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Daily pattern prediction based classification modeling approach for day-ahead electricity price forecasting

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ABSTRACT

Day-ahead electricity price forecasting (DAEPF) plays a very important role in the decision-making optimization of electricity market participants, the dispatch control of independent system operators (ISOs) and the strategy formulation of energy trading. Unified modeling that only fits a single mapping relation between the historical data and future data usually produces larger errors because the different fluctuation patterns in electricity price data show different mapping relations. A daily pattern prediction (DPP) based classification modeling approach for DAEPF is proposed to solve this problem. The basic idea is that first recognize the price pattern of the next day from the "rough" day-ahead forecasting results provided by conventional forecasting methods and then perform classification modeling to further improve the forecasting accuracy through building a specific forecasting model for each pattern. The proposed approach consists of four steps. First, K-means is utilized to group all the historical daily electricity price curves into several clusters in order to assign each daily curve a pattern label for the training of the following daily pattern recognition (DPR) model and classification modeling. Second, a DPP model is proposed to recognize the price pattern of the next day from the forecasting results provided by multiple conventional forecasting methods. A weighted voting mechanism (WVM) method is proposed in this step to combine multiple day-ahead pattern predictions to obtain a more accurate DPP result. Third, the classification forecasting model of each different daily pattern can be established according to the clustering results in step 1. Fourth, the credibility of DPP result is checked to eventually determine whether the proposed classification DAEPF modeling approach can be adopted or not. A case study using the real electricity price data from the PJM market indicates that the proposed approach presents a better performance than unified modeling for a certain daily pattern whose DPP results show high reliability and accuracy.

1. Introduction

1.1. Background

The power industry market reform all over the world has made electricity prices become the core of market operation and electricity energy trading [1–4]. The time scales of electricity price forecasting (EPF) include long term (years), midterm (months), short term (days) and very short term (hours) [5]. Accurate EPF in all time scales is necessary for market participants and market operation [6–8]. In particular, day-ahead electricity price forecasting (DAEPF) has already been analysed due to its importance for the day-ahead market. For example, sellers and buyers need DAEPF to strategically submit their bids and offers before a certain closing time of the day-ahead energy market for the delivery of electricity during each hour of the next day [9] and independent system operators (ISOs) need DAEPF to foresee and deal with those possible abnormal conditions such as extreme high or low values and great fluctuations of electricity prices, so as to

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Nomenclature

EPF	electricity price forecasting
DAEPF	day-ahead electricity price forecasting
ISO	independent system operator
DR	demand response
DPP	daily pattern prediction
DPR	daily pattern recognition
WVM	weight voting mechanism
ANN	artifical neural network
SVM	support vector machine
LSSVM	least square support vector machine
SVC	support vector classification
SVR	support vector regression
RBF	radial basis function
ELM	extreme learning machine
AR	autoregression
MA	moving average
ARIMA	autoregressive integrated moving average
GARCH	generalized autoregressive conditional heteroskedastic
MAPE	mean absolute percentage error
RMSE	root mean square error
SDE	standard deviation of errors
ENN	elman nerual network
ED	effective distances
ER	effective radius

operate accordingly to guarantee the stability and orderly competition of the electricity market. Only with an accurate DAEPF can the maximum profit for all market participants be obtained as well as the minimum risk for the ISOs. However, the characteristics of electricity prices, such as non-stationarity, high volatility, seasonality and calendar effect [10,11], make EPF more complex and challenging than electricity load or renewable energy power forecasting [12–16], particularly in the presence of demand response (DR), which brings uncertainty to electricity prices [17–21].

