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Smart Meter Consumption

stability of electricity smart meter consumption clusters over time

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Introduction

For more than a decade researchers have successfully analyzed smart-meter data to identify consumption patterns. Numerous projects have applied K-Means and other clustering algorithms from machine learning to identify various consumption patterns hidden in the **smart-meter data**.

What motivates both researchers and private stakeholders is the possibility of producing consumption-clustering solutions applicable outside academia to facilitate value propositions for both utilities and consumers. However, for clusters to be truly applicable beyond academia, they need to be defined in such a way that they are meaningful and stable. Therefore, it is important to study the stability of the clusters across time periods to ensure that cluster solutions remain the same and that the transition between clusters is understood and quantified.

This paper investigates if the clustering solutions that currently represent the state of the art in **smart-meter** analyses are stable across time periods by answering two questions:

Investigation

1. Are the cluster independent of the time of year at which the data have been recorded?
2. Are meters that were clustered together in a month also clustered together in the next month, or is there an unstable cluster definition?

Data description

This paper presents the clustering of over 25,000 households, in the southern region of Denmark, on a weekly basis for the whole of 2011. The data are divided into four quarters in order to evaluate and quantify cluster stability through the course of a year, but each quarter evaluated independently. The data have been collected throughout 2011 and the meters included in the analysis are connected to a district heating and thus the households do not use electricity for heating.

Methodology

The analytical process followed during analysis of the **smart-meter data** was divided in five sections.

.Data Preparation: the pre-processing undertaken prior to analysis, where meters which have missing values or zero mean, median and variance consumption were removed.

.K-Means: simple and efficient algorithm that has been selected as the clustering method for the analysis of cluster stability across time periods.

.Varatio: there must be invariance in the period
Analyzed for clusters created from **smart-meter** consumption data to be stable.

.Autocorrelation Feature (ACF): quantifies the influence of previous observations on the present observation. There is a significant reduction in dimension as the ACF retains only significant features.

.Cluster Validation Indices: assess the performance of different clustering solutions by evaluating the diverse properties of the clusters. In addition, it is desirable that the application of several indices are simultaneous.

Discussion

The developed method shows that clusters created by applying K-Means to **smart-meter** consumption data are not stable from one week to the next. Moreover, the analysis suggests that the clustering is highly dependent on initial decisions about which week to cluster. In addition, Varatio method shows that clusters from one week are not mapped 1:1 on to any other week within the same quarter.

In the context of Danish electricity consumption clustering, this means that the preferred method, K-means, is not able to create practically applicable clusters.

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