

Final Lab Evaluation

May 1, 2023

1 Lab Evaluation Details

1.1 Problem Statement

<https://www.kaggle.com/datasets/spsayakpaul/arxiv-paper-abstracts>

Download the above dataset and build a text classifier model that can predict the subject areas given paper abstracts and titles using latest NLP techniques taught to you. Show the use of word2vec and BERT especially here.

Extra 1 hour is given to write comments in your code and upload it. Proper commenting after each function or wherever seems fit should be done. Upload the pdf of your code here. Plag should not be more than 10.

1.2

2 Check if GPU is Connected

```
[ ]: !nvidia-smi
```

```
Mon May  1 23:54:56 2023
```

```
+-----+
| NVIDIA-SMI 530.30.02                  Driver Version: 530.30.02   CUDA Version: 12.1     |
+-----+-----+-----+
| GPU Name                               Persistence-M| Bus-Id        Disp.A | Volatile Uncorr. ECC |
| Fan  Temp  Perf    Pwr:Usage/Cap|      Memory-Usage | GPU-Util  Compute M. |
|====================================+==================+=====|
| 0  NVIDIA GeForce GTX 1650 Ti        On | 00000000:01:00.0 Off |           N/A       |
| N/A   53C    P0              18W /  50W|  783MiB /  4096MiB |      37% Default   |
+-----+-----+-----+
```

```

|
N/A |
+-----+-----+-----+
-----+

+-----+
-----+
| Processes:
|
| GPU    GI    CI          PID    Type    Process name                      GPU
Memory |
|        ID    ID
Usage   |
|=====
=====|
|    0    N/A  N/A        3155     G    /usr/lib/xorg/Xorg
316MiB |
|    0    N/A  N/A        3309     G    /usr/bin/gnome-shell
105MiB |
|    0    N/A  N/A        6249     G    x-terminal-emulator
8MiB |
|    0    N/A  N/A        6387     G    ...3926377,15061526928302148035,131072
175MiB |
|    0    N/A  N/A       13045     G    ...sion,SpareRendererForSitePerProcess
134MiB |
|    0    N/A  N/A       60912     G    ...,WinRetrieveSuggestionsOnlyOnDemand
38MiB |
+-----+
-----+

```

3 Import Required Libraries

```

[ ]: import pandas as pd
import numpy as np
import re

from gensim.models import Word2Vec

from sklearn.model_selection import train_test_split
from sklearn.metrics import precision_score
from sklearn.preprocessing import MultiLabelBinarizer
from sklearn.linear_model import LogisticRegression

import torch

from nltk import sent_tokenize, word_tokenize, PorterStemmer, WordNetLemmatizer
from nltk.corpus import stopwords

```

```
stopWords = set(stopwords.words('english'))
lemmatizer = WordNetLemmatizer()
```

```
/home/volt/.local/lib/python3.10/site-packages/scipy/__init__.py:146:
UserWarning: A NumPy version >=1.16.5 and <1.23.0 is required for this version
of SciPy (detected version 1.24.3
  warnings.warn(f"A NumPy version >={np_minversion} and <{np_maxversion}")
```

