Outage prediction: Using big data to solve big problems

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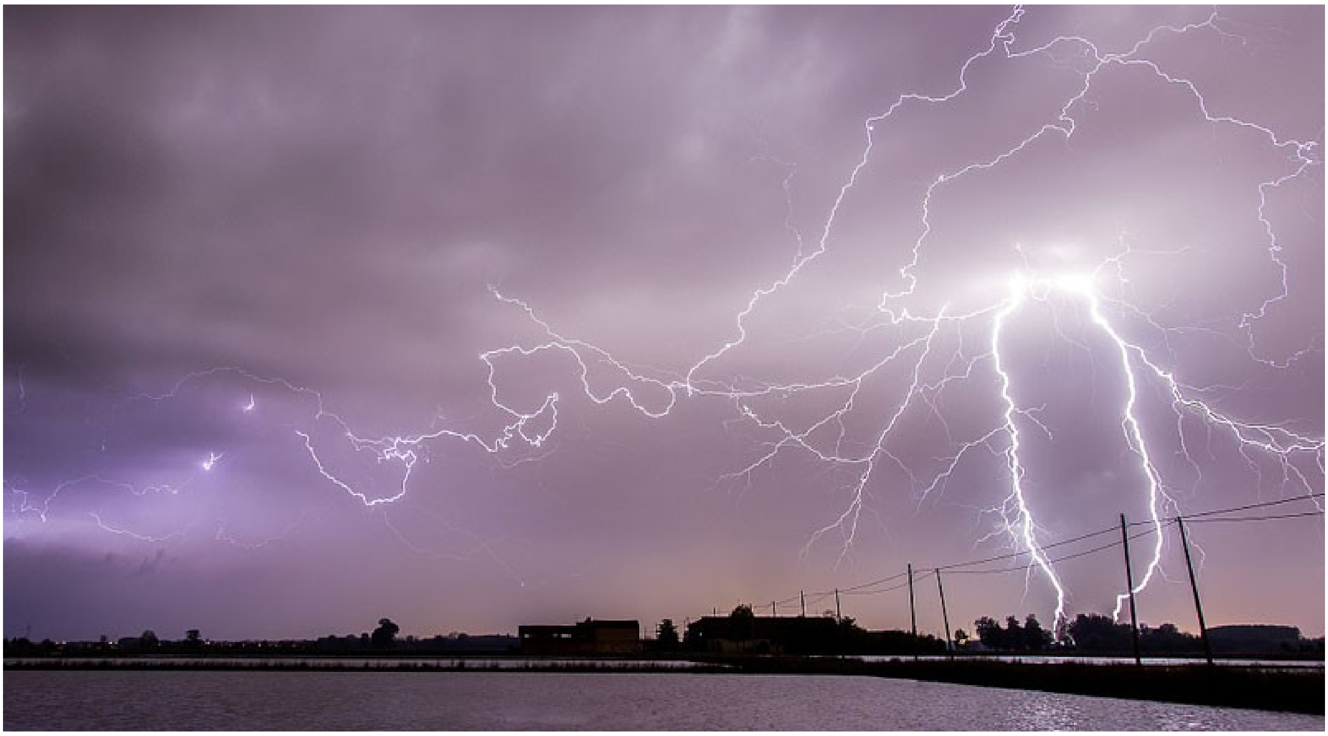
ASSET MANAGEMENT BIG DATA CLIMATE OUTAGE MANAGEMENT

Better weather prediction will be a key feature in combating the effects of climate change on grid reliability. Models based on machine-learning algorithms are a promising approach.

1 comment



Key points to develop:

The combination of more powerful computers, increasingly sophisticated programming and the availability of vast quantities of data is transforming any activity involving a network, ranging from online shopping to cancer diagnosis. It is no surprise therefore that the electricity sector, whose power networks everybody depends on to function, is also exploring how the latest advances in science and technology can be used to improve reliability, efficiency and resilience.

RWE, one of Europe's most innovative and forward-looking utilities, has teamed up with GE to develop an outage prediction methodology that integrates data from a number of sources to predict and prevent outages and respond quickly before they occur. Manuel Weindorf, GE Grid Solutions Technical Solutions Director, outlines the context. "Weather has always been a major influence on grid performance of course, causing and influencing around 70% of outages. With climate change we're likely to see more extreme weather events and increasing threats to operations. RWE is already seeking ways to respond to the emerging challenges and maintain its high levels of customer satisfaction."

Climate variables and variance

The GE team started by collecting asset, operational and incident-response data. The asset data contained the network topology of the substations and the distribution lines; data related to the assets; outages reported from 2006 to 2015; notifications received and actions taken regarding the notifications. RWE also provided its own data on a number of other features, for example physical asset characteristics and network topology, and nearly 30,000 outage reports.

