



UA Summit[®]

May 10 - 12, 2022 | New Orleans, LA

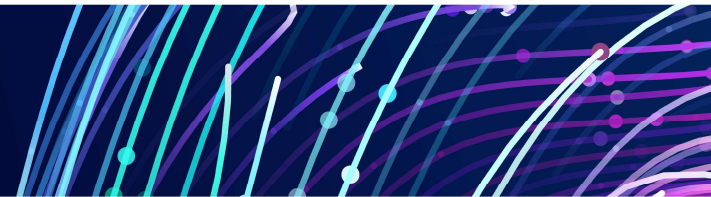
Hosted by **Entergy**

301: Tree-Outage Predictive Model

Presenters: Matt Fernandez & Nate Turner Ph.D.

Agenda

- Company Background
- Project Overview
- Model Development Progression
- GIS Display Tool Architecture & Demo
- Model Validation & Potential Enhancements
- Acknowledgements & References
- Q & A



About Us



*Ohio, Pennsylvania, West Virginia, New Jersey, Maryland

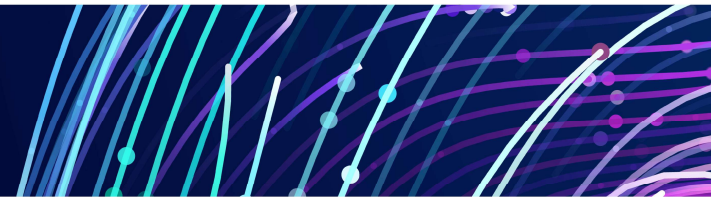
 Digital Transformation Initiative



 GIS Implementation



Twitter: @weareucal
#UASummit2022 #UtilityAnalytics



Project Challenge Statement & Value

Identified various advanced analytics opportunities in Forestry area via Design Thinking, determined the below could yield the most value

The Challenge



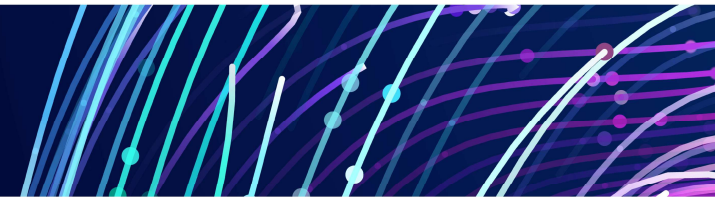
How might we predict potential occurrences of distribution tree-caused outages based on physical and environmental impacts, so that we can make data-driven vegetation management decisions to maximize investment value.

The Value



This tool aims to achieve a net improvement in reliability metrics as they relate to tree-caused outages. Model output, coupled with proper preventative maintenance action could:

- Reduce number of tree-caused outages
- Reduce revenue impact of tree-caused outages
- Improve utility reliability metrics
- Improve customer satisfaction



Use Cases

- Forestry Manager
- Forestry Specialist

The below applications were defined through user research sessions with FirstEnergy Forestry professionals

Use Case 1 ●

DATA-DRIVEN MAPPING TO SUPPORT CONTRACTOR COLLABORATION

- Pull dashboard insights and data points to enhance physical GIS maps used in the field
- Support Forester conversations and work activity prioritization with contractor crews

Use Case 2 ● ●

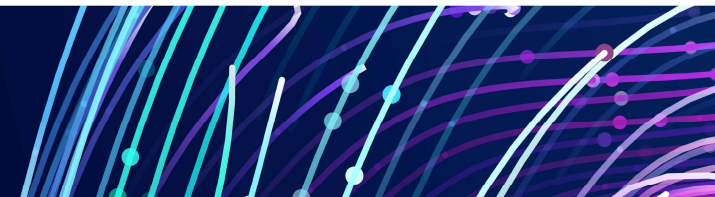
RISK PREDICTION TO GUIDE WORK ACTIVITIES

- Prioritize high-risk areas when planning scheduled trimming activities
- Identify high-impact circuits to allocate unexpected funds

