In [1]:
```python
import pandas as pd
import numpy as np
import matplotlib.pyplot as plt
import seaborn as sns
import sklearn

from sklearn.neighbors import KNeighborsClassifier
from sklearn.model_selection import cross_val_score,KFold,train_test_split
from sklearn.preprocessing import StandardScaler,MinMaxScaler,RobustScaler,LabelEnc
from sklearn.datasets import make_classification,make_regression
from sklearn.model_selection import train_test_split,StratifiedKFold
from sklearn.neighbors import KNeighborsClassifier,KNeighborsRegressor
from sklearn.metrics import accuracy_score,confusion_matrix,ConfusionMatrixDisplay,
from sklearn.dummy import DummyClassifier,DummyRegressor
from mlxtend.plotting import plot_decision_regions
```

In [2]:
```python
df=pd.read_csv(r"C:\Users\pavan\Downloads\Dry_Bean_Dataset.csv")
```

In [3]:
```python
df
```

Out[3]:

	Area	Perimeter	MajorAxisLength	MinorAxisLength	AspectRation	Eccentricity	C
0	28395	610.291	208.178117	173.888747	1.197191	0.549812	
1	28734	638.018	200.524796	182.734419	1.097356	0.411785	
2	29380	624.110	212.826130	175.931143	1.209713	0.562727	
3	30008	645.884	210.557999	182.516516	1.153638	0.498616	
4	30140	620.134	201.847882	190.279279	1.060798	0.333680	
...	...	...	...	...	...	...	
13606	42097	759.696	288.721612	185.944705	1.552728	0.765002	
13607	42101	757.499	281.576392	190.713136	1.476439	0.735702	
13608	42139	759.321	281.539928	191.187979	1.472582	0.734065	
13609	42147	763.779	283.382636	190.275731	1.489326	0.741055	
13610	42159	772.237	295.142741	182.204716	1.619841	0.786693	

13611 rows × 17 columns

In [4]:
```python
df.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 13611 entries, 0 to 13610
Data columns (total 17 columns):
 #   Column           Non-Null Count  Dtype  
---  ------           --------------  -----  
 0   Area             13611 non-null  int64  
 1   Perimeter        13611 non-null  float64
 2   MajorAxisLength  13611 non-null  float64
 3   MinorAxisLength  13611 non-null  float64
 4   AspectRation     13611 non-null  float64
 5   Eccentricity     13611 non-null  float64
 6   ConvexArea       13611 non-null  int64  
 7   EquivDiameter    13611 non-null  float64
 8   Extent           13611 non-null  float64
 9   Solidity         13611 non-null  float64
 10  roundness        13611 non-null  float64
 11  Compactness      13611 non-null  float64
 12  ShapeFactor1     13611 non-null  float64
 13  ShapeFactor2     13611 non-null  float64
 14  ShapeFactor3     13611 non-null  float64
 15  ShapeFactor4     13611 non-null  float64
 16  Class            13611 non-null  object 
dtypes: float64(14), int64(2), object(1)
memory usage: 1.8+ MB
```

In [5]:
```
df.isna().sum()
```

Out[5]:
```
Area               0
Perimeter          0
MajorAxisLength    0
MinorAxisLength    0
AspectRation       0
Eccentricity       0
ConvexArea         0
EquivDiameter      0
Extent             0
Solidity           0
roundness          0
Compactness        0
ShapeFactor1       0
ShapeFactor2       0
ShapeFactor3       0
ShapeFactor4       0
Class              0
dtype: int64
```

In [6]:
```
df.describe()
```

Out[6]:

	Area	Perimeter	MajorAxisLength	MinorAxisLength	AspectRation	Ec
count	13611.000000	13611.000000	13611.000000	13611.000000	13611.000000	136
mean	53048.284549	855.283459	320.141867	202.270714	1.583242	
std	29324.095717	214.289696	85.694186	44.970091	0.246678	
min	20420.000000	524.736000	183.601165	122.512653	1.024868	
25%	36328.000000	703.523500	253.303633	175.848170	1.432307	
50%	44652.000000	794.941000	296.883367	192.431733	1.551124	
75%	61332.000000	977.213000	376.495012	217.031741	1.707109	
max	254616.000000	1985.370000	738.860154	460.198497	2.430306	

In [7]:

```
df.describe(include="object")
```

Out[7]:

	Class
count	13611
unique	7
top	DERMASON
freq	3546

In [8]:

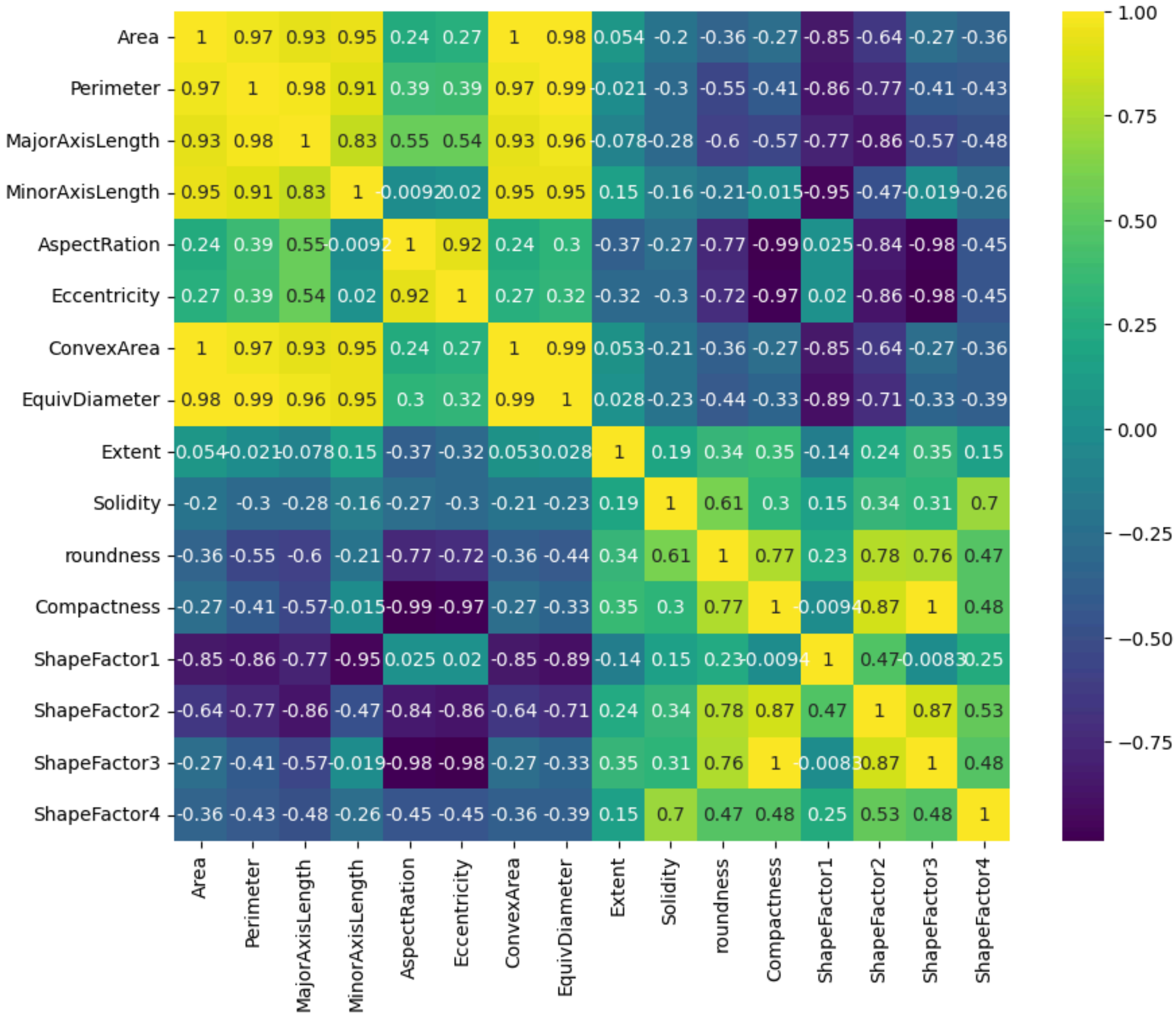
```
df.head()
```

Out[8]:

	Area	Perimeter	MajorAxisLength	MinorAxisLength	AspectRation	Eccentricity	Conve
0	28395	610.291	208.178117	173.888747	1.197191	0.549812	
1	28734	638.018	200.524796	182.734419	1.097356	0.411785	
2	29380	624.110	212.826130	175.931143	1.209713	0.562727	
3	30008	645.884	210.557999	182.516516	1.153638	0.498616	
4	30140	620.134	201.847882	190.279279	1.060798	0.333680	

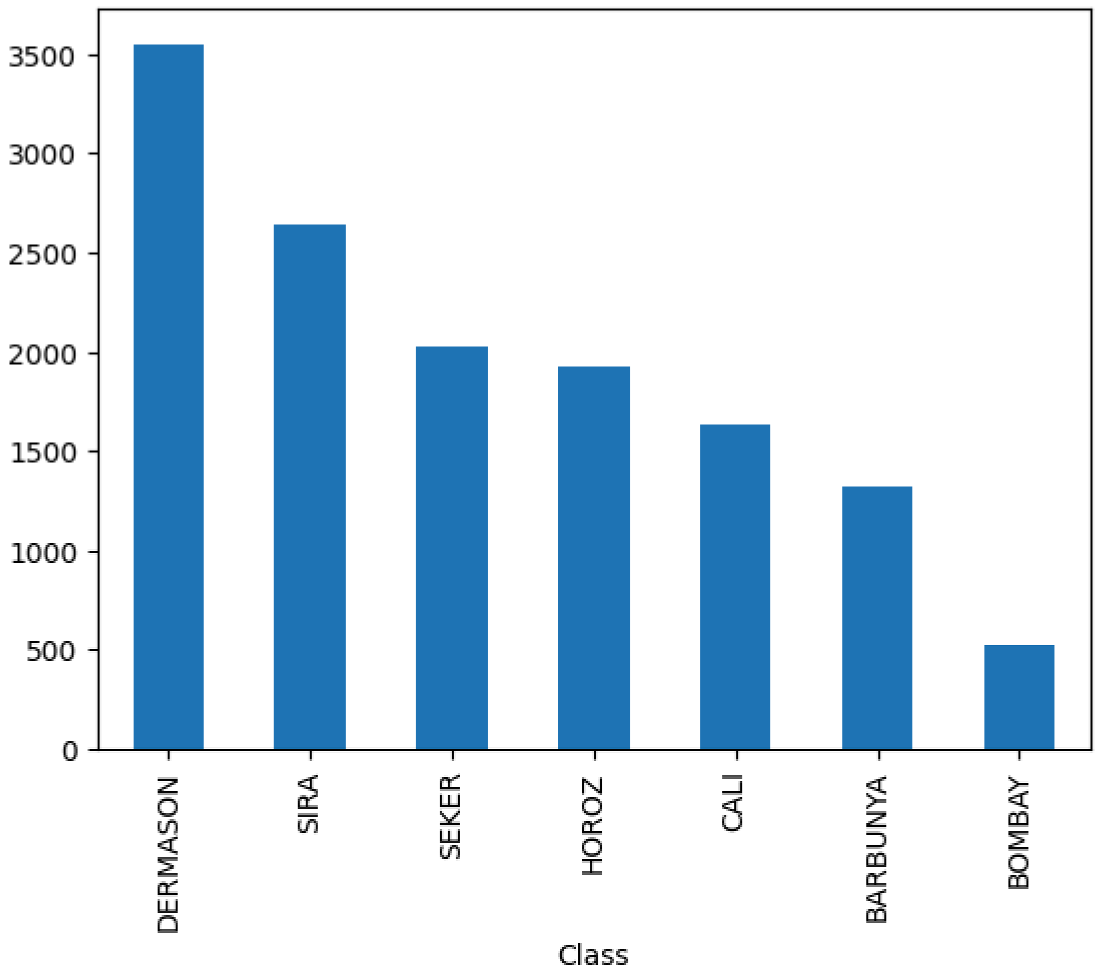
In [9]:

```
plt.figure(figsize=(10,8))
sns.heatmap(df.corr(numeric_only=True),annot=True,cmap='viridis')
plt.show()
```



In [10]:
```
df["Class"].value_counts().plot.bar()
```

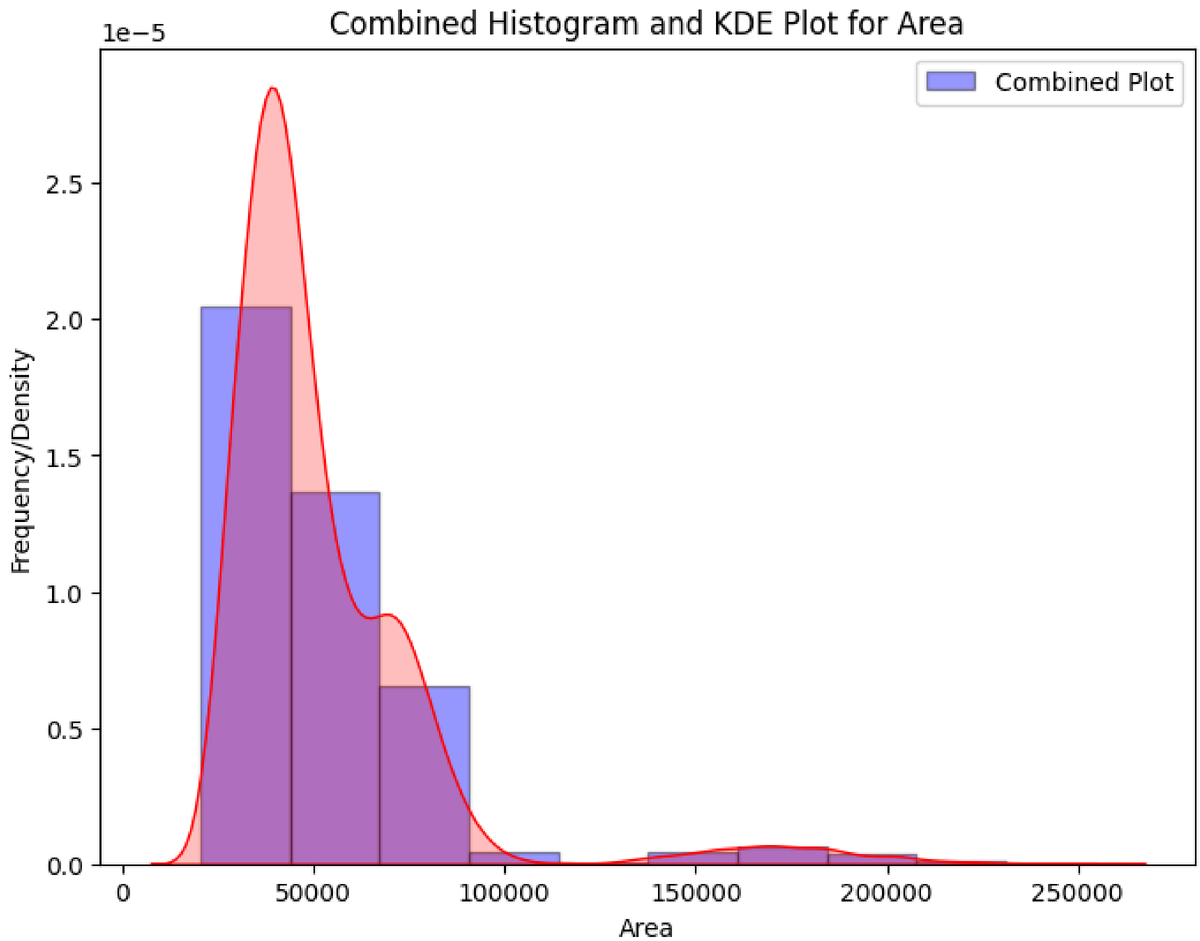
Out[10]: <Axes: xlabel='Class'>



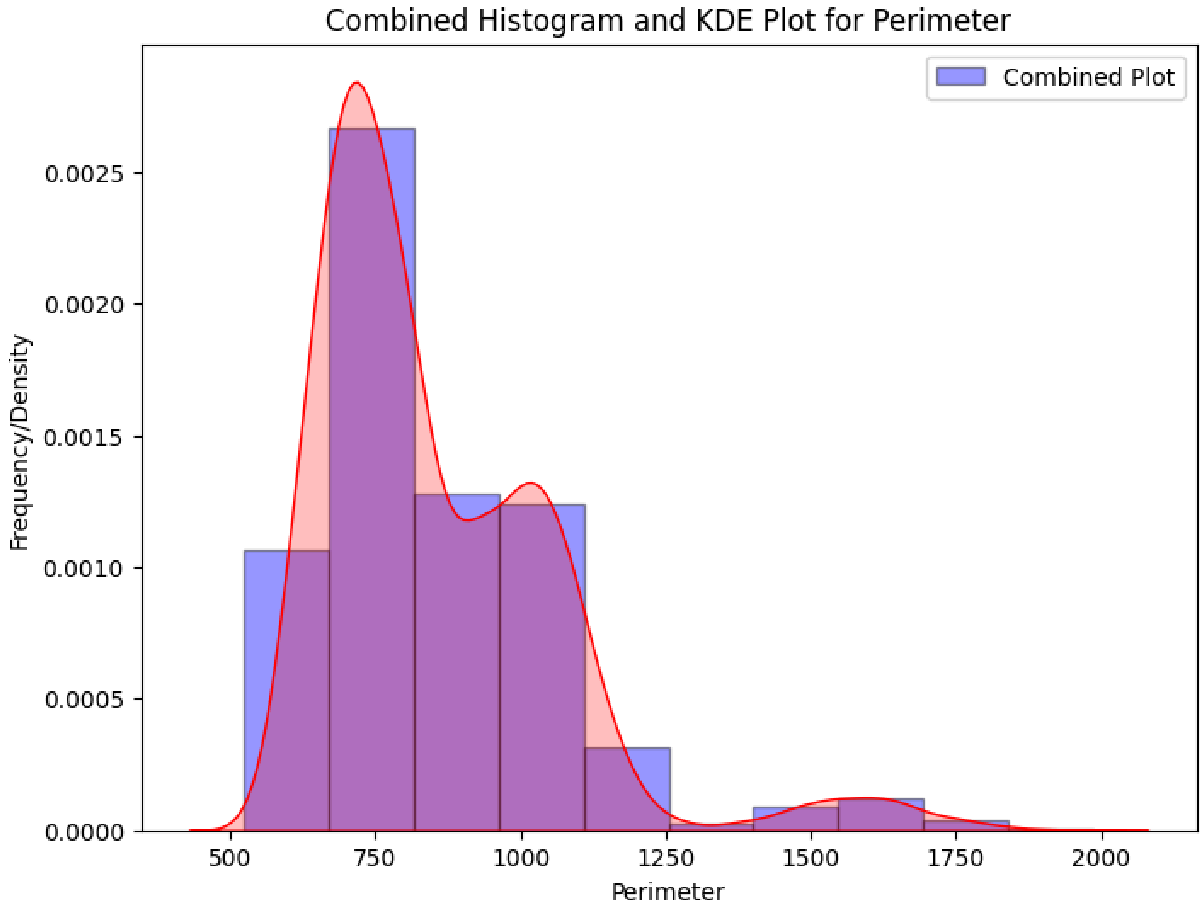
In [11]:

```
import seaborn as sns
import matplotlib.pyplot as plt

# Assuming 'df' is your DataFrame
for column in df.columns[:-1]:
    plt.figure(figsize=(8, 6))

    # Using sns.distplot for combined histogram and KDE plot
    sns.distplot(df[column], bins=10, hist_kws={'color': 'blue', 'edgecolor': 'blac

    plt.title(f'Combined Histogram and KDE Plot for {column}')
    plt.xlabel(column)
    plt.ylabel('Frequency/Density')
    plt.legend()

    plt.show()
```

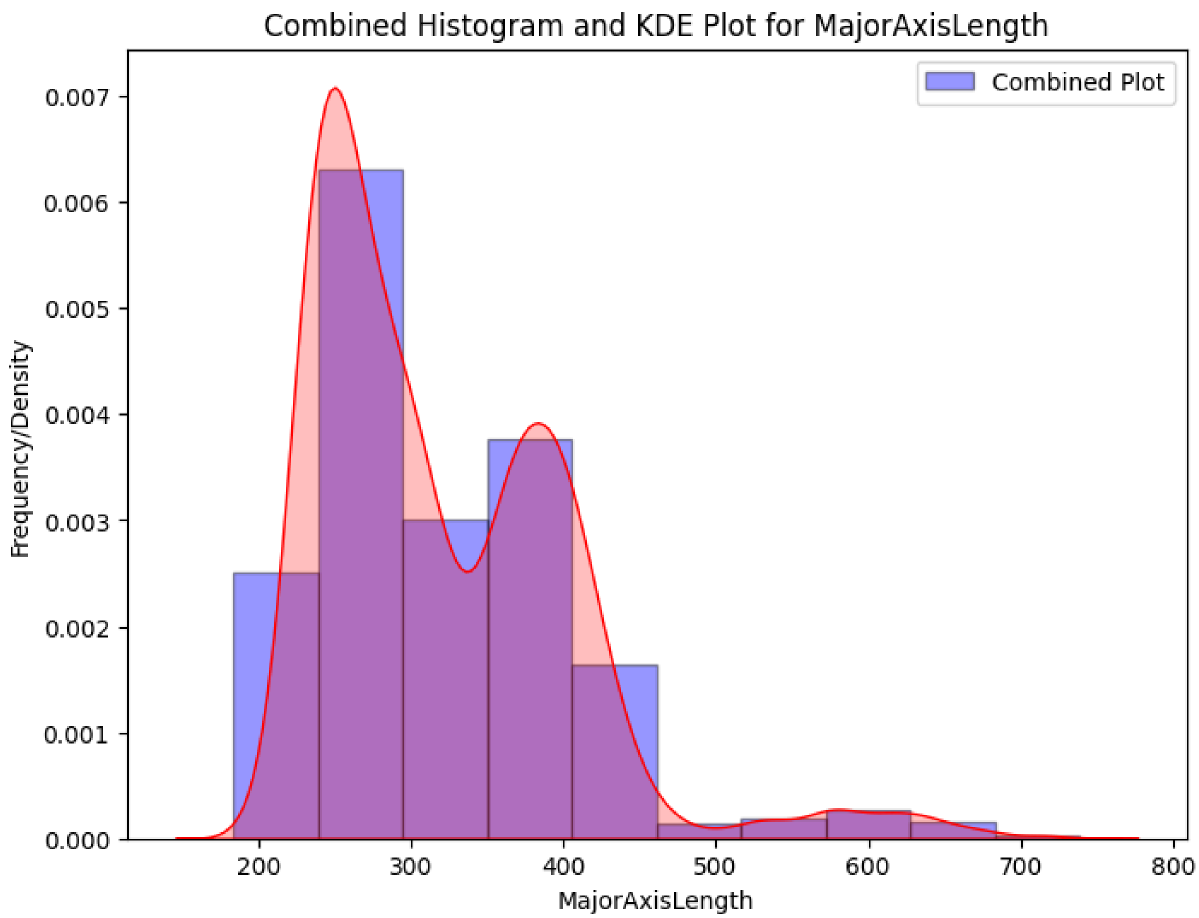
```
C:\Users\pavan\AppData\Local\Temp\ipykernel_14488\2934260078.py:9: UserWarning:

`distplot` is a deprecated function and will be removed in seaborn v0.14.0.

Please adapt your code to use either `displot` (a figure-level function with
similar flexibility) or `histplot` (an axes-level function for histograms).

For a guide to updating your code to use the new functions, please see
https://gist.github.com/mwaskom/de44147ed2974457ad6372750bbe5751

  sns.distplot(df[column], bins=10, hist_kws={'color': 'blue', 'edgecolor': 'blac
k'}, kde_kws={'color': 'red', 'fill': True}, label='Combined Plot')
```



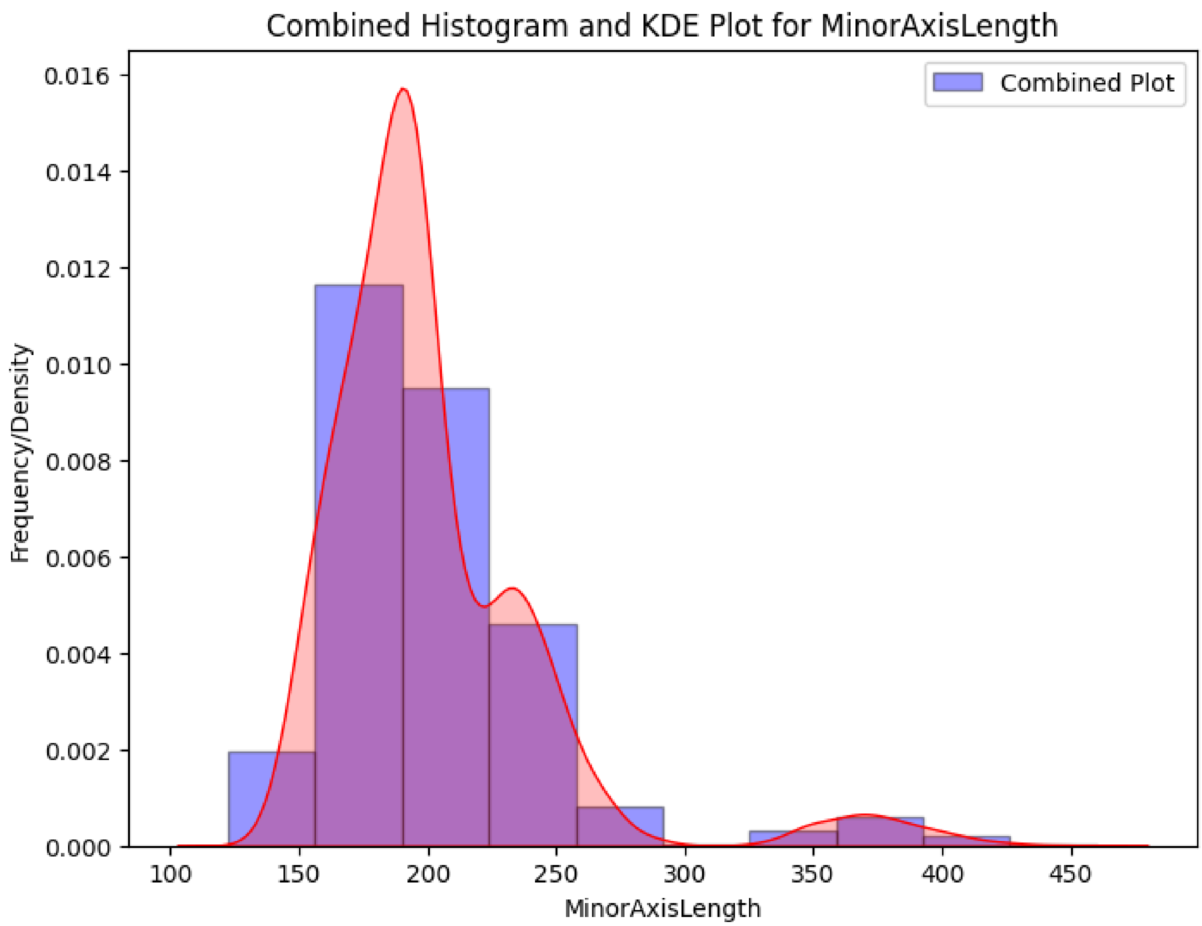

```
C:\Users\pavan\AppData\Local\Temp\ipykernel_14488\2934260078.py:9: UserWarning:

`distplot` is a deprecated function and will be removed in seaborn v0.14.0.

Please adapt your code to use either `displot` (a figure-level function with
similar flexibility) or `histplot` (an axes-level function for histograms).

For a guide to updating your code to use the new functions, please see
https://gist.github.com/mwaskom/de44147ed2974457ad6372750bbe5751

  sns.distplot(df[column], bins=10, hist_kws={'color': 'blue', 'edgecolor': 'blac
k'}, kde_kws={'color': 'red', 'fill': True}, label='Combined Plot')
```



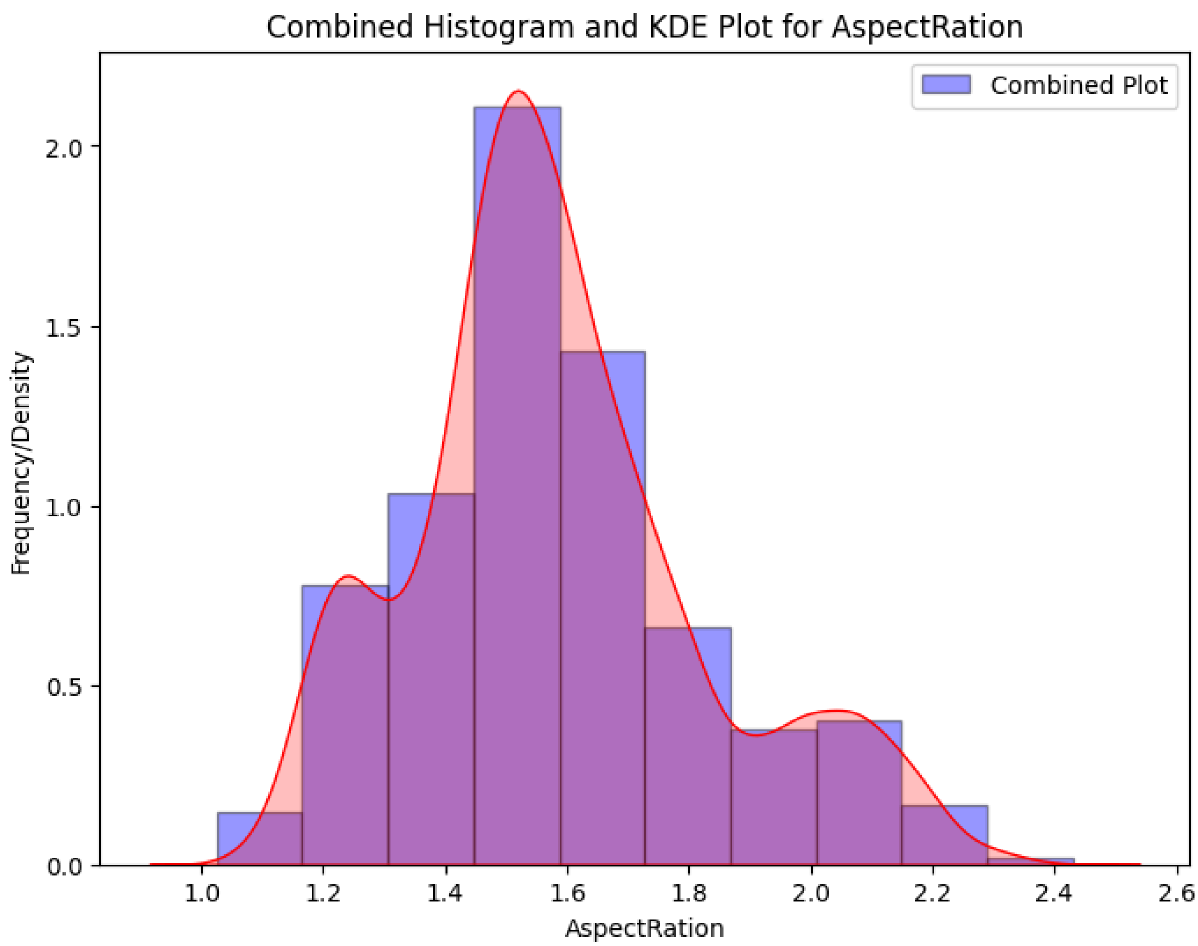

```
C:\Users\pavan\AppData\Local\Temp\ipykernel_14488\2934260078.py:9: UserWarning:

`distplot` is a deprecated function and will be removed in seaborn v0.14.0.

Please adapt your code to use either `displot` (a figure-level function with
similar flexibility) or `histplot` (an axes-level function for histograms).

For a guide to updating your code to use the new functions, please see
https://gist.github.com/mwaskom/de44147ed2974457ad6372750bbe5751

  sns.distplot(df[column], bins=10, hist_kws={'color': 'blue', 'edgecolor': 'blac
k'}, kde_kws={'color': 'red', 'fill': True}, label='Combined Plot')
```



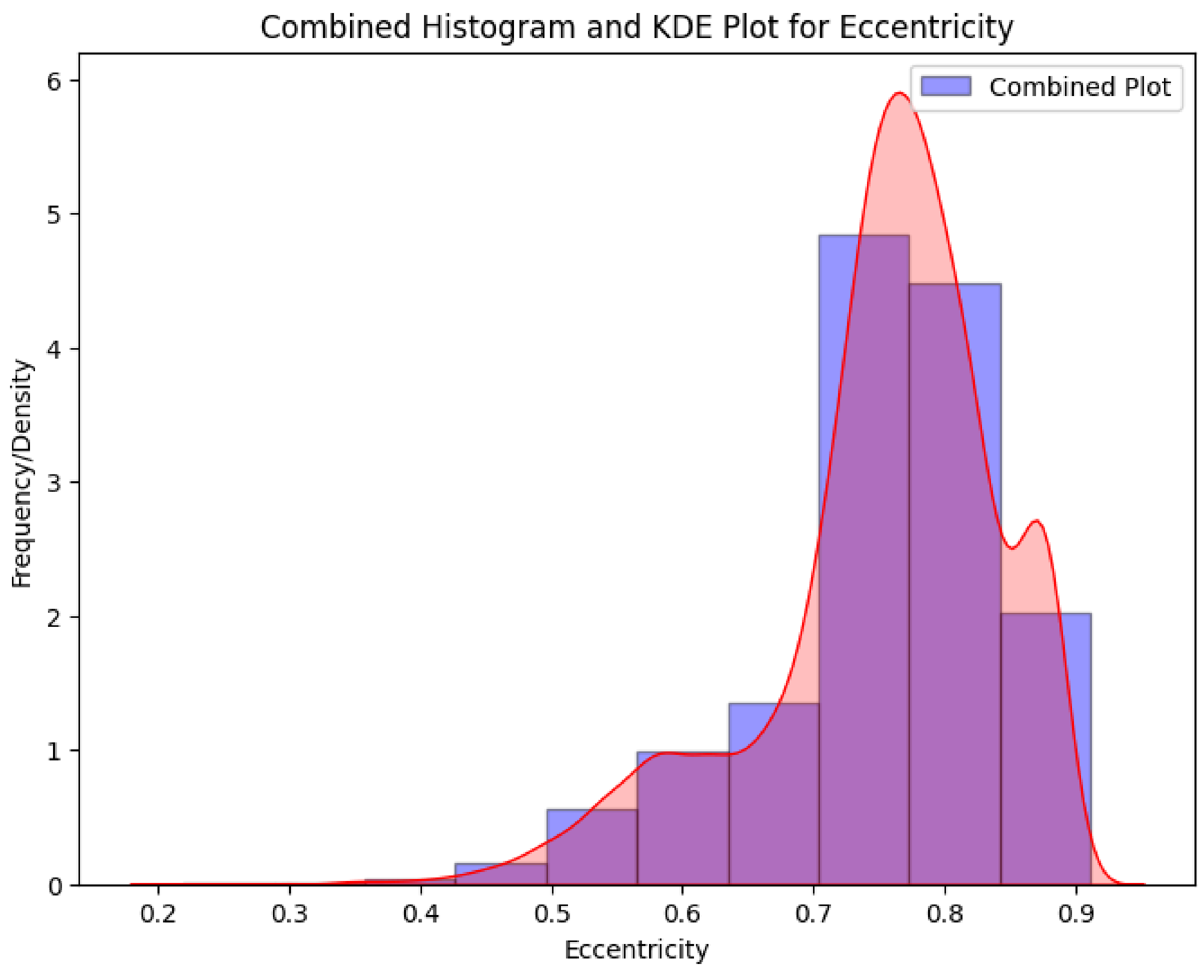

```
C:\Users\pavan\AppData\Local\Temp\ipykernel_14488\2934260078.py:9: UserWarning:

`distplot` is a deprecated function and will be removed in seaborn v0.14.0.

Please adapt your code to use either `displot` (a figure-level function with
similar flexibility) or `histplot` (an axes-level function for histograms).

For a guide to updating your code to use the new functions, please see
https://gist.github.com/mwaskom/de44147ed2974457ad6372750bbe5751

  sns.distplot(df[column], bins=10, hist_kws={'color': 'blue', 'edgecolor': 'blac
k'}, kde_kws={'color': 'red', 'fill': True}, label='Combined Plot')
```



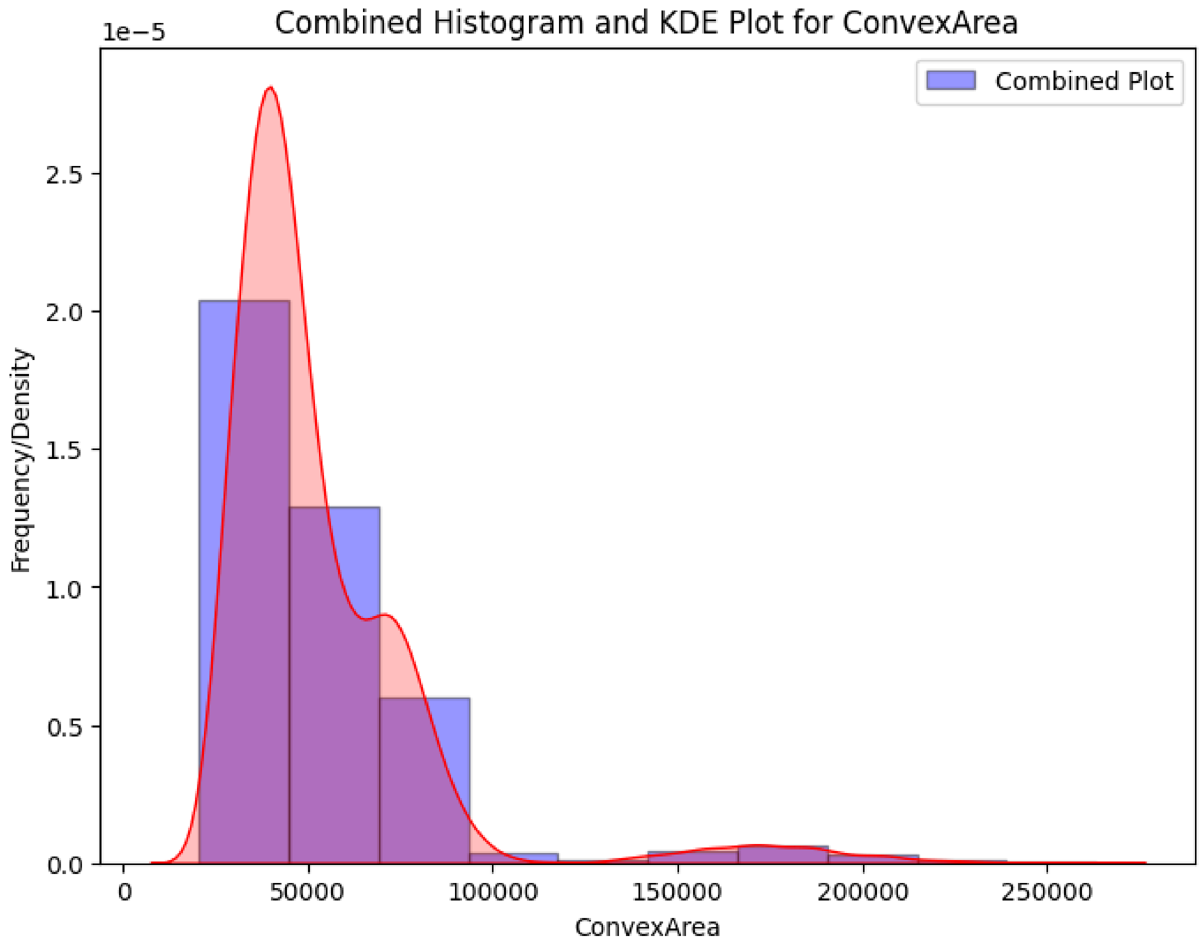

```
C:\Users\pavan\AppData\Local\Temp\ipykernel_14488\2934260078.py:9: UserWarning:

`distplot` is a deprecated function and will be removed in seaborn v0.14.0.

Please adapt your code to use either `displot` (a figure-level function with
similar flexibility) or `histplot` (an axes-level function for histograms).

For a guide to updating your code to use the new functions, please see
https://gist.github.com/mwaskom/de44147ed2974457ad6372750bbe5751

  sns.distplot(df[column], bins=10, hist_kws={'color': 'blue', 'edgecolor': 'blac
k'}, kde_kws={'color': 'red', 'fill': True}, label='Combined Plot')
```



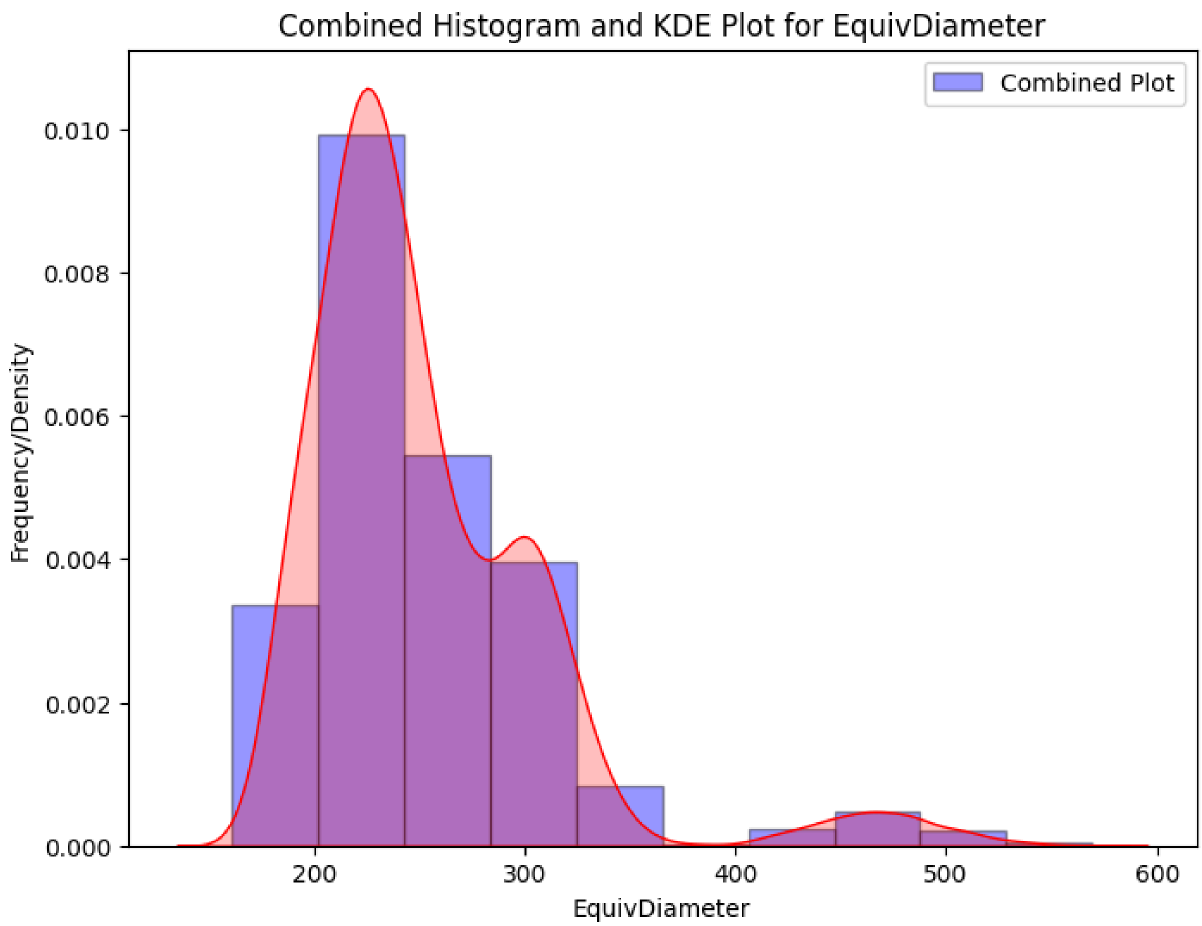

```
C:\Users\pavan\AppData\Local\Temp\ipykernel_14488\2934260078.py:9: UserWarning:

`distplot` is a deprecated function and will be removed in seaborn v0.14.0.

Please adapt your code to use either `displot` (a figure-level function with
similar flexibility) or `histplot` (an axes-level function for histograms).

For a guide to updating your code to use the new functions, please see
https://gist.github.com/mwaskom/de44147ed2974457ad6372750bbe5751

  sns.distplot(df[column], bins=10, hist_kws={'color': 'blue', 'edgecolor': 'blac
k'}, kde_kws={'color': 'red', 'fill': True}, label='Combined Plot')
```



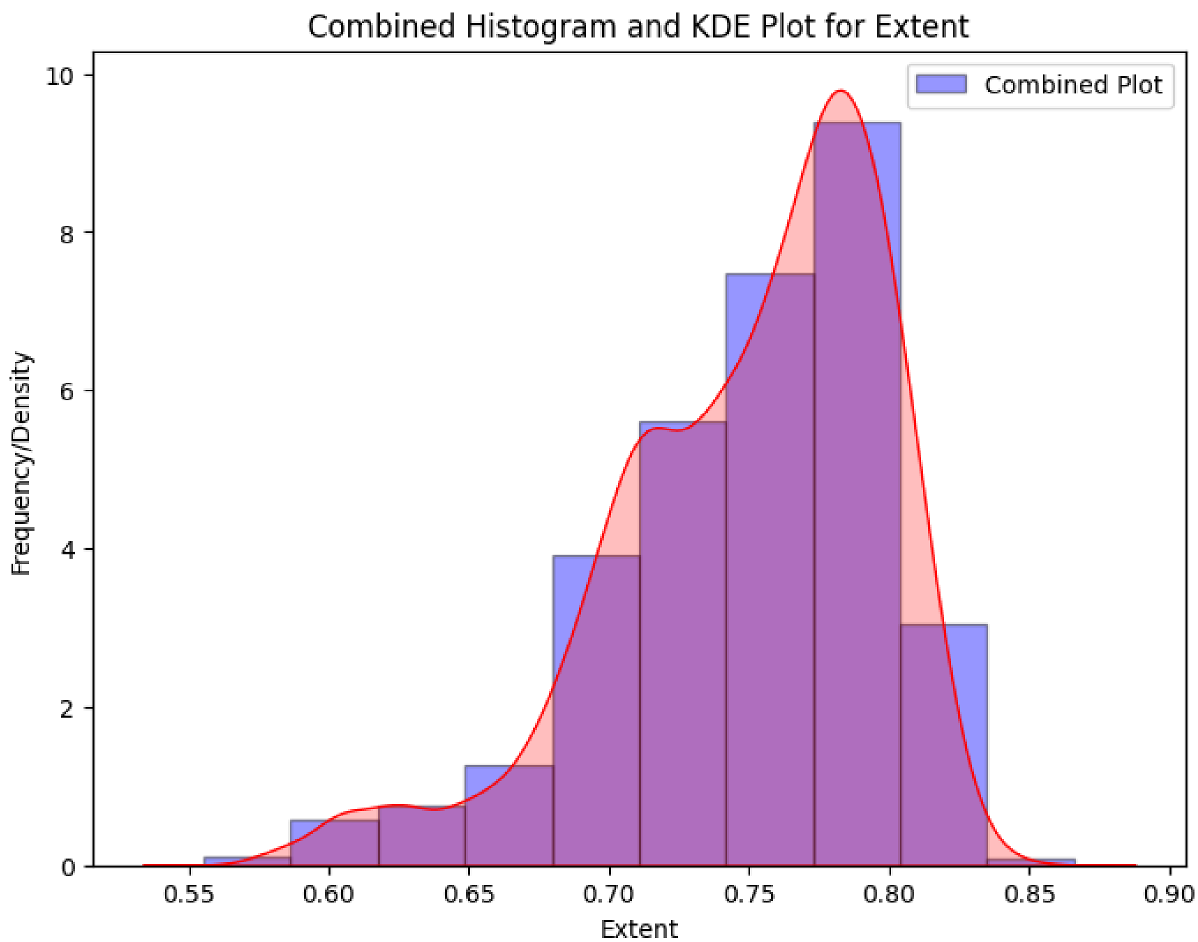

```
C:\Users\pavan\AppData\Local\Temp\ipykernel_14488\2934260078.py:9: UserWarning:

`distplot` is a deprecated function and will be removed in seaborn v0.14.0.

Please adapt your code to use either `displot` (a figure-level function with
similar flexibility) or `histplot` (an axes-level function for histograms).

For a guide to updating your code to use the new functions, please see
https://gist.github.com/mwaskom/de44147ed2974457ad6372750bbe5751

  sns.distplot(df[column], bins=10, hist_kws={'color': 'blue', 'edgecolor': 'blac
k'}, kde_kws={'color': 'red', 'fill': True}, label='Combined Plot')
```



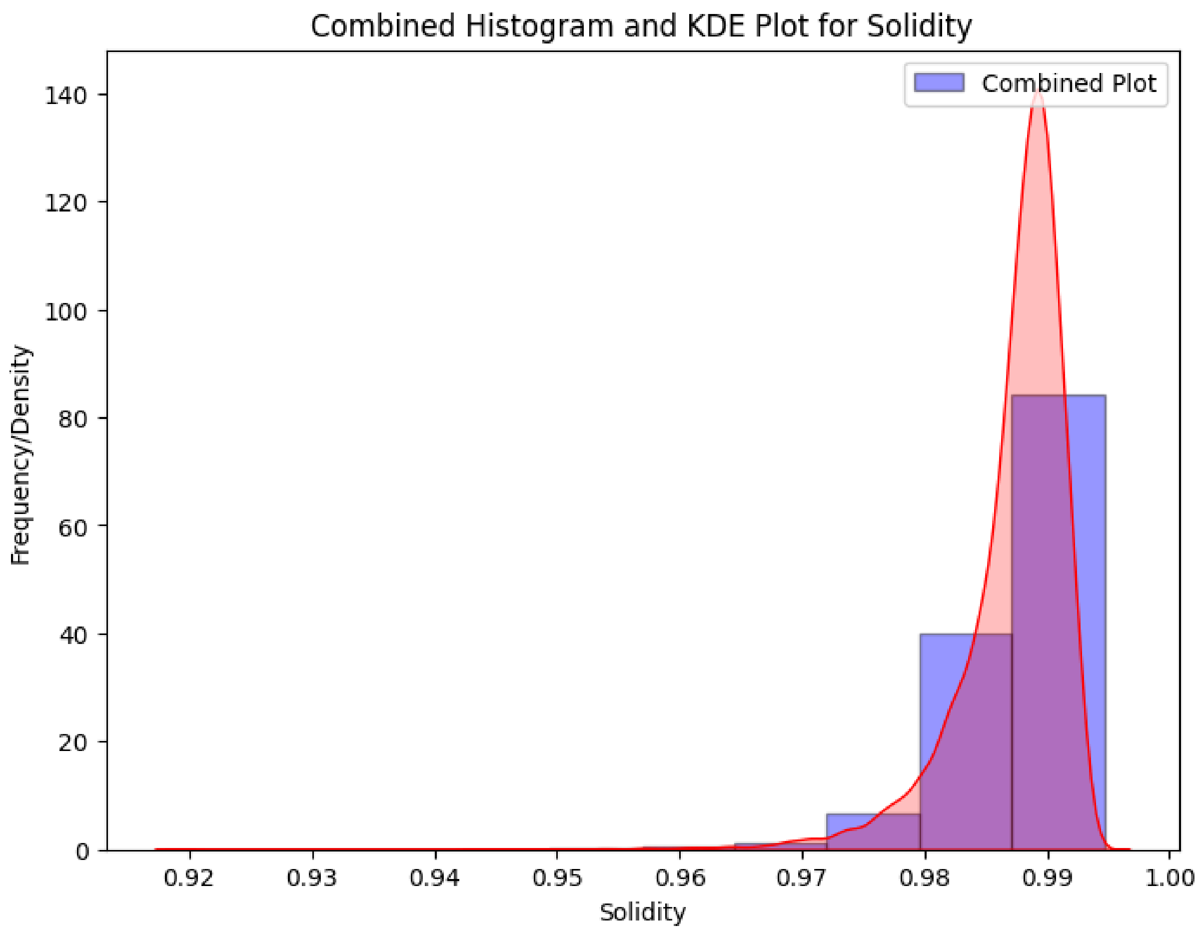

```
C:\Users\pavan\AppData\Local\Temp\ipykernel_14488\2934260078.py:9: UserWarning:

`distplot` is a deprecated function and will be removed in seaborn v0.14.0.

Please adapt your code to use either `displot` (a figure-level function with
similar flexibility) or `histplot` (an axes-level function for histograms).

For a guide to updating your code to use the new functions, please see
https://gist.github.com/mwaskom/de44147ed2974457ad6372750bbe5751

  sns.distplot(df[column], bins=10, hist_kws={'color': 'blue', 'edgecolor': 'blac
k'}, kde_kws={'color': 'red', 'fill': True}, label='Combined Plot')
```



