LING530F: Deep Learning for NLP

Assignment 1 : Word Embeddings

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First, Lets download the data from drive. For this we can use the GoogleDriveDownloader package.

In [1]:

```
from google_drive_downloader import GoogleDriveDownloader as gdd

gdd.download_file_from_google_drive(file_id='0B046sNk0DhCDY1B1NGZOOEFUa1E',
              # Id of file to be downloaded
                                    dest_path='data/yelp_academic_dataset_revi
ew_preprosessd.json')     # Destination path
```

```
Downloading 0B046sNk0DhCDY1B1NGZOOEFUa1E into data/yelp_academic_dataset_revi
ew_preprosessd.json... Done.
```

1. Writing text field of reviews to Text File

Required: Extract all the text fields from the YELP dataset, and write these fields into a single text file

Now, Lets read the json file line by line using json.loads() function and write the 'text' field of each review into the text file if reading the line doesnt produce a error. We print the line and continue reading the json file if there is an error.

In [2]:
```
import json
f = open('data/yelp_academic_dataset_review_preprosessd.json',mode='r')
 # Open the json file in read mode
line = f.readline()
out = open('yelp_text_data.txt',mode='w')
 # Open text file in write mode
while line:
    line = f.readline()
 # Read one line on json file
    try:
        review=json.loads(line)
 # Get the review from the line
    except:
        print(line)
        continue                                        # Print line causing e
rror and continue while writing other lines
    out.write(review['text'])                           # Write the text field
 of review to text file
    out.write('\n')
f.close()
out.close()                                             # Close both text file
 & json file
```

```
{"text": "Pepe's has great Mexican food and a pretty extensive menu, but I al
ways seem to order the same items: a chile relleno burrito, a chorizo and egg
burrito, or birria (goat) or carne asda tacos. Today I came for breakfast, so
it was one chorizo and egg burrito and two carne asda tacos, which I took hom
e to split with my husband.\n\nAs usual, the food was delish, but the only re
ason I can't give it 5 stars is because the burrito was so dang greasy. Yeah,
I know chorizo is greasy, but this was WAY too greasy ... like the tortilla w
as completely soaked through.\n\nI do love their chile relleno burrito, which
is one of the best burritos I've ever had. And their goat tacos are fantasti
c. So maybe next time I'll skip the chorizo and stick with the chile relleno.
You can't go wrong with any of their tacos, which are served street-style in
small corn tortillas. And while I've never tried them, the carne asada fries
seem to be popular. \n\nJust lighten up on the grease, please...", "review_i
d": "IzGvFn94oYUYMP-Hrtc_Dw", "stars": 4, "pos": "Pepe/NNP 's/POS has/VBZ gre
at/JJ Mexic
```

2. Word Frequency Dictionary & Top 20 words

Required: Extract a word frequency dictionary of the data, and print the top most frequent 20 words.

Lets create a dictionary of word frequencies by reading saved file line by line and incrementing the count of appropriate words

```
In [0]:  wordsfreq={}                                        # Create dictionary
         f = open('yelp_text_data.txt',mode='r')             # Open text file in read mod
         e
         for line in f:
             for word in line.split(' '):                    # Split lines by spaces to g
         et words
                 if(word in wordsfreq.keys()):
                     wordsfreq[word]=wordsfreq[word]+1       # Update frequencies for exi
         sting words
                 else:
                     wordsfreq[word] = 1                     # Include the word in dictio
         nary and assign value to 1
```

Lets create a counter object using our dictionary as argument to identify the most common words

```
In [4]:  from collections import Counter
         c = Counter(wordsfreq)                             # Create counter object of wor
         dsfreq dictionary
         c.most_common(20)                                  # Print the 20 words with high
         est frequencies
```

```
Out[4]: [('the', 980843),
         ('and', 792376),
         ('I', 664915),
         ('a', 606675),
         ('to', 593695),
         ('', 488433),
         ('was', 377753),
         ('of', 346683),
         ('\n', 330804),
         ('is', 301144),
         ('for', 278723),
         ('in', 262841),
         ('it', 208390),
         ('my', 202606),
         ('that', 201489),
         ('The', 196089),
         ('with', 183760),
         ('have', 167766),
         ('but', 160038),
         ('you', 156674)]
```

3. Preprocessing using NLTK

Required: Use NLTK or SpaCy to remove stop words, tokenize, and pos tag the data. See here, for example.

As you can see, the most common words are those like "a","the","to","and" which provide little to no information for any NLP task and are usually termed as stop words. It is often better to remove these words and we can do the same using NLTK library.

