Predictive and Prescriptive Maintenance

Dr. Krzysztof Kryszczuk,
Group Head,
krys@zhaw.ch

Dr. Somayeh Danafar,
Research Associate,
dana@zhaw.ch

We all know the inconvenience and annoyance caused when our car's engine decides to stop and die in the middle of the road, or it won't start in the morning and we have to wait for the bus, nervously typing apologetic messages on a cell phone because of the meeting we will certainly be late for. Wouldn't it be nice if we knew the evening before that the car won't start next morning? Predictive maintenance might be just the right tool to do the trick.

Predictive maintenance

Every device or machine has only so much life in it. Mechanical wear, material degradation and aging, and other factors decide how long the device can perform reliably and safely, before it must be serviced or replaced. Traditionally, the manufacturer provides a maintenance schedule to accompany the device, which specifies what must be serviced and when to ensure flawless operation. However, not all devices and machines age and deteriorate at the same pace. Factors such as the usage type and intensity, environmental factors etc., can extend or shorten the average lifespan declared by the manufacturer. In the first case, either we send our car to the mechanic too early. The later … well, we wait for the bus.

Predictive maintenance is a technique of collecting device's or machine's operating data and modeling them in order to predict how soon the vital machine's parameters are likely to exceed manufacturer's tolerances, entailing the need for maintenance actions. In complex engineering systems the number of observed parameters and the complexity of their interactions call for the deployment of machine learning techniques for predicting the necessary maintenance interventions.

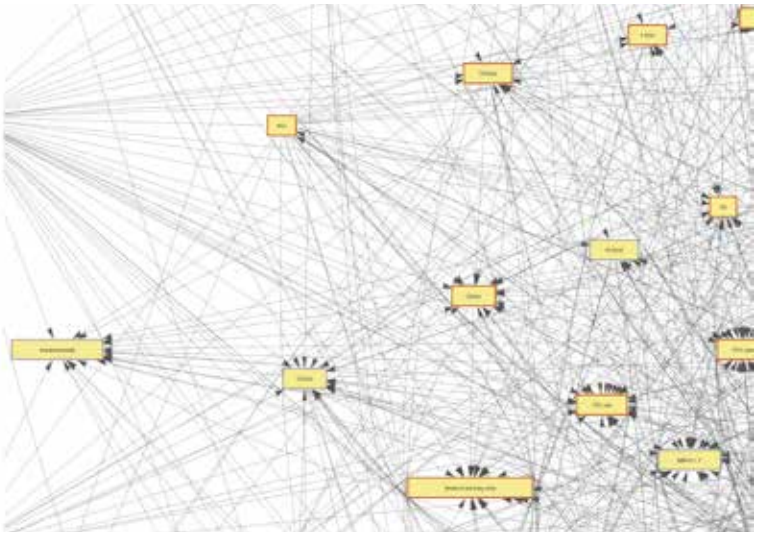
In many cases, changing the way the device is operated may drastically change the expected periods between required maintenance services. Of course, it would be desirable to choose a set of operating parameters that which are likely to extend the lifespan of the device as much as possible. Here, a search through the parameter space in pursuit of their optimal combination to yield the longest predicted lifespan of the device is referred to as *Prescriptive maintenance.*

Predictive and prescriptive maintenance for combustion monitoring in gas turbine

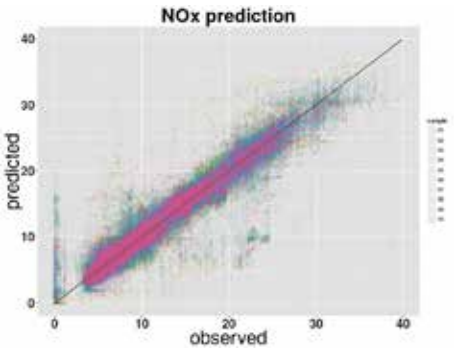
General Electric In is one of the major international suppliers of modern power generation equipment, and operates a fleet of combined-cycle gas turbines all over the world. GE and the Predictive Analytics Group of the IAS ZHAW currently collaborate on a project with a goal to devise a prescriptive maintenance system for GE turbines.

A gas turbine is an extremely complex piece of machinery, whose components must withstand high mechanical loads, extreme temperatures and intense vibrations while remaining in uninterrupted operation for periods that can extend into months or even years. Due to their mission-critical role in providing electrical power, each maintenance stoppage is a costly necessity.

A maintenance intervention is required when the gas emissions of a gas turbine exceed legally permitted thresholds. At the Predictive Analytics Group, we analyze large historical data sets consisting of readings of more than 180 sensors collected every 4 seconds over years of engine operations to best model and predict the future gas emission levels, and to prescribe the optimal parameter settings for maximum delay until next required maintenance.



Complex relationships between gas turbine's parameters, modeled using a Bayesian Network.



Predicted versus actually recorded turbine's gas emissions (NOx).

Research project

Predictive-prescriptive analytics for combustion monitoring in gas turbine power plants

Lead:	Dr. Krzysztof Kryszczuk
Partner:	General Electric, Switzerland
Project volume:	CHF 392 000
Project duration:	20 months (start 01.03.2016)