Predicting Paper Brightness with Machine Learning

Summary of the master thesis
"Improving the Efficiency of a Pulp Bleaching Plant
through Data-Based Modeling" (2024)
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Can machine learning predict the pulp bleaching results, potentially saving several million SEK?

This case study was performed at the Karlsborg pulp mill in northern Sweden. Here, 335,000 tons of pulp are produced each year. That is equivalent to an average amount of 38 tons of pulp produced every hour, every day of the year. To every ton, the bleaching chemical chlorine dioxide is added. The chemical is expensive, and the brightness of the produced pulp needs to be right, meaning that the dosages need to be accurate. But being accurate is difficult.

The bleaching process is both non-linear and has a varying production rate. The delay between changing a dosage and seeing the outcome can be several hours. Currently, experienced staff have a feel for how the process responds to different dosages and are able to react to changes in the bleaching result when they see them. But what if they can have the result immediately? Predicting these immediate bleaching results was a central aspect of this study. Using machine learning methods, models representing the process were found. Also, a way of tracking the production rate was implemented. Tracking the production rate revealed new ways of evaluating the process, and possible areas of improvement for the control of the process.

The answer to the initial question is thus, yes, it is possible to predict the result of bleaching, but whether the predictions will lead to savings, time will have to tell. The models for predicting the brightness were incorporated into a decision support system for the bleaching plant operators. The system predicts the effects of changing the bleaching chemical dosages. In Figure 1, a series of predictions can be seen plotted against the actual values. The aspiration is that this system can work as a stepping stone to transform the process control system into something more model-based. The reason is that other plants where a fully model-based control system was implemented, have seen savings of several tens of millions SEK per year.

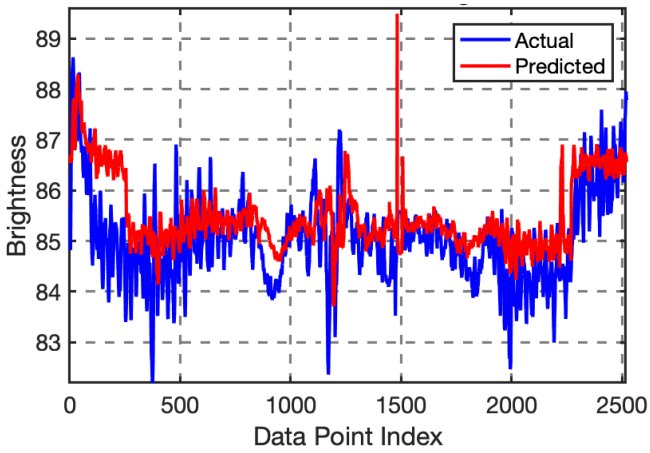

Figure 1: Prediction of the brightness of the wood pulp, plotted against the actual measured values.

This case study also highlighted the importance of giving context to stored production data. The production diary that the mill employed assisted with choosing suitable data for modeling. An important conclusion is therefore that anyone wanting to implement data-based methods in the future, should not only store their production data, but also classify it, for example by storing information about faulty sensors.This will be a sure way to make anyone using the data in the future a lot happier!