Analysis of Feature Dimensionality for Regression in Electricity Demand Forecasting

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Problem Statement

- There are various high-impact applications in which a precise methodology for real-time electricity load demand forecasting could be beneficial.
- Real-time load forecasting is usually done by feeding a model information about variables that are correlated with electricity load, such as temperature and time of year, and asking the model to predict load-demand information.
- The Global Energy Forecasting Competition provides years worth of load demand information along with logs of correlated variables.
- We sought to experiment with various methods of feature extraction and regression in search of insights about the variables provided by the competition with respect to their relationship to electricity load.
- Using various factors such as date and locational marginal (electric energy) price and its components for Rhode Island from 2001 to 2017, we aimed to predict the electricity load demand (total demand on the grid from electricity consumers in MW) for each hour.

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Approaches

Features

Original Features

- Our original data consisted primarily of **real-time** (RT) observations and the corresponding **day-ahead** (DA) observations.
- The observations in question are **locational marginal price** (LMP), and **energy component of LMP** (EC), **congestion component of LMP** (CC), **marginal loss component of LMP** (MLC).

New Feature Generation

- We multiplied variables that we believed to be correlated to create new features.

Dimensionality Reduction

To combat the size and complexity of our data, we implemented various dimensionality reduction methods

- **PCA:** uses orthogonal transformations to reduce high-dimensional data into a smaller number of principal components such that each principal component has maximum variance. We used single value decomposition to accomplish this.
- **ICA:** a method similar to PCA, but it tries to identify independent components of the data and get rid of unnecessary noise.
- **Neural Network Autoencoder:** used to compress demand-correlated input variables to a smaller or larger set of feature variables that retain as much useful information as possible for the task of reconstructing the initial input from its compressed representation.

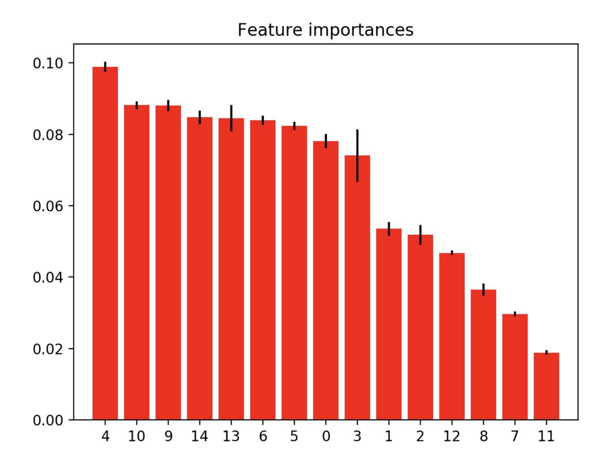
Regression

- **Multiple Regression:** very similar to linear regression except for the fact that multiple features are used in the regression instead of one.
- **Support Vector Regression:** uses kernel transforms to map out nonlinear relationships between load demand and correlated input features.
- **Neural Network Regression:** uses stacked layers of logistic regression units to learn complex nonlinear relationships underlying data in a largely unsupervised manner.

