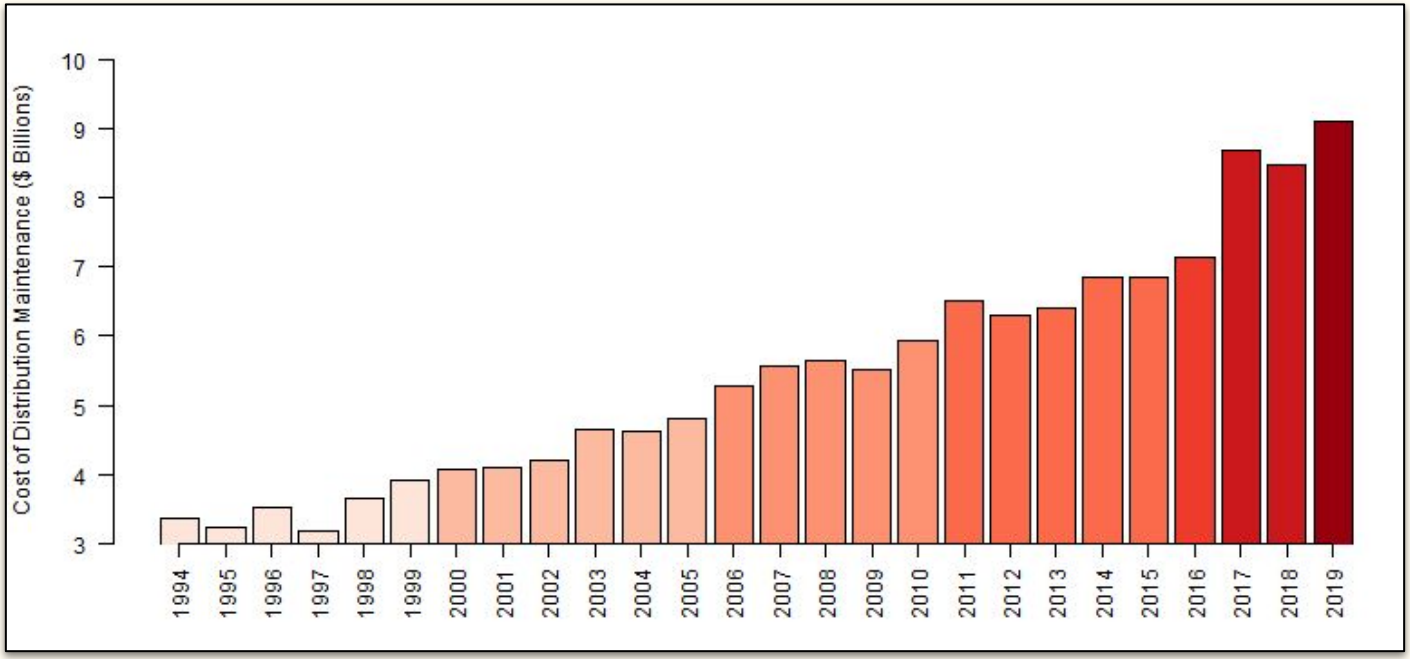




* Causing $1 Billion in damages or more, Data from NOAA: ncdc.noaa.gov/billions

Background

Annual Costs to Repair Weather-Related Power Outages in Power Distribution Systems



Data from Federal Energy Regulatory Commission F1 Reports

Problem & Solution

Storm response is inefficient because storm damages are difficult to predict.

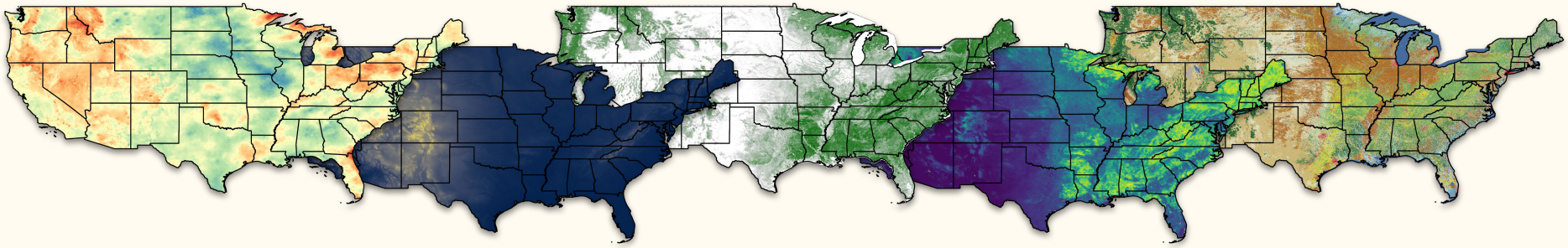
Better understanding of storm impacts would:

