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A framework for prediction and segmentation of daily energy load profiles of building clusters using machine learning

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Introduction

In the future smart grid and smart city context it is a necessary step to predict load profiles and categorize them for energy system management although the focus of existing studies on the energy profile classification and customer segmentation is still mainly on historical data analysis. In this paper, we propose a framework to identify and classify daily energy load profiles, and further categorize the forecasted future load profiles. The contributions of this study lie in:

(i) A two-step clustering method for load profiling and categorization preserving both consumption magnitude and the shape of the load profile.

(ii) A comprehensive classification procedure enabling the classification of forecasted daily heating profiles for the day ahead demand side management.

Methodology

The framework of the proposed approach includes clustering analysis, supervised classification and load forecasting which can be applied to any given group of buildings with sufficient energy metering data, e.g. hourly readings of a heating season or a year.

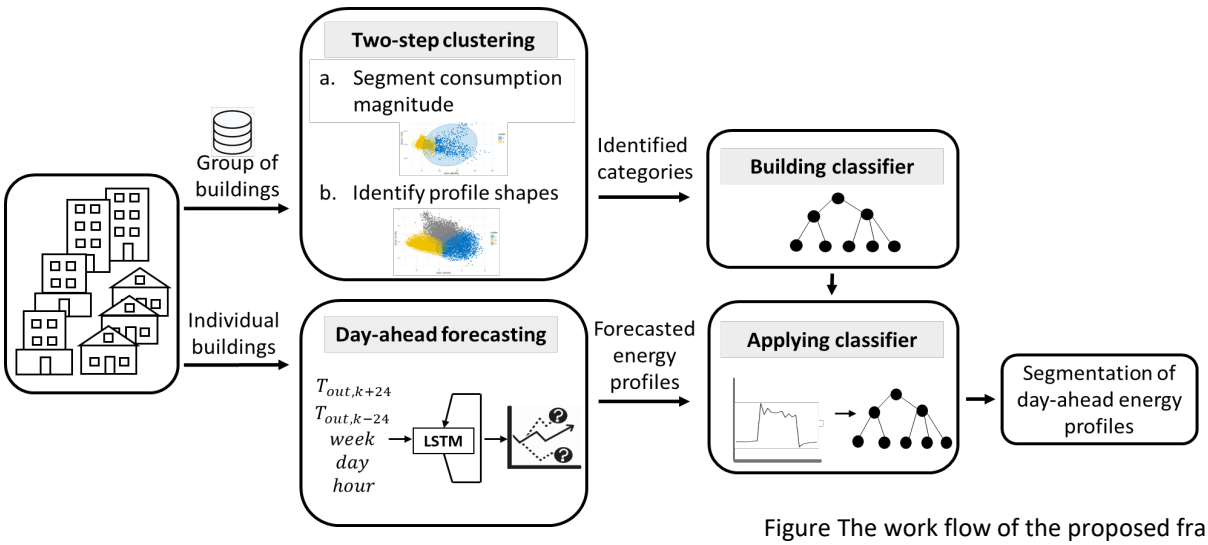

Figure The work flow of the proposed framework

Results and findings

1. As the result of the two-step clustering, **five profile categories** were identified. See the graphs below.

2. For new consumption profiles, **RF** was used to classify the profile categories with an **accuracy of 98.5%.**

3. As case studies, for two individual buildings in the group, LSTM models were developed to forecast day-ahead heating load profiles. The testing results of LSTM trained with or without calendar factors shown that the calendar effects could improve the accuracy of forecasting, especially for the profiles with lower consumption magnitude and larger daily variations. The optimal LSTM network structure for the two case-study buildings is two layers with 75 neuron of each layer. The established categories and classifier were used to segment the day-ahead daily heating load profiles of the two case buildings with classification accuracies of 91.9% and 83.8%, respectively, indicating that this **framework is competent to forecast and classify day-ahead hourly energy profiles.**

4. The framework can be applied to **support perform customer segmentation, designing tariffs and facilitate demand** side management.

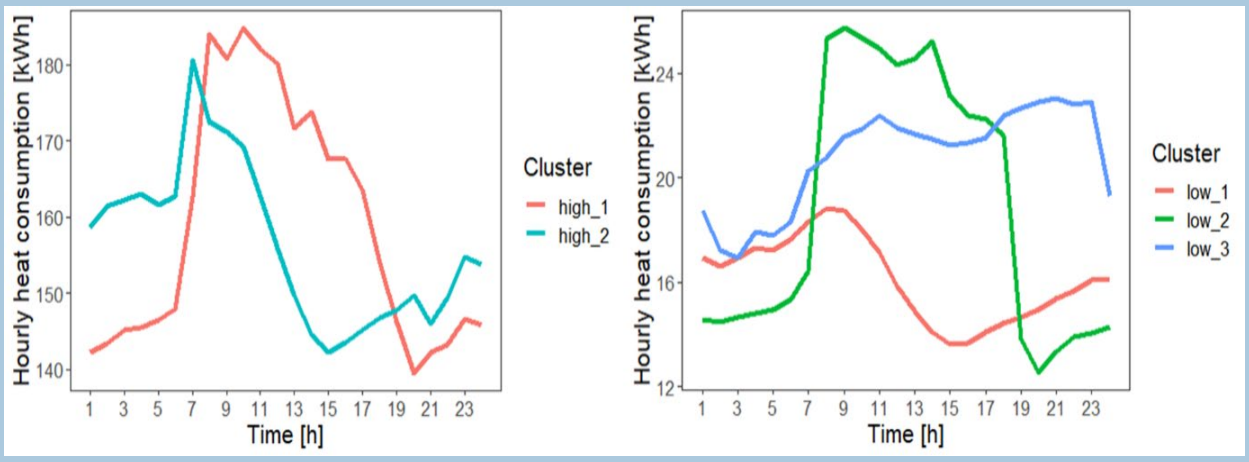

Figure Five representative daily average consumption profiles as results of the two-step clustering approach

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