1.2. Literature review and motivation

The objective of forecasting is to fit the mapping relations between the future values of a forecasted variable (output) and the historical data of any related impact factors including the forecasted variable itself (input) as accurately as possible. Basically, the forecasting accuracy depends on the two following aspects. As shown in Fig. 1, the first aspect is the expression of the forecasting problem, i.e. how we formulate the problem logically and mathematically, which mainly determines how complex the forecasting will be and how difficult the modeling will

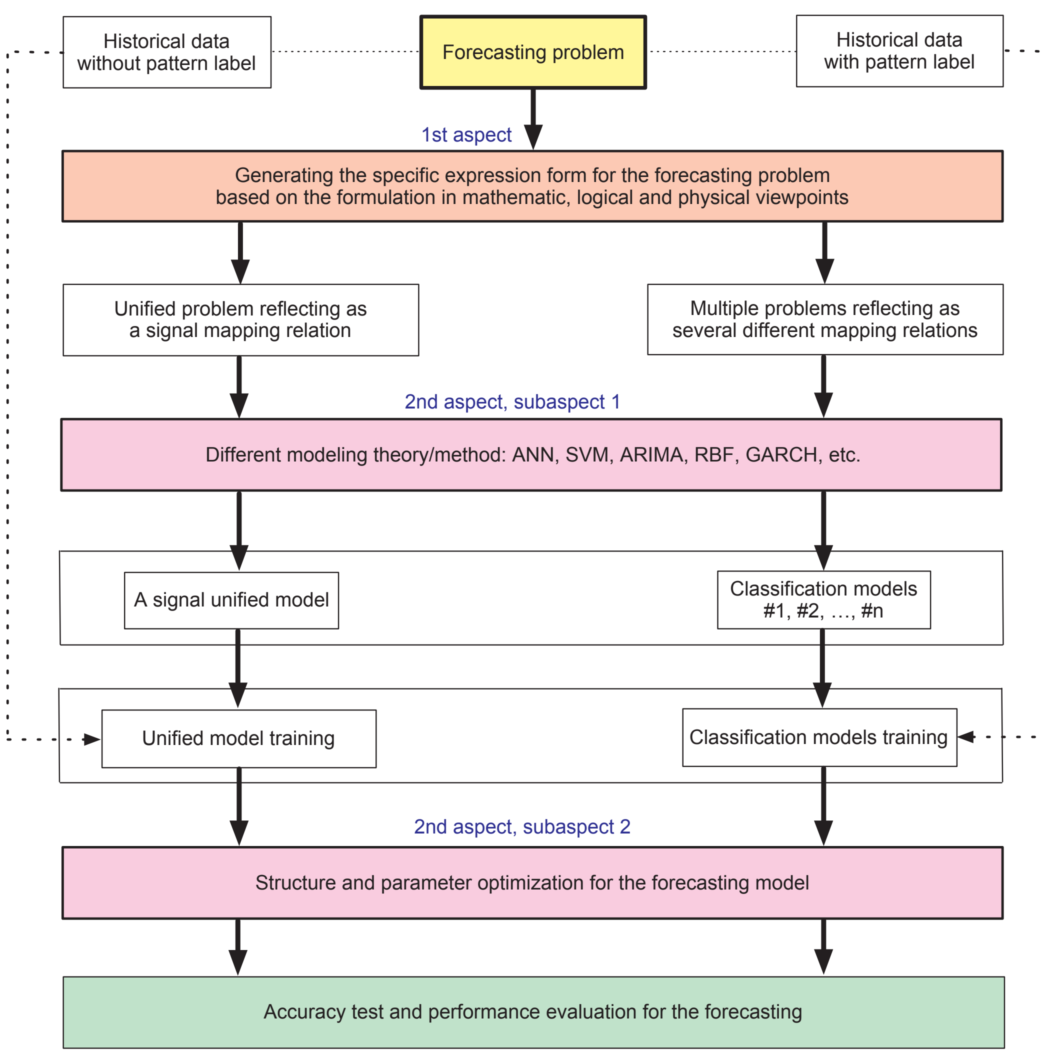

Fig. 1. Two aspects affecting the forecasting accuracy: Expression form and forecasting model.