Firstly, we tokenize the sentences and hen remove stop words. Lastly, we store the tokens of the sentences with their pos tags in a list.

In [0]:

```python
import nltk
from nltk.corpus import stopwords
from nltk.tokenize import word_tokenize

# Get the stop words defined in nltk for english
stop_words = set(stopwords.words('english'))

# Create filtered & tagged sentences as list
tagged_sentences=[]
filtered_sentences=[]


# Open the text file in read mode
f = open('yelp_text_data.txt',mode='r')

for line in f:
        # Tokenize each line
        word_tokens = word_tokenize(line)
        # Filter the tokens without stop words and put them in a list
        sentence = [w for w in word_tokens if not w in stop_words]
        # Append the sentence(a list) to filtered sentences
        filtered_sentences.append(sentence)
        # Append the pos tags of the sentence(list of tuples) to tagged senten
ces
        tagged_sentences.append(nltk.pos_tag(sentence))
```

4a. Histogram Frequency of Word Frequencies

Required: Plot a histogram of the the frequencies of a random sample of tokens in the data (pick 100 tokens).For example, suppose the word "cat" occurred 10K times and the word "elephant" occurred 7k times. You just need to produce a histogram with these frequencies. Note: you can take the log of each frequency and just plot the logs. You can use matplotlib for your visualizations. Another cool library is seaborn.

Lets create a dictionary with words as keys and dictionary of tags and their counts as values. For example, if we have abcd:{'NN:10,...'} in the dictionary it implies that the word abcd was tagged as NN in 10 of the sentences. This will help us understand the distribution of words across different pos tags.

In [0]:

```
# Create dictionary of tags & counts for each word
word_tags_count={}

for line in tagged_sentences:
    for item in line:
        # Check if word is already in the dictionary
        if(item[0] in word_tags_count.keys()):
            # Check if tag is already present as key in the dictionary of the
 word
            if(item[1] in word_tags_count[item[0]].keys()):
                # Update the count of tag for the word
                word_tags_count[item[0]][item[1]] = word_tags_count[item[0]][i
tem[1]]+1
            else:
                # Add the tag as key with value 1
                word_tags_count[item[0]][item[1]]=1

        else:
            # Create a dictionary for the word
            word_tags_count[item[0]]={}

            # Add the tag as key with value 1
            word_tags_count[item[0]][item[1]]=1
```

Now, lets randomly sample 100 words from all the words.

In [34]:

```
# Get all the words by finding all keys of word_tags_count dictionary
all_words = word_tags_count.keys()

import random
SEED = 530
random.seed(SEED)
# Sample 100 random words from all words
random_words = random.sample(all_words, 100)
# Display first 10 words
random_words[:10]
```

Out[34]:

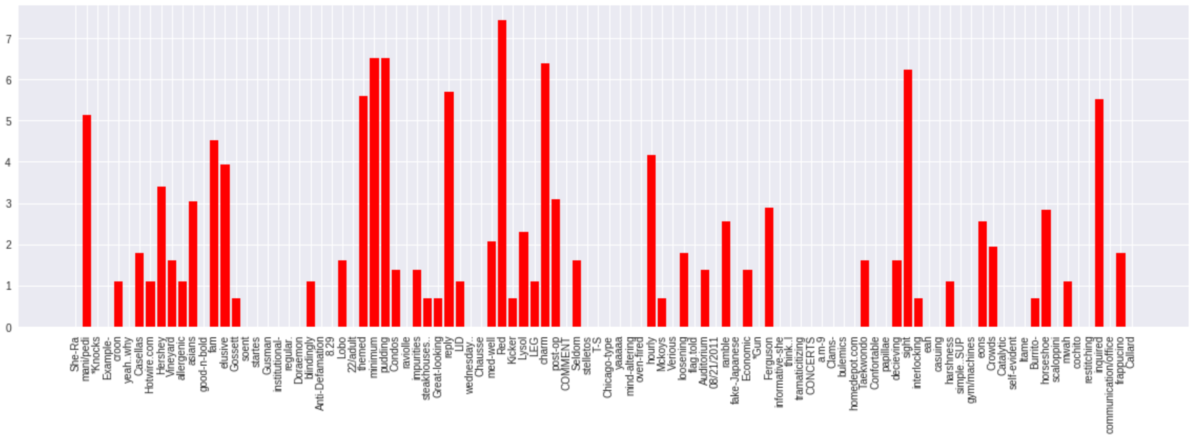
```
['She-Ra',
 'mani/pedi',
 '*Knocks',
 'Example-',
 'croon',
 'yeah..why',
 'Casellas',
 'Hotwire.com',
 'Hershey',
 'Vineyard']
```

