```
In [ ]: #Pretrained word2vec embeddings
```

```
In [1]: #from torchtext import data
        #from torchtext import datasets
        import torch
        import spacy
        import random
        import numpy as np
        import pandas as pd
        import time
        import re # for regular expressions
        import torch.nn as nn
        import torch.nn.functional as F
        from sklearn.model_selection import train_test_split
        import spacy
        nlp = spacy.load('en')

        data =  pd.read_csv('transferlearning-dl-spring2020/train.csv')

        data.head()

        questions = data['text']
        labels = data['target']

        train_data, valid_data, ytrain, yvalid = train_test_split(questions, labels,
                                                                  random_state=42,
                                                                  test_size=0.2)

        train_data.head()
```

```
Out[1]: 251      @USER All you need to know is he is empty inside
        3720                                @USER I. AM. READ. E! URL
        8376    @USER Go roger I quit watching anyway nfl is o...
        4471                @USER Yoo our dogs should totally fuck
        2835               @USER He is a troll.  Not open to facts
        Name: text, dtype: object
```

```
In [2]: data.head()
```

Out[2]:

	id	text	target
0	86426	@USER She should ask a few native Americans wh...	1
1	16820	Amazon is investigating Chinese employees who ...	0
2	62688	@USER Someone should'veTaken" this piece of sh...	1
3	43605	@USER @USER Obama wanted liberals & illega...	0
4	97670	@USER Liberals are all Kookoo !!!	1

```
In [ ]: def remove_pattern(input_txt, pattern):
            r = re.findall(pattern, input_txt)
            for i in r:
                input_txt = re.sub(i, '', input_txt)

            return input_txt

        data['text'] = np.vectorize(remove_pattern)(data['text'], "@[\w]*")

        data['text'] = data['text'].str.replace("[^a-zA-Z#]", " ")

        data['text'] = data['text'].str.replace('#','')

        data['text'] = data['text'].apply(lambda x: ' '.join([w for w in x.split() if len(w)>2]))

        tokenized_tweet = data['text'].apply(lambda x: x.split()) # tokenizing

        tokenized_tweet.head()

        len(tokenized_tweet)

        from nltk.stem import WordNetLemmatizer
        lemmatizer = WordNetLemmatizer()
        tokenized_tweet.apply(lambda x: [lemmatizer.lemmatize(i) for i in x]) # stemming
```

```
In [ ]: tokenized_tweet[1:10]
```

```
In [8]: # Using pre-trained word2vec embeddings created by Google

        import gensim

        model = gensim.models.KeyedVectors.load_word2vec_format('GoogleNews-vectors-negative300.bin', binary=Tr
        ue)

        #model.train(tokenized_tweet, total_examples= len(combi['description']), epochs=50)

        def word_vector_pretrained(tokens, size):
            vec = np.zeros(size).reshape((1, size))
            count = 0.
            for word in tokens:
                try:
                    vec += model[word].reshape((1, size))
                    count += 1.
                except KeyError: # handling the case where the token is not in vocabulary

                    continue
            if count != 0:
                vec /= count
            return vec

        wordvec_arrays = np.zeros((len(tokenized_tweet), 300))

        for i in range(len(tokenized_tweet)):
            wordvec_arrays[i,:] = word_vector_pretrained(tokenized_tweet[i], 300)

        wordvec_df = pd.DataFrame(wordvec_arrays)
        wordvec_df.shape

        X_train, X_test , y_train, y_test = train_test_split(wordvec_df, labels, test_size=0.2, random_state=1)
```

```
In [12]: from sklearn.linear_model import LogisticRegression
         from sklearn.model_selection import train_test_split
         from sklearn.metrics import f1_score
```

```
In [13]: lreg = LogisticRegression(random_state = 10)
         lreg.fit(X_train, y_train) # training the model

         prediction = lreg.predict(X_test) # predicting on the validation set

         prediction_int = prediction.astype(np.int)

         f1_score(y_test, prediction,average = 'macro') # calculating f1 score
```

```
Out[13]: 0.6691278341911253
```

```
In [14]: data_test =  pd.read_csv('transferlearning-dl-spring2020/test.csv')
```

```
In [ ]: data_test['text'] = np.vectorize(remove_pattern)(data_test['text'], "@[\w]*")

        data_test['text'] = data_test['text'].str.replace("[^a-zA-Z#]", " ")

        data_test['text'] = data_test['text'].str.replace('#','')

        data_test['text'] = data_test['text'].apply(lambda x: ' '.join([w for w in x.split() if len(w)>2]))

        tokenized_tweet_test = data_test['text'].apply(lambda x: x.split()) # tokenizing

        tokenized_tweet_test.head()

        len(tokenized_tweet_test)

        from nltk.stem import WordNetLemmatizer
        lemmatizer = WordNetLemmatizer()
        tokenized_tweet_test.apply(lambda x: [lemmatizer.lemmatize(i) for i in x]) # stemming
```

```
In [16]: wordvec_arrays_test = np.zeros((len(tokenized_tweet_test), 300))

         for i in range(len(tokenized_tweet_test)):
             wordvec_arrays_test[i,:] = word_vector_pretrained(tokenized_tweet_test[i], 300)

         wordvec_df_test = pd.DataFrame(wordvec_arrays_test)
         wordvec_df_test.shape
```

```
Out[16]: (3894, 300)
```

```
In [17]: X_test1 = np.array(wordvec_df_test)

         prediction1 = lreg.predict(X_test1) # predicting on the validation set

         prediction_int1 = prediction1.astype(np.int)
```

```
In [18]: prediction_int1
```

```
Out[18]: array([0, 1, 0, ..., 0, 0, 0])
```

```
In [ ]: data_test['Target'] = prediction_int1
        submission = data_test[['id','Target']]
        submission.to_csv('pretrained_word2vec.csv', index=False) # writing data to a CSV file
        submission
```

```
In [ ]: # Fine tuned word2vec
```

```
In [56]: model_w2v = gensim.models.Word2Vec(
                     tokenized_tweet,
                     size=50, # desired no. of features/independent variables
                     window=5, # context window size
                     min_count=2,
                     sg = 1, # 1 for skip-gram model
                     hs = 0,
                     negative = 10, # for negative sampling
                     workers= 2, # no.of cores
                     seed = 34)

         model_w2v.train(tokenized_tweet, total_examples= len(tokenized_tweet), epochs=200)

         def word_vector(tokens, size):
             vec = np.zeros(size).reshape((1, size))
             count = 0.
             for word in tokens:
                 try:
                     vec += model_w2v[word].reshape((1, size))
                     count += 1.
                 except KeyError: # handling the case where the token is not in vocabulary

                     continue
             if count != 0:
                 vec /= count
             return vec

         wordvec_arrays = np.zeros((len(tokenized_tweet), 50))

         for i in range(len(tokenized_tweet)):
             wordvec_arrays[i,:] = word_vector(tokenized_tweet[i], 50)

         wordvec_df = pd.DataFrame(wordvec_arrays)
         wordvec_df.shape
```

```
/anaconda3/lib/python3.7/site-packages/ipykernel_launcher.py:19: DeprecationWarning: Call to deprecat