4 Import Data

```
[ ]: data = pd.read_csv(r'./data/arxiv_data.csv')
data
```

```
[ ]:
titles \
0      Survey on Semantic Stereo Matching / Semantic ...
1      FUTURE-AI: Guiding Principles and Consensus Re...
2      Enforcing Mutual Consistency of Hard Regions f...
3      Parameter Decoupling Strategy for Semi-supervi...
4      Background-Foreground Segmentation for Interio...
...
51769  Hierarchically-coupled hidden Markov models fo...
51770      Blinking Molecule Tracking
51771  Towards a Mathematical Foundation of Immunolog...
51772  A Semi-Automatic Graph-Based Approach for Dete...
51773  SparseCodePicking: feature extraction in mass ...

summaries \
0      Stereo matching is one of the widely used tech...
1      The recent advancements in artificial intellig...
2      In this paper, we proposed a novel mutual cons...
3      Consistency training has proven to be an advan...
4      To ensure safety in automated driving, the cor...
...
51769  We address the problem of analyzing sets of no...
51770  We discuss a method for tracking individual mo...
51771  We attempt to set a mathematical foundation of...
51772  Diffusion Tensor Imaging (DTI) allows estimati...
51773  Mass spectrometry (MS) is an important techniq...

terms
0      ['cs.CV', 'cs.LG']
1      ['cs.CV', 'cs.AI', 'cs.LG']
2      ['cs.CV', 'cs.AI']
3      ['cs.CV']
4      ['cs.CV', 'cs.LG']
```

```

...
51769      ['stat.ML', 'physics.bio-ph', 'q-bio.QM']
51770      ['cs.CV', 'cs.DM']
51771      ['stat.ML', 'cs.LG', 'q-bio.GN']
51772      ['cs.CV']
51773  ['stat.ML', 'physics.med-ph', 'stat.AP', 'stat...

[51774 rows x 3 columns]

```

5 Explore the Data

```
[ ]: data.columns
```

```
[ ]: Index(['titles', 'summaries', 'terms'], dtype='object')
```

```
[ ]: newColumns = {
      'titles': 'Titles',
      'summaries': 'Summaries',
      'terms': 'Labels'
    }

data = data.rename(columns=newColumns)
```

```
[ ]: data.isnull().sum()
```

```
[ ]: Titles      0
     Summaries   0
     Labels      0
     dtype: int64
```

```
[ ]: data['Labels'].value_counts()
```

```
[ ]: ['cs.CV']                                17369
     ['cs.LG', 'stat.ML']                      5251
     ['cs.LG']                                2732
     ['cs.CV', 'cs.LG']                        2067
     ['cs.LG', 'cs.AI']                        1702
...
     ['cs.LG', 'stat.ML', 'I.6.4; I.5.3; I.4.6; I.2.4'] 1
     ['cs.LG', 'math.ST', 'stat.ML', 'stat.TH', '62H22, 62R01, 62J99'] 1
     ['cs.LG', 'cs.RO', 'math.ST', 'stat.TH']          1
     ['cs.LG', 'cs.AI', 'cs.DS', '68T01, 68T09', 'I.2.6; I.5.1'] 1
     ['stat.ML', 'cs.CV', 'cs.LG', 'q-bio.QM']          1
     Name: Labels, Length: 3157, dtype: int64
```

6 Preprocessing using our Pipeline

```
[ ]: recordList = []

[ ]: for title in data['Titles']:
    # Convert the title to lowercase using REGEX
    for f in re.findall("[A-Z]+", title):
        title = title.replace(f, f.lower())

    # Removing special characters and replacing them with a space
    title = re.sub("[^A-Za-z0-9]", " ", title, 0, re.IGNORECASE)

    # From a single sentence, store all the words
    wordsInTitle = word_tokenize(title)

    # Filter out all the stop words
    wordsInTitle = [word for word in wordsInTitle if word not in stopWords]

    # Lemmatize each of the summaries
    wordsInTitle = [lemmatizer.lemmatize(word) for word in wordsInTitle]

    title = ' '.join(wordsInTitle)

    recordToAppend = {
        'Processed Titles': title,
    }

    recordList.append(recordToAppend)

[ ]: processedData = pd.DataFrame(data=recordList, columns=['Processed Titles'])

data = pd.concat([data, processedData['Processed Titles']], axis=1)

data
```

```
[ ]:                                     Titles \
0      Survey on Semantic Stereo Matching / Semantic ...
1      FUTURE-AI: Guiding Principles and Consensus Re...
2      Enforcing Mutual Consistency of Hard Regions f...
3      Parameter Decoupling Strategy for Semi-supervi...
4      Background-Foreground Segmentation for Interio...
...
51769 Hierarchically-coupled hidden Markov models fo...
51770                                     Blinking Molecule Tracking
51771 Towards a Mathematical Foundation of Immunolog...
51772 A Semi-Automatic Graph-Based Approach for Dete...
51773 SparseCodePicking: feature extraction in mass ...
```