Lets calculate the frequencies of these random words

```
In [35]: # Get frequencies of random words by summing the tag counts
         rand_words_freq = [sum(word_tags_count[w].values()) for w in random_words]

         # Print the frequencies of last 10 random words
         rand_words_freq[:10]

Out[35]: [1, 168, 1, 1, 3, 1, 6, 3, 30, 5]
```

Lets use matplotlib library to plot the log of frequencies of these words against the words

```
In [9]:  import matplotlib.pyplot as plt
         import numpy as np

         indices = np.arange(len(random_words))                              # Get list of
          numbers from 0 to length of random words
         plt.figure(figsize=(16,6))
         plt.bar(indices, np.log(rand_words_freq), color='r')                # Plot log of
          frequencies with indices
         plt.xticks(indices, random_words, rotation='vertical')              # Assign xtick
         s to the labels of the random words
         plt.tight_layout()                                                  # Fit the plot
          in the figure area
         plt.show()
```



4b. Histogram Frequency of POS Tag Frequencies

Required: Plot a histogram of the frequencies of all the pos tags assigned by the tagger. For example, you can have "NN" (a noun category) occurring 4K times, etc. So, this is similar to (a) above, but seeks to get you working with POS and also see their distribution in the data.

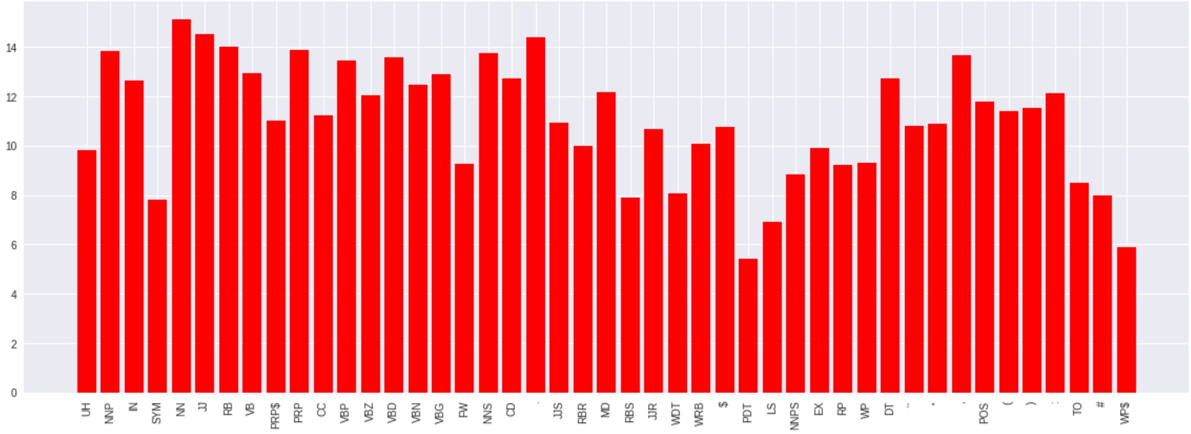
Lets create a dictionary with tags as keys and dictionary of words and their counts as values. For example, if we have NN:{'abcd:10,...'} in the dictionary it implies that the word abcd was tagged in 10 of the sentences as NN. This will help us understand the distribution of tags across different words.

In [0]:

```
tag_words_count = {}                                               # Create diction
ary of words & counts for each tag

for word in word_tags_count.keys():                                # For all words
 in word_tags_count
    for key,value in word_tags_count[word].items():                # Loop through e
ach tag,value pair
        if(key in tag_words_count.keys()):                         # Check if tag i
s in the dictionary
            tag_words_count[key][word]=value                       # Add the word,v
alue pair to the tag dictionary
        else:
            tag_words_count[key]={}                                # Create a dicti
onary for the tag
            tag_words_count[key][word]=value                       # Add the word,v
alue pair to the tag dictionary
```

Now, lets find the frequencies of each tag by calculating the sum of all values in their dictionary and plot them to visualize it.

In [11]:
```
# Get list of all tags
all_tags = tag_words_count.keys()

# The count of each tags as sum of the values for different words
tags_count = [sum(tag_words_count[pos].values()) for pos in tag_words_count.ke
ys()]

# Get list of numbers from 0 to length of all tags
indices = np.arange(len(all_tags))

plt.figure(figsize=(16,6))
# Plot log of frequencies with indices
plt.bar(indices, np.log(tags_count), color='r')

# Assign xticks to the labels of the all tags
plt.xticks(indices, all_tags, rotation='vertical')

# Fit the plot in the figure area
plt.tight_layout()

plt.show()
```



4c. Top 20 Adjectives

Required: Print the top 20 adjectives in the data. (Note: adjectives are tagged "JJ" with NLTK UPenn tagset.