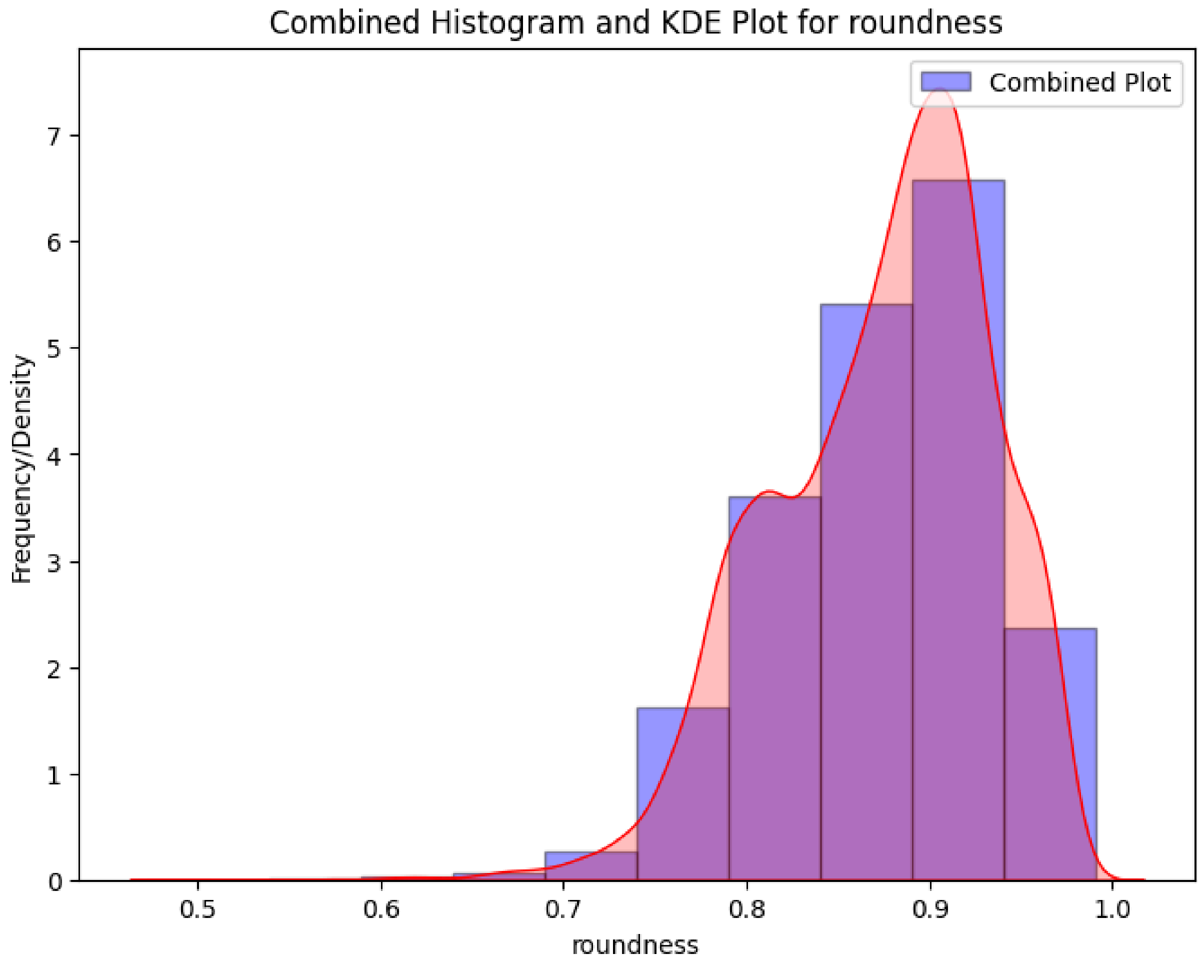

```
C:\Users\pavan\AppData\Local\Temp\ipykernel_14488\2934260078.py:9: UserWarning:

`distplot` is a deprecated function and will be removed in seaborn v0.14.0.

Please adapt your code to use either `displot` (a figure-level function with
similar flexibility) or `histplot` (an axes-level function for histograms).

For a guide to updating your code to use the new functions, please see
https://gist.github.com/mwaskom/de44147ed2974457ad6372750bbe5751

  sns.distplot(df[column], bins=10, hist_kws={'color': 'blue', 'edgecolor': 'blac
k'}, kde_kws={'color': 'red', 'fill': True}, label='Combined Plot')
```



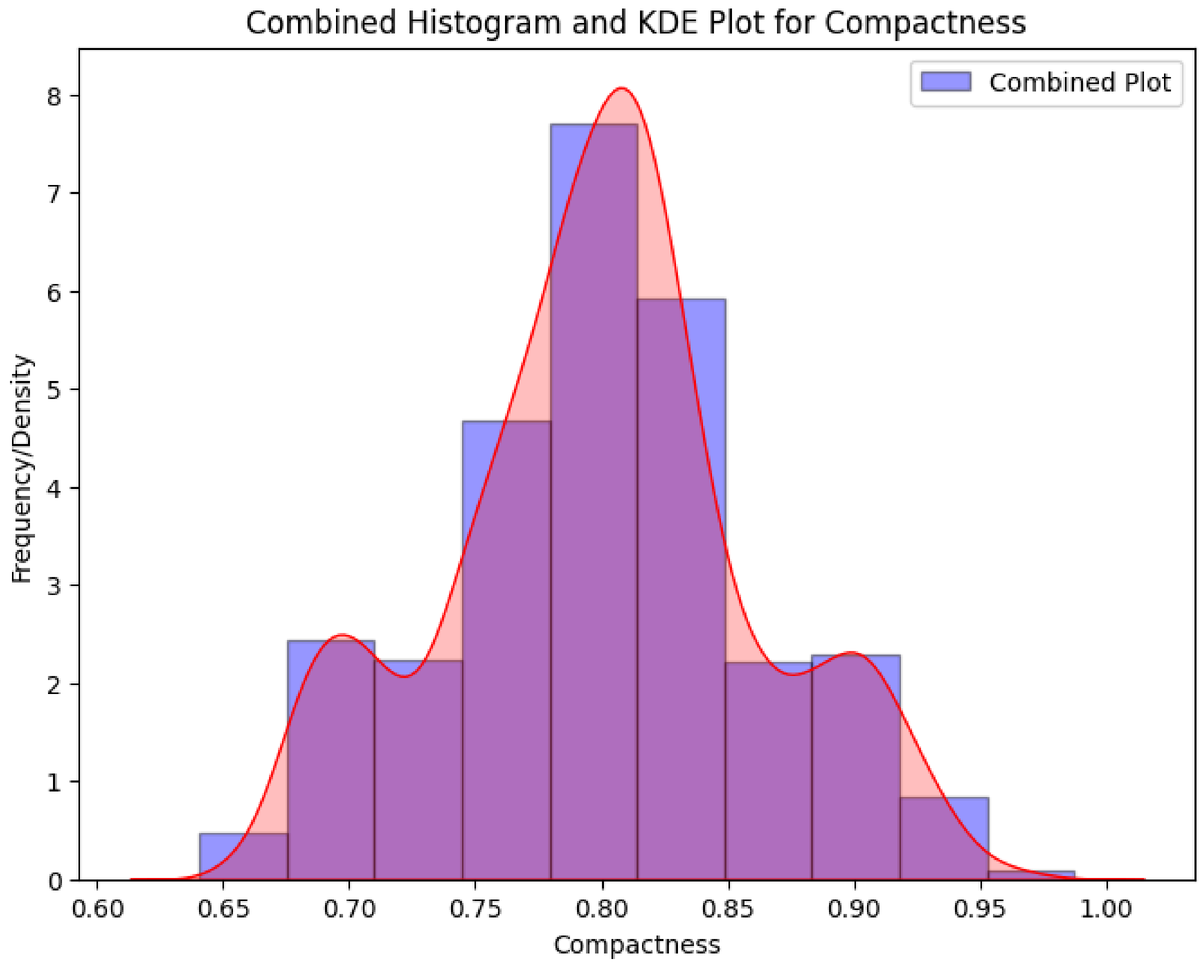

```
C:\Users\pavan\AppData\Local\Temp\ipykernel_14488\2934260078.py:9: UserWarning:

`distplot` is a deprecated function and will be removed in seaborn v0.14.0.

Please adapt your code to use either `displot` (a figure-level function with
similar flexibility) or `histplot` (an axes-level function for histograms).

For a guide to updating your code to use the new functions, please see
https://gist.github.com/mwaskom/de44147ed2974457ad6372750bbe5751

  sns.distplot(df[column], bins=10, hist_kws={'color': 'blue', 'edgecolor': 'blac
k'}, kde_kws={'color': 'red', 'fill': True}, label='Combined Plot')
```



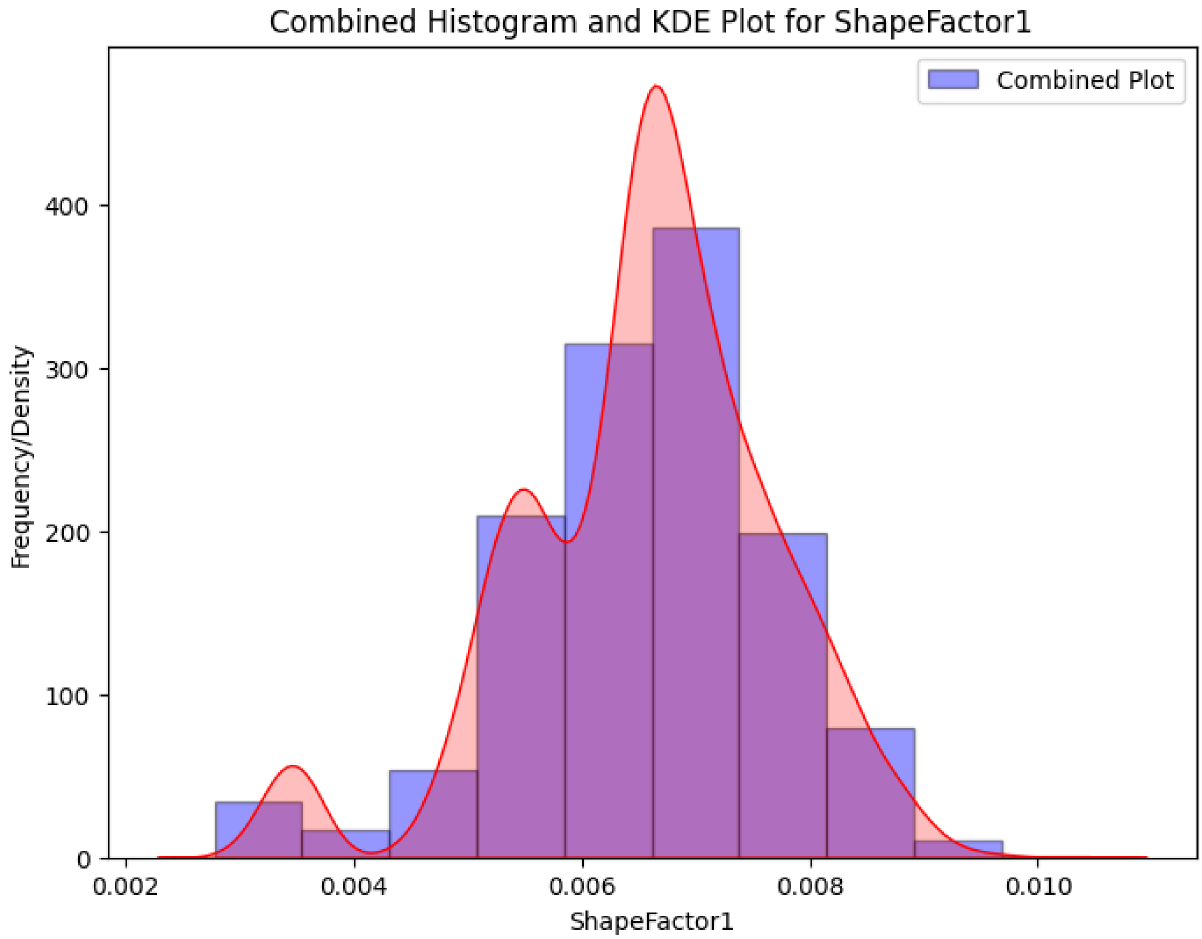

```
C:\Users\pavan\AppData\Local\Temp\ipykernel_14488\2934260078.py:9: UserWarning:

`distplot` is a deprecated function and will be removed in seaborn v0.14.0.

Please adapt your code to use either `displot` (a figure-level function with
similar flexibility) or `histplot` (an axes-level function for histograms).

For a guide to updating your code to use the new functions, please see
https://gist.github.com/mwaskom/de44147ed2974457ad6372750bbe5751

  sns.distplot(df[column], bins=10, hist_kws={'color': 'blue', 'edgecolor': 'blac
k'}, kde_kws={'color': 'red', 'fill': True}, label='Combined Plot')
```



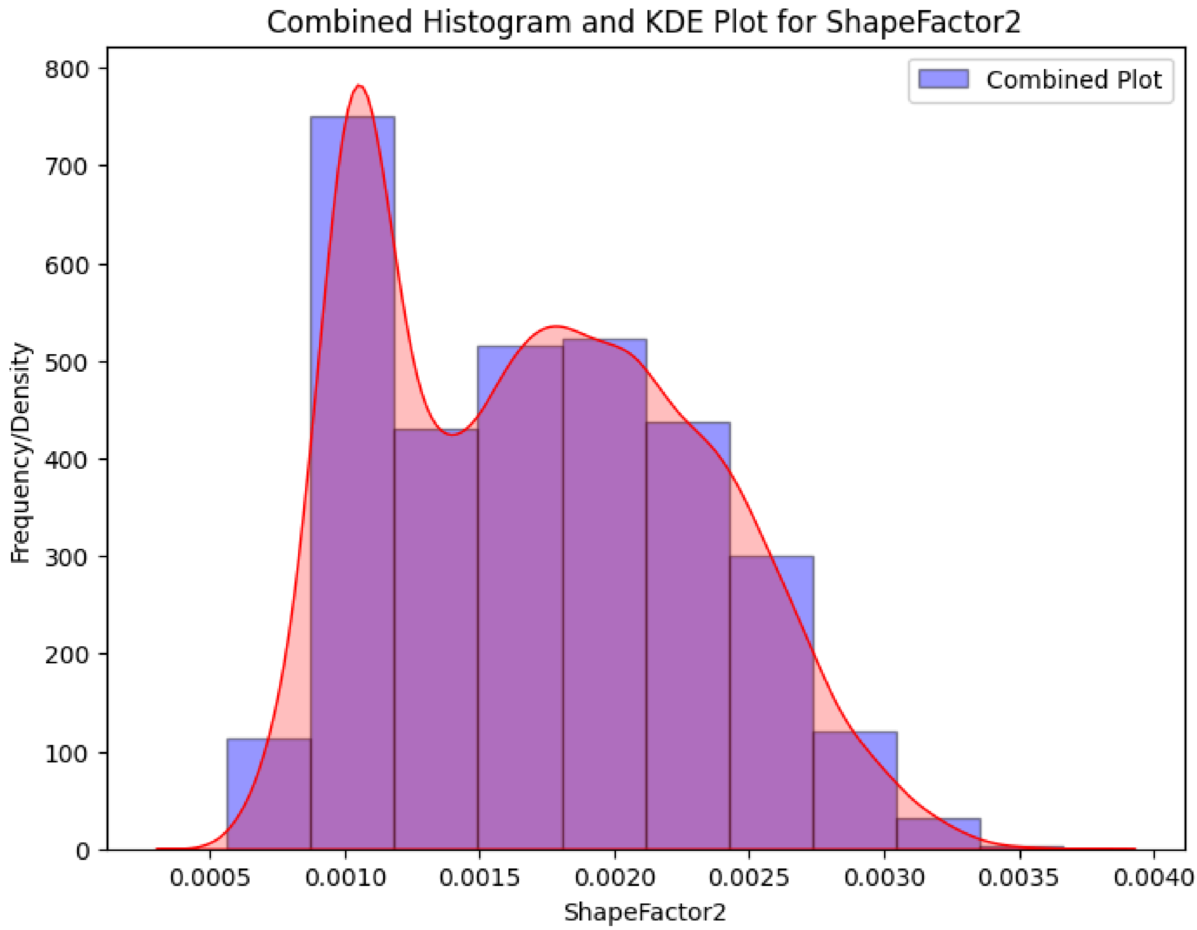

```
C:\Users\pavan\AppData\Local\Temp\ipykernel_14488\2934260078.py:9: UserWarning:

`distplot` is a deprecated function and will be removed in seaborn v0.14.0.

Please adapt your code to use either `displot` (a figure-level function with
similar flexibility) or `histplot` (an axes-level function for histograms).

For a guide to updating your code to use the new functions, please see
https://gist.github.com/mwaskom/de44147ed2974457ad6372750bbe5751

  sns.distplot(df[column], bins=10, hist_kws={'color': 'blue', 'edgecolor': 'blac
k'}, kde_kws={'color': 'red', 'fill': True}, label='Combined Plot')
```



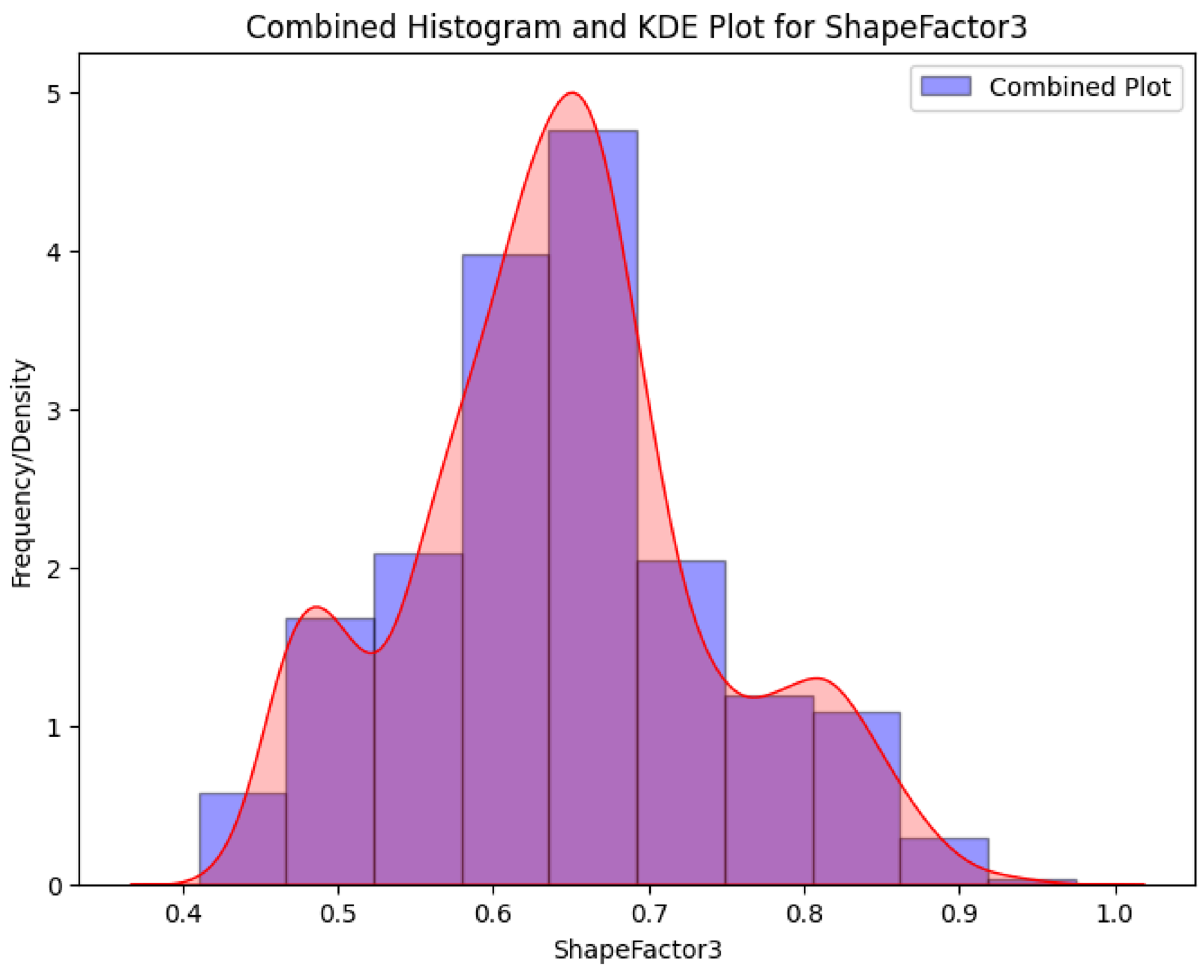

```
C:\Users\pavan\AppData\Local\Temp\ipykernel_14488\2934260078.py:9: UserWarning:

`distplot` is a deprecated function and will be removed in seaborn v0.14.0.

Please adapt your code to use either `displot` (a figure-level function with
similar flexibility) or `histplot` (an axes-level function for histograms).

For a guide to updating your code to use the new functions, please see
https://gist.github.com/mwaskom/de44147ed2974457ad6372750bbe5751

  sns.distplot(df[column], bins=10, hist_kws={'color': 'blue', 'edgecolor': 'blac
k'}, kde_kws={'color': 'red', 'fill': True}, label='Combined Plot')
```



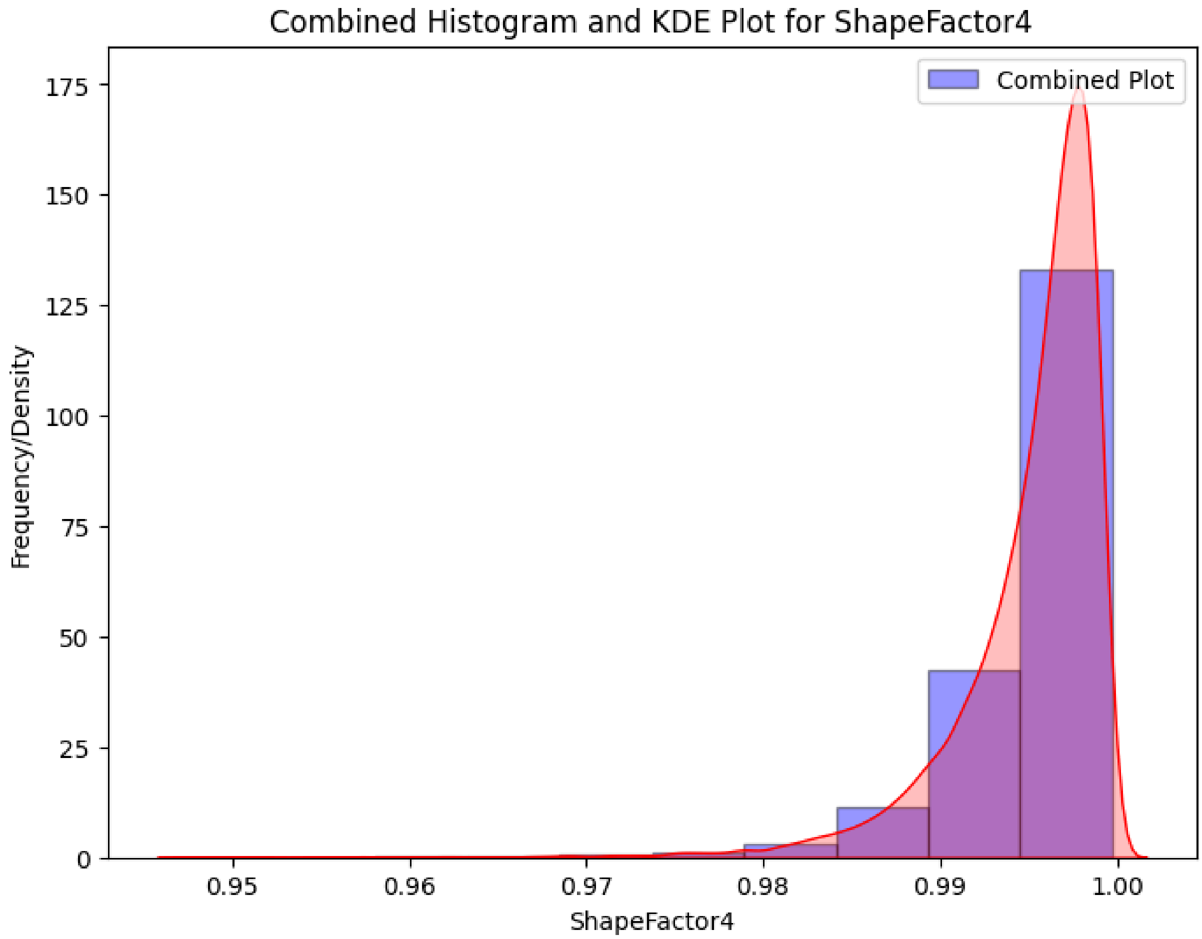

```
C:\Users\pavan\AppData\Local\Temp\ipykernel_14488\2934260078.py:9: UserWarning:

`distplot` is a deprecated function and will be removed in seaborn v0.14.0.

Please adapt your code to use either `displot` (a figure-level function with
similar flexibility) or `histplot` (an axes-level function for histograms).

For a guide to updating your code to use the new functions, please see
https://gist.github.com/mwaskom/de44147ed2974457ad6372750bbe5751

  sns.distplot(df[column], bins=10, hist_kws={'color': 'blue', 'edgecolor': 'blac
k'}, kde_kws={'color': 'red', 'fill': True}, label='Combined Plot')
```



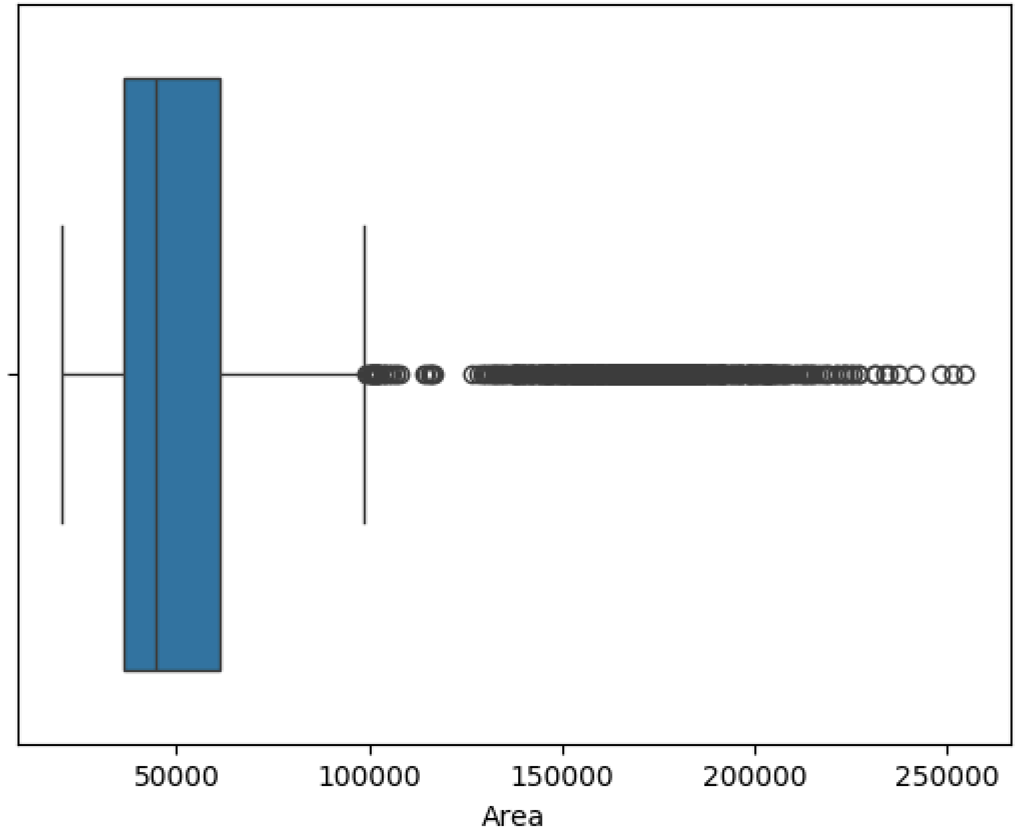

```
C:\Users\pavan\AppData\Local\Temp\ipykernel_14488\2934260078.py:9: UserWarning:

`distplot` is a deprecated function and will be removed in seaborn v0.14.0.

Please adapt your code to use either `displot` (a figure-level function with
similar flexibility) or `histplot` (an axes-level function for histograms).

For a guide to updating your code to use the new functions, please see
https://gist.github.com/mwaskom/de44147ed2974457ad6372750bbe5751

  sns.distplot(df[column], bins=10, hist_kws={'color': 'blue', 'edgecolor': 'blac
k'}, kde_kws={'color': 'red', 'fill': True}, label='Combined Plot')
```

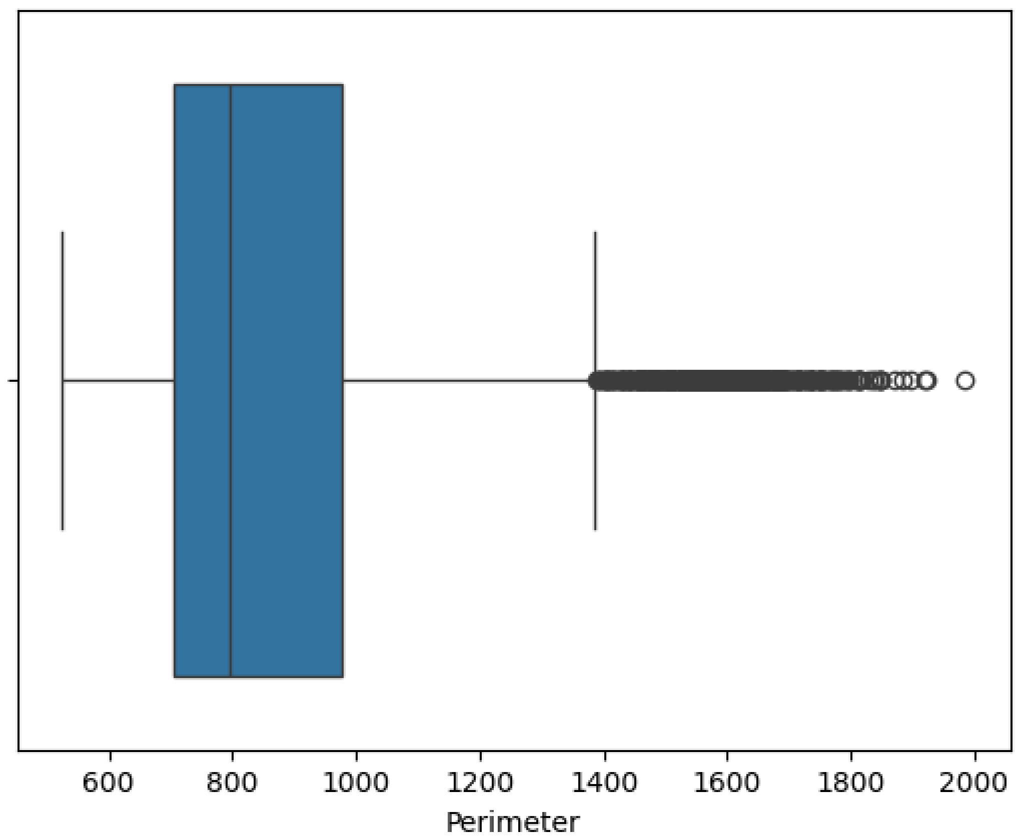


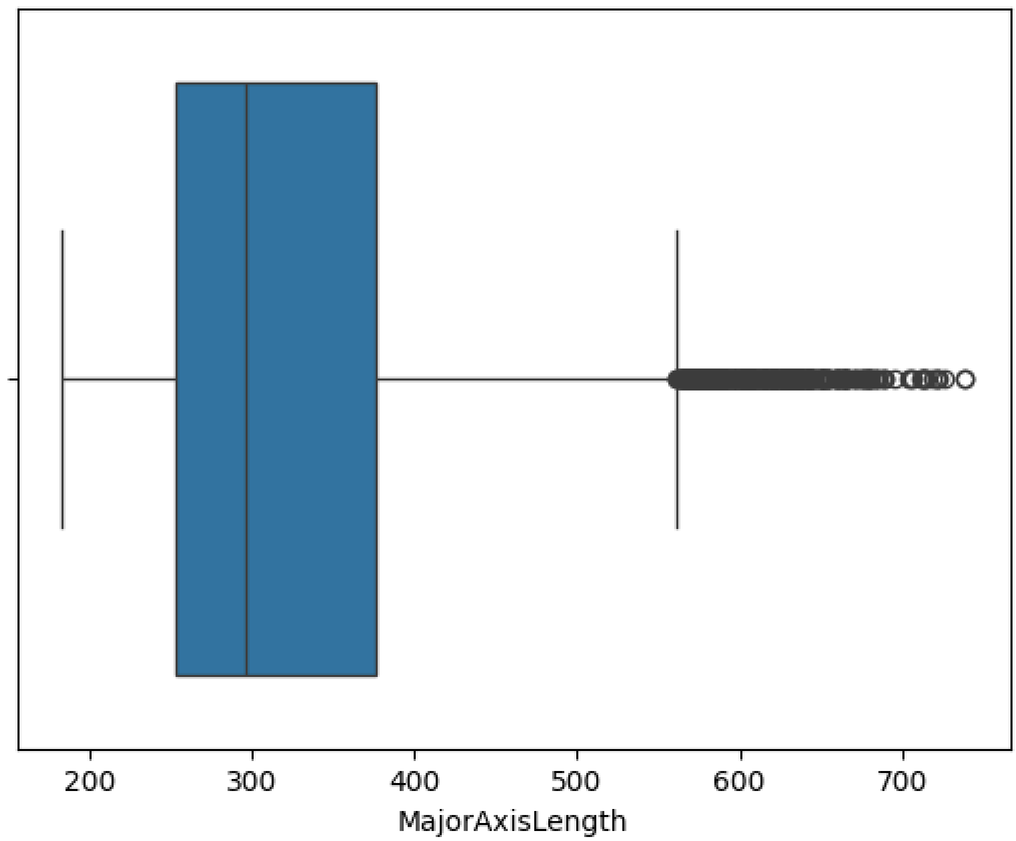

```
C:\Users\pavan\AppData\Local\Temp\ipykernel_14488\2934260078.py:9: UserWarning:

`distplot` is a deprecated function and will be removed in seaborn v0.14.0.

Please adapt your code to use either `displot` (a figure-level function with
similar flexibility) or `histplot` (an axes-level function for histograms).

For a guide to updating your code to use the new functions, please see
https://gist.github.com/mwaskom/de44147ed2974457ad6372750bbe5751

  sns.distplot(df[column], bins=10, hist_kws={'color': 'blue', 'edgecolor': 'blac
k'}, kde_kws={'color': 'red', 'fill': True}, label='Combined Plot')
```

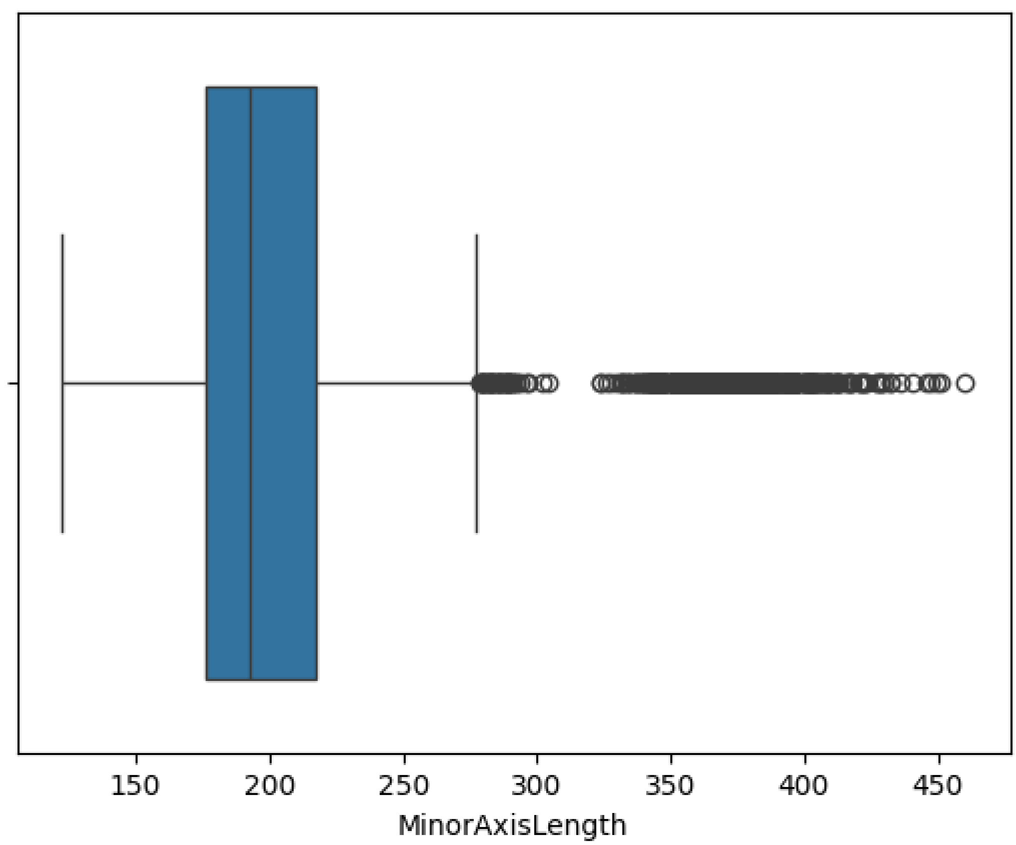


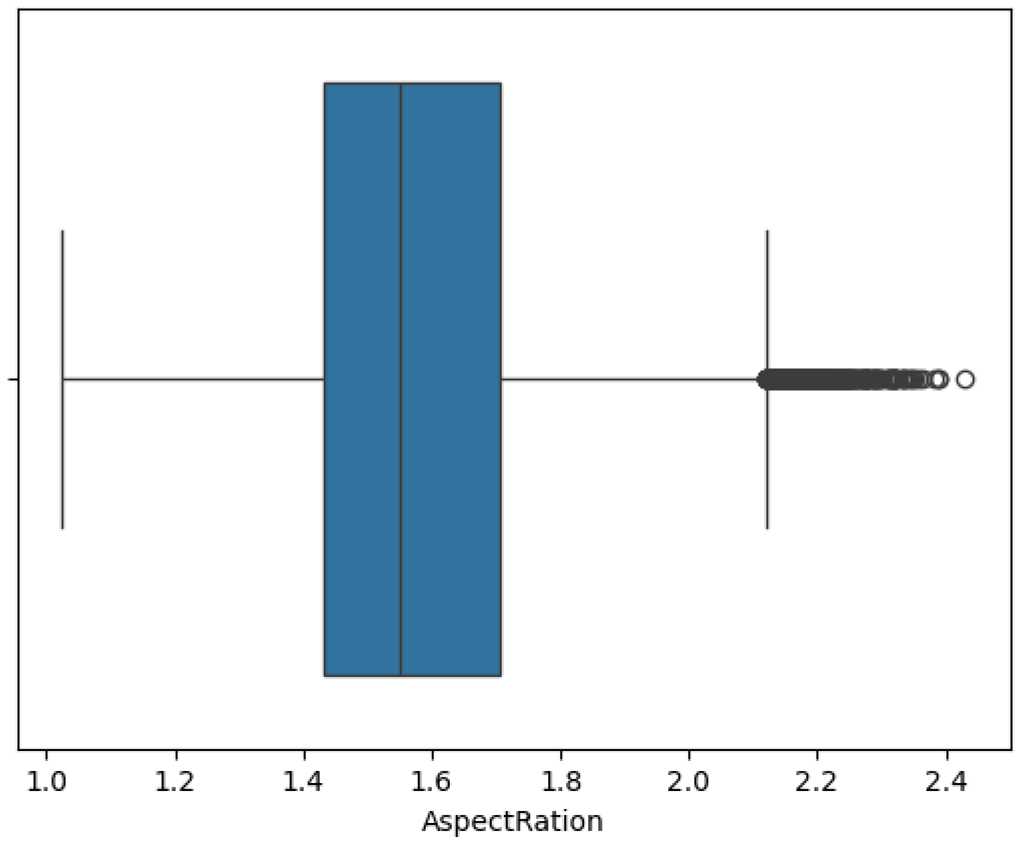
In [12]:
```
for i in df.columns[:-1]:
    sns.boxplot(data=df,x=df[i])
    plt.show()
```

