Intro Deep Learning Homework 3

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GitHub:
https://github.com/jaskinkabir/Intro_Deep_Learning/tree/master/HM3

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1 Problem 1: Character Prediction Small Dataset

1a. *Training Curves*

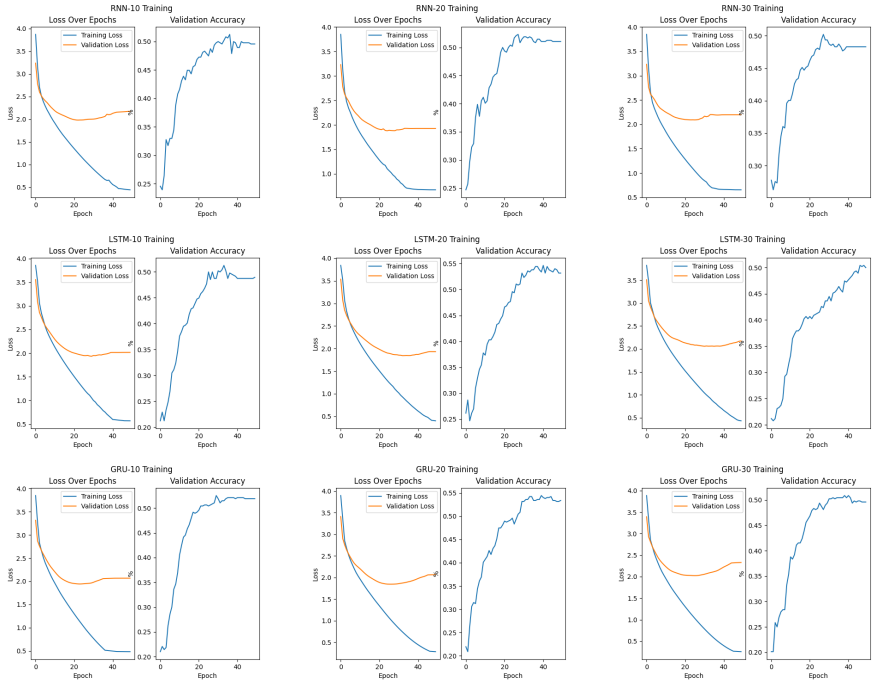

Figure 1: Problem 1 Training Curves

1b. *Results Comparison*

Model	Parameter Count	Training Time (s)	Overfit (%)	Accuracy (%)
RNN-10	44846	1.93	389.68	49.58
RNN-20	44846	3.65	185.97	51.05
RNN-30	44846	5.24	235.41	48.31
LSTM-10	143918	5.79	253.80	48.95
LSTM-20	143918	11.21	381.00	53.16
LSTM-30	143918	18.23	399.18	50.00
GRU-10	110894	5.30	329.01	51.89
GRU-20	110894	9.88	347.95	54.01
GRU-30	110894	15.41	460.00	50.85

Table 1: Problem 1 Data Comparison

1c. *Discussion*

- Parameter Count

  The parameter count of the LSTM network was more than triple that of the basic RNN network, and the GRU was almost halfway between the two. This is to be expected, as the LSTM adds significant complexity to the base RNN architecture, and the GRU reduces that complexity. This complexity comes from the number of gates in each architecture.

- Training Time

  The RNN was the quickest to train, followed by the GRU and then the LSTM. Training time seemed to increase linearly with sequence length for all architectures.

- Effect of Sequence Length

  The sequence length of 10 was too short for the models to have enough relevant information, while the length of 30 was too difficult for the models to learn. The sequence length of 20 was the best compromise between the two.

- Overfitting

  For the best sequence length of 20, the RNN had the lowest overfit and the LSTM the highest. This is likely a result of the difference in complexity between the architectures. The most complex model, the LSTM, had the highest overfit.

Interestingly, for the sequence length of 10, the RNN the highest overfit while the LSTM had the lowest. This could be due to the RNN not having enough information to memorize the training data, while the LSTM was able to memorize more from the shorter sequences.

For the sequence length of 30, the GRU had the highest overfit and the RNN the lowest. As the GRU was the most effective at generalizing from the training data, it makes sense that it would also overfit the most

- Accuracy

  Across all sequence lengths, the GRU was the most accurate and the RNN the least. The LSTM was in the middle. This is likely due to the complexity of the LSTM and the simplicity of the RNN. The GRU is a good compromise between the two, which is why it performed the best.

