FIT1043 Introduction to Data Science Assignment 2

Name : Ooi Yu Zhang
Student ID : 32713339
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Introduction

In this assignment, I will be predictive analysis on a dataset that consists of essays with a lot of varying attributes.</br> My approach will be to do research on different techniques and attempting to create the best model I am able to.</br> References will also be provided at the end of the assignment.

Importing Libraries

In [1]:
```
import pandas as pd
import matplotlib.pyplot as plt
from sklearn.feature_selection import RFE
from sklearn.linear_model import LogisticRegression
from sklearn.model_selection import train_test_split
from sklearn.preprocessing import StandardScaler
from sklearn.svm import SVC
from sklearn.metrics import confusion_matrix, ConfusionMatrixDisplay, cohen_kappa_score
from IPython.display import display, Markdown, Latex
```

Reading The Files

In [2]:
```
dataset = pd.read_csv('FIT1043-Essay-Features.csv')
```

Reading The Data

Reading data from FIT1043 Essay Features

Displaying the data

In [3]:
```
dataset
```

Out[3]:

	essayid	chars	words	commas	apostrophes	punctuations	avg_word_length	sentences	questio

	essayid	chars	words	commas	apostrophes	punctuations	avg_word_length	sentences	questio
0	1457	2153	426	14	6	0	5.053991	16	
1	503	1480	292	9	7	0	5.068493	11	
2	253	3964	849	19	26	1	4.669022	49	
3	107	988	210	8	7	0	4.704762	12	
4	1450	3139	600	13	8	0	5.231667	24	
...	...	...	...	...	...	...	...	...	
1327	1151	2404	467	16	10	0	5.147752	22	
1328	1015	1182	241	0	14	0	4.904564	16	
1329	1345	1814	363	5	11	0	4.997245	13	
1330	344	1427	287	5	8	0	4.972125	13	
1331	1077	2806	542	24	6	0	5.177122	22	

1332 rows × 19 columns

In [4]:

```
dataset.head()
```

Out[4]:

	essayid	chars	words	commas	apostrophes	punctuations	avg_word_length	sentences	questions
0	1457	2153	426	14	6	0	5.053991	16	0
1	503	1480	292	9	7	0	5.068493	11	0
2	253	3964	849	19	26	1	4.669022	49	2
3	107	988	210	8	7	0	4.704762	12	0
4	1450	3139	600	13	8	0	5.231667	24	1

Checking the dimensions of the data

In [5]:

```
dataset.shape
```

Out[5]:

```
(1332, 19)
```

Checking how the column headers are stored

In [6]:

```
dataset.columns
```

Out[6]:

```
Index(['essayid', 'chars', 'words', 'commas', 'apostrophes', 'punctuations',
       'avg_word_length', 'sentences', 'questions', 'avg_word_sentence', 'POS',
       'POS/total_words', 'prompt_words', 'prompt_words/total_words',
       'synonym_words', 'synonym_words/total_words', 'unstemmed', 'stemmed',
       'score'],
      dtype='object')
```

Displaying more detailed parts of the data

In [7]:

```
dataset.info
```

Out[7]:

```
<bound method DataFrame.info of       essayid  chars  words  commas  apostrophes  punctu
ations  \
0        1457   2153    426      14            6            0
1         503   1480    292       9            7            0
2         253   3964    849      19           26            1
3         107    988    210       8            7            0
4        1450   3139    600      13            8            0
...       ...    ...    ...     ...          ...          ...
1327     1151   2404    467      16           10            0
1328     1015   1182    241       0           14            0
1329     1345   1814    363       5           11            0
1330      344   1427    287       5            8            0
1331     1077   2806    542      24            6            0

      avg_word_length  sentences  questions  avg_word_sentence         POS  \
0            5.053991         16          0          26.625000  423.995272
1            5.068493         11          0          26.545455  290.993103
2            4.669022         49          2          17.326531  843.990544
3            4.704762         12          0          17.500000  207.653784
4            5.231667         24          1          25.000000  594.652150
...               ...        ...        ...                ...         ...
1327         5.147752         22          0          21.227273  462.987069
1328         4.904564         16          0          15.062500  238.655462
1329         4.997245         13          3          27.923077  362.329640
1330         4.972125         13          1          22.076923  284.657277
1331         5.177122         22          3          24.636364  538.988889

      POS/total_words  prompt_words  prompt_words/total_words  synonym_words  \
0            0.995294           207                  0.485915            105
1            0.996552           148                  0.506849             77
2            0.994100           285                  0.335689            130
3            0.988828           112                  0.533333             62
4            0.991087           255                  0.425000            165
...               ...           ...                       ...            ...
1327         0.991407           200                  0.428266            113
1328         0.990272            94                  0.390041             67
1329         0.998153           170                  0.468320            107
1330         0.991837           144                  0.501742             83
1331         0.994444           284                  0.523985            155

      synonym_words/total_words  unstemmed  stemmed  score
0                      0.246479        424      412      4
1                      0.263699        356      345      4
2                      0.153121        750      750      4
3                      0.295238        217      209      3
4                      0.275000        702      677      4
...                         ...        ...      ...    ...
1327                   0.241970        529      519      4
1328                   0.278008        293      283      3
1329                   0.294766        427      415      3
1330                   0.289199        323      312      3
1331                   0.285978        596      575      4

[1332 rows x 19 columns]>
```

In [8]:
```
dataset.describe()
```

Out[8]:

	essayid	chars	words	commas	apostrophes	punctuations	avg_word_length
count	1332.00000	1332.000000	1332.000000	1332.000000	1332.000000	1332.00000	1332.000000
mean	905.27027	2101.745495	424.485736	14.667417	8.141141	0.47973	4.939762
std	526.68760	865.963750	171.873730	10.920781	6.124520	1.27168	0.231071
min	0.00000	169.000000	36.000000	0.000000	2.000000	0.00000	2.231322
25%	442.75000	1527.250000	310.000000	7.000000	4.000000	0.00000	4.791679
50%	914.50000	2029.500000	411.000000	13.000000	6.000000	0.00000	4.946059
75%	1369.75000	2613.500000	525.000000	21.000000	11.000000	0.00000	5.092938
max	1799.00000	6142.000000	1170.000000	72.000000	51.000000	26.00000	5.681429

Describing The Data

Measures of Central Tendency (Mean and Median)

