

# Deep Learning:

## Assignment 2: Machine Translation

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Due: December 10th 2022

### **Question: Attentional Neural Machine Translation**

You should train a neural network model to automatically translate from English words to their transformed forms. The transformation rules are as follows:

- if the first letter is a consonant, then that letter is moved to the end of the word and “ay” is appended, e.g., slow → lowsay
- if a word starts with a vowel, then append “way” at the end, e.g., amoeba → amoebaway.
- some consonant pairs like “sh” are moved together to end of the word with “ay” appended, e.g., shallow → allowshay.

To translate a sentence, simply translate each word independently.

Your tasks:

1. build and train a machine translation system using data.txt to learn these rules implicitly. You should use a character based translation model. That means each word token is a character.
2. The first model you use is based on RNN, sequence to sequence model. The encoder RNN compresses the input sequence into a fixed-length vector, represented by the final hidden state  $h_T$ . The decoder RNN conditions on this vector to produce the translation, character by character. Input characters are passed through an embedding layer before they are fed into the encoder RNN; in our model, we learn a 2910 embedding matrix, where each of the 29 characters in the vocabulary is assigned a 10-dimensional embedding. At each time step, the decoder RNN outputs a vector of unnormalized log probabilities given by a linear transformation of the decoder hidden state. When these probabilities are normalized, they define a distribution over the vocabulary, indicating the most probable characters for that time step. The model is trained via a cross-entropy loss between the decoder distribution and ground-truth at each time step. [2 Points]
3. Split the data.txt into 80% training and 20% and get the accuracy on the test set. [2 Points]
4. Question: If you input a very long sentence, do you have problem of translation this sentence? If so, what could be potentially the problem? Write down the answer. [2 Points]
5. What model or activation function can you use to improve long sentence translation? Implement such a model. [2 Points]
6. Design and implement an attention model that reduces the error you get from the test set. [2 Points]

In data.txt, we group word pairs based on the lengths. So, in each mini-batch the source words and target words are all the same length, respectively, you do not have to worry about batches of variable-length sequences.

Assignment 3 Submission Guidelines:

1. Adversarial Machine Translation Inputs - Submit a single pdf containing your solution. If the pdf contains handwritten solutions, make sure it is legible.
2. Bonus Question: Attentional Neural Machine Translation - Submit working code and a pdf report containing training and test accuracies, answers to the question from task 4, and any other information that will be required to understand your solution.