ed `__getitem__` (Method will be removed in 4.0.0, use self.wv.__getitem__() instead).
```

```
Out[56]: (9346, 50)
```

```
In [58]: X_train, X_test , y_train, y_test = train_test_split(wordvec_df, labels, test_size=0.2, random_state=1)

         lreg = LogisticRegression(random_state = 20)
         lreg.fit(X_train, y_train) # training the model

         prediction = lreg.predict(X_test) # predicting on the validation set

         prediction_int = prediction.astype(np.int)

         f1_score(y_test, prediction,average = 'macro') # calculating f1 score
```

```
Out[58]: 0.5291078614322713
```

```
In [ ]: # CNN for text classification
```

```
In [60]: top_data_df_small = data
```

```
In [61]: from gensim.utils import simple_preprocess
         # Tokenize the text column to get the new column 'tokenized_text'
         top_data_df_small['tokenized_text'] = [simple_preprocess(line, deacc=True) for line in top_data_df_smal
         l['text']]
         print(top_data_df_small['tokenized_text'].head(10))
```

```
0    [she, should, ask, few, native, americans, wha...
1    [amazon, investigating, chinese, employees, wh...
2    [someone, should, vetaken, this, piece, shit, ...
3    [obama, wanted, liberals, amp, illegals, move,...
4                        [liberals, are, all, kookoo]
5    [was, literally, just, talking, about, this, l...
6                               [buy, more, icecream]
7             [not, fault, you, support, gun, control]
8    [what, the, difference, between, kavanaugh, an...
9    [you, are, lying, corrupt, traitor, nobody, wa...
Name: tokenized_text, dtype: object
```

```
In [62]: from gensim.parsing.porter import PorterStemmer
         porter_stemmer = PorterStemmer()
         # Get the stemmed_tokens
         top_data_df_small['stemmed_tokens'] = [[porter_stemmer.stem(word) for word in tokens] for tokens in top
         _data_df_small['tokenized_text'] ]
         top_data_df_small['stemmed_tokens'].head(10)
```

```
Out[62]: 0    [she, should, ask, few, nativ, american, what,...
         1    [amazon, investig, chines, employe, who, ar, s...
         2    [someon, should, vetaken, thi, piec, shit, vol...
         3    [obama, want, liber, amp, illeg, move, into, r...
         4                          [liber, ar, all, kookoo]
         5    [wa, liter, just, talk, about, thi, lol, all, ...
         6                             [bui, more, icecream]
         7             [not, fault, you, support, gun, control]
         8    [what, the, differ, between, kavanaugh, and, o...
         9    [you, ar, ly, corrupt, traitor, nobodi, want, ...
         Name: stemmed_tokens, dtype: object
```

```
In [63]: from sklearn.model_selection import train_test_split
         # Train Test Split Function
         def split_train_test(top_data_df_small, test_size=0.3, shuffle_state=True):
             X_train, X_test, Y_train, Y_test = train_test_split(top_data_df_small[[ 'text',  'stemmed_tokens'
         ]],
                                                                 top_data_df_small['target'],
                                                                 shuffle=shuffle_state,
                                                                 test_size=test_size,
                                                                 random_state=15)
             print("Value counts for Train sentiments")
             print(Y_train.value_counts())
             print("Value counts for Test sentiments")
             print(Y_test.value_counts())
             print(type(X_train))
             print(type(Y_train))
             X_train = X_train.reset_index()
             X_test = X_test.reset_index()
             Y_train = Y_train.to_frame()
             Y_train = Y_train.reset_index()
             Y_test = Y_test.to_frame()
             Y_test = Y_test.reset_index()
             print(X_train.head())
             return X_train, X_test, Y_train, Y_test

         # Call the train_test_split
         X_train, X_test, Y_train, Y_test = split_train_test(top_data_df_small)
```

```
Value counts for Train sentiments
0    4365
1    2177
Name: target, dtype: int64
Value counts for Test sentiments
0    1855
1     949
Name: target, dtype: int64
<class 'pandas.core.frame.DataFrame'>
<class 'pandas.core.series.Series'>
   index                                               text  \
0   8030                           least you are honest lmao
1   3722                          All that shit was hers URL
2   3522                          Cutie connection authentic
3   4232  What interview Evanne honest and right from th...
4   1678  Warriorscoach fundraising for gun control Brad...

                                      stemmed_tokens
0                      [least, you, ar, honest, lmao]
1                     [all, that, shit, wa, her, url]
2                            [cuti, connect, authent]
3  [what, interview, evann, honest, and, right, f...
4  [warriorscoach, fundrais, for, gun, control, b...
```

```
In [64]: import torch.nn as nn
         import torch.nn.functional as F
         import torch.optim as optim

         import torch
         # Use cuda if present
         device = torch.device("cuda" if torch.cuda.is_available() else "cpu")
         print("Device available for running: ")
         print(device)
```

```
Device available for running:
cpu
```

```
In [67]: from gensim.models import Word2Vec
         size = 500
         window = 3
         min_count = 1
         workers = 3
         sg = 1

         # Function to train word2vec model
         def make_word2vec_model(top_data_df_small, padding=True, sg=1, min_count=1, size=500, workers=3, window
         =3):
             if  padding:
                 print(len(top_data_df_small))
                 temp_df = pd.Series(top_data_df_small['stemmed_tokens']).values
                 temp_df = list(temp_df)
                 temp_df.append(['pad'])
                 word2vec_file =   'word2vec_' + str(size) + '_PAD.model'
             else:
                 temp_df = top_data_df_small['stemmed_tokens']
                 word2vec_file =   'word2vec_' + str(size) + '.model'
             w2v_model = Word2Vec(temp_df, min_count = min_count, size = size, workers = workers, window = windo
         w, sg = sg)

             w2v_model.save(word2vec_file)
             return w2v_model, word2vec_file

         # Train Word2vec model
         w2vmodel, word2vec_file = make_word2vec_model(top_data_df_small, padding=True, sg=sg, min_count=min_cou
         nt, size=size, workers=workers, window=window)
```

```
9346
```

```
In [68]: # Function to get the output tensor
         def make_target(label):
             if label == -1:
                 return torch.tensor([0], dtype=torch.long, device=device)
             elif label == 0:
                 return torch.tensor([1], dtype=torch.long, device=device)
             else:
                 return torch.tensor([2], dtype=torch.long, device=device)
```

```
In [71]: EMBEDDING_SIZE = 500
         NUM_FILTERS = 10
         import gensim

         class CnnTextClassifier(nn.Module):
             def __init__(self, vocab_size, num_classes, window_sizes=(1,2,3,5)):
                 super(CnnTextClassifier, self).__init__()
                 w2vmodel = gensim.models.KeyedVectors.load( 'word2vec_500_PAD.model')
