Programming Assignment 3

Recurrent Neural Network

SE395: Introduction to Deep Learning

Objective

- **(Main) Recurrent Neural Network for sentiment analysis generation without deep learning framework**
  - If you cannot design the networks without DL framework,
    you can use DL framework (but, you will only get 30% score of total)

- **(Extra credit) No extra credit**

[Andrew Ng, Sequential Models Course, Deep Learning Specialization]

Overall steps

1. **Prepare the training/test datasets and word embedding**
    1. Prepare data (Sentiments, Glove)
    2. Implement data loader and word embedding
2. **Design Recurrent Neural Network (using only python)**
    1. Design RNN (Vanilla RNN and LSTM)
    2. Design output layer with Cross-Entropy loss
    3. Design Dropout
3. **Implement whole training & test pipeline with optimizer**
    1. Design optimizer (SGD and ADAM)
    2. Training procedure
4. **Evaluate the performance**

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1. Prepare training/test dataset & word embedding

1. **Prepare the dataset & load data (using emo_utils.py)**
    1. *Sentiment analysis* dataset [1]: 'test_emoji.csv', 'train_emoji.csv' (Check the uploaded file: **data_train_test.zip**)
        1. Train: 132 sentences, Test: 56 sentences with 5 emoji
    2. *Glove*: word embedding
        1. Prepare '**glove.6B.50d.txt**' and '**glove.6B.100d.txt**' that read 50d features and 100d features glove file (download link: [2])

Sentiments example

X (sentences)	Y (labels)
I love you	0
Congrats on the new job	2
I think I will end up alone	3
I want to have sushi for dinner!	4
It was funny lol	2
she did not answer my text	3
Happy new year	2
my algorithm performs poorly	3
he can pitch really well	1
you are failing this exercise	3
you did well on your exam.	2
What you did was awesome	2
I am frustrated	3

code	emoji	label
:heart:	❤️	0
:baseball:	⚾	1
:smile:	😀	2
:disappointed:	😔	3
:fork_and_knife:	🍴	4

[1] https://github.com/omerbsezer/LSTM_RNN_Tutorials_with_Demo
[2] http://nlp.stanford.edu/data/glove.6B.zip (Reference: https://nlp.stanford.edu/projects/glove/)

What is Glove?

- Glove, EMNLP'14
  - An unsupervised learning algorithm for obtaining vector representations for words. Training is performed on aggregated global word-word co-occurrence statistics from a corpus, and the resulting representations showcase interesting linear substructures of the word vector space.
    - Project site: https://nlp.stanford.edu/projects/glove/
    - Paper: https://nlp.stanford.edu/pubs/glove.pdf
    - Download: http://nlp.stanford.edu/data/glove.6B.zip

    - word_to_index: dictionary mapping from words to their indices in the vocabulary (400,001 words, with the valid indices ranging from 0 to 400,000)
    - index_to_word: dictionary mapping from indices to their corresponding words in the vocabulary
    - word_to_vec_map: dictionary mapping words to their GloVe vector representation.

[1] Pennington, Jeffrey, Richard Socher, and Christopher D. Mann
ing. "Glove: Global vectors for word representation." *EMNLP* 2014.

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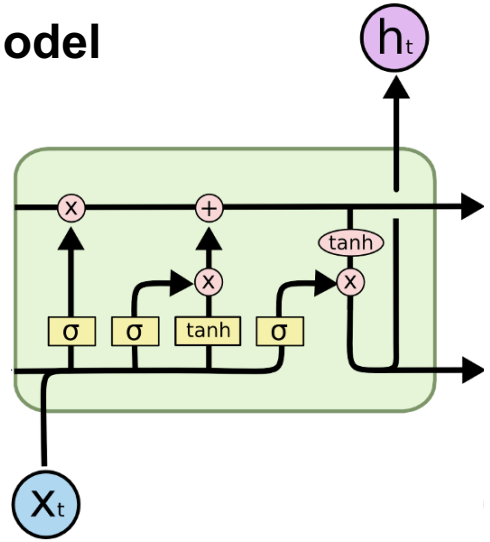
2. Design neural network