Essay ID

In [9]:
```
dataset['essayid'].mean()
```

Out[9]: 905.2702702702703

In [10]:
```
dataset['essayid'].median()
```

Out[10]: 914.5

Characters

In [11]:
```
dataset['chars'].mean()
```

Out[11]: 2101.7454954954956

In [12]:
```
dataset['chars'].median()
```

Out[12]: 2029.5

Words

In [13]:
```
dataset['words'].mean()
```

Out[13]: 424.4857357357357

In [14]:
```
dataset['words'].median()
```
Out[14]:
```
411.0
```

Commas

In [15]:
```
dataset['commas'].mean()
```
Out[15]:
```
14.667417417417417
```

In [16]:
```
dataset['commas'].median()
```
Out[16]:
```
13.0
```

Apostrophes

In [17]:
```
dataset['apostrophes'].mean()
```
Out[17]:
```
8.14114114114114
```

In [18]:
```
dataset['apostrophes'].median()
```
Out[18]:
```
6.0
```

Punctuations

In [19]:
```
dataset['punctuations'].mean()
```
Out[19]:
```
0.4797297297297297
```

In [20]:
```
dataset['punctuations'].median()
```
Out[20]:
```
0.0
```

Average Word Length

In [21]:
```
dataset['avg_word_length'].mean()
```
Out[21]:
```
4.939762160950457
```

In [22]:
```
dataset['avg_word_length'].median()
```
Out[22]:
```
4.946059456
```

Sentences

In [23]:
```
dataset['sentences'].mean()
```
Out[23]:
```
19.704204204204203
```
In [24]:
```
dataset['sentences'].median()
```
Out[24]:
```
18.0
```

Questions

In [25]:
```
dataset['questions'].mean()
```
Out[25]:
```
1.222972972972973
```
In [26]:
```
dataset['questions'].median()
```
Out[26]:
```
1.0
```

Average Words Per Sentence

In [27]:
```
dataset['avg_word_sentence'].mean()
```
Out[27]:
```
23.884686874754497
```
In [28]:
```
dataset['avg_word_sentence'].median()
```
Out[28]:
```
22.03033088
```

Part-Of-Speech

In [29]:
```
dataset['POS'].mean()
```
Out[29]:
```
420.596541695675
```
In [30]:
```
dataset['POS'].median()
```
Out[30]:
```
406.9828691
```

Ratio of Part-Of-Speech to Total Number Of Words

In [31]:
```
dataset['POS/total_words'].mean()
```
Out[31]:
```
0.9899351385195204
```
In [32]:
```
dataset['POS/total_words'].median()
```

Out[32]: 0.9915724335

Prompt Words

In [33]:
```
dataset['prompt_words'].mean()
```
Out[33]: 198.91366366366367

In [34]:
```
dataset['prompt_words'].median()
```
Out[34]: 193.0

Ratio of Prompt Words to Total Number Of Words

In [35]:
```
dataset['prompt_words/total_words'].mean()
```
Out[35]: 0.4691638682162157

In [36]:
```
dataset['prompt_words/total_words'].median()
```
Out[36]: 0.465851523

Synonym Words

In [37]:
```
dataset['synonym_words'].mean()
```
Out[37]: 110.16966966966967

In [38]:
```
dataset['synonym_words'].median()
```
Out[38]: 107.5

Ratio of Synonym Words to Total Number Of Words

In [39]:
```
dataset['synonym_words/total_words'].mean()
```
Out[39]: 0.2638456025600604

In [40]:
```
dataset['synonym_words/total_words'].median()
```
Out[40]: 0.26287187050000005

Unstemmed Words

In [41]:
```
dataset['unstemmed'].mean()
```
Out[41]: 468.987987987988

In [42]:
```
dataset['unstemmed'].median()
```
Out[42]:
```
463.0
```

Stemmed Words

In [43]:
```
dataset['stemmed'].mean()
```
Out[43]:
```
455.5075075075075
```

In [44]:
```
dataset['stemmed'].median()
```
Out[44]:
```
448.0
```

Score

In [45]:
```
dataset['score'].mean()
```
Out[45]:
```
3.4271771771771773
```

In [46]:
```
dataset['score'].median()
```
Out[46]:
```
3.0
```

Measures of Variability (Range and Variance)

Essay ID

In [47]:
```
dataset['essayid'].max() - dataset['essayid'].min()
```
Out[47]:
```
1799
```

In [48]:
```
dataset['essayid'].var()
```
Out[48]:
```
277399.8277255469
```

Characters

In [49]:
```
dataset['chars'].max() - dataset['chars'].min()
```
Out[49]:
```
5973
```

In [50]:
```
dataset['chars'].var()
```
```
749893.2161705282
```

Out[50]:

Words

In [51]:
```
dataset['words'].max() - dataset['words'].min()
```
Out[51]:
```
1134
```
In [52]:
```
dataset['words'].var()
```
Out[52]:
```
29540.57906008939
```

Commas

In [53]:
```
dataset['commas'].max() - dataset['commas'].min()
```
Out[53]:
```
72
```
In [54]:
```
dataset['commas'].var()
```
Out[54]:
```
119.26346049279931
```

Apostrophes

In [55]:
```
dataset['apostrophes'].max() - dataset['apostrophes'].min()
```
Out[55]:
```
49
```
In [56]:
```
dataset['apostrophes'].var()
```
Out[56]:
```
37.50974114610453
```

Punctuations

In [57]:
```
dataset['punctuations'].max() - dataset['punctuations'].min()
```
Out[57]:
```
26
```
In [58]:
```
dataset['punctuations'].var()
```
Out[58]:
```
1.6171695737811695
```

Average Word Length

In [59]:
```
dataset['avg_word_length'].max() - dataset['avg_word_length'].min()
```
Out[59]:
```
3.4501067320000005
```

In [60]:
```
dataset['avg_word_length'].var()
```
Out[60]:
```
0.05339401973194578
```

Sentences

In [61]:
```
dataset['sentences'].max() - dataset['sentences'].min()
```
Out[61]:
```
642
```

In [62]:
```
dataset['sentences'].var()
```
Out[62]:
```
368.74489591018533
```

Questions

In [63]:
```
dataset['questions'].max() - dataset['questions'].min()
```
Out[63]:
```
17
```

In [64]:
```
dataset['questions'].var()
```
Out[64]:
```
3.4130556176010507
```

Average Words Per Sentence

In [65]:
```
dataset['avg_word_sentence'].max() - dataset['avg_word_sentence'].min()
```
Out[65]:
```
301.91588785
```

