Performance Measures for Electricity Consumption Prediction

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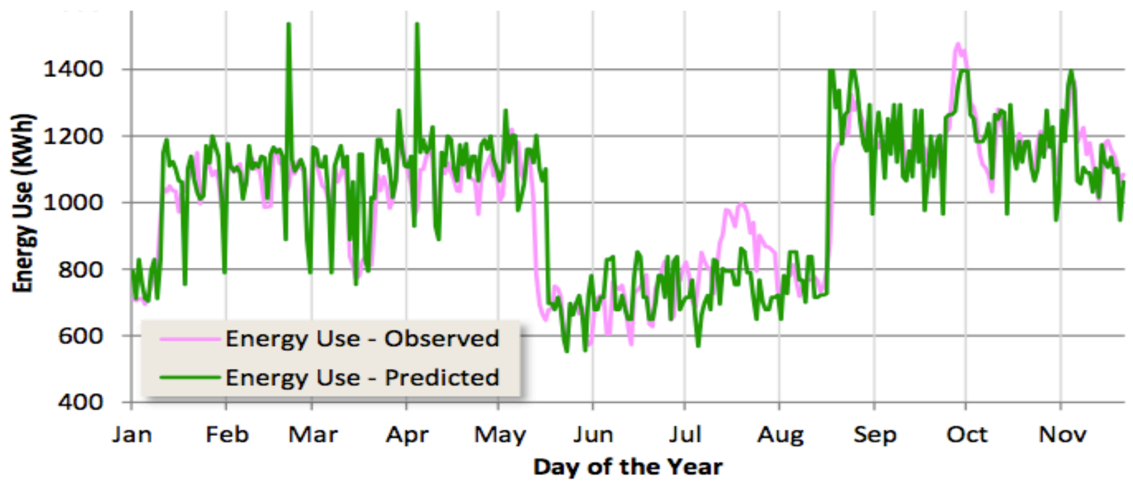
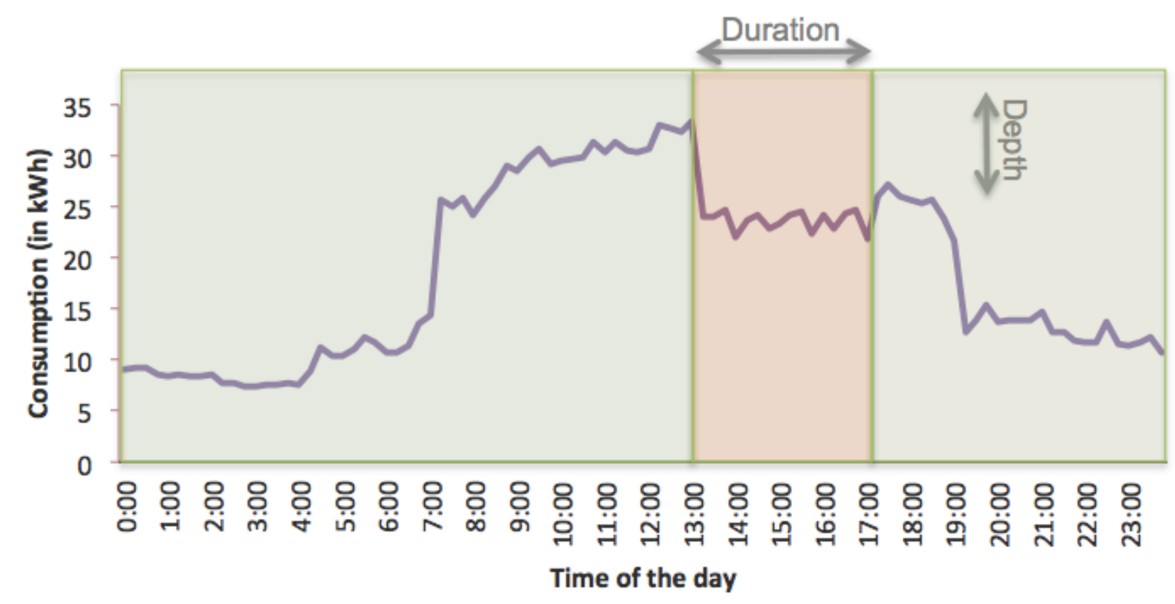
Problem: Evaluation of KWh prediction



Motivation: Dynamic Demand Response (D^2R)

