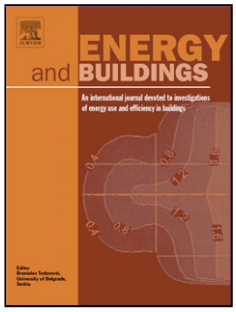

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Predicting fuel consumption for commercial buildings with machine learning algorithms

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Abstract

This paper presents a modeling framework that uses machine learning algorithms to make long-term, i.e. one year-ahead predictions, of fuel consumption in multiple types of commercial prototype buildings at one-hour resolutions. Weather and schedule variables were used as model inputs, and the hourly fuel consumption simulated with EnergyPlus provided target values. The data was partitioned on a monthly basis, and a feature selection method was incorporated as part of the model to select the best subset of input variables for a given month. Neural networks (NN) and Gaussian process (GP) regression were shown to perform better than multivariate linear regression and ridge regression, and as such, were included as part of the model. The modeling framework was applied to make predictions about fuel consumption in a small office, supermarket, and restaurant in multiple climate zone. It was shown that for all climate zones for all months, the maximum errors pertaining to one year-ahead forecasts of fuel consumption made by the ML model are 15.7 MJ (14,880 Btu), 284.3 MJ (268,516 Btu) and 74.0 MJ (70,138 Btu) respectively. The methods and results from this study can be used to estimate on-site fuel consumption and emissions from buildings, thereby enabling improved decisions pertaining to building efficiency with respect to fuel use.

Keywords: Building energy modeling, Machine learning, Prediction, Heating load, Data-driven modeling

NOMENCLATURE

ARX	Auto-regressive eXogenous
CV	Cross-validation
CDD	Cooling degree-days
e+	EnergyPlus building simulation package
EPR	Evolutionary Polynomial Regression
GP	Gaussian Processes
HDD	Heating degree-days
ML	Machine Learning
MLR	Multivariate linear regression
NARX	Neural auto-regressive with eXogenous input
NN	Neural network