Lets define a counter object on dictionary corrosponding to 'JJ' tag to get the most common adjectives.

```
In [12]: c = Counter(tag_words_count['JJ'])          # Create counter object of diction
         ary for JJ tag distribution
         top20_adj = c.most_common(20)               # Get the 20 most common adjective
         s(JJ tag)
         top20_adj
```

```
Out[12]: [('good', 96970),
          ('great', 72814),
          ('little', 29323),
          ('nice', 28300),
          ('new', 20287),
          ('bad', 20070),
          ('much', 19720),
          ('many', 18071),
          ('first', 17298),
          ('delicious', 17156),
          ('last', 17053),
          ('sure', 16873),
          ('small', 15156),
          ('next', 15126),
          ('fresh', 14552),
          ('happy', 13855),
          ('friendly', 13659),
          ('big', 13219),
          ('hot', 13113),
          ('old', 12919)]
```

4d. Top 20 Proper Nouns

Required: Print the top 20 proper nouns in the data. (If using UPenn tagset, proper nouns will be tagged as "NNPS").

Similarly, we define a counter object on dictionary corrosponding to 'NNPS' tag to get the most common Proper Nouns.

```
In [13]: c = Counter(tag_words_count['NNPS'])          # Create counter object of dict
         ionary for NNPS tag distribution
         c.most_common(20)                             # Print 20 most common proper n
         ouns(NNPS tag)
```

```
Out[13]: [('Prices', 160),
          ('Americans', 160),
          ('Brothers', 149),
          ('Services', 148),
          ('States', 125),
          ('Beans', 122),
          ('Always', 109),
          ('Friends', 97),
          ('Foods', 93),
          ('Suns', 85),
          ('Trans', 80),
          ('Airlines', 79),
          ('Anyways', 77),
          ('Sundays', 74),
          ('Jewelers', 71),
          ('Asians', 69),
          ('Yelpers', 66),
          ('Thats', 58),
          ('Cleaners', 52),
          ('Airways', 50)]
```

5a. Word2vec Training

Required: Train a word2vect or FastText model word embeddings model. Make some reasonable choices about window size, threshold of words to include, and other important model parameters. Explain these choices in the Jupyter Notebook you will submit.

Now, lets define & train a word2vec model on the filtered sentences (obtained after tokenizing & removing stop words).

For finding the hyperparameters of word2vec model, lets first find the total number of words in our vocabulary(after removing stop words).

```
In [14]: len(all_words)                                          # Get the total number
          of words
```

```
Out[14]: 210778
```

Now, lets find the average length of a sentence

In [15]:

```
# Get lengths of each sentence as list
lengths = [len(i) for i in filtered_sentences]

# Average length of sentence = Total length of sentences/Number of sentences
sum(lengths)/len(lengths)
```

Out[15]:

```
24.36501127694536
```

Lets get Average frequency of a word

In [16]:

```
# Get average frequency of word (sum of frequencies/no of words)
sum(wordsfreq.values())/len(wordsfreq.keys())
```

Out[16]:

```
49.153461160544765
```

1. For a vocabulary consisting of approximately 200k words, dimension of word vectors can be taken has 100.

2. Since each sentence has average length of 24, window size can be assumed to be 10 as it covers 10 words surrounding the context word. Also, window size of 10 gives results that are more semantic in nature compared to window size of 5 as it gives results that are syntactic in nature.

3. Min_count is for ignoring words having lower frequency and since average frequency of words is around 50, we choose this value as 50 in order to remove noisy words.

4. Since, the corpus is large, we can use CBOW instead of Skip gram as it works better and leave sg to be default value of 0.

5. The number of iterations is set to 3 in order to keep training time lower.

In [0]:

```
# Train a word2vec model

from gensim.models import Word2Vec
model=Word2Vec(filtered_sentences,size=100, window=10,min_count=50)
  # Define a word2vec model
model.train(filtered_sentences,total_examples=len(filtered_sentences),epochs=3
) # Train the model for 3 epochs
model.save("word2vec.model")
  # Save the model
```

5b. Most similar Adjectives

Required: For the top 20 adjectives in the text data file you used for training your embedding model, query the embedding model for the 3 most similar words.

Now, lets print the most similar words for the top 20 adjectives that we had found earlier.