In [66]:
```
dataset['avg_word_sentence'].var()
```
Out[66]:
```
124.54604743033157
```

Part-Of-Speech

In [67]:
```
dataset['POS'].max() - dataset['POS'].min()
```
Out[67]:
```
1123.33750418
```

In [68]:
```
dataset['POS'].var()
```
Out[68]:
```
29235.908018788636
```

Ratio of Part-Of-Speech to Total Number Of Words

In [69]:
```
dataset['POS/total_words'].max() - dataset['POS/total_words'].min()
```
Out[69]:
```
0.07522861199999997
```
In [70]:
```
dataset['POS/total_words'].var()
```
Out[70]:
```
5.3412047135317936e-05
```

Prompt Words

In [71]:
```
dataset['prompt_words'].max() - dataset['prompt_words'].min()
```
Out[71]:
```
655
```
In [72]:
```
dataset['prompt_words'].var()
```
Out[72]:
```
6844.131533674911
```

Ratio of Prompt Words to Total Number Of Words

In [73]:
```
dataset['prompt_words/total_words'].max() - dataset['prompt_words/total_words'].min()
```
Out[73]:
```
0.672318008
```
In [74]:
```
dataset['prompt_words/total_words'].var()
```
Out[74]:
```
0.0027526862975129464
```

Synonym Words

In [75]:
```
dataset['synonym_words'].max() - dataset['synonym_words'].min()
```
Out[75]:
```
344
```
In [76]:
```
dataset['synonym_words'].var()
```
Out[76]:
```
1932.6503791545117
```

Ratio of Synonym Words to Total Number Of Words

In [77]:
```
dataset['synonym_words/total_words'].max() - dataset['synonym_words/total_words'].min()
```
Out[77]:
```
0.43821839
```
In [78]:
```
dataset['synonym_words/total_words'].var()
```

Out[78]: 0.0015109093517610816

Unstemmed Words

In [79]:
```
dataset['unstemmed'].max() - dataset['unstemmed'].min()
```

Out[79]: 702

In [80]:
```
dataset['unstemmed'].var()
```

Out[80]: 25423.48896153852

Stemmed Words

In [81]:
```
dataset['stemmed'].max() - dataset['stemmed'].min()
```

Out[81]: 700

In [82]:
```
dataset['stemmed'].var()
```

Out[82]: 24258.44246801268

Score

In [83]:
```
dataset['score'].max() - dataset['score'].min()
```

Out[83]: 5

In [84]:
```
dataset['score'].var()
```

Out[84]: 0.5995012668566343

Supervised Learning

What is Supervised Learning?

Supervised Learning which is also known as Supervised Machine Learning, is a subcategory of machine learning and artificial intelligence. Through the cross</br>-validation process, which is a technique where an untrained sample of the provided dataset is used to assess the machine learning model's performance, all the input data that is fed into the model will contribute towards the approximation of the desired output. **[1] [2]**

What is the notion of labeled data?

Labeled data is essentially data that have been labeled to be made identifiable according to specific properties, characteristics or classifications. In terms of supervised machine learning, labeled data acts as the starting point for training and testing machine learning models. It is used by models to perform analysis and comparisons betweem them to determine the nature of the data and sort them into their own individual categories. The result of this operation will be useful in the predictive analysis of unlabeled data wherein we will be able to predict the labels for these unlabeled data or in other words be able to categorize them. **[3]**

What are the purpose of training and test datasets?

The training and test datasets make up the one dataset in which they have been split into training and test datasets individually with different ratios for different purposes. It is very important that the training and test datasets are derived from the same dataset and that the test dataset is large enough to ensure that the results of the machine learning process are justifiable. In terms of the purpose of the datasets, the training dataset will be used to train the model while the test dataset will be used to test the trained model. Most importantly, the test dataset should never be used to train the model as this will result in a very high accuracy when the test dataset is tested using this kind of model, this scenario would be considered as overfitting. **[4]**

Splitting of Features and Labels

Explanation for choice of features and labels:

After looking at the dataset, it can be easily concluded that the labels would be the scores which we will be attempting to perform predicitive analysis on, and the features would be the rest of the data in the dataset. However, it can be seen that the the amount of data for the features is quite bloated, hence I will be trimming it down later on.

Obtaining the features (All data besides score)

In [85]:
```
data_features = dataset.iloc[:,:-1].values
```

In [86]:
```
data_features
```

Out[86]:
```
array([[1.45700000e+03, 2.15300000e+03, 4.26000000e+02, ...,
        2.46478873e-01, 4.24000000e+02, 4.12000000e+02],
       [5.03000000e+02, 1.48000000e+03, 2.92000000e+02, ...,
        2.63698630e-01, 3.56000000e+02, 3.45000000e+02],
       [2.53000000e+02, 3.96400000e+03, 8.49000000e+02, ...,
        1.53121319e-01, 7.50000000e+02, 7.50000000e+02],
       ...,
       [1.34500000e+03, 1.81400000e+03, 3.63000000e+02, ...,
        2.94765840e-01, 4.27000000e+02, 4.15000000e+02],
       [3.44000000e+02, 1.42700000e+03, 2.87000000e+02, ...,
        2.89198606e-01, 3.23000000e+02, 3.12000000e+02],
       [1.07700000e+03, 2.80600000e+03, 5.42000000e+02, ...,
        2.85977860e-01, 5.96000000e+02, 5.75000000e+02]])
```

Obtaining the labels (Score)

In [87]:
```
data_labels = dataset.iloc[:,-1].values
```

In [88]:

```
data_labels
```

Out[88]:

```
array([4, 4, 4, ..., 3, 3, 4], dtype=int64)
```

Trimming down the Features (Using Feature Selection Methods)

Recursive Feature Elimination (RFE)

Recursive Feature Elimination essentially selects features by recursively considering smaller and smaller sets of features. It selects features based on the importance of the feature with regards to the predicting the output of the model. It eliminates features that are of less importance and selects the top features indicated. Along with RFE, I will also be using the Logistic Regression Algorithm which is a linear model for classification despite its name. In this model, a logistic function is used to model the probabilities describing the possible outcomes of a single trial, which in our case will be the features. **[5] [6] [7]**

Explanation: Here I will be using Recursive Feature Elimination (RFE) to identify the top 9 features which is approximately half the features that contribute the most to predicting the Score. These 9 features will be used to train the model.