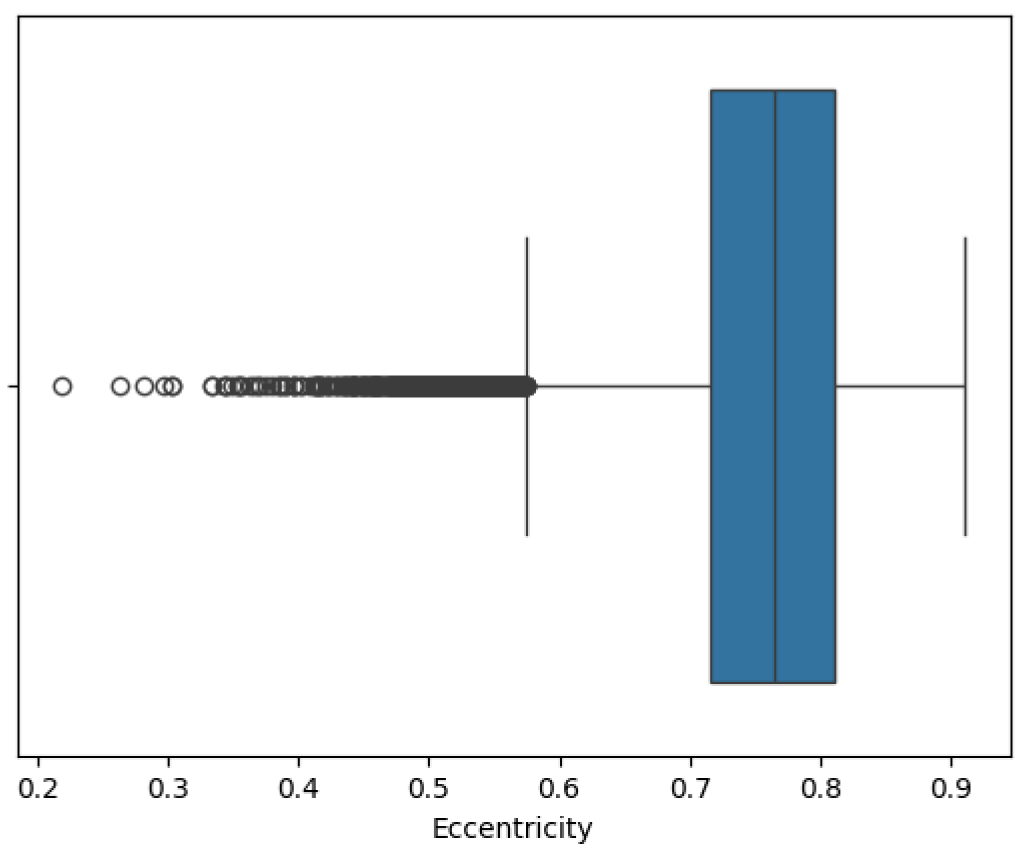

50000
100000
150000
200000
250000
Area

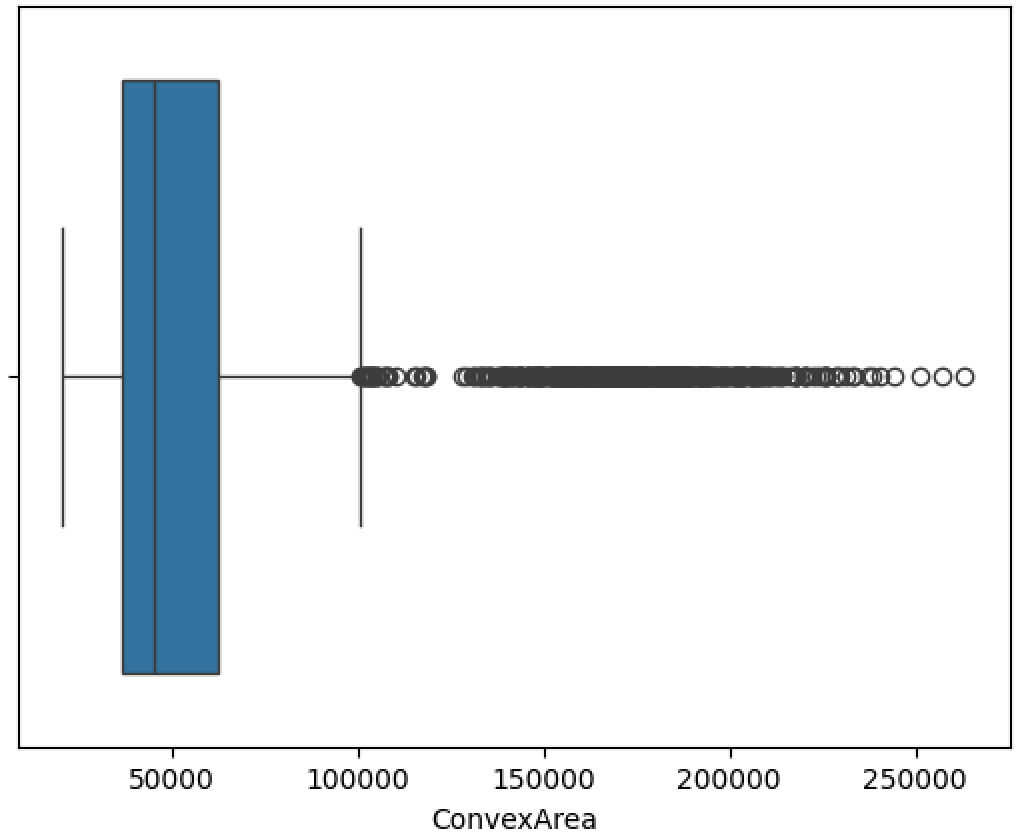

600
800
1000
1200
1400
1600
1800
2000
Perimeter

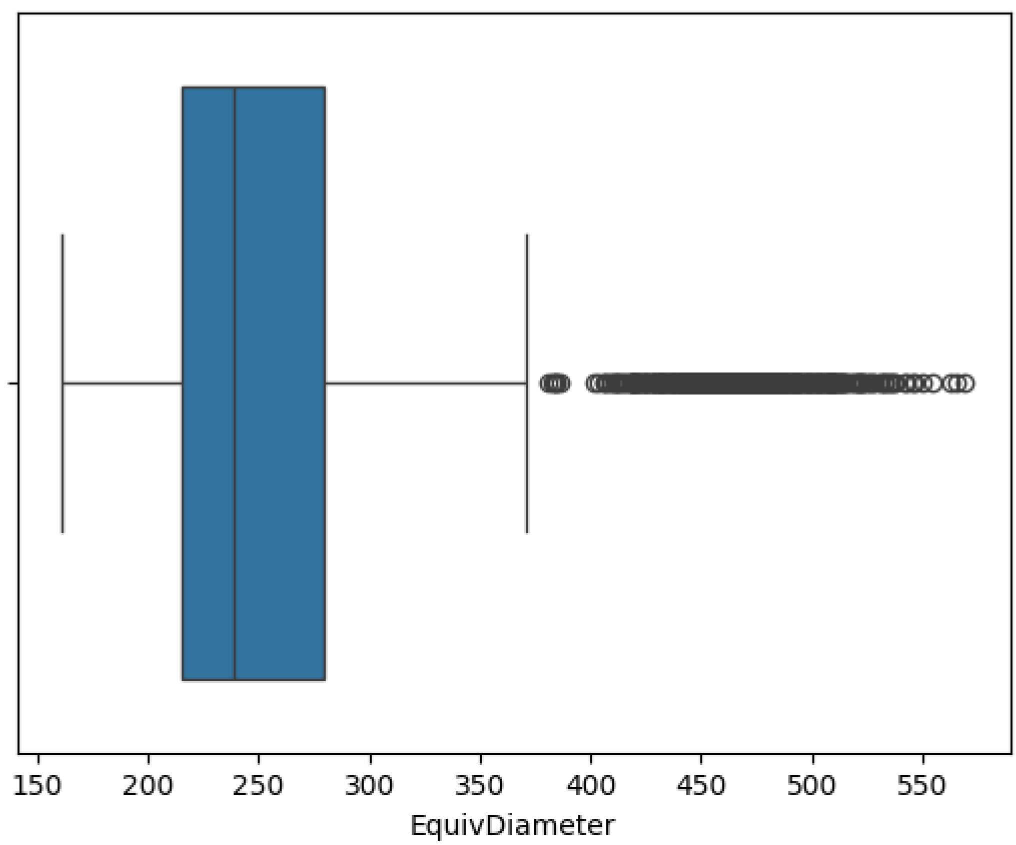

200
300
400
500
600
700
MajorAxisLength

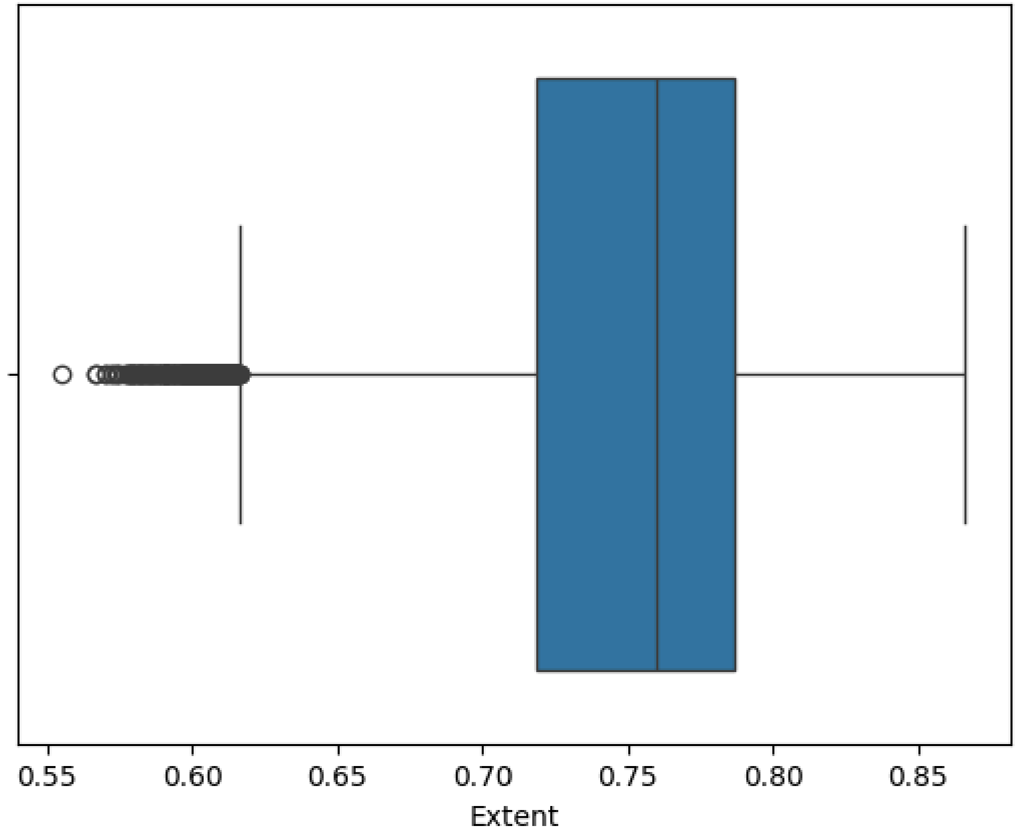

150
200
250
300
350
400
450
MinorAxisLength

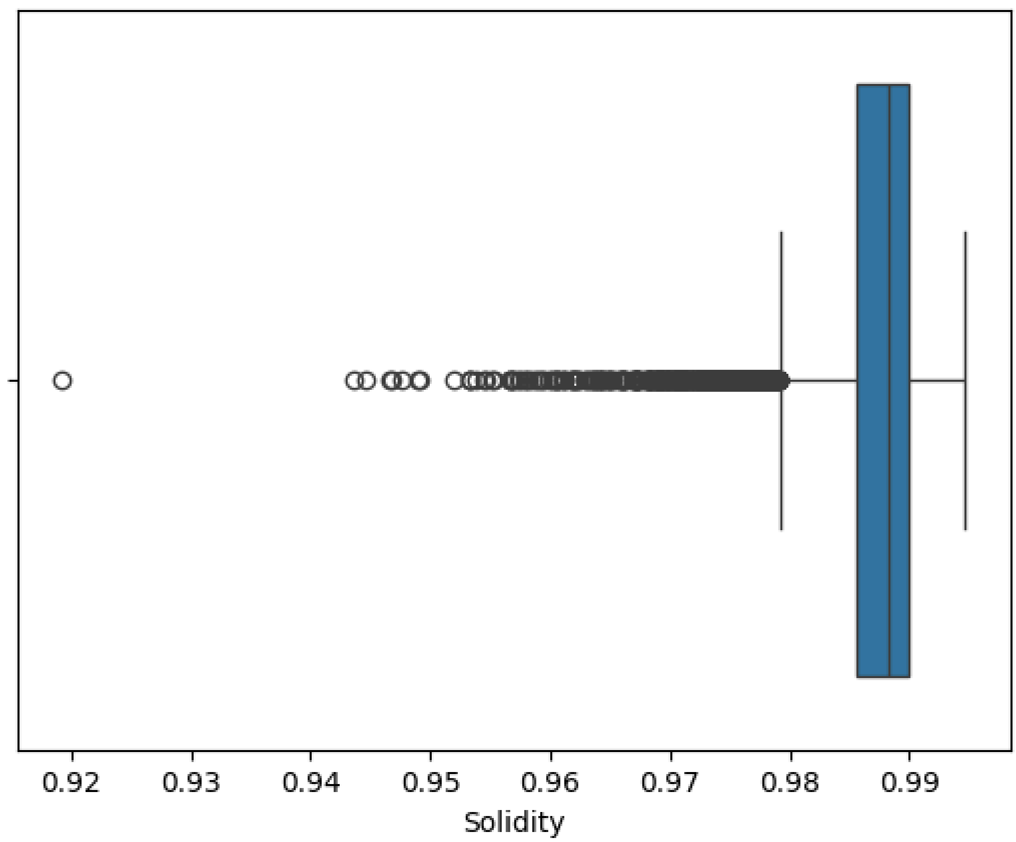

1.0
1.2
1.4
1.6
1.8
2.0
2.2
2.4
AspectRation

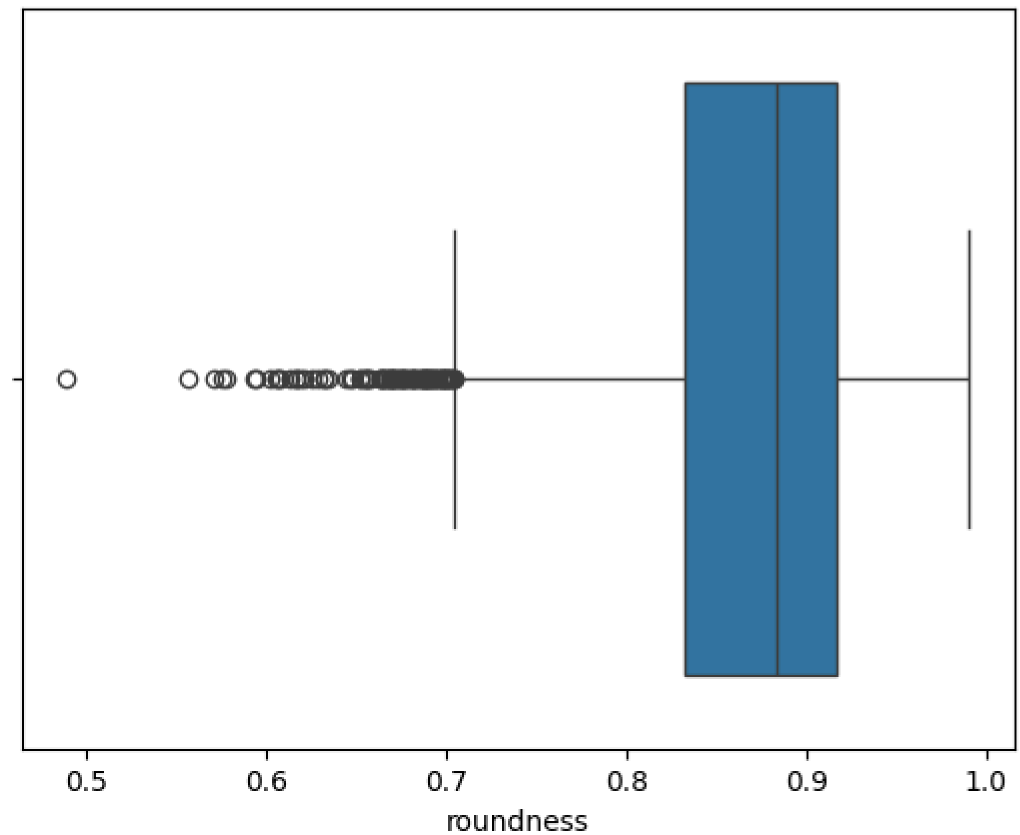

0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
Eccentricity

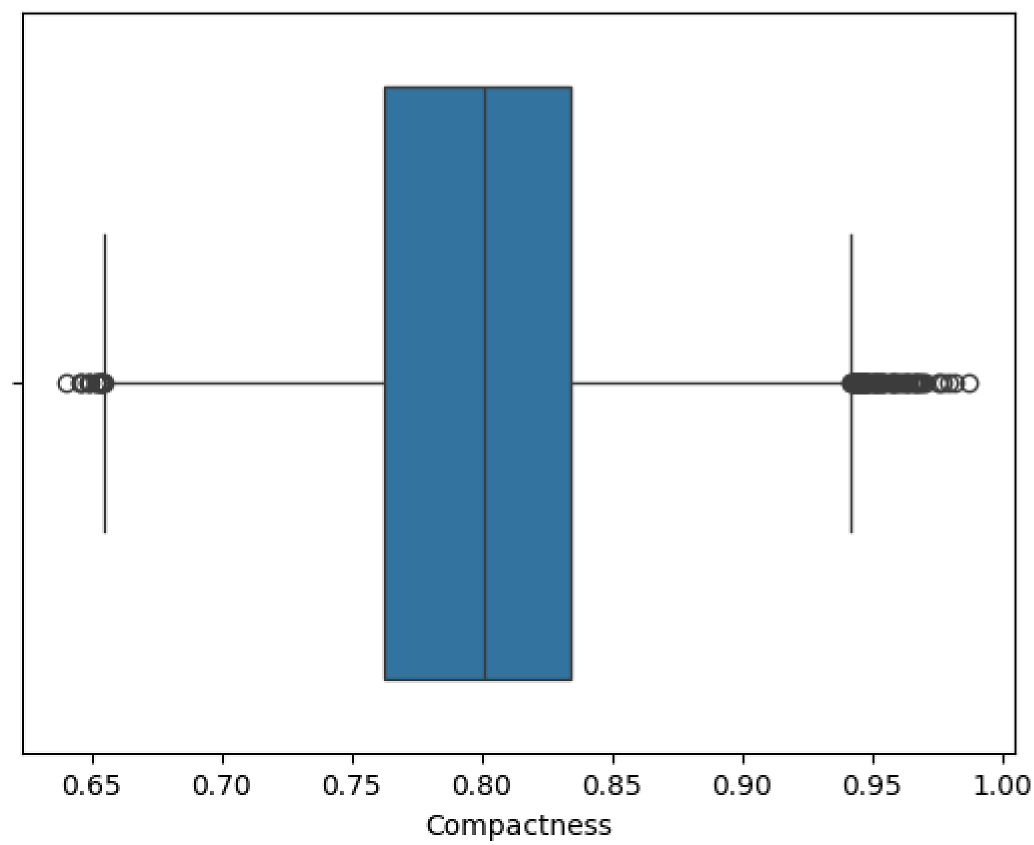

50000
100000
150000
200000
250000
ConvexArea

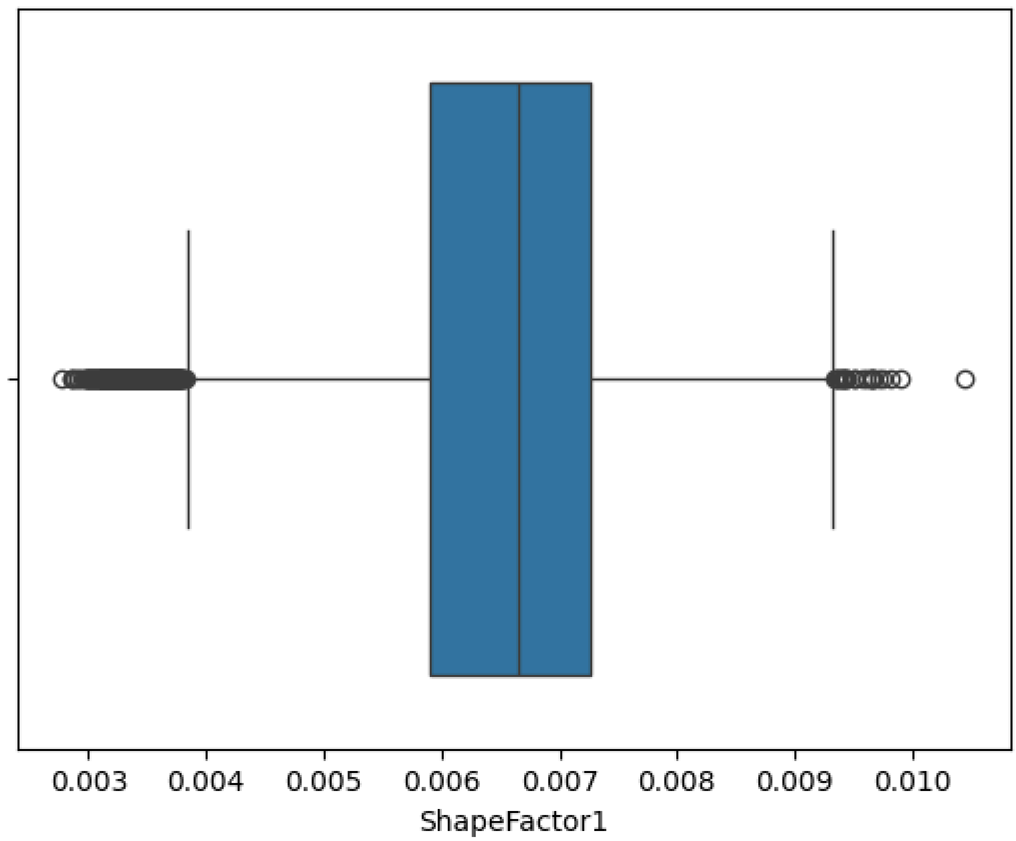

150
200
250
300
350
400
450
500
550
EquivDiameter

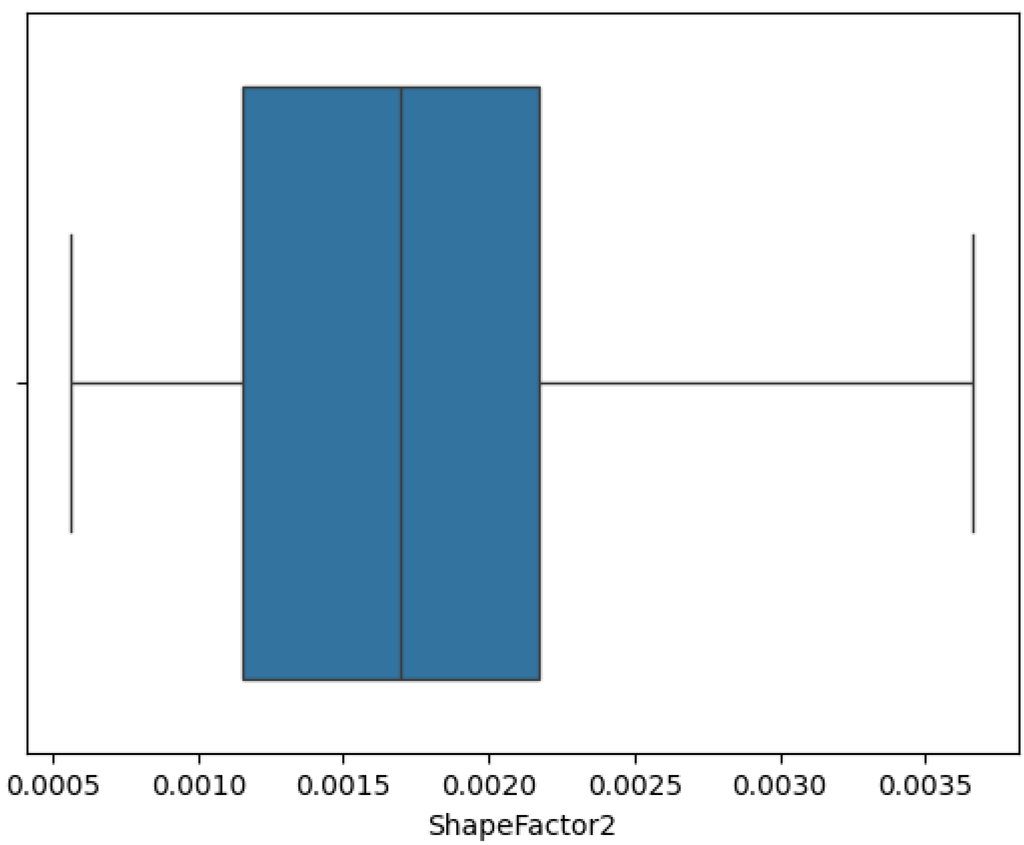

0.55
0.60
0.65
0.70
0.75
0.80
0.85
Extent

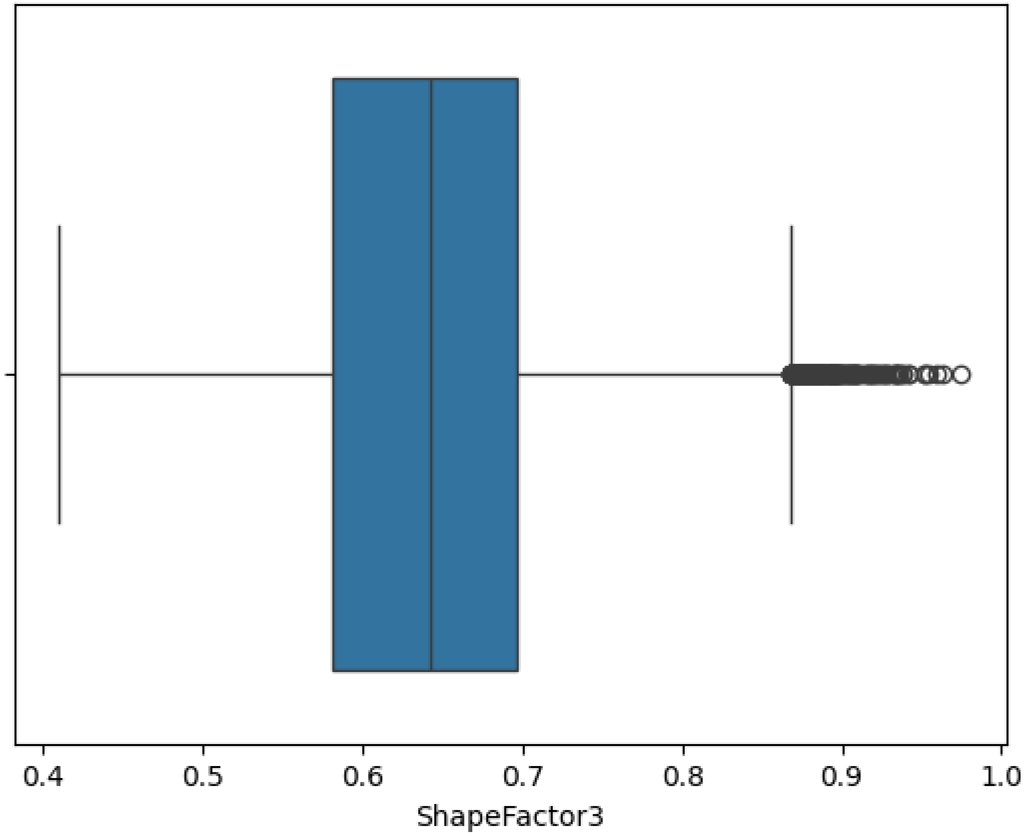

0.92
0.93
0.94
0.95
0.96
0.97
0.98
0.99
Solidity

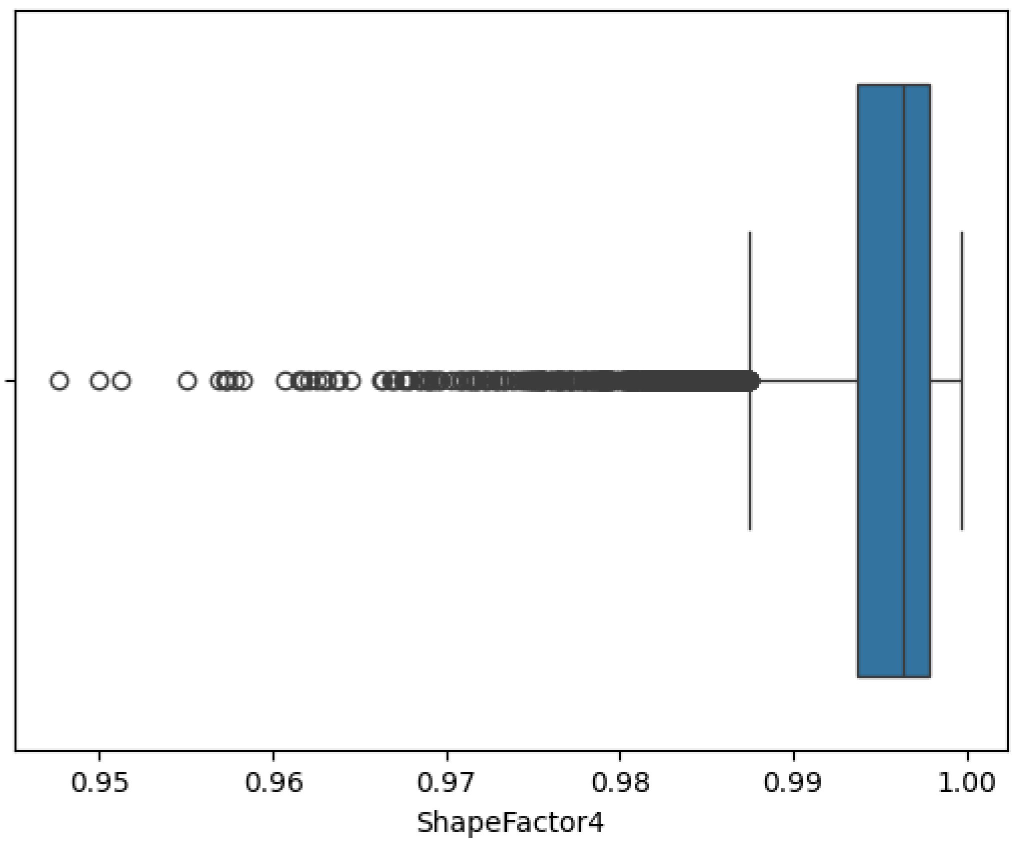

0.5
0.6
0.7
0.8
0.9
1.0
roundness


0.65
0.70
0.75
0.80
0.85
0.90
0.95
1.00
Compactness


0.003
0.004
0.005
0.006
0.007
0.008
0.009
0.010
ShapeFactor1

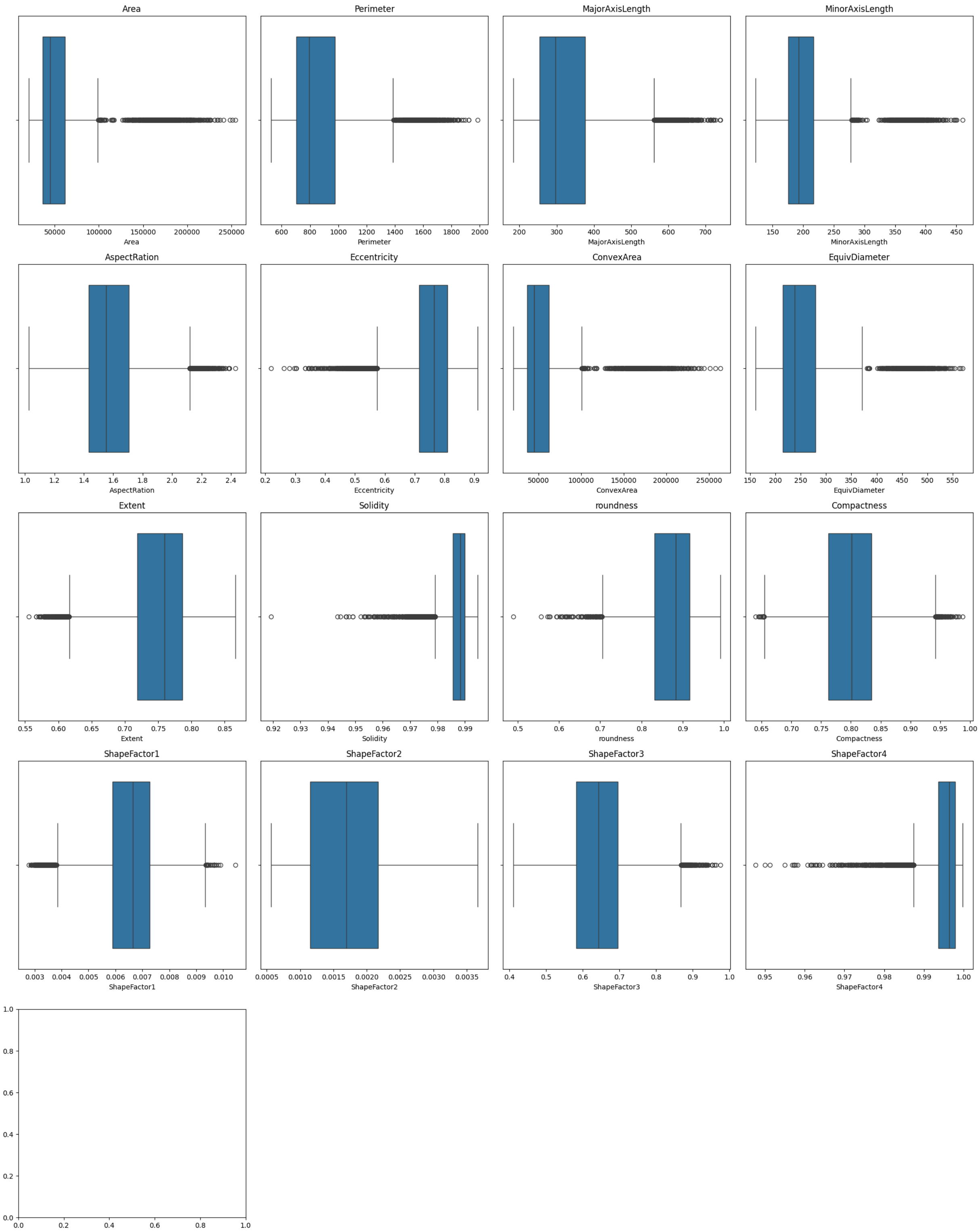

0.0005
0.0010
0.0015
0.0020
0.0025
0.0030
0.0035
ShapeFactor2





In [14]:
```
num_plots = len(df.columns)
num_cols = 4
num_rows = (num_plots + num_cols - 1) // num_cols
```

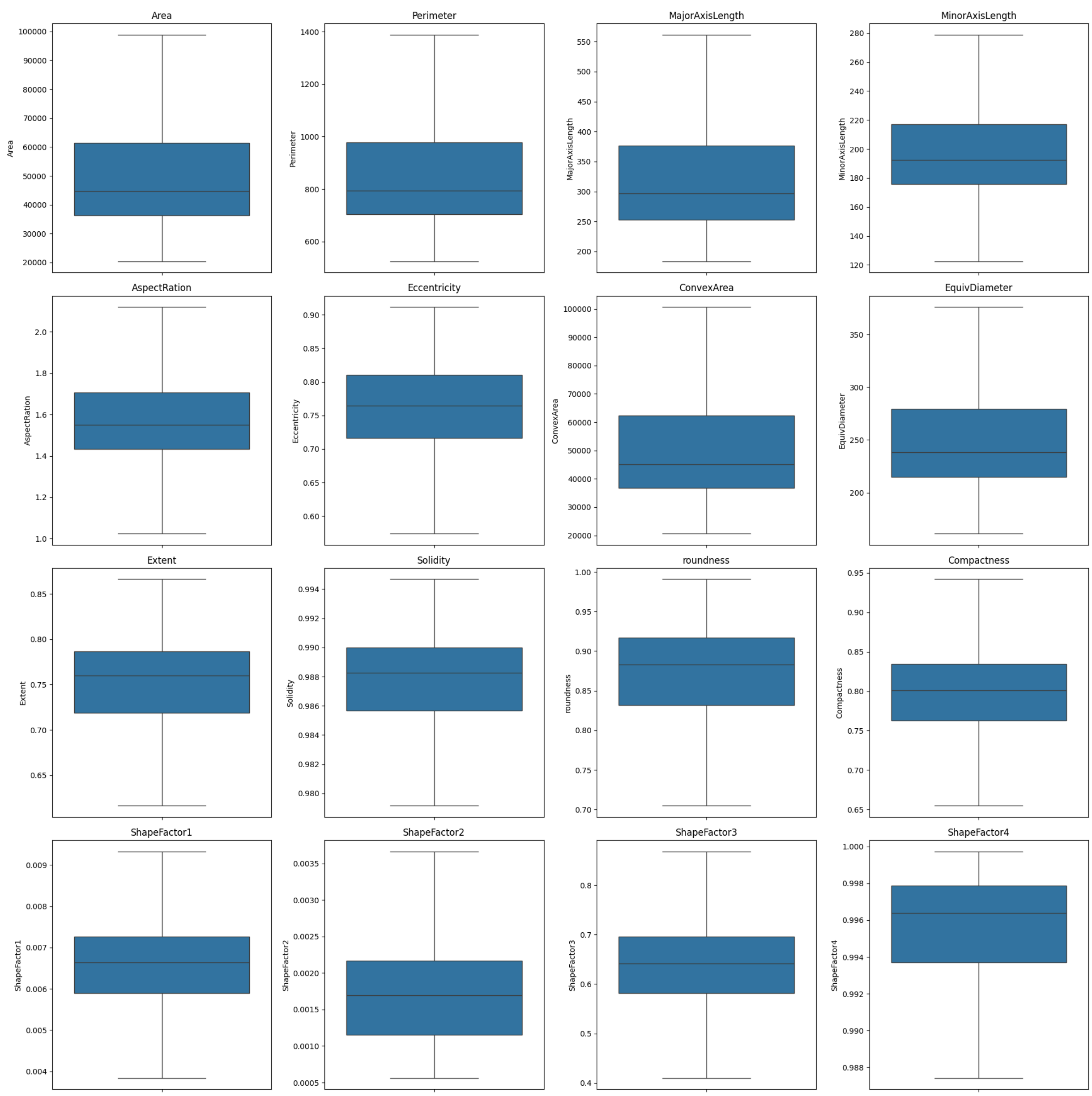
```
# Create subplots
fig, axes = plt.subplots(nrows=num_rows, ncols=num_cols, figsize=(20, 5*num_rows))

# Loop through each column (excluding the last column)
for i, column in enumerate(df.columns[:-1]):
    row_idx = i // num_cols
    col_idx = i % num_cols
    sns.boxplot(data=df, x=column, ax=axes[row_idx, col_idx])
    axes[row_idx, col_idx].set_title(column)

# Hide empty subplots
for i in range(num_plots, num_rows * num_cols):
    row_idx = i // num_cols
    col_idx = i % num_cols
    fig.delaxes(axes[row_idx, col_idx])

plt.tight_layout()
plt.show()
```



In [15]:

```python
num_plots = 16
num_cols = 4
num_rows = (num_plots + num_cols - 1) // num_cols

# Create subplots
fig, axes = plt.subplots(nrows=num_rows, ncols=num_cols, figsize=(20, 5*num_rows))

# Loop through each column and create boxplots
for i, column in enumerate(df.columns[:-1]):
    row_idx = i // num_cols
```

```
    col_idx = i % num_cols
    IQR = df[column].quantile(0.75) - df[column].quantile(0.25)
    upper_limit = df[column].quantile(0.75) + 1.5 * IQR
    lower_limit = df[column].quantile(0.25) - 1.5 * IQR
    df[column] = np.clip(df[column], lower_limit, upper_limit)

    # Plot boxplot
    sns.boxplot(df[column], ax=axes[row_idx, col_idx])
    axes[row_idx, col_idx].set_title(column)

# Hide empty subplots
for i in range(num_plots, num_rows * num_cols):
    row_idx = i // num_cols
    col_idx = i % num_cols
    fig.delaxes(axes[row_idx, col_idx])

plt.tight_layout()
plt.show()
```



In [16]:
```
df
```

Out[16]:

	Area	Perimeter	MajorAxisLength	MinorAxisLength	AspectRation	Eccentricity	C
0	28395	610.291	208.178117	173.888747	1.197191	0.574120	
1	28734	638.018	200.524796	182.734419	1.097356	0.574120	
2	29380	624.110	212.826130	175.931143	1.209713	0.574120	
3	30008	645.884	210.557999	182.516516	1.153638	0.574120	
4	30140	620.134	201.847882	190.279279	1.060798	0.574120	
...	...	...	...	...	...	...	
13606	42097	759.696	288.721612	185.944705	1.552728	0.765002	
13607	42101	757.499	281.576392	190.713136	1.476439	0.735702	
13608	42139	759.321	281.539928	191.187979	1.472582	0.734065	
13609	42147	763.779	283.382636	190.275731	1.489326	0.741055	
13610	42159	772.237	295.142741	182.204716	1.619841	0.786693	

13611 rows × 17 columns

In [17]:
```
label=LabelEncoder()
a=label.fit_transform(df["Class"])
```

In [18]:
```
df["Class"]=a
```

feature selection

from the above heat map i can see that area is directly to the convex area so we can remove the convex area

i can see that from the descriptive staistics the solidity range for all the beans are same

i can see that equdiameter is directly corelated to the area

In [19]:
```
df
```

Out[19]:

	Area	Perimeter	MajorAxisLength	MinorAxisLength	AspectRation	Eccentricity	C
0	28395	610.291	208.178117	173.888747	1.197191	0.574120	
1	28734	638.018	200.524796	182.734419	1.097356	0.574120	
2	29380	624.110	212.826130	175.931143	1.209713	0.574120	
3	30008	645.884	210.557999	182.516516	1.153638	0.574120	
4	30140	620.134	201.847882	190.279279	1.060798	0.574120	
...	...	...	...	...	...	...	
13606	42097	759.696	288.721612	185.944705	1.552728	0.765002	
13607	42101	757.499	281.576392	190.713136	1.476439	0.735702	
13608	42139	759.321	281.539928	191.187979	1.472582	0.734065	
13609	42147	763.779	283.382636	190.275731	1.489326	0.741055	
13610	42159	772.237	295.142741	182.204716	1.619841	0.786693	

13611 rows × 17 columns

In [20]:

```
df.drop(["ConvexArea","Solidity","EquivDiameter","Compactness"],axis=1,inplace=True
```

In [21]:

```
df
```

Out[21]:

	Area	Perimeter	MajorAxisLength	MinorAxisLength	AspectRation	Eccentricity	
0	28395	610.291	208.178117	173.888747	1.197191	0.574120	0
1	28734	638.018	200.524796	182.734419	1.097356	0.574120	0
2	29380	624.110	212.826130	175.931143	1.209713	0.574120	0
3	30008	645.884	210.557999	182.516516	1.153638	0.574120	0
4	30140	620.134	201.847882	190.279279	1.060798	0.574120	0
...	...	...	...	...	...	...	
13606	42097	759.696	288.721612	185.944705	1.552728	0.765002	0
13607	42101	757.499	281.576392	190.713136	1.476439	0.735702	0
13608	42139	759.321	281.539928	191.187979	1.472582	0.734065	0
13609	42147	763.779	283.382636	190.275731	1.489326	0.741055	0
13610	42159	772.237	295.142741	182.204716	1.619841	0.786693	0

13611 rows × 13 columns

Spliting the data into the feature variable and the class variable

In [22]:
```
fv=df.iloc[:,:-1]
cv=df.iloc[:,-1]
```

In [23]:
```
fv
```

Out[23]:

	Area	Perimeter	MajorAxisLength	MinorAxisLength	AspectRation	Eccentricity	
0	28395	610.291	208.178117	173.888747	1.197191	0.574120	0
1	28734	638.018	200.524796	182.734419	1.097356	0.574120	0
2	29380	624.110	212.826130	175.931143	1.209713	0.574120	0
3	30008	645.884	210.557999	182.516516	1.153638	0.574120	0
4	30140	620.134	201.847882	190.279279	1.060798	0.574120	0
...	...	...	...	...	...	...	
13606	42097	759.696	288.721612	185.944705	1.552728	0.765002	0
13607	42101	757.499	281.576392	190.713136	1.476439	0.735702	0
13608	42139	759.321	281.539928	191.187979	1.472582	0.734065	0
13609	42147	763.779	283.382636	190.275731	1.489326	0.741055	0
13610	42159	772.237	295.142741	182.204716	1.619841	0.786693	0

13611 rows × 12 columns

In [24]:
```
cv
```

Out[24]:
```
0        5
1        5
2        5
3        5
4        5
        ..
13606    3
13607    3
13608    3
13609    3
13610    3
Name: Class, Length: 13611, dtype: int32
```

In [25]:
```
x_train,x_test,y_train,y_test=train_test_split(fv,cv,test_size=0.1,random_state=10,
```

In [26]:
```
x_trainf,x_cv,y_trainf,y_cv=train_test_split(x_train,y_train,test_size=0.1,random_s
```

Feature Scaling in Machine Learning: StandardScaler

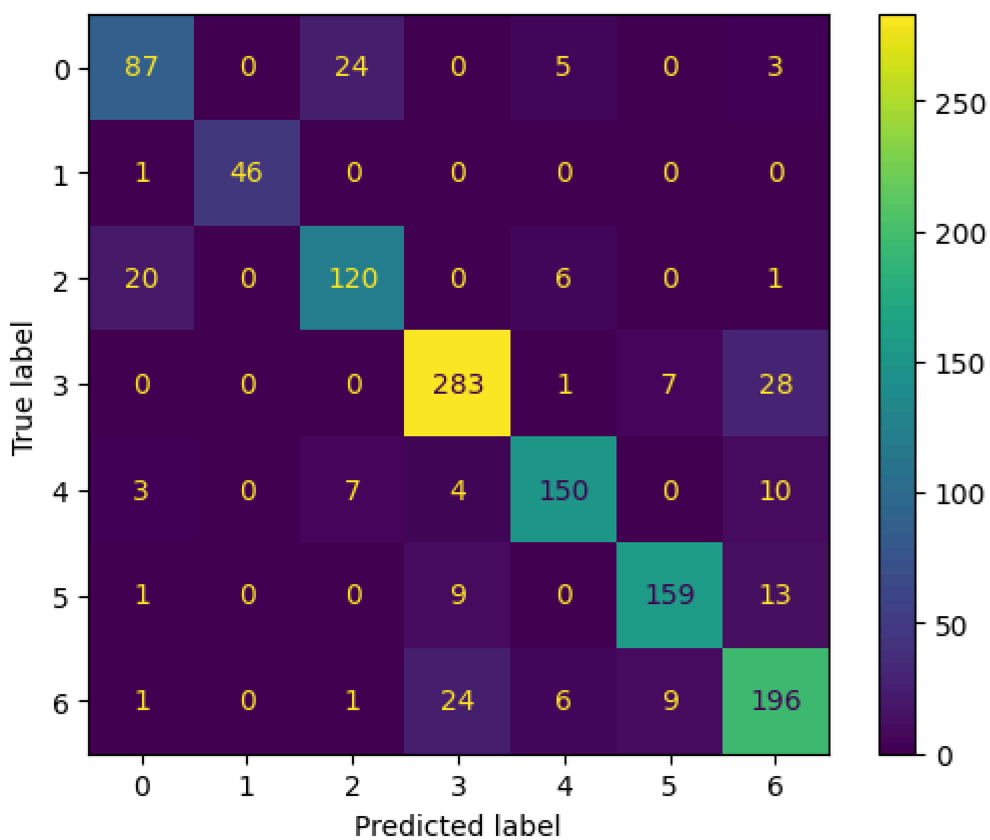
In [27]:
```
std=StandardScaler()
px_train=std.fit_transform(x_trainf)
px_cv=std.transform(x_cv)
px_test=std.transform(x_test)
```

Finding the k value based on the dtrainf and d_cv

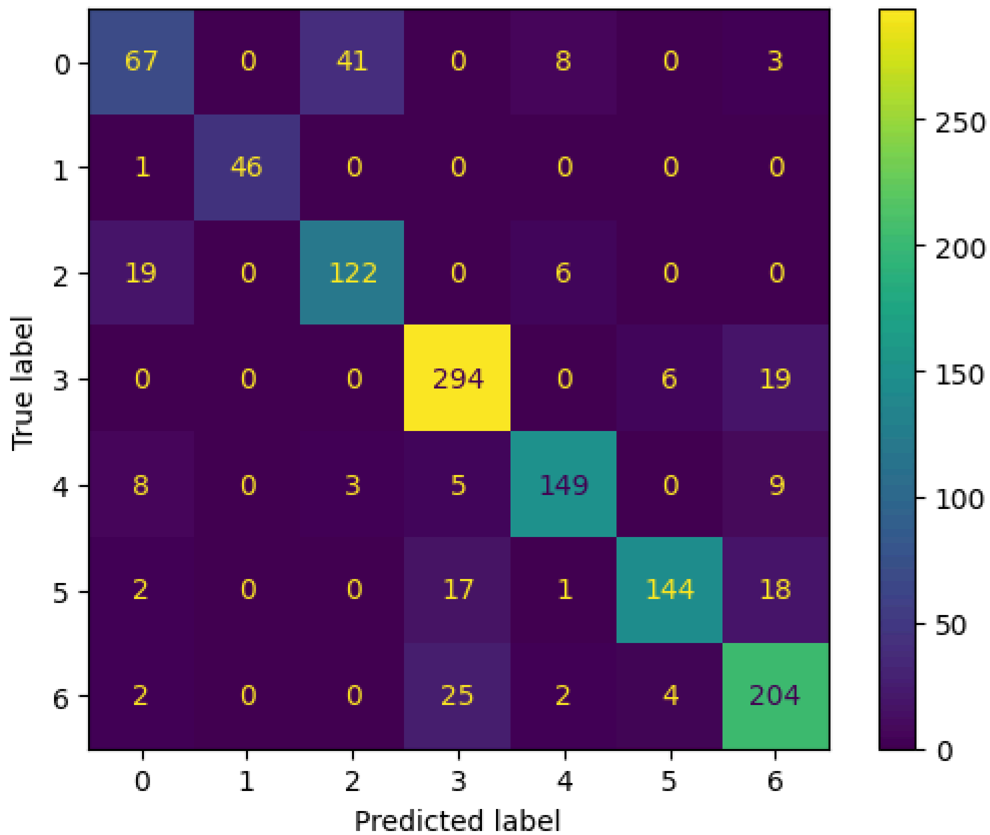
In [28]:
```
k=[]
a=[]
a_train=[]
e=[]
p=[]
r=[]
l=[]
l_d=[]
for i in range(1,30,2):
    knn=KNeighborsClassifier(n_neighbors=i)
    model=knn.fit(x_trainf,y_trainf)
    predict_train=model.predict(x_trainf)
    a_train.append(accuracy_score(y_trainf,predict_train))

    predicted=model.predict(x_cv)
    print("no of neighbours :",i)
    print(" ")
    k.append(i)
    print("accuaracy train :",accuracy_score(y_trainf,predict_train))
    print("")
    a.append(accuracy_score(y_cv,predicted))
    print("accuaracy :",accuracy_score(y_cv,predicted))
    print(" ")
    print("")
    e.append(1-accuracy_score(y_cv,predicted))
    print("error :",1-accuracy_score(y_cv,predicted))
    print(" ")
    cm=ConfusionMatrixDisplay(confusion_matrix(y_cv,predicted,labels=model.classes_
    cm.plot()
    plt.show()
    print(" ")
    p.append(precision_score(y_cv,predicted,average=None))
    print("precision_score :",precision_score(y_cv,predicted,average=None))
    print(" ")
    r.append(recall_score(y_cv,predicted,average=None))
    print("recall_score :",recall_score(y_cv,predicted,average=None))
    print(" ")
    print(classification_report(y_cv,predicted))
    print(" ")
    predicted_probablity=model.predict_proba(x_cv)
    l.append(log_loss(y_cv,predicted_probablity))
    print("logloss :",log_loss(y_cv,predicted_probablity))
    print(" ")
    dc=DummyClassifier()
```

```
    dc_model=dc.fit(x_train,y_train)
    dc_predit=dc_model.predict_proba(x_cv)
    l_d.append(log_loss(y_cv,dc_predit))
    print(" ")
    print("log_loss dummy :",log_loss(y_cv,dc_predit))
    print(" ")
    print("*"*100)
    print("")
```

```
no of neighbours : 1

accuaracy train : 1.0

accuaracy : 0.8497959183673469


error : 0.15020408163265309
```

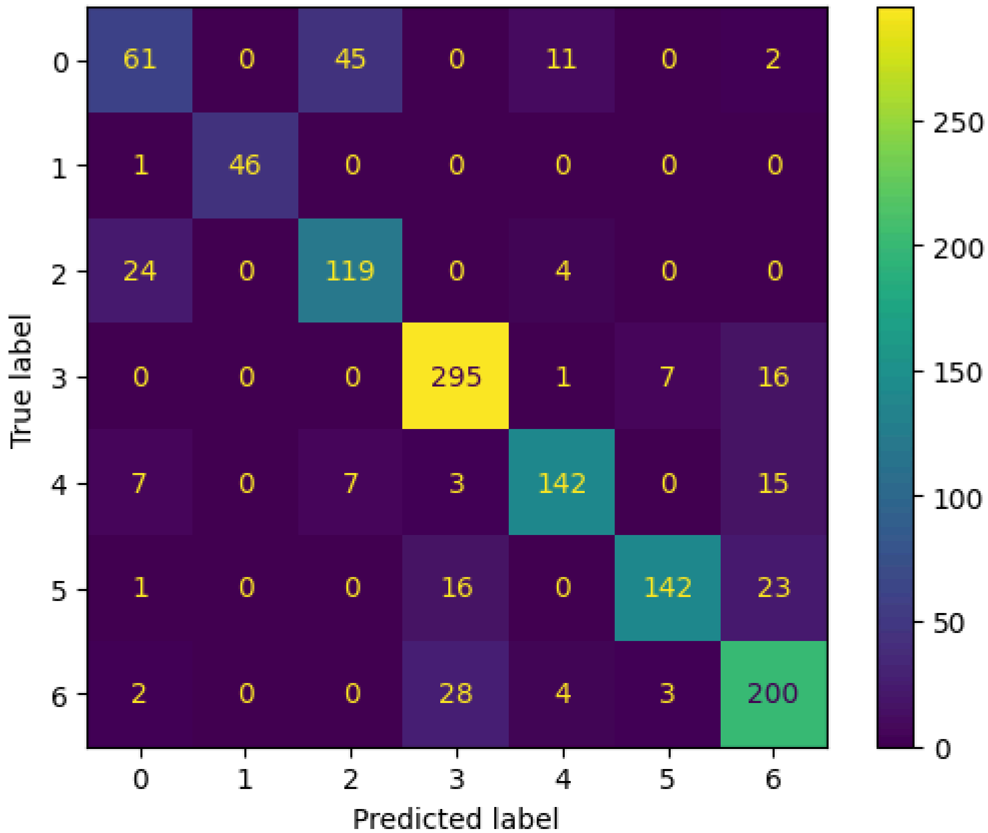


```
precision_score : [0.7699115  1.         0.78947368 0.884375   0.89285714 0.90857143
 0.78087649]

recall_score : [0.73109244 0.9787234  0.81632653 0.88714734 0.86206897 0.87362637
 0.82700422]

              precision    recall  f1-score   support

           0       0.77      0.73      0.75       119
           1       1.00      0.98      0.99        47
           2       0.79      0.82      0.80       147
           3       0.88      0.89      0.89       319
           4       0.89      0.86      0.88       174
           5       0.91      0.87      0.89       182
           6       0.78      0.83      0.80       237

    accuracy                           0.85      1225
   macro avg       0.86      0.85      0.86      1225
weighted avg       0.85      0.85      0.85      1225


logloss : 5.413903855998007


log_loss dummy : 1.8346996197876575

************************************************************************************
****************

no of neighbours : 3

accuaracy train : 0.9093795355587808

accuaracy : 0.8375510204081633


error : 0.16244897959183668
```

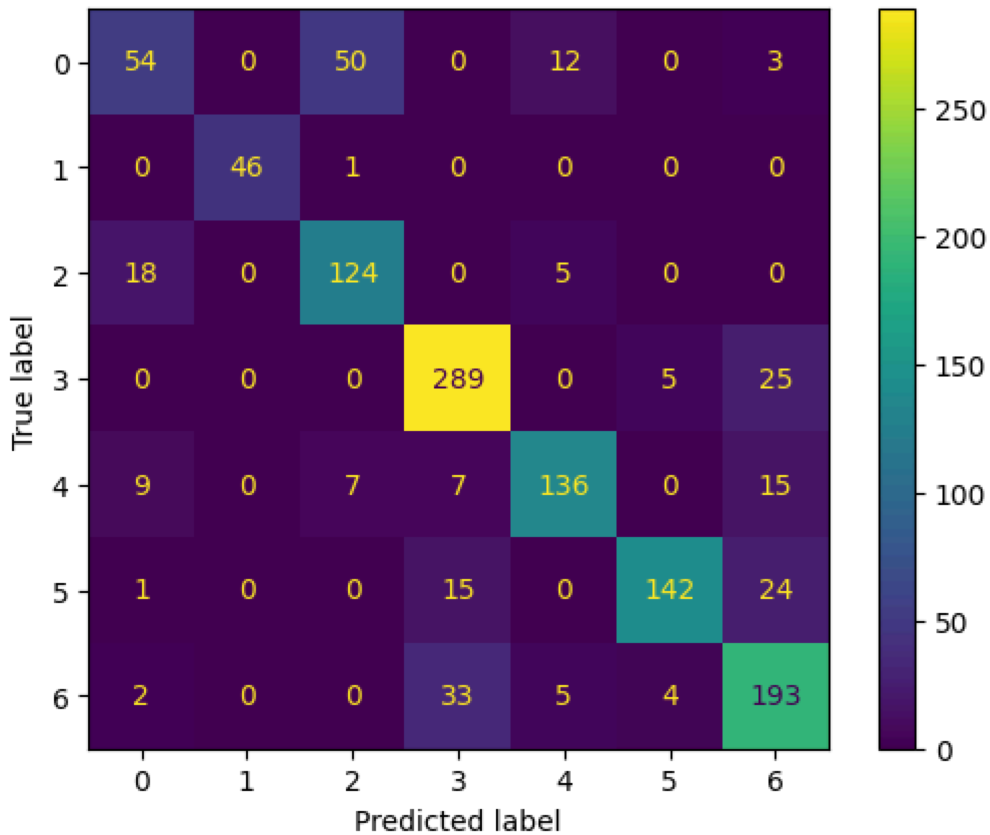


True label
Predicted label
0 1 2 3 4 5 6
67 0 41 0 8 0 3
1 46 0 0 0 0 0
19 0 122 0 6 0 0
0 0 0 294 0 6 19
8 0 3 5 149 0 9
2 0 0 17 1 144 18
2 0 0 25 2 4 204
0 50 100 150 200 250

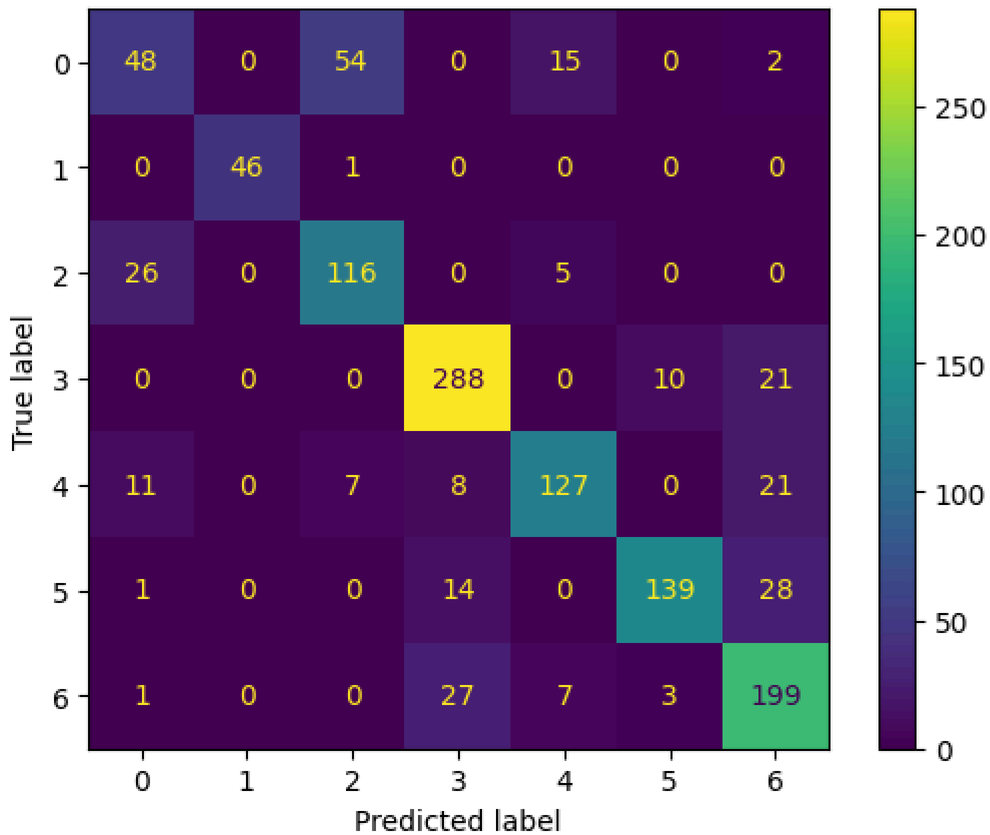
```
precision_score : [0.67676768 1.         0.73493976 0.86217009 0.89759036 0.93506494
 0.80632411]

recall_score : [0.56302521 0.9787234  0.82993197 0.92163009 0.85632184 0.79120879
 0.86075949]

              precision    recall  f1-score   support

           0       0.68      0.56      0.61       119
           1       1.00      0.98      0.99        47
           2       0.73      0.83      0.78       147
           3       0.86      0.92      0.89       319
           4       0.90      0.86      0.88       174
           5       0.94      0.79      0.86       182
           6       0.81      0.86      0.83       237

    accuracy                           0.84      1225
   macro avg       0.84      0.83      0.83      1225
weighted avg       0.84      0.84      0.84      1225


logloss : 2.3252825844788947


log_loss dummy : 1.8346996197876575

**********************************************************************************
****************

no of neighbours : 5

accuaracy train : 0.8780841799709724

accuaracy : 0.8204081632653061


error : 0.17959183673469392
```


True label
Predicted label
0 1 2 3 4 5 6
61 0 45 0 11 0 2
1 46 0 0 0 0 0
24 0 119 0 4 0 0
0 0 0 295 1 7 16
7 0 7 3 142 0 15
1 0 0 16 0 142 23
2 0 0 28 4 3 200
0
50
100
150
200
250

```
precision_score : [0.63541667 1.         0.69590643 0.8625731  0.87654321 0.93421053
 0.78125   ]

recall_score : [0.51260504 0.9787234  0.80952381 0.92476489 0.81609195 0.78021978
 0.84388186]

              precision    recall  f1-score   support

           0       0.64      0.51      0.57       119
           1       1.00      0.98      0.99        47
           2       0.70      0.81      0.75       147
           3       0.86      0.92      0.89       319
           4       0.88      0.82      0.85       174
           5       0.93      0.78      0.85       182
           6       0.78      0.84      0.81       237

    accuracy                           0.82      1225
   macro avg       0.83      0.81      0.81      1225
weighted avg       0.82      0.82      0.82      1225


logloss : 1.683962528050476


log_loss dummy : 1.8346996197876575

**********************************************************************************
****************

no of neighbours : 7

accuaracy train : 0.8489658925979681

accuaracy : 0.803265306122449


error : 0.19673469387755105
```

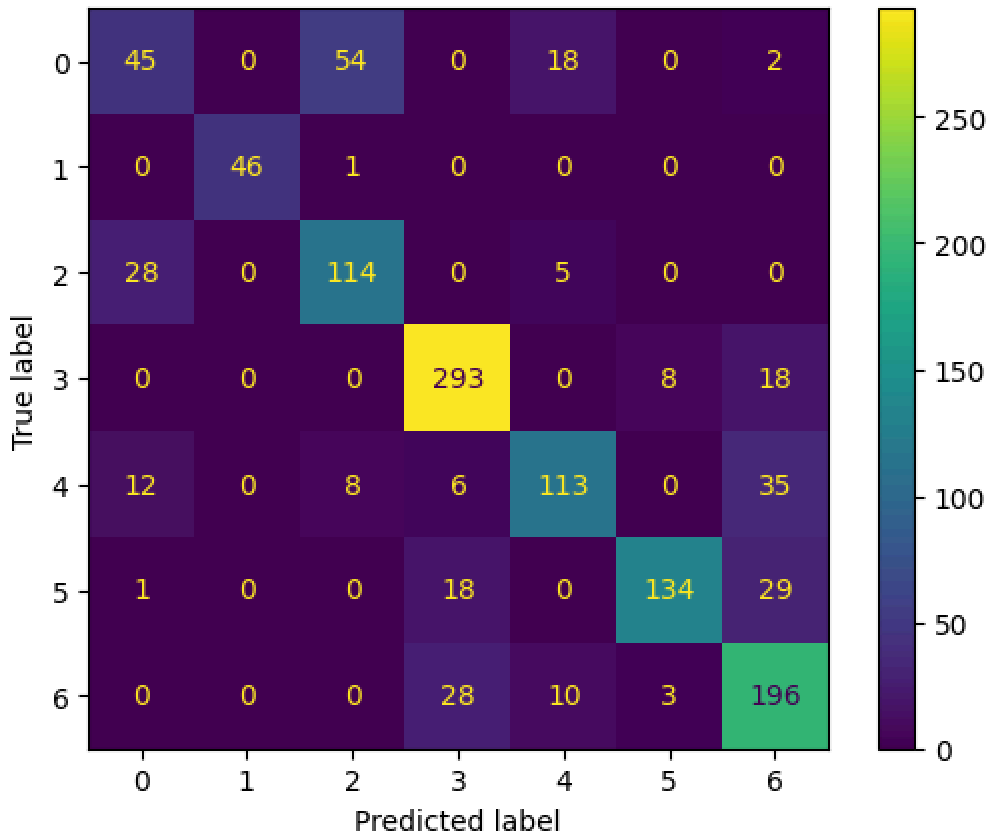

54 0 50 0 12 0 3
0 46 1 0 0 0 0
18 0 124 0 5 0 0
0 0 0 289 0 5 25
9 0 7 7 136 0 15
1 0 0 15 0 142 24
2 0 0 33 5 4 193
0 1 2 3 4 5 6
True label
Predicted label
0
50
100
150
200
250

```
precision_score : [0.64285714 1.         0.68131868 0.84011628 0.86075949 0.94039735
 0.74230769]

recall_score : [0.45378151 0.9787234  0.84353741 0.90595611 0.7816092  0.78021978
 0.81434599]

              precision    recall  f1-score   support

           0       0.64      0.45      0.53       119
           1       1.00      0.98      0.99        47
           2       0.68      0.84      0.75       147
           3       0.84      0.91      0.87       319
           4       0.86      0.78      0.82       174
           5       0.94      0.78      0.85       182
           6       0.74      0.81      0.78       237

    accuracy                           0.80      1225
   macro avg       0.82      0.79      0.80      1225
weighted avg       0.81      0.80      0.80      1225


logloss : 1.4498288060971456


log_loss dummy : 1.8346996197876575

************************************************************************************
****************

no of neighbours : 9

accuaracy train : 0.8290094339622641

accuaracy : 0.7861224489795918


error : 0.21387755102040817
```



