COS40007 Artificial Intelligence for Engineering

Week 8 Studio Activities

ILO	Understand and apply time-series forecasting techniques using regression and LSTM models.
Aim	• Learn the basics of time-series data and forecasting • Implement simple regression models for time-series forecasting • Understand and apply LSTM networks for time-series prediction • Compare different forecasting techniques
Resources	Books: 1. Prosise, Jeff. Applied machine learning and AI for engineers. " O'Reilly Media, Inc.", 2022. 2. Raschka, Sebastian, Yuxi Hayden Liu, and Vahid Mirjalili. Machine Learning with PyTorch and Scikit-Learn: Develop machine learning and deep learning models with Python. Packt Publishing Ltd, 2022. 3. Géron, Aurélien. "Hands-on machine learning with Scikit-Learn, Keras, and TensorFlow: Concepts, tools, and techniques to build intelligent systems." O'Reilly Media, 2019. 4. Brownlee, Jason. "Deep Learning for Time Series Forecasting: Predict the Future with MLPs, CNNs and LSTMs in Python." Machine Learning Mastery, 2018. Web Resources: 1. https://www.kaggle.com/code/iamleonie/intro-to-time-series-forecasting 2. https://www.tensorflow.org/tutorials/structured_data/time_series 3. https://scikit-learn.org/stable/modules/generated/sklearn.linear_model.LinearRegression.html
Requiremen ts for to be marked as complete	Demonstrate the completed activities and discuss the results with your tutor.

Note: It is recommended that students use Google CoLab or other free GPU computing environments to complete activities 2-4 of this studio.

Studio Activity 1: Introduction to Time-series Data

This activity will teach you how to load, visualise, and preprocess time-series data.

1) Load the time-series dataset given at https://archive.ics.uci.edu/dataset/322/gas+sensor+array+under+dynamic+gas+mixtures
2) Visualise the data using matplotlib
3) Perform basic preprocessing, such as handling missing values and resampling.

Use this tutorial as a reference: https://www.kaggle.com/code/iamleonie/intro-to- time-series-forecasting#Data-Preprocessing

Studio Activity 2: Simple Moving Average

Implement a simple moving average model for time-series forecasting,

1) Calculate and plot simple moving averages with different window sizes
2) Use the moving average to make short-term predictions
3) Evaluate the performance using metrics like Mean Absolute Error (MAE) and Root Mean Square Error (RMSE).

Refer to this guide for implementation details:
https://www.kaggle.com/code/iamleonie/intro-to-time-series-forecasting#Models- for-Univariate-Time-Series

Studio Activity 3: **Linear Regression for Time-series Forecasting**

Apply linear regression to predict future values in a time series.

4) Prepare the data by creating lagged features
5) Split the data into training and testing sets
6) Train a linear regression model using sci-kit-learn
7) Make predictions and evaluate the model's performance

Use this tutorial as a reference: https://www.kaggle.com/code/ryanholbrook/linear-regression-with-time-series

Studio Activity 4: **Introduction to LSTM Networks**

Learn the basics of Long Short-Term Memory (LSTM) networks and how they can be applied to time-series forecasting.

8) Understand the architecture of LSTM networks.

9) Prepare time-series data for LSTM input (sequence creation)

10) Build a simple LSTM model using Keras

11) Train the model and make predictions

Follow this guide for LSTM implementation:
https://www.kaggle.com/code/maryanalyze/simple-lstm-pytorch-time-series-forecasting-model.

Studio Activity 5: **LSTM for Multivariate Time-series Forecasting**

Extend the previous activity to handle multivariate time-series data.

12) Load the time-series dataset you used earlier

13) Preprocess and prepare the data for LSTM input

14) Build and train an LSTM model for multivariate forecasting

15) Make predictions and visualise the results

Use this tutorial as a reference: https://www.kaggle.com/code/maryanalyze/simple-lstm-pytorch-time-series-forecasting-model

Next Steps:
In this studio, you have learned various techniques for time-series forecasting, including simple statistical methods, regression, and advanced deep-learning approaches using LSTM.