- Help utilities prepare
- Shorten/reduce power outages
- Save utilities money
- Improve customer relations

Methods - Multidisciplinary

To predict storm damages we combine:

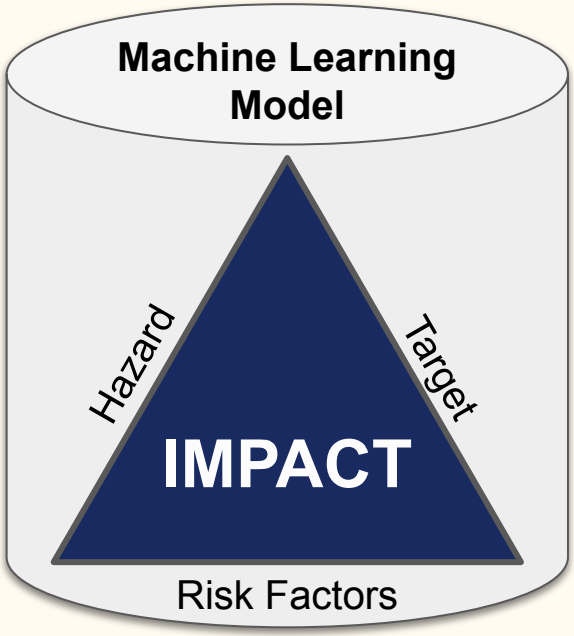
- Machine Learning
- Spatial Analytics
- Physical Modeling
- Environmental Science



Methods - Data-Driven Impact Modeling

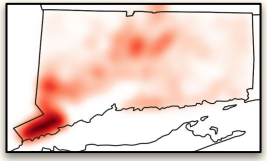
It's important to include data about:

- **The Hazard:**
  - Extreme Weather
- **The Target:**
  - Power Distribution Infrastructure
- **The Risk Factors:**
  - Vegetation, Soils, Elevation, etc
- **The Impact:**
  - Power Outages: "Trouble Spots"

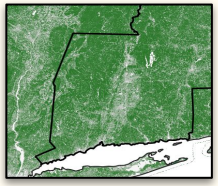


Methods - Architecture

Outage Data

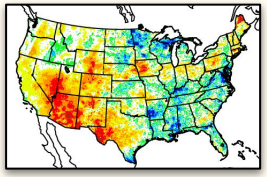


Vegetation Data



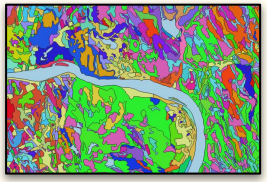
Infrastructure Data

Drought Data



Weather Data

Soils Data



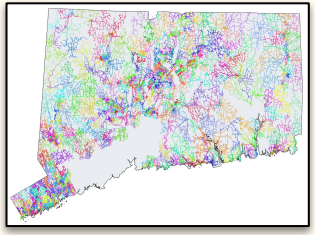
Develop Data Sources

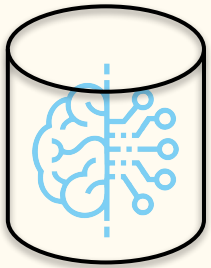
Aggregate Data

By Area

OR

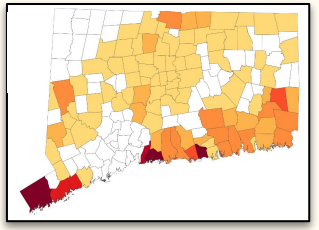
By Circuit





Machine Learning Model

Damage Prediction



Operational Development - Domain

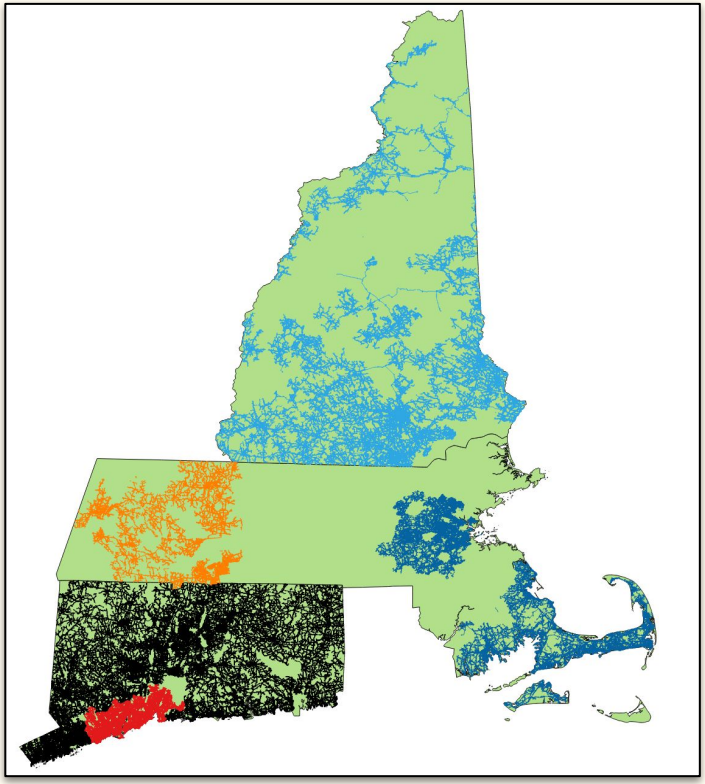
The UConn OPM has been operational for years in parts of:

- Connecticut
- New Hampshire
- Massachusetts

Currently in development for:

- New York

Our ability to build models is limited by access to data and utility partnerships



The Outage Prediction Model Domain

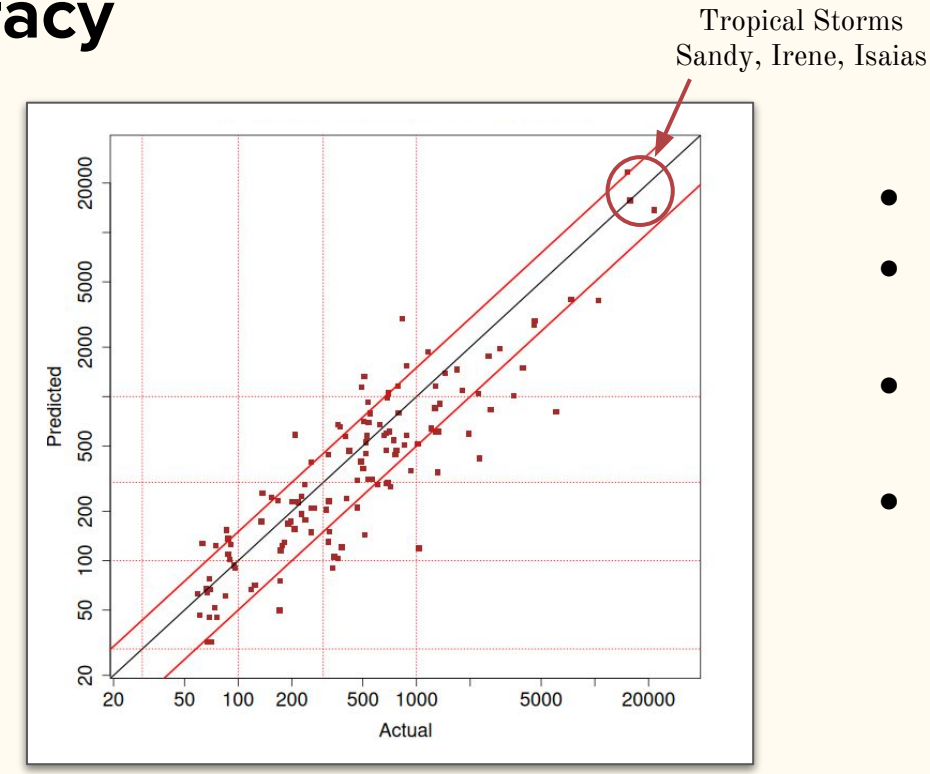
Operational Development - Models

There operational models for different types of weather:

- High Impact Storms
- Rain / Wind Storms
- Thunderstorms
- Winter Storms

Weather forecasts and models can limit the accuracy of outage forecasts

Accuracy



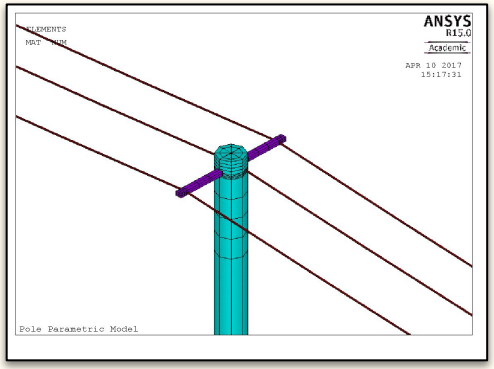
Outage Model Cross-Validation Results

R^2: 0.78, MAPE: 44%

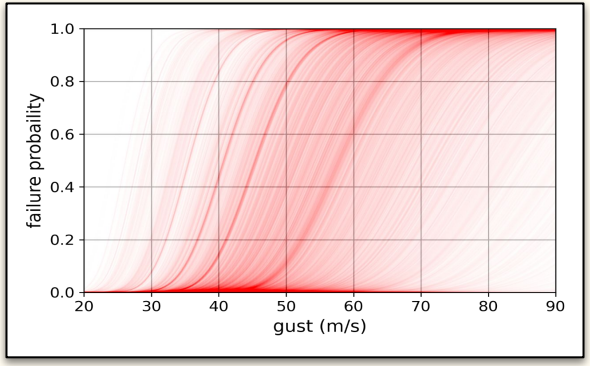
- We predict ‘Trouble Spots’
- This is an ‘out-of-sample’ evaluation of the outage model
- Perfectly accurate predictions along 45° line
- Very good at capturing the magnitude of the impact of storms
    - This is *critical* information for storm preparation