In [18]:

```
for word,count in top20_adj:                                           # For word an
d count in top20 adjectives
    print(word)
    print(model.wv.most_similar(positive = word,topn=3))             # Print wor
d and 3 of their most similar words
```

```
good
[('decent', 0.8281090259552002), ('great', 0.7617058753967285), ('so-so', 0.7
471593618392944)]
great
[('fantastic', 0.8623530864715576), ('awesome', 0.8622987866401672), ('excell
ent', 0.8209205269813538)]
little
[('bit', 0.8873640298843384), ('tad', 0.7941861152648926), ('kinda', 0.654479
3248176575)]
nice
[('friendly', 0.7203831672668457), ('pleasant', 0.7137796878814697), ('grea
t', 0.6392579078674316)]
new
[('newly', 0.5325199365615845), ('current', 0.5212125778198242), ('newest',
0.48027071356773376)]
bad
[('horrible', 0.7084616422653198), ('terrible', 0.7004413604736328), ('awfu
l', 0.6622617244720459)]
much
[('actually', 0.5734549164772034), ('MUCH', 0.51764976978302), ('lot', 0.5103
425979614258)]
many
[('several', 0.8038645386695862), ('numerous', 0.7983697056770325), ('countle
ss', 0.7686682939529419)]
first
[('1st', 0.7909747958183289), ('second', 0.7833964824676514), ('First', 0.672
5066304206848)]
delicious
[('delish', 0.8621597290039062), ('yummy', 0.8572527170181274), ('scrumptiou
s', 0.8438035249710083)]
last
[('Last', 0.8242403268814087), ('ago', 0.7143625617027283), ('past', 0.694086
0748291016)]
sure
[('guessing', 0.6650516390800476), ('assuming', 0.6311231851577759), ('glad',
0.57407546043396)]
small
[('large', 0.8202035427093506), ('tiny', 0.7571879625320435), ('smallish', 0.
6871476173400879)]
next
[('Next', 0.7251099348068237), ('first', 0.5392769575119019), ('second', 0.53
67599725723267)]
fresh
[('freshly', 0.7411985993385315), ('Fresh', 0.7376164793968201), ('FRESH', 0.
6271103024482727)]
happy
[('Happy', 0.7408075928688049), ('pleased', 0.5109667181968689), ('24', 0.508
4593892097473)]
friendly
[('polite', 0.7864802479743958), ('Friendly', 0.7680663466453552), ('courteou
s', 0.7569925785064697)]
big
[('huge', 0.8777388334274292), ('HUGE', 0.72176593542099), ('large', 0.700389
9812698364)]
hot
[('HOT', 0.6627265214920044), ('Hot', 0.653127133846283), ('steaming', 0.6204
107999801636)]
```

```
old
[('olds', 0.746889054775238), ('elementary', 0.6475654244422913), ('ago', 0.5
658596754074097)]
```

References:

1)Downloading files from google drive

https://stackoverflow.com/questions/38511444/python-download-files-from-google-drive-using-url (https://stackoverflow.com/questions/38511444/python-download-files-from-google-drive-using-url)

2)Writing to text files

https://www.pythonforbeginners.com/files/reading-and-writing-files-in-python (https://www.pythonforbeginners.com/files/reading-and-writing-files-in-python)

3)Try except continue

https://stackoverflow.com/questions/19522990/python-catch-exception-and-continue-try-block (https://stackoverflow.com/questions/19522990/python-catch-exception-and-continue-try-block)

4)Counter for most frequent words

https://stackoverflow.com/questions/40050154/python-get-top-values-in-dictionary (https://stackoverflow.com/questions/40050154/python-get-top-values-in-dictionary)

5)Removing stop words & POS tagging

https://www.geeksforgeeks.org/part-speech-tagging-stop-words-using-nltk-python/ (https://www.geeksforgeeks.org/part-speech-tagging-stop-words-using-nltk-python/)

6)Random words with seed

https://docs.python.org/3/library/random.html (https://docs.python.org/3/library/random.html)

7)NLTK Packages download

https://stackoverflow.com/questions/34828742/how-to-download-all-packages-in-nltk-in-python (https://stackoverflow.com/questions/34828742/how-to-download-all-packages-in-nltk-in-python)

8)Sum all values in dictionary

https://stackoverflow.com/questions/4880960/how-to-sum-all-the-values-in-a-dictionary (https://stackoverflow.com/questions/4880960/how-to-sum-all-the-values-in-a-dictionary)

9)Barplot with labels

https://stackoverflow.com/questions/45080698/make-frequency-histogram-from-list-with-tuple-elements (https://stackoverflow.com/questions/45080698/make-frequency-histogram-from-list-with-tuple-elements)

10)Gensim Word2Vec

http://kavita-ganesan.com/gensim-word2vec-tutorial-starter-code/#.W62YVGhKjIV (http://kavita-