Here we build our dictionary and train our model

Using the candidates and parties preprocessed tweets as our labeled dataset

In [2]:

```
# Libs
import csv
import string
import numpy as np
import time
import sys
import nltk
import random
import matplotlib.pyplot as plt

from tqdm import tqdm_notebook as tqdm

from nltk.tokenize import word_tokenize

from keras.preprocessing.text import one_hot
from keras.preprocessing.sequence import pad_sequences
from keras.models import Sequential
from keras.layers.core import Activation, Dropout, Dense
from keras.layers import Flatten
from keras.layers import GlobalMaxPooling1D
from keras.layers.embeddings import Embedding
from keras.preprocessing.text import Tokenizer
```

```
Using TensorFlow backend.
```

In [3]:

```
from sklearn.model_selection import train_test_split
```

In [ ]:

```
import libs.bag_of_worder as bag_of_worder
import libs.preprocessor as tweet_preproc

# Init Preprocessor
twitterPreprocessor = tweet_preproc.TwitterPreprocessor()
```

Dataset

IMPORTANT, the label should have only two states 0: dems, 1: republican

In [4]:

```python
def load_dataset(path):

    x = []
    y = []

    with open(path, 'r', newline='', encoding="utf-8") as csvfile:

        reader = csv.reader(csvfile, quotechar='"', delimiter=',')

        # Taking the header of the file + the index of useful columns:
        header = next(reader)
        ind_label = header.index('label')
        ind_text = header.index('text')

        for row in reader:

            label = row[ind_label]
            if label == "democrat":
                y.append(0)
            elif label == "republican":
                y.append(1)
            else:
                continue

            x.append(row[ind_text])


        assert len(x) == len(y)

        return x, y
```

In [5]:

```python
def checkBalanced(labels):
    return np.count_nonzero(labels)/len(labels)


def balance_dataset(features, labels):

    # Combine the features with the labels
    combined = list(zip(features, labels))

    # Shuffle the list
    random.shuffle(combined)

    # Split the feature and label
    X[:], y[:] = zip(*combined)

    # Count number of '1'
    nbrOfOnes = np.count_nonzero(y)
    nbrOfZeros = len(y) - nbrOfOnes
    excessNbr = abs(nbrOfOnes - nbrOfZeros)

    # Balance dataset
    removed_counter = 0
    if(nbrOfOnes > nbrOfZeros):  # too much '1'

        for ind in range(0,len(y)):
            if(y[ind] == 1):
                X.pop(ind)
                y.pop(ind)
                removed_counter = removed_counter + 1

            if(removed_counter >= abs(excessNbr)):
                break

    else:                        # too much '0'

        for ind in range(0,len(y)):
            if(y[ind] == 0):
                X.pop(ind)
                y.pop(ind)
                removed_counter = removed_counter + 1

            if(removed_counter >= abs(excessNbr)):
                break

    return X, y
```

In [17]:

```python
# Path of the labeled dataset
path = "data/parties_candidates/sources.csv"

# Load dataset from path
X, y = load_dataset(path)

# Make sure there is 50/50 of both labels
X, y = balance_dataset(X,y)

# Split the data
train_X, valid_X, train_Y, valid_Y = train_test_split(X, y, test_size=0.2, random_state=12, shuffl
e=True, stratify=y)

print("Length of training set : ", len(train_X))
print("Length of validation set : ", len(valid_X))
```

```
Length of training set :  93948
Length of validation set :  23488
```

In [18]:

```python
# Make sure the training data is balanced
print("--- Proportion of republican label ---")
print(checkBalanced(train_Y))
```

```
--- Proportion of republican label ---
0.5
```