Use Case 3 ●

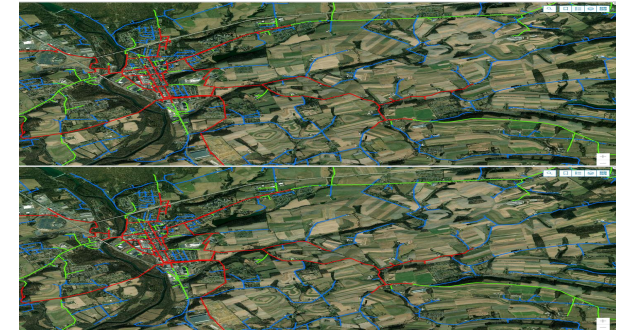
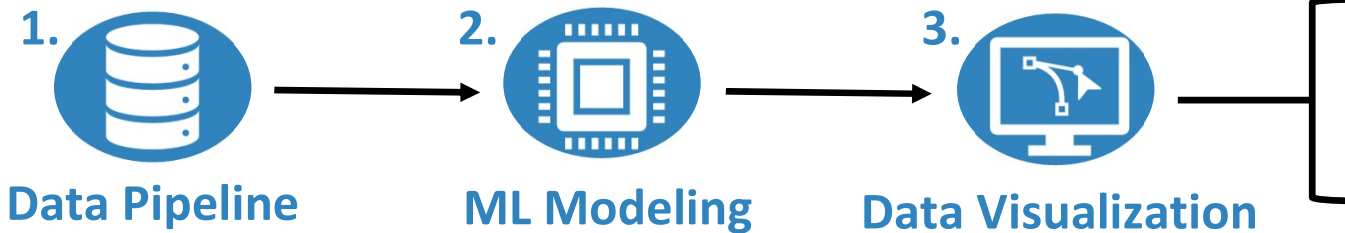
YEARLY BUDGET PLANNING

- Support budget proposals for yearly budget planning meetings
- Enhance work planning estimates (e.g., estimated cost per mile, trees per mile, etc.)



Model Approach

Through additional user research sessions, the team decided on the main components of the tool




Next, the team needed to evaluate all available internal data and source external data



Bottom-Up OR Top-Down?

Bottom-Up: Start with the highest quality information we can obtain

- Example: LiDAR, Drones, Truck mounted cameras



Top-Down: Collect as much data as possible available for footprint, then make best model within those data constraints

- Example: soil, weather, topology

Model Approach (cont'd)

More decisions were made on how to define initial data pipeline and modeling scope


? Model entire service territory up front OR one area?

Entire Service Territory: Construct data pipeline and model for all company territory:

- + Less risk of model overfitting
- + More opportunities for feedback
- More effort for data wrangling/cleaning
- All or nothing success/failure

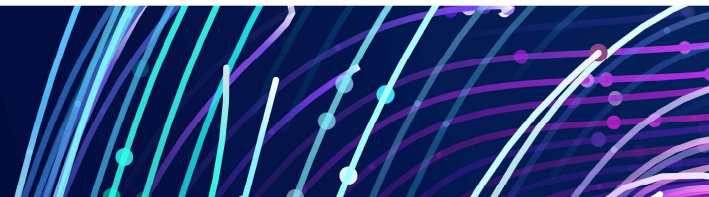


- Diversity of terrain
- Receptive Forestry team
- Typical data quality



Choose One Region: Construct data pipeline and model for one region with plans to scale based on success:

