

Hierarchical Forecasting for Vehicle Sales: an Evaluation of Nixtla's Framework

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Abstract

Hierarchical forecasting is important for predicting sales across multiple aggregation levels, particularly in industries like automotive, where forecasting at various granularities—from individual vehicles to regional sales—is critical for decision-making. This study applies Nixtla's open-source hierarchical forecasting framework to a vehicle sales dataset containing approximately 12,000 data points. The research is organized into two phases to evaluate different reconciliation methods and their effectiveness in improving forecast accuracy across hierarchical levels. **Phase 1** of the study involves applying four reconciliation techniques: top-down, bottom-up, MinTrace MinShrink, and MinTrace OLS. The above methods are assessed based on their ability to reconcile forecasts across multiple levels, from total sales to individual vehicle categories, and their impact on overall forecasting accuracy.

In **Phase 2**, we rigorously evaluate the performance of these methods by calculating and comparing scaled mean squared error (scaled-MSE) at each hierarchical level, from high-level aggregations to granular sales forecasts. The results show that forecast accuracy remains consistently high at the first two levels of aggregation, with a scaled MSE below 1. However, as the hierarchy levels increase and forecasts become more granular, the scaled MSE increases significantly, indicating difficulties in maintaining accuracy at lower hierarchical levels. Among the methods tested, MinTrace OLS stands out as the most effective technique, achieving the best predictive performance and minimizing error propagation at more profound levels of the hierarchy. This suggests that MinTrace OLS can better handle the complexities of hierarchical forecasting than the other methods. These findings highlight the importance of selecting appropriate reconciliation techniques for hierarchical forecasting and emphasize the challenges in maintaining forecast accuracy at finer granularities. The study also points to the need for further research into advanced reconciliation methods to address these challenges and improve forecast precision at all hierarchy levels.

Keywords

Hierarchical forecasting, Nixtla framework, vehicle sales prediction, reconciliation methods, MinTrace OLS, forecast accuracy, error propagation