Dictionary

In [9]:

```
def bigram(tokens):
    """
    tokens: a list of strings
    """
    # Init array
    bigrams = []

    # Go through tokens
    for i in range(0,len(tokens)-1):
        bigrams.append(" ".join([tokens[i],tokens[i+1]]))

    # This function returns the list of bigrams
    return bigrams


# Returns unique words
def buildDict(tweets, addBigram=False):

    # Init empty set
    wordDict = set()

    # Go through each tweet of the validation set
    for tweet in tweets:

        # Tokenize
        words = word_tokenize(tweet)

        # Add Bigram
        if(addBigram):
            words = words + bigram(words)

        # Go through each word
        for word in words:

            # Append to dictionary if not already there
            if(word not in wordDict):
                wordDict.add(word)

    # Get the stats
    print("Dict Dimension: " + str(len(wordDict)))

    return list(wordDict)


def loadDict():

    # Init dict
    wordDict = []

    path = "model/dictionary.txt"
    with open(path, 'r', newline='', encoding="utf-8") as input_file:
        for row in input_file:
            wordDict.append(row.strip())

    # Get the stats
    print("Dict Dimension: " + str(len(wordDict)))

    return wordDict
```

In [10]:

```
# Create a dictionary of all the words
wordDict = loadDict()
```

```
Dict Dimension: 25890
```

Dictionary Reduction

In [ ]:

```
def reduceDict(wordDict,countBoW,tweets):

    # Init the BoW Matrix
    matrixBoW = np.zeros((1, len(wordDict)),dtype=np.int16)

    for tweet in tqdm(tweets):

        # Compute the BoW
        bowObject = countBoW.computeLine(tweet)

        # Add to matrixBoW
        matrixBoW = np.add(matrixBoW,bowObject)


    # Only keep words that occured more than once
    newWordDict = []
    for ind in np.argwhere(matrixBoW > 1):
        newWordDict.append(wordDict[ind[1]])

    reduction = len(newWordDict)/(1.0*len(wordDict))
    print(reduction)


    # Write to file
    path = "model/dictionary_new.txt"
    with open(path, 'w+', newline='', encoding="utf-8") as output_file:
        for word in newWordDict:
            output_file.write(str(word) + "\n")

    print("New dictionary created!")
```

In [ ]:

```
# reduceDict(wordDict,countBoW,train_X)
```

Classifier

In [11]:

```
from joblib import dump, load

# Load Model
def loadModel():

    try:
        classifier = load('model/logistic.joblib')
        print("Model Loaded!")
        return classifier

    except:
        print("ERROR: Model not saved")


def saveModel(clf):

    dump(clf, 'model/logistic.joblib')
```

In [12]:

```
from sklearn.metrics import accuracy_score
from sklearn.linear_model import LogisticRegression

def train_evaluate(training_X, training_Y, validation_X, validation_Y, bowObj):
    """
    training_X: tweets from the training dataset
    training_Y: tweet labels from the training dataset
    validation_X: tweets from the validation dataset
    validation_Y: tweet labels from the validation dataset
    bowObj: Bag-of-word object

    :return: the classifier and its accuracy in the training and validation dataset.
    """

    classifier = LogisticRegression(n_jobs=-1,solver='lbfgs', multi_class='auto')

    training_rep = bowObj.computeMatrix(training_X)

    classifier.fit(training_rep, training_Y)

    trainAcc = accuracy_score(training_Y, classifier.predict(training_rep))
    validationAcc = accuracy_score(
        validation_Y, classifier.predict(bowObj.computeMatrix(validation_X)))

    return classifier, trainAcc, validationAcc
```

In [ ]:

```
# Init Bag-of-Worder using the dictionary
countBoW = bag_of_worder.BagOfWorder(wordDict)

# Train
classifier, trainAcc, validationAcc = train_evaluate(train_X,train_Y,valid_X,valid_Y,countBoW)
print("Training Accuracy: " + str(trainAcc))
print("Validation Accuracy: " + str(validationAcc))
```

In [ ]:

```
# Save Model
saveModel(classifier)
```

In [ ]:

```
def checkPerf(classifier, countBoW):

    # Check performance
    preds = classifier.predict(countBoW.computeMatrix(train_X[1:4]))
    np.count_nonzero(np.equal(preds,train_Y))/len(preds)
```

Training and testing models

Codes copied from: https://stackabuse.com/python-for-nlp-movie-sentiment-analysis-using-deep-learning-in-keras/ (https://stackabuse.com/python-for-nlp-movie-sentiment-analysis-using-deep-learning-in-keras/)

