# NLP_assignment 2

## Yogesh Kumar (c0852435)

In [1]:
```
# Read in and clean data
import nltk
import numpy as np
import pandas as pd
import re
from sklearn.model_selection import train_test_split
import string

stopwords = nltk.corpus.stopwords.words('english')

path=r'C:/Users/Yogi/Downloads/'

messages = pd.read_csv(path+'spam.csv', encoding='latin-1')
messages = messages.drop(labels = ["Unnamed: 2", "Unnamed: 3", "Unnamed: 4"], axis = 1)
messages.columns = ["label", "text"]
messages['label'] = np.where(messages['label']=='spam', 1, 0)


def clean_text(text):
    text = "".join([word.lower() for word in text if word not in string.punctuation])
    tokens = re.split('\W+', text)
    text = [word for word in tokens if word not in stopwords]
    return " ".join(text)

messages['clean_text'] = messages['text'].apply(lambda x: clean_text(x))
messages.head()

2.
# Split data into train and test set
X_train, X_test, y_train, y_test = train_test_split(messages['clean_text'],
                                                    messages['label'], test_size=0.2)

X_train.to_csv(path+'X_train.csv', index=False, header=True)
X_test.to_csv(path+'X_test.csv',index=False, header=True)
y_train.to_csv(path+'y_train.csv',index=False, header=True)
y_test.to_csv(path+'y_test.csv',index=False, header=True)
```

## Implementing TF_IDF on Random Forest Classifier

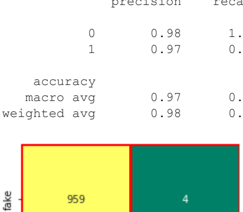
In [2]:
```
import pandas as pd
from sklearn.feature_extraction.text import TfidfVectorizer

tfidf_vect = TfidfVectorizer(analyzer=clean_text)
X_train_tf = tfidf_vect.fit_transform(X_train)
X_test_tf = tfidf_vect.transform(X_test)

print(X_train_tf)
print(tfidf_vect.get_feature_names())
print(X_test_tf.shape)
```

```
  (0, 12)	0.1305215467349456
  (0, 20)	0.23365117051855516
  (0, 11)	0.07811019208852882
  (0, 28)	0.08522129078428922
  (0, 17)	0.19403961573899664
  (0, 18)	0.0966270093375372
  (0, 30)	0.16015821047986506
  (0, 23)	0.19436439289921897
  (0, 14)	0.0956659857770686
  (0, 24)	0.1624279213243988
  (0, 31)	0.1015433601160494
  (0, 16)	0.1356621471009756
  (0, 15)	0.2997464826664797
  (0, 19)	0.16228036373342095
  (0, 0)	0.424115627507151
  (0, 29)	0.25321492731224543
  (0, 21)	0.3475688278006075
  (0, 25)	0.4786268869111465
  (0, 22)	0.17400706897799065
  (1, 26)	0.04302915389069457
  (1, 7)	0.09276490402987163
  (1, 6)	0.1728998119165411
  (1, 9)	0.08369949552655141
  (1, 1)	0.491689998291232
  (1, 13)	0.11488561434643722
  :	:
  (4455, 30)	0.38450713632640726
  (4455, 23)	0.07777153175973134
  (4455, 14)	0.22967448327981874
  (4455, 24)	0.32496354022255647
  (4455, 31)	0.08126161935792414
  (4455, 16)	0.32569709372624284
  (4455, 15)	0.29984585587972634
  (4455, 19)	0.1948009963216655
  (4455, 0)	0.5091074785221629
  (4455, 29)	0.06754636645033862
  (4455, 21)	0.09271574807430057
  (4455, 25)	0.06383807510767087
  (4455, 22)	0.2088777078390567
  (4456, 33)	0.26078134134777164
  (4456, 12)	0.2993581878103964
  (4456, 20)	0.5358915270001587
  (4456, 28)	0.19545961421875488
  (4456, 17)	0.22252014776154772
  (4456, 30)	0.18366573508959125
  (4456, 24)	0.3725371740822554
  (4456, 15)	0.17187117012143327
  (4456, 19)	0.18609937140532734
  (4456, 0)	0.16212200060530585
  (4456, 21)	0.2657226004251656
  (4456, 25)	0.36591883635891814
[' ', '0', '1', '2', '3', '4', '5', '6', '7', '8', '9', 'a', 'b', 'c', 'd', 'e', 'f', 'g', 'h', 'i', 'j', 'k',
'l', 'm', 'n', 'o', 'p', 'q', 'r', 's', 't', 'u', 'v', 'w', 'x', 'y', 'z', 'ª', '¼', 'á', 'â', 'ä', 'å', 'è',
'ì', 'ï', 'ð', 'ò', 'ó', 'ô', 'õ', 'ö', 'û']
(1115, 53)
```

