

Short-Term Electric Load Forecasting using Signal Processing Principles

1st Pulak Mehrotra

*Dept. of Electrical and Electronics Engineering
BITS Pilani
Rajasthan 333031, India*

2nd Sandeep Joshi

*Dept. of Electrical and Electronics Engineering
BITS Pilani
Rajasthan 333031, India*

Abstract—Abstract. Lorem Ipsum is simply dummy text of the printing and typesetting industry. Lorem Ipsum has been the industry's standard dummy text ever since the 1500s, when an unknown printer took a galley of type and scrambled it to make a type specimen book. It has survived not only five centuries, but also the leap into electronic typesetting, remaining essentially unchanged. It was popularised in the 1960s with the release of Letraset sheets containing Lorem Ipsum passages, and more recently with desktop publishing software like Aldus PageMaker including versions of Lorem Ipsum.

Index Terms—Keywords.

I. INTRODUCTION

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II. METHODOLOGY

A. Recurrent Neural Networks (RNNs)

A RNN is a neural network that works on the principle of a feedback loop, saving the output of a particular layer and feeding this back to the input in order to predict the output of the layer. Recurrent networks use their feedback connections to store representations of recently input events in form of activations. This enables it to show dynamic behaviour that is only present for a short period of time, making it perfect for Time Series Forecasting.

1) **Long Short-Term Memory (LSTM)**: LSTM Networks are specialised forms of RNNs that are specifically designed to capture the long-term dependencies in data, making it an ideal fit for sequential prediction. Introduced by S. Hochreiter and J. Schmidhuber in 1997 [1], LSTM models are implemented using memory cells known as a 'cell states' that maintain the sequence's state as data passes through the cell (denoted by c_t in Fig. 1). Information can be reviewed and then appended or removed from the cell state using the gates shown in Fig. 1. These gates let the information flow in and out of the cell depending on the data's relative importance. This is how a LSTM forgets and remembers things selectively, which makes it an improvement over RNNs.

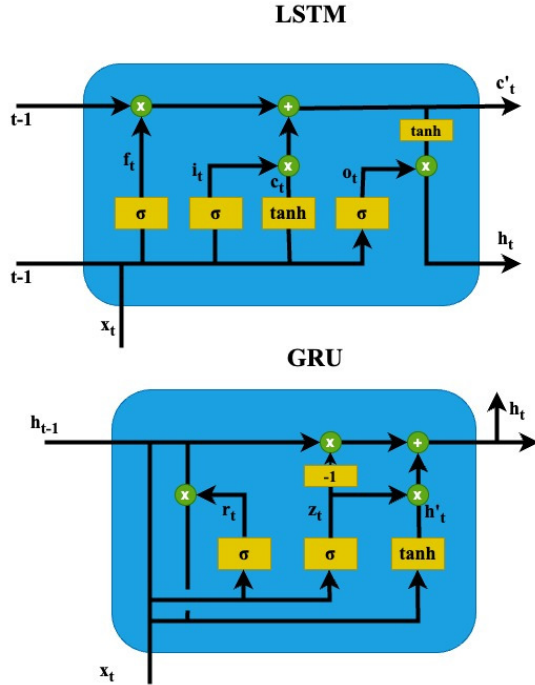


Fig. 1. GRU and LSTM Cell Structure.

2) **Gated Recurrent Unit (GRU)**: The GRU is another neural network with a similar structure to the LSTM apart from a few key differences, introduced in 2014 by Kyunghyun Cho et al [2]. Firstly, the GRU has two gates while the LSTM has three, which leads to more computation and slower training compared to a GRU network. The GRU does not possess any

internal memory as it doesn't have the output gate present in the LSTM. In GRU, the gates work directly with the previous hidden state. In practice, the choice between LSTM and GRU networks depends on the task, size of the dataset, and the computational resources available. It's often recommended to experiment with both and choose the one that performs best on your specific problem.

<https://arxiv.org/pdf/1406.1078.pdf>

3) **Bidirectional LSTM (BiLSTM)**: A Bidirectional LSTM (BiLSTM) is a type of sequence model which contains two LSTM layers, one for processing input in the forward direction and the other for processing in the backward direction. The intuition behind this approach is that by processing data in both directions, the model is able to better understand the relationship between sequences (e.g. knowing the following and preceding readings in a sentence). This makes it clearly more advantageous over a simple LSTM.

Using bidirectional will run your inputs in two ways, one from past to future and one from future to past and what differs this approach from unidirectional is that in the LSTM that runs backward you preserve information from the future and using the two hidden states combined you are able in any point in time to preserve information from both past and future.

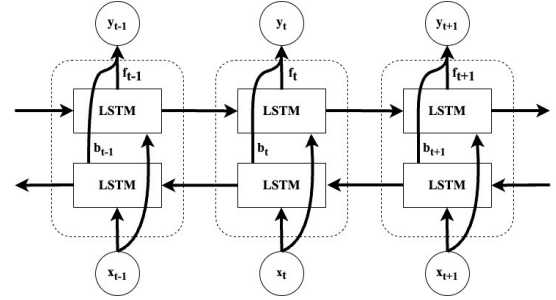


Fig. 2. The unfolded topology of a BiLSTM Network.

