

2023 IEEE International Conference on Information Technologies

Short-term Load Forecasting Using Artificial Neural Network Techniques: A Case Study for Republic of North Macedonia

Ana Kotevska, Nevenka Kiteva Rogleva

1. Introduction

- Immplementation of Artificial Neural Network (ANN) for Power system planning
- Distribution system operator (DSO)/Transmission system operator (TSO) requirements:
- to predict the load flow at real time and in different locations of the power system
- ▶ to define generation scheduling, electricity transaction, etc.
- The aim of this paper is define the features important short-term load forecasting.

2. Artificial Neural Networks

- ANN has the advantage of learning directly from the historical data.
- Back propagation architecture is used for short-term load forecasting



Figure 1. Multiple neural network

2.1. ANN architecture for STLF

Input parameters for STLF model:

- Consumption information may include historical consumption.
- Weather information mostly includes temperature.
- Time information may include month, day and time of the day.
- Optimal number of hidden neurons.
 - Small data set means a lack of information and inaccurate predictions;
 - Iarge data results in a very long training process.

2.2. Back propagation architecture is used for short-term load forecasting

- First input values are propagated through the network in order to optain an output
- The Network Output (NO) is compared with the Desired Output (DO) and an Error
- ► Is calculated
- The output error is propagated back through the network, changing the internal weights along the way in order to simulate a lower error between the predictions and the actual data
- Process continue until for one epoch, all outputs for each pattern are within the define tolerance.

3. ANN Model

Model 1:

- 46 neurons are used in the input layer
- The first 7 neurons indicate the type of day (Monday to Sunday)
- The next 24 neurons are the type of hour
- The next 12 neurons are the type of month and
- I neuron is used for the consumption from the previous day, temperature from the previous day and temperature for the forecasted day.
- There are 2 hidden layers. The output layer contains 1 neuron, i.e. the forecasted hour.

3.1. ANN models with transformed data

▶ I. Using cyclic transformation and data normalization

- ► Model N1:
 - 9 neurons are used in the input layer: the first 2 neurons indicate the hour of the day, the next 2 neurons are the type of day and the next 2 neurons are the type of month, represented with sin and cos values according to the cyclic transformation.
 - The next neurons for consumption from the previous day, temperature from the previous day and temperature for the forecasted day are normalized.
 - The neural network has 2 hidden layers and the output layer has 1 neuron, i.e. the forecasted hour.

3.1. ANN models with transformed data

- ► II. Using cyclic transformation and standardization of data
- ► Model S1:
 - 9 neurons are used in the input layer: the first 2 neurons indicate the hour of the day, the next 2 neurons are the type of day and the next 2 neurons are the type of month, represented with sin and cos values according to the cyclic transformation.
 - The next neurons for consumption from the previous day, temperature from the previous day and temperature for the forecasted day are standardized.
 - The neural network has 2 hidden layers and the output layer contains 1 neuron, i.e. the forecasted hour.

3.1. ANN models with transformed data

► For Model 1 the training data set contains about 14,000 records, the validation data set around 1,000 records and the test data set is around 1,000 records.

- ► The models are developed in Python using the Keras library.
- ► The parameters of the models:
- The input layer receives 46 neurons and gives 150 neurons to the output.
- The first hidden layer gives 80 neurons.
- The second hidden layer gives 30 neurons.
- The output layer gives 1 neuron

3.2. Simulation Results

► Before starting the training of the model, the learning process needs to be set with the 'compile' method.

- ► This method has three parameters:
- optimizer (in the model is used Adam algorithm),
- ► loss function (in the model is used MSE, the purpose is to try to minimize this loss) and

▶ a metric (in the model is used MAPE).







4. Conclusion

► ANNs are capable for STLF modeling

- Neural networks are using learning method, meaning their output is not always the same, although the same input data and parameters are used.
- The network is learning better if there is more data, such as type of hour, day (within the week or if it is working, non-working or a holiday), month, previous consumption, previous temperature and forecasted temperature (or other weather information).
- ► The size of the data set has a crucial role, since it has shown a reduction of the error measurement