Makani Walensee: Wind speed predictions at Walensee

Comparing spatio-temporal forecast models for wind speed

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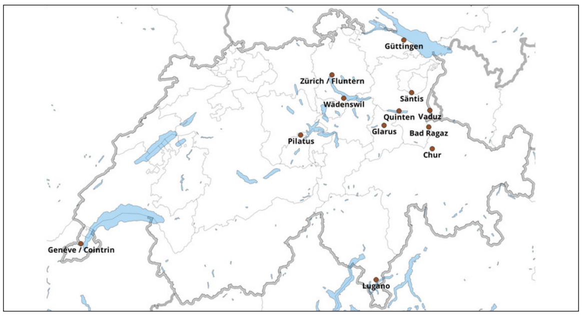
Introduction: In this study, we examine different spatio-temporal approaches to predicting wind speed for a 3-hour horizon every 10 minutes at Walensee (lake in Switzerland) at the station Quinten. This work follows up on "Makani Walensee: Wind speed predictions at Walensee: Comparing simple forecast models."

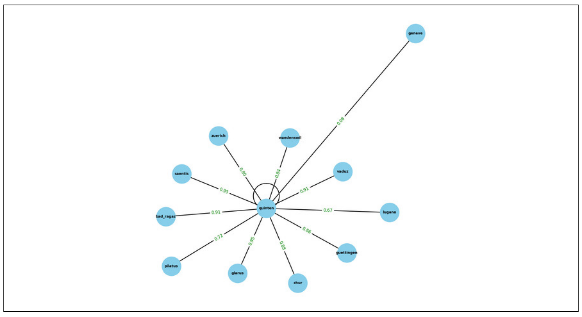
Approach: Our research has shown that wind speed forecasting is a spatio-temporal problem. Several promising solutions exist to address spatio-temporal problems. The neuronal networks "Convolutional LSTM network" and "Spatio-temporal Graph Convolutional Network" have been examined and compared in this study. These models have in common that their architecture is specially designed to capture temporal as well as spatial correlations. The forecast is based on 10-minute measurements of wind speed, wind direction, and maximum wind speed gusts taken at multiple stations scattered throughout Switzerland. A "Long Short-Term Memory (LSTM) model" is used as a baseline to compare the results.

Result: The results show that spatio-temporal neuronal networks are able to learn to forecast wind speed. The Spatio-temporal Graph Convolutional Network has the lowest test error. This means it can better generalise to unseen data than the Convolutional LSTM network and the LSTM model. However, the difference is small. Reasons for that may lay in the missing architectural considerations to capture not only spatial relations between past values of the same feature but also from different features. Another reason could be the missing attention mechanism, which could learn the weights of a graph's edges to properly aggregate information from adjacent nodes. This study demonstrates the potential of spatio-temporal neural networks for wind speed prediction. However, the results suggest that exploring more complex architectures may be necessary to achieve results that far outperform a conventional LSTM model.

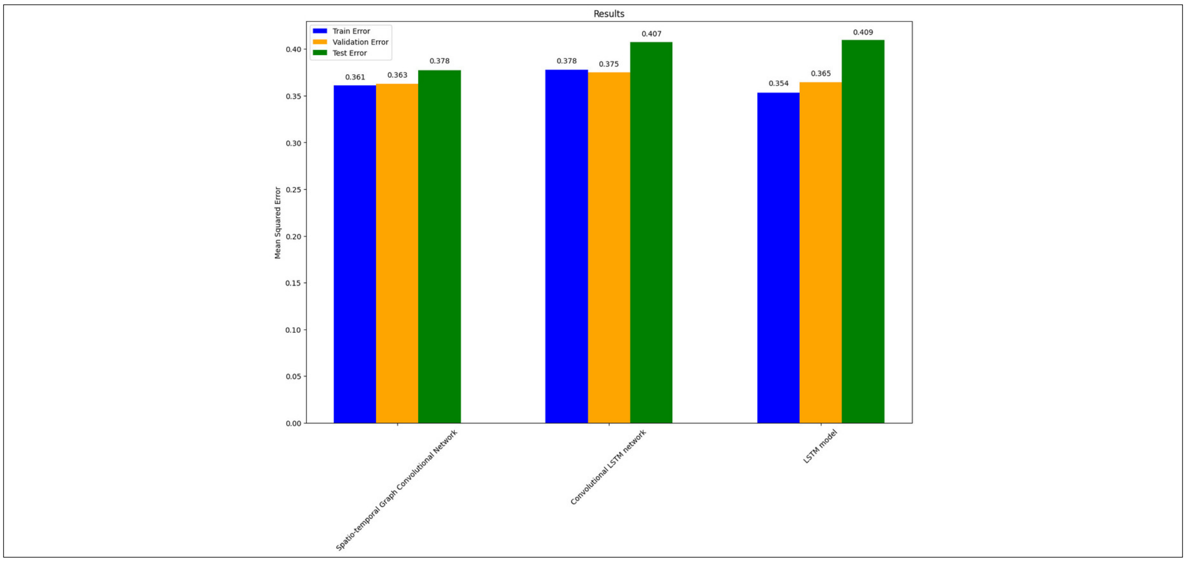
MeteoSwiss measurement stations used for forecasting, scattered across Switzerland
Federal Office of Topography swisstopo "Map of Switzerland"



Graph representation of the data showing all nodes adjacent to the Quinten station and their respective weights.
Own presentment



The Mean Squared Error (MSE) of the examined models.
Own presentment



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Subject Area
Data Science, Energy and Environment