B. Hidden Markov Models (HMMs)

It is a model which is used to generate hidden states from observable data. The main goal of this model as stated in [5] is to determine the hidden state sequence that corresponds to the observed output sequence and to learn model parameters from the history of observed output sequence.

In a standard Hidden Markov model the states are in discrete form whereas the observations can either be discrete or continuous

For achieving the above stated goal, apart from set of hidden states and set of output states, the Hidden Markov Model uses two more parameters [9] that are State Transition Probability and State Emission Probability.

The State Transition Probability (A) is the probability that a model from hidden state $q(t)$ at time instant t' will make transition to hidden state $q(t+1)$ at time instant $t'+1$. Mathematically:

State Emission Probability (B) is the probability that the model which is in hidden state $q(t)$ at time instant t' will emit the observable state $vk(t)$. Mathematically:

The aim of this problem is to find out that for a given model O and output state sequence V' , what is the hidden state sequence which most likely led to the generation of the output state sequence, i.e. for a model O we have to find out the most probable hidden state sequence oF which has led to the generation of a particular output state sequence vI . This problem can be solved using Viterbi algorithm

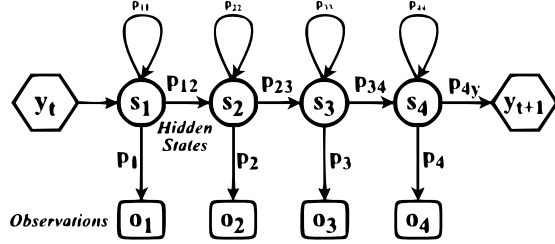


Fig. 3. Topology of a HMM used for Prediction

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III. SYSTEM MODEL

In this section, we present the design considerations and architecture of our short-term electric load forecasting system.

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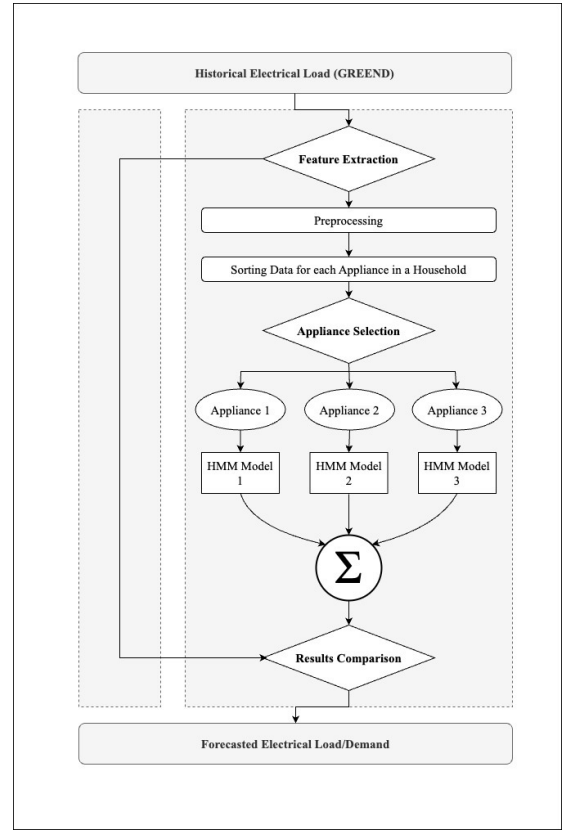


Fig. 4. Description of the first figure.

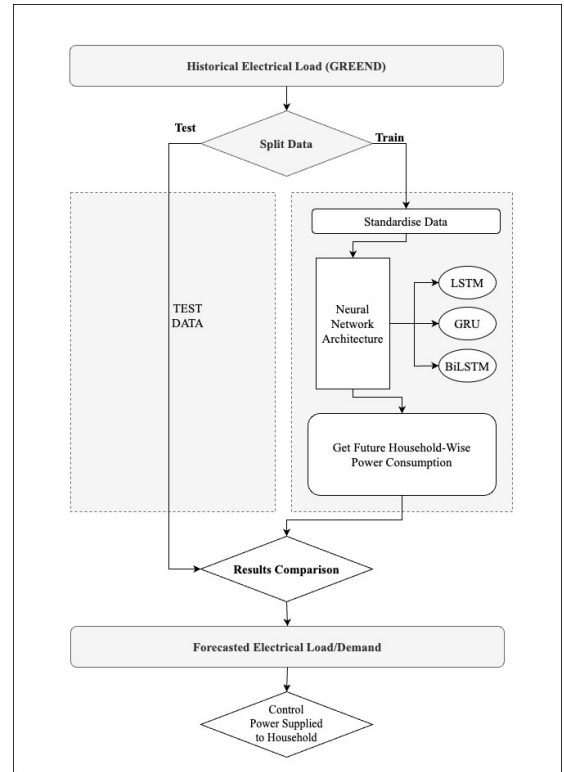


Fig. 5. Description of the second figure.

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V. CONCLUSIONS

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ACKNOWLEDGMENT

The preferred spelling of the word “acknowledgment” in America is without an “e” after the “g”. Avoid the stilted expression “one of us (R. B. G.) thanks ...”. Instead, try “R. B. G. thanks...”. Put sponsor acknowledgments in the unnumbered footnote on the first page.

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