                 weights = w2vmodel.wv
                 # With pretrained embeddings
                 self.embedding = nn.Embedding.from_pretrained(torch.FloatTensor(weights.vectors), padding_idx=w
         2vmodel.wv.vocab['pad'].index)
                 # Without pretrained embeddings
                 # self.embedding = nn.Embedding(vocab_size, EMBEDDING_SIZE)

                 self.convs = nn.ModuleList([
                                            nn.Conv2d(1, NUM_FILTERS, [window_size, EMBEDDING_SIZE], padding=(wi
         ndow_size - 1, 0))
                                            for window_size in window_sizes
                 ])

                 self.fc = nn.Linear(NUM_FILTERS * len(window_sizes), num_classes)

             def forward(self, x):
                 x = self.embedding(x) # [B, T, E]

                 # Apply a convolution + max_pool layer for each window size
                 x = torch.unsqueeze(x, 1)
                 xs = []
                 for conv in self.convs:
                     x2 = torch.tanh(conv(x))
                     x2 = torch.squeeze(x2, -1)
                     x2 = F.max_pool1d(x2, x2.size(2))
                     xs.append(x2)
                 x = torch.cat(xs, 2)

                 # FC
                 x = x.view(x.size(0), -1)
                 logits = self.fc(x)

                 probs = F.softmax(logits, dim = 1)

                 return probs
```

```
In [73]: max_sen_len = top_data_df_small.stemmed_tokens.map(len).max()
         padding_idx = w2vmodel.wv.vocab['pad'].index
         def make_word2vec_vector_cnn(sentence):
             padded_X = [padding_idx for i in range(max_sen_len)]
             i = 0
             for word in sentence:
                 if word not in w2vmodel.wv.vocab:
                     padded_X[i] = 0
                     print(word)
                 else:
                     padded_X[i] = w2vmodel.wv.vocab[word].index
                 i += 1
             return torch.tensor(padded_X, dtype=torch.long, device=device).view(1, -1)
```

```
In [74]: NUM_CLASSES = 3
         VOCAB_SIZE = len(w2vmodel.wv.vocab)

         cnn_model = CnnTextClassifier(vocab_size=VOCAB_SIZE, num_classes=NUM_CLASSES)
         cnn_model.to(device)
         loss_function = nn.CrossEntropyLoss()
         optimizer = optim.Adam(cnn_model.parameters(), lr=0.001)
         num_epochs = 30

         # Open the file for writing loss
         loss_file_name = 'cnn_class_big_loss_with_padding.csv'
         f = open(loss_file_name,'w')
         f.write('iter, loss')
         f.write('\n')
         losses = []
         cnn_model.train()
         for epoch in range(num_epochs):
             print("Epoch" + str(epoch + 1))
             train_loss = 0
             for index, row in X_train.iterrows():
                 # Clearing the accumulated gradients
                 cnn_model.zero_grad()

                 # Make the bag of words vector for stemmed tokens
                 bow_vec = make_word2vec_vector_cnn(row['stemmed_tokens'])

                 # Forward pass to get output
                 probs = cnn_model(bow_vec)

                 # Get the target label
                 target = make_target(Y_train['target'][index])

                 # Calculate Loss: softmax --> cross entropy loss
                 loss = loss_function(probs, target)
                 train_loss += loss.item()

                 # Getting gradients w.r.t. parameters
                 loss.backward()

                 # Updating parameters
                 optimizer.step()


             # if index == 0:
             #     continue
             print("Epoch ran :"+ str(epoch+1))
             f.write(str((epoch+1)) + "," + str(train_loss / len(X_train)))
             f.write('\n')
             train_loss = 0

         torch.save(cnn_model, 'cnn_big_model_500_with_padding.pth')

         f.close()
         print("Input vector")
         print(bow_vec.cpu().numpy())
         print("Probs")
         print(probs)
         print(torch.argmax(probs, dim=1).cpu().numpy()[0])
```

```
Epoch1
Epoch ran :1
Epoch2
Epoch ran :2
Epoch3
Epoch ran :3
Epoch4
Epoch ran :4
Epoch5
Epoch ran :5
Epoch6
Epoch ran :6
Epoch7
Epoch ran :7
Epoch8
Epoch ran :8
Epoch9
Epoch ran :9
Epoch10
Epoch ran :10
Epoch11
Epoch ran :11
Epoch12
Epoch ran :12
Epoch13
Epoch ran :13
Epoch14
Epoch ran :14
Epoch15
Epoch ran :15
Epoch16
Epoch ran :16
Epoch17
Epoch ran :17
Epoch18
Epoch ran :18
Epoch19
Epoch ran :19
Epoch20
Epoch ran :20
Epoch21
Epoch ran :21
Epoch22
Epoch ran :22
Epoch23
Epoch ran :23
Epoch24
Epoch ran :24
Epoch25
Epoch ran :25
Epoch26
Epoch ran :26
Epoch27
Epoch ran :27
Epoch28
Epoch ran :28
Epoch29
Epoch ran :29
Epoch30
Epoch ran :30
Input vector
[[  235    13    16     0   928   172   358   244     7     7 10887 10887
  10887 10887 10887 10887 10887 10887 10887 10887 10887 10887 10887 10887
  10887 10887 10887 10887 10887 10887 10887 10887 10887 10887 10887 10887
  10887 10887 10887 10887 10887 10887 10887 10887 10887 10887 10887 10887
  10887]]
Probs
tensor([[1.1411e-11, 9.5633e-01, 4.3666e-02]], grad_fn=<SoftmaxBackward>)
1
```

```
In [79]: from sklearn.metrics import classification_report
         bow_cnn_predictions = []
         original_lables_cnn_bow = []
         cnn_model.eval()
         loss_df = pd.read_csv('cnn_class_big_loss_with_padding.csv')
         print(loss_df.columns)
         # loss_df.plot('loss')
         with torch.no_grad():
             for index, row in X_test.iterrows():
                 bow_vec = make_word2vec_vector_cnn(row['stemmed_tokens'])
                 probs = cnn_model(bow_vec)
                 _, predicted = torch.max(probs.data, 1)
                 bow_cnn_predictions.append(predicted.cpu().numpy()[0])
                 original_lables_cnn_bow.append(make_target(Y_test['target'][index]).cpu().numpy()[0])

         print(classification_report(original_lables_cnn_bow,bow_cnn_predictions))
         loss_file_name = 'cnn_class_big_loss_with_padding.csv'
         loss_df = pd.read_csv(loss_file_name)
         print(loss_df.columns)
         plt_500_padding_30_epochs = loss_df[' loss'].plot()
         fig = plt_500_padding_30_epochs.get_figure()
         fig.savefig('loss_plt_500_padding_30_epochs.pdf')
```

```
Index(['iter', ' loss'], dtype='object')
```

```
/anaconda3/lib/python3.7/site-packages/sklearn/metrics/_classification.py:1272: UndefinedMetricWarnin
g: Precision and F-score are ill-defined and being set to 0.0 in labels with no predicted samples. Us
e `zero_division` parameter to control this behavior.
  _warn_prf(average, modifier, msg_start, len(result))
```

```
              precision    recall  f1-score   support

           1       0.66      1.00      0.80      1855
           2       0.00      0.00      0.00       949

    accuracy                           0.66      2804
   macro avg       0.33      0.50      0.40      2804
weighted avg       0.44      0.66      0.53      2804

Index(['iter', ' loss'], dtype='object')
```

```
In [88]: data_test =  pd.read_csv('transferlearning-dl-spring2020/test.csv')
```

```
In [89]: from gensim.utils import simple_preprocess
         # Tokenize the text column to get the new column 'tokenized_text'
         data_test['tokenized_text'] = [simple_preprocess(line, deacc=True) for line in data_test['text']]