Dynamic decision making for

- start time
- duration
- depth (kWh)
- customer selection
- curtailment strategy selection



Need for novel Performance Measures

Prediction Bias

- *understand the frequency of over- or under-prediction*
- *under-prediction might miss the peak*

Domain Bias Percentage Error (DBPE) An asymmetric loss function is used to assign different costs to over and under predictions. These costs are application-specific. (Reduces to MAPE when costs are same)

$$DBPE = \frac{1}{n}\sum_{i=1}^{n}\frac{\mathcal{L}(p_i, o_i)}{o_i} \qquad \mathcal{L}(p_i,o_i) = \begin{cases}\alpha|p_i - o_i|, & \text{if } p_i > o_i\\ 0, & \text{if } p_i = o_i\\ \beta|p_i - o_i|, & \text{if } p_i < o_i\end{cases}$$

Scale Independence

- *compare across different scales (unlike MAE, RMSE)*
- *address diversity in customers*

Coefficient of Variation of RMSE (CV-RMSE) The root mean square error is divided by the mean of observed values. The normalized RMSE can then be used to compare across scales.

$$CVRMSE = \frac{1}{\bar{o}}\sqrt{\frac{1}{n}\sum_{i=1}^{n}(p_i - o_i)^2}$$

Reliability

- *how often the model performs better than a baseline or within an error threshold*

Reliability, REL Measures the count of performances less than the error threshold.

$$REL = \frac{1}{n}\sum_{i=1}^{n} C(p_i, o_i)$$

$$C(p_i, o_i) = \begin{cases}1, & \text{if } \frac{|p_i - o_i|}{o_i} < e_t\\ 0, & otherwise\end{cases}$$

Relative Improvement, RIM Measures the count of performances better than the baseline.

$$RIM = \frac{1}{n}\sum_{i=1}^{n} C(p_i, o_i, b_i)$$

$$C(p_i, o_i, b_i) = \begin{cases}1, & \text{if } |p_i - o_i| < |b_i - o_i|\\ 0, & otherwise\end{cases}$$

Cost

- *quantify the cost of collecting data, training and applying a model for prediction*

Data Cost, DC The number of unique values of all features in the model.

Compute Cost, CC The time in seconds required to train a model

Normalized Model cost, $C = f(DC, CC)/m$

Cost-Benefit Metric, CBM Measures the relative benefit of using a model with respect to normalized cost.

$$CBM = \frac{(1 - CVRMSE)}{C}$$

Volatility

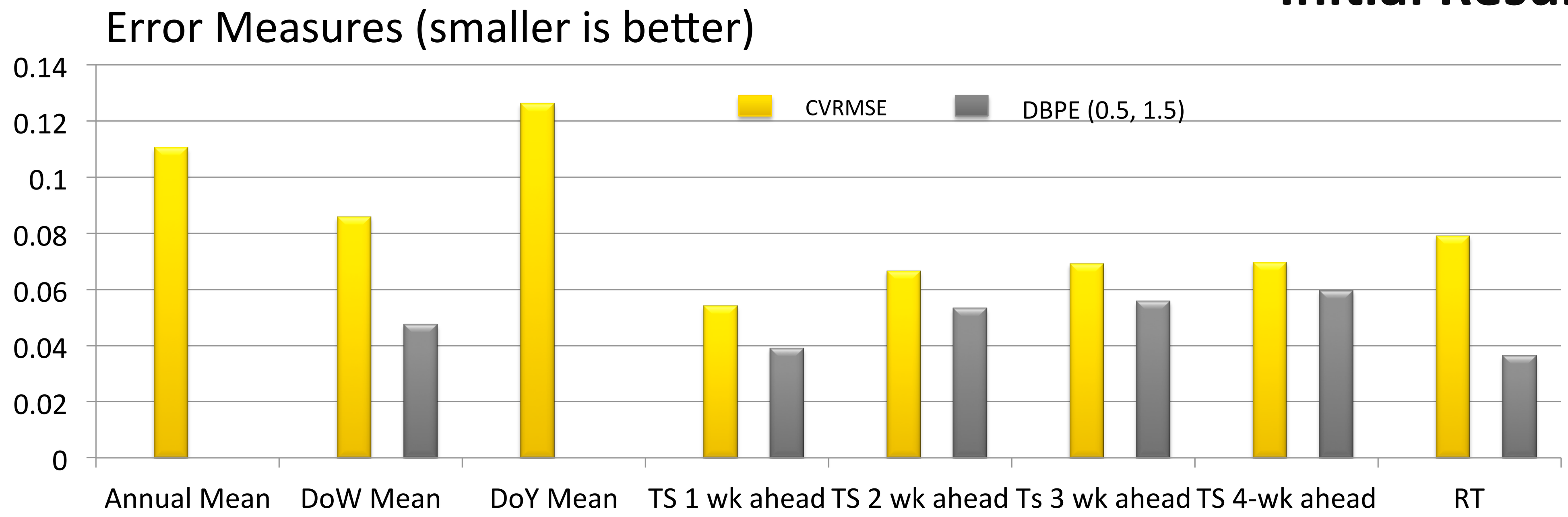
- *risk-adjusted improvement over baseline*
- *factor in volatility of model with respect to baseline*