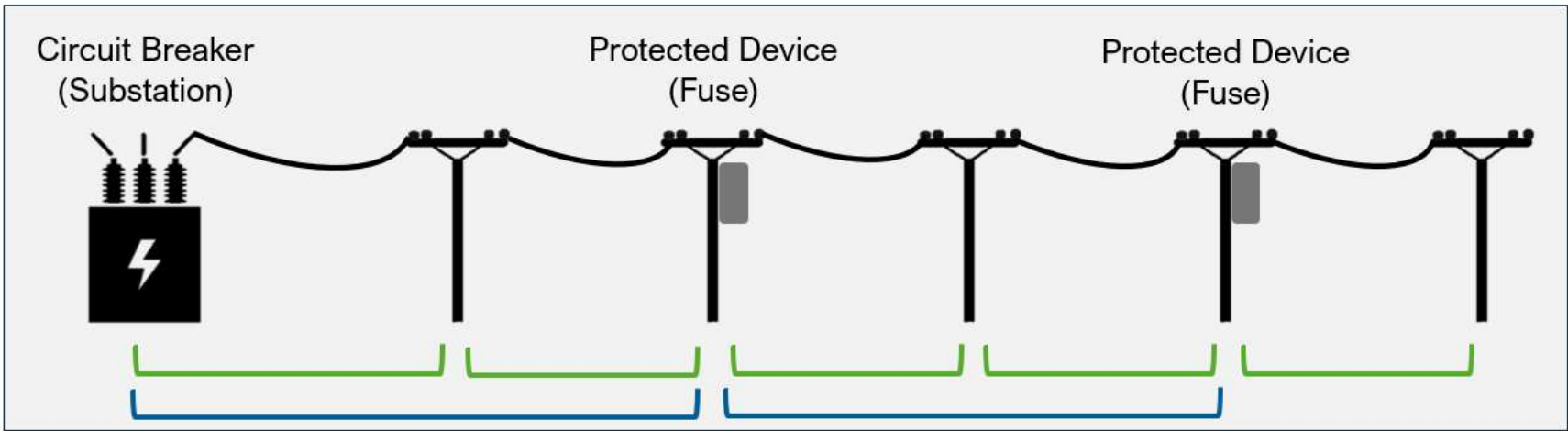
- + More manageable data set sizes
- + Ideal scale for ArcGIS proof of concept
- Risk of data quality differences when scaling
- Groups of foresters using different tools



Model Approach *(cont'd)*

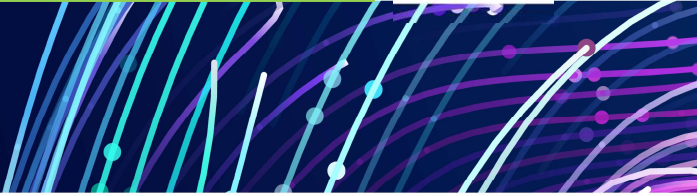
Team pivoted on model granularity

? Model by Protected Device OR Wire Span?



Protected Device-Level Model:
Likelihood of outage between each faultable device

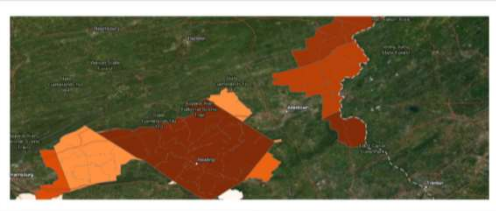
Wire Span-Level Model:
Likelihood of outage between each span of wire



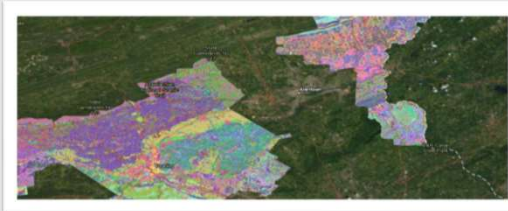
Datasets

Externally-Sourced

¹**FIADB**: Tree population and species estimates by county



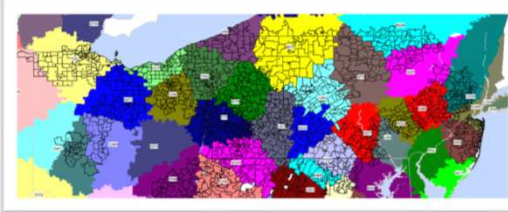
²**gSSURGO**: Soil information at sub-city scale