In [3]:
```
from sklearn.ensemble import RandomForestClassifier

model = RandomForestClassifier(n_estimators=100, criterion='entropy', random_state =0)
```

In [4]:
```
model.fit(X_train_tf, y_train)
pred=model.predict(X_test_tf)

from sklearn.metrics import precision_score, recall_score, confusion_matrix, classification_report, accuracy_sc
from sklearn.model_selection import cross_val_score

acc1=accuracy_score(y_test,pred)
pre1=precision_score(y_test,pred)

print("Accuracy Score :",acc1)
print("Precision Score :",pre1)

import seaborn as sns
sns.heatmap(confusion_matrix(y_test,pred),annot=True, cmap='summer', cbar=False, linewidths=3, linecolor='r', s

print(classification_report(y_test,pred))
```

```
Accuracy Score : 0.9757847533632287
Precision Score : 0.9699248120300752
              precision    recall  f1-score   support

           0       0.98      1.00      0.99       963
           1       0.97      0.85      0.91       152

    accuracy                           0.98      1115
   macro avg       0.97      0.92      0.95      1115
weighted avg       0.98      0.98      0.98      1115
```




## Implementing Word2vec on Random Forest Classifier

In [5]:
```
! pip install gensim
import gensim
from gensim.models import Word2Vec
w2v_model = gensim.models.Word2Vec(X_train,
                                   vector_size=100,
                                   window=5,
                                   min_count=2)

words = set(w2v_model.wv.index_to_key )
X_train_vect = np.array([np.array([w2v_model.wv[i] for i in ls if i in words])
                         for ls in X_train])
X_test_vect = np.array([np.array([w2v_model.wv[i] for i in ls if i in words])
                         for ls in X_test])
```

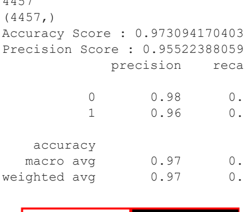
```
Requirement already satisfied: gensim in c:\users\yogi\anaconda3\lib\site-packages (4.2.0)
Requirement already satisfied: smart-open>=1.8.1 in c:\users\yogi\anaconda3\lib\site-packages (from gensim) (6.
0.0)
Requirement already satisfied: numpy>=1.17.0 in c:\users\yogi\anaconda3\lib\site-packages (from gensim) (1.20.
3)
Requirement already satisfied: Cython==0.29.28 in c:\users\yogi\anaconda3\lib\site-packages (from gensim) (0.2
9.28)
Requirement already satisfied: scipy>=0.18.1 in c:\users\yogi\anaconda3\lib\site-packages (from gensim) (1.7.1)
C:\Users\Yogi\AppData\Local\Temp/ipykernel_37152/1448500749.py:10: VisibleDeprecationWarning: Creating an ndarr
ay from ragged nested sequences (which is a list-or-tuple of lists-or-tuples-or ndarrays with different lengths
or shapes) is deprecated. If you meant to do this, you must specify 'dtype=object' when creating the ndarray.
  X_train_vect = np.array([np.array([w2v_model.wv[i] for i in ls if i in words])
C:\Users\Yogi\AppData\Local\Temp/ipykernel_37152/1448500749.py:12: VisibleDeprecationWarning: Creating an ndarr
ay from ragged nested sequences (which is a list-or-tuple of lists-or-tuples-or ndarrays with different lengths
or shapes) is deprecated. If you meant to do this, you must specify 'dtype=object' when creating the ndarray.
  X_test_vect = np.array([np.array([w2v_model.wv[i] for i in ls if i in words])
```

In [6]:
```
#print(X_train_vect[0:10])
#print(X_test_vect[0:10])
X_train_vect_avg = []
for v in X_train_vect:
    if v.size:
        X_train_vect_avg.append(v.mean(axis=0))
    else:
        X_train_vect_avg.append(np.zeros(100, dtype=float))

X_test_vect_avg = []
for v in X_test_vect:
    if v.size:
        X_test_vect_avg.append(v.mean(axis=0))
    else:
        X_test_vect_avg.append(np.zeros(100, dtype=float))

print(X_train_vect.shape)
```

```
(4457,)
```

In [7]:
```
model_rf = RandomForestClassifier()
model_rf.fit(X_train_vect_avg,y_train.values.ravel())
pred=model_rf.predict(X_test_vect_avg)

print(len(X_train_vect_avg))
print(y_train.values.ravel().shape)

from sklearn.metrics import precision_score, recall_score, confusion_matrix, classification_report, accuracy_sc
from sklearn.model_selection import cross_val_score

acc2=accuracy_score(y_test,pred)
pre2=precision_score(y_test,pred)

print("Accuracy Score :",acc2)
print("Precision Score :",pre2)

import seaborn as sns
sns.heatmap(confusion_matrix(y_test,pred),annot=True, cmap='CMRmap', cbar=False, linewidths=3, linecolor='r', s

print(classification_report(y_test,pred))
```

```
4457
(4457,)
Accuracy Score : 0.9730941704035875
Precision Score : 0.9552238805970149
              precision    recall  f1-score   support

           0       0.98      0.99      0.98       963
           1       0.96      0.84      0.90       152

    accuracy                           0.97      1115
   macro avg       0.97      0.92      0.94      1115
weighted avg       0.97      0.97      0.97      1115
```




## Implementing doc2vec on Random Forest Classifier

In [8]:
```
tagged_docs = [gensim.models.doc2vec.TaggedDocument(v, [i]) for i, v in enumerate(X_train)]


tagged_docs[0]

d2v_model = gensim.models.Doc2Vec(tagged_docs,
                                  vector_size=100,
                                   window=5,
                                   min_count=2)

print(X_train[0:10])
X_train_doc=[]
for i in X_train:
        X_train_doc.append(i.split(" "))

print(X_train_doc[0:10])

print(X_test[0:10])
X_test_doc=[]
for i in X_test:
        X_test_doc.append(i.split(" "))

print(X_test_doc[0:10])
```

```
3372          looks like found something smoke great job
2819     interflora åòits late order interflora flowers...
2258     sad story man last week bday wife didnt wish p...
1889                         gotta collect da car 6 lei
2122                                        know result
2937      hey ive booked pilates yoga lesson already haha
978                            hey pay salary de ltgt
3402            good night dear sleepwellamptake care
2230     hey thk juz go accordin wat discussed yest lor...
502                                    check nuerologist
Name: clean_text, dtype: object
[['looks', 'like', 'found', 'something', 'smoke', 'great', 'job'], ['interflora', 'åòits', 'late', 'order', 'in
terflora', 'flowers', 'christmas', 'call', '0800', '505060', 'place', 'order', 'midnight', 'tomorrow'], ['sad',
'story', 'man', 'last', 'week', 'bday', 'wife', 'didnt', 'wish', 'parents', 'forgot', 'n', 'kids', 'went', 'wor
k', 'even', 'colleagues', 'wish'], ['gotta', 'collect', 'da', 'car', '6', 'lei'], ['know', 'result'], ['hey',
'ive', 'booked', 'pilates', 'yoga', 'lesson', 'already', 'haha'], ['hey', 'pay', 'salary', 'de', 'ltgt', ''],
['good', 'night', 'dear', 'sleepwellamptake', 'care'], ['hey', 'thk', 'juz', 'go', 'accordin', 'wat', 'discusse
d', 'yest', 'lor', 'except', 'kb', 'sun', 'cos', 'theres', 'nt', 'much', 'lesson', 'go', 'attend', 'kb', 'sa
t'], ['check', 'nuerologist']]
3077                            okay thought expert
1625     hi dear call urgnt dont know whats problem don...
2355     hello love went day alright think sweet send j...
1122                      okok okthenwhats ur todays plan
1939     people dogging area call 09090204448 join like...
855      talk sexy make new friends fall love worlds di...
2500                          remember ask alex pizza
5372                      ok problem u frm wats matter
4275                         please send auntys number
1048     walked hour 2 c u doesnåõt show care wont u be...
Name: clean_text, dtype: object
[['okay', 'thought', 'expert'], ['hi', 'dear', 'call', 'urgnt', 'dont', 'know', 'whats', 'problem', 'dont', 'wa
nt', 'work', 'problem', 'least', 'tell', 'wating', 'reply'], ['hello', 'love', 'went', 'day', 'alright', 'thin
k', 'sweet', 'send', 'jolt', 'heart', 'remind', 'love', 'hear', 'screamed', 'across', 'sea', 'world', 'hear',
'ahmad', 'al', 'hallaq', 'loved', 'owned', 'possessive', 'passionate', 'kiss'], ['okok', 'okthenwhats', 'ur',
'todays', 'plan'], ['people', 'dogging', 'area', 'call', '09090204448', 'join', 'like', 'minded', 'guys', 'arra
nge', '1', 'theres', '1', 'evening', 'aå', '150', 'minapn', 'ls278bb'], ['talk', 'sexy', 'make', 'new', 'friend
s', 'fall', 'love', 'worlds', 'discreet', 'text', 'dating', 'service', 'text', 'vip', '83110', 'see', 'could',
'meet'], ['remember', 'ask', 'alex', 'pizza'], ['ok', 'problem', 'u', 'frm', 'wats', 'matter'], ['please', 'sen
d', 'auntys', 'number'], ['walked', 'hour', '2', 'c', 'u', 'doesnåõt', 'show', 'care', 'wont', 'u', 'believe',
'im', 'serious']]
```

In [9]:
```
X_train_doc_vect = np.array([d2v_model.infer_vector(i) for i in X_train_doc])

X_test_doc_vect = np.array([d2v_model.infer_vector(i) for i in X_test_doc])

print(X_train_doc_vect[0:10])
X_train_doc_vect.shape

print(X_test_doc_vect[0:10])
X_test_doc_vect.shape
```

```
[[-1.97096705e-03  1.89116603e-04  1.79397408e-03  3.21650156e-03
  -1.46501960e-04 -4.86364868e-03 -4.69636079e-03 -3.78340040e-03
  -3.67069780e-03 -2.48226710e-03 -2.55713821e-03  4.99928882e-03
   1.45393785e-03  2.49507488e-03 -8.46061084e-05  1.94053049e-04
  -2.24484736e-03 -2.98719225e-03 -1.11764995e-03  9.15783632e-04
   5.61350571e-05 -2.47923145e-03 -4.22814535e-03  3.37808905e-03
  -3.72007908e-03 -1.03709043e-03 -2.93633156e-03  1.26775028e-03
   4.27068351e-03 -1.86327007e-03 -2.60812049e-05  1.33782264e-03
   2.73997779e-04 -1.25242467e-03 -2.45185802e-04  2.73799663e-03
  -3.74487112e-03 -3.61587713e-03 -1.93792314e-03 -1.31568883e-03
   1.00927532e-03 -4.34413878e-03 -4.64724423e-03 -3.27371527e-03
   1.73319574e-03 -1.56345638e-03 -4.06962034e-04  3.15540441e-04
  -1.19444553e-03  3.85201280e-03  1.28663599e-03  8.16088344e-04
  -1.99977588e-03 -6.78795550e-05  8.40884459e-04  4.44133859e-03
   3.19875544e-03  4.99354722e-03  3.08746821e-03 -1.38380169e-03
   2.69842218e-03  2.02928190e-04  4.55617253e-03 -4.31599608e-03
   2.12017301e-04  1.12942874e-03 -2.02006544e-03 -7.19274860e-04
   2.71455175e-03  2.34174542e-03  2.16660742e-03 -4.41146316e-03
  -3.60637973e-03 -3.19188298e-03  5.50605648e-04 -4.24018688e-03
  -3.21501610e-03  2.75668432e-03 -3.80394282e-03  4.51803859e-03
  -3.08856834e-03  2.92636757e-03  4.29136446e-03  3.78820952e-03
  -2.28936947e-03 -2.11889157e-03 -1.60276773e-03 -4.13687294e-03
   2.45422847e-03 -1.58591929e-03 -1.99517701e-03 -2.24435629e-04
   7.97715795e-04  2.43963534e-03 -3.11900978e-03 -4.57696337e-03
   3.55282542e-03  2.64127087e-03  4.60635824e-03  8.36285355e-04]
 [ 4.48413379e-03  2.44626397e-04  3.54981539e-03 -2.70133372e-03
   3.98495788e-04  2.73300940e-03  2.65656295e-03  3.28538008e-03
   2.68956600e-03  5.59385400e-04 -2.25706049e-03  9.59072728e-04
   1.53078558e-03  2.67903320e-03 -2.57783540e-04  3.11671267e-03
  -4.07306291e-03  4.43579489e-03 -1.17100810e-03  9.52193164e-04
   1.96281541e-03  4.26336052e-03  1.93470949e-03  2.98191677e-03
   2.87507894e-03  9.76170879e-04 -2.88352044e-03  3.21545545e-03
  -3.46912863e-03  2.40935269e-03 -4.48730728e-03  3.91324982e-03
   1.75873877e-03  4.26968513e-03 -1.31236797e-03 -3.13599175e-03
  -2.73311860e-03 -4.39819461e-03  6.75788498e-04  8.16345200e-05
  -2.28925981e-03 -4.98499442e-03 -3.76006449e-03 -1.49675133e-03
   5.80207095e-04  4.08831099e-03  1.82866934e-03  4.93304664e-03
  -3.51736974e-03  1.58695702e-03 -8.12330225e-04 -2.38086190e-03
  -4.82690339e-05  4.91506234e-03  3.83886811e-03  2.15272899e-04
  -3.57381883e-03  2.35990225e-03 -2.33425526e-03 -4.35061473e-03
  -3.59224528e-03 -1.67626445e-03  4.30664467e-03 -2.80259480e-03
  -1.67705445e-03 -3.14151775e-03 -3.81832127e-04  5.76865103e-04
  -1.20366097e-03 -3.53604276e-03  1.74811843e-03  3.12279235e-03
  -4.29844437e-03  3.98078607e-03 -3.93536920e-03 -3.08903167e-04
  -1.43758650e-03  3.12288874e-03  3.52566014e-03 -9.82839148e-04
   2.76797422e-04  3.34875216e-03 -4.40385100e-03  3.32460529e-03
  -2.58580752e-04  2.62086280e-03  2.07542768e-03  3.74424038e-03
   3.03011248e-03 -3.17586237e-03 -1.37094315e-03  2.98606465e-03
   3.98311438e-03 -4.39885352e-03  3.22064763e-04 -3.93010536e-03
  -2.44358298e-03  1.07752020e-03  1.43448648e-03  3.19932867e-03]
 [-1.50326053e-02  2.33720485e-02  4.27093245e-02 -8.67371820e-03
   7.62364944e-04 -8.38285591e-03  1.75248012e-02  3.87595929e-02
  -3.34964581e-02 -2.33036559e-02  1.23848682e-02 -2.45889686e-02
  -2.31660865e-02 -1.63986087e-02  2.74699666e-02 -1.07484013e-02
   2.91726645e-02  2.51875687e-02 -2.12938096e-02 -6.05102330e-02
   2.52604000e-02 -1.05914902e-02  5.48903719e-02 -4.09843512e-02
  -4.91047427e-02  3.47440019e-02 -4.91700508e-03 -1.36402398e-02
  -4.14595567e-03  1.68750789e-02  2.69708340e-03 -2.20290273e-02
   6.97579607e-03  1.70566812e-02 -1.46828629e-02  6.16768561e-03
  -2.78133806e-02  1.04409987e-02 -1.54850194e-02 -3.50269419e-03
   6.62003532e-03  8.48833937e-03 -5.52371750e-03  3.34543176e-02
  -8.95058736e-03  7.87579454e-03 -1.37616298e-04 -2.60825530e-02
   5.61093539e-03  1.62323210e-02  5.00275940e-03 -4.19090353e-02
   1.56034222e-02 -1.16800042e-02 -2.71011554e-02  1.83153385e-03
   2.82120355e-03 -1.64997764e-03  2.57056896e-02 -2.16343440e-02
  -1.02113904e-02  7.60074938e-03  3.93435322e-02 -1.95588712e-02
  -2.12915484e-02  4.90818806e-02  3.12895887e-02  4.00264859e-02
  -1.05817998e-02 -1.78802572e-02  4.26569395e-03  2.44223811e-02
   1.34106958e-02  4.46485840e-02  2.01959070e-02  2.80952770e-02
   4.94695269e-02 -4.48416872e-03 -2.29242779e-02 -2.82812249e-02
  -3.88493165e-02  2.21420005e-02  1.47683015e-02  1.27959643e-02
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 [-1.14243710e-02  4.08698246e-02  7.59659559e-02 -2.23000459e-02
  -2.02016048e-02 -2.81370636e-02  1.74839888e-02  6.35988638e-02
  -5.24329431e-02 -6.96849898e-02  1.57731511e-02 -4.10088636e-02
  -3.39860842e-02 -4.11406271e-02  6.60655200e-02 -1.44113451e-02
   4.27038707e-02  3.74182090e-02 -2.84840781e-02 -9.56150368e-02
   4.14373465e-02 -1.83257814e-02  5.95930330e-02 -6.04322627e-02
  -6.85705915e-02  4.19557504e-02 -1.85567327e-02 -2.23696157e-02
  -1.92271341e-02  1.13440948e-02  1.58242304e-02 -3.93442884e-02
   2.27016844e-02  2.52873451e-03 -1.49477962e-02  2.00738274e-02
  -2.43375413e-02  2.42335517e-02 -3.19421254e-02 -1.33402301e-02
   8.94114748e-02  1.59770325e-02 -1.07836127e-02  5.92442602e-02
  -1.23081803e-02 -7.51141878e-03 -1.30087445e-02 -3.64692919e-02
   3.18519701e-03  3.70854214e-02  8.18810053e-03 -5.05383462e-02
   1.13018733e-02 -3.53291780e-02 -4.98894416e-02  3.49357491e-03
   1.03191677e-02 -3.89416260e-03  4.60515954e-02 -4.54453416e-02
  -2.08020192e-02  2.25796290e-02  6.56830892e-02 -2.68713944e-02
  -3.09991445e-02  9.58280861e-02  4.29001153e-02  4.65281382e-02
  -1.99445207e-02 -3.48530896e-02  1.61293391e-02  4.27644327e-02
   1.67636462e-02  6.94420561e-02  4.06254418e-02  7.19528496e-02
   7.54765645e-02 -9.59256198e-03 -4.39969786e-02 -3.22896652e-02
  -8.13663006e-02  1.88639164e-02  3.19711268e-02  1.88643858e-02
   3.42357741e-03 -2.11408809e-02  4.39295694e-02 -7.45151984e-03
  -4.09549996e-02 -2.12903153e-02  3.12322434e-02  3.93284932e-02
  -2.55133188e-03  4.32699956e-02  4.50843126e-02  4.91437502e-02
   5.18986993e-02  1.74695998e-03  1.37147391e-02  5.25171086e-02]]
```
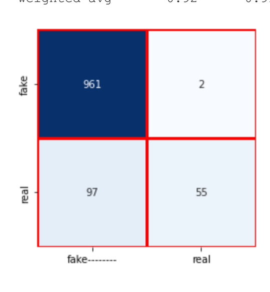

Out[9]:
```
(1115, 100)
```

In [10]:
```
model_doc_rf = RandomForestClassifier()
model_doc_rf.fit(X_train_doc_vect,y_train.values.ravel())
pred_doc_rf=model_doc_rf.predict(X_test_doc_vect)
```

In [11]:
```
print(pred_doc_rf.shape)
print(y_test.shape)
acc3=accuracy_score(y_test,pred_doc_rf)
pre3=precision_score(y_test,pred_doc_rf)

print("Accuracy Score :",acc3)
print("Precision Score :",pre3)

import seaborn as sns
sns.heatmap(confusion_matrix(y_test,pred_doc_rf),annot=True, cmap='Blues', cbar=False, linewidths=3, linecolor=

print(classification_report(y_test,pred_doc_rf))
```

```
(1115,)
(1115,)
Accuracy Score : 0.9112107623318386
Precision Score : 0.9649122807017544
              precision    recall  f1-score   support

           0       0.91      1.00      0.95       963
           1       0.96      0.36      0.53       152

    accuracy                           0.91      1115
   macro avg       0.94      0.68      0.74      1115
weighted avg       0.92      0.91      0.89      1115
```

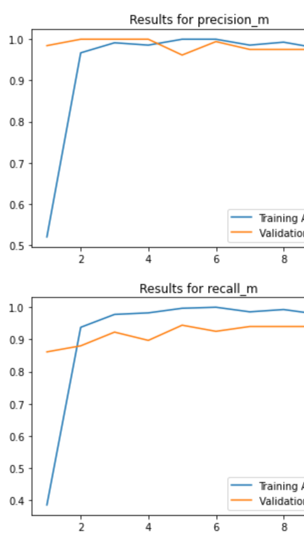


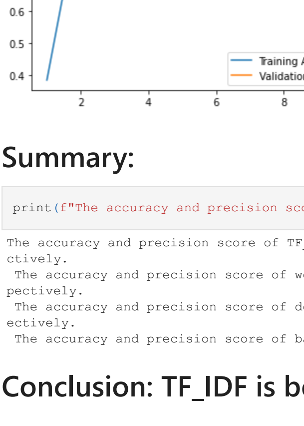

## Implementing Basic RNN

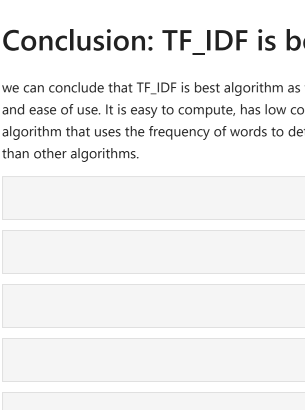
In [12]:

```python
!pip install -U keras

from keras.preprocessing.text import Tokenizer # simple pre-process function from genesis celan and tokenize ou
from keras.preprocessing.sequence import pad_sequences


tokenizer = Tokenizer()
tokenizer.fit_on_texts(X_train)


X_train_seq = tokenizer.texts_to_sequences(X_train)
X_test_seq = tokenizer.texts_to_sequences(X_test)

X_train_seq[0]


X_train_seq_padded = pad_sequences(X_train_seq, 50)
X_test_seq_padded = pad_sequences(X_test_seq, 50)


X_train_seq_padded[0]


import keras.backend as K
from keras.layers import Dense, Embedding, LSTM
from keras.models import Sequential

def recall_m(y_true, y_pred):
        true_positives = K.sum(K.round(K.clip(y_true * y_pred, 0, 1)))
        possible_positives = K.sum(K.round(K.clip(y_true, 0, 1)))
        recall = true_positives / (possible_positives + K.epsilon())
        return recall

def precision_m(y_true, y_pred):
        true_positives = K.sum(K.round(K.clip(y_true * y_pred, 0, 1)))
        predicted_positives = K.sum(K.round(K.clip(y_pred, 0, 1)))
        precision = true_positives / (predicted_positives + K.epsilon())
        return precision

# Construct a simple RNN model
model = Sequential()
model.add(Embedding(len(tokenizer.index_word)+1, 32))
model.add(LSTM(32, dropout=0, recurrent_dropout=0))
model.add(Dense(32, activation='relu'))
model.add(Dense(1, activation='sigmoid'))
model.summary()


model.compile(optimizer='adam',
              loss='binary_crossentropy',
              metrics=['accuracy', precision_m, recall_m])

11.
# Fit the RNN model
history = model.fit(X_train_seq_padded, y_train,
                    batch_size=32, epochs=10,
                    validation_data=(X_test_seq_padded, y_test))

12.

# Plot the evaluation metrics by each epoch for the model to see if we are over or underfitting
import matplotlib.pyplot as plt

for i in ['accuracy', 'precision_m', 'recall_m']:
    acc = history.history[i]
    val_acc = history.history['val_{}'.format(i)]
    epochs = range(1, len(acc) + 1)

    plt.figure()
    plt.plot(epochs, acc, label='Training Accuracy')
    plt.plot(epochs, val_acc, label='Validation Accuracy')
    plt.title('Results for {}'.format(i))
    plt.legend()
    plt.show()
```

```
Requirement already satisfied: keras in c:\users\yogi\anaconda3\lib\site-packages (2.9.0)
Model: "sequential"
_________________________________________________________________
 Layer (type)                Output Shape              Param #
=================================================================
 embedding (Embedding)       (None, None, 32)          265888

 lstm (LSTM)                 (None, 32)                8320

