A method to assess the impact of the region-specific factors on hourly electricity consumption
Yuki HIRUTA, Lu GAO and Shuichi ASHINA
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I Introduction
Back Ground
Highly fluctuating electricity demand
• Decrease the efficiency of electricity supply system
• Increase the fossil fuel consumption.
Warming urban thermal environment
• Multiple problems such as heat strokes
To reduce power demand and its fluctuations, effective measures should be adopted from a wide range of options including urban planning.

Research Overview
Proposes a series of method to build a single regression model that explain hourly electricity consumption by multiple factors including region-specific factors and time-varying factors.

II Challenges & Solutions
Challenges

1. Time-region consideration
- The factors affect electricity demand have different time-space resolution.
- How to consider the complex combination of region-specific factors and time-varying factors?
2. Variable selection
- How to select effective variables from a wide range of possibilities?
3. Model construction
- How to model complex relationships, such as nonlinearity, while avoiding overfitting problems?

Solutions

- Focuses on the effectiveness of interaction features based on the hypothesis below
- Construct a series of algorithms that repeatedly applies existing machine learning algorithms
- Apply MARS to construct a flexible and highly generalizable model

III Methods
Data
Target area

2. Variable selection

- 10 predictors
- 15 indicators
- 8 region-specific features, 7 time-varying features
- R² = 0.9903
- GCVR² = 0.9901

The selected variables were reasonable

1. Time-region consideration
Hypothesis
The magnitude of the hourly fluctuation in power demand are determined by the hourly fluctuation scaled by the region-specific factors of the region such as socioeconomic conditions.

0. Region-specific features
Difference by location ⇒ Change over time
- The socioeconomic conditions in each region
- Geographical characteristic in each region

3. Model construction
MARS (Friedman, 1991)
- Multivariate adaptive regression splines
- Captures the complexity of the potential model by applying a locally linear model.
- Selects important variables during the model building process.
- Showed excellent prediction performance in short-term power consumption modeling in past studies.

An example of the variable selecting process by Algorithm-A

Model evaluation 1

- Model construction
- 10 predictors
- 15 indicators
- 8 region-specific features, 7 time-varying features
- R² = 0.9903
- GCVR² = 0.9901

The selected variables were reasonable

Model evaluation 2

- Prediction by the single model constructed for all regions
- Prediction by the models constructed for each region

IV An Experimental simulation
The effect of spatial distribution of households on hourly power demand

- The power consumption decreases as HCG increases.
- Higher residential density, less power per household

VI Summary
The measures for reducing the fluctuation range of the power demand should be considered from a wide range of options including region-specific factors such as land use and urban planning. However, there is no established method for validating the effectiveness of such measures. The proposed method has great potential to be one of the validation methods.

References

Data sources