Transforming data

In [63]:

```
top_words = 5000
```

In [22]:

```
tokenizer = Tokenizer(num_words=top_words)
tokenizer.fit_on_texts(train_X)

train_X_t = tokenizer.texts_to_sequences(train_X)
valid_X_t = tokenizer.texts_to_sequences(valid_X)
```

In [23]:

```
# Adding 1 because of reserved 0 index
vocab_size = len(tokenizer.word_index) + 1

maxlen = 100

train_X_t = pad_sequences(train_X_t, padding='post', maxlen=maxlen)
valid_X_t = pad_sequences(valid_X_t, padding='post', maxlen=maxlen)

print('vocab_size: {}'.format(vocab_size))
```

```
vocab_size: 32097
```

```
In [31]: train_X_t[3]
```

```
array([  59,    2,  187, 1246, 2133, 2018,  893,  784,  473,   90, 1709,
        677,    2, 3229,  134,    3,  141,  745,    0,    0,    0,    0,
          0,    0,    0,    0,    0,    0,    0,    0,    0,    0,    0,
          0,    0,    0,    0,    0,    0,    0,    0,    0,    0,    0,
          0,    0,    0,    0,    0,    0,    0,    0,    0,    0,    0,
          0,    0,    0,    0,    0,    0,    0,    0,    0,    0,    0,
          0,    0,    0,    0,    0,    0,    0,    0,    0,    0,    0,
          0,    0,    0,    0,    0,    0,    0,    0,    0,    0,    0,
          0,    0,    0,    0,    0,    0,    0,    0,    0,    0,    0,
          0])
```

Random Forest algorithm

Here, we don't need any normalization.

```
In [24]: from sklearn.ensemble import RandomForestClassifier

         text_classifier = RandomForestClassifier(n_estimators=200, random_state=0)
         text_classifier.fit(train_X_t, train_Y)
```

```
c:\program files\python36\lib\site-packages\sklearn\ensemble\weight_boosting.py:29: DeprecationWarning: numpy.core.umath_tests is an inter
nal NumPy module and should not be imported. It will be removed in a future NumPy release.
  from numpy.core.umath_tests import inner1d
```

```
RandomForestClassifier(bootstrap=True, class_weight=None, criterion='gini',
            max_depth=None, max_features='auto', max_leaf_nodes=None,
            min_impurity_decrease=0.0, min_impurity_split=None,
            min_samples_leaf=1, min_samples_split=2,
            min_weight_fraction_leaf=0.0, n_estimators=200, n_jobs=1,
            oob_score=False, random_state=0, verbose=0, warm_start=False)
```

```
In [25]: predictions = text_classifier.predict(valid_X_t)
```

```
In [26]: from sklearn.metrics import classification_report, confusion_matrix, accuracy_score

         print(confusion_matrix(valid_Y, predictions))
         print(classification_report(valid_Y, predictions))
         print(accuracy_score(valid_Y, predictions))
```

```
[[10192  1552]
 [ 2147  9597]]
             precision    recall  f1-score   support

          0       0.83      0.87      0.85     11744
          1       0.86      0.82      0.84     11744

avg / total       0.84      0.84      0.84     23488

0.8425153269754768
```

Logistic Regression algorithm

```
In [32]: from sklearn.preprocessing import MinMaxScaler
         # Normalize data
         scaler = MinMaxScaler()
         train_X_t_n = scaler.fit_transform(train_X_t)
         valid_X_t_n = scaler.transform(valid_X_t)
```

```
c:\program files\python36\lib\site-packages\sklearn\utils\validation.py:475: DataConversionWarning: Data with input dtype int32 was conver
ted to float64 by MinMaxScaler.
  warnings.warn(msg, DataConversionWarning)
```

```
In [33]: from sklearn.linear_model import LogisticRegression

         text_classifier = LogisticRegression()
         text_classifier.fit(train_X_t, train_Y)
```

```
LogisticRegression(C=1.0, class_weight=None, dual=False, fit_intercept=True,
          intercept_scaling=1, max_iter=100, multi_class='ovr', n_jobs=1,
          penalty='l2', random_state=None, solver='liblinear', tol=0.0001,
          verbose=0, warm_start=False)
```

```
In [34]: predictions = text_classifier.predict(valid_X_t)
```