In [89]:

```
#the 'lbfgs' solver is used here as it is the most robust solver
model = LogisticRegression(solver='lbfgs')
rfe = RFE(model, n_features_to_select=9)
fit = rfe.fit(data_features, data_labels)
d = {'Feature':dataset.columns[:-1], 'Contribution': fit.support_, 'Ranking': fit.ranki
df = pd.DataFrame(data=d)
df
```

```
C:\Users\andre\anaconda3\lib\site-packages\sklearn\linear_model\_logistic.py:814: Conver
genceWarning: 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(
C:\Users\andre\anaconda3\lib\site-packages\sklearn\linear_model\_logistic.py:814: Conver
genceWarning: 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(
C:\Users\andre\anaconda3\lib\site-packages\sklearn\linear_model\_logistic.py:814: Conver
genceWarning: 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(
C:\Users\andre\anaconda3\lib\site-packages\sklearn\linear_model\_logistic.py:814: Conver
genceWarning: 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(
C:\Users\andre\anaconda3\lib\site-packages\sklearn\linear_model\_logistic.py:814: Conver
genceWarning: 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(
C:\Users\andre\anaconda3\lib\site-packages\sklearn\linear_model\_logistic.py:814: Conver
genceWarning: 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(
C:\Users\andre\anaconda3\lib\site-packages\sklearn\linear_model\_logistic.py:814: Conver
genceWarning: 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(
C:\Users\andre\anaconda3\lib\site-packages\sklearn\linear_model\_logistic.py:814: Conver
genceWarning: 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(
C:\Users\andre\anaconda3\lib\site-packages\sklearn\linear_model\_logistic.py:814: Conver
genceWarning: 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(
C:\Users\andre\anaconda3\lib\site-packages\sklearn\linear_model\_logistic.py:814: Conver
genceWarning: 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(
```

Out[89]:

	Feature	Contribution	Ranking
0	essayid	False	4
1	chars	True	1
2	words	True	1
3	commas	True	1
4	apostrophes	False	5
5	punctuations	False	8
6	avg_word_length	False	3
7	sentences	False	2
8	questions	False	6
9	avg_word_sentence	True	1
10	POS	True	1
11	POS/total_words	False	7
12	prompt_words	True	1
13	prompt_words/total_words	False	9
14	synonym_words	True	1
15	synonym_words/total_words	False	10
16	unstemmed	True	1
17	stemmed	True	1

Result: The 9 features selected that will be used for training the model are 'chars', 'words', 'commas', avg_word_sentence', 'POS', 'prompt_words', 'synonym_words', 'unstemmed' and 'stemmed'.

Selecting The Features

In [90]:

```
table = df[df['Ranking'] == 1]
table
```

Out[90]:

	Feature	Contribution	Ranking
1	chars	True	1
2	words	True	1
3	commas	True	1

	Feature	Contribution	Ranking
9	avg_word_sentence	True	1
10	POS	True	1
12	prompt_words	True	1
14	synonym_words	True	1
16	unstemmed	True	1
17	stemmed	True	1

In [91]:

```
sel_feat = ['chars', 'words', 'commas','avg_word_sentence', 'POS', 'prompt_words', 'syn
new_features = dataset[sel_feat].values
new_features
```

Out[91]:

```
array([[2153.,  426.,   14., ...,  105.,  424.,  412.],
       [1480.,  292.,    9., ...,   77.,  356.,  345.],
       [3964.,  849.,   19., ...,  130.,  750.,  750.],
       ...,
       [1814.,  363.,    5., ...,  107.,  427.,  415.],
       [1427.,  287.,    5., ...,   83.,  323.,  312.],
       [2806.,  542.,   24., ...,  155.,  596.,  575.]])
```

Splitting the Training and Test Dataset

Here the dataset will be split into training and test datasets using the sklearn.model_selection.train_test_split function. </br>

As a reminder for later on:</br> *train_feat = Training dataset for Features*</br>*test_feat = Test dataset for Features* </br>*train_label = Training dataset for Labels*</br>*test_label = Test dataset for Labels*

In [92]:

```
train_feat, test_feat, train_label, test_label = train_test_split(new_features, data_la
```

In [93]:

```
train_feat
```

Out[93]:

```
array([[1.900e+03, 3.580e+02, 9.000e+00, ..., 8.000e+01, 4.460e+02,
        4.320e+02],
       [1.929e+03, 3.640e+02, 3.000e+00, ..., 1.160e+02, 3.400e+02,
        3.240e+02],
       [1.589e+03, 3.040e+02, 1.500e+01, ..., 8.300e+01, 2.840e+02,
        2.700e+02],
       ...,
       [1.676e+03, 3.320e+02, 1.200e+01, ..., 9.700e+01, 3.990e+02,
        3.880e+02],
       [3.154e+03, 6.790e+02, 3.200e+01, ..., 2.000e+02, 6.960e+02,
        6.780e+02],
       [3.344e+03, 6.200e+02, 2.400e+01, ..., 1.380e+02, 6.180e+02,
        6.000e+02]])
```

In [94]:

```
test_feat
```

Out[94]:

```
array([[1.841e+03, 3.700e+02, 2.100e+01, ..., 9.100e+01, 4.560e+02,
        4.480e+02],
       [1.491e+03, 3.280e+02, 0.000e+00, ..., 9.800e+01, 3.890e+02,
        3.750e+02],
       [2.404e+03, 4.670e+02, 1.600e+01, ..., 1.130e+02, 5.290e+02,
        5.190e+02],
       ...,
       [1.965e+03, 4.220e+02, 2.300e+01, ..., 1.000e+02, 4.770e+02,
        4.640e+02],
       [2.228e+03, 4.550e+02, 2.100e+01, ..., 1.270e+02, 5.410e+02,
        5.310e+02],
       [1.174e+03, 2.320e+02, 2.000e+00, ..., 7.600e+01, 2.350e+02,
        2.290e+02]])
```