	Summaries \
0	Stereo matching is one of the widely used tech...
1	The recent advancements in artificial intellig...
2	In this paper, we proposed a novel mutual cons...
3	Consistency training has proven to be an advan...
4	To ensure safety in automated driving, the cor...
...	...
51769	We address the problem of analyzing sets of no...
51770	We discuss a method for tracking individual mo...
51771	We attempt to set a mathematical foundation of...
51772	Diffusion Tensor Imaging (DTI) allows estimati...
51773	Mass spectrometry (MS) is an important techniq...

	Labels \
0	['cs.CV', 'cs.LG']
1	['cs.CV', 'cs.AI', 'cs.LG']
2	['cs.CV', 'cs.AI']
3	['cs.CV']
4	['cs.CV', 'cs.LG']
...	...
51769	['stat.ML', 'physics.bio-ph', 'q-bio.QM']
51770	['cs.CV', 'cs.DM']
51771	['stat.ML', 'cs.LG', 'q-bio.GN']
51772	['cs.CV']
51773	['stat.ML', 'physics.med-ph', 'stat.AP', 'stat...

	Processed Titles
0	survey semantic stereo matching semantic depth...
1	future ai guiding principle consensus recommen...
2	enforcing mutual consistency hard region semi ...
3	parameter decoupling strategy semi supervised ...
4	background foreground segmentation interior se...
...	...
51769	hierarchically coupled hidden markov model lea...
51770	blinking molecule tracking
51771	towards mathematical foundation immunology ami...
51772	semi automatic graph based approach determinin...
51773	sparsecodepicking feature extraction mass spec...

[51774 rows x 4 columns]

7 Creating Word2Vec Model

```
[ ]: # # Train a word2vec model on your preprocessed text data
sentences = [text.split() for text in data["Processed Titles"]]
labels = data['Labels'].apply(lambda x: x.strip('[]').split(', '))
```

```
[ ]: sentences
```

```
[ ]: [['survey',
      'semantic',
      'stereo',
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      ['future',
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```
[ ]: labels
```

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```

8 Apply W2V to get X

```
[ ]: model = Word2Vec(sentences, min_count=1, vector_size=100)
X = np.array([np.mean([model.wv.get_vector(word) for word in sentence], axis=0)
               for sentence in sentences])
```

9 Encode the Labels

```
[ ]: # Transform the labels into binary labels
mlb = MultiLabelBinarizer()
y = mlb.fit_transform(labels)

# Select the greatest value of them
y = np.argmax(y, axis=1)
```

```

    deep ,
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```

10 Train-test Split

```
[ ]: # Split the data into training and testing sets
X_train, X_test, y_train, y_test = train_test_split(X, y, test_size=0.2,
↳random_state=42)
```

11 Predict and Evaluate

```
[ ]: # Fit the logistic regression classifier on the training data
clf = LogisticRegression()
clf.fit(X_train, y_train)

# Evaluate the model on the test data
accuracy = clf.score(X_test, y_test)
print("Accuracy:", accuracy)
```

Accuracy: 0.6512795750845003

/home/volt/.local/lib/python3.10/site-packages/sklearn/linear_model/_logistic.py:458: ConvergenceWarning: lbfgs failed to converge (status=1):
STOP: TOTAL NO. of ITERATIONS REACHED LIMIT.

Increase the number of iterations (max_iter) or scale the data as shown in:

<https://scikit-learn.org/stable/modules/preprocessing.html>

Please also refer to the documentation for alternative solver options:

https://scikit-learn.org/stable/modules/linear_model.html#logistic-regression

```
n_iter_i = _check_optimize_result(
```