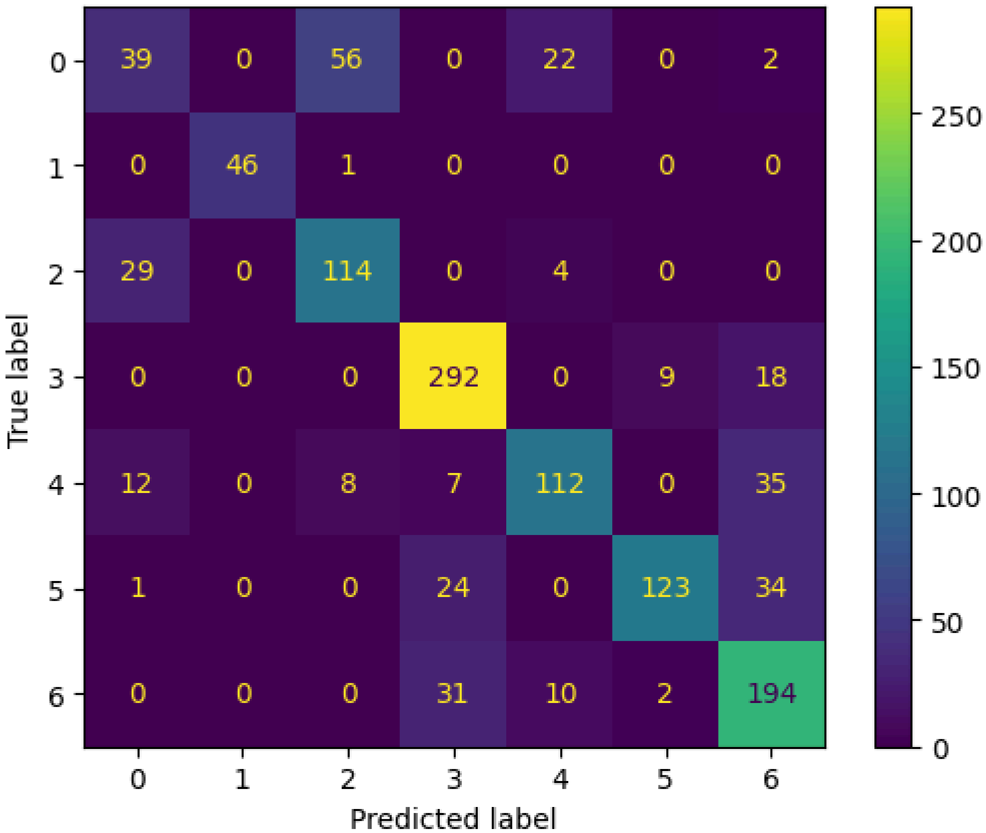
True label
Predicted label
0
1
2
3
4
5
6
48 0 54 0 15 0 2
0 46 1 0 0 0 0
26 0 116 0 5 0 0
0 0 0 288 0 10 21
11 0 7 8 127 0 21
1 0 0 14 0 139 28
1 0 0 27 7 3 199
0
50
100
150
200
250

```
precision_score : [0.55172414 1.         0.65168539 0.85459941 0.82467532 0.91447368
 0.73431734]

recall_score : [0.40336134 0.9787234  0.78911565 0.90282132 0.72988506 0.76373626
 0.83966245]

              precision    recall  f1-score   support

           0       0.55      0.40      0.47       119
           1       1.00      0.98      0.99        47
           2       0.65      0.79      0.71       147
           3       0.85      0.90      0.88       319
           4       0.82      0.73      0.77       174
           5       0.91      0.76      0.83       182
           6       0.73      0.84      0.78       237

    accuracy                           0.79      1225
   macro avg       0.79      0.77      0.78      1225
weighted avg       0.79      0.79      0.78      1225


logloss : 1.1320083797295186


log_loss dummy : 1.8346996197876575

************************************************************************************
****************

no of neighbours : 11

accuaracy train : 0.8099600870827286

accuaracy : 0.7681632653061224


error : 0.23183673469387756
```



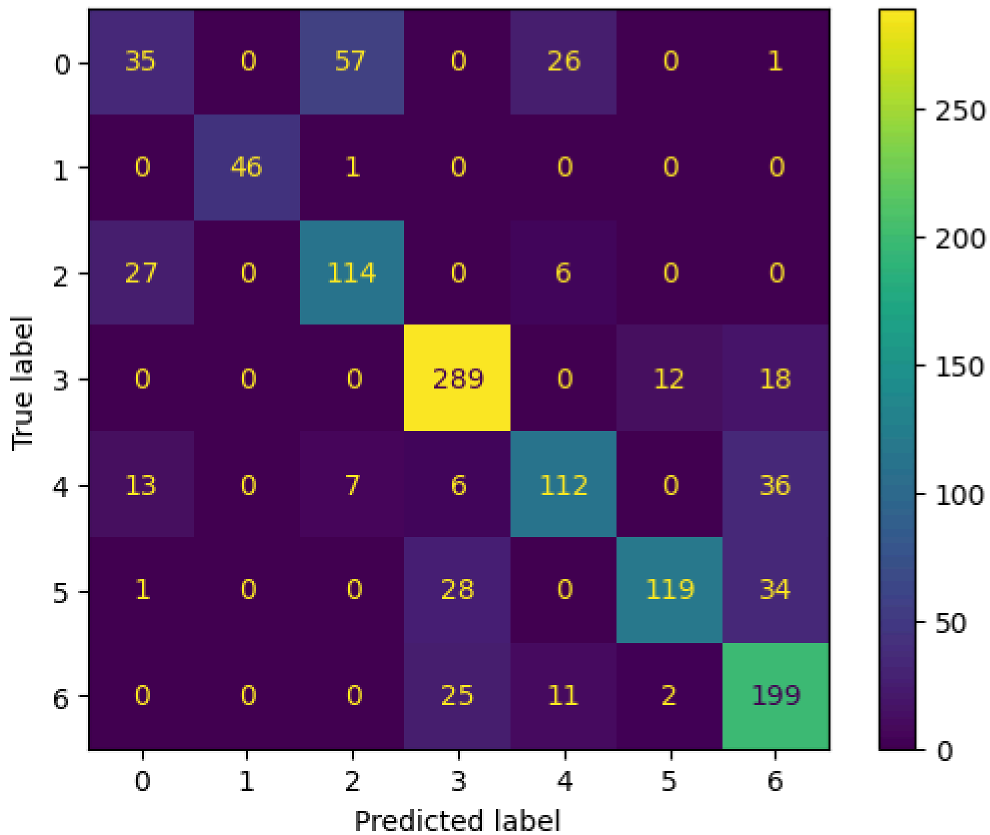
True label
Predicted label
0
1
2
3
4
5
6
45 0 54 0 18 0 2
0 46 1 0 0 0 0
28 0 114 0 5 0 0
0 0 0 293 0 8 18
12 0 8 6 113 0 35
1 0 0 18 0 134 29
0 0 0 28 10 3 196
0
50
100
150
200
250

```
precision_score : [0.52325581 1.         0.6440678  0.84927536 0.7739726  0.92413793
 0.7       ]

recall_score : [0.37815126 0.9787234  0.7755102  0.9184953  0.64942529 0.73626374
 0.82700422]

              precision    recall  f1-score   support

           0       0.52      0.38      0.44       119
           1       1.00      0.98      0.99        47
           2       0.64      0.78      0.70       147
           3       0.85      0.92      0.88       319
           4       0.77      0.65      0.71       174
           5       0.92      0.74      0.82       182
           6       0.70      0.83      0.76       237

    accuracy                           0.77      1225
   macro avg       0.77      0.75      0.76      1225
weighted avg       0.77      0.77      0.76      1225


logloss : 1.026101687139419


log_loss dummy : 1.8346996197876575

************************************************************************************
****************

no of neighbours : 13

accuaracy train : 0.7891872278664731

accuaracy : 0.7510204081632653


error : 0.24897959183673468
```



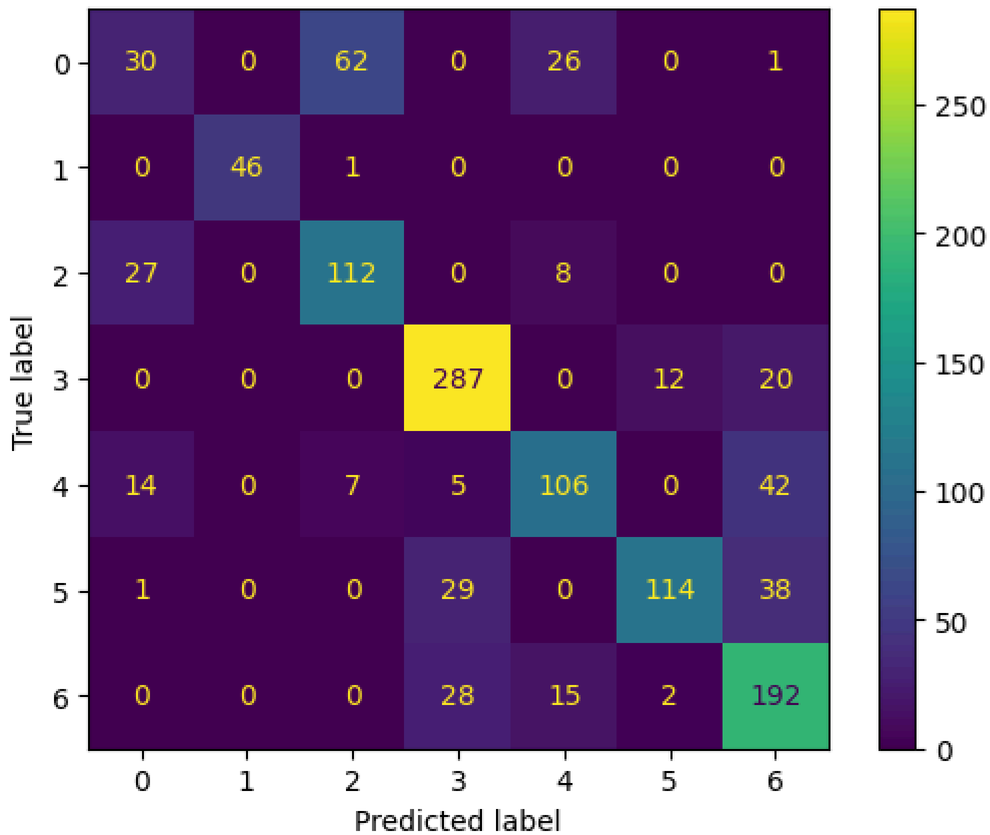
True label
Predicted label
0 1 2 3 4 5 6
39 0 56 0 22 0 2
0 46 1 0 0 0 0
29 0 114 0 4 0 0
0 0 0 292 0 9 18
12 0 8 7 112 0 35
1 0 0 24 0 123 34
0 0 0 31 10 2 194
0
50
100
150
200
250

```
precision_score : [0.48148148 1.         0.63687151 0.82485876 0.75675676 0.91791045
 0.68551237]

recall_score : [0.32773109 0.9787234  0.7755102  0.9153605  0.64367816 0.67582418
 0.8185654 ]

              precision    recall  f1-score   support

           0       0.48      0.33      0.39       119
           1       1.00      0.98      0.99        47
           2       0.64      0.78      0.70       147
           3       0.82      0.92      0.87       319
           4       0.76      0.64      0.70       174
           5       0.92      0.68      0.78       182
           6       0.69      0.82      0.75       237

    accuracy                           0.75      1225
   macro avg       0.76      0.73      0.74      1225
weighted avg       0.75      0.75      0.74      1225


logloss : 0.945905538216687


log_loss dummy : 1.8346996197876575

************************************************************************************
****************

no of neighbours : 15

accuaracy train : 0.7759433962264151

accuaracy : 0.7461224489795918


error : 0.2538775510204082
```



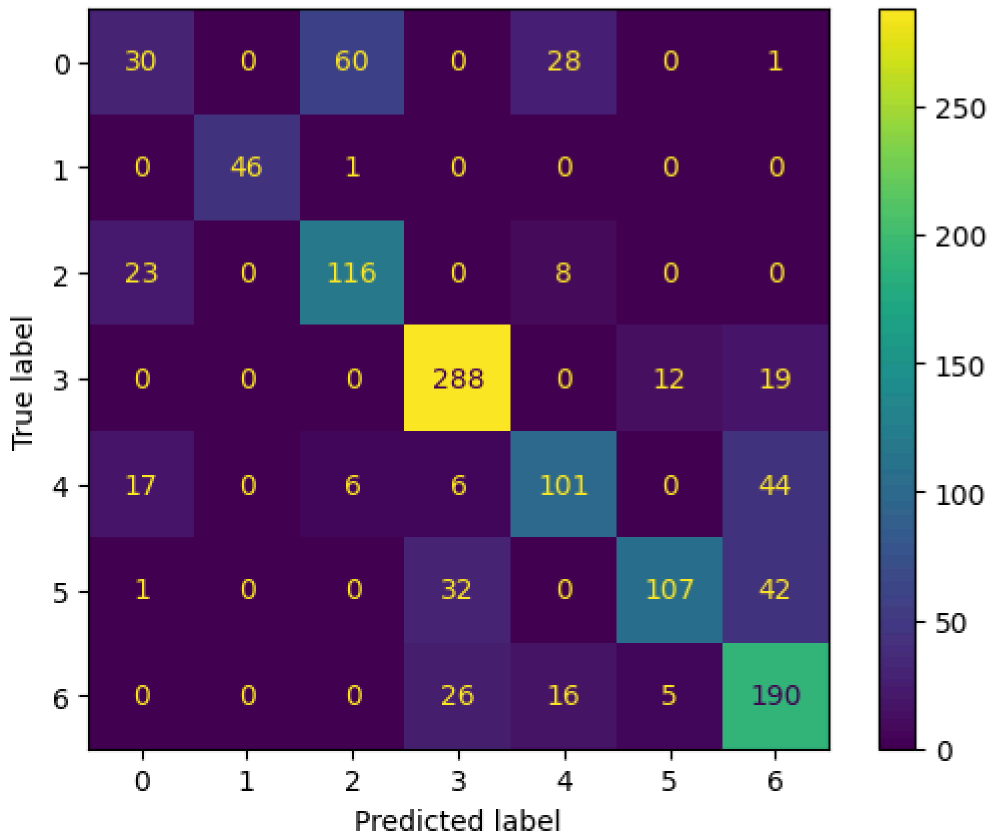
True label
Predicted label
0
1
2
3
4
5
6
35 0 57 0 26 0 1
0 46 1 0 0 0 0
27 0 114 0 6 0 0
0 0 0 289 0 12 18
13 0 7 6 112 0 36
1 0 0 28 0 119 34
0 0 0 25 11 2 199
250
200
150
100
50
0

```
precision_score : [0.46052632 1.         0.63687151 0.83045977 0.72258065 0.89473684
 0.69097222]

recall_score : [0.29411765 0.9787234  0.7755102  0.90595611 0.64367816 0.65384615
 0.83966245]

              precision    recall  f1-score   support

           0       0.46      0.29      0.36       119
           1       1.00      0.98      0.99        47
           2       0.64      0.78      0.70       147
           3       0.83      0.91      0.87       319
           4       0.72      0.64      0.68       174
           5       0.89      0.65      0.76       182
           6       0.69      0.84      0.76       237

    accuracy                           0.75      1225
   macro avg       0.75      0.73      0.73      1225
weighted avg       0.75      0.75      0.74      1225


logloss : 0.9446509212406085


log_loss dummy : 1.8346996197876575

************************************************************************************
****************

no of neighbours : 17

accuaracy train : 0.7644230769230769

accuaracy : 0.7240816326530612


error : 0.27591836734693875
```



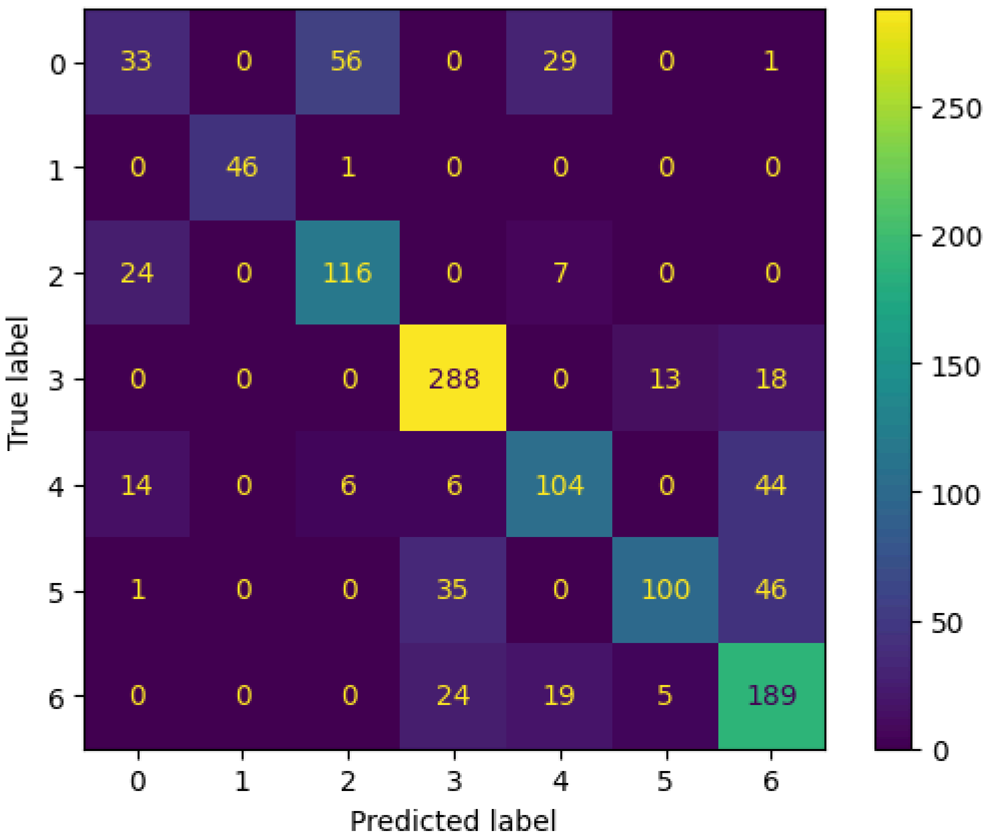
True label
Predicted label
0
1
2
3
4
5
6
30
0
62
0
26
0
1
46
112
8
27
287
12
20
14
7
5
106
42
29
114
38
28
15
2
192
250
200
150
100
50

```
precision_score : [0.41666667 1.         0.61538462 0.82234957 0.68387097 0.890625
 0.6552901 ]

recall_score : [0.25210084 0.9787234  0.76190476 0.89968652 0.6091954  0.62637363
 0.81012658]

              precision    recall  f1-score   support

           0       0.42      0.25      0.31       119
           1       1.00      0.98      0.99        47
           2       0.62      0.76      0.68       147
           3       0.82      0.90      0.86       319
           4       0.68      0.61      0.64       174
           5       0.89      0.63      0.74       182
           6       0.66      0.81      0.72       237

    accuracy                           0.72      1225
   macro avg       0.73      0.71      0.71      1225
weighted avg       0.72      0.72      0.71      1225


logloss : 0.9400443138405687


log_loss dummy : 1.8346996197876575

************************************************************************************
****************

no of neighbours : 19

accuaracy train : 0.752177068214804

accuaracy : 0.7167346938775511


error : 0.28326530612244893
```



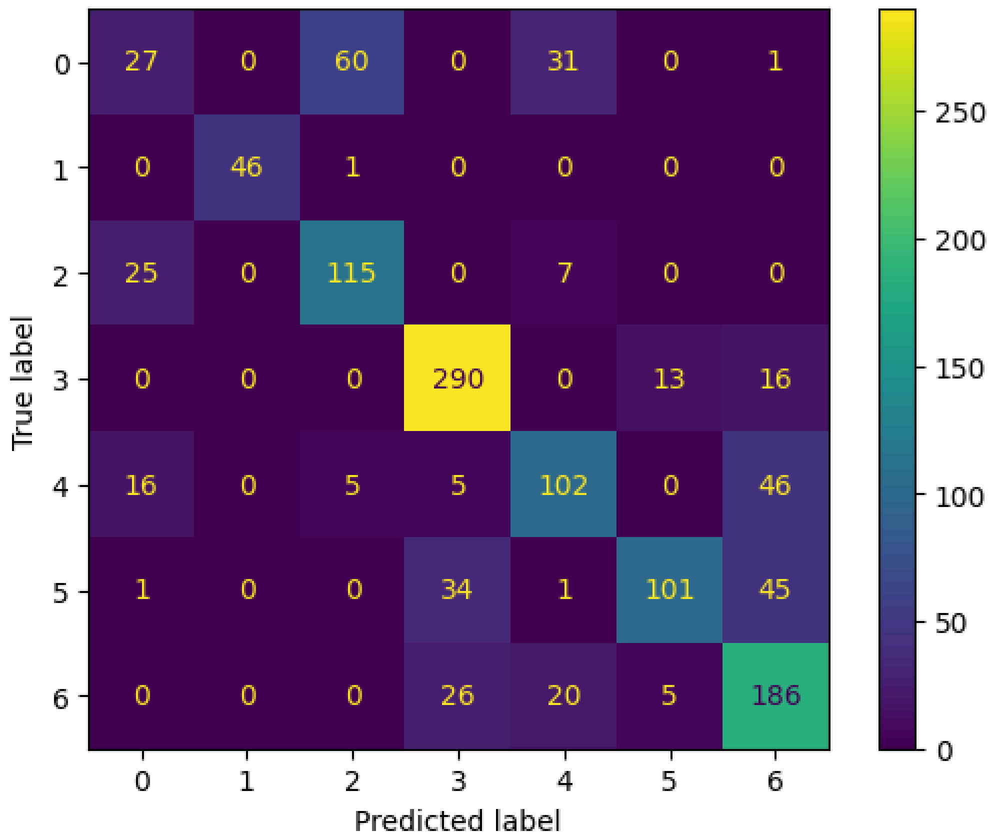
True label
Predicted label
0
1
2
3
4
5
6
30 0 60 0 28 0 1
0 46 1 0 0 0 0
23 0 116 0 8 0 0
0 0 0 288 0 12 19
17 0 6 6 101 0 44
1 0 0 32 0 107 42
0 0 0 26 16 5 190
250
200
150
100
50
0

```
precision_score : [0.42253521 1.         0.63387978 0.81818182 0.66013072 0.86290323
 0.64189189]

recall_score : [0.25210084 0.9787234  0.78911565 0.90282132 0.58045977 0.58791209
 0.80168776]

              precision    recall  f1-score   support

           0       0.42      0.25      0.32       119
           1       1.00      0.98      0.99        47
           2       0.63      0.79      0.70       147
           3       0.82      0.90      0.86       319
           4       0.66      0.58      0.62       174
           5       0.86      0.59      0.70       182
           6       0.64      0.80      0.71       237

    accuracy                           0.72      1225
   macro avg       0.72      0.70      0.70      1225
weighted avg       0.71      0.72      0.71      1225


logloss : 0.9097212388371554


log_loss dummy : 1.8346996197876575

*************************************************************************************
****************

no of neighbours : 21

accuaracy train : 0.7434687953555879

accuaracy : 0.7151020408163266


error : 0.28489795918367344
```



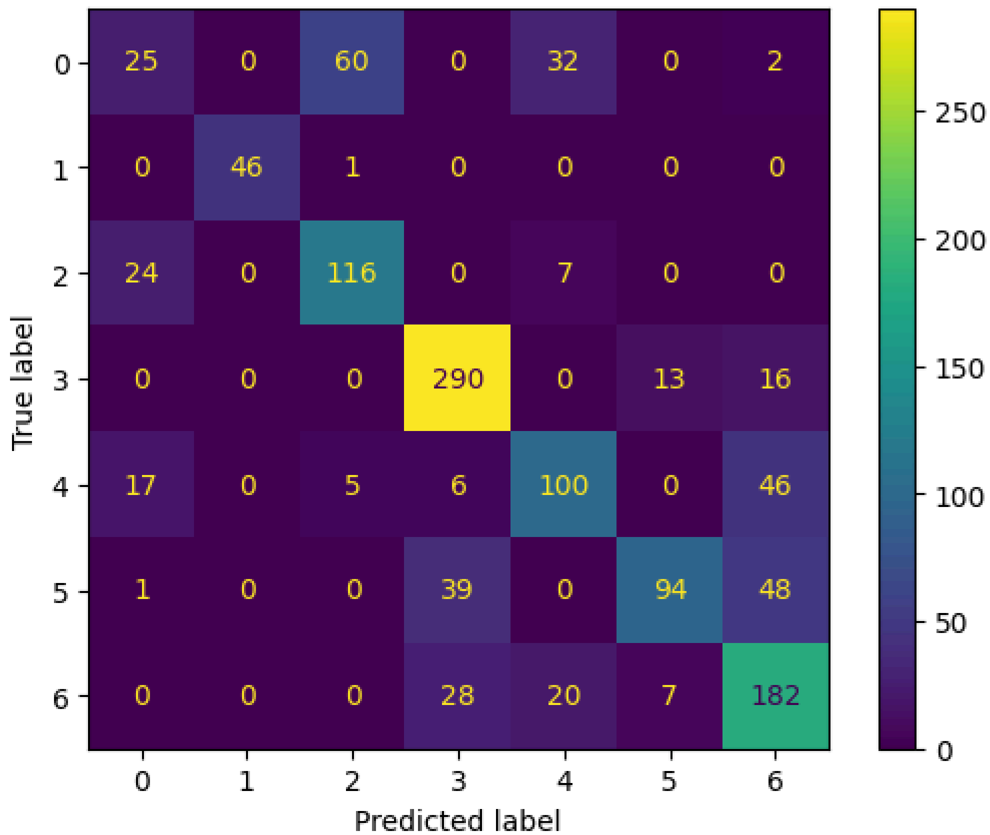
True label
Predicted label
0 1 2 3 4 5 6
33 0 56 0 29 0 1
0 46 1 0 0 0 0
24 0 116 0 7 0 0
0 0 0 288 0 13 18
14 0 6 6 104 0 44
1 0 0 35 0 100 46
0 0 0 24 19 5 189
0 50 100 150 200 250

```
precision_score : [0.45833333 1.         0.64804469 0.81586402 0.65408805 0.84745763
 0.63422819]

recall_score : [0.27731092 0.9787234  0.78911565 0.90282132 0.59770115 0.54945055
 0.79746835]

              precision    recall  f1-score   support

           0       0.46      0.28      0.35       119
           1       1.00      0.98      0.99        47
           2       0.65      0.79      0.71       147
           3       0.82      0.90      0.86       319
           4       0.65      0.60      0.62       174
           5       0.85      0.55      0.67       182
           6       0.63      0.80      0.71       237

    accuracy                           0.72      1225
   macro avg       0.72      0.70      0.70      1225
weighted avg       0.71      0.72      0.70      1225


logloss : 0.9038109390872345


log_loss dummy : 1.8346996197876575

************************************************************************************
****************

no of neighbours : 23

accuaracy train : 0.7327648766328012

accuaracy : 0.7077551020408164


error : 0.2922448979591836
```

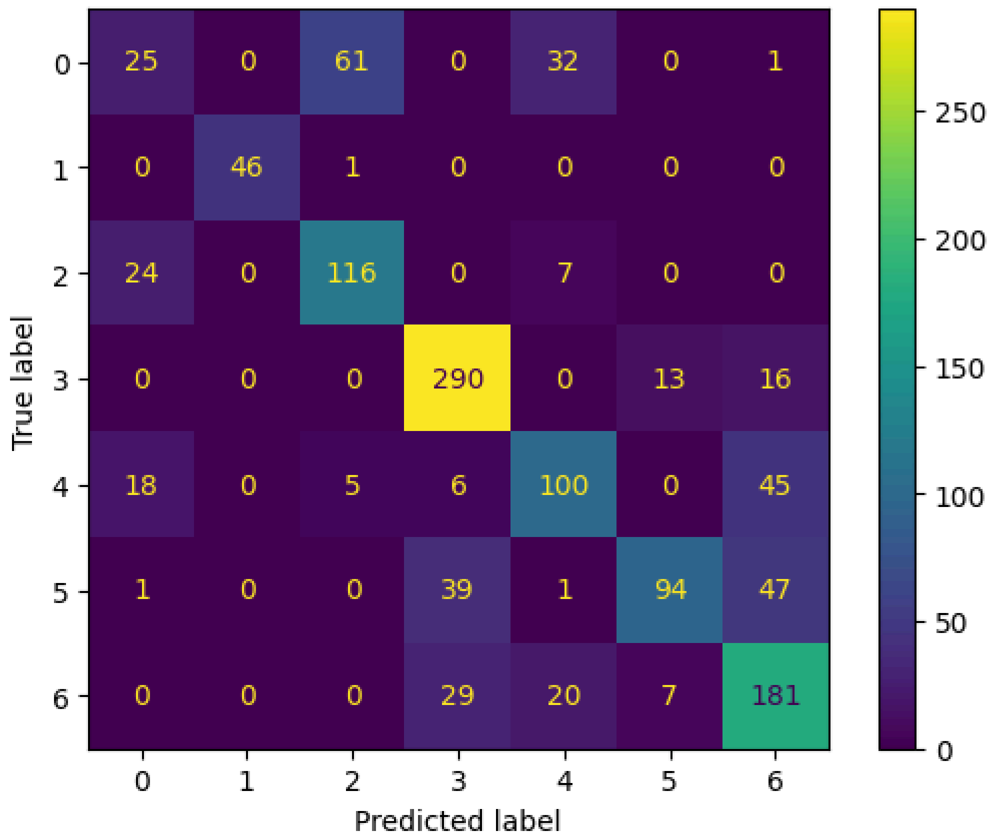


27
0
60
0
31
0
1
0
46
1
0
0
0
0
25
0
115
0
7
0
0
0
0
0
290
0
13
16
16
0
5
5
102
0
46
1
0
0
34
1
101
45
0
0
0
26
20
5
186
0
1
2
3
4
5
6
True label
Predicted label
250
200
150
100
50

```
precision_score : [0.39130435 1.         0.63535912 0.81690141 0.63354037 0.8487395
 0.63265306]

recall_score : [0.22689076 0.9787234  0.78231293 0.90909091 0.5862069  0.55494505
 0.78481013]

              precision    recall  f1-score   support

           0       0.39      0.23      0.29       119
           1       1.00      0.98      0.99        47
           2       0.64      0.78      0.70       147
           3       0.82      0.91      0.86       319
           4       0.63      0.59      0.61       174
           5       0.85      0.55      0.67       182
           6       0.63      0.78      0.70       237

    accuracy                           0.71      1225
   macro avg       0.71      0.69      0.69      1225
weighted avg       0.70      0.71      0.70      1225


logloss : 0.8924082359316066


log_loss dummy : 1.8346996197876575

************************************************************************************
****************

no of neighbours : 25

accuaracy train : 0.726233671988389

accuaracy : 0.6963265306122449


error : 0.3036734693877551
```

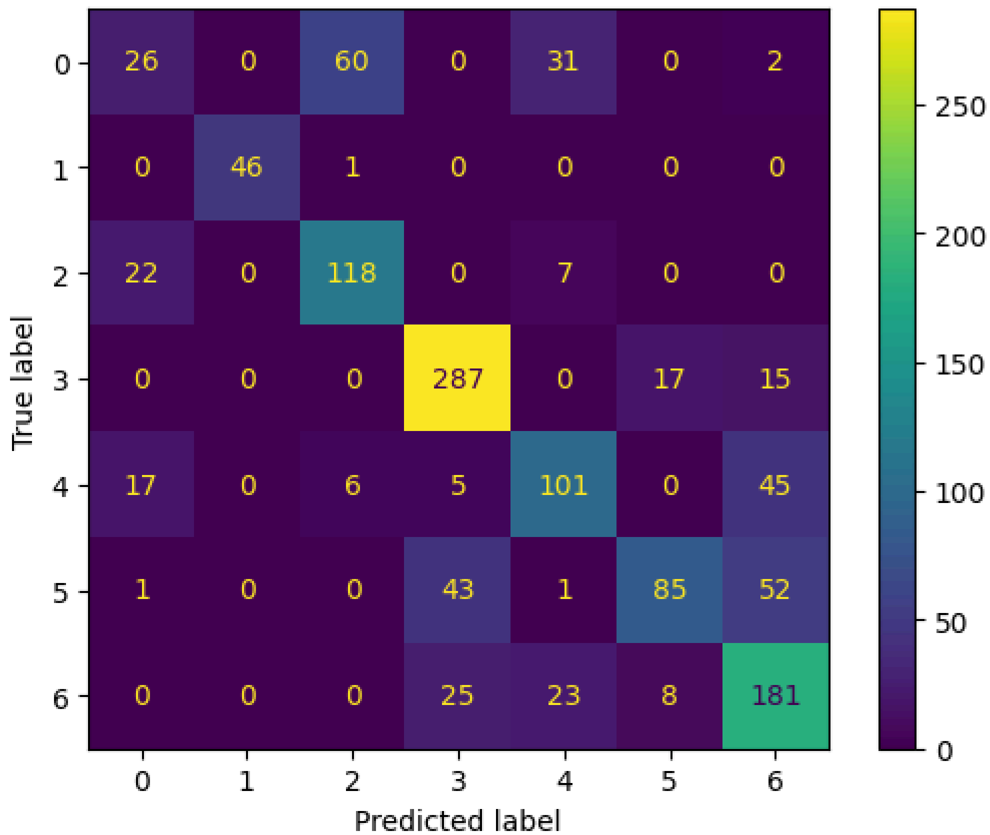

True label
Predicted label
0
1
2
3
4
5
6
25 0 60 0 32 0 2
0 46 1 0 0 0 0
24 0 116 0 7 0 0
0 0 0 290 0 13 16
17 0 5 6 100 0 46
1 0 0 39 0 94 48
0 0 0 28 20 7 182
0
50
100
150
200
250

```
precision_score : [0.37313433 1.         0.63736264 0.79889807 0.62893082 0.8245614
 0.61904762]

recall_score : [0.21008403 0.9787234  0.78911565 0.90909091 0.57471264 0.51648352
 0.76793249]

              precision    recall  f1-score   support

           0       0.37      0.21      0.27       119
           1       1.00      0.98      0.99        47
           2       0.64      0.79      0.71       147
           3       0.80      0.91      0.85       319
           4       0.63      0.57      0.60       174
           5       0.82      0.52      0.64       182
           6       0.62      0.77      0.69       237

    accuracy                           0.70      1225
   macro avg       0.70      0.68      0.68      1225
weighted avg       0.69      0.70      0.68      1225


logloss : 0.8794946369586336


log_loss dummy : 1.8346996197876575

************************************************************************************
****************

no of neighbours : 27

accuaracy train : 0.7197024673439768

accuaracy : 0.6955102040816327


error : 0.30448979591836733
```



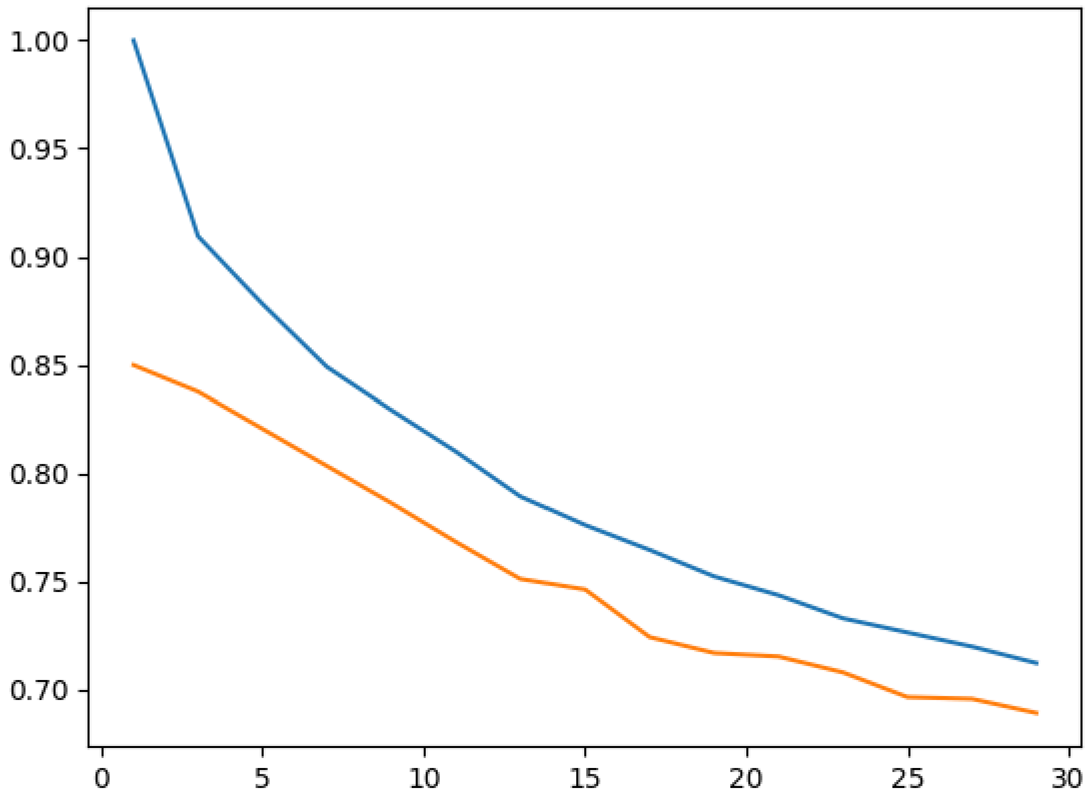
True label
Predicted label
0
1
2
3
4
5
6
25 0 61 0 32 0 1
0 46 1 0 0 0 0
24 0 116 0 7 0 0
0 0 0 290 0 13 16
18 0 5 6 100 0 45
1 0 0 39 1 94 47
0 0 0 29 20 7 181
0
50
100
150
200
250

```
precision_score : [0.36764706 1.         0.63387978 0.7967033  0.625      0.8245614
 0.62413793]

recall_score : [0.21008403 0.9787234  0.78911565 0.90909091 0.57471264 0.51648352
 0.76371308]

              precision    recall  f1-score   support

           0       0.37      0.21      0.27       119
           1       1.00      0.98      0.99        47
           2       0.63      0.79      0.70       147
           3       0.80      0.91      0.85       319
           4       0.62      0.57      0.60       174
           5       0.82      0.52      0.64       182
           6       0.62      0.76      0.69       237

    accuracy                           0.70      1225
   macro avg       0.70      0.68      0.68      1225
weighted avg       0.69      0.70      0.68      1225


logloss : 0.8901366984225116


log_loss dummy : 1.8346996197876575

************************************************************************************
****************

no of neighbours : 29

accuaracy train : 0.7120827285921626

accuaracy : 0.6889795918367347


error : 0.31102040816326526
```



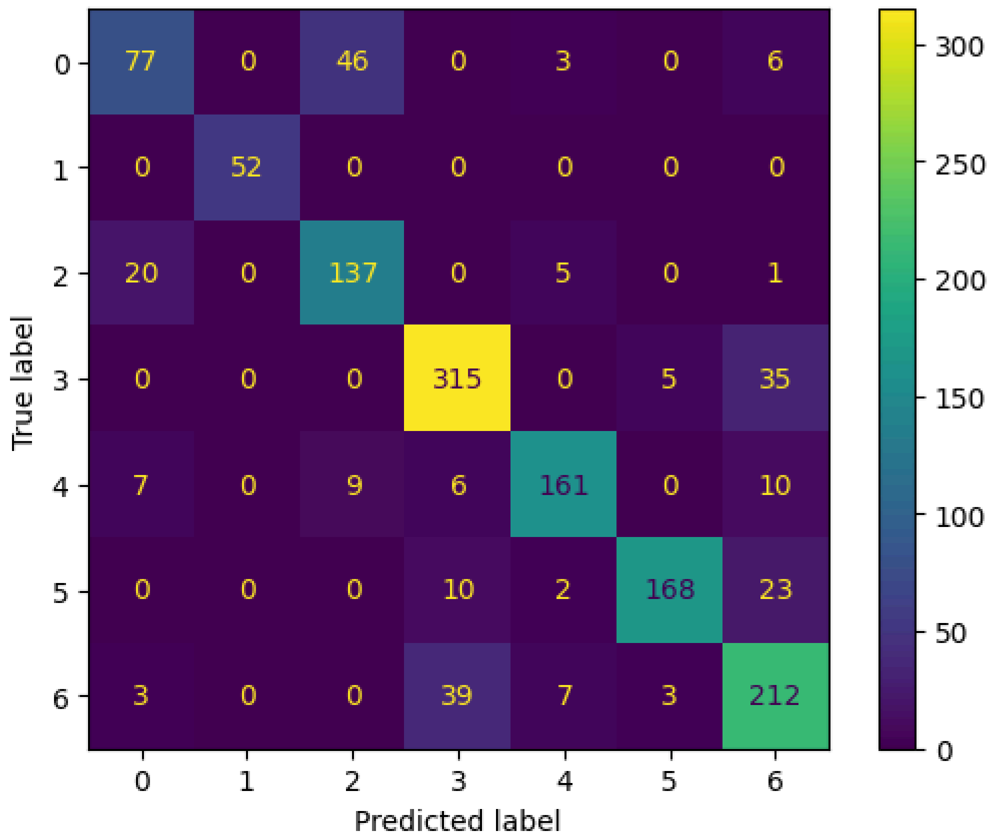

```
precision_score : [0.39393939 1.         0.63783784 0.79722222 0.6196319  0.77272727
 0.61355932]

recall_score : [0.21848739 0.9787234  0.80272109 0.89968652 0.58045977 0.46703297
 0.76371308]

              precision    recall  f1-score   support

           0       0.39      0.22      0.28       119
           1       1.00      0.98      0.99        47
           2       0.64      0.80      0.71       147
           3       0.80      0.90      0.85       319
           4       0.62      0.58      0.60       174
           5       0.77      0.47      0.58       182
           6       0.61      0.76      0.68       237

    accuracy                           0.69      1225
   macro avg       0.69      0.67      0.67      1225
weighted avg       0.68      0.69      0.67      1225


logloss : 0.8769737559218076


log_loss dummy : 1.8346996197876575

********************************************************************************
****************
```

In [29]:
```
plt.plot(k,a_train)
plt.plot(k,a)
plt.show()
```



In [30]:
```
knn=KNeighborsClassifier(n_neighbors=3)
model=knn.fit(x_trainf,y_trainf)
predicted=model.predict(x_test)
print("accuracy score : ",accuracy_score(y_test,predicted))
print("")
print("error score :",1-accuracy_score(y_test,predicted))
print("")
cm=ConfusionMatrixDisplay(confusion_matrix(y_test,predicted,labels=model.classes_))
cm.plot()
plt.show()
print("recall score",recall_score(y_test,predicted,average=None))
print("")
print("precision score :",precision_score(y_test,predicted,average=None))
print("")
print(classification_report(y_test,predicted))
predicted=model.predict_proba(x_test)
print("precision score :",log_loss(y_test,predicted))
```

```
accuracy score :  0.8237885462555066

error score : 0.17621145374449343
```




```
recall score [0.58333333 1.         0.8404908  0.88732394 0.83419689 0.82758621
 0.8030303 ]

precision score : [0.71962617 1.         0.71354167 0.85135135 0.90449438 0.95454545
 0.73867596]

              precision    recall  f1-score   support

           0       0.72      0.58      0.64       132
           1       1.00      1.00      1.00        52
           2       0.71      0.84      0.77       163
           3       0.85      0.89      0.87       355
           4       0.90      0.83      0.87       193
           5       0.95      0.83      0.89       203
           6       0.74      0.80      0.77       264

    accuracy                           0.82      1362
   macro avg       0.84      0.83      0.83      1362
weighted avg       0.83      0.82      0.82      1362

precision score : 2.9284165675745806
```

In [31]:
```
kf=KFold(n_splits=3)
```

In [32]:
```
acc_train=[]
acc_cv=[]
k_values=[]
for i in range(1,30,2):
    acc=[]
    acc_train=[]
```

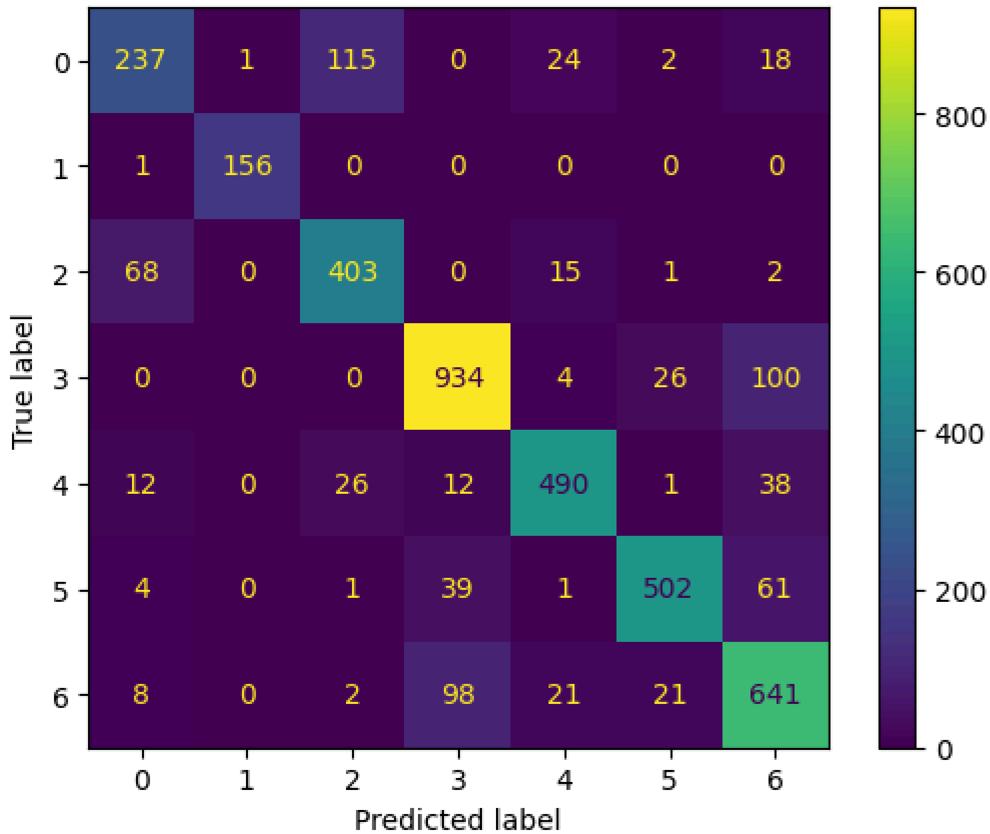
```
    err=[]
    conf=[]
    recall=[]
    prec=[]
    k=[]
    logloss=[]
    logloss_dummy=[]
    for train_index,cv_index in kf.split(x_train,y_train):
        x_trainf,x_cv,y_trainf,y_cv=x_train.iloc[train_index],x_train.iloc[cv_index
        knn=KNeighborsClassifier(n_neighbors=i)
        model=knn.fit(x_trainf,y_trainf)
        predicted_train=model.predict(x_trainf)
        acc_train.append(accuracy_score(y_trainf,predicted_train))
        predicted=model.predict(x_cv)
        acc.append(accuracy_score(y_cv,predicted))
        err.append(1-accuracy_score(y_cv,predicted))
        conf.append(confusion_matrix(y_cv,predicted,labels=model.classes_))
        recall.append(recall_score(y_cv,predicted,average=None))
        prec.append(precision_score(y_cv,predicted,average=None))
        predicted=model.predict_proba(x_cv)
        logloss.append(log_loss(y_cv,predicted))
        dc=DummyClassifier()
        dc_model=dc.fit(x_trainf,y_trainf)
        dc_predit=dc_model.predict_proba(x_test)
        logloss_dummy.append(log_loss(y_test,dc_predit))

    print("K_value",i)
    print("")
    acc_train
    print("")
    acc_cv.append(np.mean(acc))
    print("avg_accuracy : ",np.mean(acc))
    print("")
    print("avg_err : ",np.mean(err))
    print(" ")

    plt.figure(figsize=(20,8))
    cm=ConfusionMatrixDisplay(np.int64(np.round((conf[0]+conf[1]+conf[2])/3)))
    cm.plot()
    plt.show()
    print(" ")
    print("recall_score : ",np.mean(recall))
    print(" ")
    print("precision Score : ",np.mean(prec))
    print(" ")
    print("log loss : ",np.mean(logloss))
    print(" ")
    print("log loss_dummy : ",np.mean(logloss_dummy))
    print(" ")
    print("*"*100)
k_values.append(i)


print(" ")
```

K_value 1

avg_accuracy : 0.8234141562576537

avg_err : 0.17658584374234632

<Figure size 2000x800 with 0 Axes>



recall_score : 0.8251404425874777

precision Score : 0.8357553113955363

log loss : 6.364798945273935

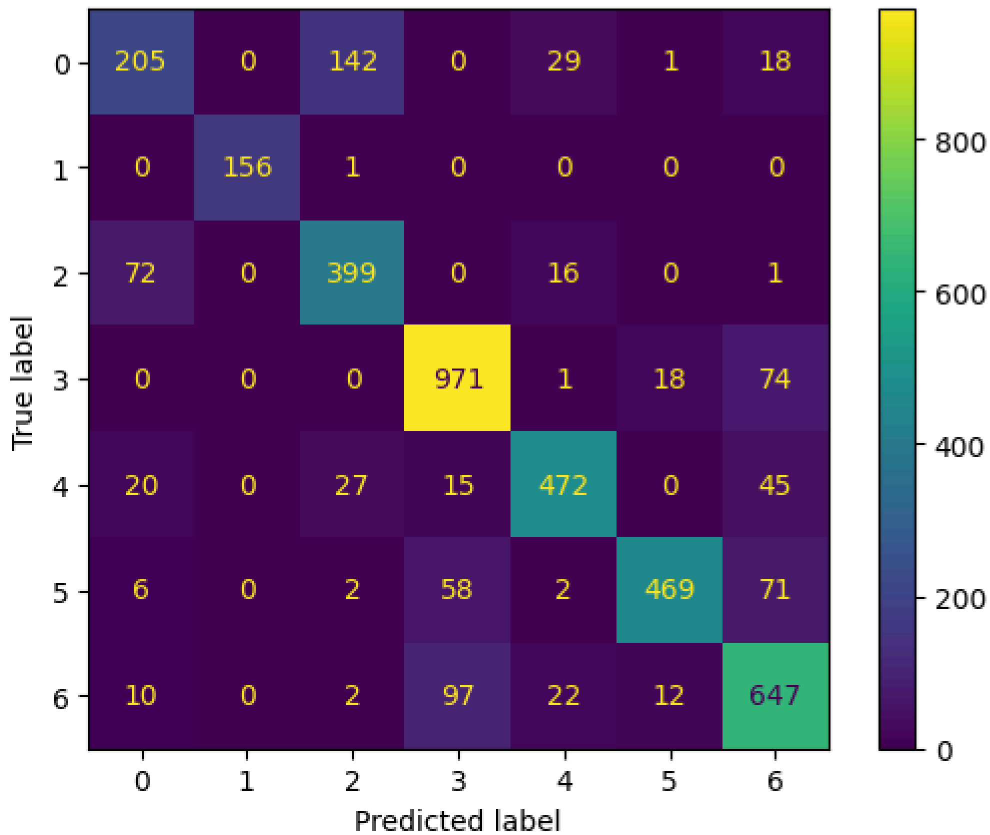
log loss_dummy : 1.834217157999518

****
****
K_value 3

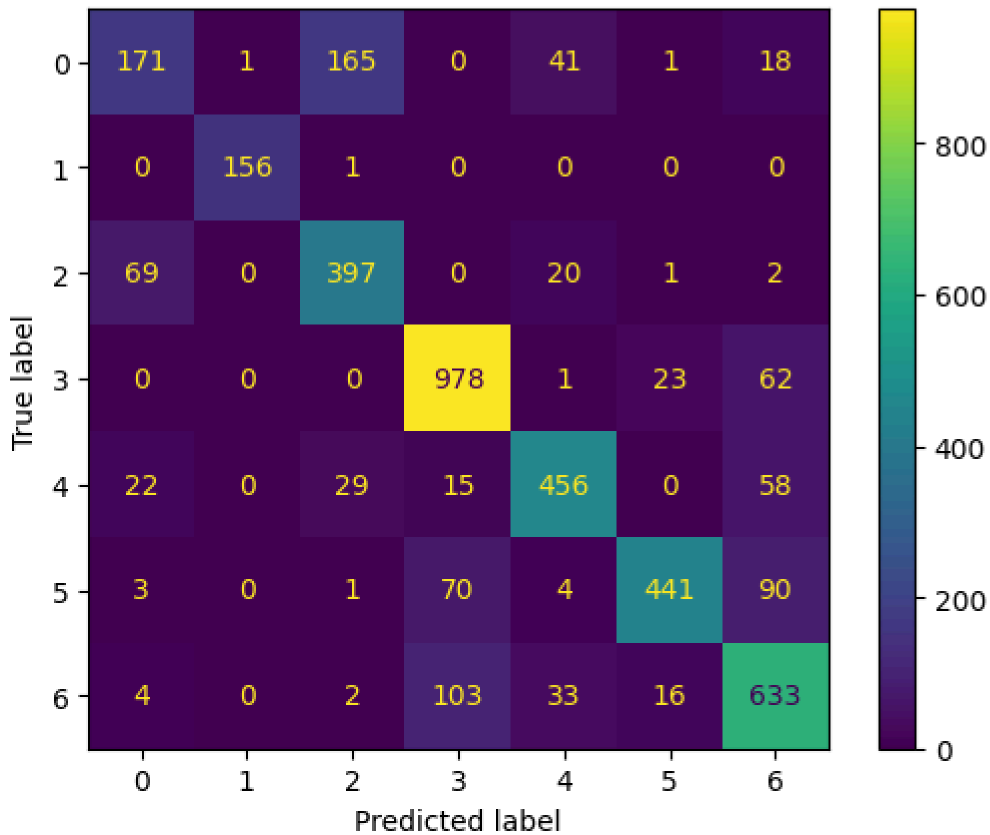
avg_accuracy : 0.8126377663482733

avg_err : 0.18736223365172666

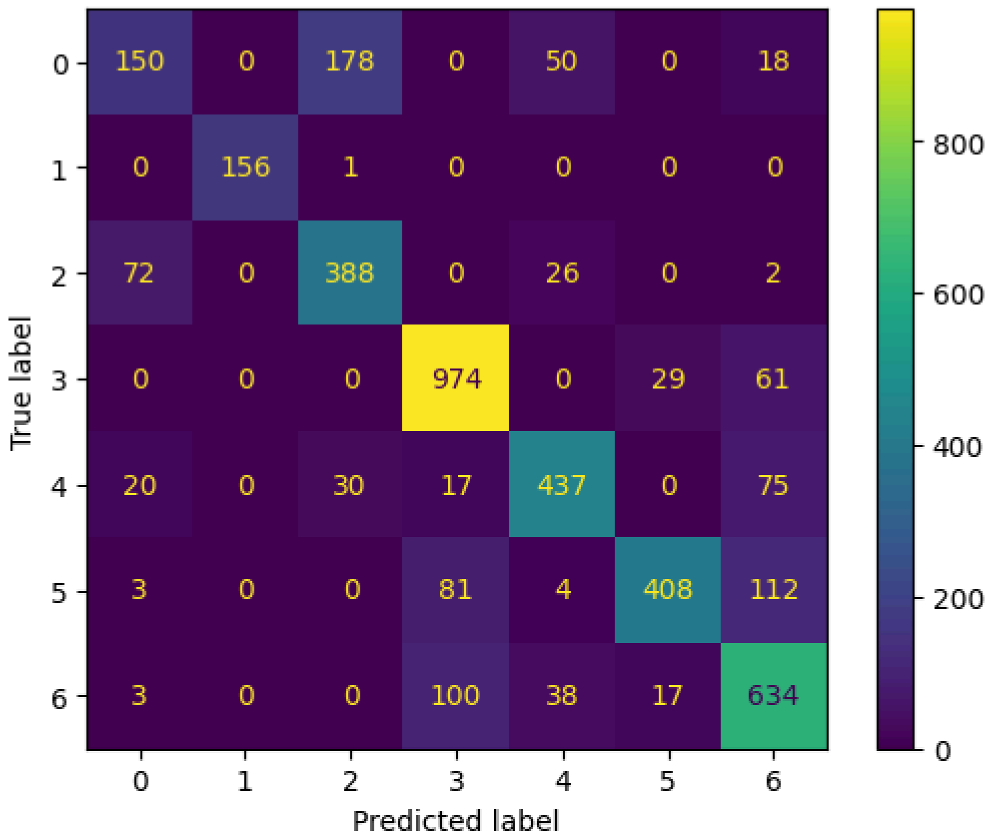
<Figure size 2000x800 with 0 Axes>



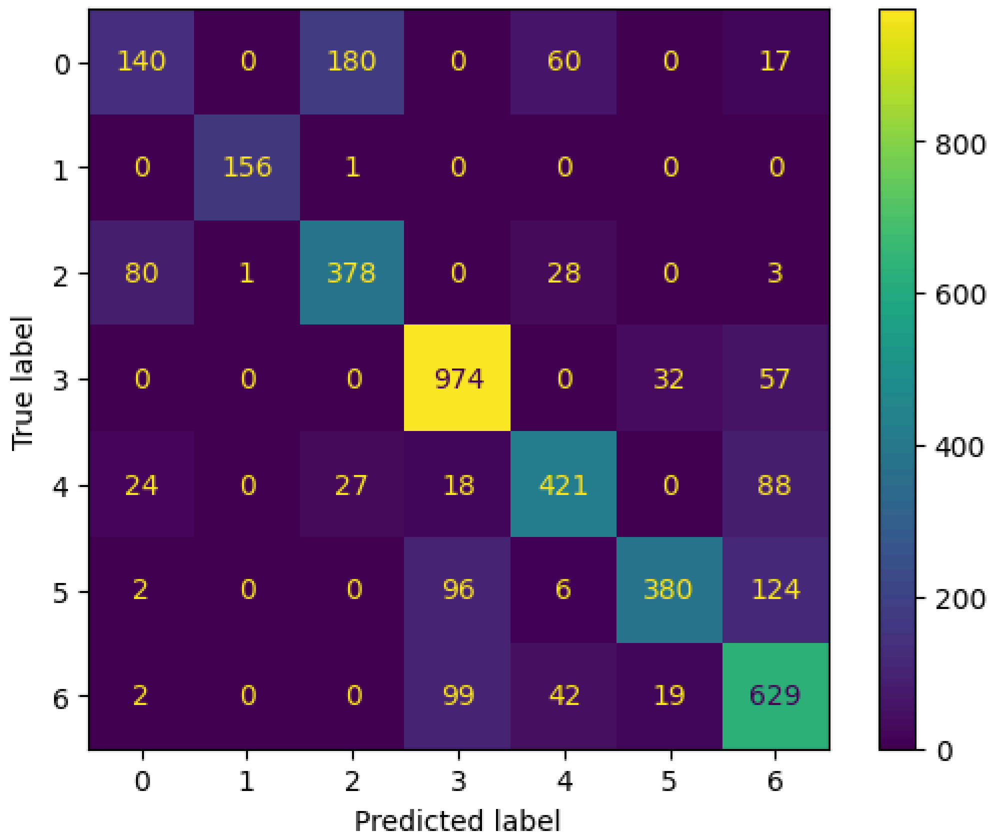

```
recall_score :  0.8063116220104359

precision Score :  0.822837318654935

log loss :  2.9567680815923403

log loss_dummy :  1.834217157999518

************************************************************************************
****************
K_value 5


avg_accuracy :  0.7913299044819985

avg_err :  0.20867009551800145

<Figure size 2000x800 with 0 Axes>
```