In [95]:

```
train_label
```

Out[95]:

```
array([4, 3, 3, 4, 3, 4, 4, 4, 3, 4, 4, 4, 2, 5, 3, 2, 4, 3, 3, 4, 2, 3,
       4, 4, 3, 3, 4, 1, 3, 4, 3, 4, 4, 4, 3, 4, 4, 3, 5, 4, 3, 4, 4, 4,
       3, 1, 3, 5, 3, 4, 3, 4, 3, 3, 3, 4, 3, 4, 3, 4, 4, 4, 2, 2, 2, 2,
       3, 3, 3, 3, 1, 4, 2, 4, 3, 4, 1, 4, 4, 3, 4, 4, 3, 3, 3, 2, 4, 3,
       3, 4, 3, 3, 2, 3, 3, 3, 3, 3, 3, 4, 4, 4, 4, 4, 3, 3, 3, 4, 4, 3,
       3, 5, 3, 4, 3, 4, 1, 4, 4, 3, 3, 4, 4, 5, 4, 3, 3, 3, 3, 4, 3, 1,
       4, 4, 1, 4, 4, 3, 3, 4, 3, 4, 4, 5, 5, 3, 3, 4, 4, 4, 3, 4, 4, 4,
       3, 5, 3, 3, 3, 2, 4, 3, 3, 3, 4, 3, 4, 4, 4, 2, 3, 3, 4, 3, 4, 4,
       3, 3, 3, 4, 3, 4, 4, 4, 3, 3, 4, 3, 4, 4, 3, 4, 3, 5, 2, 4, 4, 4,
       4, 2, 3, 1, 5, 3, 4, 3, 4, 4, 5, 4, 3, 4, 4, 4, 3, 4, 3, 3, 4, 4,
       3, 3, 3, 3, 4, 4, 3, 2, 4, 4, 5, 4, 2, 4, 3, 4, 2, 4, 3, 4, 3, 4,
       3, 3, 4, 4, 2, 4, 4, 4, 3, 4, 3, 4, 2, 3, 5, 4, 3, 4, 3, 4, 4, 3,
       4, 3, 4, 4, 3, 3, 4, 4, 3, 3, 3, 4, 4, 2, 2, 4, 2, 4, 4, 3, 4, 3,
       4, 2, 3, 4, 4, 3, 4, 4, 4, 4, 3, 4, 3, 5, 3, 4, 3, 4, 3, 4, 5, 4,
       4, 4, 3, 3, 4, 4, 4, 3, 3, 3, 3, 3, 3, 3, 4, 4, 4, 4, 2, 4, 4, 3,
       3, 2, 2, 4, 4, 3, 4, 3, 3, 2, 4, 2, 3, 3, 3, 4, 4, 1, 3, 3, 4, 4,
       3, 4, 3, 5, 2, 3, 4, 5, 2, 3, 4, 3, 3, 3, 4, 3, 4, 4, 2, 4, 3, 3,
       4, 4, 3, 3, 2, 2, 4, 3, 4, 4, 4, 4, 4, 4, 4, 3, 4, 4, 4, 3, 4, 3,
       3, 2, 4, 4, 3, 3, 3, 3, 2, 3, 3, 3, 4, 4, 4, 4, 2, 4, 3, 3, 4, 3,
       4, 1, 4, 2, 4, 2, 4, 3, 3, 3, 4, 3, 5, 3, 5, 4, 3, 4, 4, 1, 3, 3,
       4, 4, 4, 4, 4, 3, 3, 3, 4, 3, 4, 3, 2, 4, 4, 4, 4, 2, 5, 3, 2, 4,
       1, 4, 3, 3, 4, 2, 4, 2, 3, 4, 4, 3, 3, 4, 4, 4, 3, 3, 4, 4, 4, 4,
       3, 4, 4, 4, 4, 2, 2, 3, 4, 2, 3, 1, 3, 3, 4, 4, 4, 3, 4, 4, 4, 4,
       4, 2, 3, 2, 3, 4, 4, 3, 3, 3, 3, 3, 5, 3, 3, 3, 4, 5, 4, 2, 2, 4,
       3, 4, 3, 4, 4, 4, 5, 2, 4, 3, 4, 2, 3, 3, 4, 4, 4, 3, 4, 4, 4, 4,
       4, 3, 4, 4, 4, 4, 5, 3, 4, 3, 3, 3, 5, 4, 3, 4, 3, 4, 4, 4, 3, 4,
       3, 4, 4, 3, 3, 4, 3, 4, 3, 3, 3, 3, 4, 4, 4, 2, 4, 3, 3, 3, 3, 3,
       3, 2, 3, 4, 3, 4, 4, 3, 6, 3, 5, 3, 4, 3, 3, 5, 4, 3, 3, 4, 3, 4,
       2, 4, 2, 4, 4, 3, 4, 3, 2, 3, 4, 3, 4, 4, 3, 4, 3, 4, 3, 2, 4, 4,
       3, 3, 4, 3, 5, 4, 4, 3, 4, 3, 2, 4, 3, 4, 4, 3, 2, 2, 5, 4, 2, 4,
       3, 5, 3, 4, 3, 5, 3, 3, 3, 4, 2, 4, 5, 4, 3, 4, 3, 6, 4, 3, 4, 3,
       3, 4, 4, 4, 5, 2, 3, 3, 3, 3, 4, 4, 3, 3, 2, 4, 3, 3, 4, 4, 3, 3,
       3, 3, 3, 2, 4, 4, 4, 3, 4, 4, 4, 4, 3, 3, 2, 4, 5, 3, 3, 3, 4, 3,
       3, 3, 4, 4, 2, 3, 3, 3, 4, 2, 4, 3, 3, 4, 2, 4, 5, 4, 4, 3, 3, 4,
       4, 4, 3, 3, 4, 3, 5, 3, 2, 4, 4, 4, 3, 3, 4, 3, 3, 3, 4, 4, 4, 4,
       4, 2, 3, 3, 4, 3, 3, 3, 3, 3, 4, 3, 4, 3, 3, 4, 3, 3, 3, 3, 3, 3,
       4, 4, 3, 4, 3, 4, 3, 3, 3, 1, 3, 4, 3, 3, 3, 4, 4, 3, 2, 3, 3, 4,
       3, 3, 4, 4, 3, 4, 3, 4, 3, 3, 3, 3, 4, 4, 4, 4, 3, 3, 4, 5, 4, 4,
       3, 4, 3, 4, 4, 4, 3, 4, 4, 3, 3, 4, 3, 4, 3, 3, 3, 3, 4, 4, 3, 4,
       2, 3, 4, 4, 3, 4, 4, 6, 5, 3, 4, 4, 4, 3, 4, 3, 3, 3, 3, 3, 4, 3,
```

```
       3, 3, 3, 4, 5, 3, 4, 4, 2, 5, 4, 3, 3, 2, 4, 4, 4, 3, 3, 4, 5, 4,
       3, 4, 4, 3, 3, 3, 2, 3, 2, 4, 4, 4, 3, 3, 4, 2, 5, 4, 3, 4, 4, 4,
       4, 3, 4, 3, 2, 5, 3, 4, 4, 3, 2, 5, 3, 4, 4, 3, 4, 3, 4, 4, 2, 4,
       3, 3, 4, 4, 3, 5, 3, 4, 3, 4, 4, 4, 5, 3, 2, 4, 4, 2, 3, 2, 3, 3,
       3, 3, 3, 3, 3, 4, 3, 3, 4, 5, 4, 3, 4, 5, 4, 4, 4, 3, 4, 3, 3, 4,
       4, 4, 3, 2, 4, 3, 4, 4, 4], dtype=int64)
```