³**DEP**: Elevation transformed into slope and aspect grid



⁴**NOAA**: Detailed hourly weather



Internally-Sourced



Vegetation Mgmt System:
Tree maintenance program information



Outage Mgmt System:
Tree-caused outage information



GIS Circuit:
Asset location and identification information

Predictive Modeling Technique

Model Overview



Random Forest: Supervised learning model which identifies patterns within feature variables using decision tree methodology
(see right for sample feature list)



Sample of Features

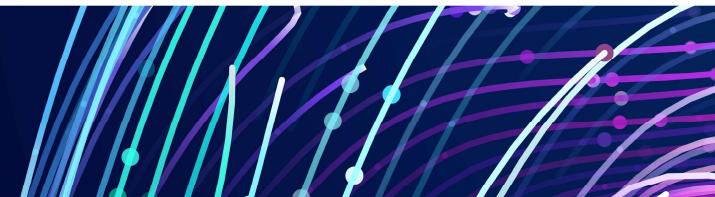
1. Slope
2. Length of Wire
3. Elevation
4. Average Pole Age
5. Aspect
6. Frost Free Days
7. Average Air Temperature
8. Mean Annual Precipitation
9. Albedo
10. Total Annual Precipitation

Model Output



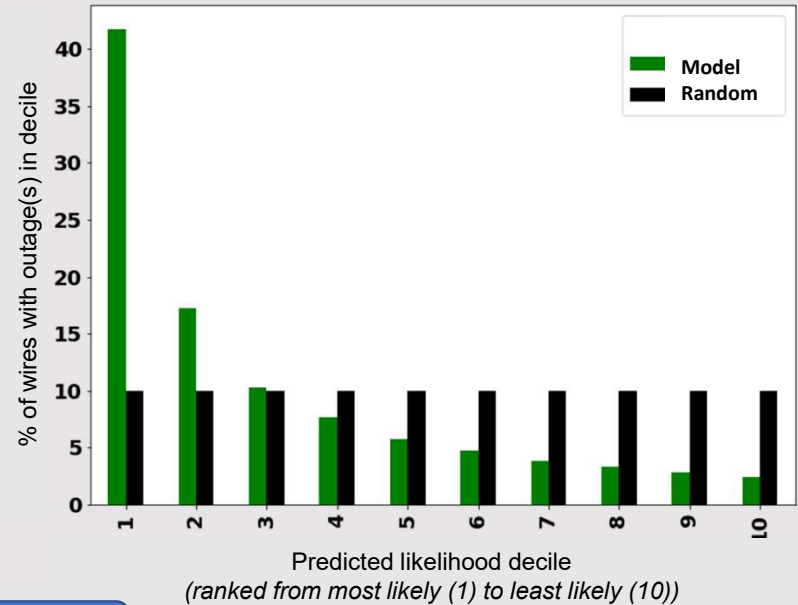
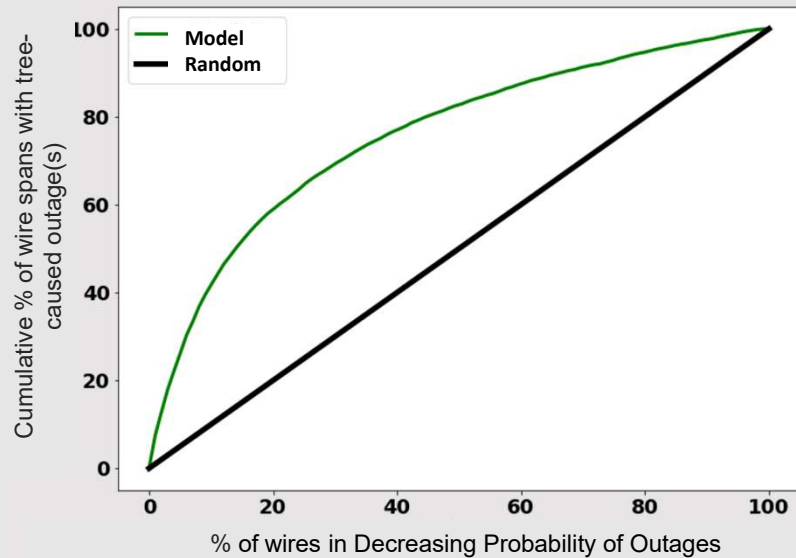
Model calculates a numerically-represented **likelihood** of a tree-caused outage on a particular span of distribution wire.

