Simple RNN Project Report: Sine Wave Prediction

ADTA 5560.701 - Recurrent Neural Networks for Sequence Data

1. Introduction

This report presents the results of implementing a Simple Recurrent Neural Network (RNN) for predicting sine wave patterns. The project demonstrates the application of RNNs in sequence prediction tasks using the Keras deep learning framework with TensorFlow backend.

2. Methodology

2.1 Data Preparation

* Generated synthetic sine wave data using numpy's linspace function
* Data points: 1024 samples over the interval [0, 64]
* Training/Testing split: 80%/20%
* Data normalized using MinMaxScaler
* Sequence length: 50 timesteps

2.2 Model Architecture

A diagram of a diagram

Description automatically generated

* Input Layer: SimpleRNN with 100 units
* Output Layer: Dense layer with 1 unit
* Total Parameters: ~10,200

2.3 Training Configuration

* Optimizer: Adam
* Loss Function: Mean Squared Error (MSE)
* Batch Size: 1
* Epochs: 5
* TimeseriesGenerator used for sequence generation

A graph of a train-test split visualization

Description automatically generated

3. Results Analysis

3.1 Model Performance

Based on the visualization provided, the Simple RNN demonstrates strong predictive capabilities:

A graph of a function

Description automatically generated with medium confidence

1. Pattern Recognition: The model successfully captured the fundamental sinusoidal pattern, showing its ability to learn periodic functions.
2. Phase Alignment: The predicted values (orange line) closely align with the actual sine wave (blue line), indicating good temporal coherence.
3. Amplitude Accuracy: The model accurately predicts the sine wave's amplitude, with minor deviations at the peaks and troughs.

4. Conclusion

The Simple RNN implementation achieves successful predictions of sine wave patterns. The model demonstrates a solid fit with both the amplitude and phase components of the sine wave while there are slight deviations. These results confirm that RNNs are effective at sequence prediction problems and set the stage for more complex applications.

The project achieves its goals of implementation and experimentation with a Simple RNN for the task of sequence prediction but also provides insights on new research directions for future improvement.