CSC4093 Programming Assignment 02 **S/19/813**

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LSTM vs Bi-LSTM Report

1. Performance Comparison

Model	**Validation Accuracy**	**Validation Loss**	**Test Accuracy**
LSTM	0.7374	0.5773	0.7097
Bi-LSTM	0.7334	0.5169	0.8046

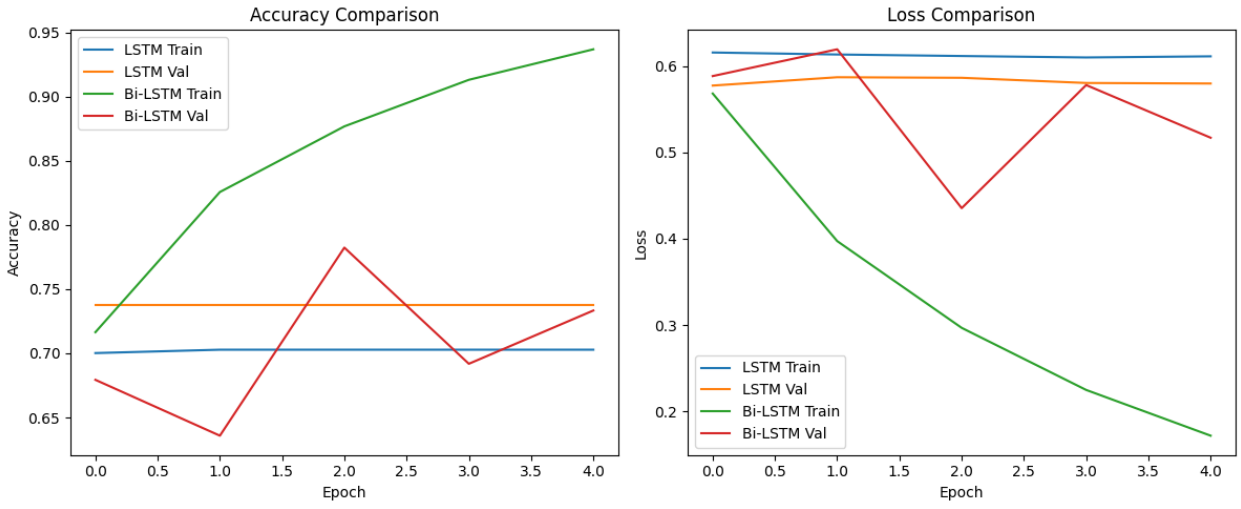
The performance metrics above reflect the validation and test results from training both models. Although the Bi-LSTM model had similar validation accuracy to the LSTM, it achieved significantly better test accuracy.

```
Training LSTM model...
Epoch 1/5
/usr/local/lib/python3.11/dist-packages/keras/src/layers/core/embedding.py:90: UserWarning: Argument `input_length` is deprecated. Just remove it.
  warnings.warn(
125/125 ━━━━━━━━━━━━━━━━━━━━ 16s 98ms/step - accuracy: 0.6878 - loss: 0.6277 - val_accuracy: 0.7374 - val_loss: 0.5773
Epoch 2/5
125/125 ━━━━━━━━━━━━━━━━━━━━ 20s 97ms/step - accuracy: 0.6987 - loss: 0.6182 - val_accuracy: 0.7374 - val_loss: 0.5870
Epoch 3/5
125/125 ━━━━━━━━━━━━━━━━━━━━ 21s 98ms/step - accuracy: 0.6994 - loss: 0.6139 - val_accuracy: 0.7374 - val_loss: 0.5863
Epoch 4/5
125/125 ━━━━━━━━━━━━━━━━━━━━ 20s 91ms/step - accuracy: 0.7001 - loss: 0.6121 - val_accuracy: 0.7374 - val_loss: 0.5803
Epoch 5/5
125/125 ━━━━━━━━━━━━━━━━━━━━ 21s 94ms/step - accuracy: 0.7002 - loss: 0.6138 - val_accuracy: 0.7374 - val_loss: 0.5797
105/105 ━━━━━━━━━━━━━━━━━━━━ 2s 19ms/step

LSTM Test Accuracy: 0.7097
              precision    recall  f1-score   support

           0       0.71      1.00      0.83      2364
           1       0.00      0.00      0.00       967

    accuracy                           0.71      3331
   macro avg       0.35      0.50      0.42      3331
weighted avg       0.50      0.71      0.59      3331

/usr/local/lib/python3.11/dist-packages/sklearn/metrics/_classification.py:1565: UndefinedMetricWarning: Precision is ill-defined and being set to 0.0 in labels with no predicted samples. Use `zero_di
  _warn_prf(average, modifier, f"{metric.capitalize()} is", len(result))
/usr/local/lib/python3.11/dist-packages/sklearn/metrics/_classification.py:1565: UndefinedMetricWarning: Precision is ill-defined and being set to 0.0 in labels with no predicted samples. Use `zero_di
  _warn_prf(average, modifier, f"{metric.capitalize()} is", len(result))
