REPORT

Assignment no.4 (PART 2)

Objective

The goal of this experiment is to evaluate and compare the Mean Squared Error (MSE) performance of LSTM, GRU, Bidirectional RNN, and Deep RNN models on a synthetic time series dataset. Each model was first tested on the original dataset, followed by repeated experiments on a dataset three times larger to examine how performance varies with increased data size.

Results

The MSE results for each model on the original dataset and the larger dataset (across three trials) are as follows:

Algorithm	Original dataset (MSE)	Experiment 1 (MSE)	Experiment 2 (MSE)	Experiment 3 (MSE)
LSTM	0.0259	0.0281	0.0168	0.0149
GRU	0.0181	0.0164	0.0173	0.0159
Bidirectional RNN	0.0279	0.0213	0.0162	0.0148
Deep RNN	0.0150	0.0171	0.0139	0.0138

Analysis

The following observations highlight how each model performed across different dataset sizes:

1. **LSTM:**
    - The LSTM model's performance improved with the larger dataset, showing a notable MSE reduction in later trials (0.0281 to 0.0149).
    - This aligns with LSTM's strength in capturing long-term dependencies, which becomes more advantageous as more patterns are introduced with increased data.
2. **GRU:**
    - The GRU model maintained stable MSE values across both datasets, with minimal variation.
    - GRU's design, which is computationally efficient, appeared to handle the larger dataset well without substantial shifts in performance, suggesting it as a reliable choice when resources are limited.
3. **Bidirectional RNN:**
    - Bidirectional RNN showed significant improvement on the larger dataset, with MSE dropping from 0.0279 on the original dataset to 0.0148 in later trials.
    - By processing information in both directions, the bidirectional RNN leveraged more context, especially beneficial with the larger dataset's added information.
4. **Deep RNN:**
    - Deep RNN consistently achieved the lowest MSE across both datasets, with minimal fluctuation in error (0.0150 to 0.0138).
    - Its layered structure allowed it to capture complex temporal patterns, making it particularly effective with more data.

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Conclusion

Across all models, increasing the dataset size led to performance gains, with LSTM and Bidirectional RNN models showing the most significant improvements. Deep RNN consistently delivered the lowest MSE, likely due to its deep structure's ability to capture intricate patterns, particularly in larger datasets. For time series tasks with ample data, deep or bidirectional architectures (Deep RNN and Bidirectional RNN) offer advantages. GRU, however, remains a robust option for its efficiency and reliable performance when data or resources are limited.