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Forecasting the discharge of the Meuse with a vector autoregression model

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The weir at Lixhe in Belgium is used to control the water levels of the river Meuse between Lixhe and Monsin, and is the last weir in Belgium before the Meuse reaches the Netherlands. At the weir, there is also a hydropower station. During low flow periods, the turbines of this station cannot be operated full-time and release water in pulses, in a process called hydropeaking. The timing and magnitude of these pulses is hard to predict, which presents a problem for the water management of the downstream areas, where navigability is very important. Additionally, these pulses lead to strong discharge fluctuations which have an adverse effect on the ecology of the downstream section of the river. Currently, the Dutch operational system for flood forecasting uses advanced hydrological and hydraulic forecasting models to predict discharges and water levels in the Meuse. These predict the discharge from Lixhe fairly well. However, these models only capture the overall tendency during low flow periods, being unable at predict hour-to-hour discharge variations at the Dutch border.

We use state of the art machine learning techniques to predict the discharge at Lixhe on an hour-to-hour basis. The end goal is to use the resulting model in an operational forecasting system, so we focus on training data that is available operationally. As potential predictors parameters such as rainfall, temperature, water level, discharge in locations upstream of the weir at Lixhe and energy price in Belgium were explored. After data analysis we selected a subset of these predictors; the predictors with the coefficients (from an ordinary least squares approach) higher than the median coefficient over all predictors were chosen. We use the vector autoregression (VAR) technique to create a multidimensional time series model that predicts the discharge at Lixhe, using 4 years of historical data. The resulting optimal number of lagged terms is 50 per predictor. In a short test period, this model has a root mean squared error of 59 m3/s which corresponds to a median absolute percentage error of 3%. We will extend the test period, and do detailed analysis of the performance in low flow periods. Additionally, we will use and assess various other machine learning techniques and will determine if we should change the data used to train the model(s).