Electricity Load Forecasting using Artificial Neural Network

Department of Electrical Engineering
Indian Institute of Technology(BHU), Varanasi

Prakhar Rastogi
Roll No. 14084022
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Sub: Neural Network and its Applications

Contents

Introduction

- Load Forecasting: A model that can forecast electricity demands.
- To predict future energy demands and needs.
- Load: Electric Loads, Electrical Losses in Transmission Lines.
- Estimation of Power Export and Import Revenues.
- Traditional Methods such as Regression, Auto-Regressive Moving Average.
- Recent Trends are to forecast Load using Artificial Neural Network, Feed forward Back-Propagation NN, RNN, LSTM-RNN.

Motivation

What is the requirement of Load Forecasting?

- Failure to generate an adequate amount of energy can lead to grid failures.
- Oversupply of energy can lead to a waste of energy and resources.
- Estimating future network flow accurately can also allow providers to the following:
  - Plan electricity generation.
  - Develop grid infrastructure.
  - Respond to varying frequencies.
  - Improve overall network reliability.

Data Preprocessing

- The dataset is of Delhi Electricity Boards, from 2009 to 2014.
- Dataset is divided into 2 parts: Training and Testing
- 5 years dataset is for training and 1 year dataset is for Testing.
- X train - The sequence of vectors that compose the load time series from 2009-2013, in chronological order.
- Each vector is 96-dimensional since the total load on the electric grid is measured every fifteen minutes.
- Y train - The corresponding next day average total load for the examples in X train .
- Estimate all the missing values by averaging the surrounding values.

Preprocessing

- **Logarithmic Scaling:** The time series contains very large numerical values, which make the problem computationally intensive. To combat this problem, the values in X_{train} , Y_{train} and X_{test} will be scaled by the natural logarithm before the learning stage.
- **Trend Removal:** Eliminating the trend in the target values can improve forecaster accuracy by removing the notion of time. This trend will be due to increase number of energy appliances, electric vehicles, etc. *The trend is estimated by performing least squares linear regression on Y_{train} dataset and subtract the regression predicted value from each value in Y_{train} to get the residuals.*

Preprocessing

- **Principal Component Analysis:** I reduced the dimensionality of the feature vectors because training examples are very few (2190) and Input Neurons are 96.
- I used PCA to reduce the data into lower dimensional while maintaining Maximum amount of variance.

Data is ready to train the Neural Network!!!

