ECGR 5106 Homework 4: Language Translation with a GRU-Based Encoder-Decoder

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GitHub Link

Click here to view the code

Problem 1.

For the GRU-based encoder-decoder for English to French translation, the validation loss was found to be 0.20560937239027252 and the accuracy was 89.6%. This was found using 45 epochs, a learning rate of 0.008, and a hidden size of 256. The training loss over 40 epochs and 10 language predictions can be seen in Figure 1 below:

Figure 1: Training Loss + Language Predictions

```
Epoch 0, Loss: 3.68735145340013
Epoch 10, Loss: 2.7110702150901607
Epoch 20, Loss: 1.9316876419891504
Epoch 30, Loss: 1.0958532428205732
Epoch 40, Loss: 0.37833696200205746
Input: They laugh at the joke, Target: Ils rient de la blague, Predicted: Ils rient de la blague
Input: He listens to music while jogging, Target: Il écoute de la musique en faisant du jogging, Predicted: Il écoute de la musique en
Input: They travel around the world, Target: Ils voyagent autour du monde, Predicted: Ils voyagent autour du monde
Input: The cat is sleeping, Target: Le chat dort, Predicted: Le chat dort
Input: She dances at the party, Target: Elle danse à la fête, Predicted: Elle danse à la fête
Input: We celebrate birthdays with cake, Target: Nous célébrons les anniversaires avec un gâteau, Predicted: Nous célébrons les anniversaires avec un
Input: She walks along the beach, Target: Elle se promène le long de la plage, Predicted: Elle se promène le long de la poésie
Input: The sun is shining, Target: Le soleil brille, Predicted: Le soleil brille
Input: The sun sets in the evening, Target: Le soleil se couche le soir, Predicted: Le soleil se couche le soir
Input: The restaurant serves delicious food, Target: Le restaurant sert une délicieuse cuisine, Predicted: Le restaurant sert une délicieuse cuisine
Evaluation Loss: 0.20560937239027252, Accuracy: 0.8961038961038961
```

Problem 2.

For the same model as Problem 1 but with attention, the validation loss was found to be 0.13047321887068264 and the accuracy was 94.8%. This was found using 45 epochs, a learning rate of 0.008, and a hidden size of 256. The accuracy improved once attention was added. The training loss over 40 epochs and 10 language predictions can be seen in Figure 2 below:

Figure 2: Training Loss + Language Predictions

```
Epoch 0, Loss: 3.8221275875431266
Epoch 10, Loss: 2.7021728879322695
Epoch 20, Loss: 1.8247840667159203
Epoch 30, Loss: 0.794136008899793
Epoch 40, Loss: 0.233283590073992
Input: He works hard every day, Target: Il travaille dur tous les jours, Predicted: Il travaille dur tous les jours
Input: The children play in the park, Target: Les enfants jouent dans le parc, Predicted: Les enfants jouent dans le parc
Input: We love music, Target: Nous aimons la musique, Predicted: Nous aimons la musique
Input: They listen to the radio, Target: Ils écoutent la radio, Predicted: Ils écoutent la radio
Input: We eat breakfast together, Target: Nous prenons le petit déjeuner ensemble, Predicted: Nous prenons le petit déjeuner ensemble
Input: They swim in the pool, Target: Ils nagent dans la piscine, Predicted: Ils nagent dans la piscine
Input: We watch a movie together, Target: Nous regardons un film ensemble, Predicted: Nous regardons un film ensemble
Input: She dances at the party, Target: Elle danse à la fête, Predicted: Elle danse à la fête
Input: They visit the Eiffel Tower, Target: Ils visitent la tour Eiffel, Predicted: Ils visitent la tour Eiffel
Input: He cooks dinner for his family, Target: Il cuisine le dîner pour sa famille, Predicted: Il cuisine le dîner pour sa sa
Evaluation Loss: 0.13047321887068264, Accuracy: 0.948051948051948
```

Problem 3.1.

For the same model as Problem 1 but with French to English, the validation loss was found to be 0.1459810031505374 and the accuracy was 98.7%. This was found using 45 epochs, a learning rate of 0.008, and a hidden size of 256. The training loss over 40 epochs and 10 language predictions can be seen in Figure 3 below:

Figure 3: Training Loss + Language Predictions

```
Epoch 0, Loss: 3.826842745661221
Epoch 10, Loss: 2.673940489995458
Epoch 20, Loss: 1.8036874773772178
Epoch 30, Loss: 0.9331451587236136
Epoch 40, Loss: 0.27152714518739185
Input: Les étoiles scintillent la nuit, Target: The stars twinkle at night, Predicted: The stars twinkle at night
Input: Ils parlent différentes langues, Target: They speak different languages, Predicted: They speak different languages
Input: Le restaurant sert une délicieuse cuisine, Target: The restaurant serves delicious food, Predicted: The restaurant serves delicious food
Input: Le chien aboie bruyamment, Target: The dog barks loudly, Predicted: The dog barks loudly
Input: Les enfants jouent dans le parc, Target: The children play in the park, Predicted: The children play in the park
Input: Nous regardons un film ensemble, Target: We watch a movie together, Predicted: We watch a movie together
Input: Nous apprenons quelque chose de nouveau chaque jour, Target: We learn something new every day, Predicted: We learn something new every day
Input: Il peint des paysages, Target: He paints landscapes, Predicted: He paints landscapes
Input: Les fleurs fleurissent au printemps, Target: The flowers bloom in spring, Predicted: The flowers bloom in spring
Input: Ils écoutent la radio, Target: They listen to the radio, Predicted: They listen to the radio
Evaluation Loss: 0.1459810031505374, Accuracy: 0.987012987012987
```

Problem 3.2.

For the same model as Problem 2 but with French to English, the validation loss was found to be 0.0918305050160093 and the accuracy was 100%. This was found using 45 epochs, a learning rate of 0.008, and a hidden size of 256. The training loss over 40 epochs and 10 language predictions can be seen in Figure 3 below:

Figure 4: Training Loss + Language Predictions

```
Epoch 0, Loss: 3.9545984552167566
Epoch 10, Loss: 2.74366770628137
Epoch 20, Loss: 1.680318783799586
Epoch 30, Loss: 0.5547488249889037
Epoch 40, Loss: 0.16473954681424574
Input: Nous prenons le petit déjeuner ensemble, Target: We eat breakfast together, Predicted: We eat breakfast together
Input: Ils nagent dans la piscine, Target: They swim in the pool, Predicted: They swim in the pool
Input: Nous dansons au mariage, Target: We dance at the wedding, Predicted: We dance at the wedding
Input: Ils voyagent autour du monde, Target: They travel around the world, Predicted: They travel around the world
Input: Il cuisine le dîner pour sa famille, Target: He cooks dinner for his family, Predicted: He cooks dinner for his family
Input: Elle rêve de voler, Target: She dreams of flying, Predicted: She dreams of flying
Input: Il conduit une voiture bleue, Target: He drives a blue car, Predicted: He drives a blue car
Input: Nous regardons des films le vendredi, Target: We watch movies on Fridays, Predicted: We watch movies on Fridays
Input: Ils font de la randonnée dans la forêt, Target: They hike in the forest, Predicted: They hike in the forest
Input: Les fleurs fleurissent au printemps, Target: The flowers bloom in spring, Predicted: The flowers bloom in spring
Evaluation Loss: 0.0918305050160093, Accuracy: 1.0
```