Performance Measures for Electricity Consumption Prediction

Saima Aman
(Advisors: Yogesh Simmhan and Viktor K. Prasanna)

**Problem:** Evaluation of KWh prediction

**Motivation:** Dynamic Demand Response (D^3R)

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

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

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

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

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

**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)

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

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

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

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

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

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

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

**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.

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

**Initial Results**

**Error Measures (smaller is better)**

**Goodness Measures (larger is better)**