Decision support for electricity market participants: point and probabilistic forecasting using resampling methods and statistical learning

Abstract

The participants of electricity markets make a multitude of operational decisions on a day-to-day basis. They make these decisions using their knowledge of the market and forecasts of prices and fundamental variables, such as electricity demand and generation. With the progressing decentralization and development of electrical power exchanges, the complexity of the market situation increases, and with it, the difficulty of producing accurate forecasts. While large companies are able to devote significant amounts of money and computational power to research in-house forecasting models or procure proprietary data, smaller market participants typically do not have such capabilities. Therefore, accessible forecasts basing on openly available data and produced with interpretable models address needs of a growing number of firms.

This doctoral thesis aims to develop data-driven forecasting methods designed to support the decision-making processes of small and medium companies participating in electricity markets. The thesis comprises five research papers which fulfill four objectives, addressing different research gaps related to this main goal: (i) conduct a critical study of calibration sample selection for automation of electricity price forecasting; (ii) use resampling methods to generate predictive distributions of electricity prices and better assess uncertainty; (iii) utilize renewable generation and load forecasts to design trading strategies in day-ahead and intraday markets; (iv) develop decision support methods for day-ahead bidding that use combinations of predictive distributions.

Three of the aforementioned research papers propose new forecasting methods (ARHNN, NOT-based algorithm, Multiple Split), which rely on forecast averaging, filtering calibration samples and resampling forecast errors. Another research article applies a state-of-the-art probabilistic forecast averaging method (CRPS learning) to optimize usage of a battery storage system. The methods are designed with low to medium computational complexity and high level of automation, to facilitate their use by smaller companies. They are evaluated from statistical and financial points of view, offering both scientific novelty and practical applicability. The research papers include three case studies which utilize these forecasting approaches to improve decision-making processes of electricity market participants. They design and discuss trading strategies relevant for such companies, e.g. day-ahead optimal market choice for a wind farm, and prediction of daily highest and lowest prices for daily operation of a battery. The thesis covers current research directions in electricity price forecasting, while keeping in mind business value and accessibility for forecast users.

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