In [37]:
```python
from sklearn.metrics import classification_report, confusion_matrix, accuracy_score

print(confusion_matrix(valid_Y, predictions))
print(classification_report(valid_Y, predictions))
print(accuracy_score(valid_Y, predictions))
```

```
[[4706 7038]
 [3527 8217]]
             precision    recall  f1-score   support

          0       0.57      0.40      0.47     11744
          1       0.54      0.70      0.61     11744

avg / total       0.56      0.55      0.54     23488

0.5501958446866485
```

SVM algorithm

In [42]:
```python
from sklearn import svm

text_classifier = svm.SVC(gamma='auto')
text_classifier.fit(train_X_t_n, train_Y)
```

```
SVC(C=1.0, cache_size=200, class_weight=None, coef0=0.0,
  decision_function_shape='ovr', degree=3, gamma='auto', kernel='rbf',
  max_iter=-1, probability=False, random_state=None, shrinking=True,
  tol=0.001, verbose=False)
```

In [43]:
```python
predictions = text_classifier.predict(valid_X_t_n)
```

In [44]:
```python
print(confusion_matrix(valid_Y, predictions))
print(classification_report(valid_Y, predictions))
print(accuracy_score(valid_Y, predictions))
```

```
[[2550 9194]
 [1838 9906]]
             precision    recall  f1-score   support

          0       0.58      0.22      0.32     11744
          1       0.52      0.84      0.64     11744

avg / total       0.55      0.53      0.48     23488

0.5303133514986376
```

In [45]:
```python
dump(text_classifier, 'model/svm_svc.joblib')
```

```
['model/svm_svc.joblib']
```

Simple Neural Network

Inspired from: https://machinelearningmastery.com/predict-sentiment-movie-reviews-using-deep-learning/ (https://machinelearningmastery.com/predict-sentiment-movie-reviews-using-deep-learning/)

In [88]:
```python
# create the model
model = Sequential()
model.add(Embedding(top_words, 32, input_length=maxlen))
model.add(Flatten())
model.add(Dense(250, activation='relu'))
model.add(Dense(1, activation='sigmoid'))
model.compile(loss='binary_crossentropy', optimizer='adam', metrics=['accuracy'])
print(model.summary())
```

```
_________________________________________________________________
Layer (type)                 Output Shape              Param #
=================================================================
embedding_8 (Embedding)      (None, 100, 32)           160000
_________________________________________________________________
flatten_7 (Flatten)          (None, 3200)              0
_________________________________________________________________
dense_11 (Dense)             (None, 250)               800250
_________________________________________________________________
dense_12 (Dense)             (None, 1)                 251
=================================================================
Total params: 960,501
Trainable params: 960,501
Non-trainable params: 0
_________________________________________________________________
None
```

In [89]:
```
history = model.fit(train_X_t, train_Y, batch_size=128, epochs=5, verbose=2, validation_split=0.2)
```

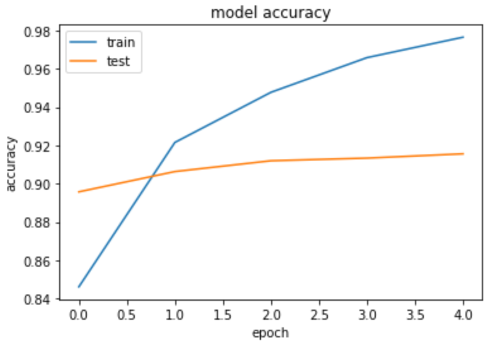
```
Train on 75158 samples, validate on 18790 samples
Epoch 1/5
 - 3s - loss: 0.3315 - acc: 0.8461 - val_loss: 0.2466 - val_acc: 0.8957
Epoch 2/5
 - 2s - loss: 0.1941 - acc: 0.9215 - val_loss: 0.2318 - val_acc: 0.9063
Epoch 3/5
 - 2s - loss: 0.1346 - acc: 0.9477 - val_loss: 0.2356 - val_acc: 0.9119
Epoch 4/5
 - 2s - loss: 0.0916 - acc: 0.9658 - val_loss: 0.2636 - val_acc: 0.9133
Epoch 5/5
 - 2s - loss: 0.0656 - acc: 0.9764 - val_loss: 0.3005 - val_acc: 0.9155
```

