This project has received funding from the European Union's Horizon 2020 Research and Innovation Programme under grant agreement No 101035813

Enhancing Energy Consumption Forecasting Accuracy through Automated Machine Learning

Francesco Zito, Mario Pavone, Vincenzo Cutello

Department of Mathematics and Computer Science, University of Catania, v.le Andrea Doria 6, 95125 Catania, Italy

In recent years, the use of deep learning techniques has gained popularity due to their ability to extract patterns from data and generate valuable knowledge for decision-making. Several applications of deep neural networks are growing in the field of energy. The challenges of creating buildings or factories that are increasingly sustainable have brought the use of machine learning techniques to forecast the demand for energy required by them and redistribute energy to avoid wastage. Energy efficiency is crucial in all contexts related to sustainability, and the use of deep learning techniques allows for accurate forecasting of energy demand, enabling energy systems to redistribute energy to customers as required. However, the increasing amount of data to be processed in such applications presents a significant challenge. Deep neural networks are becoming more complex, requiring numerous hidden layers to process the data. Moreover, existing models in the literature require ad hoc tuning of hyperparameters to maximize accuracy. To address this issue, several techniques have been developed to generate automatic deep neural networks that can improve the performance of multivariate time series problems, such as in the case of energy demand prediction. All these techniques are denoted as Automated Machine Learning (AutoML) [1] and can be categorized into two types: Neural Architecture Search (NAS) and Hyperparameter Optimization (HPO). Neural Architecture Search methods are based on an optimization algorithm to select the best neural network architecture that fits the dataset and avoids overfitting to achieve the best model accuracy. On the other hand, Hyperparameter Optimization selects the best hyperparameters of neural network architectures that maximize the performance of such a network. The problem of predicting the energy demand of customers, such as buildings or factories, can be modelled as a multivariate time series since several variables can affect the demand for energy required. In [2], it has been demonstrated how variables can affect each other in multivariate time series forecasting, and the use of metaheuristic algorithms can help to select the best predictors for each variable, improving the accuracy of the prediction. In this research work, we employ our algorithm of Automated Machine Learning, denoted as GP-NAS (General-Purpose Neural Architecture Search), published in [3], to design a neural network architecture that maximizes the performance in forecasting the consumption of energy in hospital facilities [4]. Our goal is to demonstrate how our algorithm can also be used in a multivariate time series forecasting problem, providing a valuable contribution in designing deep neural network architectures to be used in this field.

References

1. https://doi.org/10.1007/978-3-030-05318-5. 2. https://doi.org/10.1007/978-3-031-42529-5_24.
3. Zito, F., Cutello, V., & Pavone, M. (2024) A General-Purpose Neural Architecture Search Algorithm for building Deep Neural Networks. In 15th Metaheuristics International Conference (MIC 2024). Lecture Notes in Computer Science (LNCS), Springer, Cham (In press). 4. https://doi.org/10.1038/s41598-024-56602-4