In [96]:

```
test_label
```

Out[96]:

```
array([4, 3, 4, 4, 3, 4, 4, 3, 3, 3, 3, 4, 4, 3, 3, 3, 3, 4, 4, 3, 3, 3,
       4, 4, 3, 4, 3, 2, 3, 3, 4, 3, 3, 4, 3, 3, 3, 3, 4, 3, 3, 2, 5, 3,
       3, 4, 4, 4, 4, 4, 3, 4, 4, 3, 4, 5, 4, 4, 3, 2, 4, 3, 4, 2, 1, 3,
       2, 4, 3, 3, 3, 3, 3, 4, 4, 2, 3, 3, 3, 4, 4, 3, 2, 3, 4, 3, 4, 5,
       3, 2, 3, 4, 5, 3, 4, 4, 3, 4, 3, 4, 4, 4, 4, 4, 3, 3, 3, 4, 4, 3,
       3, 3, 3, 3, 4, 3, 4, 4, 3, 5, 3, 2, 4, 3, 5, 3, 3, 2, 2, 5, 4, 4,
       4, 3, 4, 3, 3, 4, 3, 6, 4, 4, 4, 1, 4, 4, 3, 4, 3, 2, 4, 4, 3, 4,
       4, 4, 4, 3, 3, 3, 4, 4, 4, 3, 3, 3, 3, 3, 3, 4, 4, 4, 3, 4, 4, 3,
       4, 3, 4, 3, 2, 4, 3, 4, 4, 4, 3, 4, 4, 3, 2, 4, 5, 2, 3, 4, 3, 1,
       3, 3, 3, 4, 3, 4, 4, 4, 5, 4, 3, 4, 4, 4, 3, 5, 3, 3, 4, 3, 4, 3,
       4, 4, 4, 3, 3, 3, 4, 4, 4, 2, 4, 3, 4, 2, 2, 4, 4, 4, 3, 2, 4, 3,
       3, 3, 3, 4, 4, 4, 4, 2, 4, 3, 4, 4, 4, 3, 4, 4, 3, 3, 3, 4, 5, 3,
       4, 4, 4, 4, 4, 4, 3, 2, 3, 3, 4, 3, 3, 3, 5, 3, 4, 3, 3, 4, 4, 3,
       3, 4, 4, 3, 3, 2, 4, 3, 4, 3, 4, 3, 3, 3, 3, 3, 3, 4, 2, 2, 3, 4,
       4, 4, 4, 3, 4, 3, 3, 3, 4, 3, 3, 4, 4, 1, 3, 4, 3, 3, 3, 3, 3, 3,
       4, 4, 3], dtype=int64)
```

Classification

What is the difference between binary and multi-class classification?

Classification is the act of classifying data into different classes which is used to predict from which classes the input data are derived from. Binary classification and multi-class classification are two different types of classification.</br>

__*Binary classification*__ is the classification of a dataset into two distinct classes. For example, you are presented a basket of fruits and vegetables which act as the dataset here and you will have to sort them into two batches, the two distinct classes here would obviously be Fruits and the other Vegetables. In fact, I have already performed binary classification earlier in this assignment which would be the application of Logistic Regression during Feature Selection. Other examples of algorithms used by binary classification are Decision Trees and Support Vector Machines, the latter of which we will be exploring later in the assignment as well.</br>

__*Multi-class classification*__ is the classification of a dataset into many distinct classes, many being more than two. For example, instead of just a basket of fruits and vegetables from earlier, this time you are presented a basket of groceries to sort instead, there would be many distinct classes to sort them into, from Toiletries, to different types of Food classes, to Beverages and possibly to Meats. This is the main difference that sets multi-class classification from binary-classification wherein multi-class classification classifies a dataset into many distinct classes while binary classification just classifies a dataset into two distinct classes. Examples of algorithms used by multi-class classification are Decision Trees and Random Forests. **[8]**

Data Normalisation

What is the purpose of normalised / scaling of data?

Data Normalisation is the process of scaling data to a standard scale. Due to the possibly broad range of values in given data, objective functions may not work properly in some machine learning algorithms without normalising data. Certain features may lose their effectiveness if their data is on a different scale when compared to other features. Hence, normalising data is important to ensure that all data is on a similar scale so that a good machine learning model can be produced. **[9]**

Feature Scaling

Use StandardScaler to normalise the data

In [97]:

```
sc = StandardScaler()
train_feat = sc.fit_transform(train_feat)
test_feat = sc.transform(test_feat)
```

Checking if the data has been normalised appropriately

In [98]:

```
train_feat
```

Out[98]:

```
array([[-0.23062001, -0.38254297, -0.51644799, ..., -0.67255429,
        -0.139495  , -0.14675677],
       [-0.19750726, -0.34795727, -1.08164595, ...,  0.14280868,
        -0.79744712, -0.83384211],
       [-0.58572572, -0.69381424,  0.04874997, ..., -0.60460738,
        -1.14504447, -1.17738478],
       ...,
       [-0.48638746, -0.53241432, -0.23384901, ..., -0.28752178,
        -0.43122849, -0.42668043],
       [ 1.20122102,  1.46779183,  1.6501442 , ...,  2.04532228,
         1.41227888,  1.41827095],
       [ 1.41816663,  1.12769914,  0.89654692, ...,  0.64108605,
         0.92812543,  0.92204265]])
```

In [99]:

```
test_feat
```

Out[99]:

```
array([[-0.29798733, -0.31337157,  0.61394794, ..., -0.42341561,
        -0.07742404, -0.04496635],
       [-0.69762398, -0.55547145, -1.36424493, ..., -0.26487281,
        -0.49329944, -0.50938515],
       [ 0.34485677,  0.24576386,  0.14294964, ...,  0.07486177,
         0.37569393,  0.40672864],
       ...,
       [-0.15640177, -0.01362886,  0.80234726, ..., -0.21957486,
         0.05292496,  0.05682407],
       [ 0.14389663,  0.17659247,  0.61394794, ...,  0.39194737,
```

```
    0.45017908,  0.48307146],
  [-1.0595806 , -1.10884261, -1.17584561, ..., -0.76315018,
   -1.44919215, -1.43822274]])
```

SVM Classification Model

What is SVM?

