Weather-Related Power Outage Prediction: An Application of Machine-Learning and Impact Modeling

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Background/Objectives. Severe weather events significantly disrupt the power grid every year in the United States. While for many individuals, these power outages may be considered a nuisance, power outages are a leading cause of the loss of life in natural disasters, and weather-related power outages cost the US economy tens of billions of dollars every year. They are also very difficult for power utilities to respond to. A big storm may require a power utility to grow its workforce many times over in a matter of hours, spending millions of dollars on extra repair crews every day that customers are out of power. There have been many high-profile examples of power utilities being caught unprepared for severe weather, resulting in prolonged power outages and large punitive fines for the utility. In order for utilities to be able to improve the resilience of the US power grid and prepare it for the challenges that climate change presents, better predictions about the impacts of weather to electrical infrastructure need to be made available to them.

Approach/Activities. A dynamic power outage prediction system has been in development at the University of Connecticut for several years. This system uses weather forecasts and a machine learning model trained on a large number of historical storms and a wide range of interdisciplinary environmental datasets, to forecast the impacts of approaching weather events to a utility's electrical distribution network. Not only does this system validate well on historical storms, but it is currently issuing operational forecasts for several power utilities. Over time, the operational forecasting system has proven to be invaluable in generating insights and guiding improvements of the machine-learning outage model. Over several iterations we have been able to converge on a model architecture that is able to accurately predict the impacts of severe weather events, and provide emergency managers actionable information that lets them prepare effectively.

Results/Lessons Learned. Over the years we have developed approaches to address several problems associated with predicting storm impacts. These include methods to accurately predict the impact of particularly extreme weather events, which can be several orders of magnitude stronger than other storms; techniques to communicate the uncertainty associated with outage forecasts; and strategies on how to manage the weather forecasting error that can cause errors in the outage prediction model. In addition, we have developed several case studies where the dynamic outage model has been able to quantify the effects of adaptive changes, like enhanced tree trimming, in the power grid. While development has taken some time, this technology has the potential to radically improve the types of information that is available to decision makers before severe weather events, and thus significantly improve the resilience of infrastructural systems to climate change.