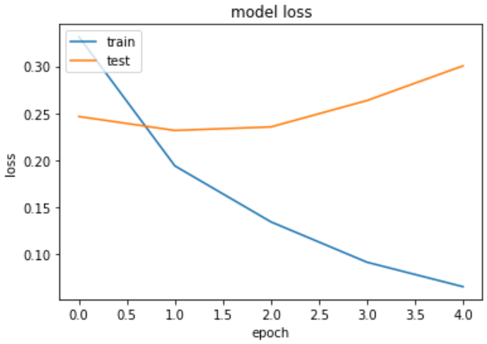
In [90]:
```
model.save('model/dl_snn.h5')
```

In [91]:
```
score = model.evaluate(valid_X_t, valid_Y, verbose=0)

print('Test Score: {}'.format(score[0]))
print('Test Accuracy: {}'.format(score[1]))
```

```
Test Score: 0.300509051837874 63
Test Accuracy: 0.9119550408719346
```

In [92]:
```
fig = plt.figure()
plt.plot(history.history['acc'])
plt.plot(history.history['val_acc'])
plt.title('model accuracy')
plt.ylabel('accuracy')
plt.xlabel('epoch')
plt.legend(['train','test'], loc='upper left')
plt.show()
fig.savefig('results/dl_snn_train_curve_acc.pdf', bbox_inches='tight')

fig = plt.figure()
plt.plot(history.history['loss'])
plt.plot(history.history['val_loss'])
plt.title('model loss')
plt.ylabel('loss')
plt.xlabel('epoch')
plt.legend(['train','test'], loc='upper left')
plt.show()
fig.savefig('results/dl_snn_train_curve_loss.pdf', bbox_inches='tight')
```





In [93]:
```
predictions = model.predict(valid_X_t)
```

In [95]:
```
print(confusion_matrix(valid_Y, predictions.round()))
print(classification_report(valid_Y, predictions.round()))
print(accuracy_score(valid_Y, predictions.round()))
```

```
[[10798   946]
 [ 1122 10622]]
             precision    recall  f1-score   support

          0       0.91      0.92      0.91     11744
          1       0.92      0.90      0.91     11744

avg / total       0.91      0.91      0.91     23488

0.9119550408719346
```

One-Dimensional Convolutional Neural Network Model

Inspired from: https://machinelearningmastery.com/predict-sentiment-movie-reviews-using-deep-learning/ (https://machinelearningmastery.com/predict-sentiment-movie-reviews-using-deep-learning/)

In [96]:
```
from keras.layers.convolutional import Conv1D
from keras.layers.convolutional import MaxPooling1D
```

In [102]:
```
# create the model
model = Sequential()
model.add(Embedding(top_words, 32, input_length=maxlen))
model.add(Conv1D(filters=32, kernel_size=3, padding='same', activation='relu'))
model.add(MaxPooling1D(pool_size=2))
model.add(Flatten())
model.add(Dense(250, activation='relu'))
model.add(Dense(1, activation='sigmoid'))
model.compile(loss='binary_crossentropy', optimizer='adam', metrics=['accuracy'])
model.summary()
```

```
_________________________________________________________________
Layer (type)                 Output Shape              Param #   
=================================================================
embedding_10 (Embedding)     (None, 100, 32)           160000    
_________________________________________________________________
conv1d_4 (Conv1D)            (None, 100, 32)           3104      
_________________________________________________________________
max_pooling1d_4 (MaxPooling1 (None, 50, 32)            0         
_________________________________________________________________
flatten_9 (Flatten)          (None, 1600)              0         
_________________________________________________________________
dense_15 (Dense)             (None, 250)               400250    
_________________________________________________________________
dense_16 (Dense)             (None, 1)                 251       
=================================================================
Total params: 563,605
Trainable params: 563,605
Non-trainable params: 0
_________________________________________________________________
```