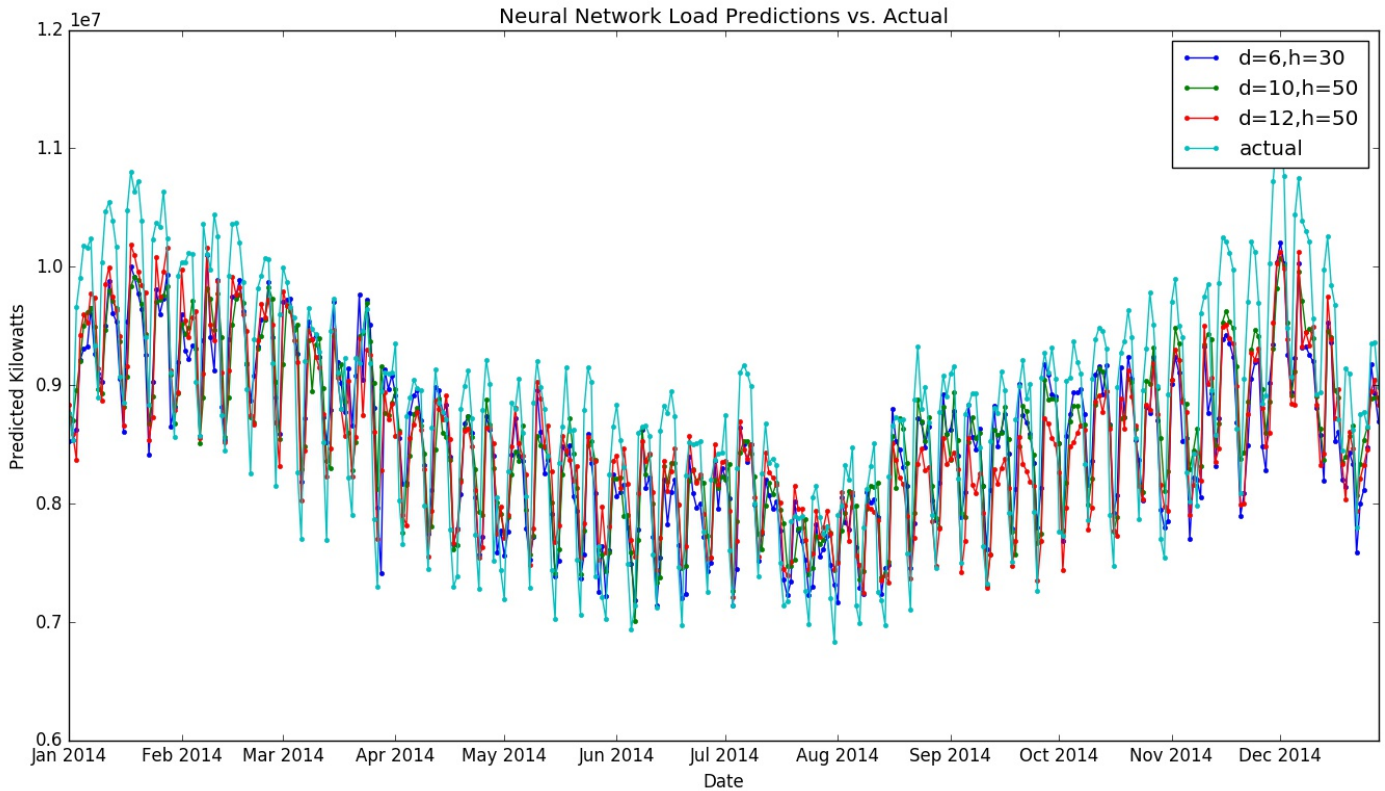
Archiecture

- **Feed-forward Neural Network** with Back Propagation.
- **Input Layer Neurons:** 3 tests with 6, 10, and 12 neurons respectively.
- **Hidden Layers:** 1
- **Neurons in Hidden Layer:** Three tests with 30, 50, and 50 neurons respectively.
- **Output Layer Neurons:**1
- **No. of Epochs:** 40
- **Error Function:** Normalised Root Mean Square Error Function
- **Optimization Function:** Gradient Descent
- **Neuron Activation Function:** Sigmoid
- **Loss Function:** Squared Loss Function

Implementation Files:

- Pybrain Library: Python Library to construct Neural Network.
- scikit-learn: Python based Machine Learning Algorithms Library.
- Numpy Library: Python Numerical Computation Library.
- Pandas Library: Data Analysis Library.
- datagen.py: A file to Load and construct example data vectors.
- statistics.py: File containing functions for performing all statistical operations.
- visualizer.py: File containing functions to plot the data.
- neural.py: Main File of the code defining neural network, calling functions to load dataset, visualize dataset and train the Neural Network.

- Logarithmic Scaling and Detrending the Load time series increased the accuracy of the model.
- The Results of the Neural Network Architecture is as follows:



References

- Luis Hernández, Carlos Baladrón, Javier M. Aguiar, Lorena Calavia, Belén Carro, Antonio Sánchez-Esguevillas, Francisco Pérez, Ángel Fernández and Jaime Lloret. Artificial Neural Network for Short-Term Load Forecasting in Distribution Systems.
- Arjun Baliyan, Kumar Gaurav, Sudhansu Kumar Mishra. A Review of Short Term Load Forecasting using Artificial Neural Network Models.