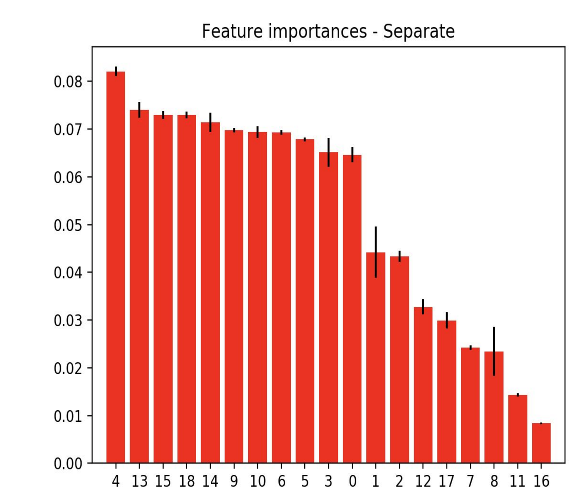
Results & Analysis

Feature Impact

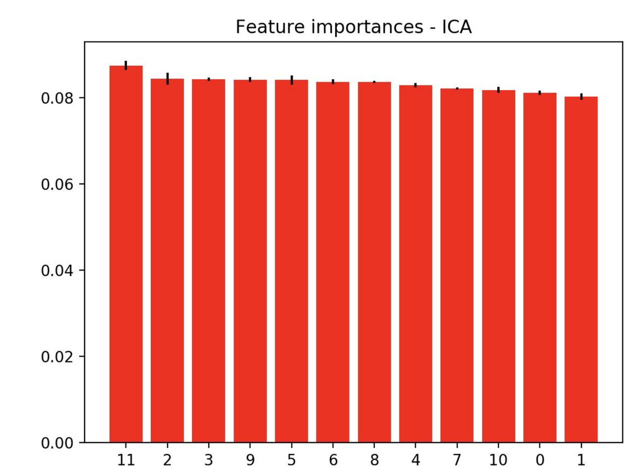
Original



Expanded

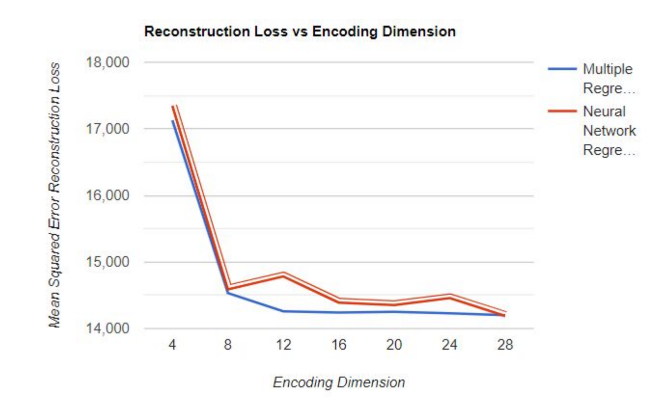


Reduced-Dimension

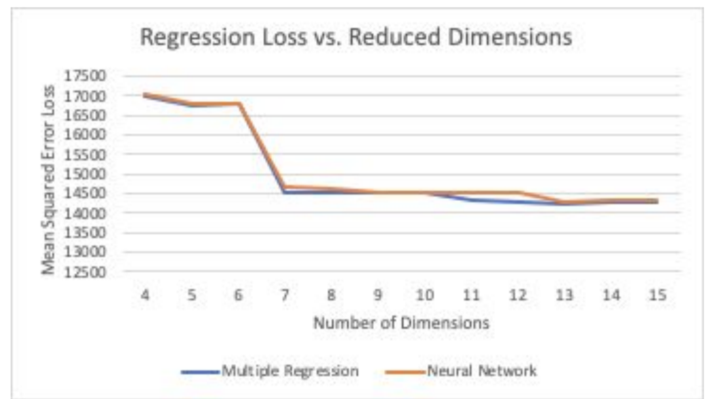


Optimal Dimension

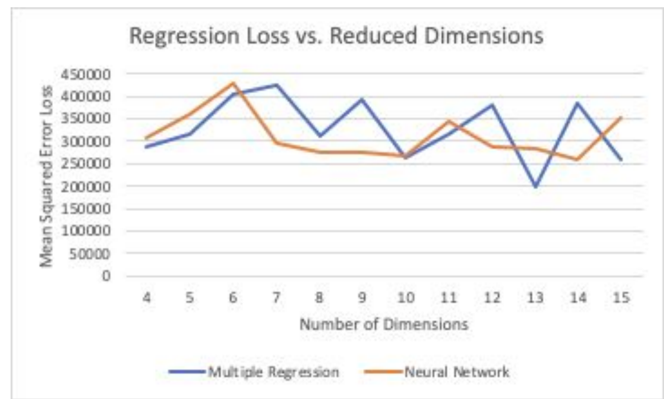
Neural Network Autoencoders



PCA



ICA



Overall Accuracy