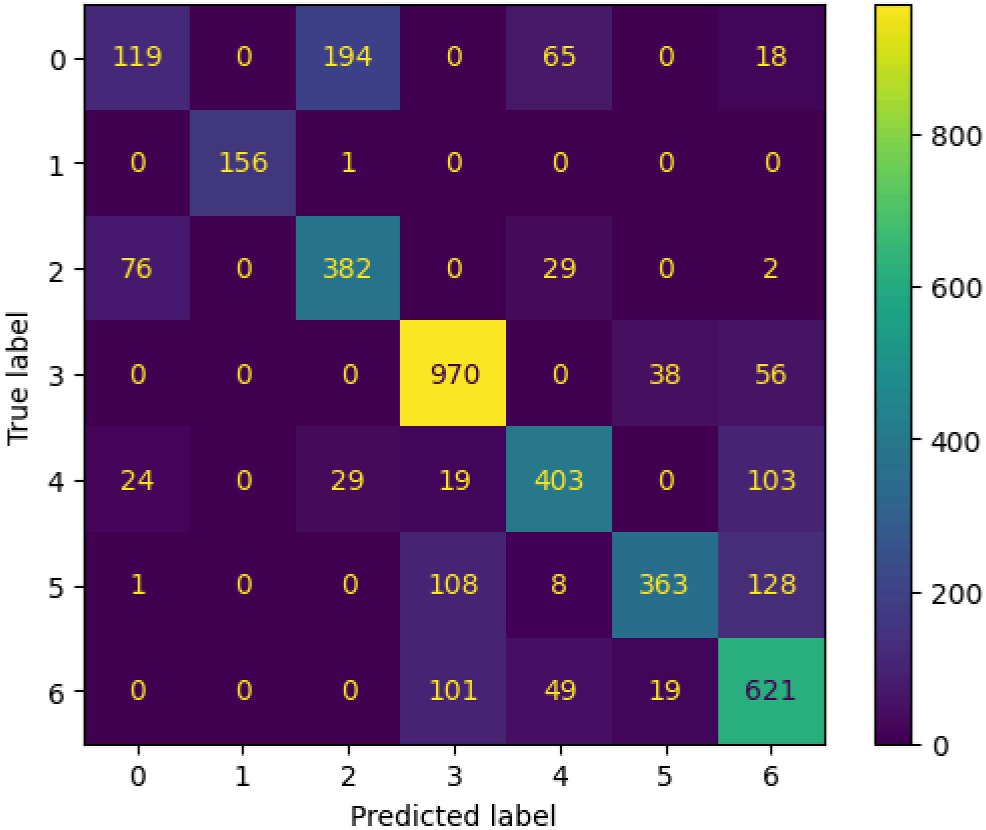

```
recall_score :  0.7811994173128243

precision Score :  0.8016457200759577

log loss :  2.1476688325288786

log loss_dummy :  1.834217157999518

**************************************************************************************
****************
K_value 7


avg_accuracy :  0.7704302392032002

avg_err :  0.22956976079679972

<Figure size 2000x800 with 0 Axes>
```



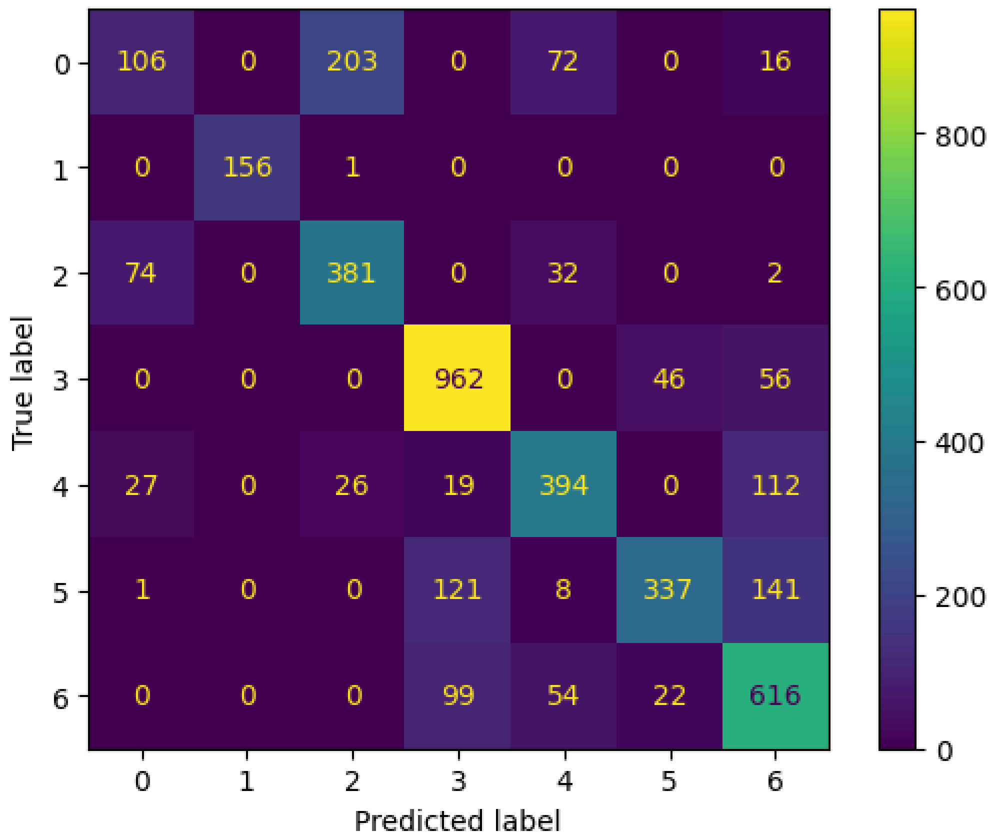

```
recall_score :  0.7586233970709605

precision Score :  0.7813774339257245

log loss :  1.769392442446806

log loss_dummy :  1.834217157999518

************************************************************************************
****************
K_value 9


avg_accuracy :  0.7538574577516531

avg_err :  0.24614254224834684

<Figure size 2000x800 with 0 Axes>
```



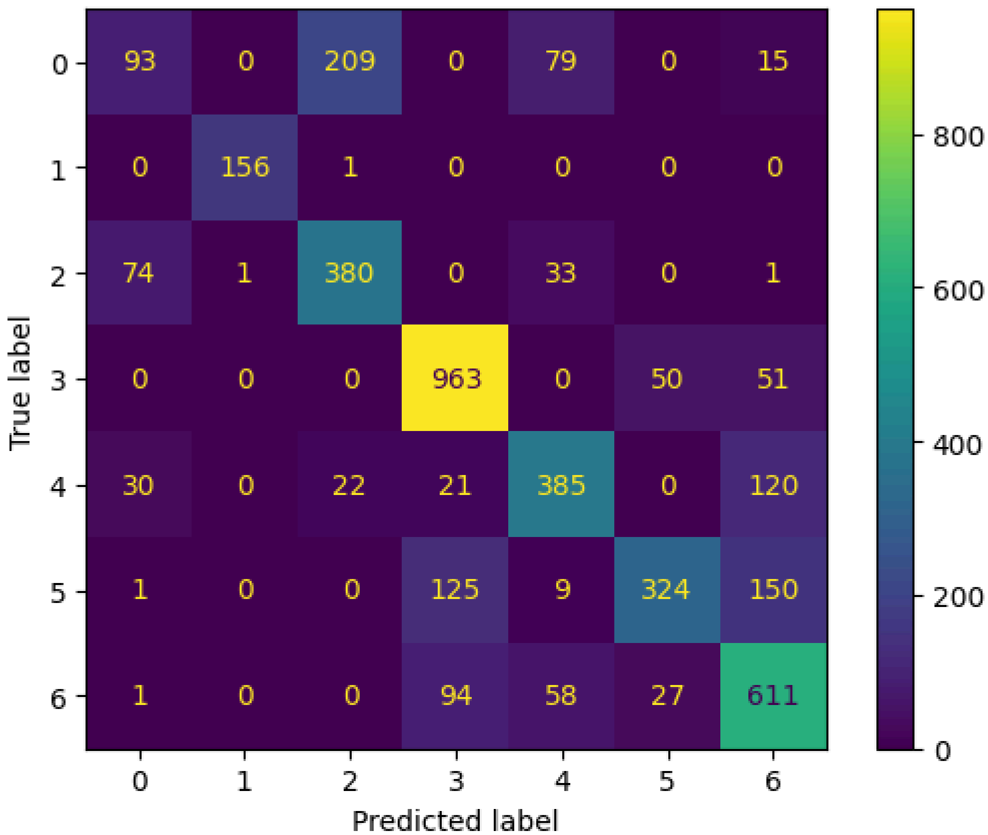

```
recall_score :  0.7408418559540463

precision Score :  0.763939091867034

log loss :  1.524297957776321

log loss_dummy :  1.834217157999518

************************************************************************************
****************
K_value 11


avg_accuracy :  0.7382643481100498

avg_err :  0.2617356518899502

<Figure size 2000x800 with 0 Axes>
```



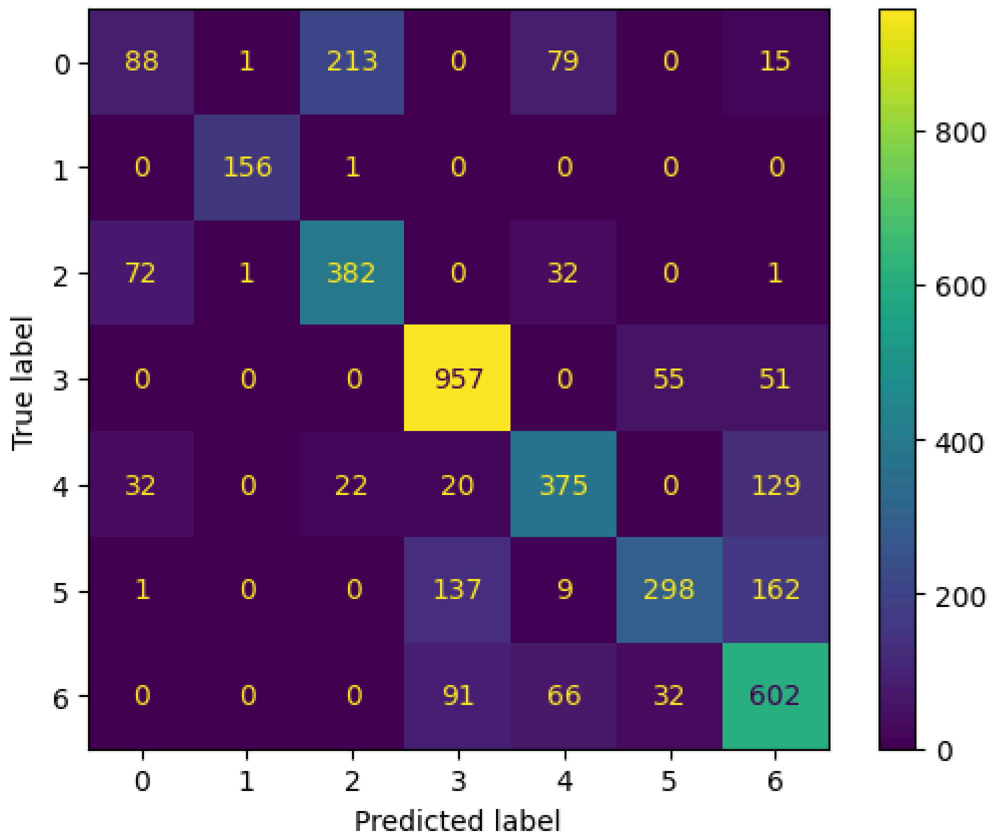

```
recall_score :  0.7242331156637712

precision Score :  0.7483810055833919

log loss :  1.3938582795179772

log loss_dummy :  1.834217157999518

************************************************************************************
****************
K_value 13


avg_accuracy :  0.7229977957384276

avg_err :  0.27700220426157235

<Figure size 2000x800 with 0 Axes>
```




```
recall_score :  0.7088690776668566

precision Score :  0.7315705712896279

log loss :  1.314407970762016

log loss_dummy :  1.834217157999518

************************************************************************************
****************
K_value 15


avg_accuracy :  0.7132827169564863

avg_err :  0.28671728304351374

<Figure size 2000x800 with 0 Axes>
```




```
recall_score :  0.6978126778560305

precision Score :  0.7171294355020862

log loss :  1.2567635565850492

log loss_dummy :  1.834217157999518

************************************************************************************
****************
K_value 17


avg_accuracy :  0.7000571475222467

avg_err :  0.2999428524777533

<Figure size 2000x800 with 0 Axes>
```



recall_score : 0.6855606495824125

precision Score : 0.7029346670766715

log loss : 1.2208601145888027

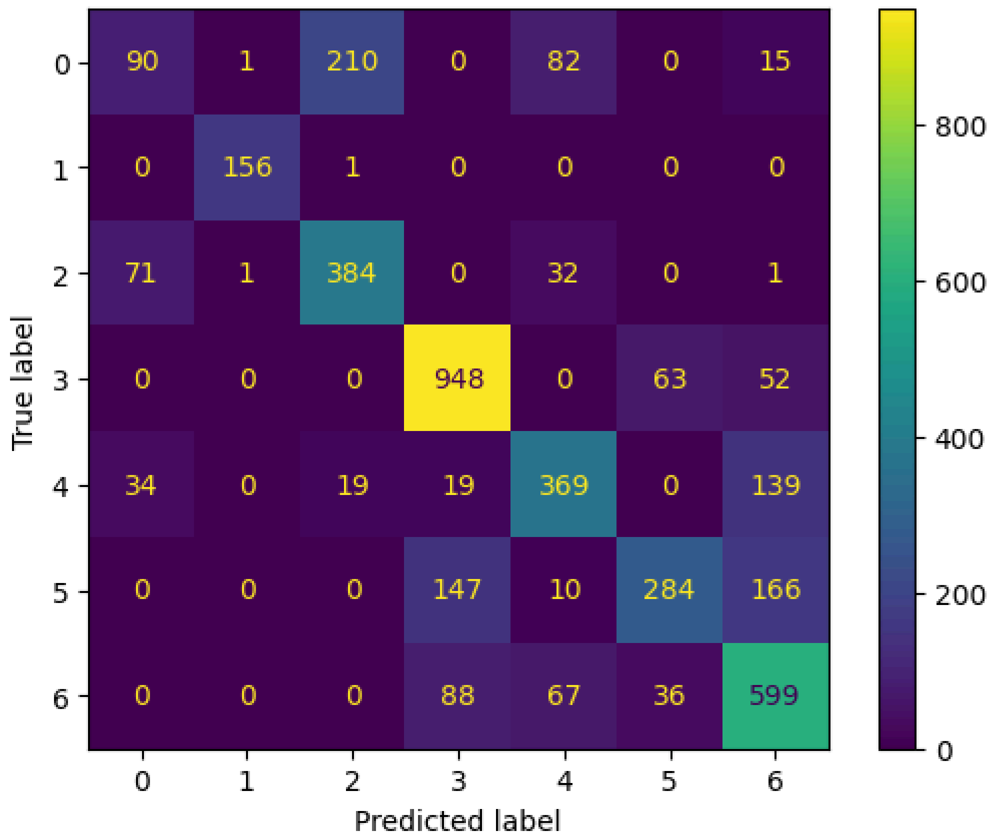
log loss_dummy : 1.834217157999518

****
****
K_value 19

avg_accuracy : 0.6930361662176504

avg_err : 0.3069638337823496

<Figure size 2000x800 with 0 Axes>



recall_score : 0.6801200749920688

precision Score : 0.6969371596130948

log loss : 1.1911573583137398

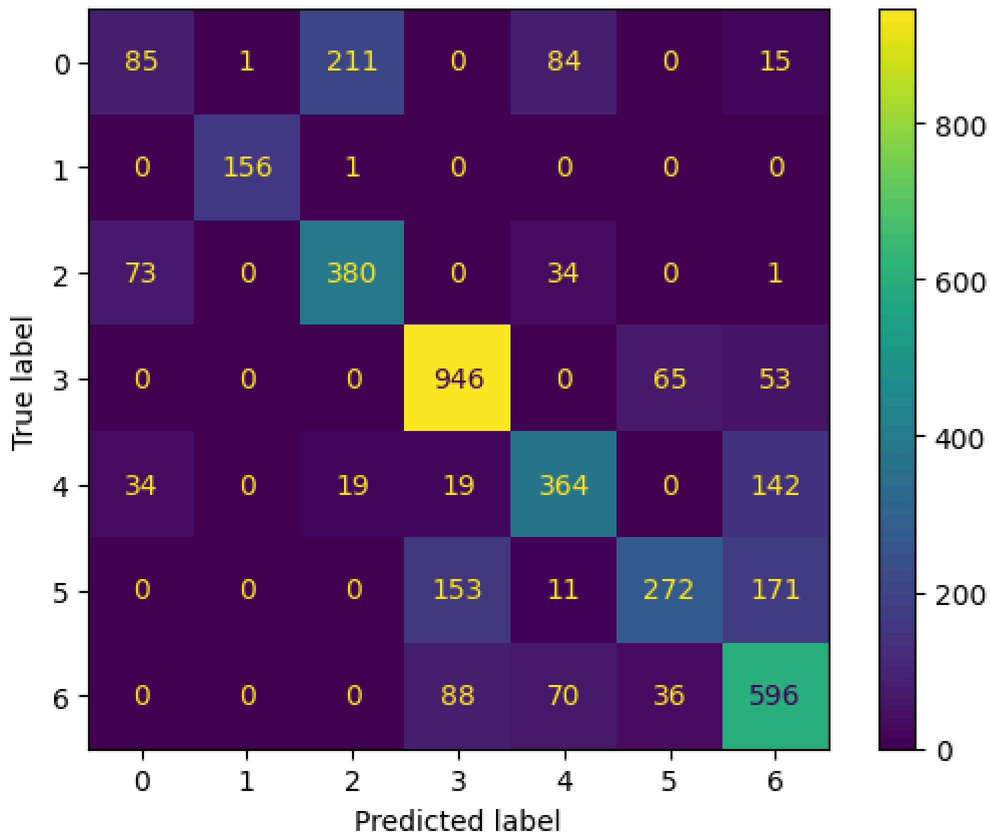
log loss_dummy : 1.834217157999518

****
****
K_value 21

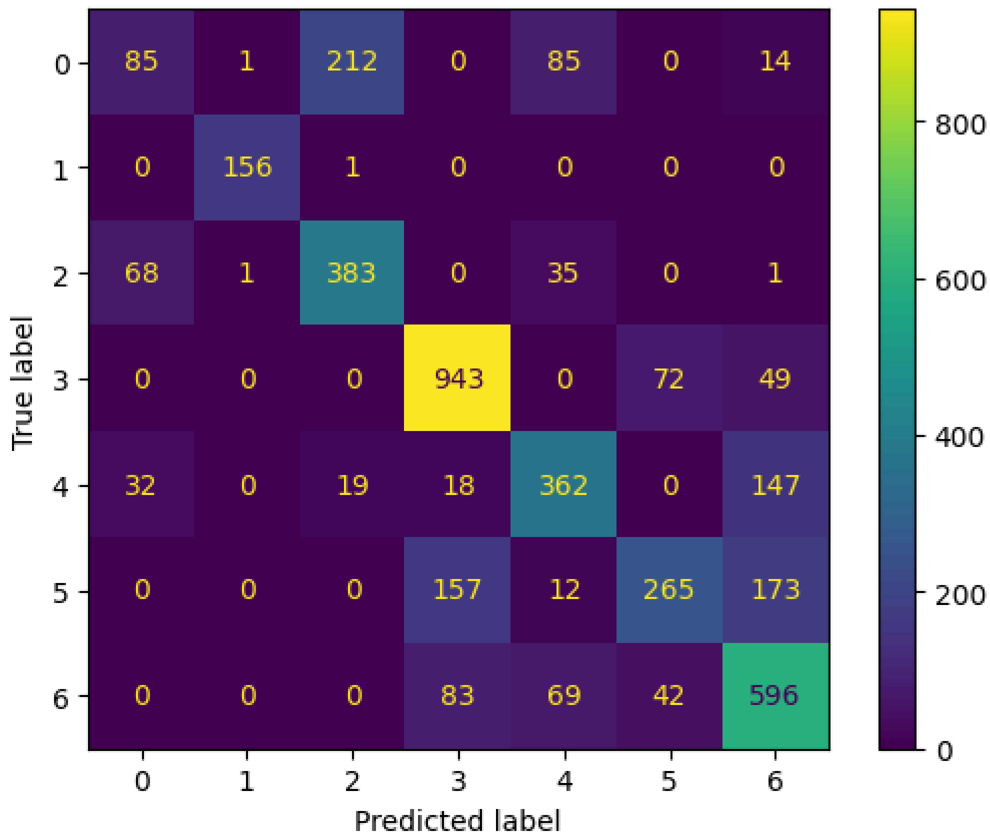
avg_accuracy : 0.6860151849130541

avg_err : 0.31398481508694587

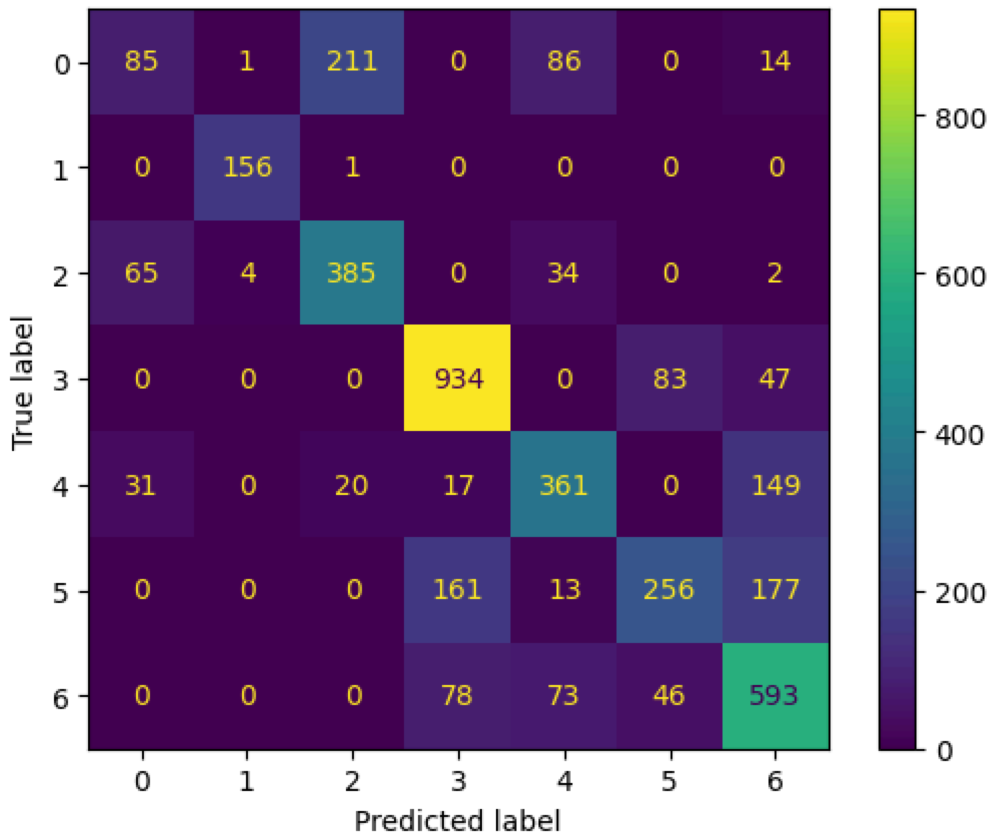
<Figure size 2000x800 with 0 Axes>



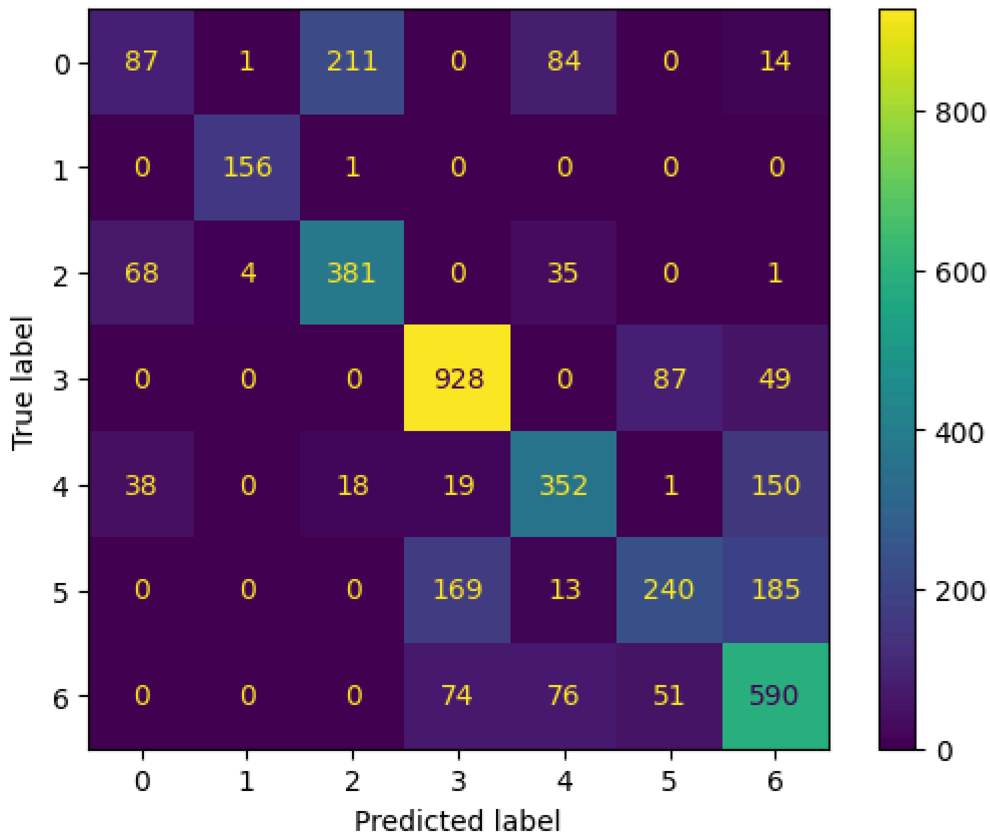

```
recall_score :  0.6729986106003335

precision Score :  0.6896463663523

log loss :  1.1769580436364786

log loss_dummy :  1.834217157999518

************************************************************************************
****************
K_value 23


avg_accuracy :  0.6831578088007184

avg_err :  0.31684219119928153

<Figure size 2000x800 with 0 Axes>
```




```
recall_score :  0.6706807614682132

precision Score :  0.6862081033493774

log loss :  1.1395032154701266

log loss_dummy :  1.834217157999518

************************************************************************************
****************
K_value 25


avg_accuracy :  0.6783410890684953

avg_err :  0.3216589109315046

<Figure size 2000x800 with 0 Axes>
```




```
recall_score :  0.667242208283678

precision Score :  0.6794791869624268

log loss :  1.1123471075252038

log loss_dummy :  1.834217157999518

************************************************************************************
****************
K_value 27


avg_accuracy :  0.6697689607314882

avg_err :  0.3302310392685118

<Figure size 2000x800 with 0 Axes>
```



recall_score : 0.659779921987875

precision Score : 0.6696309007696621

log loss : 1.0923289685809705

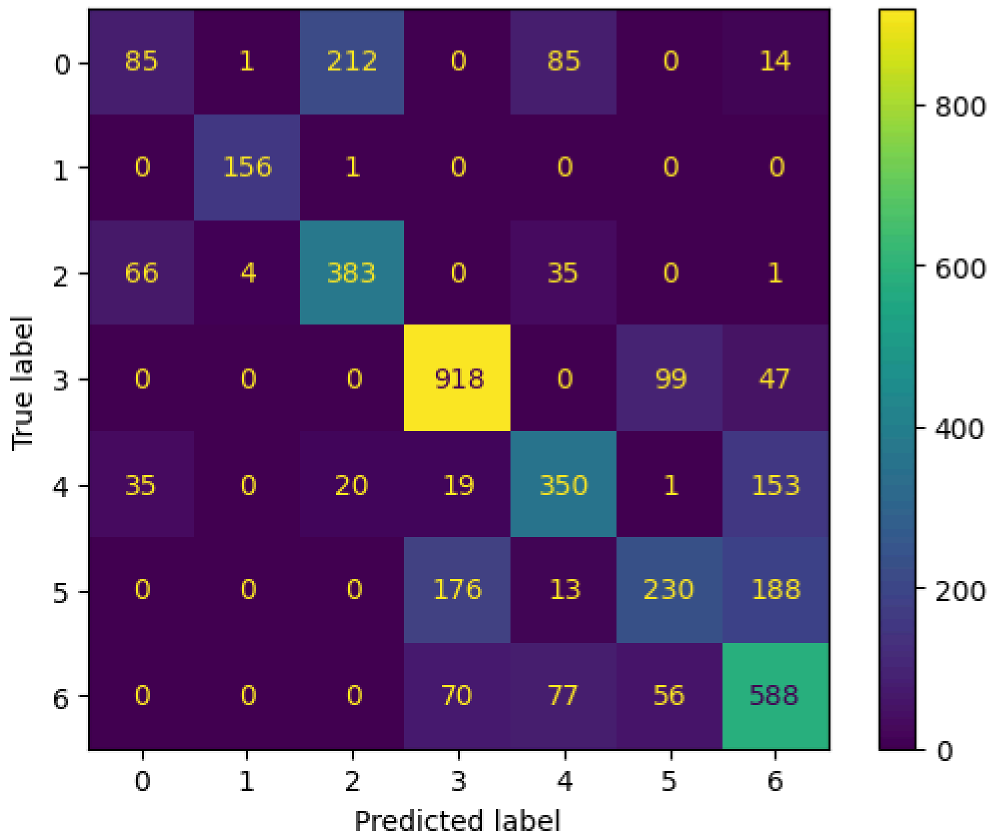
log loss_dummy : 1.834217157999518

****
****
K_value 29

avg_accuracy : 0.6638909298718263

avg_err : 0.33610907012817376

<Figure size 2000x800 with 0 Axes>




```
recall_score :  0.6551124126542112

precision Score :  0.6632301874609948

log loss :  1.0738462342454322

log loss_dummy :  1.834217157999518

************************************************************************************
****************
```

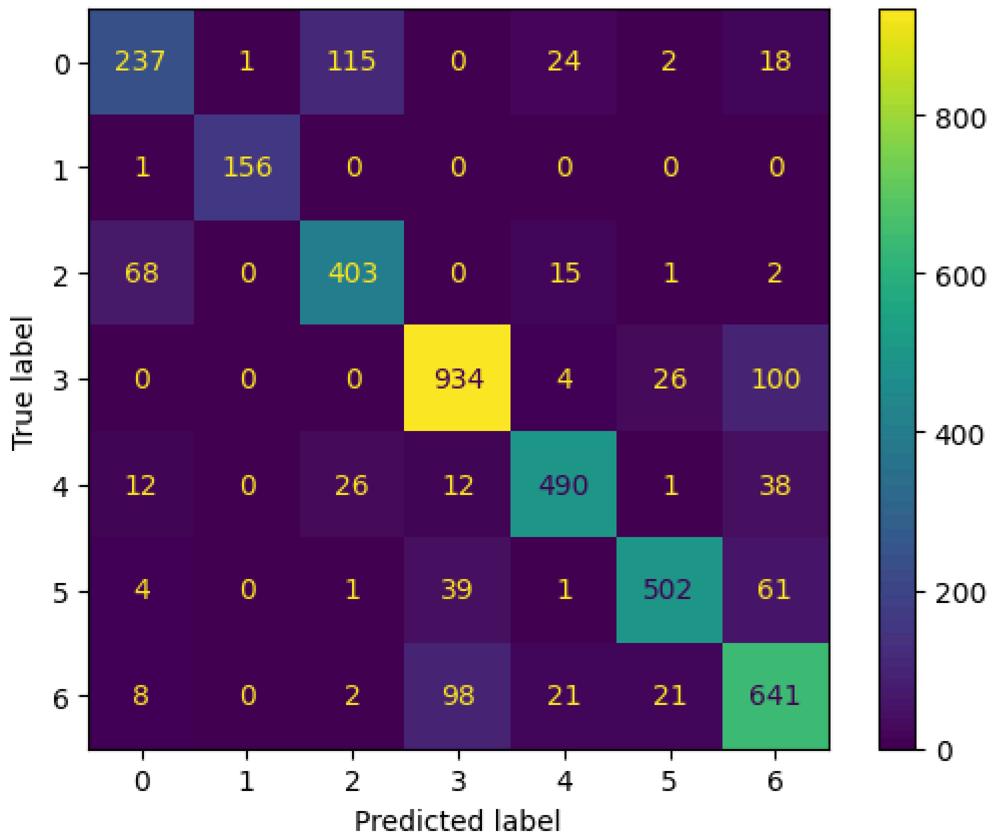
In [33]:
```python
sf=StratifiedKFold(n_splits=3)
```

In [34]:
```python
import matplotlib.pyplot as plt
no_of_splits=3
k=[]
avg_training_accuracy=[]
avg_accuracy=[]
avg_error=[]
avg_recall_score=[]
avg_log_loss=[]
avg_precision_score=[]
avg_f1_score=[]
avg_log_loss_dummy=[]
for i in range(1, 60, 2):
    acc = []
    acc_train = []
    err = []
```

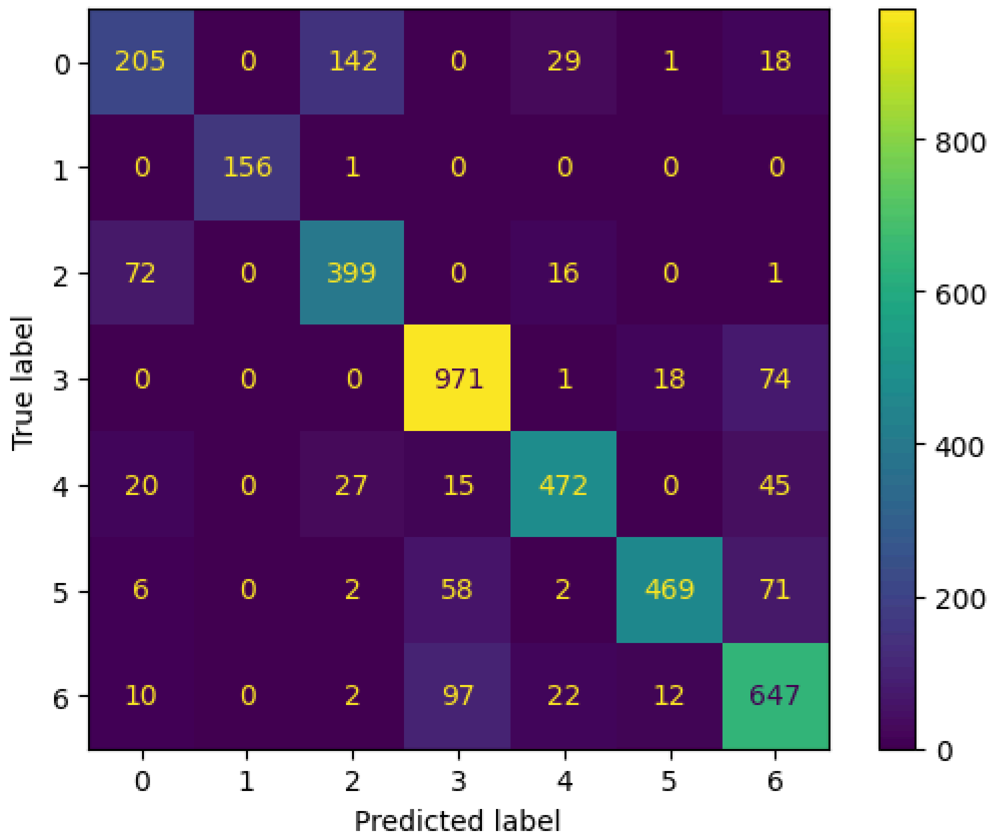
```
    conf = []
    recall = []
    prec = []
    k = []
    logloss = []
    logloss_dummy = []
    Classification_report=[]
    f1_score_=[]
    for train_index, cv_index in kf.split(x_train, y_train):
        x_trainf, x_cv, y_trainf, y_cv = x_train.iloc[train_index], x_train.iloc[cv
        #Training the model
        knn = KNeighborsClassifier(n_neighbors=i)
        model = knn.fit(x_trainf, y_trainf)
        # Predicting the Model
        predicted_train = model.predict(x_trainf)
        # training accuracy of an model
        acc_train.append(accuracy_score(y_trainf, predicted_train))
        predicted = model.predict(x_cv)
        acc.append(accuracy_score(y_cv, predicted))
        err.append(1 - accuracy_score(y_cv, predicted))
        conf.append(confusion_matrix(y_cv, predicted, labels=model.classes_))
        recall.append(recall_score(y_cv, predicted, average=None))
        prec.append(precision_score(y_cv, predicted, average=None))
        f1_score_.append(f1_score(y_cv, predicted, average=None))
        Classification_report.append(classification_report(y_cv,predicted))
        predicted = model.predict_proba(x_cv)
        logloss.append(log_loss(y_cv, predicted))
        dc = DummyClassifier()
        dc_model = dc.fit(x_trainf, y_trainf)
        dc_predit = dc_model.predict_proba(x_test)
        logloss_dummy.append(log_loss(y_test, dc_predit))
    a = np.mean(acc_train)
    b = np.mean(acc)

    print("K_value", i)
    k.append(i)
    print("")

    avg_training_accuracy.append(np.mean(acc_train))
    print("avg_accuracy train : ", np.mean(acc_train))
    print("")

    avg_accuracy.append(np.mean(acc))
    print("avg_accuracy : ", np.mean(acc))
    print("")

    avg_error.append(np.mean(err))
    print("avg_err : ", np.mean(err))
    print(" ")

    print(np.round(sum(conf) / no_of_splits))
    print(" ")


    plt.figure(figsize=(20, 8))
    cm = ConfusionMatrixDisplay(np.int64(np.round((conf[0] + conf[1] + conf[2]) / 3
```

```
    cm.plot()
    plt.show()
    print(" ")

    avg_recall_score.append( np.mean(recall))
    print("recall_score : ", np.mean(recall))
    print(" ")

    avg_precision_score.append(np.mean(prec))
    print("precision Score : ", np.mean(prec))
    print(" ")

    avg_f1_score.append(np.mean(f1_score_))
    print("f1_score :",np.mean(f1_score_))
    print("")

    avg_log_loss.append(np.mean(logloss))
    print("log loss : ", np.mean(logloss))
    print(" ")

    avg_log_loss_dummy.append(np.mean(logloss_dummy))
    print("log loss dummy : ", np.mean(logloss_dummy))
    print(" ")
    print("*" * 100)

print(" ")
```

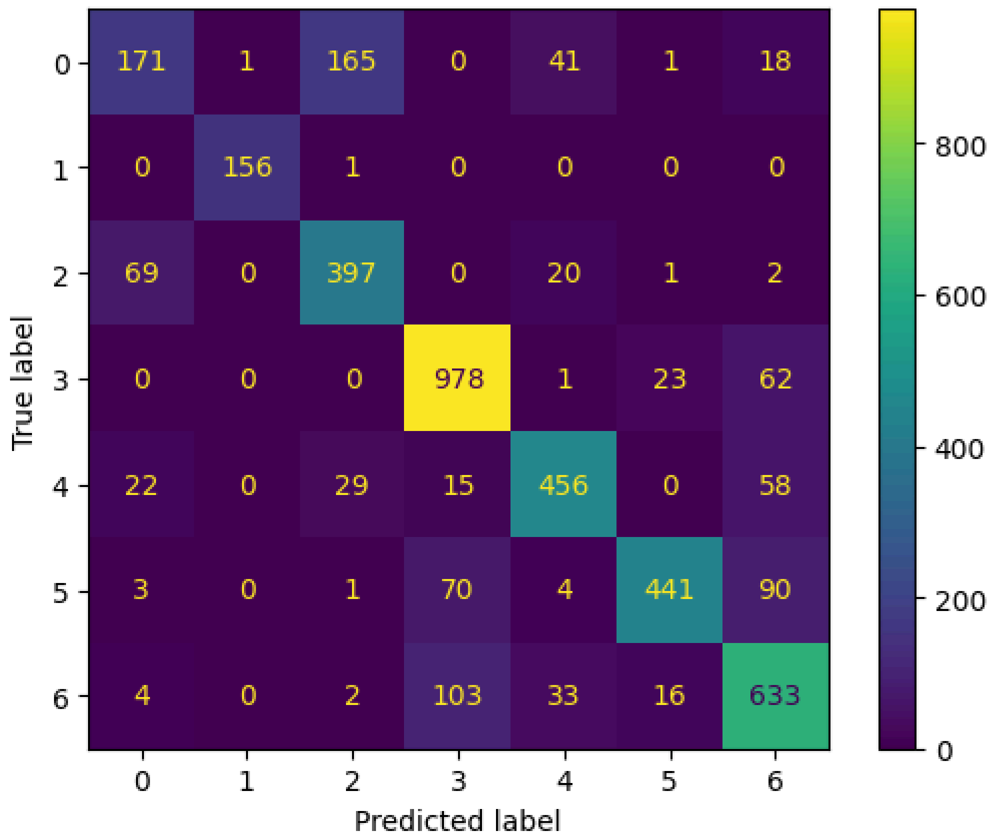
```
K_value 1

avg_accuracy train :  1.0

avg_accuracy :  0.8234141562576537

avg_err :  0.17658584374234632

[[237.   1. 115.   0.  24.   2.  18.]
 [  1. 156.   0.   0.   0.   0.   0.]
 [ 68.   0. 403.   0.  15.   1.   2.]
 [  0.   0.   0. 934.   4.  26. 100.]
 [ 12.   0.  26.  12. 490.   1.  38.]
 [  4.   0.   1.  39.   1. 502.  61.]
 [  8.   0.   2.  98.  21.  21. 641.]]

<Figure size 2000x800 with 0 Axes>
```



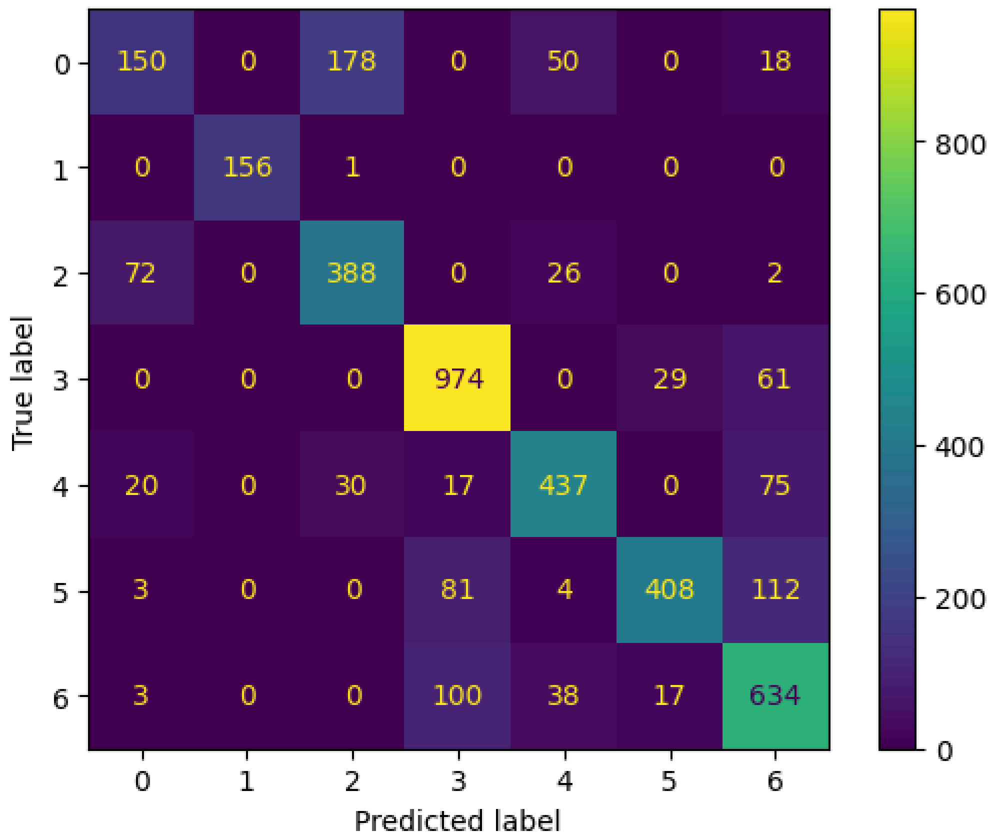

```
recall_score :  0.8251404425874777

precision Score :  0.8357553113955363

f1_score : 0.828681686307948

log loss :  6.364798945273935

log loss dummy :  1.834217157999518

************************************************************************************
****************
K_value 3

avg_accuracy train :  0.9013388848069231

avg_accuracy :  0.8126377663482733

avg_err :  0.18736223365172666

[[205.   0. 142.   0.  29.   1.  18.]
 [  0. 156.   1.   0.   0.   0.   0.]
 [ 72.   0. 399.   0.  16.   0.   1.]
 [  0.   0.   0. 971.   1.  18.  74.]
 [ 20.   0.  27.  15. 472.   0.  45.]
 [  6.   0.   2.  58.   2. 469.  71.]
 [ 10.   0.   2.  97.  22.  12. 647.]]

<Figure size 2000x800 with 0 Axes>
```



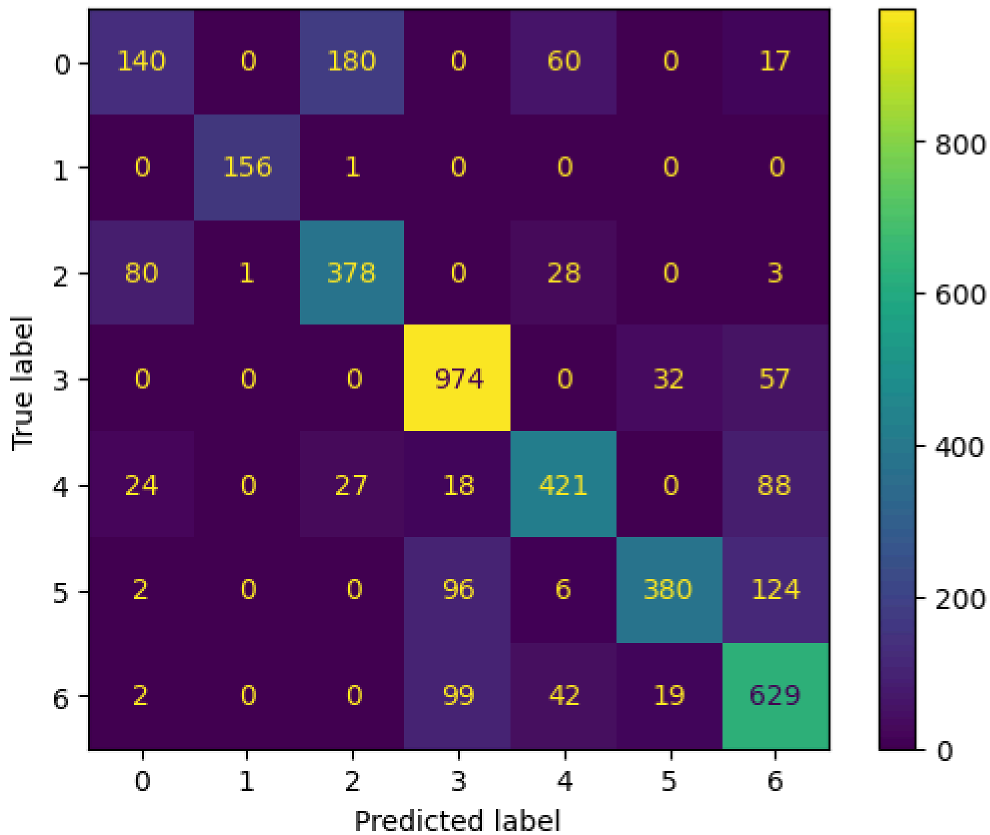

```
recall_score :  0.8063116220104359

precision Score :  0.822837318654935

f1_score : 0.811074974923937

log loss :  2.9567680815923403

log loss dummy :  1.834217157999518

********************************************************************************
****************
K_value 5

avg_accuracy train :  0.8632133235366153

avg_accuracy :  0.7913299044819985

avg_err :  0.20867009551800145

[[171.   1. 165.   0.  41.   1.  18.]
 [  0. 156.   1.   0.   0.   0.   0.]
 [ 69.   0. 397.   0.  20.   1.   2.]
 [  0.   0.   0. 978.   1.  23.  62.]
 [ 22.   0.  29.  15. 456.   0.  58.]
 [  3.   0.   1.  70.   4. 441.  90.]
 [  4.   0.   2. 103.  33.  16. 633.]]

<Figure size 2000x800 with 0 Axes>
```



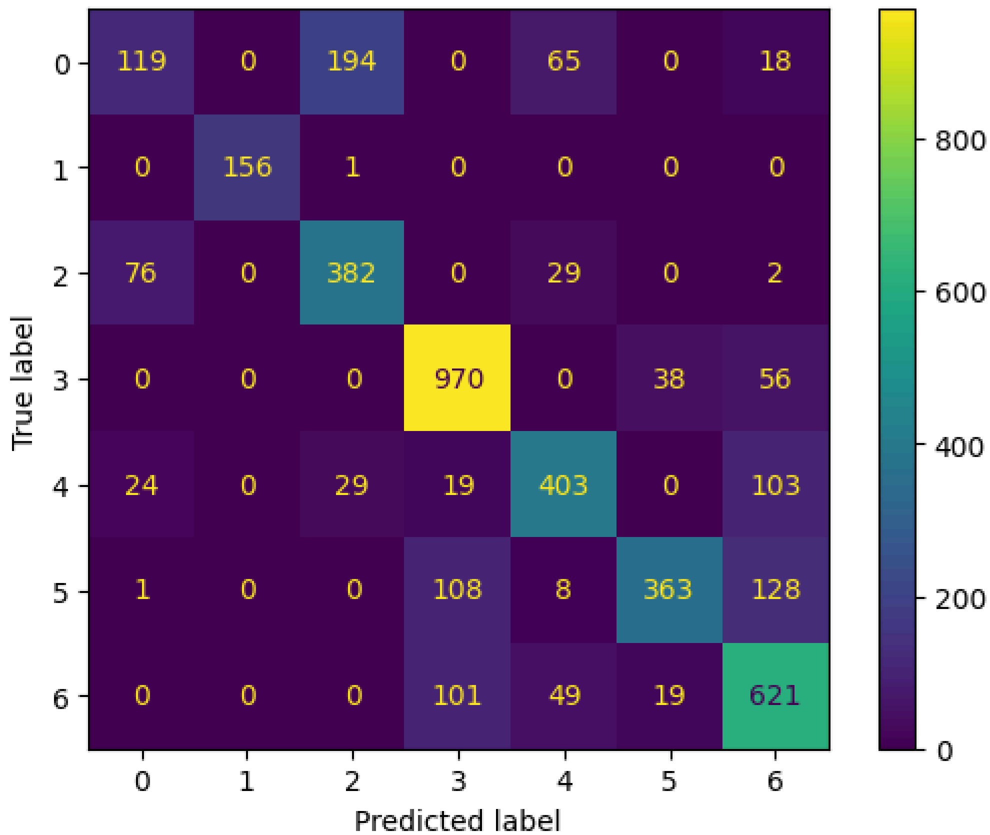

```
recall_score :  0.7811994173128243

precision Score :  0.8016457200759577

f1_score : 0.7853433841465789

log loss :  2.1476688325288786

log loss dummy :  1.834217157999518

*************************************************************************************
****************
K_value 7

avg_accuracy train :  0.8300269409747734

avg_accuracy :  0.7704302392032002

avg_err :  0.22956976079679972

[[150.   0. 178.   0.  50.   0.  18.]
 [  0. 156.   1.   0.   0.   0.   0.]
 [ 72.   0. 388.   0.  26.   0.   2.]
 [  0.   0.   0. 974.   0.  29.  61.]
 [ 20.   0.  30.  17. 437.   0.  75.]
 [  3.   0.   0.  81.   4. 408. 112.]
 [  3.   0.   0. 100.  38.  17. 634.]]

<Figure size 2000x800 with 0 Axes>
```