Applications: Evaluating Resilience Upgrades

Proposed changes to physical infrastructure can be evaluated and effects quantified



Physical Simulations



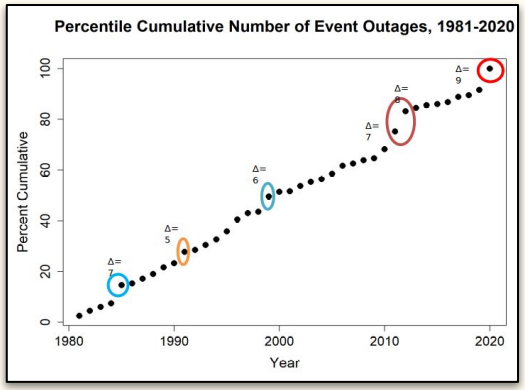
Fragility Curves

Granular Infrastructure Vulnerability

Applications: Long Term Vulnerability Analysis

The outage model can be used to estimate frequency and intensity of storms over long periods:

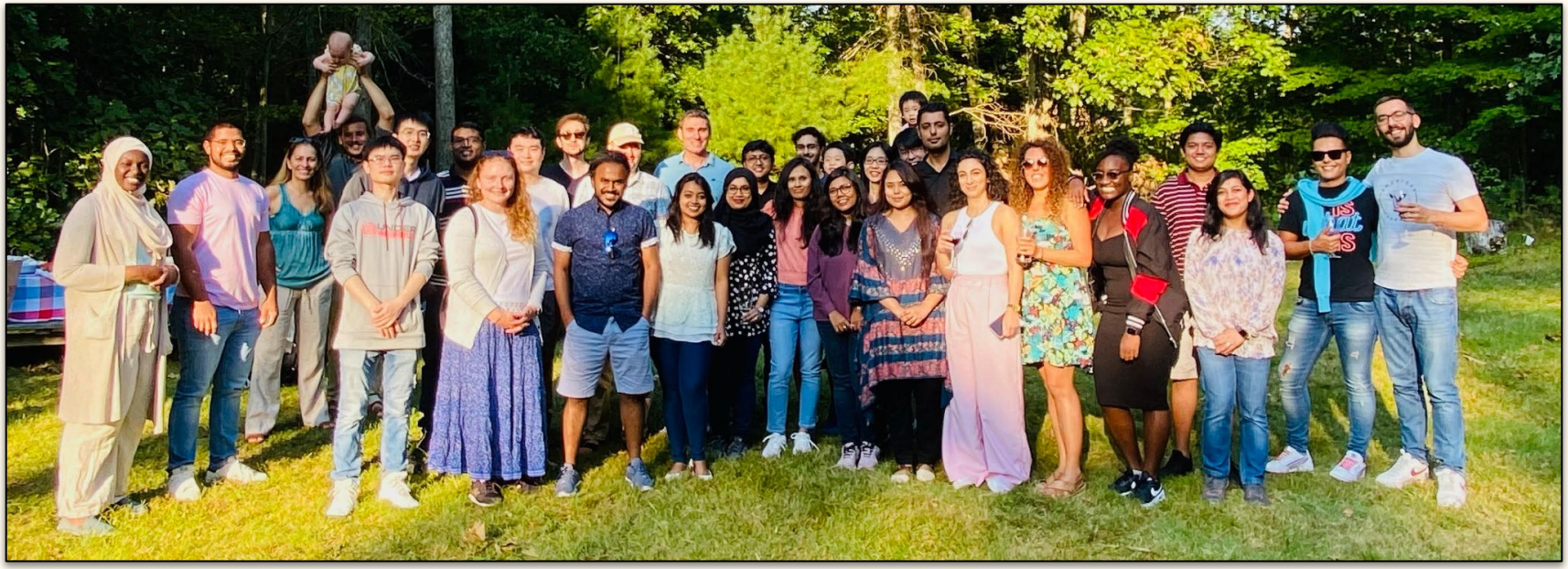
- Generate return frequencies for outage events
- Estimate future impacts via global climate projections



Return Period of Major Outage Events in CT

Gloria	Bob	Irene	Sandy	Floyd	Isaias
12 years	16 years	29 years	31 years	40 years	50 years

Acknowledgements



Large Team, Years of Effort!

Thank you!!

Questions, Comments, Feedback to:

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