Support Vector Machines (SVMs) are supervised machine learning models that are used for classification and regression but mainly for classification. For classification, the main objective of the SVM algorithm is to find the most optimal hyperplane in an N-dimensional space that best classifies the input data where N is the number of features. To achieve this, the SVM algorithm finds the hyperplane with the maximum margin which is described as the maximum distance between input data of two classes. The hyperplanes mentioned are decision boundaries that help classify the input data, they are supported by support vectors which determine the position the hyperplanes are in. This very similar to a bridge supported by girders. **[10]**

How does SVM/SVR compare to Linear Regression?

Linear Regression are also supervised machine learning models but are conversely used for regression only, hence their purposes are entirely different. Linear Regression is used to minimise the sum of squared errors while Support Vector Regression (SVR) minimises the coefficients instead of the squared error which is handled in the constraints where the absolute error is set to less than or equal to the maximum error. This gives SVR a flexibility advantage over Linear Regression as errors are disregarded within a certain limits. **[11]**

What is the kernel in SVM/SVR?

The kernel is a function used in SVM that transforms input data to the desired output data. It utilises pre-defined mathematical functions to perform complex calculations of datasets of any dimension to help the SVM algorithm decide on the hyperplane or in other terms the decision boundary. The kernel is also referred to as the kernel trick in which it will tend to solve a non-linearly separable problem with the help of linear classifying features. The kernel has values such as linear or polynomial that can be modified at will, this means that kernel can transmit the decision boundary to datasets of higher dimensions. The Radial Basis Function is the most commonly used kernel due to its robustness of being able to efficiently work with different sizes of datasets, however overfitting may occur on smaller datasets. Hence, linear or polynomial kernels should be used on smaller datasets instead. **[12]**

Building The SVM Model

Approach: Here I will be using the sklearn.svm.SCV function to build the SVM model. The parameters for the function will be changed with different combinations and submitted to Kaggle for testing, the code here will be for the combination with the best results. The only parameters that will be tested are 'C' which is a regularization parameter and 'kernel' which is the type of kernel. My approach will be to take different numbers of different scales and changing values in small intervals once I obtain a value that is comparatively quite higher than others. The kernel will be interchanged between linear and and rbf as they are most suitable for the model that I will be building. **[13]**

In [100…

```
svm = SVC(C = 8.5, kernel = 'linear', random_state = 7)
svm.fit(train_feat, train_label)
```

Out[100…

```
SVC(C=8.5, kernel='linear', random_state=7)
```

Model Testing

Predicting the Score using test data

In [101…

```
prediction = svm.predict(test_feat)
```

In [102…

```
prediction
```

Out[102…

```
array([4, 3, 4, 4, 3, 3, 3, 3, 3, 3, 3, 4, 4, 4, 4, 2, 4, 3, 4, 3, 3, 3,
       4, 3, 4, 4, 3, 2, 3, 3, 4, 3, 3, 4, 3, 3, 3, 3, 4, 3, 3, 3, 4, 3,
       4, 4, 3, 4, 3, 4, 3, 3, 4, 4, 3, 4, 4, 4, 3, 3, 4, 3, 4, 2, 3, 3,
       3, 4, 4, 3, 2, 3, 3, 4, 4, 3, 3, 3, 3, 4, 4, 4, 3, 3, 4, 4, 4, 4,
       3, 3, 3, 3, 4, 3, 3, 4, 3, 4, 4, 4, 4, 4, 4, 4, 3, 4, 3, 4, 4, 4,
       4, 3, 3, 3, 4, 3, 4, 4, 3, 4, 3, 3, 4, 4, 4, 3, 4, 1, 3, 4, 3, 4,
       4, 3, 3, 3, 3, 3, 3, 4, 4, 3, 4, 2, 4, 4, 3, 4, 3, 3, 4, 4, 3, 4,
       4, 4, 3, 4, 4, 3, 4, 4, 4, 4, 3, 3, 3, 4, 3, 4, 4, 3, 3, 4, 3, 3,
       4, 4, 4, 3, 3, 4, 3, 4, 4, 4, 3, 3, 4, 3, 2, 4, 4, 2, 4, 3, 4, 4,
       3, 3, 3, 4, 4, 3, 4, 4, 4, 4, 3, 3, 3, 4, 3, 4, 3, 3, 3, 4, 3, 3,
       4, 4, 4, 3, 3, 4, 4, 4, 3, 2, 4, 3, 4, 2, 3, 4, 4, 4, 2, 2, 4, 3,
       3, 3, 4, 4, 4, 4, 3, 3, 3, 3, 4, 4, 3, 4, 4, 3, 3, 4, 3, 4, 4, 3,
       4, 4, 4, 4, 4, 4, 3, 2, 3, 3, 4, 3, 3, 4, 4, 3, 4, 4, 3, 4, 4, 3,
       3, 4, 4, 3, 3, 2, 3, 3, 3, 3, 4, 3, 3, 3, 2, 3, 3, 4, 2, 3, 4, 4,
       4, 4, 3, 3, 3, 4, 3, 2, 3, 3, 3, 3, 3, 1, 3, 3, 2, 3, 3, 3, 3, 4,
       4, 4, 3], dtype=int64)
```

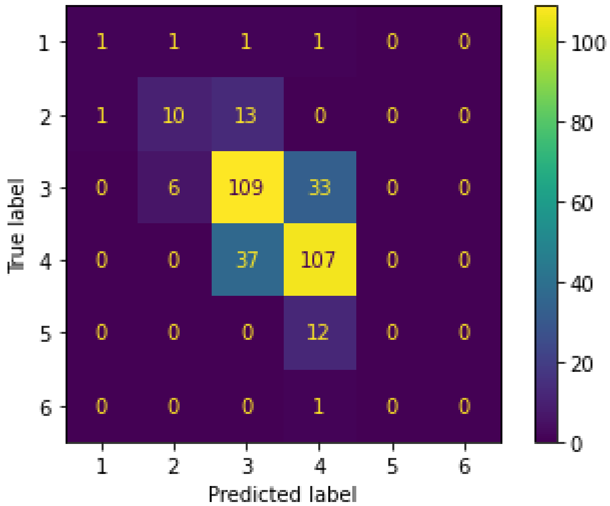
Displaying the Confusion Matrix

In [103…

```
cm = confusion_matrix(test_label, prediction)
cmd = ConfusionMatrixDisplay(cm, display_labels=[1,2,3,4,5,6])
cmd.plot()
```