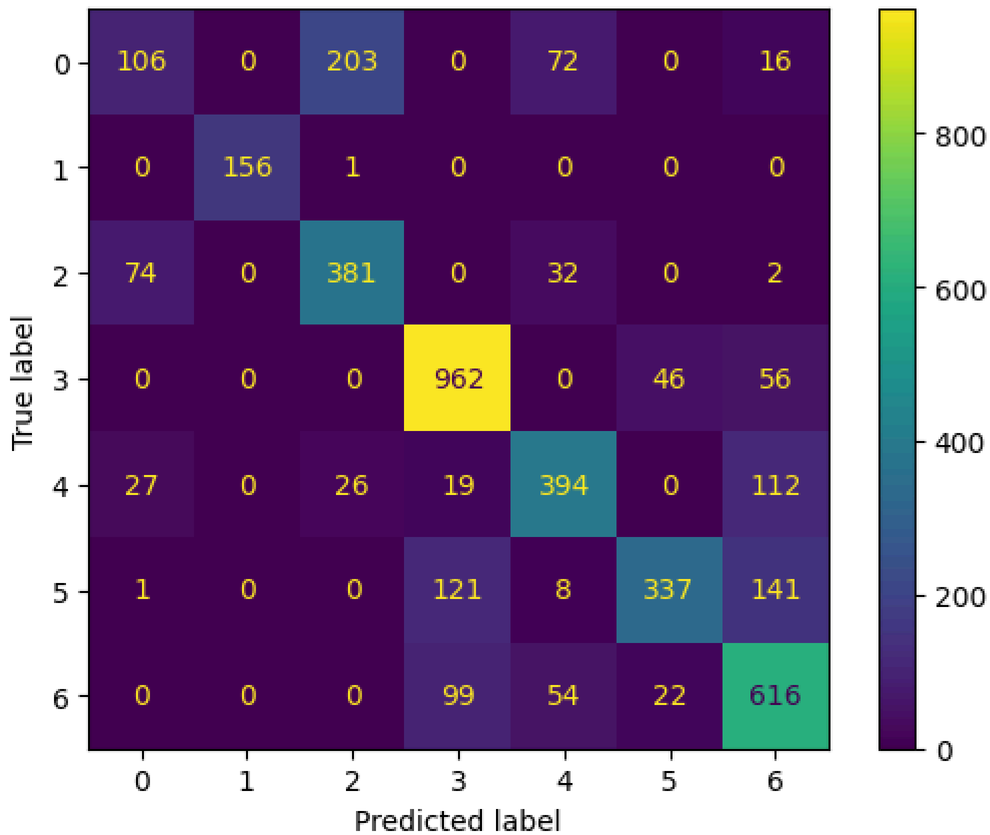

```
recall_score :  0.7586233970709605

precision Score :  0.7813774339257245

f1_score : 0.7620720991566718

log loss :  1.769392442446806

log loss dummy :  1.834217157999518

************************************************************************************
****************
K_value 9

avg_accuracy train :  0.8052902277736959

avg_accuracy :  0.7538574577516531

avg_err :  0.24614254224834684

[[140.   0. 180.   0.  60.   0.  17.]
 [  0. 156.   1.   0.   0.   0.   0.]
 [ 80.   1. 378.   0.  28.   0.   3.]
 [  0.   0.   0. 974.   0.  32.  57.]
 [ 24.   0.  27.  18. 421.   0.  88.]
 [  2.   0.   0.  96.   6. 380. 124.]
 [  2.   0.   0.  99.  42.  19. 629.]]

<Figure size 2000x800 with 0 Axes>
```



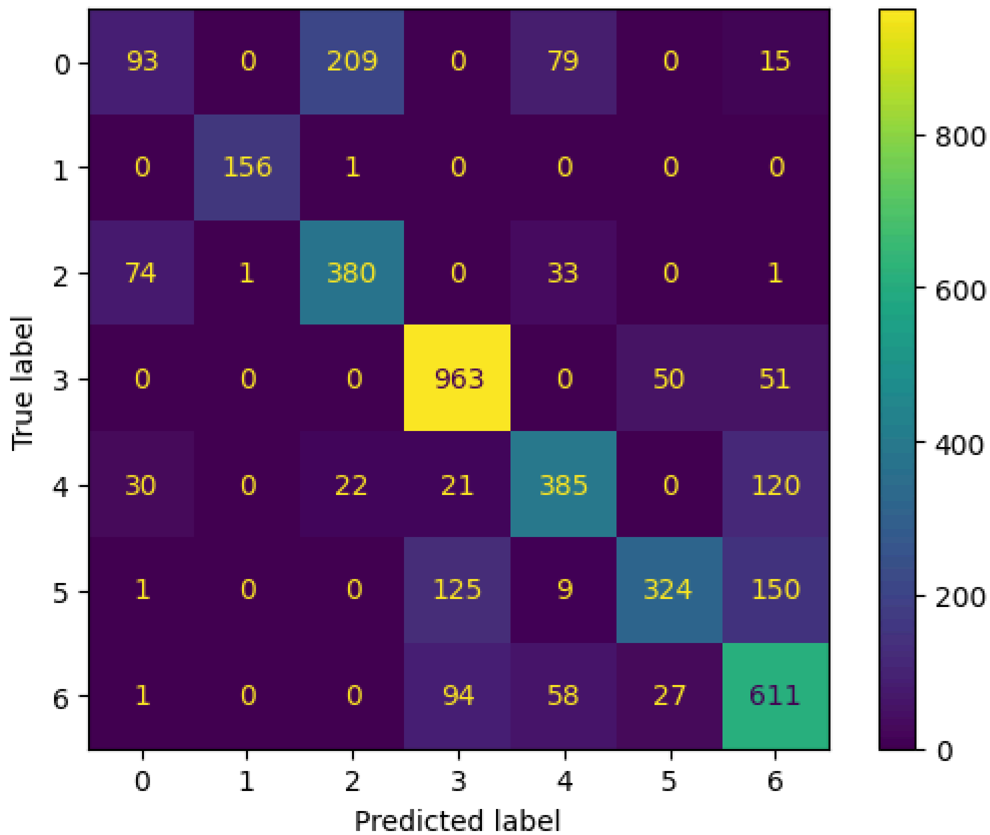

```
recall_score :  0.7408418559540463

precision Score :  0.763939091867034

f1_score : 0.7438963440368104

log loss :  1.524297957776321

log loss dummy :  1.834217157999518

************************************************************************************
****************
K_value 11

avg_accuracy train :  0.7862682667972895

avg_accuracy :  0.7382643481100498

avg_err :  0.2617356518899502

[[119.   0. 194.   0.  65.   0.  18.]
 [  0. 156.   1.   0.   0.   0.   0.]
 [ 76.   0. 382.   0.  29.   0.   2.]
 [  0.   0.   0. 970.   0.  38.  56.]
 [ 24.   0.  29.  19. 403.   0. 103.]
 [  1.   0.   0. 108.   8. 363. 128.]
 [  0.   0.   0. 101.  49.  19. 621.]]

<Figure size 2000x800 with 0 Axes>
```



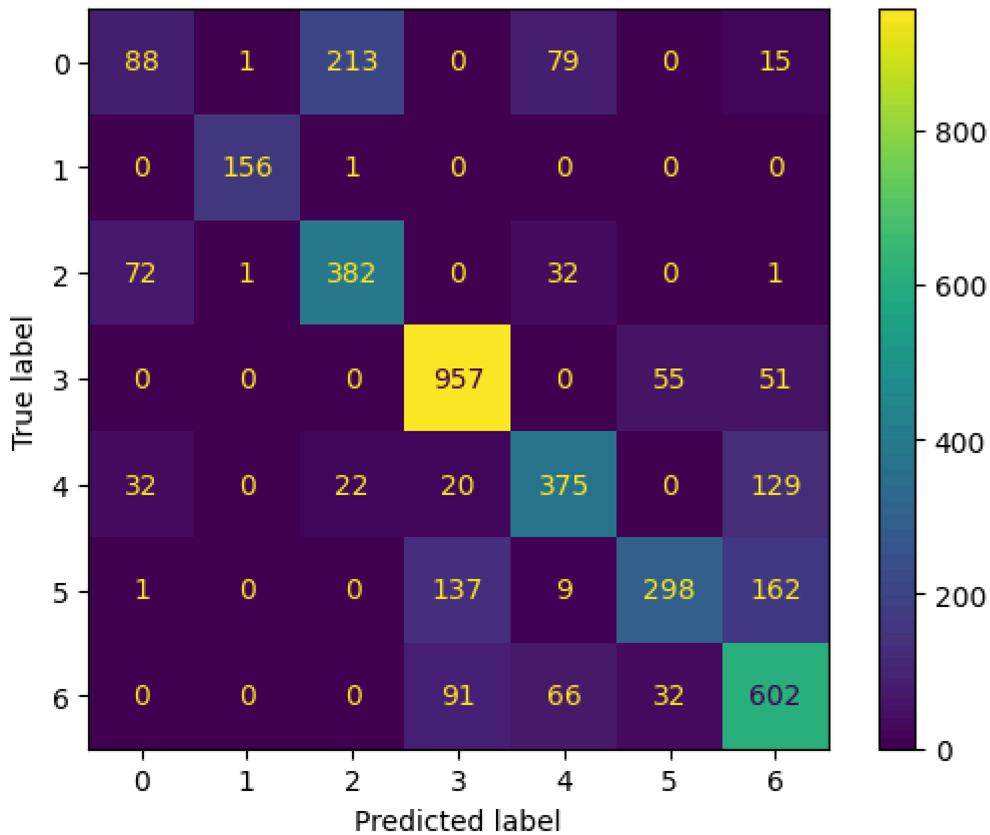

```
recall_score :  0.7242331156637712

precision Score :  0.7483810055833919

f1_score : 0.7254363532284891

log loss :  1.3938582795179772

log loss dummy :  1.834217157999518

************************************************************************************
****************
K_value 13

avg_accuracy train :  0.7658176177647155

avg_accuracy :  0.7229977957384276

avg_err :  0.27700220426157235

[[106.   0. 203.   0.  72.   0.  16.]
 [  0. 156.   1.   0.   0.   0.   0.]
 [ 74.   0. 381.   0.  32.   0.   2.]
 [  0.   0.   0. 962.   0.  46.  56.]
 [ 27.   0.  26.  19. 394.   0. 112.]
 [  1.   0.   0. 121.   8. 337. 141.]
 [  0.   0.   0.  99.  54.  22. 616.]]

<Figure size 2000x800 with 0 Axes>
```



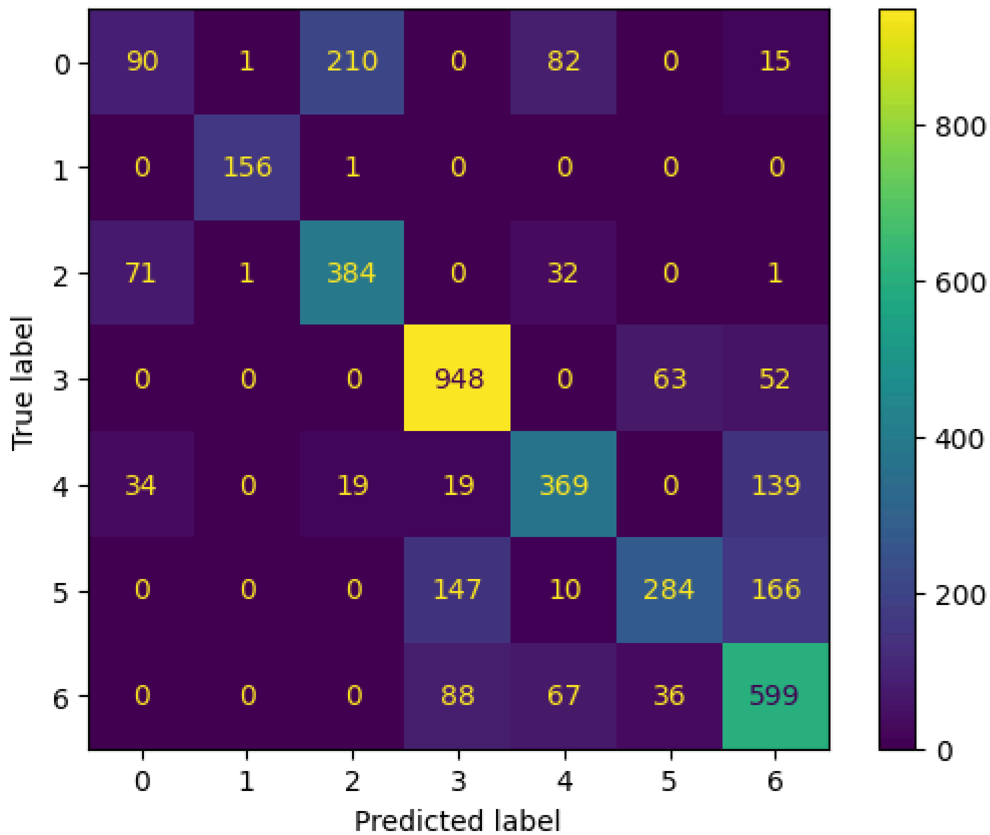

```
recall_score :  0.7088690776668566

precision Score :  0.7315705712896279

f1_score : 0.7081288161923693

log loss :  1.314407970762016

log loss dummy :  1.834217157999518

************************************************************************************
****************
K_value 15

avg_accuracy train :  0.7484284431382154

avg_accuracy :  0.7132827169564863

avg_err :  0.28671728304351374

[[ 93.   0. 209.   0.  79.   0.  15.]
 [  0. 156.   1.   0.   0.   0.   0.]
 [ 74.   1. 380.   0.  33.   0.   1.]
 [  0.   0.   0. 963.   0.  50.  51.]
 [ 30.   0.  22.  21. 385.   0. 120.]
 [  1.   0.   0. 125.   9. 324. 150.]
 [  1.   0.   0.  94.  58.  27. 611.]]

<Figure size 2000x800 with 0 Axes>
```



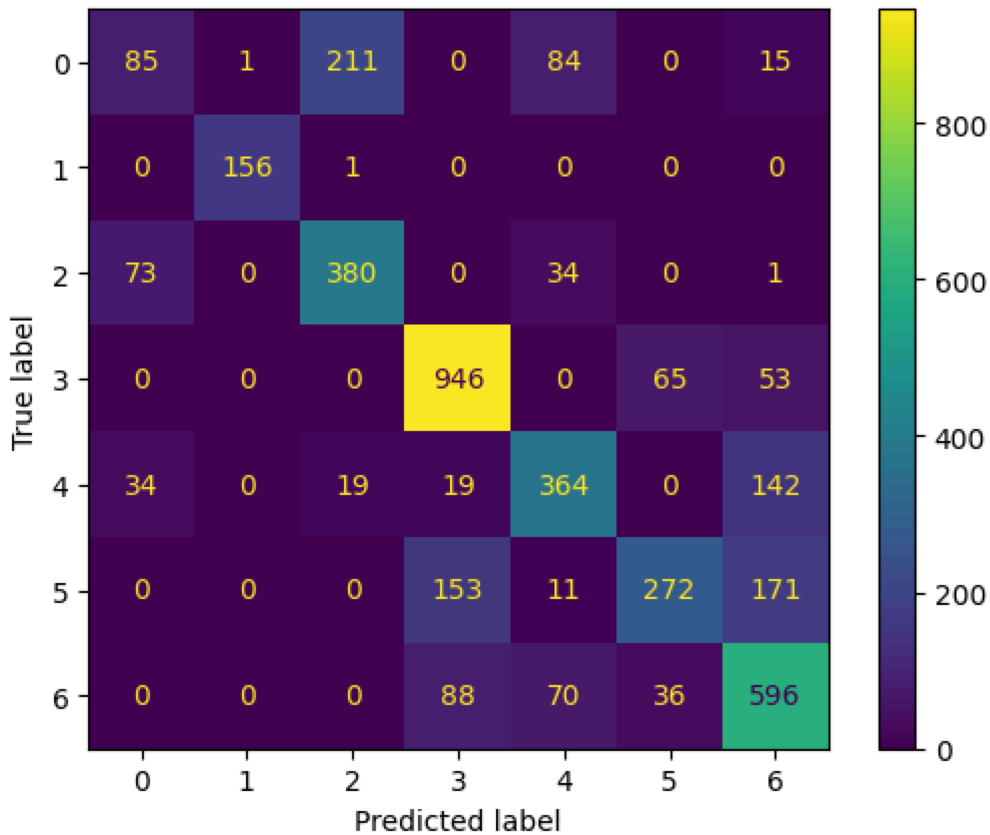

```
recall_score :  0.6978126778560305

precision Score :  0.7171294355020862

f1_score : 0.695131629455029

log loss :  1.2567635565850492

log loss dummy :  1.834217157999518

************************************************************************************
****************
K_value 17

avg_accuracy train :  0.734835496775247

avg_accuracy :  0.7000571475222467

avg_err :  0.2999428524777533

[[ 88.   1. 213.   0.  79.   0.  15.]
 [  0. 156.   1.   0.   0.   0.   0.]
 [ 72.   1. 382.   0.  32.   0.   1.]
 [  0.   0.   0. 957.   0.  55.  51.]
 [ 32.   0.  22.  20. 375.   0. 129.]
 [  1.   0.   0. 137.   9. 298. 162.]
 [  0.   0.   0.  91.  66.  32. 602.]]

<Figure size 2000x800 with 0 Axes>
```



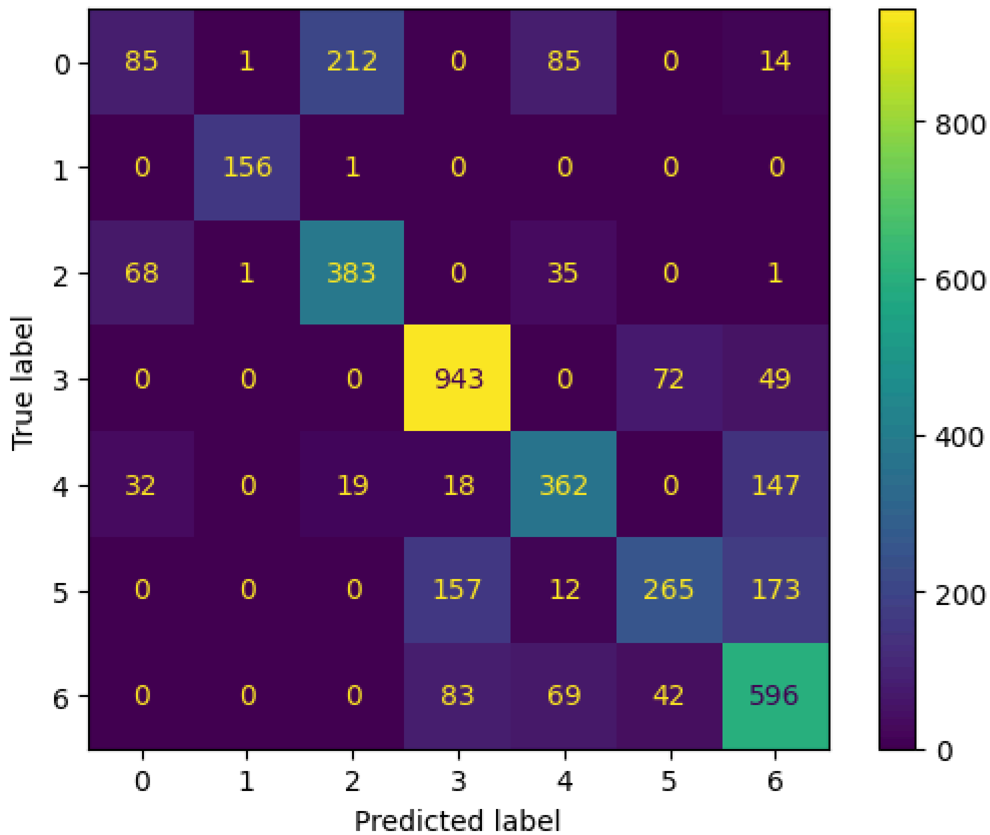

```
recall_score :  0.6855606495824125

precision Score :  0.7029346670766715

f1_score : 0.6811068252814495

log loss :  1.2208601145888027

log loss dummy :  1.834217157999518

************************************************************************************
****************
K_value 19

avg_accuracy train :  0.7271614009306883

avg_accuracy :  0.6930361662176504

avg_err :  0.3069638337823496

[[ 90.   1. 210.   0.  82.   0.  15.]
 [  0. 156.   1.   0.   0.   0.   0.]
 [ 71.   1. 384.   0.  32.   0.   1.]
 [  0.   0.   0. 948.   0.  63.  52.]
 [ 34.   0.  19.  19. 369.   0. 139.]
 [  0.   0.   0. 147.  10. 284. 166.]
 [  0.   0.   0.  88.  67.  36. 599.]]

<Figure size 2000x800 with 0 Axes>
```



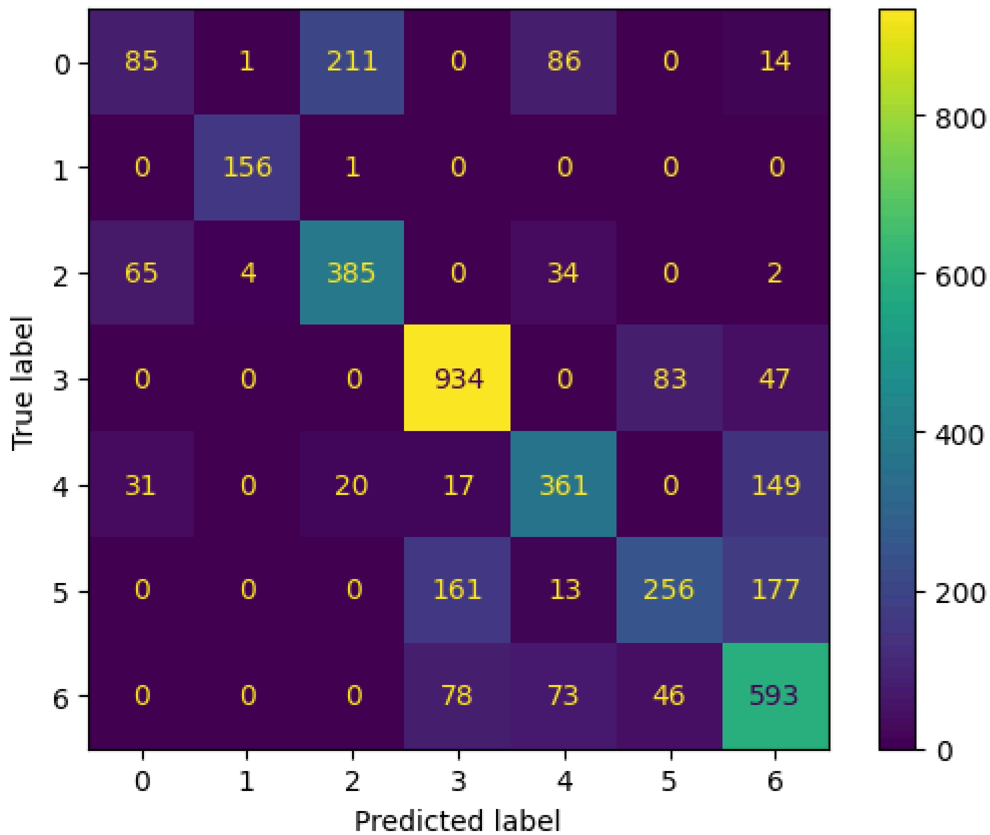

```
recall_score :  0.6801200749920688

precision Score :  0.6969371596130948

f1_score : 0.6754019426843676

log loss :  1.1911573583137398

log loss dummy :  1.834217157999518

************************************************************************************
****************
K_value 21

avg_accuracy train :  0.7160992734100743

avg_accuracy :  0.6860151849130541

avg_err :  0.31398481508694587

[[ 85.   1. 211.   0.  84.   0.  15.]
 [  0. 156.   1.   0.   0.   0.   0.]
 [ 73.   0. 380.   0.  34.   0.   1.]
 [  0.   0.   0. 946.   0.  65.  53.]
 [ 34.   0.  19.  19. 364.   0. 142.]
 [  0.   0.   0. 153.  11. 272. 171.]
 [  0.   0.   0.  88.  70.  36. 596.]]

<Figure size 2000x800 with 0 Axes>
```



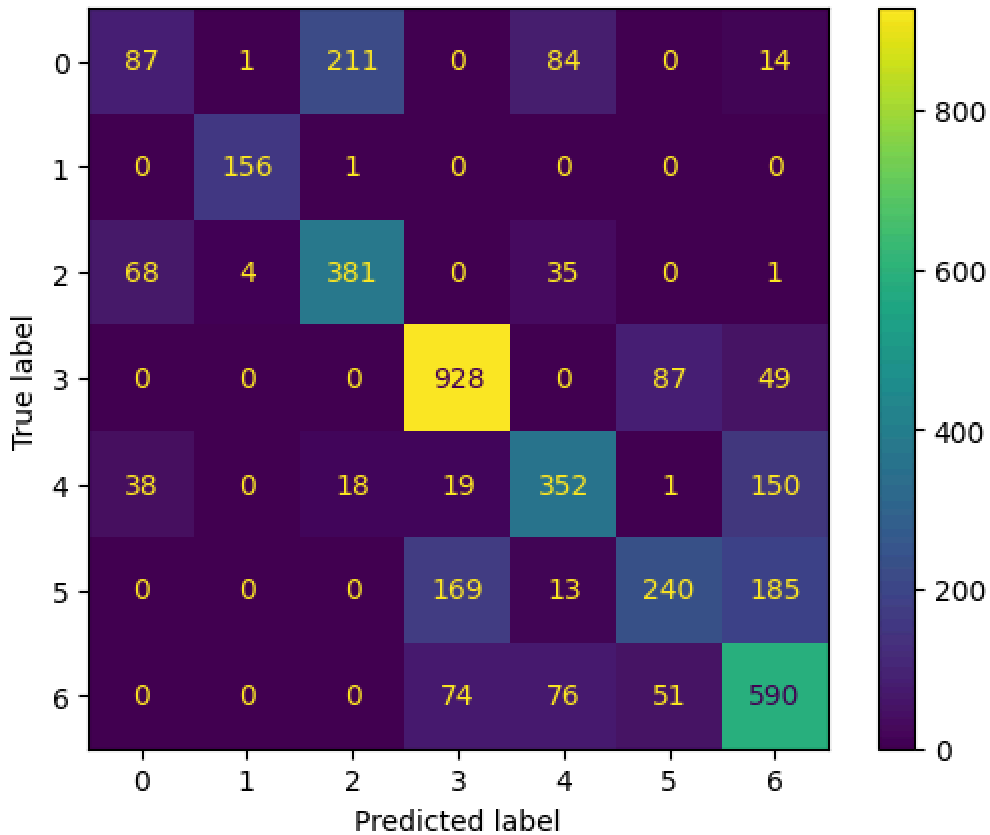

```
recall_score :  0.6729986106003335

precision Score :  0.6896463663523

f1_score : 0.6678059688116427

log loss :  1.1769580436364786

log loss dummy :  1.834217157999518

**********************************************************************************
****************
K_value 23

avg_accuracy train :  0.7080578006367867

avg_accuracy :  0.6831578088007184

avg_err :  0.31684219119928153

[[ 85.   1. 212.   0.  85.   0.  14.]
 [  0. 156.   1.   0.   0.   0.   0.]
 [ 68.   1. 383.   0.  35.   0.   1.]
 [  0.   0.   0. 943.   0.  72.  49.]
 [ 32.   0.  19.  18. 362.   0. 147.]
 [  0.   0.   0. 157.  12. 265. 173.]
 [  0.   0.   0.  83.  69.  42. 596.]]

<Figure size 2000x800 with 0 Axes>
```



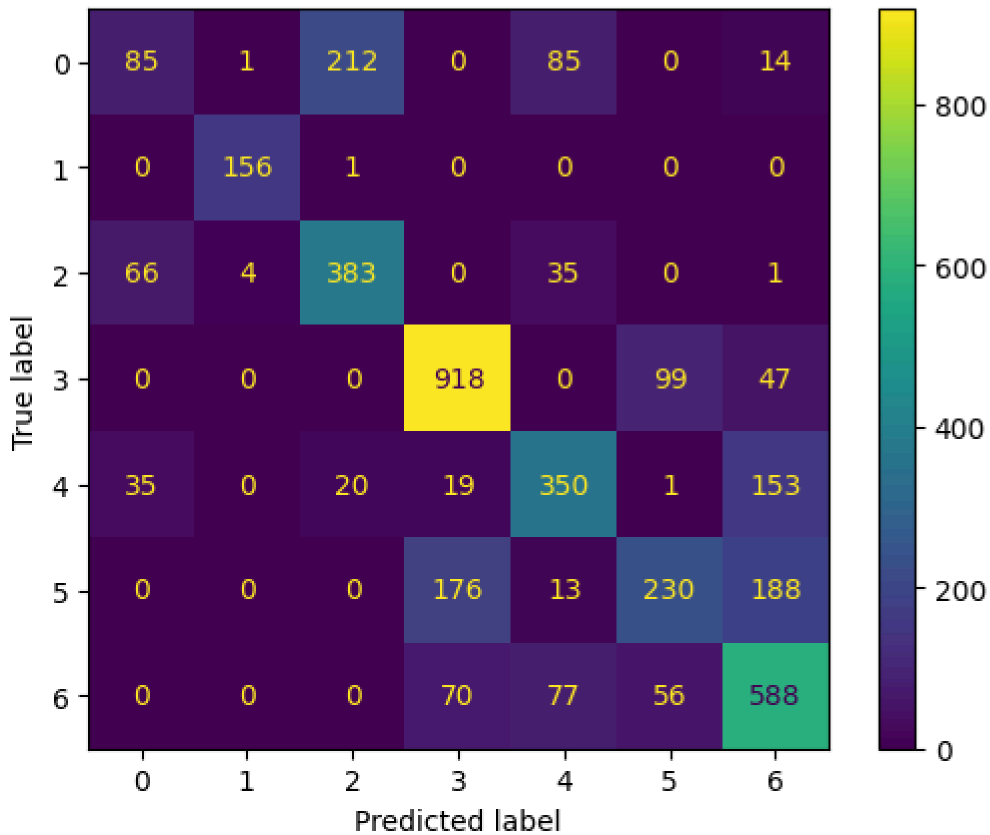

```
recall_score :  0.6706807614682132

precision Score :  0.6862081033493774

f1_score : 0.6644808967324396

log loss :  1.1395032154701266

log loss dummy :  1.834217157999518

************************************************************************************
****************
K_value 25

avg_accuracy train :  0.7004245244509756

avg_accuracy :  0.6783410890684953

avg_err :  0.3216589109315046

[[ 85.   1. 211.   0.  86.   0.  14.]
 [  0. 156.   1.   0.   0.   0.   0.]
 [ 65.   4. 385.   0.  34.   0.   2.]
 [  0.   0.   0. 934.   0.  83.  47.]
 [ 31.   0.  20.  17. 361.   0. 149.]
 [  0.   0.   0. 161.  13. 256. 177.]
 [  0.   0.   0.  78.  73.  46. 593.]]

<Figure size 2000x800 with 0 Axes>
```



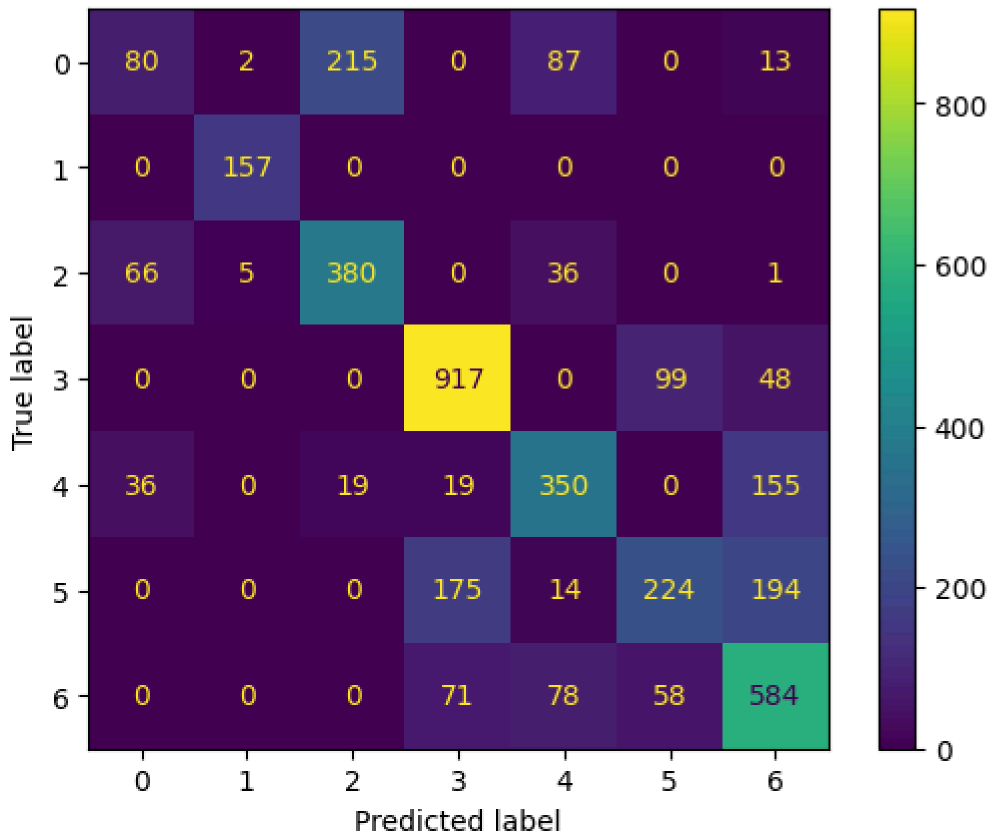

```
recall_score :  0.667242208283678

precision Score :  0.6794791869624268

f1_score : 0.6593124104698246

log loss :  1.1123471075252038

log loss dummy :  1.834217157999518

************************************************************************************
****************
K_value 27

avg_accuracy train :  0.6933627234876316

avg_accuracy :  0.6697689607314882

avg_err :  0.3302310392685118

[[ 87.   1. 211.   0.  84.   0.  14.]
 [  0. 156.   1.   0.   0.   0.   0.]
 [ 68.   4. 381.   0.  35.   0.   1.]
 [  0.   0.   0. 928.   0.  87.  49.]
 [ 38.   0.  18.  19. 352.   1. 150.]
 [  0.   0.   0. 169.  13. 240. 185.]
 [  0.   0.   0.  74.  76.  51. 590.]]

<Figure size 2000x800 with 0 Axes>
```



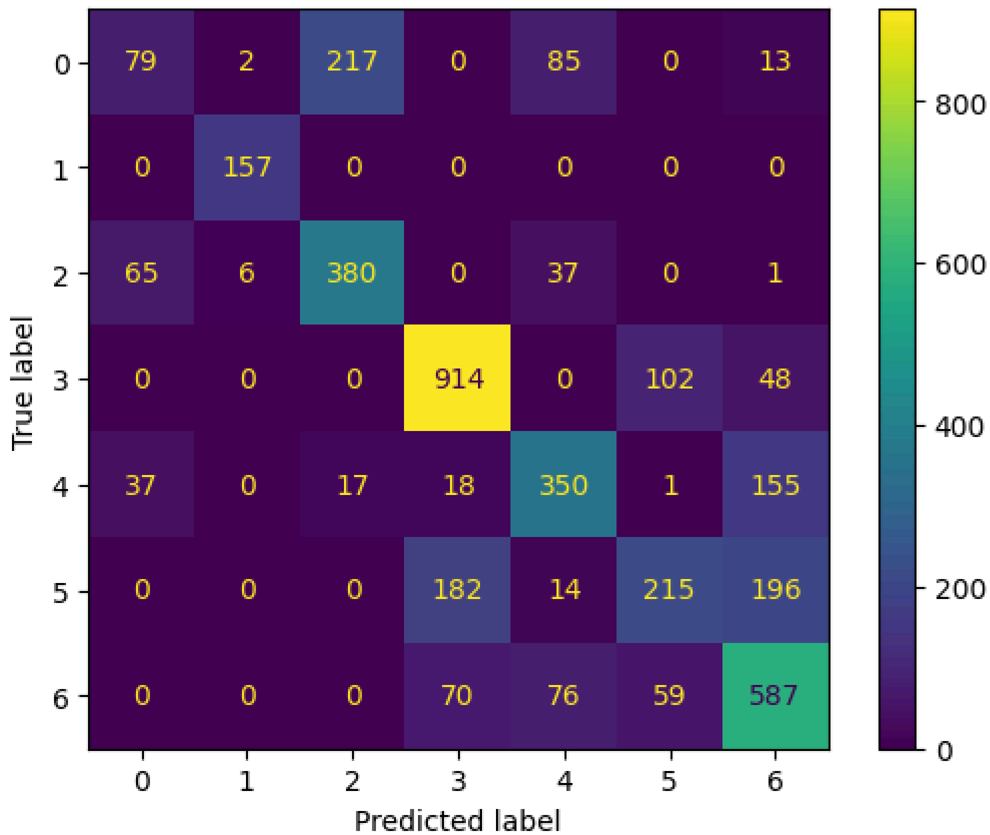

```
recall_score :  0.659779921987875

precision Score :  0.6696309007696621

f1_score : 0.651723684157035

log loss :  1.0923289685809705

log loss dummy :  1.834217157999518

************************************************************************************
****************
K_value 29

avg_accuracy train :  0.6895664952241

avg_accuracy :  0.6638909298718263

avg_err :  0.33610907012817376

[[ 85.   1. 212.   0.  85.   0.  14.]
 [  0. 156.   1.   0.   0.   0.   0.]
 [ 66.   4. 383.   0.  35.   0.   1.]
 [  0.   0.   0. 918.   0.  99.  47.]
 [ 35.   0.  20.  19. 350.   1. 153.]
 [  0.   0.   0. 176.  13. 230. 188.]
 [  0.   0.   0.  70.  77.  56. 588.]]

<Figure size 2000x800 with 0 Axes>
```



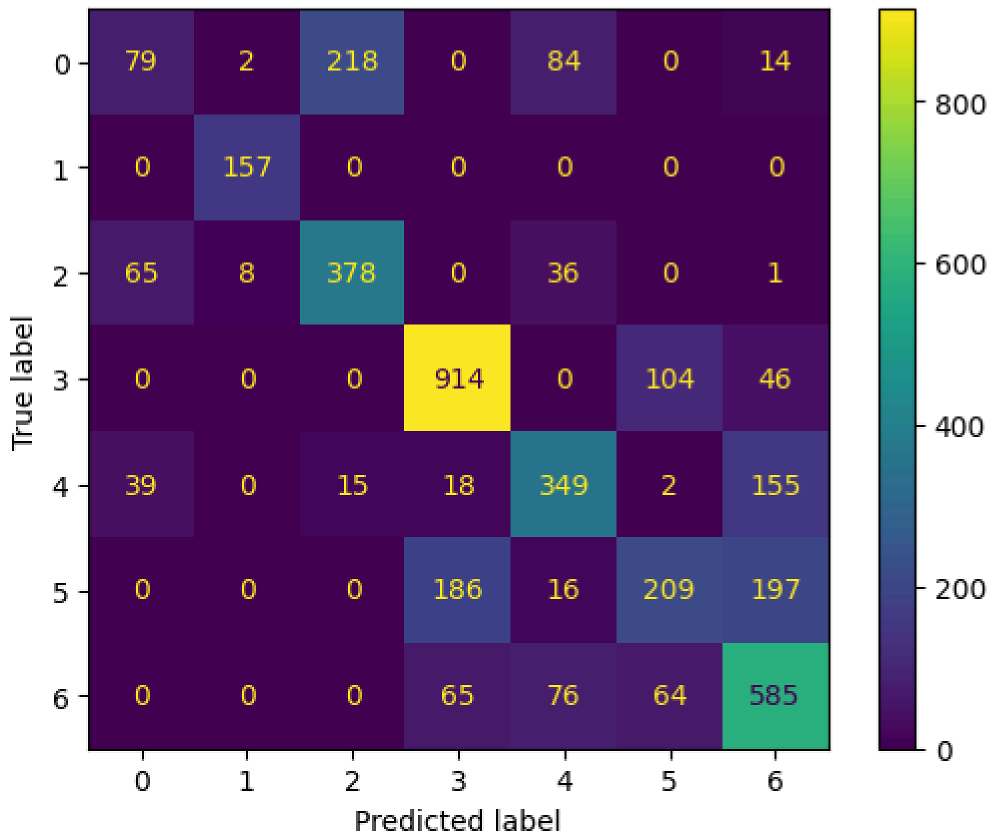

```
recall_score :  0.6551124126542112

precision Score :  0.6632301874609948

f1_score : 0.6461410179732751

log loss :  1.0738462342454322

log loss dummy :  1.834217157999518

*************************************************************************************
****************
K_value 31

avg_accuracy train :  0.6840558412931669

avg_accuracy :  0.6592374887745939

avg_err :  0.3407625112254061

[[ 80.   2. 215.   0.  87.   0.  13.]
 [  0. 157.   0.   0.   0.   0.   0.]
 [ 66.   5. 380.   0.  36.   0.   1.]
 [  0.   0.   0. 917.   0.  99.  48.]
 [ 36.   0.  19.  19. 350.   0. 155.]
 [  0.   0.   0. 175.  14. 224. 194.]
 [  0.   0.   0.  71.  78.  58. 584.]]

<Figure size 2000x800 with 0 Axes>
```



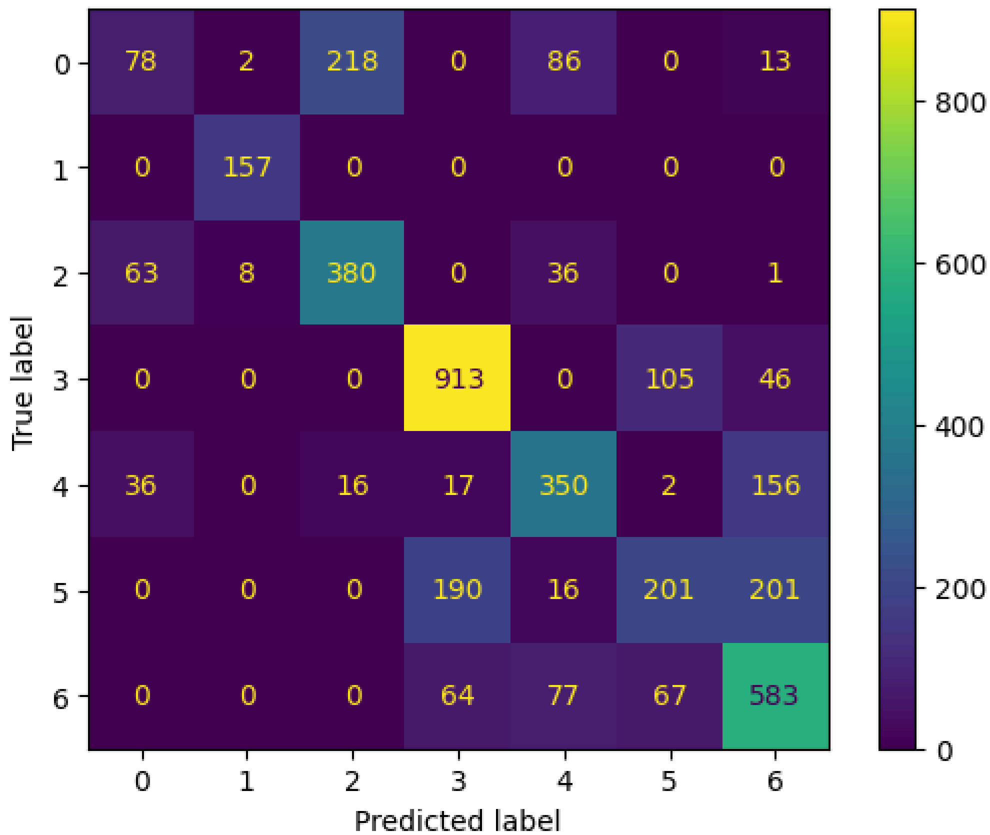

```
recall_score :  0.6506448213100685

precision Score :  0.6551323134349727

f1_score : 0.6396230474617453

log loss :  1.0489821898598921

log loss dummy :  1.834217157999518

************************************************************************************
****************
K_value 33

avg_accuracy train :  0.680626989958364

avg_accuracy :  0.6567066699322394

avg_err :  0.3432933300677606

[[ 79.   2. 217.   0.  85.   0.  13.]
 [  0. 157.   0.   0.   0.   0.   0.]
 [ 65.   6. 380.   0.  37.   0.   1.]
 [  0.   0.   0. 914.   0. 102.  48.]
 [ 37.   0.  17.  18. 350.   1. 155.]
 [  0.   0.   0. 182.  14. 215. 196.]
 [  0.   0.   0.  70.  76.  59. 587.]]

<Figure size 2000x800 with 0 Axes>
```



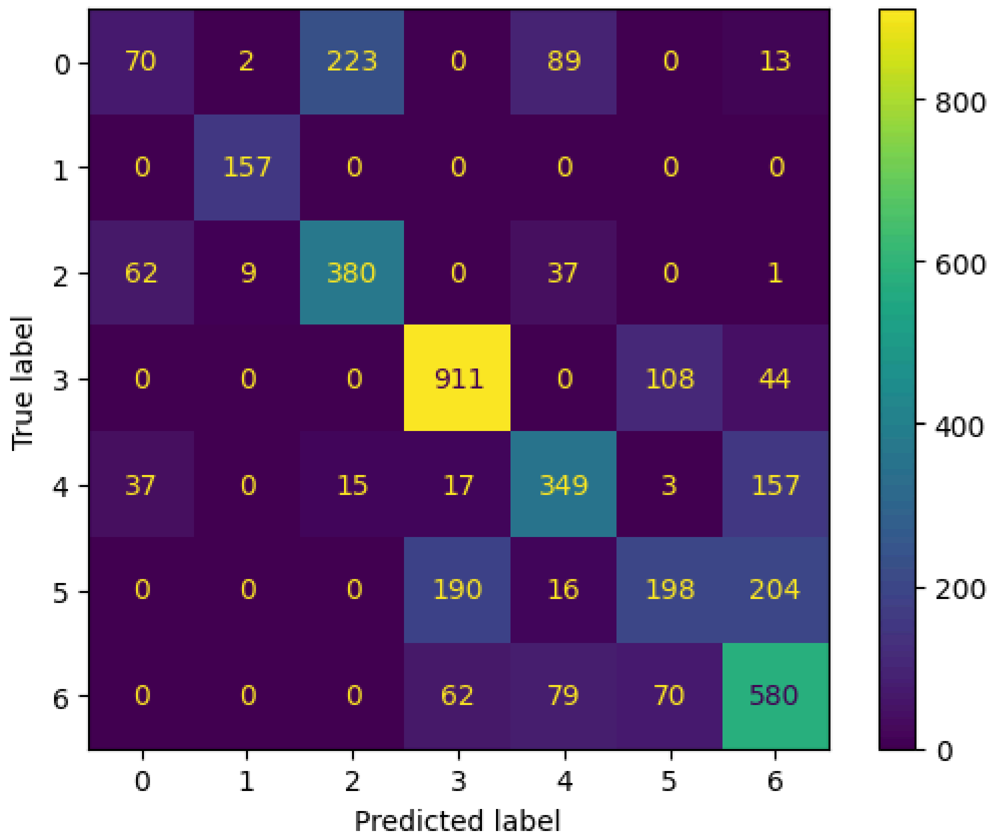

```
recall_score :  0.6483806411632825

precision Score :  0.6517579371697899

f1_score : 0.636558234734546

log loss :  1.0415956994443434

log loss dummy :  1.834217157999518

********************************************************************************
****************
K_value 35

avg_accuracy train :  0.6747081394399542

avg_accuracy :  0.6543391297248754

avg_err :  0.3456608702751245

[[ 79.   2. 218.   0.  84.   0.  14.]
 [  0. 157.   0.   0.   0.   0.   0.]
 [ 65.   8. 378.   0.  36.   0.   1.]
 [  0.   0.   0. 914.   0. 104.  46.]
 [ 39.   0.  15.  18. 349.   2. 155.]
 [  0.   0.   0. 186.  16. 209. 197.]
 [  0.   0.   0.  65.  76.  64. 585.]]

<Figure size 2000x800 with 0 Axes>
```



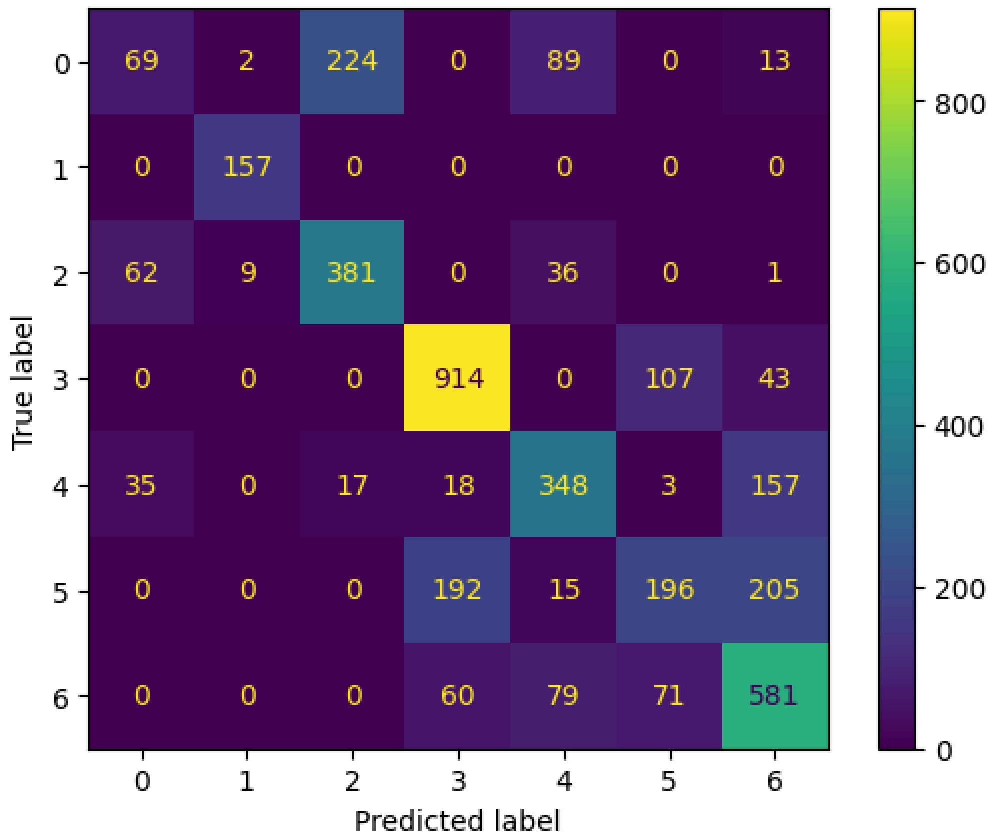

```
recall_score :  0.6459984436177825

precision Score :  0.6467299038481672

f1_score : 0.6333214908549667

log loss :  1.0221148597310428

log loss dummy :  1.834217157999518

********************************************************************************************
K_value 37

avg_accuracy train :  0.6698506000489836

avg_accuracy :  0.6518899502000164

avg_err :  0.34811004979998367

[[ 78.   2. 218.   0.  86.   0.  13.]
 [  0. 157.   0.   0.   0.   0.   0.]
 [ 63.   8. 380.   0.  36.   0.   1.]
 [  0.   0.   0. 913.   0. 105.  46.]
 [ 36.   0.  16.  17. 350.   2. 156.]
 [  0.   0.   0. 190.  16. 201. 201.]
 [  0.   0.   0.  64.  77.  67. 583.]]

<Figure size 2000x800 with 0 Axes>
```