1. Overall steps

1. Design both RNN & LSTM layers
2. Design Dropout layer
3. Design FC layer and SoftMax (If you've designed already, use them)
4. Design Cross-entropy loss (If you've designed already, use them)

LSTM model



LSTM computation

$$\begin{pmatrix} i \\ f \\ o \\ g \end{pmatrix} = \begin{pmatrix} \sigma \\ \sigma \\ \sigma \\ \tanh \end{pmatrix} W \begin{pmatrix} h_{t-1} \\ x_t \end{pmatrix}$$

$$c_t = f \odot c_{t-1} + i \odot g$$

$$h_t = o \odot \tanh(c_t)$$

2. Design neural network

- **Overall network**

Bias should be added

Layer (type)	Output Shape	Param #
input_1 (InputLayer)	(None, 10)	0
embedding_1 (Embedding)	(None, 10, 50)	20000050
lstm_1 (LSTM)	(None, 10, 128)	91648
dropout_1 (Dropout)	(None, 10, 128)	0
lstm_2 (LSTM)	(None, 128)	131584
dropout_2 (Dropout)	(None, 128)	0
dense_1 (Dense)	(None, 5)	645
activation_1 (Activation)	(None, 5)	0

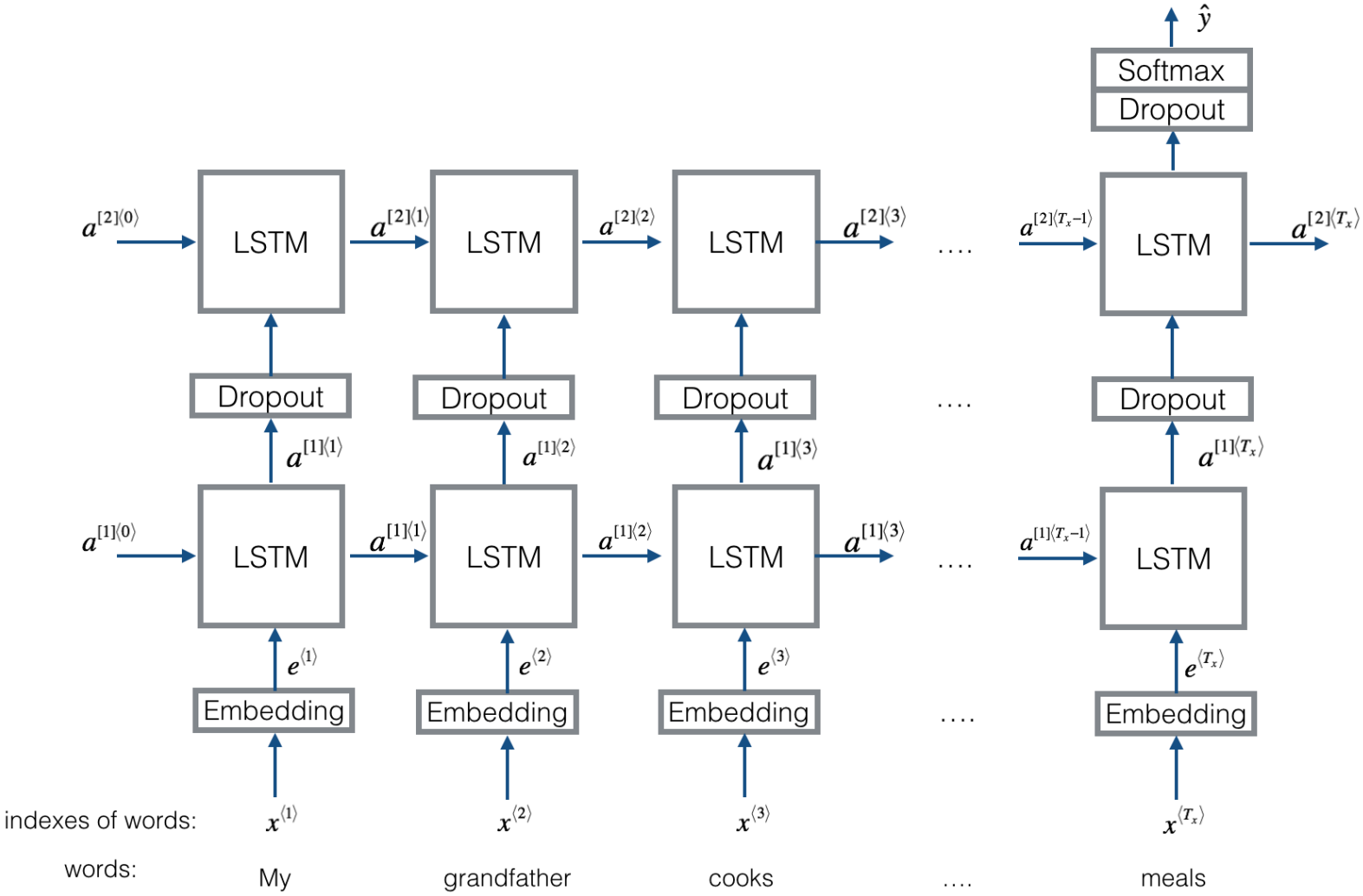
Total params: 20,223,927
Trainable params: 20,223,927
Non-trainable params: 0

