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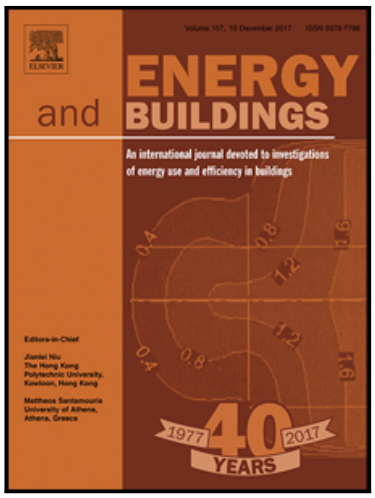

Analysis of correlation between actual heating energy consumption and building physics, heating system, and room position using data mining approach

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Analysis of correlation between actual heating energy consumption and building physics, heating system, and room position using data mining approach

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Abstract: Residential buildings in northern China have annually consumed over 4.4% of China's total energy by space heating, and the proportion is still growing. A key task when making an energy conservation guide is to identify the parameters that have significant impacts on the building heating energy consumption. The traditional methods for this task, such as optimization-simulation, regression, and artificial neural network (ANN) methods, either require considerable amounts of computing capacity and time, or present the results in complex equations or networks that are difficult to understand. This study proposed a data mining approach to analyze the correlation between a building's heating energy consumption and its physical & heating system parameters, based on a field survey of 5615 households from 116 buildings in Tianjin, a city in China's cold winter climate region. The box-plot method was used to detect outliers in the original database, and determine the attributes. The information gain ratio calculation algorithm was applied to rank the correlation between the heating energy consumption per unit area (*HECPA*) and 16 (19) attributes on both household and building scales. Finally, the C4.5 decision tree classifier was used to model the correlations and output the classification rules. The results indicated that the window heat-transmission coefficient and type of heating-terminal were the two attributes that most significantly affected the heating energy consumption on both scales. According to the classification rules, a higher window heat-transmission coefficient for a household usually resulted in a higher *HECPA* level, while buildings that used floor heating as their heating-terminals had a high probability of consuming more heating energy than those that used radiators. Nevertheless, a higher window-to-wall ratio may not necessarily result in more heating energy consumption. The main contribution of this study was the development of a promising approach that could assist in quickly understanding the hidden correlation between heating energy consumption and related factors through a massive amount of collected data.

Keywords: Correlation analysis; heating energy consumption; data mining; box-plot approach; outliers; information gain ratio; C4.5 decision tree

1. Introduction

Both the number and construction speed of residential buildings in China are among the highest in the world, especially in the last decade. According to the survey of the 2017 Annual Report on China Building Energy Efficiency [1], the total floor area of residential buildings in 2015 was 45.7 billion m^2, and residential buildings in northern China (covering most of China's severe cold and cold climate zones) have annually consumed over 0.19 billion tce, which is 4.4% of the total energy in China, just by the space heating used to provide a suitable indoor environment during winter. This percentage is still growing because of the accelerated urbanization, increase in income level,

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