         print(data_test['tokenized_text'].head(10))
```

```
0    [user, user, go, home, you, re, drunk, user, m...
1                  [user, user, oh, noes, tough, shit]
2    [user, canada, doesn, need, another, cuck, we,...
3    [user, user, user, it, should, scare, every, a...
4    [user, user, user, user, lol, throwing, the, b...
5                      [user, user, you, are, correct]
6    [user, user, kind, of, like, when, conservativ...
7    [the, only, thing, the, democrats, have, is, l...
8    [user, user, user, user, user, user, user, use...
9    [user, user, user, user, user, user, user, use...
Name: tokenized_text, dtype: object
```

```
In [90]: from gensim.parsing.porter import PorterStemmer
         porter_stemmer = PorterStemmer()
         # Get the stemmed_tokens
         data_test['stemmed_tokens'] = [[porter_stemmer.stem(word) for word in tokens] for tokens in data_test[
         'tokenized_text'] ]
         data_test['stemmed_tokens'].head(10)
```

```
Out[90]: 0    [user, user, go, home, you, re, drunk, user, m...
         1                   [user, user, oh, noe, tough, shit]
         2    [user, canada, doesn, need, anoth, cuck, we, a...
         3    [user, user, user, it, should, scare, everi, a...
         4    [user, user, user, user, lol, throw, the, bull...
         5                       [user, user, you, ar, correct]
         6    [user, user, kind, of, like, when, conserv, wa...
         7    [the, onli, thing, the, democrat, have, is, ly...
         8    [user, user, user, user, user, user, user, use...
         9    [user, user, user, user, user, user, user, use...
         Name: stemmed_tokens, dtype: object
```

```
In [92]: from sklearn.model_selection import train_test_split
         # Train Test Split Function
         def split_train_test(top_data_df_small, test_size=1, shuffle_state=True):
             X_train, X_test, Y_train, Y_test = train_test_split(top_data_df_small[[ 'text',  'stemmed_tokens'
         ]],
                                                                 top_data_df_small['target'],
                                                                 shuffle=shuffle_state,
                                                                 test_size=test_size,
                                                                 random_state=15)
             print("Value counts for Train sentiments")
             print(Y_train.value_counts())
             print("Value counts for Test sentiments")
             print(Y_test.value_counts())
             print(type(X_train))
             print(type(Y_train))
             X_train = X_train.reset_index()
             X_test = X_test.reset_index()
             Y_train = Y_train.to_frame()
             Y_train = Y_train.reset_index()
             Y_test = Y_test.to_frame()
             Y_test = Y_test.reset_index()
             print(X_train.head())
             return X_train, X_test, Y_train, Y_test

         # Call the train_test_split
         X_test = data_test[[ 'text',  'stemmed_tokens']]
```

```
In [93]: import torch.nn as nn
         import torch.nn.functional as F
         import torch.optim as optim

         import torch
         # Use cuda if present
         device = torch.device("cuda" if torch.cuda.is_available() else "cpu")
         print("Device available for running: ")
         print(device)
```

```
Device available for running:
cpu
```

```
In [94]: from gensim.models import Word2Vec
         size = 500
         window = 3
         min_count = 1
         workers = 3
         sg = 1

         # Function to train word2vec model
         def make_word2vec_model(top_data_df_small, padding=True, sg=1, min_count=1, size=500, workers=3, window
         =3):
             if  padding:
                 print(len(top_data_df_small))
                 temp_df = pd.Series(top_data_df_small['stemmed_tokens']).values
                 temp_df = list(temp_df)
                 temp_df.append(['pad'])
                 word2vec_file =   'word2vec_' + str(size) + '_PAD.model'
             else:
                 temp_df = top_data_df_small['stemmed_tokens']
                 word2vec_file =   'word2vec_' + str(size) + '.model'
             w2v_model = Word2Vec(temp_df, min_count = min_count, size = size, workers = workers, window = windo
         w, sg = sg)

             w2v_model.save(word2vec_file)
             return w2v_model, word2vec_file

         # Train Word2vec model
         w2vmodel, word2vec_file = make_word2vec_model(X_test, padding=True, sg=sg, min_count=min_count, size=si
         ze, workers=workers, window=window)
```

```
3894
```

```
In [97]: max_sen_len = X_test.stemmed_tokens.map(len).max()
         padding_idx = w2vmodel.wv.vocab['pad'].index
         def make_word2vec_vector_cnn(sentence):
             padded_X = [padding_idx for i in range(max_sen_len)]
             i = 0
             for word in sentence:
                 if word not in w2vmodel.wv.vocab:
                     padded_X[i] = 0
                     print(word)
                 else:
                     padded_X[i] = w2vmodel.wv.vocab[word].index
                 i += 1
             return torch.tensor(padded_X, dtype=torch.long, device=device).view(1, -1)

         from sklearn.metrics import classification_report
         bow_cnn_predictions = []
         original_lables_cnn_bow = []
         cnn_model.eval()
         #loss_df = pd.read_csv('cnn_class_big_loss_with_padding.csv')
         #print(loss_df.columns)
         # loss_df.plot('loss')
         with torch.no_grad():
             for index, row in X_test.iterrows():
                 bow_vec = make_word2vec_vector_cnn(row['stemmed_tokens'])
                 probs = cnn_model(bow_vec)
                 _, predicted = torch.max(probs.data, 1)
                 bow_cnn_predictions.append(predicted.cpu().numpy()[0])
         #        original_lables_cnn_bow.append(make_target(Y_test['target'][index]).cpu().numpy()[0])

         #print(classification_report(original_lables_cnn_bow,bow_cnn_predictions))
         #loss_file_name = 'cnn_class_big_loss_with_padding.csv'
         #loss_df = pd.read_csv(loss_file_name)
         #print(loss_df.columns)
         #plt_500_padding_30_epochs = loss_df[' loss'].plot()
         #fig = plt_500_padding_30_epochs.get_figure()
         #fig.savefig('loss_plt_500_padding_30_epochs.pdf')
```

```
In [ ]: data_test['Target'] = bow_cnn_predictions
        submission = data_test[['id','Target']]
        submission.to_csv('cnn.csv', index=False) # writing data to a CSV file
        submission
```

```
In [ ]: # LSTM for text classification
```

```
In [38]: import pandas as pd
         import numpy as np
         import matplotlib.pyplot as plt
         import seaborn as sns
         from sklearn.model_selection import train_test_split
         from sklearn.preprocessing import LabelEncoder
         from keras.models import Model
         from keras.layers import LSTM, Activation, Dense, Dropout, Input, Embedding
         from keras.optimizers import RMSprop
         from keras.preprocessing.text import Tokenizer
         from keras.preprocessing import sequence
         from keras.utils import to_categorical
         from keras.callbacks import EarlyStopping
         %matplotlib inline
```

```
In [167]: df = data
          df.head()
```

