RelevanceDetector

April 25, 2021

[137]:

```
import os
import sys
os.environ['TRANSFORMERS_CACHE'] = '/projectnb/cs505/mahirp/cache'
os.environ['PREFIX_PATH']="/projectnb/cs505/mahirp/python"
os.environ['TFHUB_CACHE_DIR']='/projectnb/cs505/mahirp/tfcache'
sys.path.append('/projectnb/cs505/mahirp/python/bin')
sys.path.append('/projectnb/cs505/mahirp/cache')
sys.path.append('/projectnb/cs505/mahirp/tfcache')
sys.path.append('/projectnb/cs505/mahirp/usr/bin')
```

[ ]:

```
!pip install --ignore-installed --prefix=$PREFIX_PATH transformers sklearn
```

[2]:

```
from transformers import pipeline, set_seed
import re
import pandas as pd
import tensorflow_hub as hub
from datetime import datetime
from sklearn.metrics.pairwise import cosine_similarity
import random
import tensorflow as tf
import matplotlib.pyplot as plt
%matplotlib inline
tf.device('/GPU:0')
import numpy as np
import nltk
nltk.data.path.append("/projectnb/cs505/mahirp/nltk/")
from nltk.corpus import stopwords
from nltk.tokenize import word_tokenize
loadFromFile=False

prepend=datetime.now().strftime("%m-%d-%Y-%H-%M-%S-")

stop_words = set(stopwords.words('english'))
```

[3]:

```
useGlove=True
if useGlove:
    embeddings_index = {}
    f = open('glove.42B.300d.txt')
    for line in f:
        values = line.split()
        word = values[0]
        coefs = np.asarray(values[1:], dtype='float32')
        embeddings_index[word] = coefs
    f.close()
    print('Found %s word vectors.' % len(embeddings_index))
```

```
Found 1917494 word vectors.
```

[18]:

```
prepend=datetime.now().strftime("%m-%d-%Y-%H-%M-%S-")
dataset = pd.read_excel('CS505-gunviolence/GVFC_AnnotatedHeadlines.xlsx',␣
 ↪index_col=0)
if not loadFromFile:
    true=dataset[dataset['V3relevance']==1]
    false=dataset[dataset['V3relevance']==0]
    trainDataset=true.sample(frac=0.7)
    testDataset=true.drop(trainDataset.index)
    ftrainDataset=false.sample(frac=0.7)
    ftestDataset=false.drop(ftrainDataset.index)
    trainDataset=trainDataset.append(ftrainDataset).sample(frac=1)
    testDataset=testDataset.append(ftestDataset).sample(frac=1)
    indices=np.array(trainDataset.index)
    np.save(open('train_indices.npy','wb'),indices)
else:
    print('loaded from storage')
    indices=np.load(open('train_indices.npy','rb'))
    trainDataset=dataset.iloc[indices]
    testDataset=dataset.drop(indices)
print(len(trainDataset))
print(len(testDataset))
```

```
910
390
```

[22]:

```
len(testDataset)
```

[22]: 390

[4]:

```
# embed = hub.load("https://tfhub.dev/google/universal-sentence-encoder-large/5")
embed = hub.load("https://tfhub.dev/google/universal-sentence-encoder/4")
generator = pipeline('text-generation', model='gpt2',device=0)
tokenizer=generator.tokenizer
```

```
INFO:absl:Using /projectnb/cs505/mahirp/tfcache to cache modules.
All model checkpoint layers were used when initializing TFGPT2LMHeadModel.

All the layers of TFGPT2LMHeadModel were initialized from the model checkpoint
at gpt2.
```

```
If your task is similar to the task the model of the checkpoint was trained on,
you can already use TFGPT2LMHeadModel for predictions without further training.
```

[5]:

```
def generateDataset(dataset,isTest=False):
    df = pd.DataFrame(columns=['original','headline','generated','relevant'])
    c=0
    gen_seq=3 if not isTest else 1
    for original,headline,caption,relevant in␣
 ↪zip(dataset['whole_text'],dataset['news_title'],dataset['generated_caption_of_lead_image'],da
 ↪
        set_seed(random.randint(1,1000))
        print("{}/{}".format(c,len(dataset)))
        c+=1
        text=generator(caption.lower(), max_length=min(100,len(original)),␣
 ↪num_return_sequences=gen_seq)
        headLineText=generator(headline.
 ↪lower(),max_length=min(100,len(original)),num_return_sequences=gen_seq)
        for t,h in zip(text,headLineText):
          df=df.append({'original':original,'headline':
 ↪h['generated_text'],'generated': t['generated_text'],'relevant':
 ↪relevant},ignore_index = True)
    return df
```

[6]:

```
regexMap = { r"https?://[a-zA-Z0-9./]*": "", r"@[\w]*": " ", r"#[\w]*": "␣
 ↪",r"\n":" ",r"\\":" ",r"[^a-zA-Z\s]":"",r"[\s]+": " "}



def cleanData(text):
    text=text.strip()
    for regx in regexMap.keys():
        text = re.sub(regx, regexMap[regx], text)
    return text
```

[9]:

```
def getEmbeddings(text):
    global useGlove
    text=text.lower()
    if not useGlove:
        print('\rusing USE',end='')
        return embed([text]).numpy().astype(np.float)
    else:
        print('\rusing GLOVE',end='')
        embedding_matrix = np.zeros((1,512),dtype=np.float)
        tokens=word_tokenize(text)
        tokens=[word for word in tokens if word not in stop_words]
        cnt=0
        for i,word in enumerate(tokens):
            embedding_vector = embeddings_index.get(word)
            if embedding_vector is not None:
                cnt+=1
                embedding_vector = np.pad(embedding_vector, (0,212), 'constant')
                embedding_matrix = embedding_matrix +␣
 ↪((embedding_vector-embedding_matrix)/cnt)
        return embedding_matrix
```

[ ]:

```
prepend=datetime.now().strftime("%m-%d-%Y-%H-%M-%S-")
# trainDF = pd.read_csv('CS505-gunviolence/
 ↪04-25-2021-05-40-38-raw_train_relevanceDatasetV3.csv')
trainDF= generateDataset(trainDataset)
trainDF['generated']=list(map(cleanData,trainDF['generated']))
trainDF['headline']=list(map(cleanData,trainDF['headline']))
trainDF['original']=list(map(cleanData,trainDF['original']))
trainDF.to_csv('CS505-gunviolence/'+prepend+'raw_train_relevanceDatasetV3.
 ↪csv',index=False)
useGlove=False
prefix='_GLOVE_' if useGlove else '_USE_'
trainDF['generated']=list(map(getEmbeddings,trainDF['generated']))
print('done')
trainDF['headline']=list(map(getEmbeddings,trainDF['headline']))
print('done')
trainDF['original']=list(map(getEmbeddings,trainDF['original']))

trainDF.to_csv('CS505-gunviolence/'+prepend+prefix+'train_relevanceDatasetV3.
 ↪csv',index=False)
trainDF = pd.read_csv('CS505-gunviolence/'+prepend+'raw_train_relevanceDatasetV3.
 ↪csv'')
useGlove=True
prefix='_GLOVE_' if useGlove else '_USE_'
trainDF['generated']=list(map(getEmbeddings,trainDF['generated']))
print('done')
trainDF['headline']=list(map(getEmbeddings,trainDF['headline']))
print('done')
trainDF['original']=list(map(getEmbeddings,trainDF['original']))

trainDF.to_csv('CS505-gunviolence/'+prepend+prefix+'train_relevanceDatasetV3.
 ↪csv',index=False)
```

[ ]:

```
# testDF  = pd.read_csv('CS505-gunviolence/
 ↪04-25-2021-05-40-38-raw_test_relevanceDatasetV3.csv')
testDF=generateDataset(testDataset,True)
testDF['generated']=list(map(cleanData,testDF['generated']))
testDF['headline']=list(map(cleanData,testDF['headline']))
testDF['original']=list(map(cleanData,testDF['original']))
testDF.to_csv('CS505-gunviolence/'+prepend+'raw_test_relevanceDatasetV3.
 ↪csv',index=False)
```

```
useGlove=False
prefix='_GLOVE_' if useGlove else '_USE_'
testDF['generated']=list(map(getEmbeddings,testDF['generated']))
print('done')
testDF['headline']=list(map(getEmbeddings,testDF['headline']))
print('done')
testDF['original']=list(map(getEmbeddings,testDF['original']))
testDF.to_csv('CS505-gunviolence/'+prepend+prefix+'test_relevanceDatasetV3.
 ↪csv',index=False)
testDF  = pd.read_csv('CS505-gunviolence/'+prepend+'raw_test_relevanceDatasetV3.
 ↪csv')
useGlove=True
prefix='_GLOVE_' if useGlove else '_USE_'
testDF['generated']=list(map(getEmbeddings,testDF['generated']))
print('done')
testDF['headline']=list(map(getEmbeddings,testDF['headline']))
print('done')
testDF['original']=list(map(getEmbeddings,testDF['original']))
testDF.to_csv('CS505-gunviolence/'+prepend+prefix+'test_relevanceDatasetV3.
 ↪csv',index=False)
```

[79]:

```
def getEnsembleModel(embeddingDims=512):
    inp=tf.keras.Input(shape=(3,embeddingDims),name='embeddings')
    inp2=tf.keras.Input(shape=(3,embeddingDims),name='glove_embeddings')
    x=tf.keras.layers.Dense(256,activation='relu',kernel_regularizer=tf.keras.
 ↪regularizers.l2(l2=8e-6),name='features01')(inp)
    x=tf.keras.layers.Flatten()(x)
    x=tf.keras.layers.Dense(64,activation='relu',kernel_regularizer=tf.keras.
 ↪regularizers.l2(l2=8e-5),name='features')(x)
    x=tf.keras.layers.Dense(2,activation='softmax')(x)

    y=tf.keras.layers.
 ↪Dense(256,activation='relu',name='features02',kernel_regularizer=tf.keras.
 ↪regularizers.l2(l2=8e-6))(inp2)
    y=tf.keras.layers.Flatten()(y)
    y=tf.keras.layers.Dense(64,activation='relu',kernel_regularizer=tf.keras.
 ↪regularizers.l2(l2=8e-5),name='features2')(y)
    y=tf.keras.layers.Dense(2,activation='softmax')(y)
    z=tf.keras.layers.Average()([x, y])
    return tf.keras.Model([inp, inp2],z)

def getModel(embeddingDims=512,isGlove=False):
    if not isGlove:
        inp=tf.keras.Input(shape=(3,embeddingDims),name='embeddings')
    else:
        inp=tf.keras.Input(shape=(3,embeddingDims),name='glove_embeddings')
    x=tf.keras.layers.Dense(256,activation='relu',kernel_regularizer=tf.keras.
 ↪regularizers.l2(l2=2e-6),name='features0')(inp)
    x=tf.keras.layers.Flatten()(x)
    x=tf.keras.layers.Dense(64,activation='relu',kernel_regularizer=tf.keras.
 ↪regularizers.l2(l2=8e-5),name='features')(x)
    x=tf.keras.layers.Dense(2,activation='softmax')(x)
    return tf.keras.Model(inp,x)

def getAutoEncoder():
    inp = tf.keras.Input(shape=(512))
    x=tf.keras.layers.Flatten()(inp)
    x=tf.keras.layers.Dense(128)(x)
    x=tf.keras.layers.Dense(512)(x)
    return tf.keras.Model(inp,x)
```

[113]:

```
model=getModel()
gloveModel=getModel(isGlove=True)
ensembleModel=getEnsembleModel()
```

[105]:

```
model.summary()
gloveModel.summary()
ensembleModel.summary()
```

```
Model: "functional_55"
_________________________________________________________________
Layer (type)                 Output Shape              Param #
=================================================================
embeddings (InputLayer)      [(None, 3, 512)]          0
_________________________________________________________________
features0 (Dense)            (None, 3, 256)            131328
_________________________________________________________________
flatten_36 (Flatten)         (None, 768)               0
_________________________________________________________________
features (Dense)             (None, 64)                49216
_________________________________________________________________
dense_36 (Dense)             (None, 2)                 130
=================================================================
Total params: 180,674
Trainable params: 180,674
Non-trainable params: 0
_________________________________________________________________
Model: "functional_57"
_________________________________________________________________
Layer (type)                 Output Shape              Param #
=================================================================
glove_embeddings (InputLayer [(None, 3, 512)]          0
_________________________________________________________________
```

```
features0 (Dense)            (None, 3, 256)            131328
-----------------------------------------------------------------
flatten_37 (Flatten)         (None, 768)               0
-----------------------------------------------------------------
features (Dense)             (None, 64)                49216
-----------------------------------------------------------------
dense_37 (Dense)             (None, 2)                 130
=================================================================
Total params: 180,674
Trainable params: 180,674
Non-trainable params: 0
-----------------------------------------------------------------
Model: "functional_59"
--------------------------------------------------------------------------------
------------------
Layer (type)                    Output Shape         Param #     Connected to
================================================================================
==================
embeddings (InputLayer)         [(None, 3, 512)]     0
--------------------------------------------------------------------------------
------------------
glove_embeddings (InputLayer)   [(None, 3, 512)]     0
--------------------------------------------------------------------------------
------------------
features01 (Dense)              (None, 3, 256)       131328
embeddings[0][0]
--------------------------------------------------------------------------------
------------------
features02 (Dense)              (None, 3, 256)       131328
glove_embeddings[0][0]
--------------------------------------------------------------------------------
------------------
flatten_38 (Flatten)            (None, 768)          0
features01[0][0]
--------------------------------------------------------------------------------
------------------
flatten_39 (Flatten)            (None, 768)          0
features02[0][0]
--------------------------------------------------------------------------------
------------------
features (Dense)                (None, 64)           49216
flatten_38[0][0]
--------------------------------------------------------------------------------
------------------
features2 (Dense)               (None, 64)           49216
flatten_39[0][0]
--------------------------------------------------------------------------------
------------------
```

```
dense_38 (Dense)                (None, 2)            130         features[0][0]
________________________________________________________________________________
__________________
dense_39 (Dense)                (None, 2)            130         features2[0][0]
________________________________________________________________________________
__________________
average_9 (Average)             (None, 2)            0           dense_38[0][0]
                                                                 dense_39[0][0]
================================================================================
==================
Total params: 361,348
Trainable params: 361,348
Non-trainable params: 0
________________________________________________________________________________
__________________
```

[19]:
```
# df=pd.read_csv('CS505-gunviolence/'+prepend+'train_relevanceDatasetV3.csv')
# df = pd.read_csv('CS505-gunviolence/
 ↪04-19-2021-04-43-45-train_relevanceDatasetV3.csv')
df = pd.read_csv('CS505-gunviolence/
 ↪04-25-2021-04-41-28-_USE_train_relevanceDatasetV3.csv')
df2 = pd.read_csv('CS505-gunviolence/
 ↪04-25-2021-04-41-28-_GLOVE_train_relevanceDatasetV3.csv')
labels=df.pop('relevant')
```

[20]:
```
regexMap = { r"\n":" ",r"[\s]+": ",",r"\[,":"["}
```

[119]:
```
def generateNPDataset(dataframe):
    features=[]
    for index,data in dataframe.iterrows():
        c1=np.array(eval(cleanData(data['headline'])),dtype=np.float)
        c2=np.array(eval(cleanData(data['generated'])),dtype=np.float)
        c3=np.array(eval(cleanData(data['original'])),dtype=np.float)
#         features.append(c1.T@((c2+c3)/2))
        features.append(np.vstack((c1,c2,c3)))
    features=np.array(features,dtype=np.float)
    return features
```

[22]:
```
features=generateNPDataset(df)
```

[23]:
```
glove_features=generateNPDataset(df2)
```

[24]:
```
print(features.shape)
print(glove_features.shape)
```

```
(2730, 3, 512)
(2730, 3, 512)
```

[49]:
```
dataset = tf.data.Dataset.from_tensor_slices(({'embeddings':
 ↪features,'glove_embeddings':glove_features}, tf.keras.utils.
 ↪to_categorical(labels)))
```

[50]:
```
l=len(dataset)
dataset=dataset.shuffle(l+1).batch(16)
l=len(dataset)
train_set=dataset.take(int(l*0.75))
test_set=dataset.skip(int(l*0.75))
val_set=test_set.take(int(l*0.75*0.10))
test_set=test_set.skip(int(l*0.75*0.10))
print(len(test_set))
print(len(train_set))
print(len(val_set))
```

```
31
128
12
```

[ ]:
```
model.compile(optimizer=tf.keras.optimizers.Adam(lr=5e-5),
              loss=tf.keras.losses.CategoricalCrossentropy(from_logits=True),
              metrics=['accuracy'])
gloveModel.compile(optimizer=tf.keras.optimizers.Adam(lr=5e-5),
              loss=tf.keras.losses.CategoricalCrossentropy(from_logits=True),
              metrics=['accuracy'])
ensembleModel.compile(optimizer=tf.keras.optimizers.Adam(lr=5e-5),
              loss=tf.keras.losses.CategoricalCrossentropy(from_logits=True),
              metrics=['accuracy'])
history=model.fit(train_set,validation_data=val_set,epochs=8,shuffle=True)
history=ensembleModel.
 ↪fit(train_set,validation_data=val_set,epochs=10,shuffle=True)
history=gloveModel.fit(train_set,validation_data=val_set,epochs=7,shuffle=True)
```

[107]:
```
model.evaluate(test_set)
gloveModel.evaluate(test_set)
ensembleModel.evaluate(test_set)
```

```
31/31 [==============================] - 0s 1ms/step - loss: 0.6212 - accuracy:
0.7286
31/31 [==============================] - 0s 1ms/step - loss: 0.6629 - accuracy:
0.6429
31/31 [==============================] - 0s 1ms/step - loss: 0.6507 - accuracy:
0.6837
```

[107]:
```
[0.6507479548454285, 0.6836734414100647]
```

[118]:
```
model.save(prepend+'final_USE.h5')
gloveModel.save(prepend+'final_GLOVE.h5')
```

```
ensembleModel.save(prepend+'final_ENSEMBLE.h5')
```

[29]:

```
results={}
sampleCount=0
testDF = pd.read_csv('CS505-gunviolence/
 ↪04-25-2021-04-41-28-_USE_test_relevanceDatasetV3.csv')
testDF2= pd.read_csv('CS505-gunviolence/
 ↪04-25-2021-04-41-28-_GLOVE_test_relevanceDatasetV3.csv')
tfeatures=[]
tlabels=tf.keras.utils.to_categorical(testDF.pop('relevant'))
tfeatures=generateNPDataset(testDF)
tfeatures_glove=generateNPDataset(testDF2)
```

[30]:

```
print(tfeatures.shape)
test_dataset = tf.data.Dataset.from_tensor_slices(({'embeddings':
 ↪tfeatures,'glove_embeddings':tfeatures_glove}, tlabels)).batch(32)
```

```
(390, 3, 512)
```

[122]:

```
# test_input=np.array(test_input,dtype=np.float)
# test_label=np.array(test_label)
model.evaluate(test_dataset)
gloveModel.evaluate(test_dataset)
ensembleModel.evaluate(test_dataset)
```

```
13/13 [==============================] - 0s 1ms/step - loss: 0.6641 - accuracy:
0.6462
13/13 [==============================] - 0s 1ms/step - loss: 0.6707 - accuracy:
0.6051
13/13 [==============================] - 0s 2ms/step - loss: 0.6662 - accuracy:
0.6385
```

[122]:

```
[0.666168212890625, 0.6384615302085876]
```

[120]:

```
from sklearn.manifold import TSNE
def getIntermediate(model,layers):
    x=None
    for layer in layers:
        if x is None:
            x=model.get_layer(layer).output
        else:
            x=model.get_layer(layer)(x)
    return tf.keras.models.Model(inputs=model.input,outputs=x)

def getTSNEData(model,listOfLayers):
    intermediate_layer_model = getIntermediate(model,listOfLayers)
    predict = intermediate_layer_model.predict(test_dataset)
    tsne = TSNE(n_components=2, verbose=1,␣
 ↪random_state=42,n_jobs=16,method='exact')
    return tsne.fit_transform(predict)
```

[128]:

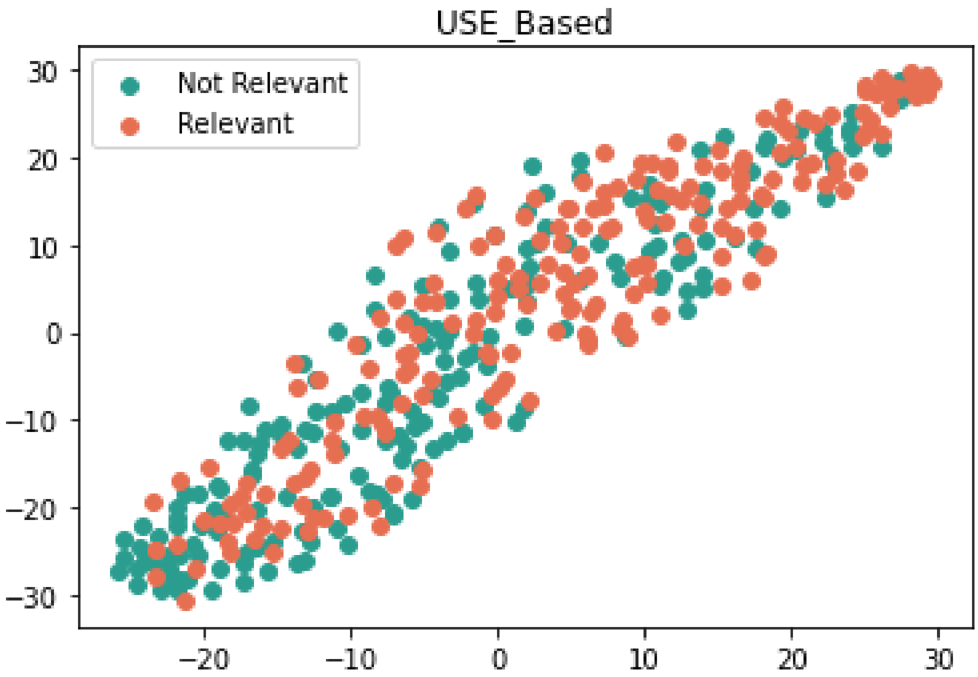
```
import matplotlib.pyplot as plt
%matplotlib inline
def plotTSNE(model,listOfLayers=['features']):
    z=getTSNEData(model,listOfLayers)
    classes = [1,0]
    label=['Relevant','Not Relevant']
    tsnedataset={}
    for c in classes:
        tsnedataset[c]=np.where(tlabels[:,0]==c)
    colors=['#e76f51','#2a9d8f','#1d3557','#a8dadc']
    for c in classes:
        plt.
 ↪scatter(z[tsnedataset[c],0],z[tsnedataset[c],1],c=colors[c],label=label[c])
    plt.legend(loc='best')
    plt.title(model.name)
    plt.show()
```

[132]:

```
model._name='USE_Based'
plotTSNE(model)
```

```
/share/pkg.7/tensorflow/2.3.1/install/lib/SCC/../python3.7/site-
packages/tensorflow/python/keras/engine/functional.py:543: UserWarning: Input
dict contained keys ['glove_embeddings'] which did not match any model input.
They will be ignored by the model.
  [n for n in tensors.keys() if n not in ref_input_names])
```

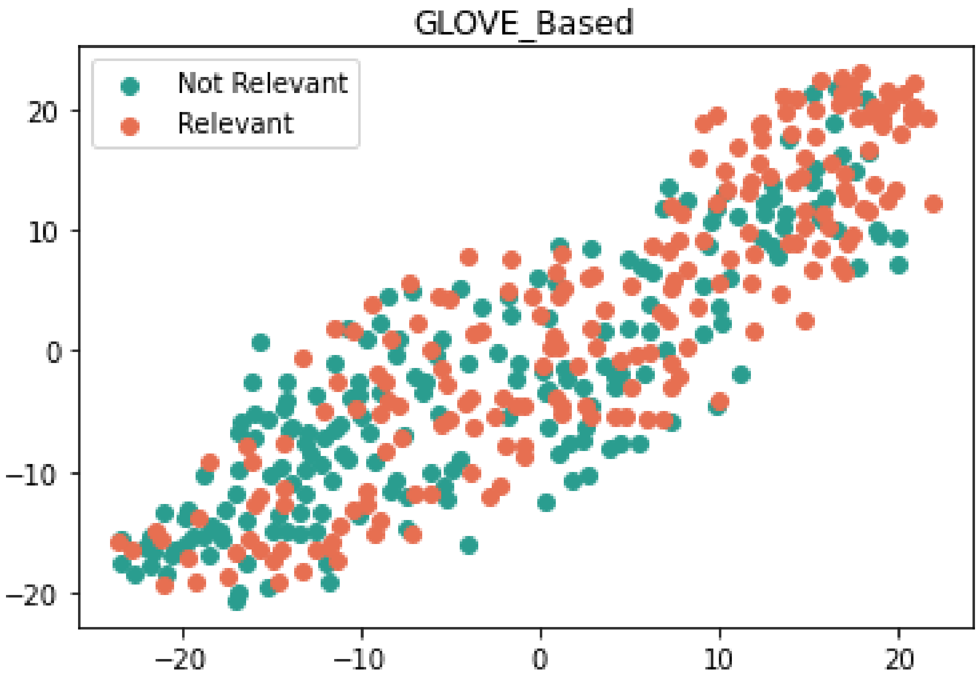
```
[t-SNE] Computing pairwise distances...
[t-SNE] Computed conditional probabilities for sample 390 / 390
[t-SNE] Mean sigma: 0.141848
[t-SNE] KL divergence after 250 iterations with early exaggeration: 64.503215
[t-SNE] KL divergence after 1000 iterations: 0.807066
```



```
[133]: gloveModel._name='GLOVE_Based'
       plotTSNE(gloveModel)
```

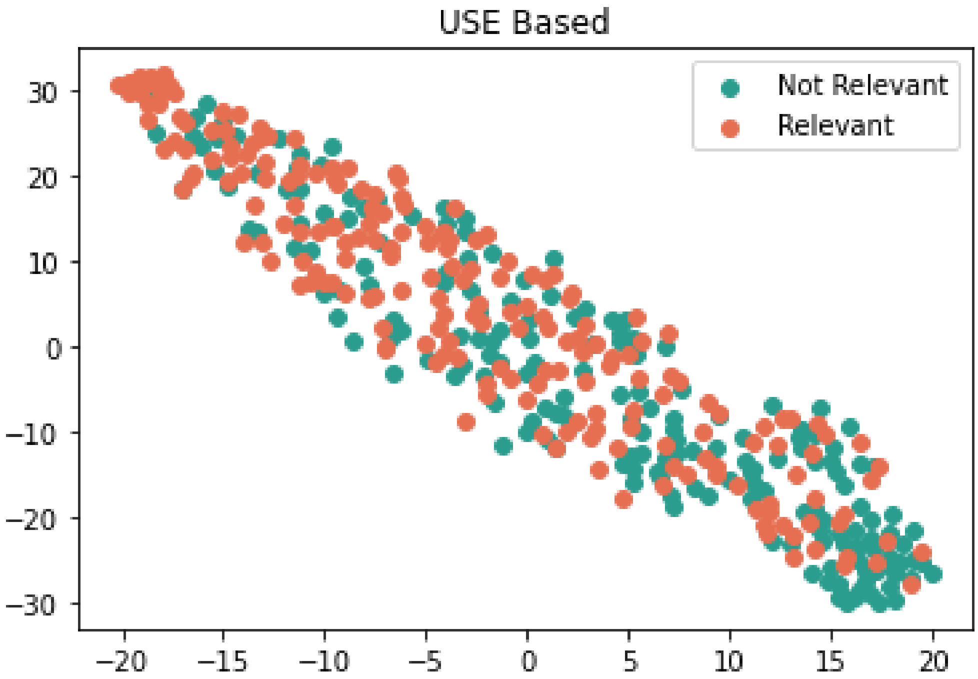
```
/share/pkg.7/tensorflow/2.3.1/install/lib/SCC/../python3.7/site-
packages/tensorflow/python/keras/engine/functional.py:543: UserWarning: Input
dict contained keys ['embeddings'] which did not match any model input. They
will be ignored by the model.
  [n for n in tensors.keys() if n not in ref_input_names])

[t-SNE] Computing pairwise distances...
[t-SNE] Computed conditional probabilities for sample 390 / 390
[t-SNE] Mean sigma: 0.179231
[t-SNE] KL divergence after 250 iterations with early exaggeration: 71.086230
[t-SNE] KL divergence after 1000 iterations: 0.913512
```

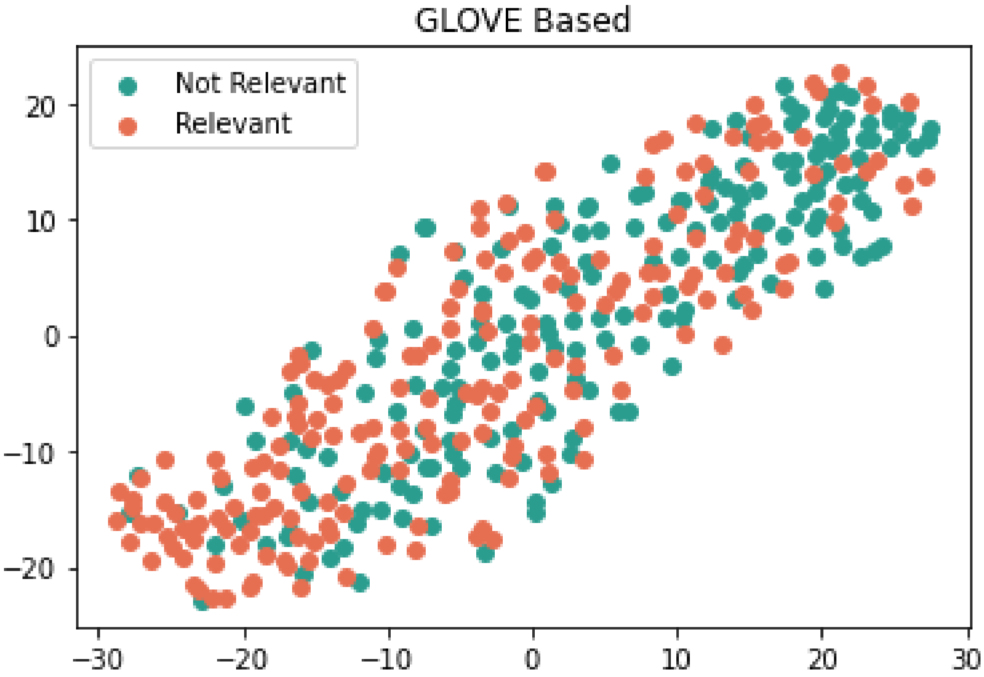


```
[134]: ensembleModel._name='USE Based'
       plotTSNE(ensembleModel)
       ensembleModel._name='GLOVE Based'
       plotTSNE(ensembleModel,['features2'])
```

```
[t-SNE] Computing pairwise distances...
[t-SNE] Computed conditional probabilities for sample 390 / 390
[t-SNE] Mean sigma: 0.160090
[t-SNE] KL divergence after 250 iterations with early exaggeration: 64.408855
[t-SNE] KL divergence after 1000 iterations: 0.698121
```



```
[t-SNE] Computing pairwise distances...
[t-SNE] Computed conditional probabilities for sample 390 / 390
[t-SNE] Mean sigma: 0.195384
[t-SNE] KL divergence after 250 iterations with early exaggeration: 66.365957
[t-SNE] KL divergence after 1000 iterations: 0.926434
```


GLOVE Based
Not Relevant
Relevant
20
10
0
−10
−20
−30
−20
−10
0
10
20
30