Out[103…

```
<sklearn.metrics._plot.confusion_matrix.ConfusionMatrixDisplay at 0x2324c195970>
```



Result: From the confusion matrix, it can be seen that most of the wrong predicted labels are just bordering the actual true labels, although not the best case scenario, it is still a decent outcome. However, there are 3 values that are outside of bordering the true labels which are the values in row 1 column 3 and 4, and the value in row 6 column 4. It can also been seen that most of the predicted values are for the scores 3 and 4, and fortunately for us, a lot of them seem to be correct or close predictions. However, you can also seen from the confusion matrix that the model did not predict any of the scores for 5 or 6 correctly which is quite the problem.

Quadratic Weighted Kappa (QWK)

What is QWK?

The Quadratic Weight Kappa (QWK) is a metric used to measure the agreement between two ratings. These ratings which can range from 0 to 5 are given according to how accurate the predicted data is to the actual data. QWK is calculated between the predicted scores and the actual scores. When calculating QWK, the main goal is to get as close to 1 as possible which is the maximum you can get, but there are also cases where the calculated QWK can fall below 0 and that is when there is less agreement between the ratings than expected. **[14]**

Explanation: Here I will be using the sklearn.metrics.cohen_kappa_score function with the parameter 'weights' set to 'Quadratic' to calculate the QWK which has been noted to be the same as QWK by the author in **[14]**. **[15]**

In [104…

```
cohen_kappa_score(test_label, prediction, weights='quadratic')
```

Out[104…

```
0.6116089652625236
```

Result: Here I received a QWK of 0.6116089652625236 which should be really good score as according to **[14]** a score of 0.6 or more is generally considered really good.

Kaggle Submission

Kaggle Submission Preparation

Reading the competition data file

In [105…
```
sub_data = pd.read_csv('FIT1043-Essay-Features-Submission.csv')
```

In [106…
```
sub_data
```

Out[106…

	essayid	chars	words	commas	apostrophes	punctuations	avg_word_length	sentences	question
0	1623	4332	900	28	13	0	4.813333	39	[illegible]
1	1143	1465	280	11	3	1	5.232143	14	[illegible]
2	660	1696	325	17	2	0	5.218462	19	[illegible]
3	1596	2640	555	20	17	0	4.756757	28	[illegible]
4	846	2844	596	33	4	1	4.771812	24	[illegible]
...	...	...	...	...	...	...	...	...	.
194	1226	1208	242	8	8	0	4.991736	13	[illegible]
195	862	4039	817	24	11	1	4.943696	47	[illegible]
196	1562	2448	468	22	7	0	5.230769	22	[illegible]
197	1336	1081	214	14	5	0	5.051402	11	[illegible]
198	1171	2094	433	11	12	0	4.836028	19	[illegible]

199 rows × 18 columns

Doing the prediction

Note: sel_feat = ['chars', 'words', 'commas', 'avg_word_sentence', 'POS', 'prompt_words', 'synonym_words', 'unstemmed', 'stemmed'] from earlier in the assignment

In [107…
```
sub_feat = sub_data[sel_feat].values
kag_feat = sc.transform(sub_feat)
```

In [108…
```
kag_pred = svm.predict(kag_feat)
```

In [109…
```
kag_pred
```

Out[109…
```
array([4, 3, 4, 4, 4, 4, 3, 3, 3, 3, 3, 3, 4, 3, 4, 4, 4, 4, 3, 3, 3, 3,
       4, 4, 4, 4, 4, 4, 4, 3, 2, 4, 3, 3, 4, 3, 4, 4, 3, 3, 3, 3, 3, 3,
       1, 3, 3, 4, 4, 3, 3, 4, 4, 4, 3, 4, 3, 3, 4, 4, 2, 3, 3, 4, 3, 3,
       4, 4, 3, 4, 3, 3, 2, 3, 3, 3, 3, 4, 4, 4, 4, 3, 4, 3, 4, 2, 4, 4,
       2, 3, 3, 3, 4, 3, 4, 4, 4, 4, 3, 3, 3, 4, 2, 3, 3, 4, 3, 3, 4, 4,
       4, 3, 4, 4, 4, 3, 3, 4, 2, 3, 4, 4, 4, 3, 2, 4, 3, 4, 3, 2, 4, 4,
       2, 3, 4, 3, 3, 4, 1, 3, 4, 4, 4, 3, 3, 4, 4, 3, 4, 4, 4, 3, 4, 3,
```

```
       4, 3, 3, 4, 3, 4, 4, 3, 2, 3, 4, 4, 3, 3, 2, 4, 3, 4, 4, 3, 4, 3,
       4, 3, 3, 4, 4, 3, 4, 4, 4, 4, 3, 3, 4, 3, 3, 4, 3, 4, 3, 4, 4, 3,
       3], dtype=int64)
```

Reading the provided submission file

In [110…

```
kag_sub = pd.read_csv('32713339-OoiYuZhang-29.csv')
kag_sub
```

Out[110…

	essayid	score
0	1623	4
1	1143	3
2	660	4
3	1596	4
4	846	4
...	...	...
194	1226	3
195	862	4
196	1562	4
197	1336	3
198	1171	3

199 rows × 2 columns

In [111…

```
kag_sub['score'] = kag_pred
kag_sub
```

Out[111…

	essayid	score
0	1623	4
1	1143	3
2	660	4
3	1596	4
4	846	4
...	...	...
194	1226	3
195	862	4
196	1562	4
197	1336	3
198	1171	3

199 rows × 2 columns

Output to the submission file

In [112…

```
kag_sub.to_csv("32713339-OoiYuZhang-29.csv", index=False)
```

Conclusion

Through this assignment, I have learnt a lot of new techniques and information, some I have applied in this assignment, and others that I know exist which may or may not be useful to me in the future. What I have learnt are the many different ways of feature selection, feature scaling, what a SVM and QWK are and how they work, and I had the opportunity to participate in my very first Kaggle competition which was quite interesting. Overall, I feel that the model I built could have been better, which is quite apparent when comparing my score to the rest of the leaderboard in the Kaggle competition.

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