Out[167]:

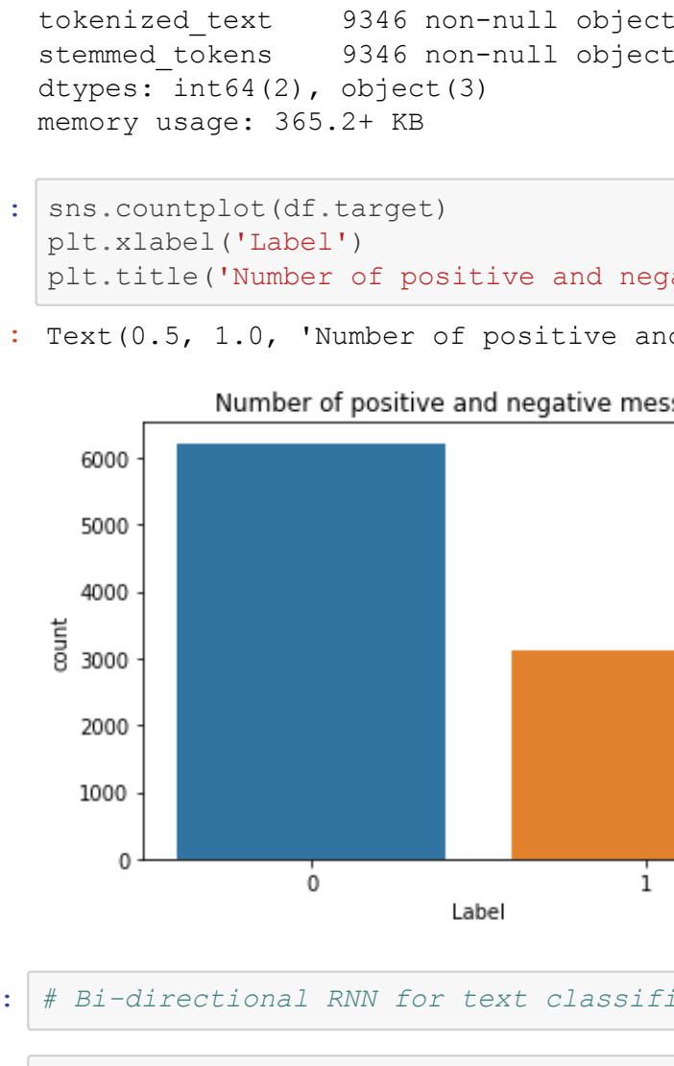
	id	text	target	tokenized_text	stemmed_tokens
0	86426	She should ask few native Americans what their...	1	[she, should, ask, few, native, americans, wha...	[she, should, ask, few, nativ, american, what,...
1	16820	Amazon investigating Chinese employees who are...	0	[amazon, investigating, chinese, employees, wh...	[amazon, investig, chines, employe, who, ar, s...
2	62688	Someone should veTaken this piece shit volcano	1	[someone, should, vetaken, this, piece, shit, ...	[someon, should, vetaken, thi, piec, shit, vol...
3	43605	Obama wanted liberals amp illegals move into r...	0	[obama, wanted, liberals, amp, illegals, move,...	[obama, want, liber, amp, illeg, move, into, r...
4	97670	Liberals are all Kookoo	1	[liberals, are, all, kookoo]	[liber, ar, all, kookoo]

```
In [168]: df.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 9346 entries, 0 to 9345
Data columns (total 5 columns):
id                9346 non-null int64
text              9346 non-null object
target            9346 non-null int64
tokenized_text    9346 non-null object
stemmed_tokens    9346 non-null object
dtypes: int64(2), object(3)
memory usage: 365.2+ KB
```

```
In [169]: sns.countplot(df.target)
          plt.xlabel('Label')
          plt.title('Number of positive and negative messages')
```

```
Out[169]: Text(0.5, 1.0, 'Number of positive and negative messages')
```