GE acquired data from six weather stations associated with the RWE regions as well as historical weather data from the weather station nearest to distribution substations and other related grid assets. Weindorf stresses the complicated relationship with weather and climate change in Germany. “Integration of renewable energy sources is a key part of the strategy to combat climate change, and hopefully in the long run they will help to mitigate the negative impacts. But in the meantime, they can also cause some variation in power generation because of their intermittent nature and unpredictable generation profiles, which puts additional stress on related grid assets.” This is especially true for the low voltage side of the distribution grid where most of the DSOs today do not have a huge amount of visibility on the actual grid condition, as automation and monitoring capabilities are not yet deployed at full scale.

A walk in the Random Forest

Once the data had been acquired and the influencing factors identified, the next step was to select a modeling approach. A random decision trees model was chosen. This is an ensemble method, meaning that it uses multiple algorithms to give better predictions than would be obtained by any of the individual algorithms. It also minimizes “overfitting”—errors that occur when highly complex models fail to spot the underlying relationship and return random errors or noise instead. Other advantages of this approach include its lower computational requirement for large volumes of data compared to other models; its ability to handle both categorical and numerical variables; and the fact that it can deal with unbalanced and missing data.

The model was applied to both weather and non-weather features and evaluated with different metrics. These included a Receiver Operating Characteristic curve explaining the expected prediction quality in terms of ratio between right versus wrong predictions (true positive vs. false positive), derived from the training data provided. Indirect weather

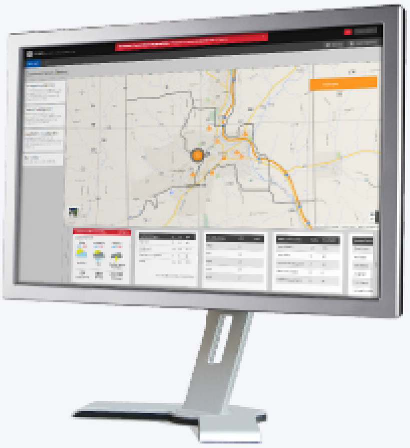
impacts had to be accounted for too, such as impacts on construction work leading to accidents that damage cables and equipment. Those kind of activities are influenced by given weather conditions (e.g. good weather could mean more road works while bad weather could mean bad working conditions and therefore more accidents / faults and slower progress.
The average true positive of outage prediction varies from 75% to 88%. The results show that historical weather data is an important predictor and variable in predicting a power outage, such as thunderstorms, rain, ice, fog, maximum temperature over the past three hours, and wind direction. Asset and geography-related features such as service area and voltage type are also important.

Teach your models well

Future iterations could test predictors other than on weather and incorporate features related to the outages themselves. The data set could also be enriched by incorporating social media feeds, for instance by identifying and analyzing outage-related keywords across a wide geographical area.
Weindorf is optimistic about the possibilities of machine-learning algorithms to improve network management and enable RWE to maintain high levels of customer satisfaction. “But,” he points out, “to learn, the machine has to be taught well. In the next stages, we’d like to use more and better data, data in its original form where possible, because aggregated and anonymized data can mask critical relationships. We may also need more geographical data to scale the models beyond two regions.”

GE’s outage restoration solutions
Damage and losses from increasingly severe weather events are costing our global economy more than $200 billion per year. From hurricanes to ice storms to wide-scale flooding, these severe weather conditions cause havoc on our power systems.
During these events, networks and substation assets can be damaged. Crews must battle storm conditions to find and assess every fault. Operators and dispatchers must navigate through a sea of disconnected data collected from various sources, leaving communities without power for extended periods of time.

To identify, assess, visualize, plan, mobilize and report all the network damage, utilities need interoperable systems and tools that are capable of sharing data between their back-office systems and their in-field teams.
GE's comprehensive suite of outage restoration solutions provide utilities with the interoperable tools they need to react and even anticipate outages, offering smart devices, geospatial visualization tools, outage and distribution management systems and mobile workforce applications. Utilities can ensure a faster and more efficient recovery.



GE's smart controls, smart sensors and substation automation devices allow utilities to implement automated switching plans that re-route and restore power, while line sensors wirelessly communicate with control sensors to identify the exact fault location.
Providing a single, accurate enterprise-wide view of the utility's network and its assets, GE's Smallworld Electric Office GIS enables utilities to visualize, collect and assess each outage.
With integrated damage assessment tools and pre-configured workflows, utilizing solutions such as GE's advanced distribution management system (ADMS), standalone outage management systems (OMS) or integrated storm management systems, operators can make more informed decisions, mobilize field personnel and communicate more accurate restoration times.
GE's Mobile Enterprise and Damage Assessment systems allow crews to visualize and capture network data using multiple platforms and devices, providing up-to-the minute information back to the central control.
GE's unique set of outage restoration solutions empowers utilities to maximize grid reliability and minimize network downtime.

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