Dissecting the Problem of Individual Home Power Consumption Prediction using Machine Learning

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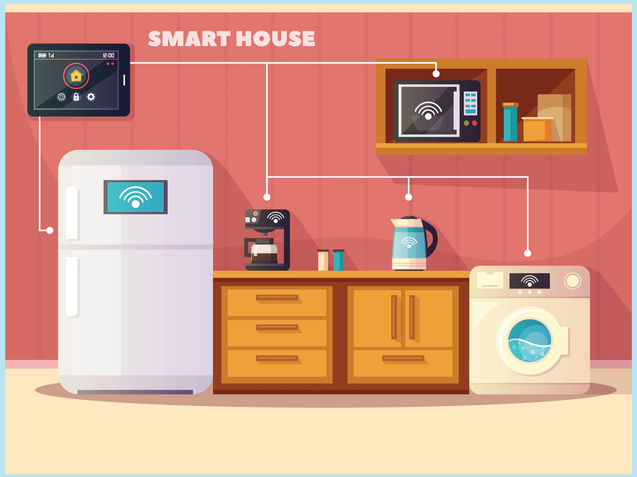
Motivation



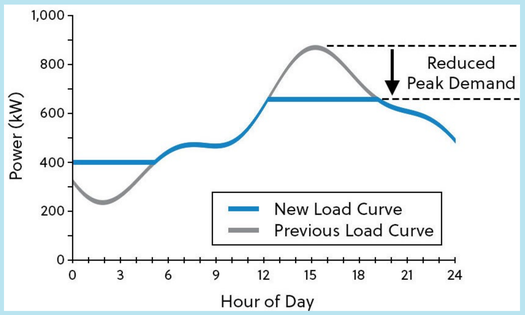
IoT enables monitoring, communication, and control

Can we use historical data to predict single home power consumption?

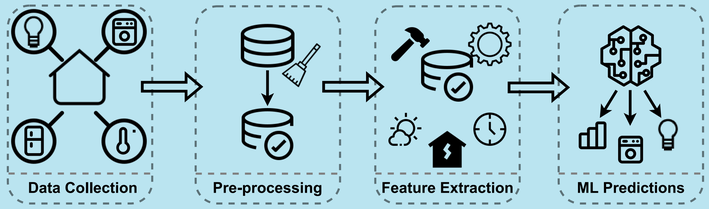
✅ Grid-level predictions [1]
✅ Building-level predictions [2]
✅ Commercial building predictions [3]
❌ Single-home predictions

Why does it matter?

- Targeted energy-efficient programs [4]
- Successful power conservation systems [4]
  - Efficient use of energy storage



Methodology



Pipeline overview of our methodology

Dataset

Data collection period: 03/20/2018 – 08/10/2018
Sampling rate: 60 samples per hour
Number of data points: 207,359

Features:

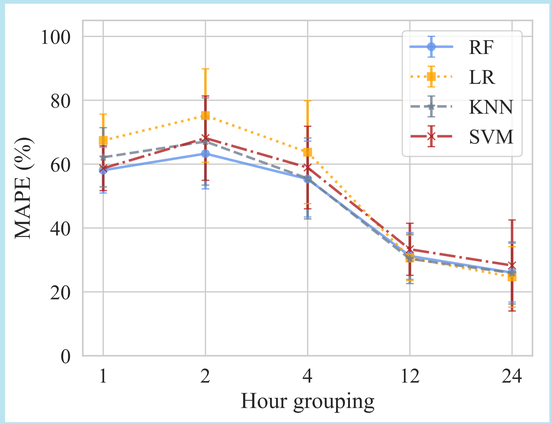
Mean and standard deviation of:

- Weather data: sun altitude, outdoor temperature, incident solar radiation, inside temperature.
- Time: hour of day, day of week, day light
- Power data: Net Total, HVAC, Lighting, All Other

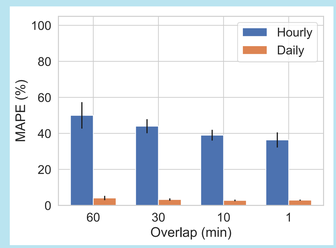
Experimental setup

Windows overlap: 1, 10, 30, 60 minutes
Hour groupings: 1, 2, 4, 12, 24 hours
Quantile transformation: 200 quantiles
10-fold cross validation
2 weeks of data for testing

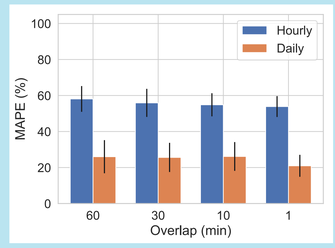
Overall performance



Impact of overlap and randomization

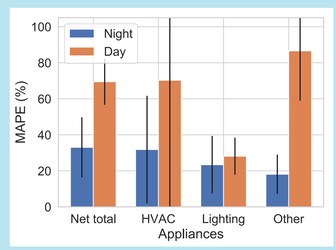


Random selection

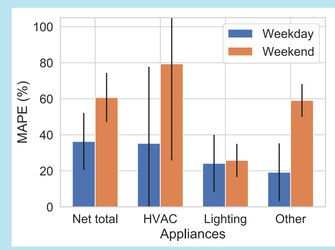


Non-random selection

Impact of human behavior



Day vs Night



Weekday vs Weekend

References:
[1] S. Walker et al., "Accuracy of different machine learning algorithms and added-value of predicting aggregated-level energy performance of commercial buildings", *Energy and Buildings*, 209, 109705, 2020.
[2] K. Amasyali and N. M. El-Gohary, "A review of data-driven building energy consumption prediction studies," *Renewable and Sustainable Energy Reviews*, vol. 81, pp. 1192–1205, 2018.
[3] D. L. Marino et al., "Building energy load forecasting using deep neural networks", in 42nd Annual Conference of the IEEE Industrial Electronics Society (IECON). IEEE, 2016
[4] E. Casella et al., "Hvac power conservation through reverse auctions and machine learning," in 2022 IEEE International Conference on Pervasive Computing and Communications (PerCom). IEEE, 2022.