In [103]:
```
history = model.fit(train_X_t, train_Y, batch_size=128, epochs=5, verbose=2, validation_split=0.2)
```

```
Train on 75158 samples, validate on 18790 samples
Epoch 1/5
 - 3s - loss: 0.3250 - acc: 0.8474 - val_loss: 0.2496 - val_acc: 0.8955
Epoch 2/5
 - 3s - loss: 0.1931 - acc: 0.9203 - val_loss: 0.2193 - val_acc: 0.9104
Epoch 3/5
 - 3s - loss: 0.1297 - acc: 0.9499 - val_loss: 0.2179 - val_acc: 0.9172
Epoch 4/5
 - 3s - loss: 0.0789 - acc: 0.9712 - val_loss: 0.2454 - val_acc: 0.9226
Epoch 5/5
 - 3s - loss: 0.0467 - acc: 0.9836 - val_loss: 0.2835 - val_acc: 0.9251
```

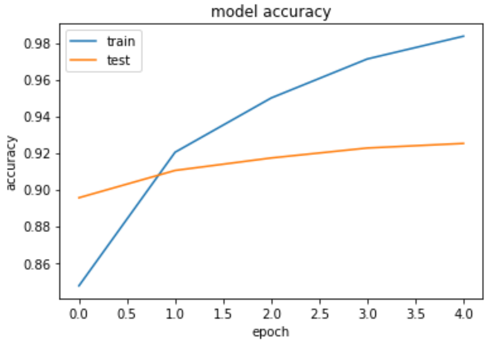
In [104]:
```
model.save('model/dl_cnn.h5')
```

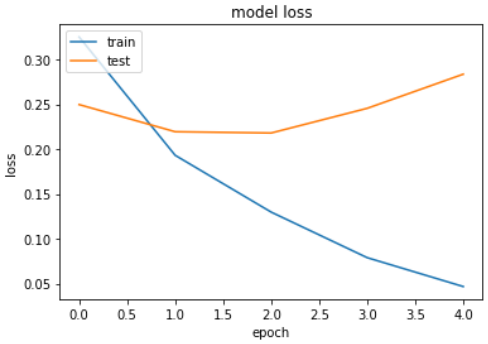
In [105]:
```
score = model.evaluate(valid_X_t, valid_Y, verbose=0)

print('Test Score: {}'.format(score[0]))
print('Test Accuracy: {}'.format(score[1]))
```

```
Test Score: 0.29008527080324154
Test Accuracy: 0.9208957765667575
```

In [106]:

```
fig = plt.figure()
plt.plot(history.history['acc'])
plt.plot(history.history['val_acc'])
plt.title('model accuracy')
plt.ylabel('accuracy')
plt.xlabel('epoch')
plt.legend(['train','test'], loc='upper left')
plt.show()
fig.savefig('results/dl_cnn_train_curve_acc.pdf', bbox_inches='tight')

fig = plt.figure()
plt.plot(history.history['loss'])
plt.plot(history.history['val_loss'])
plt.title('model loss')
plt.ylabel('loss')
plt.xlabel('epoch')
plt.legend(['train','test'], loc='upper left')
plt.show()
fig.savefig('results/dl_cnn_train_curve_loss.pdf', bbox_inches='tight')
```





In [107]:

```
predictions = model.predict(valid_X_t)
```

In [108]:

```
print(confusion_matrix(valid_Y, predictions.round()))
print(classification_report(valid_Y, predictions.round()))
print(accuracy_score(valid_Y, predictions.round()))
```

```
[[11001   743]
 [ 1115 10629]]
             precision    recall  f1-score   support

          0       0.91      0.94      0.92     11744
          1       0.93      0.91      0.92     11744

avg / total       0.92      0.92      0.92     23488

0.9208957765667575
```

In [ ]:

In [ ]:

In [ ]:

In [ ]:

In [ ]:

In [ ]: