CSE7052 Natural Language Proccessing - Midterm Project

Nazım Anıl Tepe

At the beginning of the project, the below file-wise adjustments have been made on the dataset.

- The directory named "Yıldırım Bayazıt Üniversitesi json" was under the directory "Maltepe Üniversitesi Json" as a duplicate, has been removed.
- There was a redundant character "]" at line 12 in the file "İstanbul Hukuk Mecmuası 145.json" and it was breaking the JSON structure, character has been removed.
- The file "Ankara Üniversitesi 56.pdf.json" has been deleted because there was nothing in it.
- The file "Ankara Üniversitesi 218.pdf.json" has been deleted because there was insufficient data in it.
- The file "Ankara Üniversitesi 84.pdf.json" has been deleted because it was Spanish entirely.
- The file "Ankara Üniversitesi 86.pdf.json" has been deleted because it was Italian entirely.
- The file "Ankara Üniversitesi 216.pdf.json" had missing parts, has been completed from the original paper.
- The file "Ankara Üniversitesi 217.pdf.json" had missing parts, has been completed from the original paper.
- The file "Gazi Üniversitesi 6.pdf.json" had missing parts, has been completed from the original paper.
- In the file "İstanbul Hukuk Mecmuası 104.json", there was two separate keywords supposed to be combined ("madde" and "791"), they have been combined ("madde 791").

In [ ]:
```
import os
import json
import unicodedata
import pandas as pd
import numpy as np
import re
import warnings
warnings.filterwarnings("ignore")
import matplotlib.pyplot as plt
from sklearn.feature_extraction.text import CountVectorizer
from sklearn.feature_extraction.text import TfidfVectorizer
from sklearn import metrics
from sklearn.model_selection import KFold
from sklearn import preprocessing
from sklearn.multiclass import OneVsRestClassifier
from sklearn.linear_model import SGDClassifier
from sklearn.tree import DecisionTreeClassifier
```

```
from sklearn.multioutput import MultiOutputClassifier
from sklearn.linear_model import LogisticRegression
from sklearn.ensemble import RandomForestClassifier
from sklearn.naive_bayes import MultinomialNB
from sklearn.neural_network import MLPClassifier
from sklearn.decomposition import TruncatedSVD
import gensim
```

In [ ]:
```
json_data = []
for path, dirs, files in os.walk(f"./TrainingSet"):
    for file in files:
        if file.endswith(".json"):
            f = open(os.path.join(path, file), encoding="utf-8-sig")
            json_data.append(json.load(f))
            json_data[-1]["FileName"] = file
            f.close()
```

In [ ]:
```
CHAR_CONVERSION = {9:32,10:32,33:32,35:32,38:32,40:32,41:32,42:32,43:32,4
STRING_CONVERSION = {"$": "dolar","…": " ","ff": "ff","fi": "fi","fl ": "fl"
REGEX_CONVERSION = {r"cov[ı,i]d-*\s*19": "covid19",r"(\smd?\.?\s{0,2})((\
ABBREVIATIONS = {r"(^|\s)(smk)($|\s|\.)":r"\1sınai mülkiyet kanunu\3", r"
```

In [ ]:
```
sw_file = open('./stopwords.txt')
stop_words = sw_file.read()
stop_words = stop_words.split("\n")
sw_file.close()
```

In [ ]:
```
def clean_text(string, kw=False):
    for key in STRING_CONVERSION.keys():
        string = string.replace(key, STRING_CONVERSION[key])
    string = string.lower()
    result = []
    for char in string:
        if unicodedata.combining(char):
            try:
                result[-1] = chr(CHAR_CONVERSION[ord(char)][ord(result[-1
            except:
                continue
        elif ord(char) in CHAR_CONVERSION.keys():
            if CHAR_CONVERSION[ord(char)] != -1:
                result.append(chr(CHAR_CONVERSION[ord(char)]))
        elif ord(char) >= 942:
            continue
        else:
            result.append(char)
    result_str = ''.join(result)
    result_str = ' '.join([w for w in result_str.split(" ") if w != ""])
    for key in ABBREVIATIONS.keys():
        result_str = re.sub(key, ABBREVIATIONS[key], result_str)
    if kw:
        for key in REGEX_CONVERSION.keys():
            result_str = re.sub(key, REGEX_CONVERSION[key], result_str)
    return((result_str).strip())
```

In [ ]:
```
def clean_list(li, kw=False):
    clean_list = []
    for item in li:
        if len(item.split(",")) > 1:
```

```
            clean_list.extend([it for it in item.split(",") if it != ""])
        elif len(item.split(";")) > 1:
            clean_list.extend([it for it in item.split(";") if it != ""])
        else:
            clean_list.append(item)
    clean_list = [clean_text(text, kw) for text in clean_list if text !=
    if not kw:
        clean_str = ' '.join(clean_list)
        for key in REGEX_CONVERSION.keys():
            clean_str = re.sub(key, REGEX_CONVERSION[key], clean_str)
        clean_list = [part for part in clean_str.split(" ") if part != ""
        clean_list = [text for text in clean_list if text not in stop_wor
    if kw:
        clean_list = list(dict.fromkeys(clean_list))
    clean_list = [text for text in clean_list if text != ""]
    return clean_list
```

In [ ]:
```
for data_obj in json_data:
    data_obj["Metin"] = re.sub(r"[-\w\.]+@([-\w]+\.)+[-\w]{2,4}", "", dat
    data_obj["Metin"] = re.sub(r"https?:\/\/(?:www\.)?[-a-zA-Z0-9@:%._\+~
    data_obj["Metin"] = re.sub(r"<([a-z]+)(?![^>]*\/>)[^>]*>", "", data_o
```

In [ ]:
```
words = [(data_obj["FileName"], clean_list(data_obj["Metin"].split(" ")))
words = [(wtup[0], len(wtup[1]), wtup[1]) for wtup in words]
```

In [ ]:
```
keywords = [(data_obj["FileName"], clean_list(data_obj["Anahtar Kelimeler
keywords = [(kwtup[0], len(kwtup[1]), kwtup[1]) for kwtup in keywords]
```

In [ ]:
```
X = [wtup[2] for wtup in words]
y = [kwtup[2] for kwtup in keywords]
data = [[' '.join(words[i][2]), ','.join(keywords[i][2])] for i,_ in enum
df = pd.DataFrame(data, columns = ['text', 'tags'])
df.head()
```

Out[ ]:

	text	tags
0	anonim ortaklıkların amacı kime hizmet ettiği ...	menfaat sahipliği teorisi,insan sermayesi,takı...
1	uluslararası kamu hukuku devletlerin kimi zama...	ısrarlı itirazcı,itiraz,teamül hukuku,uluslara...
2	vesayet altındaki kişinin malvarlığının yöneti...	vesayet,vasi,vesayet makamı,vesayet altındaki ...
3	dolandırıcılık doğru davranma iyiniyet kuralla...	türk ceza kanunu,suç,ceza,hile,dolandırıcılık,...
4	türkiye 2019 yılının ilk altı ayında yaklaşık ...	gümrük,döviz,mülkiyet hakkı,idari para cezası,...

In [ ]:
```
df["tags_count"] = df["tags"].apply(lambda x: len(x.split(",")))
df["tags_count"].value_counts().head()
```

Out[ ]:
```
tags_count
5    451
4     89
6     75
3     41
7     26
Name: count, dtype: int64
```

As can be seen, the majority of the documents have 5 keywords.

In [ ]:
```
vec_count = CountVectorizer(tokenizer = lambda x: x.split(","))
tags_bow = vec_count.fit_transform(df['tags'])
tags_bow.shape
```

Out[ ]:
```
(717, 2905)
```

There are 2905 unique keywords (tags).

In [ ]:
```
tags = vec_count.get_feature_names_out()
tags_freq = tags_bow.sum(axis=0).A1
tags_count = dict(zip(tags, tags_freq))
tags[0:5]
```

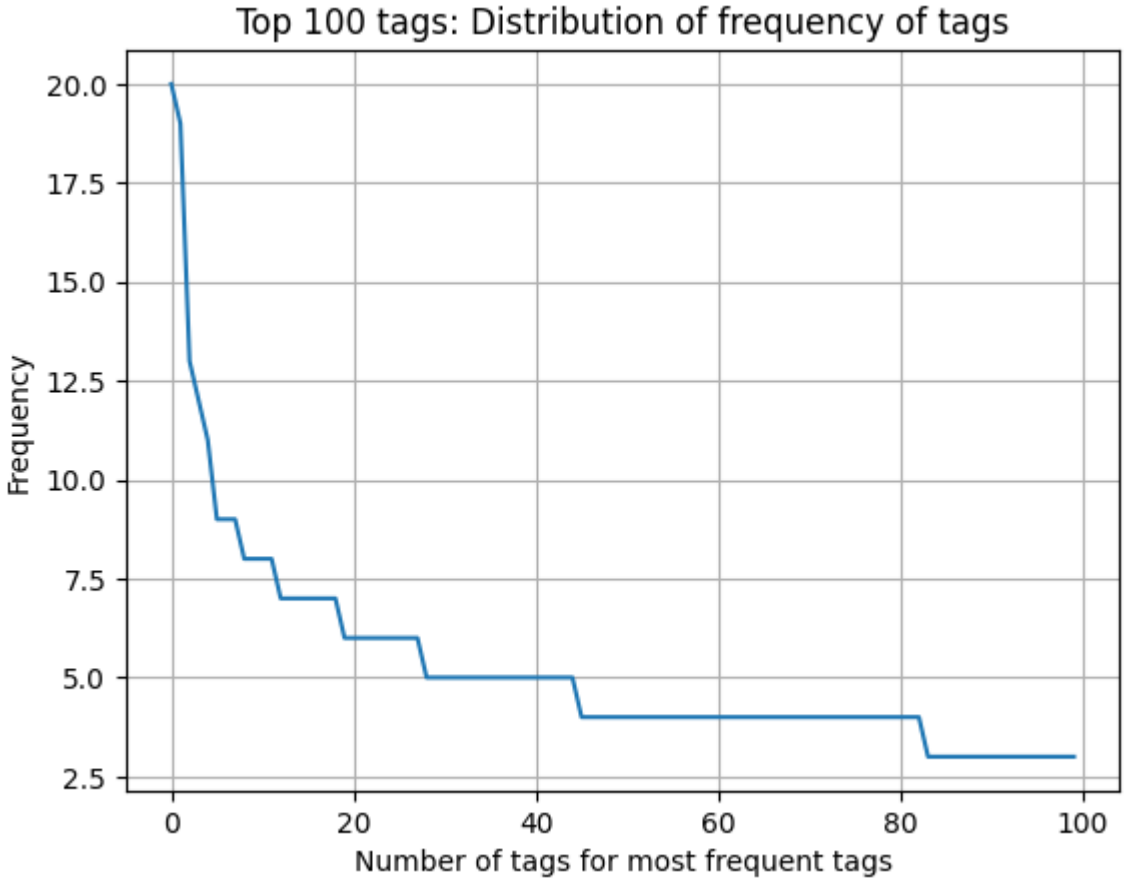
Out[ ]:
```
array(['12 aylık hoşgörü süresi',
       '1808 tarihli fransız ceza muhakemesi kanunu',
       '1855 ve 1884 fransız', '1858 ceza kanunu',
       '1864 ve 1871 osmanlı vilayet nizamnameleri'], dtype=object)
```

In [ ]:
```
tcount_list = []
for key, value in tags_count.items():
  tcount_list.append([key, value])
tcount_df = pd.DataFrame(tcount_list, columns=['tags', 'counts'])
tcount_df_sorted = tcount_df.sort_values(['counts'], ascending=False)
tcount_df_sorted.head()
```

Out[ ]:

	tags	counts
459	covid19	20
50	adil yargılanma hakkı	19
1757	mülkiyet hakkı	13
134	anayasa mahkemesi	12
132	anayasa	11

In [ ]:
```
plt.plot(tcount_df_sorted['counts'][0:100].values)
plt.grid()
plt.title("Top 100 tags: Distribution of frequency of tags")
plt.xlabel("Number of tags for most frequent tags")
plt.ylabel("Frequency")
plt.show()
```



In [ ]:
```
vec_binary = CountVectorizer(tokenizer = lambda x: x.split(","), binary=T
y_multilabel = vec_binary.fit_transform(df['tags'])
```

In [ ]:
```
df_tags = pd.DataFrame(df["tags"].apply(lambda x: x.split(",")).to_list()
df_tags_flat = pd.concat([df_tags[col] for col in df_tags])
df_tags_unique = df_tags_flat.unique()
```

In [ ]:
```
label_encoder = preprocessing.LabelEncoder()
label_encoder.fit(df_tags_unique)
y_encoded = np.array(df_tags.apply(lambda x: label_encoder.transform(x)))
```

In [ ]:
```
def binarize_encoding(row):
    a = label_encoder.inverse_transform(row)
    a = a[a != np.array(None)]
    a = np.unique(a)
    return sum(vec_binary.transform(a)).toarray()[0]
```

Approach 1

Logistic Regression with Dense Input Data (Word2Vec) & Label Encoded Multioutput Data

In [ ]:
```
VEC_SIZE = 200
vec_word2vec = gensim.models.Word2Vec(X, min_count = 1, vector_size = VEC
```

In [ ]:
```
X_np = np.zeros((len(X), VEC_SIZE))
for i, row in enumerate(X):
    for word in row:
```

```
            X_np[i] += vec_word2vec.wv[word]
        X_np[i] /= len(row)
```

In [ ]:
```
clf_logr = MultiOutputClassifier(LogisticRegression(solver='liblinear'))
```

In [ ]:
```
k = 10
kf = KFold(n_splits=k)

scores_logr = np.zeros((k, 6))
k_idx = 0
for train_index, test_index in kf.split(X_np, y_encoded):
    X_train, X_test = X_np[train_index, :], X_np[test_index, :]
    y_train, y_test = y_encoded[train_index], y_encoded[test_index]

    print("#", k_idx + 1, "Training:", X_train.shape, y_train.shape, "Tes

    clf_logr.fit(X_train, y_train)
    y_pred = clf_logr.predict(X_test)
    y_test_bin = np.array([binarize_encoding(row) for row in y_test])
    y_pred_bin = np.array([binarize_encoding(row) for row in y_pred])
    acc = metrics.accuracy_score(y_test_bin, y_pred_bin)
    prem = metrics.precision_score(y_test_bin, y_pred_bin, average = 'mic
    prew = metrics.precision_score(y_test_bin, y_pred_bin, average = 'wei
    recl = metrics.recall_score(y_test_bin, y_pred_bin, average = 'micro'
    mif1 = metrics.f1_score(y_test_bin, y_pred_bin, average = 'micro')
    maf1 = metrics.f1_score(y_test_bin, y_pred_bin, average = 'macro')
    scores_logr[k_idx,:] = np.array([acc, prem, prew, recl, mif1, maf1])
    k_idx += 1
```

```
# 1 Training: (645, 200) (645, 14) Test: (72, 200) (72, 14)
# 2 Training: (645, 200) (645, 14) Test: (72, 200) (72, 14)
# 3 Training: (645, 200) (645, 14) Test: (72, 200) (72, 14)
# 4 Training: (645, 200) (645, 14) Test: (72, 200) (72, 14)
# 5 Training: (645, 200) (645, 14) Test: (72, 200) (72, 14)
# 6 Training: (645, 200) (645, 14) Test: (72, 200) (72, 14)
# 7 Training: (645, 200) (645, 14) Test: (72, 200) (72, 14)
# 8 Training: (646, 200) (646, 14) Test: (71, 200) (71, 14)
# 9 Training: (646, 200) (646, 14) Test: (71, 200) (71, 14)
# 10 Training: (646, 200) (646, 14) Test: (71, 200) (71, 14)
```

In [ ]:
```
avg_scores_logr = scores_logr.mean(axis=0)
```

In [ ]:
```
print('Logistic Regression accuracy : {}'.format(avg_scores_logr[0]))
print('Logistic Regression micro precision : {}'.format(avg_scores_logr[1
print('Logistic Regression weighted precision : {}'.format(avg_scores_log
print('Logistic Regression recall : {}'.format(avg_scores_logr[3]))
print('Logistic Regression micro f1 : {}'.format(avg_scores_logr[4]))
print('Logistic Regression macro f1 : {}'.format(avg_scores_logr[5]))
```

```
Logistic Regression accuracy : 0.0
Logistic Regression micro precision : 0.08279088941754865
Logistic Regression weighted precision : 0.03668833693149239
Logistic Regression recall : 0.05125733295951951
Logistic Regression micro f1 : 0.06324559056969745
Logistic Regression macro f1 : 0.0040214003033178895
```

Approach 2

Multinomial Naive-Bayes with Sparse Input Data (TF-IDF) & Label Encoded Multioutput Data

In [ ]:
```
vec_tfidf = TfidfVectorizer(max_df=0.5, min_df=0.0009, max_features=10000
```

In [ ]:
```
clf_mnnb = MultiOutputClassifier(MultinomialNB(fit_prior=True, class_prio
```

In [ ]:
```
k = 10
kf = KFold(n_splits=k)

scores_mnnb = np.zeros((k, 6))
k_idx = 0
for train_index, test_index in kf.split(df, y_encoded):
    X_train, X_test = df.iloc[train_index, :], df.iloc[test_index, :]
    y_train, y_test = y_encoded[train_index], y_encoded[test_index]

    X_train_tfidf = vec_tfidf.fit_transform(X_train['text'])
    X_test_tfidf = vec_tfidf.transform(X_test['text'])

    print("#", k_idx + 1, "Training:", X_train_tfidf.shape, y_train.shape

    clf_mnnb.fit(X_train_tfidf, y_train)
    y_pred = clf_mnnb.predict(X_test_tfidf)
    y_test_bin = np.array([binarize_encoding(row) for row in y_test])
    y_pred_bin = np.array([binarize_encoding(row) for row in y_pred])
    acc = metrics.accuracy_score(y_test_bin, y_pred_bin)
    prem = metrics.precision_score(y_test_bin, y_pred_bin, average = 'mic
    prew = metrics.precision_score(y_test_bin, y_pred_bin, average = 'wei
    recl = metrics.recall_score(y_test_bin, y_pred_bin, average = 'micro'
    mif1 = metrics.f1_score(y_test_bin, y_pred_bin, average = 'micro')
    maf1 = metrics.f1_score(y_test_bin, y_pred_bin, average = 'macro')
    scores_mnnb[k_idx,:] = np.array([acc, prem, prew, recl, mif1, maf1])
    k_idx += 1
```

```
# 1 Training: (645, 100000) (645, 14) Test: (72, 100000) (72, 14)
# 2 Training: (645, 100000) (645, 14) Test: (72, 100000) (72, 14)
# 3 Training: (645, 100000) (645, 14) Test: (72, 100000) (72, 14)
# 4 Training: (645, 100000) (645, 14) Test: (72, 100000) (72, 14)
# 5 Training: (645, 100000) (645, 14) Test: (72, 100000) (72, 14)
# 6 Training: (645, 100000) (645, 14) Test: (72, 100000) (72, 14)
# 7 Training: (645, 100000) (645, 14) Test: (72, 100000) (72, 14)
# 8 Training: (646, 100000) (646, 14) Test: (71, 100000) (71, 14)
# 9 Training: (646, 100000) (646, 14) Test: (71, 100000) (71, 14)
# 10 Training: (646, 100000) (646, 14) Test: (71, 100000) (71, 14)
```

In [ ]:
```
avg_scores_mnnb = scores_mnnb.mean(axis=0)
```

In [ ]:
```
print('Naive Bayes accuracy : {}'.format(avg_scores_mnnb[0]))
print('Naive Bayes micro precision : {}'.format(avg_scores_mnnb[1]))
print('Naive Bayes weighted precision : {}'.format(avg_scores_mnnb[2]))
print('Naive Bayes recall : {}'.format(avg_scores_mnnb[3]))
print('Naive Bayes micro f1 : {}'.format(avg_scores_mnnb[4]))
print('Naive Bayes macro f1 : {}'.format(avg_scores_mnnb[5]))
```

```
Naive Bayes accuracy : 0.0
Naive Bayes micro precision : 0.032063530511370765
Naive Bayes weighted precision : 0.00807268125298313
Naive Bayes recall : 0.018021449190952606
Naive Bayes micro f1 : 0.023051387218976087
Naive Bayes macro f1 : 0.0006777351841988766
```

Approach 3

MLP Classifier with Dense Input Data (Word2Vec) & Label Encoded Multioutput Data

In [ ]:
```
clf_mlp = MultiOutputClassifier(MLPClassifier(hidden_layer_sizes=(100,2))
```

In [ ]:
```
k = 10
kf = KFold(n_splits=k)

scores_mlp = np.zeros((k, 6))
k_idx = 0
for train_index, test_index in kf.split(X_np, y_encoded):
    X_train, X_test = X_np[train_index, :], X_np[test_index, :]
    y_train, y_test = y_encoded[train_index], y_encoded[test_index]

    print("#", k_idx + 1, "Training:", X_train.shape, y_train.shape, "Tes

    clf_mlp.fit(X_train, y_train)
    y_pred = clf_mlp.predict(X_test)
    y_test_bin = np.array([binarize_encoding(row) for row in y_test])
    y_pred_bin = np.array([binarize_encoding(row) for row in y_pred])
    acc = metrics.accuracy_score(y_test_bin, y_pred_bin)
    prem = metrics.precision_score(y_test_bin, y_pred_bin, average = 'mic
    prew = metrics.precision_score(y_test_bin, y_pred_bin, average = 'wei
    recl = metrics.recall_score(y_test_bin, y_pred_bin, average = 'micro'
    mif1 = metrics.f1_score(y_test_bin, y_pred_bin, average = 'micro')
    maf1 = metrics.f1_score(y_test_bin, y_pred_bin, average = 'macro')
    scores_mlp[k_idx,:] = np.array([acc, prem, prew, recl, mif1, maf1])
    k_idx += 1
```

```
# 1 Training: (645, 200) (645, 14) Test: (72, 200) (72, 14)
# 2 Training: (645, 200) (645, 14) Test: (72, 200) (72, 14)
# 3 Training: (645, 200) (645, 14) Test: (72, 200) (72, 14)
# 4 Training: (645, 200) (645, 14) Test: (72, 200) (72, 14)
# 5 Training: (645, 200) (645, 14) Test: (72, 200) (72, 14)
# 6 Training: (645, 200) (645, 14) Test: (72, 200) (72, 14)
# 7 Training: (645, 200) (645, 14) Test: (72, 200) (72, 14)
# 8 Training: (646, 200) (646, 14) Test: (71, 200) (71, 14)
# 9 Training: (646, 200) (646, 14) Test: (71, 200) (71, 14)
# 10 Training: (646, 200) (646, 14) Test: (71, 200) (71, 14)
```

In [ ]:
```
avg_scores_mlp = scores_mlp.mean(axis=0)
```

In [ ]:
```
print('MLP accuracy : {}'.format(avg_scores_mlp[0]))
print('MLP micro precision : {}'.format(avg_scores_mlp[1]))
print('MLP weighted precision : {}'.format(avg_scores_mlp[2]))
print('MLP recall : {}'.format(avg_scores_mlp[3]))
print('MLP micro f1 : {}'.format(avg_scores_mlp[4]))
print('MLP macro f1 : {}'.format(avg_scores_mlp[5]))
```

```
MLP accuracy : 0.0
MLP micro precision : 0.010784580514448342
MLP weighted precision : 0.002174627202929247
MLP recall : 0.008367162760816987
MLP micro f1 : 0.009394495086904521
MLP macro f1 : 0.00017753788269273045
```

Approach 4

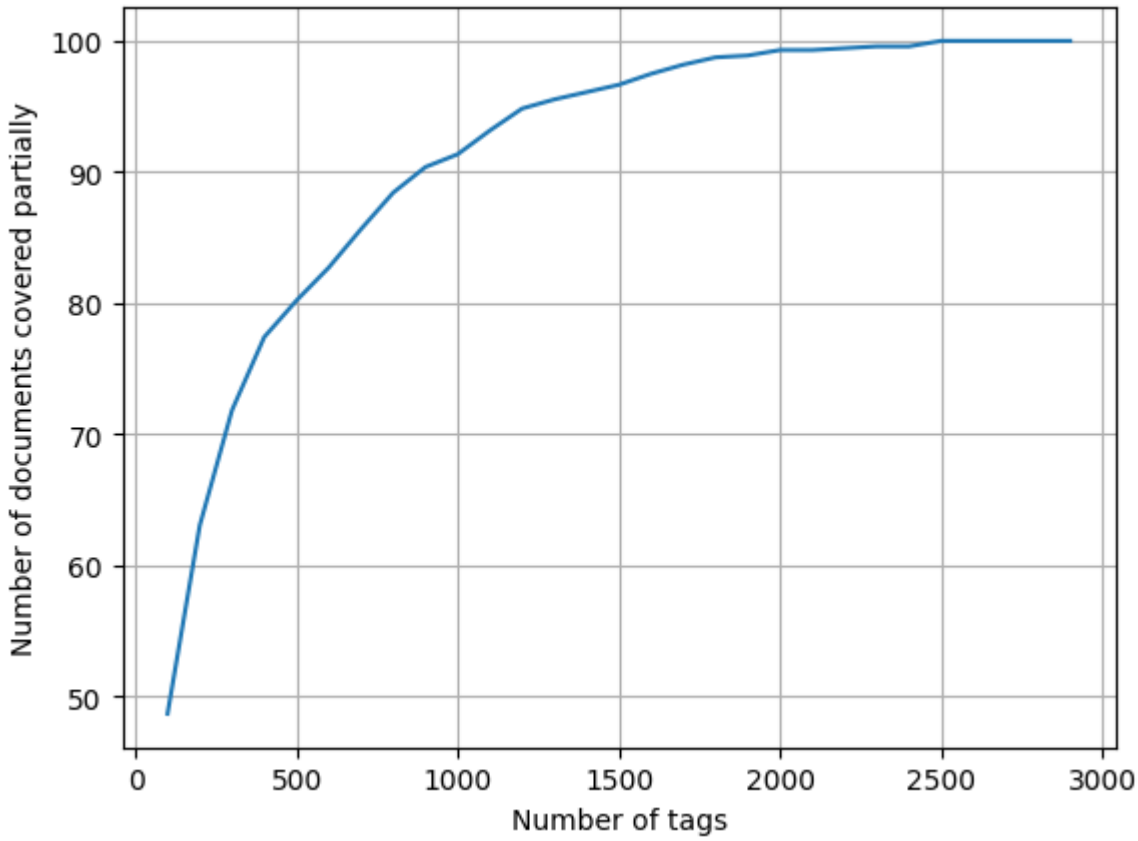
SGD Classifier with Sparse Input Data (TF-IDF) & Multilabel Binary Output Data with Reduced Class Size

In [ ]:
```
def tags_to_include(n):
    tags_sum = y_multilabel.sum(axis=0).tolist()[0]
    sorted_tags_i = sorted(range(len(tags_sum)), key=lambda i: tags_sum[i
    yn_multilabel = y_multilabel[:, sorted_tags_i[:n]]
    return yn_multilabel

def no_of_included_docs(n):
    yn_multilabel = tags_to_include(n)
    x = yn_multilabel.sum(axis=1)
    return (np.count_nonzero(x == 0))
```

In [ ]:
```
docs_included = []
tags_total = y_multilabel.shape[1]
docs_total = df.shape[0]
for i in range(100, tags_total, 100):
    docs_included.append(np.round(((docs_total - no_of_included_docs(i))
```

In [ ]:
```
plt.plot(np.arange(100, tags_total, 100), docs_included)
plt.xlabel("Number of tags")
plt.ylabel("Number of documents covered partially")
plt.grid()
plt.show()
print(f"%{docs_included[9]} of documents covered by 1000 tags")
print("Number of documents that are not covered by 1000 tags:", no_of_inc
```




```
%91.353 of documents covered by 1000 tags
Number of documents that are not covered by 1000 tags: 62 out of 717
```