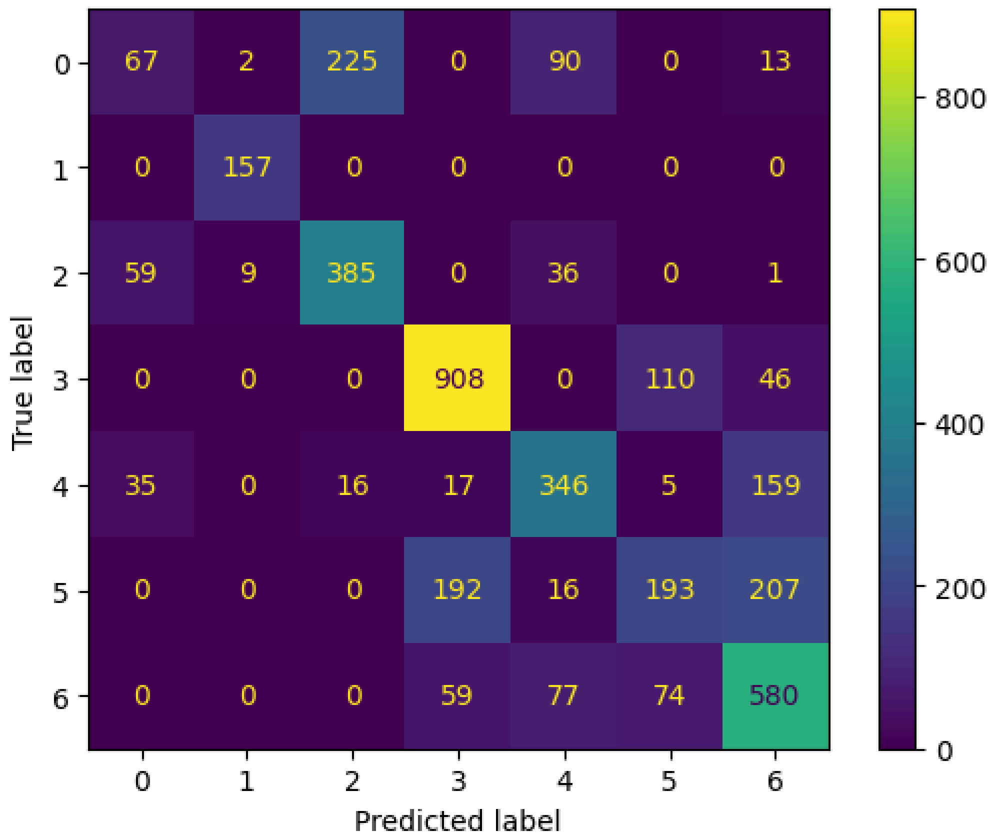

```
recall_score :  0.6438036546126459

precision Score :  0.6442329604248503

f1_score : 0.6304061303331268

log loss :  1.016053551737408

log loss dummy :  1.834217157999518

*************************************************************************************
****************
K_value 39

avg_accuracy train :  0.6663809290554331

avg_accuracy :  0.6476447056902604

avg_err :  0.3523552943097396

[[ 70.   2. 223.   0.  89.   0.  13.]
 [  0. 157.   0.   0.   0.   0.   0.]
 [ 62.   9. 380.   0.  37.   0.   1.]
 [  0.   0.   0. 911.   0. 108.  44.]
 [ 37.   0.  15.  17. 349.   3. 157.]
 [  0.   0.   0. 190.  16. 198. 204.]
 [  0.   0.   0.  62.  79.  70. 580.]]

<Figure size 2000x800 with 0 Axes>
```



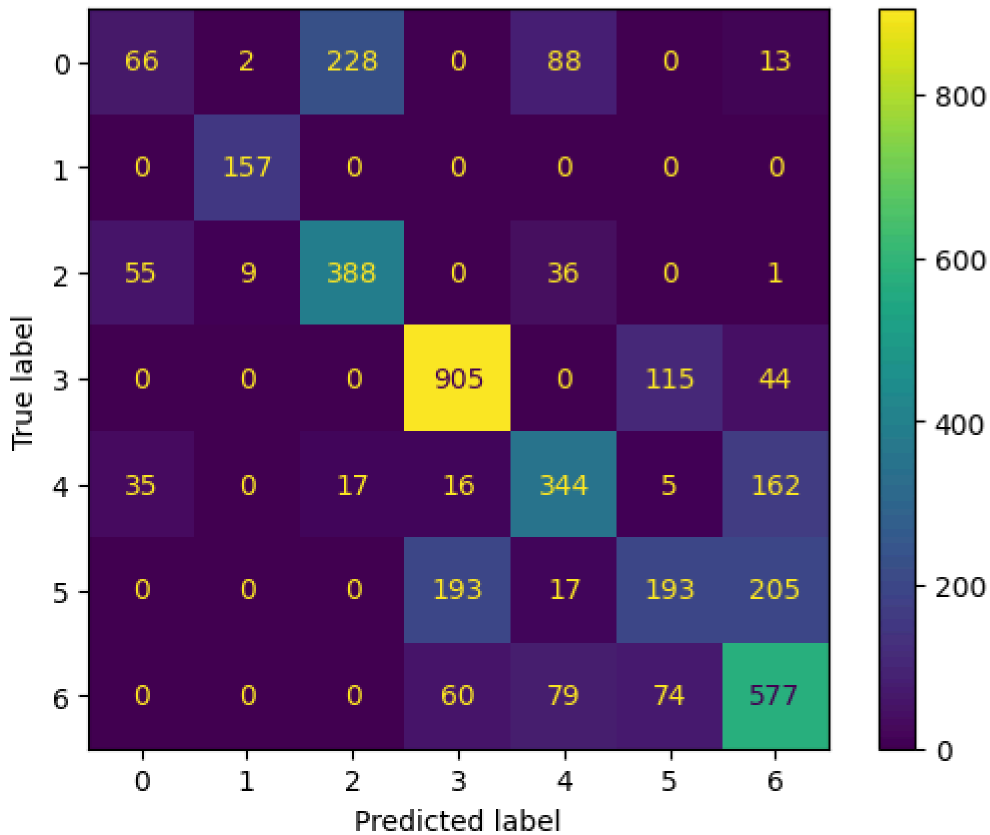

```
recall_score :  0.6390721481134259

precision Score :  0.6363644041565057

f1_score : 0.6240778107253575

log loss :  1.0103154546435167

log loss dummy :  1.834217157999518

**********************************************************************************
****************
K_value 41

avg_accuracy train :  0.664625683729284

avg_accuracy :  0.6478896236427464

avg_err :  0.3521103763572537

[[ 69.   2. 224.   0.  89.   0.  13.]
 [  0. 157.   0.   0.   0.   0.   0.]
 [ 62.   9. 381.   0.  36.   0.   1.]
 [  0.   0.   0. 914.   0. 107.  43.]
 [ 35.   0.  17.  18. 348.   3. 157.]
 [  0.   0.   0. 192.  15. 196. 205.]
 [  0.   0.   0.  60.  79.  71. 581.]]

<Figure size 2000x800 with 0 Axes>
```



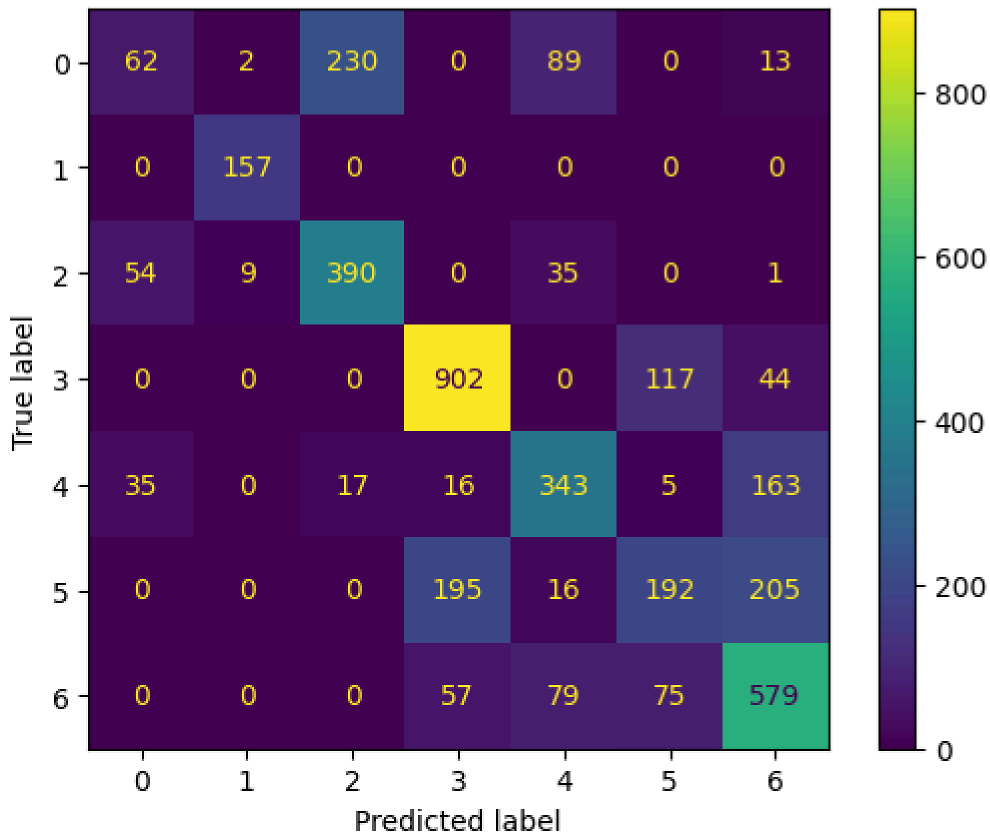

```
recall_score :  0.6388148939711963

precision Score :  0.635697910841138

f1_score : 0.6233967886700015

log loss :  1.0004048673177704

log loss dummy :  1.834217157999518

************************************************************************************
****************
K_value 43

avg_accuracy train :  0.6623806024981631

avg_accuracy :  0.6454404441178873

avg_err :  0.35455955588211285

[[ 67.   2. 225.   0.  90.   0.  13.]
 [  0. 157.   0.   0.   0.   0.   0.]
 [ 59.   9. 385.   0.  36.   0.   1.]
 [  0.   0.   0. 908.   0. 110.  46.]
 [ 35.   0.  16.  17. 346.   5. 159.]
 [  0.   0.   0. 192.  16. 193. 207.]
 [  0.   0.   0.  59.  77.  74. 580.]]

<Figure size 2000x800 with 0 Axes>
```



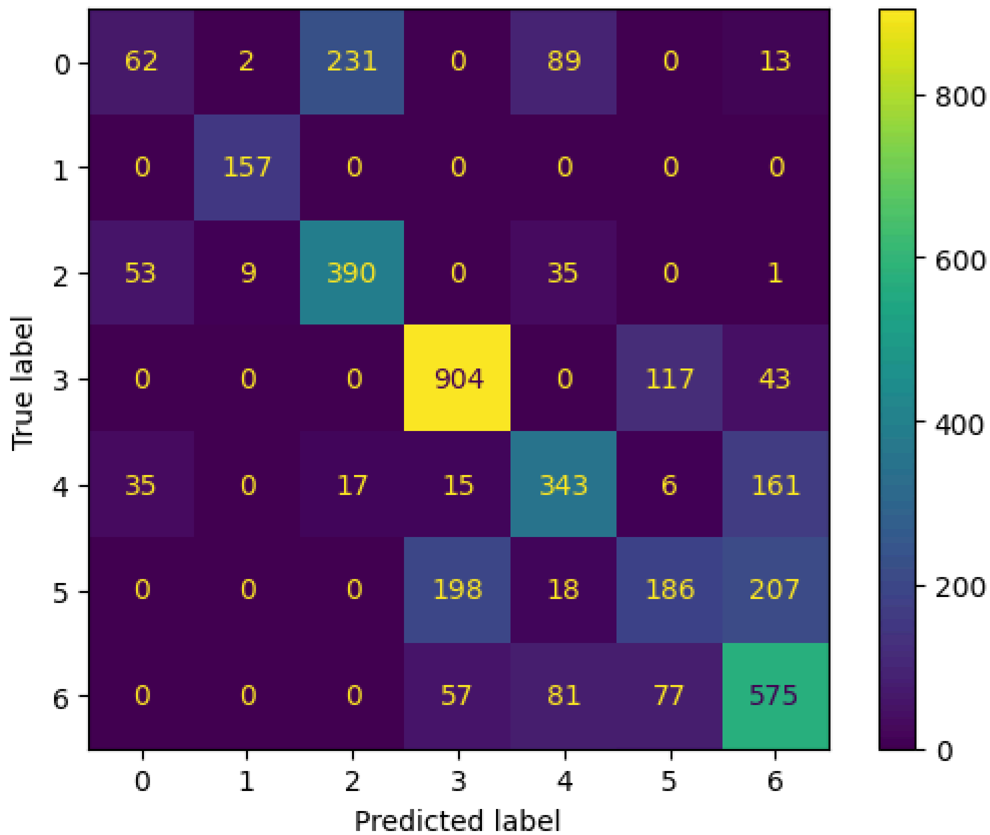

```
recall_score :  0.6369617563429409

precision Score :  0.6334310226649885

f1_score : 0.6209181393571244

log loss :  0.9796900619479331

log loss dummy :  1.834217157999518

************************************************************************************
****************
K_value 45

avg_accuracy train :  0.6602171605845375

avg_accuracy :  0.6439709364029716

avg_err :  0.3560290635970283

[[ 66.   2. 228.   0.  88.   0.  13.]
 [  0. 157.   0.   0.   0.   0.   0.]
 [ 55.   9. 388.   0.  36.   0.   1.]
 [  0.   0.   0. 905.   0. 115.  44.]
 [ 35.   0.  17.  16. 344.   5. 162.]
 [  0.   0.   0. 193.  17. 193. 205.]
 [  0.   0.   0.  60.  79.  74. 577.]]

<Figure size 2000x800 with 0 Axes>
```



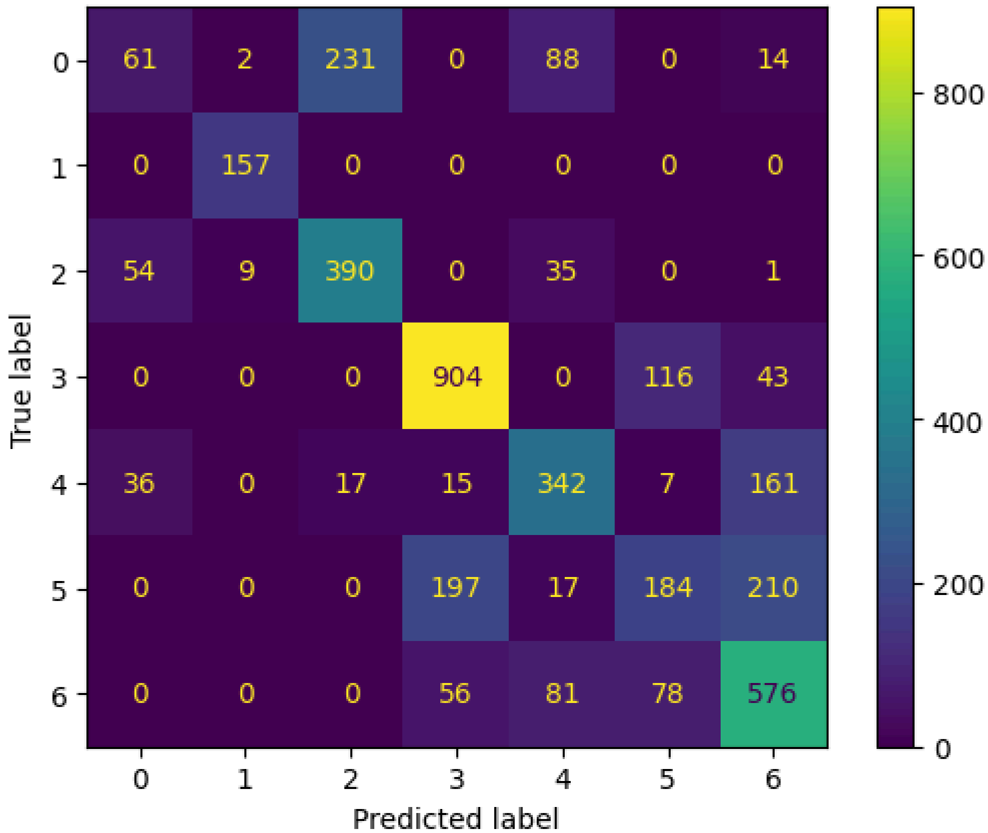

```
recall_score :  0.6359570694264588

precision Score :  0.6330678882552664

f1_score : 0.6196707734332383

log loss :  0.9764736235884156

log loss dummy :  1.834217157999518

************************************************************************************
****************
K_value 47

avg_accuracy train :  0.6575230631071926

avg_accuracy :  0.6427463466405421

avg_err :  0.3572536533594579

[[ 62.   2. 230.   0.  89.   0.  13.]
 [  0. 157.   0.   0.   0.   0.   0.]
 [ 54.   9. 390.   0.  35.   0.   1.]
 [  0.   0.   0. 902.   0. 117.  44.]
 [ 35.   0.  17.  16. 343.   5. 163.]
 [  0.   0.   0. 195.  16. 192. 205.]
 [  0.   0.   0.  57.  79.  75. 579.]]

<Figure size 2000x800 with 0 Axes>
```



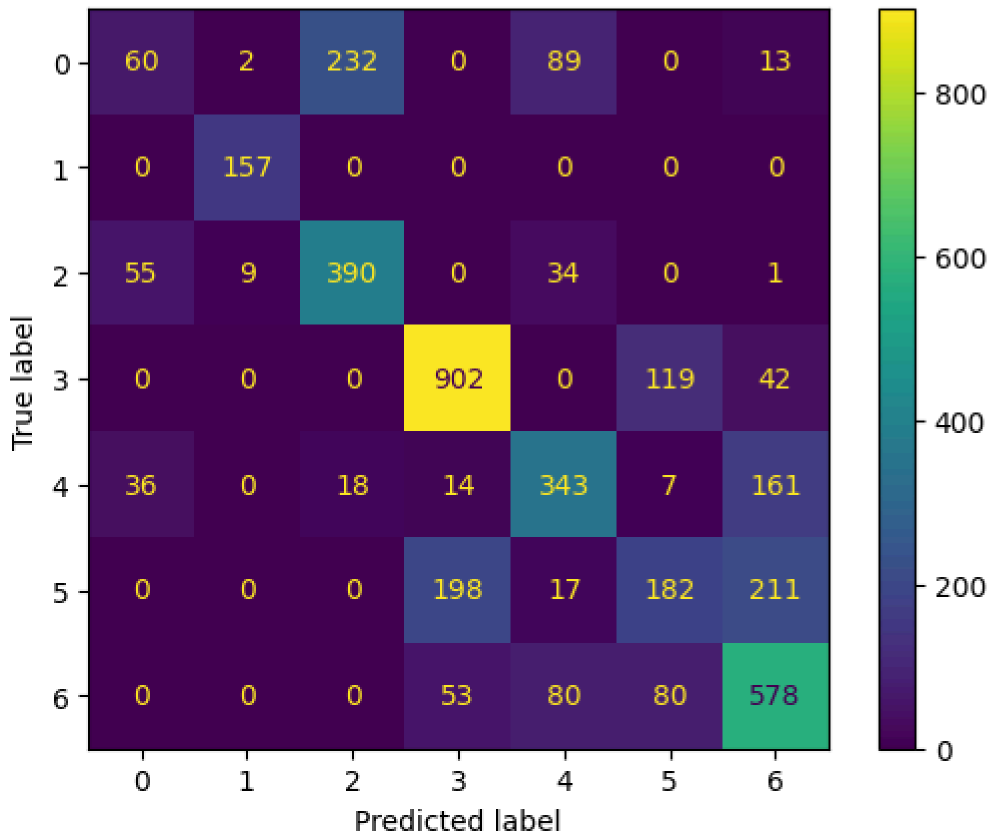

```
recall_score :  0.6345906596165608

precision Score :  0.6301794233537474

f1_score : 0.6171233892272939

log loss :  0.9709063532226181

log loss dummy :  1.834217157999518

************************************************************************************
****************
K_value 49

avg_accuracy train :  0.6567066699322394

avg_accuracy :  0.64086864233815

avg_err :  0.35913135766185

[[ 62.   2. 231.   0.  89.   0.  13.]
 [  0. 157.   0.   0.   0.   0.   0.]
 [ 53.   9. 390.   0.  35.   0.   1.]
 [  0.   0.   0. 904.   0. 117.  43.]
 [ 35.   0.  17.  15. 343.   6. 161.]
 [  0.   0.   0. 198.  18. 186. 207.]
 [  0.   0.   0.  57.  81.  77. 575.]]

<Figure size 2000x800 with 0 Axes>
```



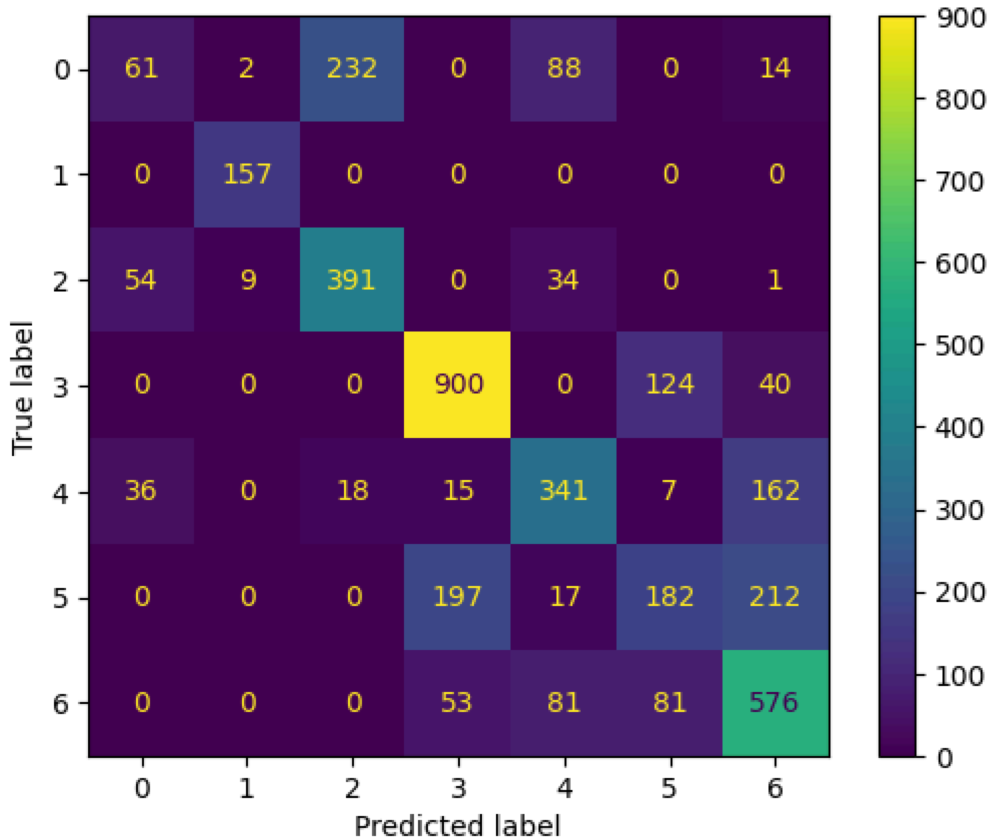

```
recall_score :  0.6328590509492654

precision Score :  0.6279035564125378

f1_score : 0.6153198606540268

log loss :  0.9721187720960208

log loss dummy :  1.834217157999518

************************************************************************************
****************
K_value 51

avg_accuracy train :  0.6546656869948567

avg_accuracy :  0.6404604457506734

avg_err :  0.3595395542493265

[[ 61.   2. 231.   0.  88.   0.  14.]
 [  0. 157.   0.   0.   0.   0.   0.]
 [ 54.   9. 390.   0.  35.   0.   1.]
 [  0.   0.   0. 904.   0. 116.  43.]
 [ 36.   0.  17.  15. 342.   7. 161.]
 [  0.   0.   0. 197.  17. 184. 210.]
 [  0.   0.   0.  56.  81.  78. 576.]]

<Figure size 2000x800 with 0 Axes>
```



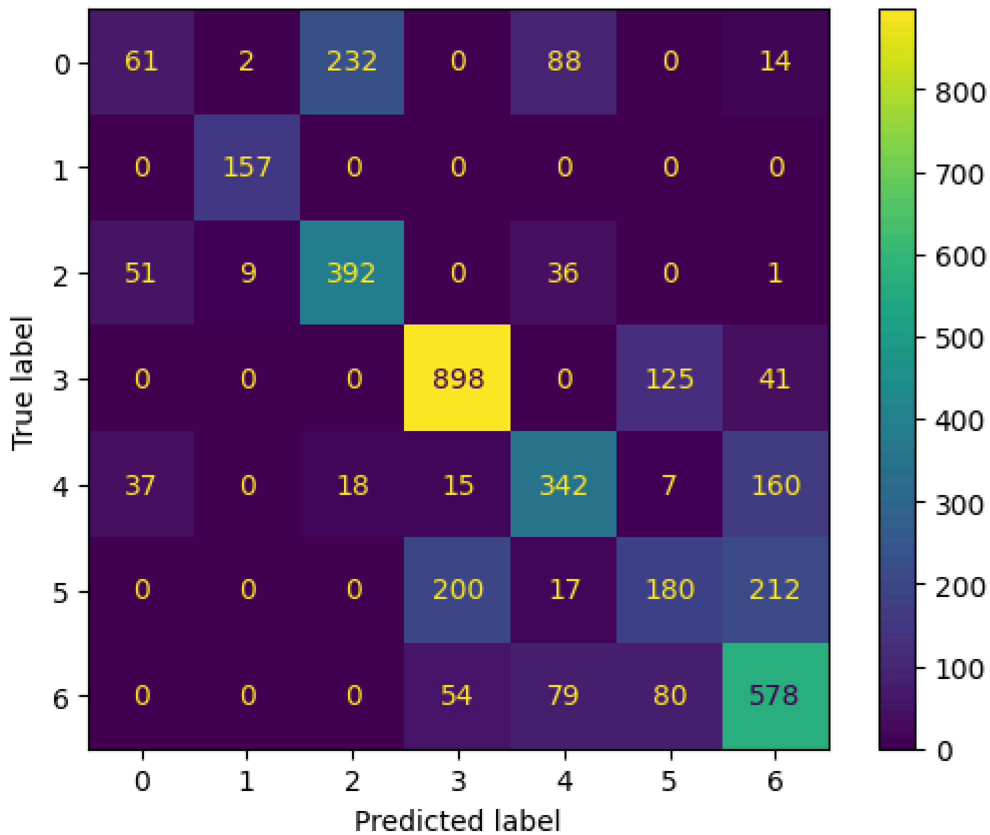

```
recall_score :  0.6322355837648513

precision Score :  0.6265542218179357

f1_score : 0.614471411261527

log loss :  0.9659145265944966

log loss dummy :  1.834217157999518

************************************************************************************
****************
K_value 53

avg_accuracy train :  0.6527879826924646

avg_accuracy :  0.6395624132582252

avg_err :  0.36043758674177484

[[ 60.   2. 232.   0.  89.   0.  13.]
 [  0. 157.   0.   0.   0.   0.   0.]
 [ 55.   9. 390.   0.  34.   0.   1.]
 [  0.   0.   0. 902.   0. 119.  42.]
 [ 36.   0.  18.  14. 343.   7. 161.]
 [  0.   0.   0. 198.  17. 182. 211.]
 [  0.   0.   0.  53.  80.  80. 578.]]

<Figure size 2000x800 with 0 Axes>
```



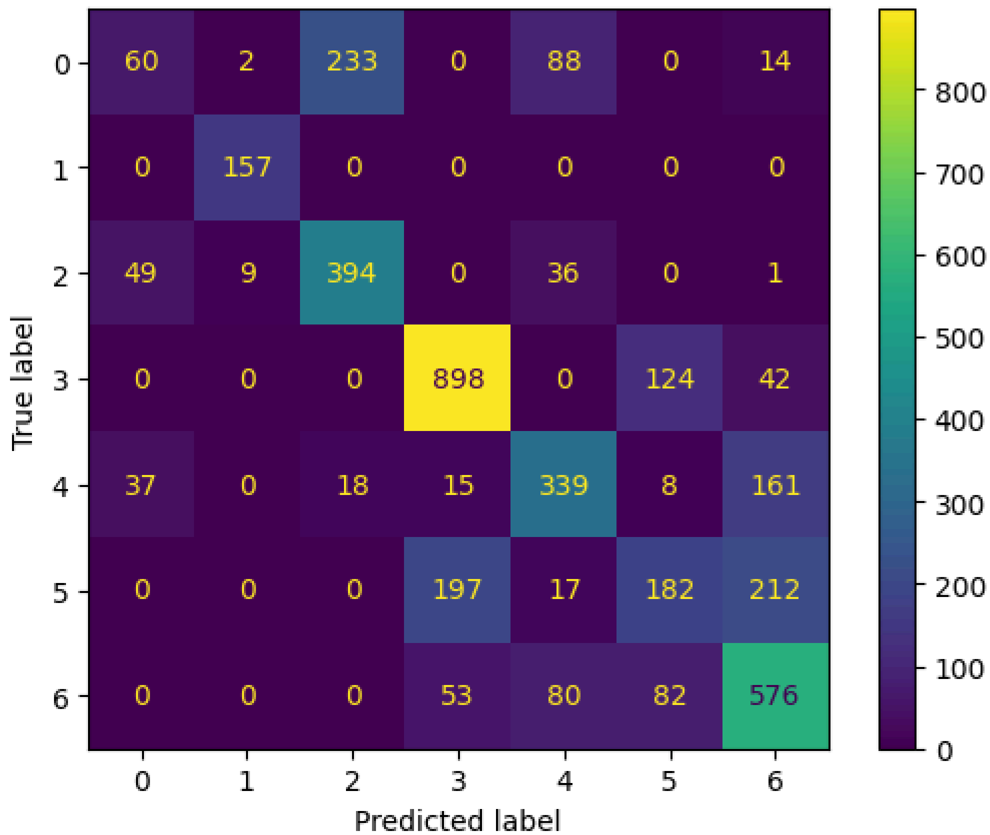

```
recall_score :  0.6313124565733746

precision Score :  0.6245725733516974

f1_score : 0.6131909269200325

log loss :  0.9593635130580211

log loss dummy :  1.834217157999518

************************************************************************************
****************
K_value 55

avg_accuracy train :  0.6510327373663157

avg_accuracy :  0.638419462813291

avg_err :  0.36158053718670913

[[ 61.   2. 232.   0.  88.   0.  14.]
 [  0. 157.   0.   0.   0.   0.   0.]
 [ 54.   9. 391.   0.  34.   0.   1.]
 [  0.   0.   0. 900.   0. 124.  40.]
 [ 36.   0.  18.  15. 341.   7. 162.]
 [  0.   0.   0. 197.  17. 182. 212.]
 [  0.   0.   0.  53.  81.  81. 576.]]

<Figure size 2000x800 with 0 Axes>
```




```
recall_score :  0.6307217381214544

precision Score :  0.6247054826618869

f1_score : 0.6128400322601802

log loss :  0.9475245414406479

log loss dummy :  1.834217157999518

************************************************************************************
****************
K_value 57

avg_accuracy train :  0.6497673279451384

avg_accuracy :  0.6385011021307861

avg_err :  0.36149889786921374

[[ 61.   2. 232.   0.  88.   0.  14.]
 [  0. 157.   0.   0.   0.   0.   0.]
 [ 51.   9. 392.   0.  36.   0.   1.]
 [  0.   0.   0. 898.   0. 125.  41.]
 [ 37.   0.  18.  15. 342.   7. 160.]
 [  0.   0.   0. 200.  17. 180. 212.]
 [  0.   0.   0.  54.  79.  80. 578.]]

<Figure size 2000x800 with 0 Axes>
```




```
recall_score :  0.6309196818816623

precision Score :  0.6247460363894447

f1_score : 0.6125886298297468

log loss :  0.9440356312797133

log loss dummy :  1.834217157999518

************************************************************************************
****************
K_value 59

avg_accuracy train :  0.6496856886276431

avg_accuracy :  0.6382561841783003

avg_err :  0.36174381582169973

[[ 60.   2. 233.   0.  88.   0.  14.]
 [  0. 157.   0.   0.   0.   0.   0.]
 [ 49.   9. 394.   0.  36.   0.   1.]
 [  0.   0.   0. 898.   0. 124.  42.]
 [ 37.   0.  18.  15. 339.   8. 161.]
 [  0.   0.   0. 197.  17. 182. 212.]
 [  0.   0.   0.  53.  80.  82. 576.]]

<Figure size 2000x800 with 0 Axes>
```




```
recall_score :  0.6307509965379721

precision Score :  0.6248313044665244

f1_score : 0.612371688598355

log loss :  0.9406680830670627

log loss dummy :  1.834217157999518

************************************************************************************
****************
```

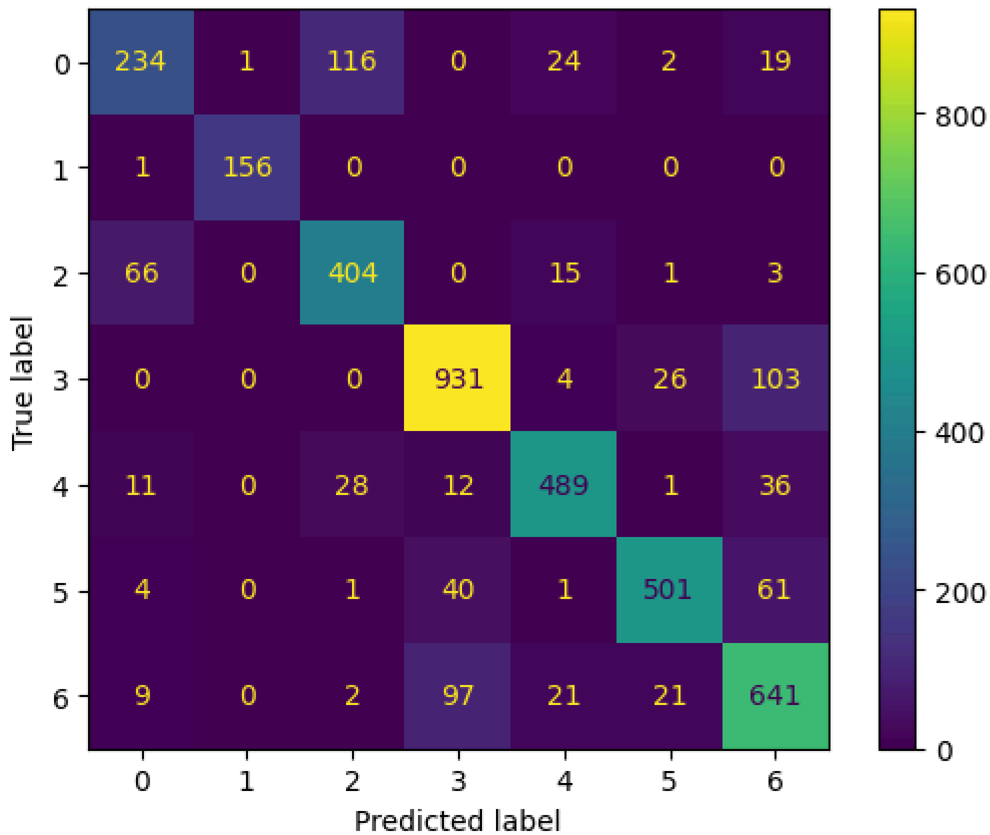
In [35]:

```python
import matplotlib.pyplot as plt
no_of_splits=3
k=[]
avg_training_accuracy=[]
avg_accuracy=[]
avg_error=[]
avg_recall_score=[]
avg_log_loss=[]
avg_precision_score=[]
avg_f1_score=[]
avg_log_loss_dummy=[]
for i in range(1, 30, 2):
    acc = []
    acc_train = []
    err = []
```

```
    conf = []
    recall = []
    prec = []
    k = []
    logloss = []
    logloss_dummy = []
    Classification_report=[]
    f1_score_=[]
    for train_index, cv_index in sf.split(x_train, y_train):
        x_trainf, x_cv, y_trainf, y_cv = x_train.iloc[train_index], x_train.iloc[cv
        #Training the model
        knn = KNeighborsClassifier(n_neighbors=i)
        model = knn.fit(x_trainf, y_trainf)
        # Predicting the Model
        predicted_train = model.predict(x_trainf)
        # training accuracy of an model

        acc_train.append(accuracy_score(y_trainf, predicted_train))
        predicted = model.predict(x_cv)
        #accuracy score
        acc.append(accuracy_score(y_cv, predicted))
        # error score
        err.append(1 - accuracy_score(y_cv, predicted))
        # confusion matrix
        conf.append(confusion_matrix(y_cv, predicted, labels=model.classes_))
        # recall scpre
        recall.append(recall_score(y_cv, predicted, average=None))
        # precsion score
        prec.append(precision_score(y_cv, predicted, average=None))
        # f1 score
        f1_score_.append(f1_score(y_cv, predicted, average=None))
        Classification_report.append(classification_report(y_cv,predicted))
        predicted = model.predict_proba(x_cv)
        # log loss score
        logloss.append(log_loss(y_cv, predicted))
        dc = DummyClassifier()
        dc_model = dc.fit(x_trainf, y_trainf)
        dc_predit = dc_model.predict_proba(x_test)
        logloss_dummy.append(log_loss(y_test, dc_predit))
    a = np.mean(acc_train)
    b = np.mean(acc)

    print("K_value", i)
    k.append(i)
    print("")

    avg_training_accuracy.append(np.mean(acc_train))
    print("avg_accuracy train : ", np.mean(acc_train))
    print("")

    avg_accuracy.append(np.mean(acc))
    print("avg_accuracy : ", np.mean(acc))
    print("")

    avg_error.append(np.mean(err))
    print("avg_err : ", np.mean(err))
```

```python
    print(" ")

    plt.figure(figsize=(20, 8))
    cm = ConfusionMatrixDisplay(np.int64(np.round(sum(conf) / no_of_splits)))
    cm.plot()
    plt.show()
    print(" ")

    avg_recall_score.append( np.mean(recall))
    print("recall_score : ", np.mean(recall))
    print(" ")

    avg_precision_score.append(np.mean(prec))
    print("precision Score : ", np.mean(prec))
    print(" ")

    avg_f1_score.append(np.mean(f1_score_))
    print("f1_score :",np.mean(f1_score_))
    print("")

    avg_log_loss.append(np.mean(logloss))
    print("log loss : ", np.mean(logloss))
    print(" ")

    avg_log_loss_dummy.append(np.mean(logloss_dummy))
    print("log loss dummy : ", np.mean(logloss_dummy))
    print(" ")
    print("*" * 100)

print(" ")
```

```
K_value 1

avg_accuracy train :  1.0

avg_accuracy :  0.8220262878602335

avg_err :  0.17797371213976654

<Figure size 2000x800 with 0 Axes>
```



recall_score : 0.8238485889207074

precision Score : 0.8348899763571325

f1_score : 0.8273762562276636

log loss : 6.4148227927402575

log loss dummy : 1.8340319962763019

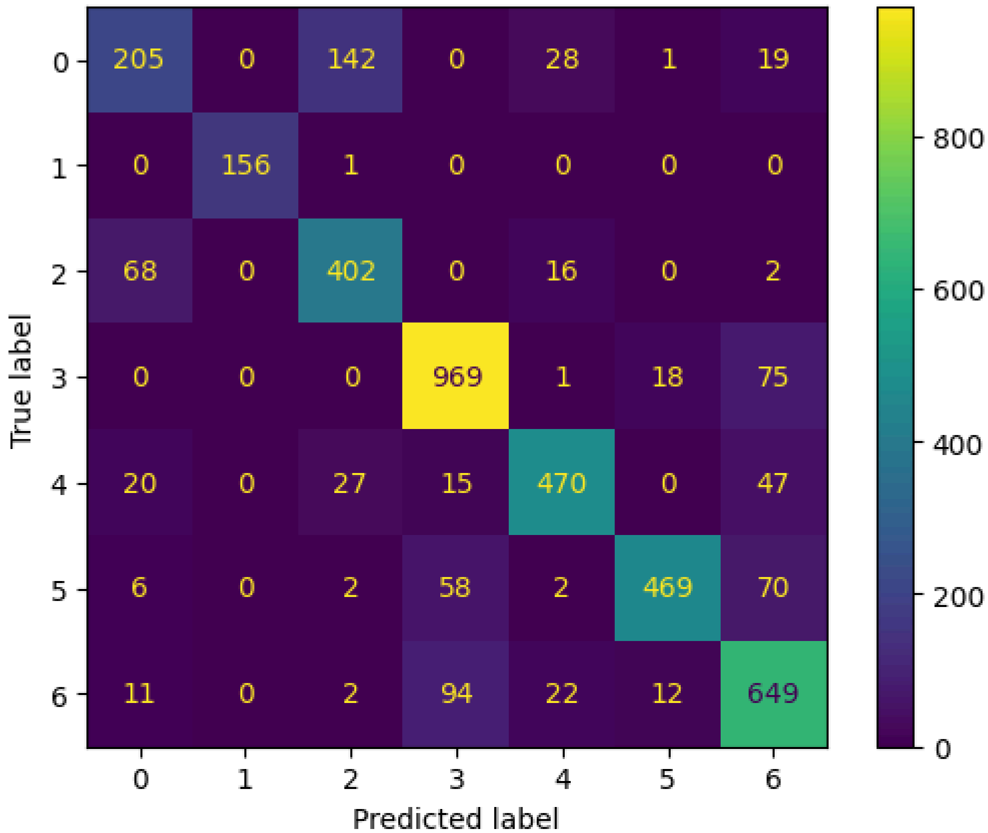
****
****
K_value 3

avg_accuracy train : 0.9010123275369418

avg_accuracy : 0.8134541595232264

avg_err : 0.1865458404767736

<Figure size 2000x800 with 0 Axes>



recall_score : 0.8073358514619703

precision Score : 0.8242825572146922

f1_score : 0.8121106004695948

log loss : 2.9505199085223723

log loss dummy : 1.8340319962763019

****

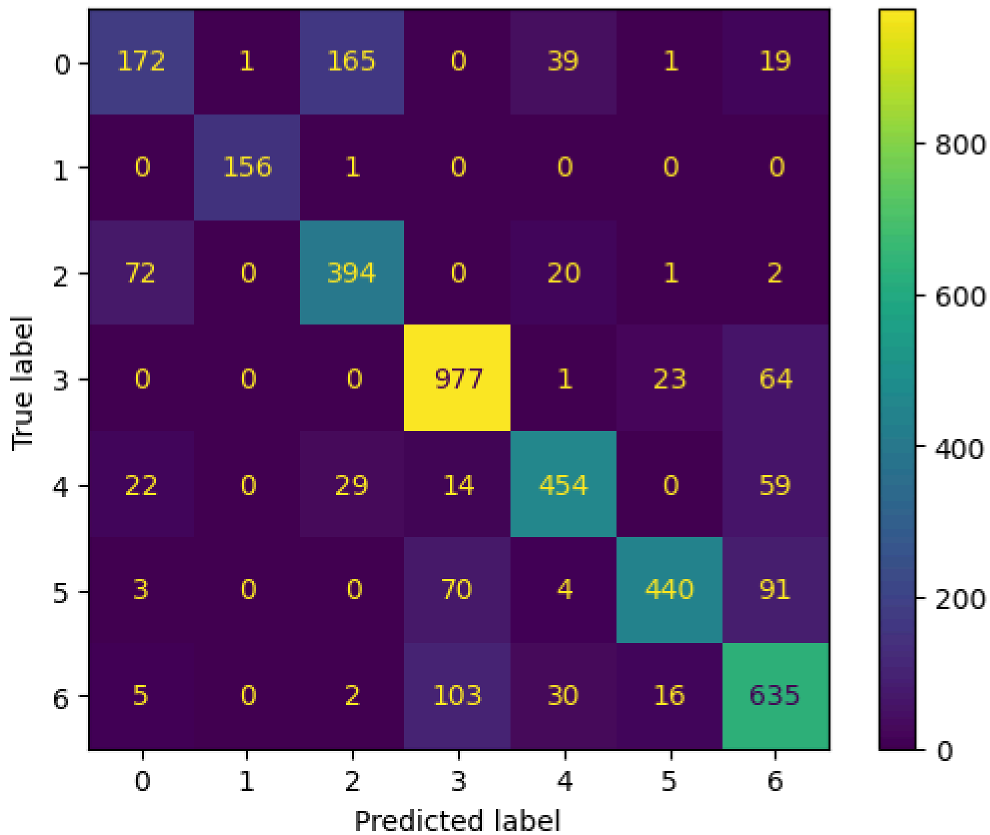
K_value 5

avg_accuracy train : 0.8626826679728957

avg_accuracy : 0.7905135113070454

avg_err : 0.20948648869295453

<Figure size 2000x800 with 0 Axes>



recall_score : 0.780539433194088

precision Score : 0.800753237752061

f1_score : 0.7848984921538916

log loss : 2.1663681559792987

log loss dummy : 1.8340319962763019

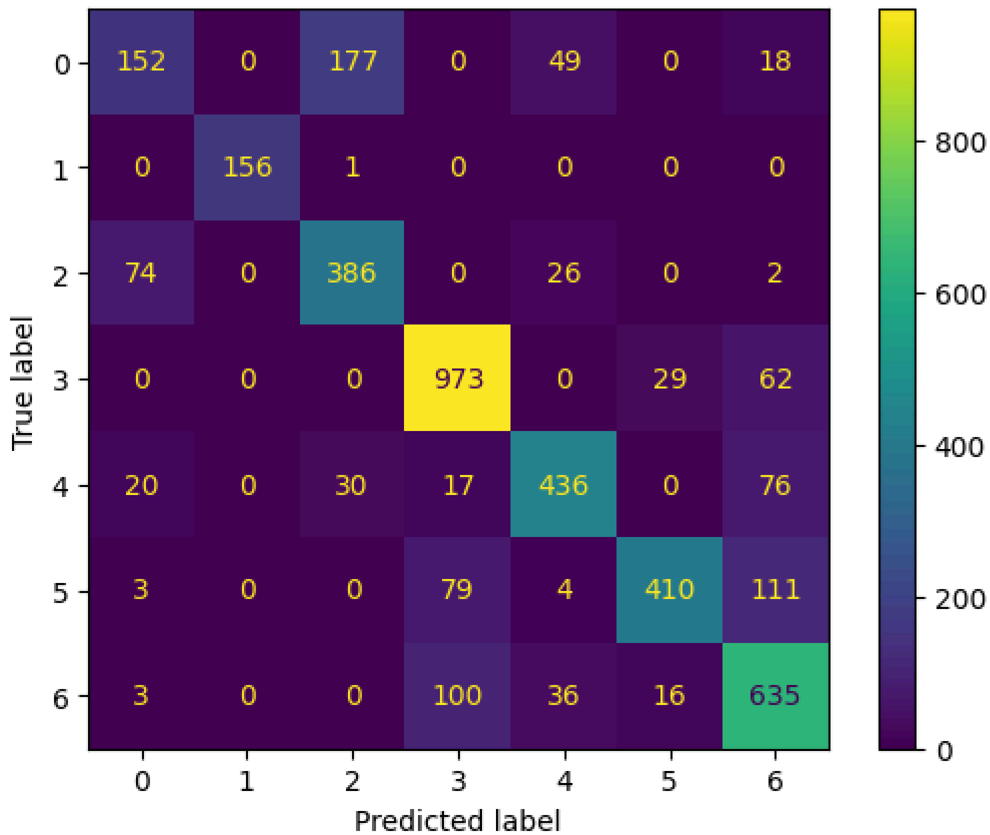
****
K_value 7

avg_accuracy train : 0.8306392358559883

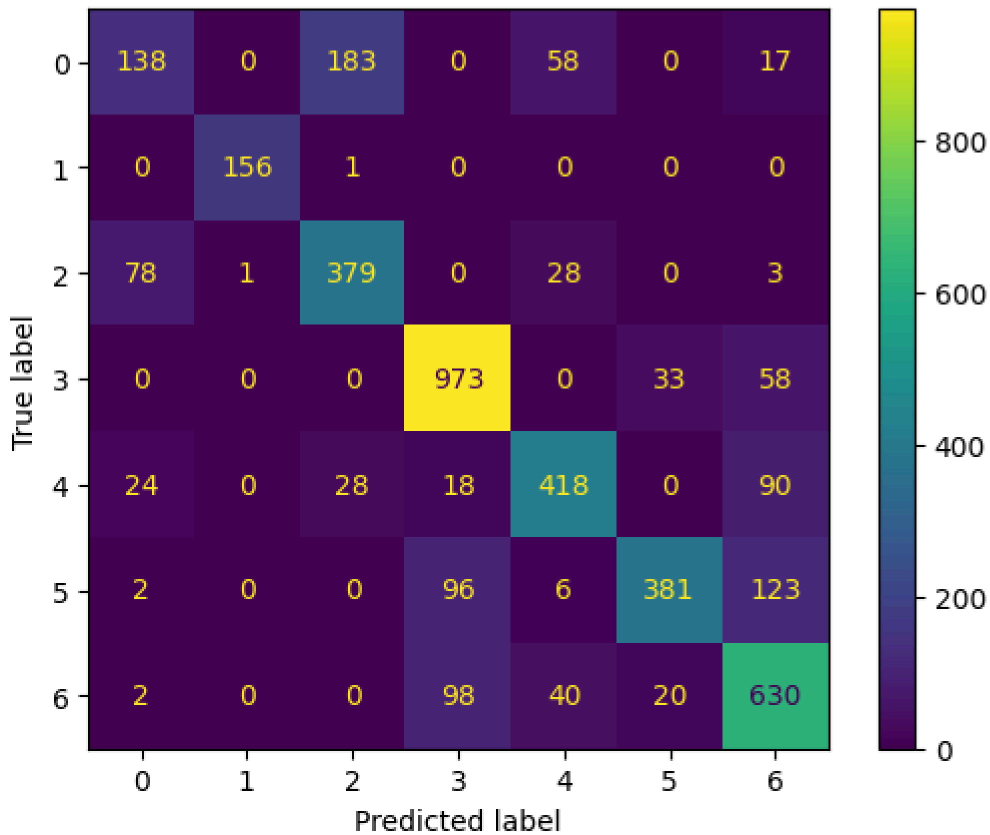
avg_accuracy : 0.7710017144256675

avg_err : 0.22899828557433258

<Figure size 2000x800 with 0 Axes>




```
recall_score :  0.7591642708117672

precision Score :  0.78211042999781

f1_score : 0.7629061350360529

log loss :  1.7600900612959673

log loss dummy :  1.8340319962763019

************************************************************************************
****************
K_value 9

avg_accuracy train :  0.804922850844967

avg_accuracy :  0.7533676218466813

avg_err :  0.24663237815331865

<Figure size 2000x800 with 0 Axes>
```