Likelihood is then multiplied by **# of customers** downstream.

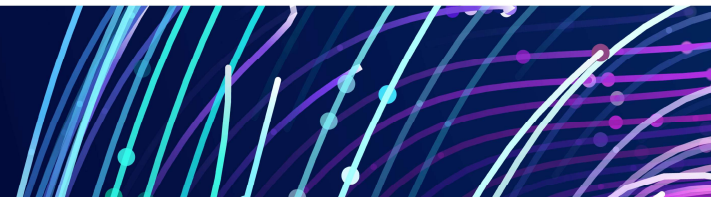


Predictive Modeling Performance

Final Predictive Model: Random Forest using Python imbalanced learn package



F1 Score: Assuming 1st decile is targeted as true positive = 0.51

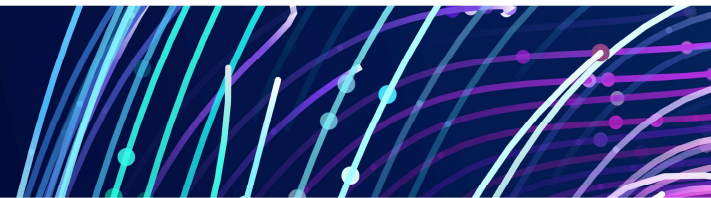


Tool Demo (Live)



Twitter: @weareuoi

#UASummit2022 #UtilityAnalytics



Model Validation

Retroactively applied the model to 2018 trimming cycle

Model identified the following:

 **914** Outages   **145k** Customers Impacted
(From 2018-2021)

A/B Testing phase began January 1, 2022, with eastern-PA operating company

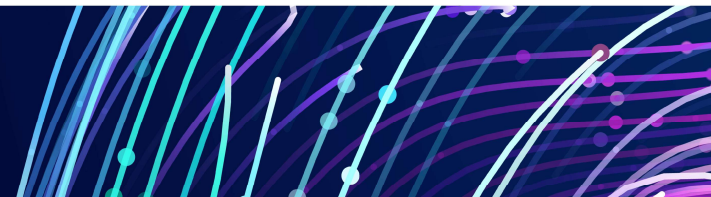


Target wire spans with the highest predicted **likelihood** of having a tree-caused outage based on model output



Split 2022 circuits into A & B pairs based on comparable features

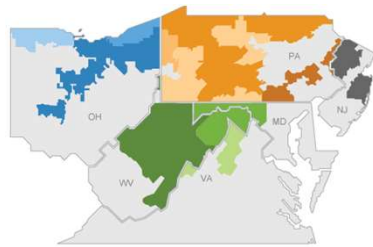
Group A (baseline/control)
Group B (tool-enhanced)



Potential Enhancements

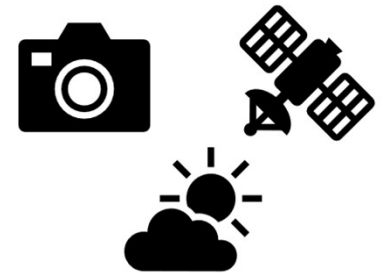
Scale to remaining footprint

- Expand internal and external dataset scope
- Explore environmental differences across remaining operating companies and potential impacts on model



*Future release possibilities

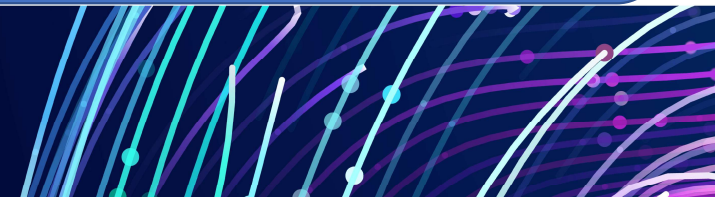
- Incorporate satellite imagery and/or LiDAR data
- Expand historical weather capabilities