/usr/local/lib/python3.11/dist-packages/sklearn/metrics/_classification.py:1565: UndefinedMetricWarning: Precision is ill-defined and being set to 0.0 in labels with no predicted samples. Use `zero_di
  _warn_prf(average, modifier, f"{metric.capitalize()} is", len(result))
```

```
Training Bi-LSTM model...
Epoch 1/5
/usr/local/lib/python3.11/dist-packages/keras/src/layers/core/embedding.py:90: UserWarning: Argument `input_length` is deprecated. Just remove it.
  warnings.warn(
125/125 ━━━━━━━━━━━━━━━━━━━━ 26s 163ms/step - accuracy: 0.7060 - loss: 0.6067 - val_accuracy: 0.6793 - val_loss: 0.5883
Epoch 2/5
125/125 ━━━━━━━━━━━━━━━━━━━━ 21s 169ms/step - accuracy: 0.8018 - loss: 0.4331 - val_accuracy: 0.6358 - val_loss: 0.6193
Epoch 3/5
125/125 ━━━━━━━━━━━━━━━━━━━━ 41s 168ms/step - accuracy: 0.8755 - loss: 0.3031 - val_accuracy: 0.7824 - val_loss: 0.4353
Epoch 4/5
125/125 ━━━━━━━━━━━━━━━━━━━━ 39s 156ms/step - accuracy: 0.9170 - loss: 0.2196 - val_accuracy: 0.6918 - val_loss: 0.5779
Epoch 5/5
125/125 ━━━━━━━━━━━━━━━━━━━━ 22s 166ms/step - accuracy: 0.9432 - loss: 0.1658 - val_accuracy: 0.7334 - val_loss: 0.5169
105/105 ━━━━━━━━━━━━━━━━━━━━ 4s 29ms/step

Bi-LSTM Test Accuracy: 0.8046
              precision    recall  f1-score   support

           0       0.87      0.86      0.86      2364
           1       0.66      0.68      0.67       967

    accuracy                           0.80      3331
   macro avg       0.76      0.77      0.76      3331
weighted avg       0.81      0.80      0.81      3331
```

2. Accuracy and Loss Plots

These plots illustrate training and validation performance of both models across 5 epochs. Bi-LSTM shows a stronger upward trend in accuracy and greater reduction in loss.



3. Discussion

The Bi-LSTM model did better than the LSTM model on the test data. It got over 80% accuracy, while the LSTM got about 70%. Even though their validation scores were close, Bi-LSTM had lower loss and improved more during training.

This is because Bi-LSTM can look at both the words before and after in a sentence. This helps it better understand the meaning, especially in short and unclear tweets.

Despite the LSTM being a solid baseline, Bi-LSTM is clearly more effective for this binary classification task, provided that computational resources are sufficient.