[illegible]

In [43]:

```python
import torch

#Reproducing same results
SEED = 2019

#Torch
torch.manual_seed(SEED)

#Cuda algorithms
torch.backends.cudnn.deterministic = True
```

In [46]:

```python
#loading custom dataset
training_data=data

#print preprocessed text
print(vars(training_data[0:1]))
```

```
{'_is_copy': <weakref at 0x1a30693f98; to 'DataFrame' at 0x1a30555a20>, '_data': BlockManager
Items: Index(['id', 'text', 'target'], dtype='object')
Axis 1: RangeIndex(start=0, stop=1, step=1)
IntBlock: slice(0, 4, 2), 2 x 1, dtype: int64
ObjectBlock: slice(1, 2, 1), 1 x 1, dtype: object, '_item_cache': {}}
```

In [49]:

```python
import random
train_data,X_test, valid_data,Y_test = train_test_split(training_data['text'],training_data['target'],t
est_size=0.2)
```

In [50]:

```python
# LSTM for text classification
```

In [118]:

```python
# LSTM for sequence classification in the IMDB dataset
import numpy
from keras.datasets import imdb
from keras.models import Sequential
from keras.layers import Dense
from keras.layers import LSTM
from keras.layers.embeddings import Embedding
from keras.preprocessing import sequence
# fix random seed for reproducibility
numpy.random.seed(7)
# load the dataset but only keep the top n words, zero the rest
top_words = 5000

X = data.text
Y = data.target
le = LabelEncoder()
Y = le.fit_transform(Y)
Y = Y.reshape(-1,1)

X_train,X_test,Y_train,Y_test = train_test_split(X,Y,test_size=0.2)

max_words = 1000
max_len = 200
tok = Tokenizer(num_words=max_words)
tok.fit_on_texts(X_train)
sequences = tok.texts_to_sequences(X_train)
X_train = sequence.pad_sequences(sequences,maxlen=max_len)
print(X_train.shape)
print(y_train.shape)
#X_train = sequence.pad_sequences(X_train, maxlen=max_review_length)
#X_test = sequence.pad_sequences(X_test, maxlen=max_review_length)
# create the model
embedding_vecor_length = 32
model = Sequential()
model.add(Embedding(top_words, embedding_vecor_length, input_length=max_len))
model.add(LSTM(100))
model.add(Dense(1, activation='sigmoid'))
model.compile(loss='binary_crossentropy', optimizer='adam', metrics=['accuracy'])
print(model.summary())
model.fit(X_train, Y_train, epochs=10, batch_size=64)
# Final evaluation of the model
scores = model.evaluate(X_test, Y_test, verbose=0)
print("Accuracy: %.2f%%" % (scores[1]*100))
```

```
(7476, 200)
(25000,)
Model: "sequential_31"
_________________________________________________________________
Layer (type)                 Output Shape              Param #
=================================================================
embedding_22 (Embedding)     (None, 200, 32)           160000
_________________________________________________________________
lstm_29 (LSTM)               (None, 100)               53200
_________________________________________________________________
dense_25 (Dense)             (None, 1)                 101
=================================================================
Total params: 213,301
Trainable params: 213,301
Non-trainable params: 0
_________________________________________________________________
None
Epoch 1/10
7476/7476 [==============================] - 120s 16ms/step - loss: 0.6291 - accuracy: 0.6651
Epoch 2/10
7476/7476 [==============================] - 112s 15ms/step - loss: 0.5440 - accuracy: 0.7289
Epoch 3/10
7476/7476 [==============================] - 113s 15ms/step - loss: 0.4807 - accuracy: 0.7746
Epoch 4/10
7476/7476 [==============================] - 125s 17ms/step - loss: 0.4601 - accuracy: 0.7925
Epoch 5/10
7476/7476 [==============================] - 111s 15ms/step - loss: 0.4495 - accuracy: 0.7968
Epoch 6/10
7476/7476 [==============================] - 105s 14ms/step - loss: 0.4337 - accuracy: 0.8091
Epoch 7/10
7476/7476 [==============================] - 106s 14ms/step - loss: 0.4179 - accuracy: 0.8146
Epoch 8/10
7476/7476 [==============================] - 105s 14ms/step - loss: 0.4056 - accuracy: 0.8234
Epoch 9/10
7476/7476 [==============================] - 106s 14ms/step - loss: 0.3928 - accuracy: 0.8261
Epoch 10/10
7476/7476 [==============================] - 112s 15ms/step - loss: 0.3918 - accuracy: 0.8277
```

```
---------------------------------------------------------------------------
ValueError                                Traceback (most recent call last)
<ipython-input-118-32a60363e4a4> in <module>
     46 model.fit(X_train, Y_train, epochs=10, batch_size=64)
     47 # Final evaluation of the model
---> 48 scores = model.evaluate(X_test, Y_test, verbose=0)
     49 print("Accuracy: %.2f%%" % (scores[1]*100))

/anaconda3/lib/python3.7/site-packages/keras/engine/training.py in evaluate(self, x, y, batch_size, v
erbose, sample_weight, steps, callbacks, max_queue_size, workers, use_multiprocessing)
   1347             x, y,
   1348             sample_weight=sample_weight,
-> 1349             batch_size=batch_size)
   1350         # Prepare inputs, delegate logic to `test_loop`.
   1351         if self._uses_dynamic_learning_phase():

/anaconda3/lib/python3.7/site-packages/keras/engine/training.py in _standardize_user_data(self, x, y,
 sample_weight, class_weight, check_array_lengths, batch_size)
    577             feed_input_shapes,
    578             check_batch_axis=False,  # Don't enforce the batch size.
--> 579             exception_prefix='input')
    580
    581         if y is not None:

/anaconda3/lib/python3.7/site-packages/keras/engine/training_utils.py in standardize_input_data(data,
 names, shapes, check_batch_axis, exception_prefix)
    143                             ': expected ' + names[i] + ' to have shape ' +
    144                             str(shape) + ' but got array with shape ' +
--> 145                             str(data_shape))
    146     return data
    147

ValueError: Error when checking input: expected embedding_22_input to have shape (200,) but got array
 with shape (1,)
```