In [ ]:
```
yn_multilabel = tags_to_include(1000)
print("Number of tags in the subset:", y_multilabel.shape[1])
print("Number of tags considered:", yn_multilabel.shape[1], f"(%{np.round
```

```
Number of tags in the subset: 2905
Number of tags considered: 1000 (%34.423)
```

In [ ]:
```
df['tags_reduced'] = [sum(yn_multilabel[i].toarray()[0]) for i in range(y
df_reduced = df[df['tags_reduced'] != 0]
yn_reduced = yn_multilabel[df['tags_reduced'] != 0]
print(df_reduced.shape[0], yn_reduced.shape)
```

```
655 (655, 1000)
```

In [ ]:
```
vec_tfidf = TfidfVectorizer(max_df=0.5, min_df=0.0009, max_features=20000
```

In [ ]:
```
clf_sgd = OneVsRestClassifier(SGDClassifier(loss='log_loss', alpha=0.0001
```

In [ ]:
```
k = 10
kf = KFold(n_splits=k)

scores_sgd = np.zeros((k, 6))
k_idx = 0
for train_index, test_index in kf.split(df_reduced, yn_reduced):
    X_train, X_test = df_reduced.iloc[train_index, :], df_reduced.iloc[te
    y_train, y_test = yn_reduced[train_index], yn_reduced[test_index]

    X_train_tfidf = vec_tfidf.fit_transform(X_train['text'])
    X_test_tfidf = vec_tfidf.transform(X_test['text'])

    print("#", k_idx + 1, "Training:", X_train_tfidf.shape, y_train.shape
```

```
    clf_sgd.fit(X_train_tfidf, y_train)
    y_pred = clf_sgd.predict(X_test_tfidf)
    acc = metrics.accuracy_score(y_test, y_pred)
    prem = metrics.precision_score(y_test, y_pred, average = 'micro')
    prew = metrics.precision_score(y_test, y_pred, average = 'weighted')
    recl = metrics.recall_score(y_test, y_pred, average = 'micro')
    mif1 = metrics.f1_score(y_test, y_pred, average = 'micro')
    maf1 = metrics.f1_score(y_test, y_pred, average = 'macro')
    scores_sgd[k_idx,:] = np.array([acc, prem, prew, recl, mif1, maf1])
    k_idx += 1
```

```
# 1 Training: (589, 200000) (589, 1000) Test: (66, 200000) (66, 1000)
# 2 Training: (589, 200000) (589, 1000) Test: (66, 200000) (66, 1000)
# 3 Training: (589, 200000) (589, 1000) Test: (66, 200000) (66, 1000)
# 4 Training: (589, 200000) (589, 1000) Test: (66, 200000) (66, 1000)
# 5 Training: (589, 200000) (589, 1000) Test: (66, 200000) (66, 1000)
# 6 Training: (590, 200000) (590, 1000) Test: (65, 200000) (65, 1000)
# 7 Training: (590, 200000) (590, 1000) Test: (65, 200000) (65, 1000)
# 8 Training: (590, 200000) (590, 1000) Test: (65, 200000) (65, 1000)
# 9 Training: (590, 200000) (590, 1000) Test: (65, 200000) (65, 1000)
# 10 Training: (590, 200000) (590, 1000) Test: (65, 200000) (65, 1000)
```

In [ ]:
```
avg_scores_sgd = scores_sgd.mean(axis=0)
```

In [ ]:
```
print('SGD Classifier accuracy : {}'.format(avg_scores_sgd[0]))
print('SGD Classifier micro precision : {}'.format(avg_scores_sgd[1]))
print('SGD Classifier weighted precision : {}'.format(avg_scores_sgd[2]))
print('SGD Classifier recall : {}'.format(avg_scores_sgd[3]))
print('SGD Classifier micro f1 : {}'.format(avg_scores_sgd[4]))
print('SGD Classifier macro f1 : {}'.format(avg_scores_sgd[5]))
```

```
SGD Classifier accuracy : 0.010675990675990676
SGD Classifier micro precision : 0.5944445750328102
SGD Classifier weighted precision : 0.07684619536187642
SGD Classifier recall : 0.06006835849953871
SGD Classifier micro f1 : 0.10801563378720018
SGD Classifier macro f1 : 0.008775238095238095
```