Use both
- LSTM & RNN
- 50D & 100D
- SGD & ADAM

2. Design neural network

- **Overall structure**

Bias should be added



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3. Implement whole training & test pipeline

1. **Design optimizer (SGD and ADAM)**

2. **Training procedure**
    1. Initialize the model parameters
    2. Implement and do forward propagation
    3. Implement and compute the cross-entropy loss
    4. Implement and do backward propagation
    5. Implement and update model parameter using optimizer
    6. Draw the plot of the loss

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4. Evaluate the performance (1)

- **Measure all accuracy of four cases using test sets & report results (emoji), accuracies, and training loss graph for all cases**
  - **Vanilla RNN vs LSTM**
    - Compare the results between RNN and LSTM
  - **SGD vs ADAM**
    - Implement dropout technique
    - Train with/without dropout
    - Report the accuracy comparison dropout

Submission

Due : Dec 11, 11:59PM
To : lms.dgist.ac.kr

1. **Submission should include (1) Source code, (2) Report**

2. **Report should include the results and results comparison**
   - Five Settings: (a) **RNN+SGD+50d**, (b) **LSTM+SGD+50d**, (c) **LSTM+ADAM+50d**, (d) **LSTM+SGD+100d,** (e) **LSTM+SGD+50d+dropout**
   - Show the results of Two optimizer (SGD, ADAM), two RNN structures (RNN, LSTM), and two glove vectors (50d, 100d) attaching followings:
     (1) **accuracy comparison for test set**
     (2) **all emojis for test set**
     (3) **Training Loss graph**
   - Report the results and the description
     (4) **Describe what Glove [1] is & why we use Glove** (~5 lines)

[1] Pennington, Jeffrey, Richard Socher, and Christopher D. Mann ing. "Glove: Global vectors for word representation." *EMNLP* 2014.

Notice

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1. **Delayed submission**
   1. 25% score will be degraded every 1-day delay & after 3 days delayed, you will get 10% of total score
      (e.g., 100% → 75% (1day) → 50% (2day) → 25% (3day) → 10% (> 3day)

2. **Plagiarism**
   1. No grade for copied codes (from friends and internet)
   2. You can refer source from internet, but do not copy and paste.

3. **Partial credit**
   1. Even though you are not successfully design the network and obtain reasonable result, please send your code.
   2. There will be partial credit for each module implementation.