In [120]:

```python
#tok.fit_on_texts(X_)
sequences = tok.texts_to_sequences(X_test)
X_test = sequence.pad_sequences(sequences,maxlen=max_len)


scores = model.evaluate(X_test, Y_test, verbose=0)
print("Accuracy: %.2f%%" % (scores[1]*100))
```

```
Accuracy: 71.98%
```

In [ ]:

```python
test_sequences = tok.texts_to_sequences(data_test['text'])
test_sequences_matrix = sequence.pad_sequences(test_sequences,maxlen=max_len)

test_sequences_matrix.shape

pred = model.predict(test_sequences_matrix)

predicted = []
for i in range(len(pred)):
    if pred[i] >= 0.5:
        predicted += [1]
    else:
        predicted += [0]

data_test['Target'] = predicted
submission = data_test[['id','Target']]
submission.to_csv('lstm2.csv', index=False) # writing data to a CSV file
submission
```

In [89]:

```python
# LSTM For text Classification With Dropout
```

In [ ]:

```python
# LSTM with Dropout for sequence classification in the IMDB dataset
import numpy
from keras.datasets import imdb
from keras.models import Sequential
from keras.layers import Dense
from keras.layers import LSTM
from keras.layers import Dropout
from keras.layers.embeddings import Embedding
from keras.preprocessing import sequence
# fix random seed for reproducibility
numpy.random.seed(7)
# load the dataset but only keep the top n words, zero the rest
top_words = 5000

X = data.text
Y = data.target
le = LabelEncoder()
Y = le.fit_transform(Y)
Y = Y.reshape(-1,1)

X_train,X_test,Y_train,Y_test = train_test_split(X,Y,test_size=0.2)

max_words = 1000
max_len = 200
tok = Tokenizer(num_words=max_words)
tok.fit_on_texts(X_train)
sequences = tok.texts_to_sequences(X_train)
X_train = sequence.pad_sequences(sequences,maxlen=max_len)
print(X_train.shape)
print(y_train.shape)


# create the model
embedding_vecor_length = 32
model = Sequential()
model.add(Embedding(top_words, embedding_vecor_length, input_length=max_len))
model.add(Dropout(0.2))
model.add(LSTM(100))
model.add(Dropout(0.2))
model.add(Dense(1, activation='sigmoid'))
model.compile(loss='binary_crossentropy', optimizer='adam', metrics=['accuracy'])
print(model.summary())
model.fit(X_train, y_train, epochs=20, batch_size=64)
# Final evaluation of the model
scores = model.evaluate(X_test, y_test, verbose=0)
print("Accuracy: %.2f%%" % (scores[1]*100))
```

```
(7476, 200)
(7476,)
Model: "sequential_34"
_________________________________________________________________
Layer (type)                 Output Shape              Param #
=================================================================
embedding_25 (Embedding)     (None, 200, 32)           160000
_________________________________________________________________
dropout_6 (Dropout)          (None, 200, 32)           0
_________________________________________________________________
lstm_32 (LSTM)               (None, 100)               53200
_________________________________________________________________
dropout_7 (Dropout)          (None, 100)               0
_________________________________________________________________
dense_28 (Dense)             (None, 1)                 101
=================================================================
Total params: 213,301
Trainable params: 213,301
Non-trainable params: 0
_________________________________________________________________
None
Epoch 1/20
7476/7476 [==============================] - 113s 15ms/step - loss: 0.6294 - accuracy: 0.6664
Epoch 2/20
7476/7476 [==============================] - 109s 15ms/step - loss: 0.5412 - accuracy: 0.7330
Epoch 3/20
7476/7476 [==============================] - 108s 15ms/step - loss: 0.4781 - accuracy: 0.7824
Epoch 4/20
7476/7476 [==============================] - 110s 15ms/step - loss: 0.4582 - accuracy: 0.7956
Epoch 5/20
7476/7476 [==============================] - 114s 15ms/step - loss: 0.4473 - accuracy: 0.8028
Epoch 6/20
7476/7476 [==============================] - 108s 14ms/step - loss: 0.4334 - accuracy: 0.8089
Epoch 7/20
7476/7476 [==============================] - 109s 15ms/step - loss: 0.4216 - accuracy: 0.8131
Epoch 8/20
7476/7476 [==============================] - 122s 16ms/step - loss: 0.4085 - accuracy: 0.8178
Epoch 9/20
6336/7476 [========================>.....] - ETA: 17s - loss: 0.4055 - accuracy: 0.8212
```