Volatility Adjusted Benefit- BVM. It is adapted from the Sharpe ratio used in the finance domain for measuring benefit to risk ratio.

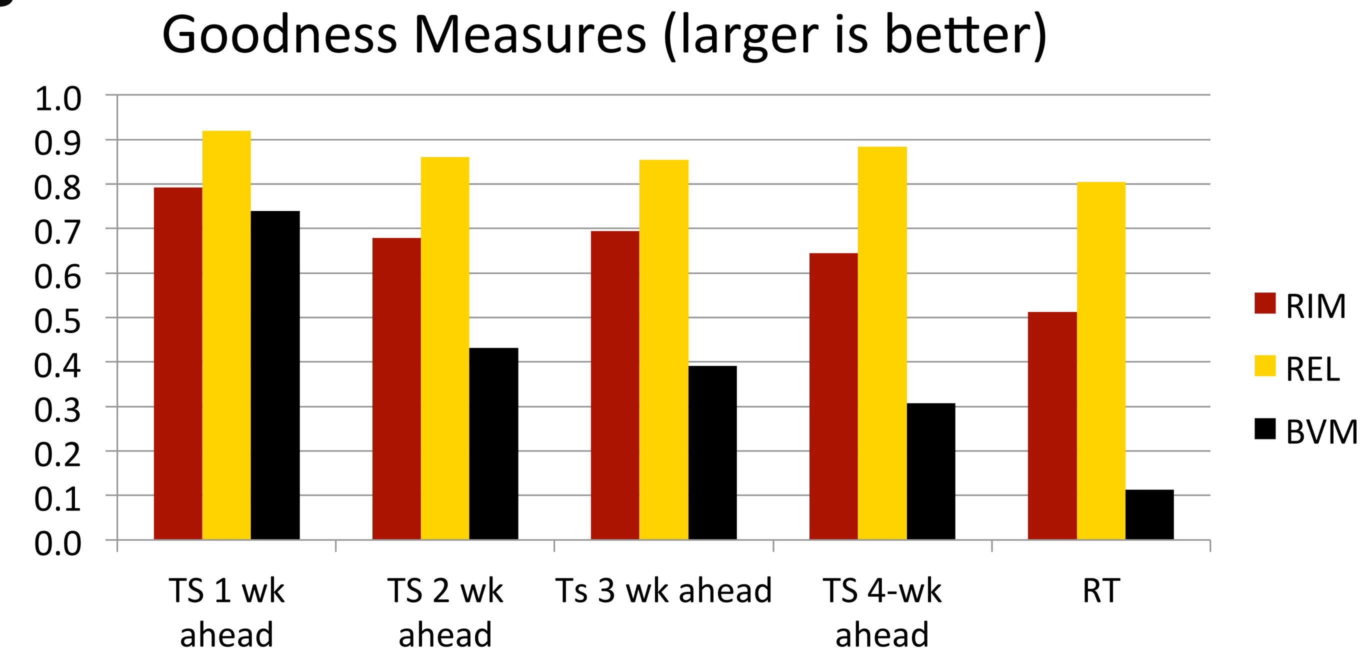
$$BVM = \frac{\frac{1}{n}\sum_{i=1}^{n}(|e_{i,b}| - |e_{i,m}|)}{\sigma(|e_{i,b}| - |e_{i,m}|)}$$

Initial Results

Error Measures (smaller is better)



Goodness Measures (larger is better)



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