Preface

Continuous balancing of electric power consumption and production is a fundamental prerequisite for the stability and efficiency of electricity grids. This balancing task requires accurate forecasts of future electricity demand and supply at any point in time. For this purpose, today's energy data management systems (EDMS) typically use quantitative models—called forecast models—that already provide accurate predictions. However, recent developments in the energy domain such as real-time intra-day trading and the integration of more renewable energy sources also require more efficient forecasting calculations and a rapid provisioning of forecasting results. Furthermore, today's EDMSs fulfill a number of different tasks, each exhibiting different requirements for the calculation of forecasts with respect to runtime and accuracy. Thus, it is necessary to flexibly adapt the forecasting process with respect to the needs of the current requests. In contrast, currently employed forecasting approaches are rather time-consuming and inflexible. One reason is the very expensive estimation of the forecast model parameters, involving a large number of simulations in a search space that increases exponential with the number of parameters.

We tackle these new requirements by introducing a novel online forecasting process that aims to improve the forecasting calculation efficiency and to provide forecasting process adaptability. For this purpose, the online forecasting process employs forecast model materialization in conjunction with flexible and fast parameter estimation to rapidly provide accurate forecasts that are iteratively improved over time. EDMSs may subscribe to the online forecasting process to retrieve improvements found during the process execution. In addition, they can adapt the progression of the forecast calculation by defining runtime constraints and accuracy targets. With that, we are able to equally server requests that require results in a limited amount of time or that target the best possible accuracy.

The online forecasting process is complemented by further optimizations on the logical as well as on the physical layer. Our optimizations on the logical layer improve the efficiency of the parameter estimation independently of the data organization and the employed forecast model. As a first approach, we introduce our context-aware forecast model repository that materializes previously used forecast models and their parameters in conjunction with information about the time series context that was valid during the time the model was used. We may then provide appropriate starting points for future forecasting calculations by reusing models that produced accurate results in a context similar to the current one. Furthermore, for some use cases, it is beneficial to consider context information directly within the forecast models. Especially when predicting renewable supply, information about the weather are very important. However, including context information typically means to add further parameters to the forecast model, which increases the efforts for the parameter estimation. To solve this issue, we introduce an integration framework that optimizes the handling of context information and reduces the additional efforts when considering them. Finally, we improve the calculation of forecasts in hierarchical environments. Instead of simply aggregating time series, we propose a forecast model aggregation that eliminates the need for estimating the forecast model parameters on higher hierarchical levels.

Our physical optimizations aim to directly provide an efficient way for forecast models to access time series values. For this purpose, we introduce an access-pattern-aware storage approach that exploits the memory access patterns of the used forecast models to physically layout the data for sequential access and high spatial locality. With that, we substantially reduce the negative influence of memory latency and bandwidth, while at the same time improving the utilization of the different cache levels. In addition, we propose a special parallelization approach for multi-equation forecast models.

Overall, with the help of our online forecasting process in conjunction with the optimizations on the logical and on the physical layer, we target to enable accurate forecasting of evolving time series considering the new requirements of the changing electricity market.

Springer

http://www.springer.com/978-3-658-11038-3

Energy Time Series Forecasting
Efficient and Accurate Forecasting of Evolving Time Series from the Energy Domain
Dannecker, L.
2015, XIX, 231 p. 92 illus., 19 illus. in color., Softcover
ISBN: 978-3-658-11038-3