In [ ]:

```python
#tok.fit_on_texts(X_)
sequences = tok.texts_to_sequences(X_test)
X_test = sequence.pad_sequences(sequences,maxlen=max_len)


scores = model.evaluate(X_test, Y_test, verbose=0)
print("Accuracy: %.2f%%" % (scores[1]*100))

test_sequences = tok.texts_to_sequences(data_test['text'])
test_sequences_matrix = sequence.pad_sequences(test_sequences,maxlen=max_len)

test_sequences_matrix.shape

pred = model.predict(test_sequences_matrix)

predicted = []
for i in range(len(pred)):
    if pred[i] >= 0.5:
        predicted += [1]
    else:
        predicted += [0]

data_test['Target'] = predicted
submission = data_test[['id','Target']]
submission.to_csv('lstm2.csv', index=False) # writing data to a CSV file
submission
```

In [ ]:

```python
# LSTM and Convolutional Neural Network For Sequence Classification
```

In [ ]:

```python
# LSTM and CNN for sequence classification in the IMDB dataset
import numpy
from keras.datasets import imdb
from keras.models import Sequential
from keras.layers import Dense
from keras.layers import LSTM
from keras.layers.convolutional import Conv1D
from keras.layers.convolutional import MaxPooling1D
from keras.layers.embeddings import Embedding
from keras.preprocessing import sequence
# fix random seed for reproducibility
numpy.random.seed(7)
# load the dataset but only keep the top n words, zero the rest
top_words = 5000
X_train,X_test,y_train,y_test = train_test_split(data['text'],data['target'],test_size=0.2)
# truncate and pad input sequences
max_review_length = 500
X_train = sequence.pad_sequences(X_train, maxlen=max_review_length)
X_test = sequence.pad_sequences(X_test, maxlen=max_review_length)
# create the model
embedding_vecor_length = 32
model = Sequential()
model.add(Embedding(top_words, embedding_vecor_length, input_length=max_review_length))
model.add(Conv1D(filters=32, kernel_size=3, padding='same', activation='relu'))
model.add(MaxPooling1D(pool_size=2))
model.add(LSTM(100))
model.add(Dense(1, activation='sigmoid'))
model.compile(loss='binary_crossentropy', optimizer='adam', metrics=['accuracy'])
print(model.summary())
model.fit(X_train, y_train, epochs=3, batch_size=64)
# Final evaluation of the model
scores = model.evaluate(X_test, y_test, verbose=0)
print("Accuracy: %.2f%%" % (scores[1]*100))
```

In [ ]:

```python
#tok.fit_on_texts(X_)
sequences = tok.texts_to_sequences(X_test)
X_test = sequence.pad_sequences(sequences,maxlen=max_len)


scores = model.evaluate(X_test, Y_test, verbose=0)
print("Accuracy: %.2f%%" % (scores[1]*100))

test_sequences = tok.texts_to_sequences(data_test['text'])
test_sequences_matrix = sequence.pad_sequences(test_sequences,maxlen=max_len)

test_sequences_matrix.shape

pred = model.predict(test_sequences_matrix)

predicted = []
for i in range(len(pred)):
    if pred[i] >= 0.5:
        predicted += [1]
    else:
        predicted += [0]

data_test['Target'] = predicted
submission = data_test[['id','Target']]
submission.to_csv('lstm2.csv', index=False) # writing data to a CSV file
submission
```

In [ ]:

```python
from random import random
from numpy import array
from numpy import cumsum
from keras.models import Sequential
from keras.layers import LSTM
from keras.layers import Dense
from keras.layers import TimeDistributed
from keras.layers import Bidirectional

# create a sequence classification instance
def get_sequence(n_timesteps):
        # create a sequence of random numbers in [0,1]
        X = array([random() for _ in range(n_timesteps)])
        # calculate cut-off value to change class values
        limit = n_timesteps/4.0
        # determine the class outcome for each item in cumulative sequence
        y = array([0 if x < limit else 1 for x in cumsum(X)])
        # reshape input and output data to be suitable for LSTMs
        X = X.reshape(1, n_timesteps, 1)
        y = y.reshape(1, n_timesteps, 1)
        return X, y

# define problem properties
n_timesteps = 10
# define LSTM
model = Sequential()
model.add(Bidirectional(LSTM(20, return_sequences=True), input_shape=(n_timesteps, 1)))
model.add(TimeDistributed(Dense(1, activation='sigmoid')))
model.compile(loss='binary_crossentropy', optimizer='adam', metrics=['accuracy'])
# train LSTM
for epoch in range(1000):
        # generate new random sequence
        X,y = get_sequence(n_timesteps)
        # fit model for one epoch on this sequence
        model.fit(X, y, epochs=1, batch_size=1, verbose=2)
# evaluate LSTM
X,y = get_sequence(n_timesteps)
yhat = model.predict_classes(X, verbose=0)
for i in range(n_timesteps):
        print('Expected:', y[0, i], 'Predicted', yhat[0, i])
```

In [ ]:

```python
#tok.fit_on_texts(X_)
sequences = tok.texts_to_sequences(X_test)
X_test = sequence.pad_sequences(sequences,maxlen=max_len)


scores = model.evaluate(X_test, Y_test, verbose=0)
print("Accuracy: %.2f%%" % (scores[1]*100))

test_sequences = tok.texts_to_sequences(data_test['text'])
test_sequences_matrix = sequence.pad_sequences(test_sequences,maxlen=max_len)

test_sequences_matrix.shape

pred = model.predict(test_sequences_matrix)

predicted = []
for i in range(len(pred)):
    if pred[i] >= 0.5:
        predicted += [1]
    else:
        predicted += [0]

data_test['Target'] = predicted
submission = data_test[['id','Target']]
submission.to_csv('lstm2.csv', index=False) # writing data to a CSV file
submission
```