**Dependent on A/B Testing results*



"With the click of a mouse, we can see the probability of outages, and this model can take us right down to the pole level. It's exciting to think of how we can use this to minimize storm impacts over time and ensure reliability for our customers " - **Doug Kinyo (Manager, Forestry Services)**



Acknowledgments

FirstEnergy

Advanced Analytics

- Denise Mullins, Manager
- Nate Turner, Data Scientist
- Jingyan Chen, Data Scientist
- Jason Goodfriend, Data Scientist
- Matt Fernandez, Business Analyst
- Mike Stansky, Consultant

Vegetation Management

- Paul Barkoukis, Supervisor and Product Owner
- Rebecca Spach, Director
- Shawn Standish, Manger
- Marvin Mantos, Manager
- Doug Kinyo, Manager
- Todd Cannon, Forestry Specialist
- PA East Forestry Team

Field Mobility & GIS

- Aaron Hughes, Supervisor
- Josef Arvidson, GIS Configuration Analyst
- Brendon Meier, GIS Configuration Analyst
- Richard Koch, GIS Specialist

accenture

Accenture Support

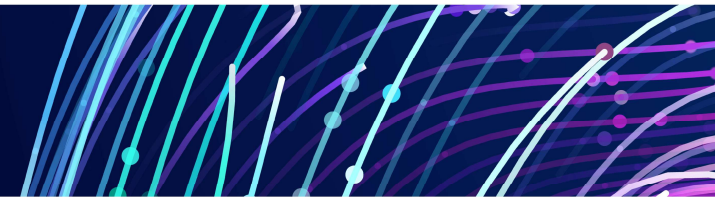
- Kyle Perline, Data Scientist
- Zac Hess, Data Scientist
- Chizoba Nwobodo, GIS Specialist
- Megan Copeland, Designer
- John Haglund, Designer
- Tamara Cody, Designer



 UA Summit®

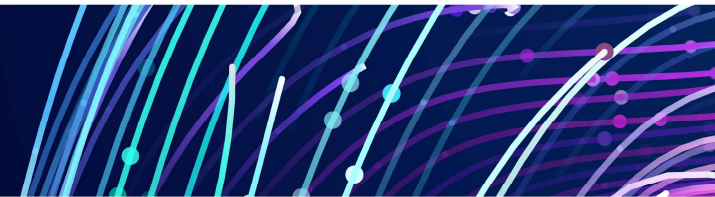
Twitter: @weareuai

#UASummit2022 #UtilityAnalytics



References

1. U.S. Department of Agriculture, Forest Service. 2022. Forest Inventory and Analysis Database (FIADB). Version 1.9.0. Washington D.C.
https://apps.fs.usda.gov/fia/datamart/CSV/datamart_csv.html. (9/01/2021).
2. Soil Survey Staff, Natural Resources Conservation Service, United States Department of Agriculture. Soil Survey Geographic (SSURGO) Database. Available online at <https://sdmdataaccess.sc.egov.usda.gov>. Accessed [7/28/2021]
3. U.S. Geological Survey, 2019, National U.S. Geological Survey, 2019, 3D Elevation Program 13 arc-second Resolution Digital Elevation (published 20190417) accessed July 22, 2021 at URL Applications & Visualization Services | U.S. Geological Survey (usgs.gov)
4. National Oceanic and Atmospheric Administration <https://www.noaa.gov/>
5. FirstEnergy Corp. Annual Factbook (published 2/10/22):
https://s27.q4cdn.com/655807321/files/doc_financials/2021/q4/4Q21_Investor-FactBook_Final.pdf



THANKS FOR ATTENDING

Please fill out an evaluation form and drop it in the collection basket located at the back of the room.

To learn about membership in the Utility Analytics Institute, please visit www.utilityanalytics.com

Additional Questions can be directed to: mfernandez@firstenergycorp.com



Twitter: @weareuai

#UASummit2022 #UtilityAnalytics