2 Problem 2: Shakespeare Character Prediction

1a. *Training Curves*

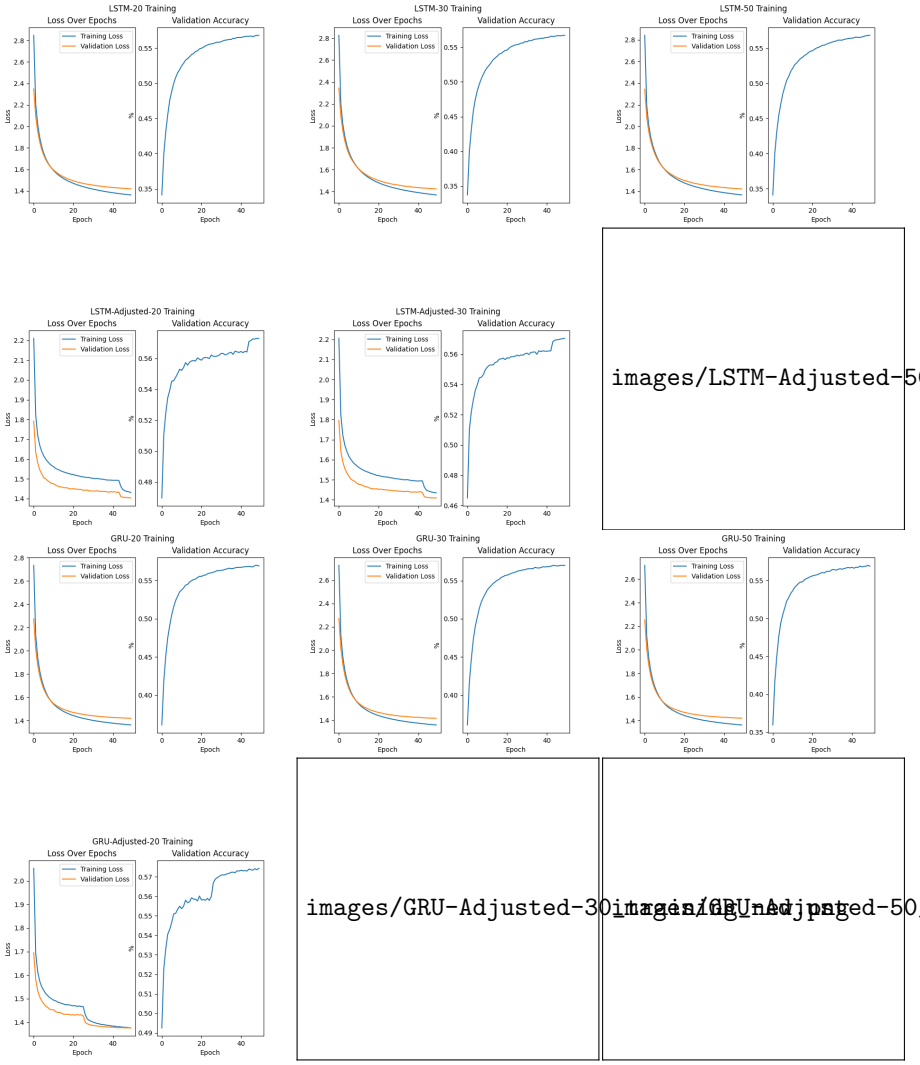

Figure 2: Problem 2 Training Curves

1b. *Results Comparison*

Model	Parameter Count	Training Time (s)	Inference Time (s)	Overfit (%)
LSTM-20	148801	346.11	3.83	56.62
LSTM-30	44846	3.65	185.97	51.05
LSTM-50	44846	5.24	235.41	48.31
LSTM-Adjusted-20	143918	5.79	253.80	48.95
LSTM-Adjusted-30	143918	11.21	381.00	53.16
LSTM-Adjusted-50	143918	18.23	399.18	50.00
GRU-20	115777	5.30	329.01	51.89
GRU-30	110894	9.88	347.95	54.01
GRU-50	110894	15.41	460.00	50.85
GRU-Adjusted-20	110894	5.30	329.01	51.89
GRU-Adjusted-30	110894	9.88	347.95	54.01
GRU-Adjusted-50	110894	15.41	460.00	50.85

Table 2: Problem 2 Data Comparison

1c. *Discussion*

- Parameter Count

  The parameter count of the LSTM network was more than triple that of the basic RNN network, and the GRU was almost halfway between the two. This is to be expected, as the LSTM adds significant complexity to the base RNN architecture, and the GRU reduces that complexity. This complexity comes from the number of gates in each architecture.

- Training Time

  The RNN was the quickest to train, followed by the GRU and then the LSTM. Training time seemed to increase linearly with sequence length for all architectures.

- Effect of Sequence Length

  The sequence length of 10 was too short for the models to have enough relevant information, while the length of 30 was too difficult for the models to learn. The sequence length of 20 was the best compromise between the two.

- Overfitting

  For the best sequence length of 20, the RNN had the lowest overfit and the LSTM the highest. This is likely a result of the difference in complexity between the architectures. The most complex model, the LSTM, had the highest overfit.

  Interestingly, for the sequence length of 10, the RNN the highest overfit while the LSTM had the lowest. This could be due to the RNN not having enough information to memorize the training data, while the LSTM was able to memorize more from the shorter sequences.

  For the sequence length of 30, the GRU had the highest overfit and the RNN the lowest. As the GRU was the most effective at generalizing from the training data, it makes sense that it would also overfit the most

- Accuracy

  Across all sequence lengths, the GRU was the most accurate and the RNN the least. The LSTM was in the middle. This is likely due to the complexity of the LSTM and the simplicity of the RNN. The GRU is a good compromise between the two, which is why it performed the best.