 dense (Dense)               (None, 32)                1056

 dense_1 (Dense)             (None, 1)                 33

=================================================================
Total params: 275,297
Trainable params: 275,297
Non-trainable params: 0
_________________________________________________________________
Epoch 1/10
140/140 [==============================] - 5s 23ms/step - loss: 0.2648 - accuracy: 0.9172 - precision_m: 0.5200
- recall_m: 0.3856 - val_loss: 0.0959 - val_accuracy: 0.9776 - val_precision_m: 0.9845 - val_recall_m: 0.8613
Epoch 2/10
140/140 [==============================] - 3s 21ms/step - loss: 0.0369 - accuracy: 0.9910 - precision_m: 0.9670
- recall_m: 0.9376 - val_loss: 0.0598 - val_accuracy: 0.9830 - val_precision_m: 1.0000 - val_recall_m: 0.8801
Epoch 3/10
140/140 [==============================] - 3s 22ms/step - loss: 0.0113 - accuracy: 0.9973 - precision_m: 0.9914
- recall_m: 0.9777 - val_loss: 0.0677 - val_accuracy: 0.9874 - val_precision_m: 1.0000 - val_recall_m: 0.9227
Epoch 4/10
140/140 [==============================] - 3s 21ms/step - loss: 0.0034 - accuracy: 0.9996 - precision_m: 0.9857
- recall_m: 0.9825 - val_loss: 0.0746 - val_accuracy: 0.9839 - val_precision_m: 1.0000 - val_recall_m: 0.8970
Epoch 5/10
140/140 [==============================] - 3s 25ms/step - loss: 0.0017 - accuracy: 0.9996 - precision_m: 1.0000
- recall_m: 0.9968 - val_loss: 0.0528 - val_accuracy: 0.9874 - val_precision_m: 0.9616 - val_recall_m: 0.9442
Epoch 6/10
140/140 [==============================] - 3s 24ms/step - loss: 4.3904e-04 - accuracy: 1.0000 - precision_m: 1.
0000 - recall_m: 1.0000 - val_loss: 0.0695 - val_accuracy: 0.9874 - val_precision_m: 0.9943 - val_recall_m: 0.9
251
Epoch 7/10
140/140 [==============================] - 3s 23ms/step - loss: 1.5941e-04 - accuracy: 1.0000 - precision_m: 0.
9857 - recall_m: 0.9857 - val_loss: 0.0645 - val_accuracy: 0.9883 - val_precision_m: 0.9752 - val_recall_m: 0.9
401
Epoch 8/10
140/140 [==============================] - 3s 20ms/step - loss: 9.9409e-05 - accuracy: 1.0000 - precision_m: 0.
9929 - recall_m: 0.9929 - val_loss: 0.0676 - val_accuracy: 0.9883 - val_precision_m: 0.9752 - val_recall_m: 0.9
401
Epoch 9/10
140/140 [==============================] - 3s 19ms/step - loss: 6.9337e-05 - accuracy: 1.0000 - precision_m: 0.
9786 - recall_m: 0.9786 - val_loss: 0.0705 - val_accuracy: 0.9883 - val_precision_m: 0.9752 - val_recall_m: 0.9
401
Epoch 10/10
140/140 [==============================] - 3s 21ms/step - loss: 5.1763e-05 - accuracy: 1.0000 - precision_m: 0.
9714 - recall_m: 0.9714 - val_loss: 0.0726 - val_accuracy: 0.9883 - val_precision_m: 0.9752 - val_recall_m: 0.9
401
```




## Summary:

In [13]:

```python
print(f"The accuracy and precision score of TF_IDF on Random forest are {acc1} and {pre1} respectively.\n The a
```

```
The accuracy and precision score of TF_IDF on Random forest are 0.9757847533632287 and 0.9699248120300752 respe
ctively.
 The accuracy and precision score of word2vec on Random forest is 0.9730941704035875 and 0.9552238805970149 res
pectively.
 The accuracy and precision score of doc2vec on Random forest is 0.9112107623318386 and 0.9649122807017544 resp
ectively.
 The accuracy and precision score of basic RNN  is 0.9208761274814605 and 0.9786 respectively.
```

## Conclusion: TF_IDF is best technique

we can conclude that TF_IDF is best algorithm as we can see accuracy is more than other models. The advantage of TF-IDF is its simplicity and ease of use. It is easy to compute, has low computational cost, and is an easy starting point for similarity computation. TF-IDF is a algorithm that uses the frequency of words to determine how relevant those words are to a particular document. This is a relatively simple than other algorithms.

In [ ]:

In [ ]:

In [ ]:

In [ ]:

In [ ]: