School of Electrical & Electronic Engineering

IE4424 Machine Learning Design and Application

Academic Year 2024-2025

Time Series Prediction Using Long Short-Term Memory (LSTM) Neural Network

Computer Engineering II (S2-B3b-08)

Laboratory Manual

1. Objective

The objective of this lab is to study the concepts and models for time series prediction using Long Short-Term Memory neural networks (LSTMs).

2. Introduction

A time series is a collection of data points recorded in chronological order and the task of time series prediction is to predict future values based on the previously observed values. Some examples of time series prediction include weather prediction, stock price prediction, housing price prediction, etc. The recurrent nature and gating mechanism of Long Short-Term Memory neural networks (LSTMs) give them certain advantages in the task of time series prediction [1].

During training, an LSTM model is fed with sequences of the time series and their corresponding future values. The sequences are obtained via a fixed-width moving window across the time series dedicated for training. For example, with a window width of 5 and a step size of 1, the first sequence will be data points 1-5 and the second sequence will be data points 2-6 and so on. Given these input sequences, the model will learn to predict the values of the next time step.

In this design experiment, we will use PyTorch [2], an optimized tensor library for deep learning using GPUs / CPUs to build LSTM models.

3. Files

There are 3 files for this lab session.
1. IE4424_time_series _lab_manual
2. Time_Series_Prediction.ipynb
3. Time_Series_Prediction_Optional.ipynb

4. Cheat sheets and reading materials

The following cheat sheets and reading materials are optional, and they are useful for this lab. You are encouraged to browse through them.

1. PyTorch LSTM:
   https://pytorch.org/docs/stable/generated/torch.nn.LSTM.html
2. Scikit-learn StandardScaler:
   https://scikit-learn.org/stable/modules/generated/sklearn.preprocessing.StandardScaler.html

5. Instructions

1. Read the instructions and complete the exercises in Time_Series_Prediction.ipynb.

2. Get the answer sheet from the lab staff. Follow the instructions and answer the questions in the answer sheet. Write your full name and other info clearly on the answer sheet. Submit the completed answer sheet at the end of lab.

3. (Optional) Read the instructions in Time_Series_Prediction_Optional.ipynb. Answer the questions in the answer sheet. This part is optional. It is more challenging and should only be attempted after you have completed the exercises in Time_Series_Prediction.ipynb.

References

[1] Hochreiter, Sepp, and Jürgen Schmidhuber. "Long short-term memory." Neural computation 9, no. 8. 1997.

[2] Paszke, Adam, et al. "Pytorch: An imperative style, high-performance deep learning library." *Advances in neural information processing systems*. 2019.