recall_score : 0.7401503491396053

precision Score : 0.7635529744523277

f1_score : 0.7431312808871307

log loss : 1.548729464547853

log loss dummy : 1.8340319962763019

****

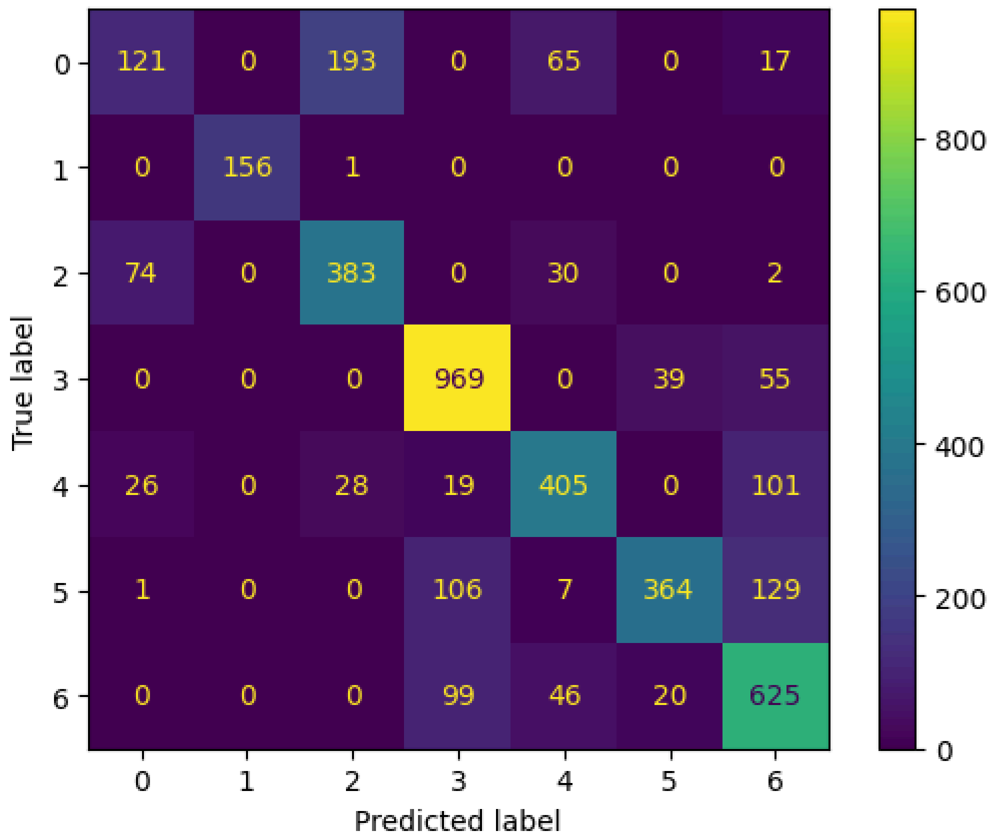
K_value 11

avg_accuracy train : 0.7864315454322801

avg_accuracy : 0.7404686096824231

avg_err : 0.25953139031757694

<Figure size 2000x800 with 0 Axes>



recall_score : 0.7263913996240478

precision Score : 0.7501824543785461

f1_score : 0.7277558166963308

log loss : 1.4205287953655974

log loss dummy : 1.8340319962763019

****

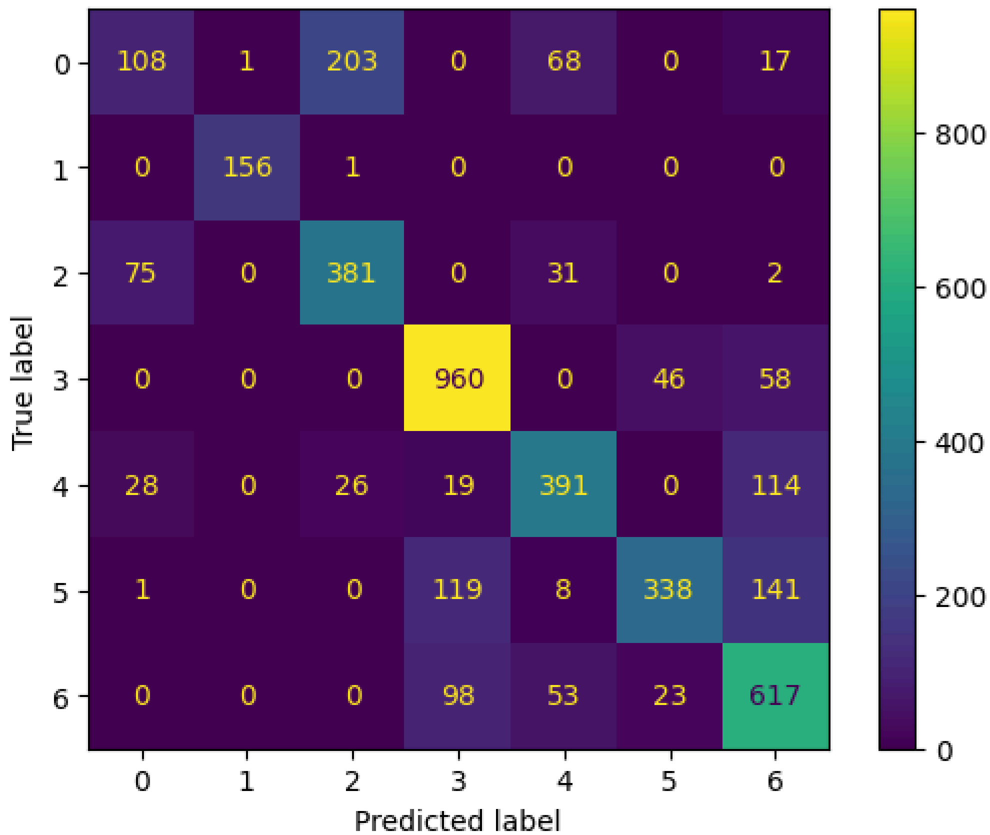
K_value 13

avg_accuracy train : 0.765858437423463

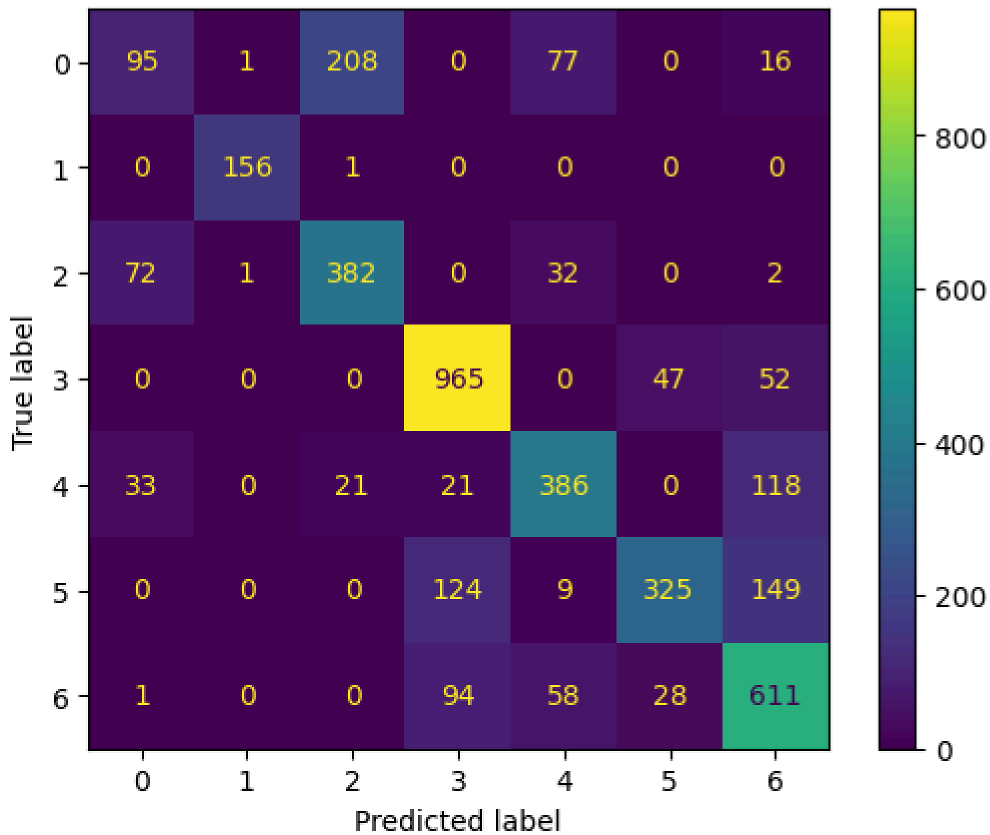
avg_accuracy : 0.7227528777859417

avg_err : 0.2772471222140583

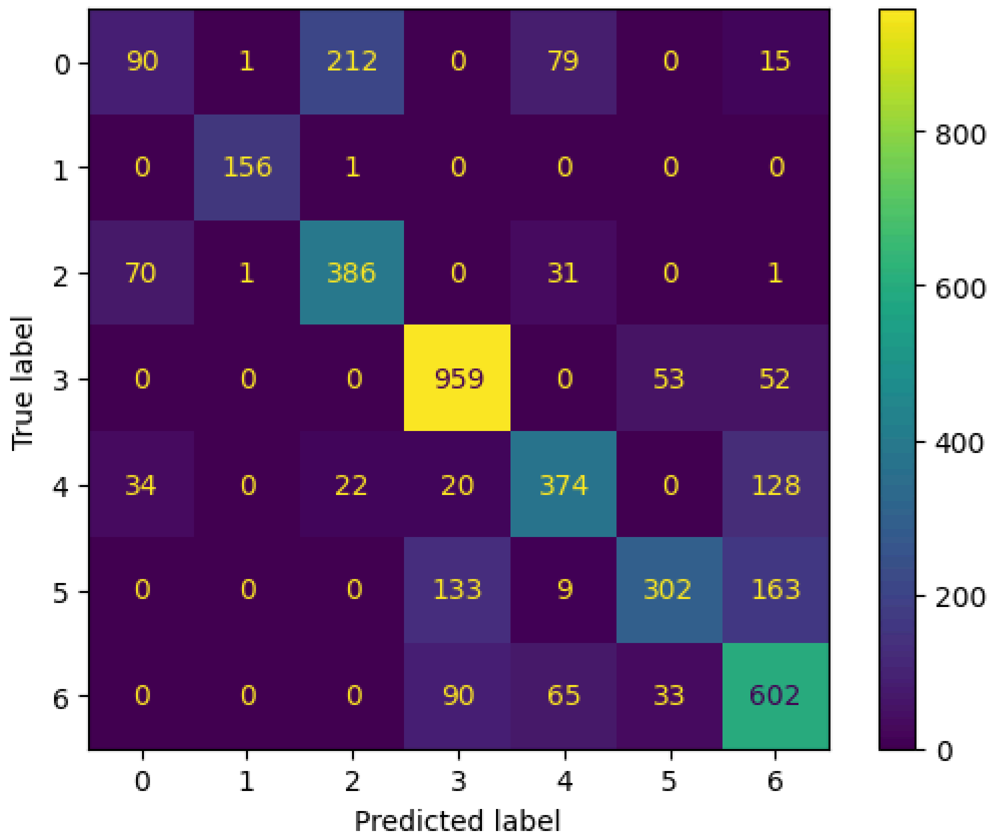
<Figure size 2000x800 with 0 Axes>



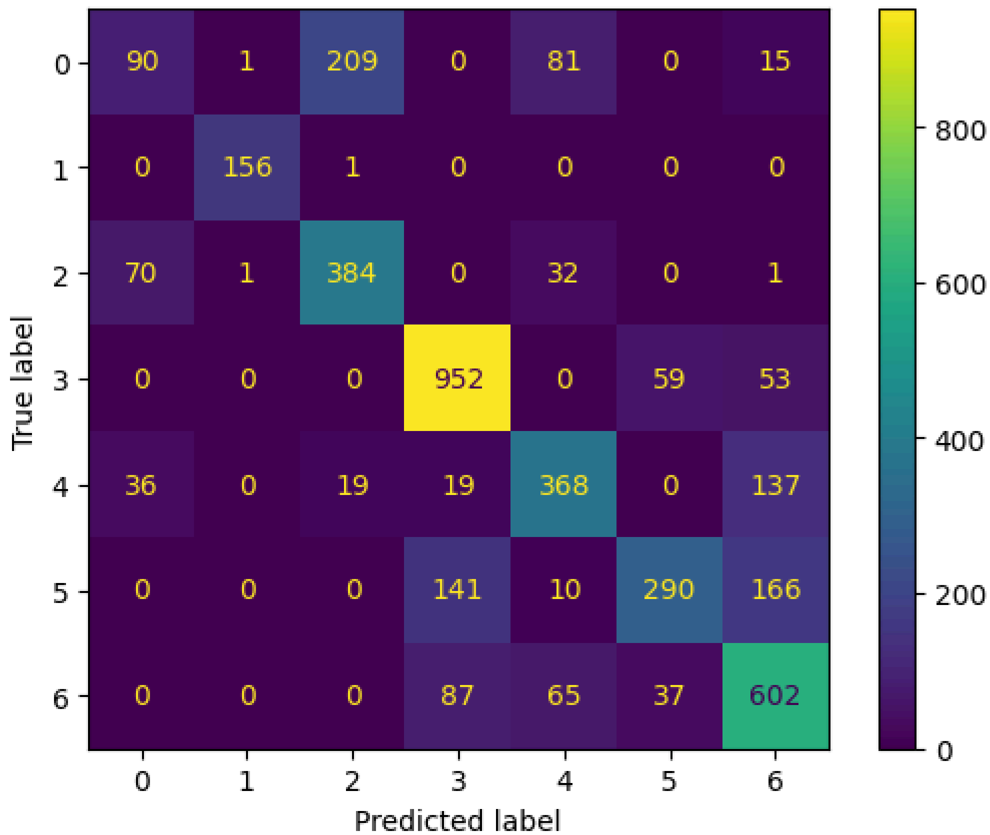

```
recall_score :  0.7088421714004566

precision Score :  0.7313505056126378

f1_score : 0.7084442897668649

log loss :  1.3447841013341415

log loss dummy :  1.8340319962763019

************************************************************************************
****************
K_value 15

avg_accuracy train :  0.7487550004081966

avg_accuracy :  0.7149971426238876

avg_err :  0.28500285737611236

<Figure size 2000x800 with 0 Axes>
```



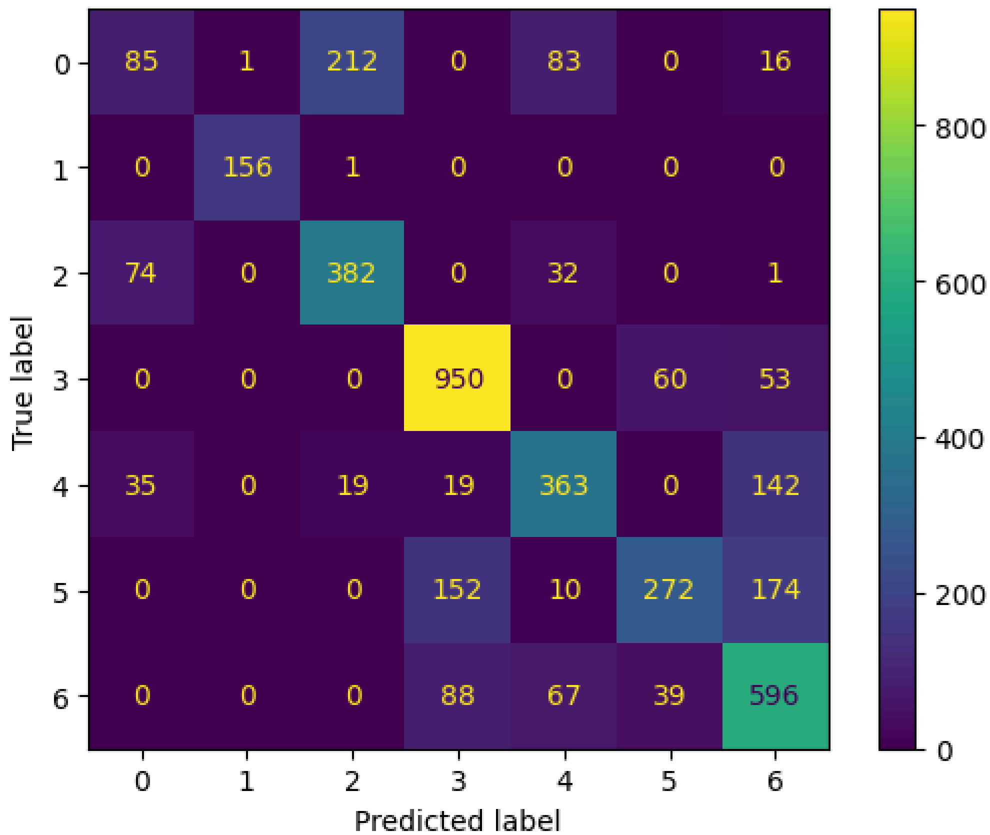

```
recall_score :  0.6996611001173868

precision Score :  0.7191260658094757

f1_score : 0.6972136292980365

log loss :  1.2845361923385195

log loss dummy :  1.8340319962763019

************************************************************************************
****************
K_value 17

avg_accuracy train :  0.7361009061964242

avg_accuracy :  0.7025063270471059

avg_err :  0.29749367295289414

<Figure size 2000x800 with 0 Axes>
```



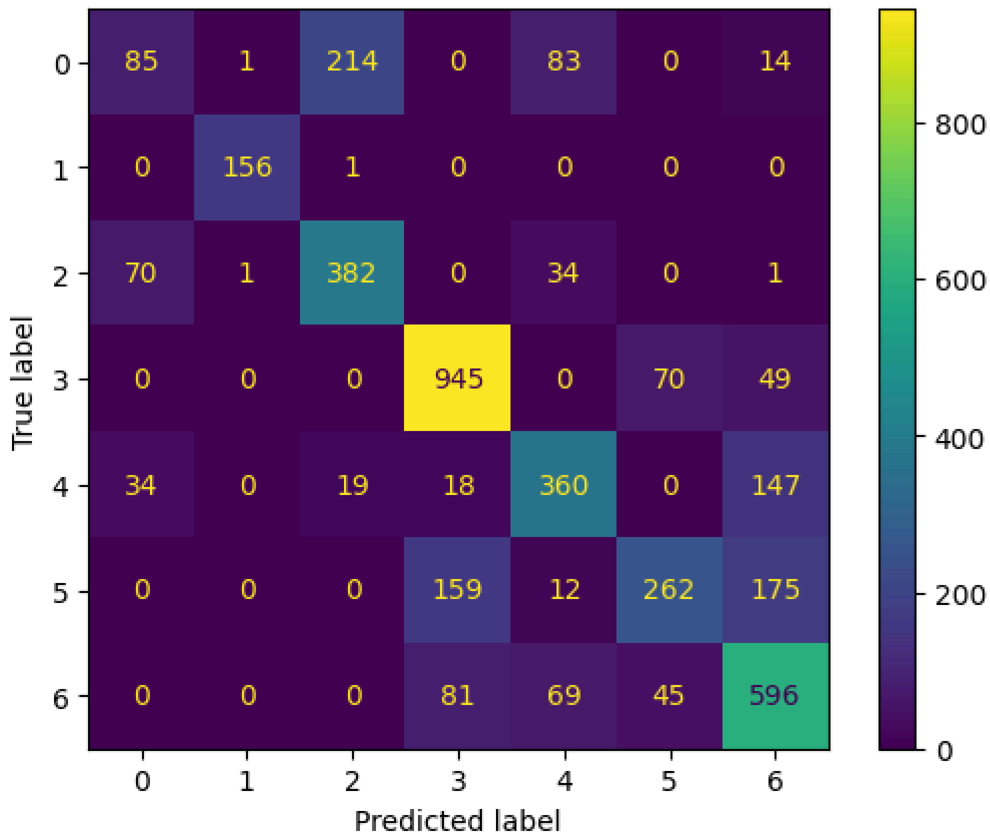

```
recall_score :  0.6881142719698091

precision Score :  0.7060903909261003

f1_score : 0.6839980569728477

log loss :  1.2428411843410867

log loss dummy :  1.8340319962763019

************************************************************************************
****************
K_value 19

avg_accuracy train :  0.7271614009306883

avg_accuracy :  0.6961384602824721

avg_err :  0.30386153971752794

<Figure size 2000x800 with 0 Axes>
```



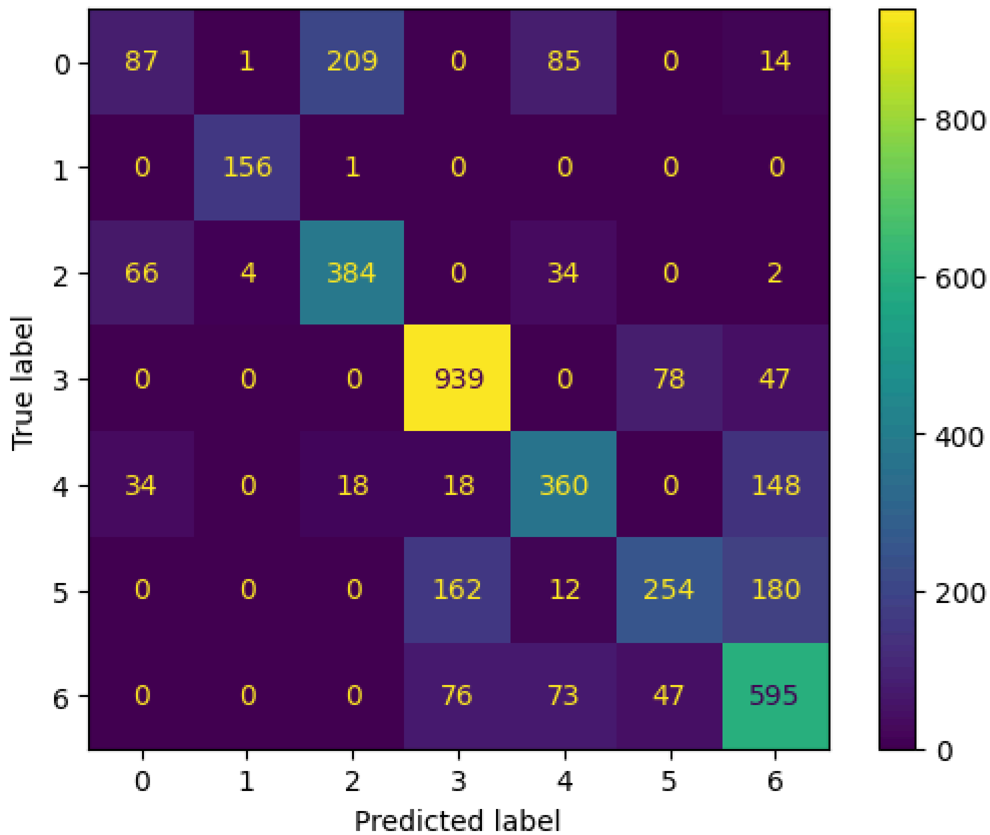

```
recall_score :  0.6826687346778583

precision Score :  0.700111209098076

f1_score : 0.6784962691870055

log loss :  1.2155430714965823

log loss dummy :  1.8340319962763019

************************************************************************************
****************
K_value 21

avg_accuracy train :  0.7163441913625602

avg_accuracy :  0.6869132174055025

avg_err :  0.31308678259449746

<Figure size 2000x800 with 0 Axes>
```



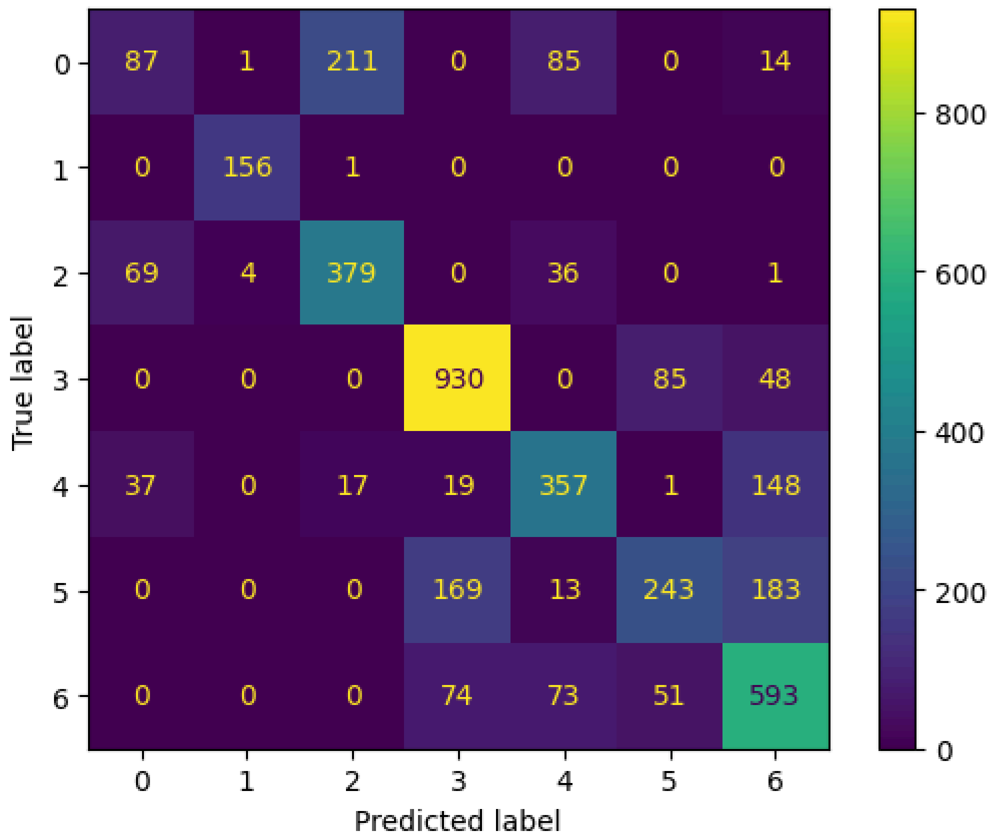

```
recall_score :  0.673443372919309

precision Score :  0.6906040194404961

f1_score : 0.6685735320506557

log loss :  1.193369762932856

log loss dummy :  1.8340319962763019

************************************************************************************
****************
K_value 23

avg_accuracy train :  0.7081802596130297

avg_accuracy :  0.6822597763082702

avg_err :  0.31774022369172994

<Figure size 2000x800 with 0 Axes>
```




```
recall_score :  0.6695440801131809

precision Score :  0.6847725913939391

f1_score : 0.6635885191477676

log loss :  1.1687553739812981

log loss dummy :  1.8340319962763019

************************************************************************************
****************
K_value 25

avg_accuracy train :  0.7016491142134051

avg_accuracy :  0.6793207608784391

avg_err :  0.32067923912156093

<Figure size 2000x800 with 0 Axes>
```




```
recall_score :  0.6677444904431725

precision Score :  0.6806547957756115

f1_score : 0.6605295744189509

log loss :  1.1395065900992185

log loss dummy :  1.8340319962763019

************************************************************************************
****************
K_value 27

avg_accuracy train :  0.694383214956323

avg_accuracy :  0.6720548616213567

avg_err :  0.3279451383786432

<Figure size 2000x800 with 0 Axes>
```



recall_score : 0.6612964468923967

precision Score : 0.6714308701403982

f1_score : 0.653685021143487

log loss : 1.108588442932277

log loss dummy : 1.8340319962763019

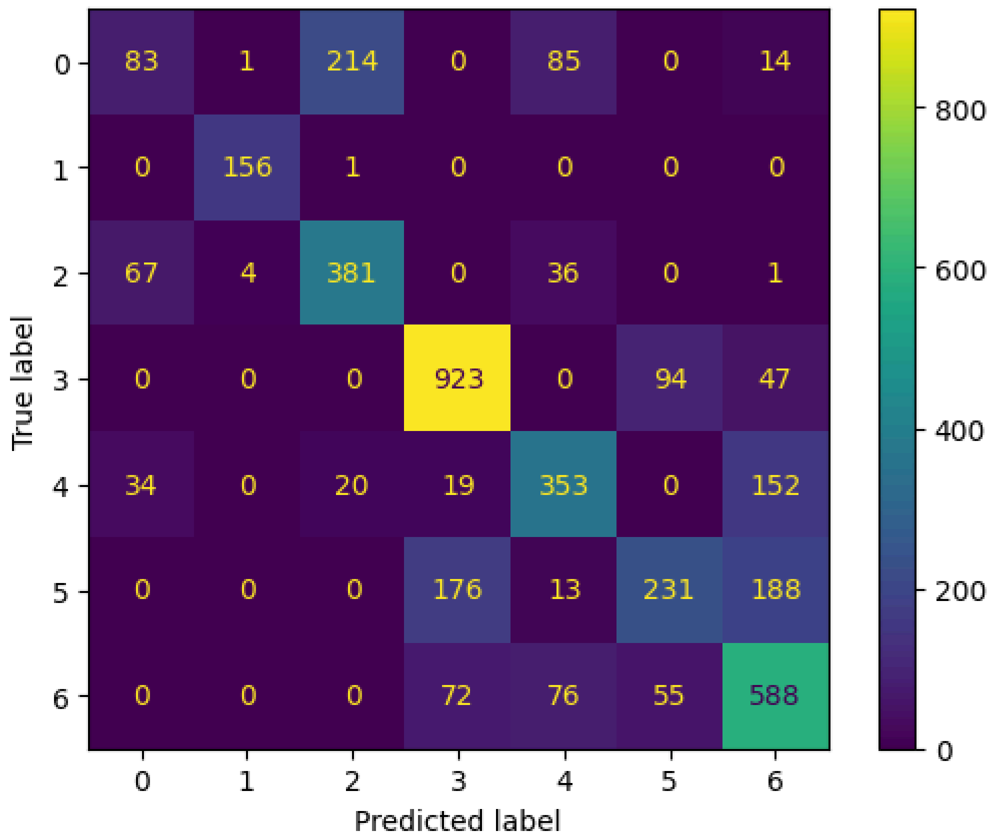
****
****
K_value 29

avg_accuracy train : 0.6899338721528289

avg_accuracy : 0.6648706016817699

avg_err : 0.33512939831823

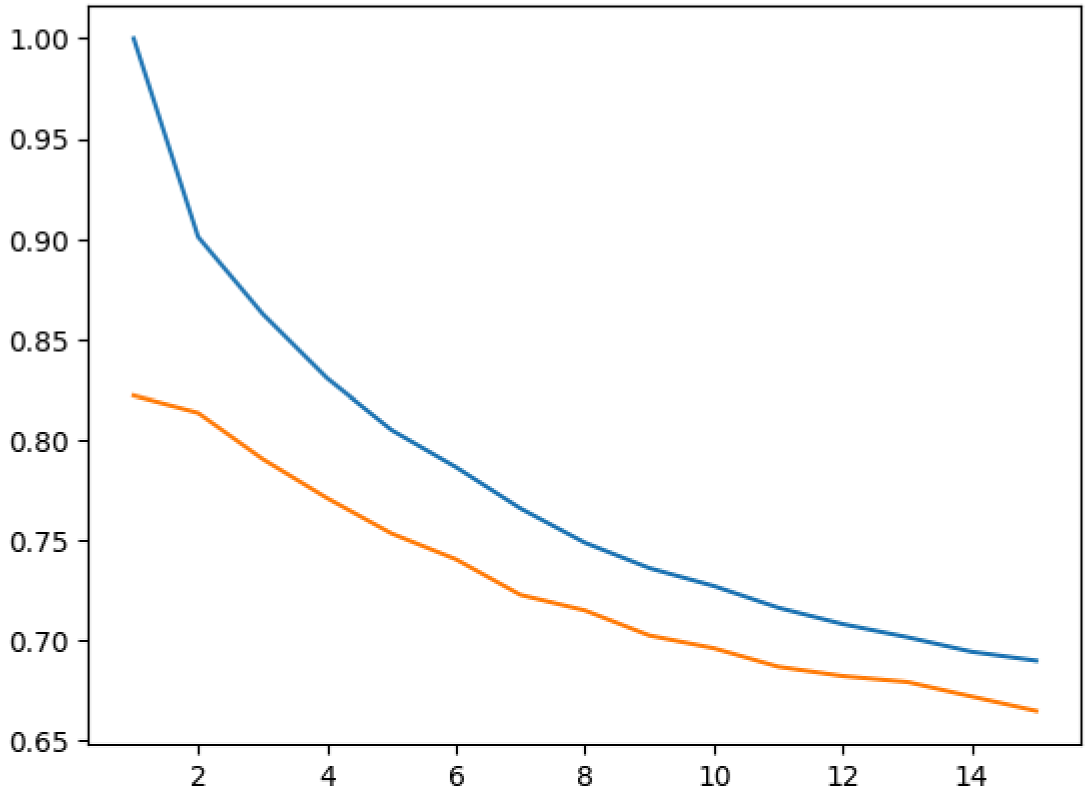
<Figure size 2000x800 with 0 Axes>




```
recall_score :  0.6549915090368369

precision Score :  0.6636007741162344

f1_score : 0.6461978024475789

log loss :  1.095352221114359

log loss dummy :  1.8340319962763019

************************************************************************************
****************
```

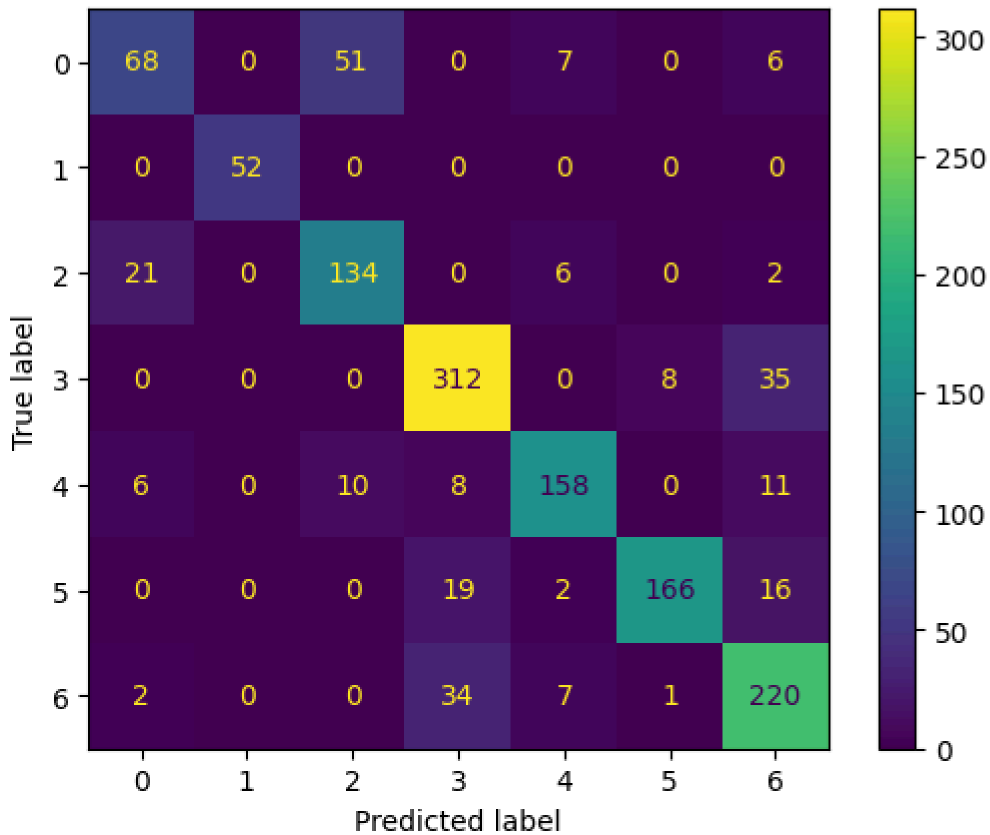
In [36]:
```
k=range(1,16)
```

In [37]:
```
plt.plot(k,avg_training_accuracy)
plt.plot(k,avg_accuracy)
plt.show()
```



In [39]:
```
knn=KNeighborsClassifier(n_neighbors=3)
model=knn.fit(x_trainf,y_trainf)
predicted=model.predict(x_test)
print("accuracy score :",accuracy_score(y_test,predicted))
print("")
cm=ConfusionMatrixDisplay(confusion_matrix(y_test,predicted))
cm.plot()
plt.show()
print("")
print("precision_score",np.mean(precision_score(y_test,predicted,average=None)))
print("")
print("recall score",np.mean(recall_score(y_test,predicted,average=None)))
print("")
print("f1 score",np.mean(f1_score(y_test,predicted,average=None)))
```

```
accuracy score : 0.8149779735682819
```




```
precision_score 0.8299487767177541

recall score 0.8122615453401051

f1 score 0.8170497662281592
```

In [40]:
```
!pip install "nbconvert[webpdf]"
```

```
Requirement already satisfied: nbconvert[webpdf] in c:\users\pavan\anaconda3\envs\gp
avan\lib\site-packages (7.11.0)
Requirement already satisfied: beautifulsoup4 in c:\users\pavan\anaconda3\envs\gpava
n\lib\site-packages (from nbconvert[webpdf]) (4.12.2)
Requirement already satisfied: bleach!=5.0.0 in c:\users\pavan\anaconda3\envs\gpavan
\lib\site-packages (from nbconvert[webpdf]) (6.1.0)
Requirement already satisfied: defusedxml in c:\users\pavan\anaconda3\envs\gpavan\li
b\site-packages (from nbconvert[webpdf]) (0.7.1)
Requirement already satisfied: jinja2>=3.0 in c:\users\pavan\anaconda3\envs\gpavan\l
ib\site-packages (from nbconvert[webpdf]) (3.1.2)
Requirement already satisfied: jupyter-core>=4.7 in c:\users\pavan\anaconda3\envs\gp
avan\lib\site-packages (from nbconvert[webpdf]) (5.5.0)
Requirement already satisfied: jupyterlab-pygments in c:\users\pavan\anaconda3\envs
\gpavan\lib\site-packages (from nbconvert[webpdf]) (0.2.2)
Requirement already satisfied: markupsafe>=2.0 in c:\users\pavan\anaconda3\envs\gpav
an\lib\site-packages (from nbconvert[webpdf]) (2.1.3)
Requirement already satisfied: mistune<4,>=2.0.3 in c:\users\pavan\anaconda3\envs\gp
avan\lib\site-packages (from nbconvert[webpdf]) (3.0.2)
Requirement already satisfied: nbclient>=0.5.0 in c:\users\pavan\anaconda3\envs\gpav
an\lib\site-packages (from nbconvert[webpdf]) (0.9.0)
Requirement already satisfied: nbformat>=5.7 in c:\users\pavan\anaconda3\envs\gpavan
\lib\site-packages (from nbconvert[webpdf]) (5.9.2)
Requirement already satisfied: packaging in c:\users\pavan\anaconda3\envs\gpavan\lib
\site-packages (from nbconvert[webpdf]) (23.2)
Requirement already satisfied: pandocfilters>=1.4.1 in c:\users\pavan\anaconda3\envs
\gpavan\lib\site-packages (from nbconvert[webpdf]) (1.5.0)
Requirement already satisfied: pygments>=2.4.1 in c:\users\pavan\anaconda3\envs\gpav
an\lib\site-packages (from nbconvert[webpdf]) (2.16.1)
Requirement already satisfied: tinycss2 in c:\users\pavan\anaconda3\envs\gpavan\lib
\site-packages (from nbconvert[webpdf]) (1.2.1)
Requirement already satisfied: traitlets>=5.1 in c:\users\pavan\anaconda3\envs\gpava
n\lib\site-packages (from nbconvert[webpdf]) (5.13.0)
Collecting playwright (from nbconvert[webpdf])
  Downloading playwright-1.42.0-py3-none-win_amd64.whl.metadata (3.5 kB)
Requirement already satisfied: six>=1.9.0 in c:\users\pavan\anaconda3\envs\gpavan\li
b\site-packages (from bleach!=5.0.0->nbconvert[webpdf]) (1.16.0)
Requirement already satisfied: webencodings in c:\users\pavan\anaconda3\envs\gpavan
\lib\site-packages (from bleach!=5.0.0->nbconvert[webpdf]) (0.5.1)
Requirement already satisfied: platformdirs>=2.5 in c:\users\pavan\anaconda3\envs\gp
avan\lib\site-packages (from jupyter-core>=4.7->nbconvert[webpdf]) (4.0.0)
Requirement already satisfied: pywin32>=300 in c:\users\pavan\anaconda3\envs\gpavan
\lib\site-packages (from jupyter-core>=4.7->nbconvert[webpdf]) (306)
Requirement already satisfied: jupyter-client>=6.1.12 in c:\users\pavan\anaconda3\en
vs\gpavan\lib\site-packages (from nbclient>=0.5.0->nbconvert[webpdf]) (8.6.0)
Requirement already satisfied: fastjsonschema in c:\users\pavan\anaconda3\envs\gpava
n\lib\site-packages (from nbformat>=5.7->nbconvert[webpdf]) (2.19.0)
Requirement already satisfied: jsonschema>=2.6 in c:\users\pavan\anaconda3\envs\gpav
an\lib\site-packages (from nbformat>=5.7->nbconvert[webpdf]) (4.19.2)
Requirement already satisfied: soupsieve>1.2 in c:\users\pavan\anaconda3\envs\gpavan
\lib\site-packages (from beautifulsoup4->nbconvert[webpdf]) (2.5)
Collecting greenlet==3.0.3 (from playwright->nbconvert[webpdf])
  Downloading greenlet-3.0.3-cp312-cp312-win_amd64.whl.metadata (3.9 kB)
Collecting pyee==11.0.1 (from playwright->nbconvert[webpdf])
  Downloading pyee-11.0.1-py3-none-any.whl.metadata (2.7 kB)
Collecting typing-extensions (from pyee==11.0.1->playwright->nbconvert[webpdf])
  Downloading typing_extensions-4.10.0-py3-none-any.whl.metadata (3.0 kB)
```

```
Requirement already satisfied: attrs>=22.2.0 in c:\users\pavan\anaconda3\envs\gpavan
\lib\site-packages (from jsonschema>=2.6->nbformat>=5.7->nbconvert[webpdf]) (23.1.0)
Requirement already satisfied: jsonschema-specifications>=2023.03.6 in c:\users\pava
n\anaconda3\envs\gpavan\lib\site-packages (from jsonschema>=2.6->nbformat>=5.7->nbco
nvert[webpdf]) (2023.11.1)
Requirement already satisfied: referencing>=0.28.4 in c:\users\pavan\anaconda3\envs
\gpavan\lib\site-packages (from jsonschema>=2.6->nbformat>=5.7->nbconvert[webpdf])
(0.31.0)
Requirement already satisfied: rpds-py>=0.7.1 in c:\users\pavan\anaconda3\envs\gpava
n\lib\site-packages (from jsonschema>=2.6->nbformat>=5.7->nbconvert[webpdf]) (0.13.
0)
Requirement already satisfied: python-dateutil>=2.8.2 in c:\users\pavan\anaconda3\en
vs\gpavan\lib\site-packages (from jupyter-client>=6.1.12->nbclient>=0.5.0->nbconvert
[webpdf]) (2.8.2)
Requirement already satisfied: pyzmq>=23.0 in c:\users\pavan\anaconda3\envs\gpavan\l
ib\site-packages (from jupyter-client>=6.1.12->nbclient>=0.5.0->nbconvert[webpdf])
(25.1.1)
Requirement already satisfied: tornado>=6.2 in c:\users\pavan\anaconda3\envs\gpavan
\lib\site-packages (from jupyter-client>=6.1.12->nbclient>=0.5.0->nbconvert[webpdf])
(6.3.3)
Downloading playwright-1.42.0-py3-none-win_amd64.whl (29.4 MB)
   ---------------------------------------- 0.0/29.4 MB ? eta -:--:--
   ---------------------------------------- 0.0/29.4 MB ? eta -:--:--
   ---------------------------------------- 0.0/29.4 MB ? eta -:--:--
   ---------------------------------------- 0.0/29.4 MB ? eta -:--:--
   ---------------------------------------- 0.1/29.4 MB 652.2 kB/s eta 0:00:45
   ---------------------------------------- 0.1/29.4 MB 652.2 kB/s eta 0:00:45
   ---------------------------------------- 0.1/29.4 MB 652.2 kB/s eta 0:00:45
   ---------------------------------------- 0.2/29.4 MB 689.9 kB/s eta 0:00:43
   ---------------------------------------- 0.3/29.4 MB 803.7 kB/s eta 0:00:37
   ---------------------------------------- 0.3/29.4 MB 863.3 kB/s eta 0:00:34
   ---------------------------------------- 0.3/29.4 MB 863.3 kB/s eta 0:00:34
    --------------------------------------- 0.4/29.4 MB 781.2 kB/s eta 0:00:38
    --------------------------------------- 0.4/29.4 MB 808.4 kB/s eta 0:00:36
    --------------------------------------- 0.5/29.4 MB 879.9 kB/s eta 0:00:33
    --------------------------------------- 0.5/29.4 MB 879.9 kB/s eta 0:00:33
    --------------------------------------- 0.5/29.4 MB 879.9 kB/s eta 0:00:33
    --------------------------------------- 0.6/29.4 MB 844.8 kB/s eta 0:00:35
    --------------------------------------- 0.7/29.4 MB 914.8 kB/s eta 0:00:32
    --------------------------------------- 0.7/29.4 MB 914.8 kB/s eta 0:00:32
    --------------------------------------- 0.7/29.4 MB 914.8 kB/s eta 0:00:32
   - -------------------------------------- 0.8/29.4 MB 877.7 kB/s eta 0:00:33
   - -------------------------------------- 0.8/29.4 MB 877.4 kB/s eta 0:00:33
   - -------------------------------------- 0.9/29.4 MB 940.5 kB/s eta 0:00:31
   - -------------------------------------- 0.9/29.4 MB 940.5 kB/s eta 0:00:31
   - -------------------------------------- 0.9/29.4 MB 940.5 kB/s eta 0:00:31
   - -------------------------------------- 0.9/29.4 MB 940.5 kB/s eta 0:00:31
   - -------------------------------------- 1.0/29.4 MB 867.3 kB/s eta 0:00:33
   - -------------------------------------- 1.0/29.4 MB 867.3 kB/s eta 0:00:33
   - -------------------------------------- 1.0/29.4 MB 867.3 kB/s eta 0:00:33
   - -------------------------------------- 1.1/29.4 MB 842.3 kB/s eta 0:00:34
   - -------------------------------------- 1.2/29.4 MB 861.0 kB/s eta 0:00:33
   - -------------------------------------- 1.3/29.4 MB 930.9 kB/s eta 0:00:31
   - -------------------------------------- 1.3/29.4 MB 930.9 kB/s eta 0:00:31
   - -------------------------------------- 1.3/29.4 MB 930.9 kB/s eta 0:00:31
   - -------------------------------------- 1.4/29.4 MB 907.9 kB/s eta 0:00:31
```

```
- -------------------------------------- 1.4/29.4 MB 913.5 kB/s eta 0:00:31
-- ------------------------------------- 1.5/29.4 MB 960.4 kB/s eta 0:00:30
-- ------------------------------------- 1.5/29.4 MB 960.4 kB/s eta 0:00:30
-- ------------------------------------- 1.5/29.4 MB 960.4 kB/s eta 0:00:30
-- ------------------------------------- 1.6/29.4 MB 938.4 kB/s eta 0:00:30
-- ------------------------------------- 1.7/29.4 MB 965.4 kB/s eta 0:00:29
-- ------------------------------------- 1.7/29.4 MB 965.4 kB/s eta 0:00:29
-- ------------------------------------- 1.7/29.4 MB 965.4 kB/s eta 0:00:29
-- ------------------------------------- 1.8/29.4 MB 950.4 kB/s eta 0:00:30
-- ------------------------------------- 1.8/29.4 MB 950.4 kB/s eta 0:00:30
-- ------------------------------------- 1.9/29.4 MB 932.3 kB/s eta 0:00:30
-- ------------------------------------- 2.0/29.4 MB 967.9 kB/s eta 0:00:29
-- ------------------------------------- 2.2/29.4 MB 1.0 MB/s eta 0:00:27
--- ------------------------------------ 2.3/29.4 MB 1.1 MB/s eta 0:00:26
--- ------------------------------------ 2.5/29.4 MB 1.1 MB/s eta 0:00:24
--- ------------------------------------ 2.7/29.4 MB 1.2 MB/s eta 0:00:23
--- ------------------------------------ 2.8/29.4 MB 1.2 MB/s eta 0:00:22
---- ----------------------------------- 3.1/29.4 MB 1.3 MB/s eta 0:00:21
---- ----------------------------------- 3.2/29.4 MB 1.4 MB/s eta 0:00:20
---- ----------------------------------- 3.4/29.4 MB 1.4 MB/s eta 0:00:19
---- ----------------------------------- 3.6/29.4 MB 1.5 MB/s eta 0:00:18
----- ---------------------------------- 3.9/29.4 MB 1.5 MB/s eta 0:00:17
----- ---------------------------------- 4.1/29.4 MB 1.6 MB/s eta 0:00:16
----- ---------------------------------- 4.3/29.4 MB 1.7 MB/s eta 0:00:16
------ --------------------------------- 4.6/29.4 MB 1.7 MB/s eta 0:00:15
------ --------------------------------- 4.8/29.4 MB 1.8 MB/s eta 0:00:15
------ --------------------------------- 5.0/29.4 MB 1.8 MB/s eta 0:00:14
------- -------------------------------- 5.2/29.4 MB 1.9 MB/s eta 0:00:13
------- -------------------------------- 5.4/29.4 MB 1.9 MB/s eta 0:00:13
------- -------------------------------- 5.6/29.4 MB 1.9 MB/s eta 0:00:13
------- -------------------------------- 5.8/29.4 MB 2.0 MB/s eta 0:00:13
-------- ------------------------------- 5.9/29.4 MB 2.0 MB/s eta 0:00:12
-------- ------------------------------- 6.1/29.4 MB 2.0 MB/s eta 0:00:12
-------- ------------------------------- 6.3/29.4 MB 2.0 MB/s eta 0:00:12
-------- ------------------------------- 6.5/29.4 MB 2.1 MB/s eta 0:00:12
--------- ------------------------------ 6.6/29.4 MB 2.1 MB/s eta 0:00:11
--------- ------------------------------ 6.8/29.4 MB 2.1 MB/s eta 0:00:11
--------- ------------------------------ 7.0/29.4 MB 2.2 MB/s eta 0:00:11
--------- ------------------------------ 7.2/29.4 MB 2.2 MB/s eta 0:00:11
---------- ----------------------------- 7.4/29.4 MB 2.2 MB/s eta 0:00:11
---------- ----------------------------- 7.5/29.4 MB 2.2 MB/s eta 0:00:10
---------- ----------------------------- 7.7/29.4 MB 2.2 MB/s eta 0:00:10
---------- ----------------------------- 7.9/29.4 MB 2.3 MB/s eta 0:00:10
---------- ----------------------------- 8.1/29.4 MB 2.3 MB/s eta 0:00:10
----------- ---------------------------- 8.3/29.4 MB 2.3 MB/s eta 0:00:10
----------- ---------------------------- 8.5/29.4 MB 2.3 MB/s eta 0:00:09
----------- ---------------------------- 8.6/29.4 MB 2.4 MB/s eta 0:00:09
----------- ---------------------------- 8.8/29.4 MB 2.4 MB/s eta 0:00:09
------------ --------------------------- 9.0/29.4 MB 2.4 MB/s eta 0:00:09
------------ --------------------------- 9.2/29.4 MB 2.4 MB/s eta 0:00:09
------------ --------------------------- 9.3/29.4 MB 2.4 MB/s eta 0:00:09
------------ --------------------------- 9.5/29.4 MB 2.4 MB/s eta 0:00:09
------------- -------------------------- 9.7/29.4 MB 2.5 MB/s eta 0:00:09
------------- -------------------------- 9.9/29.4 MB 2.5 MB/s eta 0:00:08
------------- -------------------------- 10.0/29.4 MB 2.5 MB/s eta 0:00:08
------------- -------------------------- 10.2/29.4 MB 2.5 MB/s eta 0:00:08
```

```
-------------- ------------------------- 10.4/29.4 MB 2.7 MB/s eta 0:00:08
-------------- ------------------------- 10.5/29.4 MB 2.7 MB/s eta 0:00:08
-------------- ------------------------- 10.7/29.4 MB 2.8 MB/s eta 0:00:07
-------------- ------------------------- 10.9/29.4 MB 2.9 MB/s eta 0:00:07
--------------- ------------------------ 11.1/29.4 MB 3.0 MB/s eta 0:00:07
--------------- ------------------------ 11.3/29.4 MB 3.4 MB/s eta 0:00:06
--------------- ------------------------ 11.4/29.4 MB 3.4 MB/s eta 0:00:06
--------------- ------------------------ 11.6/29.4 MB 3.5 MB/s eta 0:00:06
---------------- ----------------------- 11.8/29.4 MB 3.7 MB/s eta 0:00:05
---------------- ----------------------- 11.9/29.4 MB 3.7 MB/s eta 0:00:05
---------------- ----------------------- 12.1/29.4 MB 4.0 MB/s eta 0:00:05
---------------- ----------------------- 12.3/29.4 MB 4.0 MB/s eta 0:00:05
----------------- ---------------------- 12.5/29.4 MB 4.0 MB/s eta 0:00:05
----------------- ---------------------- 12.7/29.4 MB 4.0 MB/s eta 0:00:05
----------------- ---------------------- 12.9/29.4 MB 4.0 MB/s eta 0:00:05
----------------- ---------------------- 13.1/29.4 MB 4.0 MB/s eta 0:00:05
------------------ --------------------- 13.2/29.4 MB 4.0 MB/s eta 0:00:05
------------------ --------------------- 13.4/29.4 MB 4.0 MB/s eta 0:00:04
------------------ --------------------- 13.6/29.4 MB 4.0 MB/s eta 0:00:04
------------------ --------------------- 13.8/29.4 MB 4.0 MB/s eta 0:00:04
------------------- -------------------- 14.0/29.4 MB 4.0 MB/s eta 0:00:04
------------------- -------------------- 14.1/29.4 MB 4.0 MB/s eta 0:00:04
------------------- -------------------- 14.3/29.4 MB 4.0 MB/s eta 0:00:04
------------------- -------------------- 14.5/29.4 MB 4.0 MB/s eta 0:00:04
------------------- -------------------- 14.7/29.4 MB 4.0 MB/s eta 0:00:04
-------------------- ------------------- 14.8/29.4 MB 3.9 MB/s eta 0:00:04
-------------------- ------------------- 15.0/29.4 MB 3.9 MB/s eta 0:00:04
-------------------- ------------------- 15.2/29.4 MB 3.9 MB/s eta 0:00:04
-------------------- ------------------- 15.4/29.4 MB 3.9 MB/s eta 0:00:04
--------------------- ------------------ 15.6/29.4 MB 3.9 MB/s eta 0:00:04
--------------------- ------------------ 15.8/29.4 MB 3.9 MB/s eta 0:00:04
--------------------- ------------------ 15.9/29.4 MB 3.9 MB/s eta 0:00:04
--------------------- ------------------ 16.1/29.4 MB 3.9 MB/s eta 0:00:04
---------------------- ----------------- 16.2/29.4 MB 3.9 MB/s eta 0:00:04
---------------------- ----------------- 16.3/29.4 MB 3.9 MB/s eta 0:00:04
---------------------- ----------------- 16.5/29.4 MB 3.8 MB/s eta 0:00:04
---------------------- ----------------- 16.7/29.4 MB 3.8 MB/s eta 0:00:04
---------------------- ----------------- 16.9/29.4 MB 3.8 MB/s eta 0:00:04
----------------------- ---------------- 17.0/29.4 MB 3.9 MB/s eta 0:00:04
----------------------- ---------------- 17.2/29.4 MB 3.8 MB/s eta 0:00:04
----------------------- ---------------- 17.4/29.4 MB 3.9 MB/s eta 0:00:04
----------------------- ---------------- 17.6/29.4 MB 3.9 MB/s eta 0:00:04
------------------------ --------------- 17.8/29.4 MB 3.9 MB/s eta 0:00:04
------------------------ --------------- 18.0/29.4 MB 3.8 MB/s eta 0:00:03
------------------------ --------------- 18.1/29.4 MB 3.8 MB/s eta 0:00:03
------------------------ --------------- 18.3/29.4 MB 3.8 MB/s eta 0:00:03
------------------------- -------------- 18.5/29.4 MB 3.8 MB/s eta 0:00:03
------------------------- -------------- 18.6/29.4 MB 3.9 MB/s eta 0:00:03
------------------------- -------------- 18.8/29.4 MB 3.9 MB/s eta 0:00:03
------------------------- -------------- 19.0/29.4 MB 3.9 MB/s eta 0:00:03
-------------------------- ------------- 19.2/29.4 MB 3.8 MB/s eta 0:00:03
-------------------------- ------------- 19.4/29.4 MB 3.8 MB/s eta 0:00:03
-------------------------- ------------- 19.6/29.4 MB 3.9 MB/s eta 0:00:03
-------------------------- ------------- 19.8/29.4 MB 3.8 MB/s eta 0:00:03
--------------------------- ------------ 19.9/29.4 MB 3.8 MB/s eta 0:00:03
--------------------------- ------------ 20.1/29.4 MB 3.9 MB/s eta 0:00:03
```

```
   --------------------------- ------------ 20.3/29.4 MB 3.8 MB/s eta 0:00:03
   --------------------------- ------------ 20.4/29.4 MB 3.9 MB/s eta 0:00:03
   ---------------------------- ----------- 20.6/29.4 MB 3.9 MB/s eta 0:00:03
   ---------------------------- ----------- 20.8/29.4 MB 3.8 MB/s eta 0:00:03
   ---------------------------- ----------- 21.0/29.4 MB 3.9 MB/s eta 0:00:03
   ---------------------------- ----------- 21.2/29.4 MB 3.8 MB/s eta 0:00:03
   ----------------------------- ---------- 21.4/29.4 MB 3.8 MB/s eta 0:00:03
   ----------------------------- ---------- 21.5/29.4 MB 3.9 MB/s eta 0:00:03
   ----------------------------- ---------- 21.7/29.4 MB 3.8 MB/s eta 0:00:03
   ----------------------------- ---------- 21.9/29.4 MB 3.9 MB/s eta 0:00:02
   ------------------------------ --------- 22.1/29.4 MB 3.8 MB/s eta 0:00:02
   ------------------------------ --------- 22.3/29.4 MB 3.9 MB/s eta 0:00:02
   ------------------------------ --------- 22.5/29.4 MB 3.8 MB/s eta 0:00:02
   ------------------------------ --------- 22.7/29.4 MB 3.8 MB/s eta 0:00:02
   ------------------------------- -------- 22.8/29.4 MB 3.9 MB/s eta 0:00:02
   ------------------------------- -------- 23.0/29.4 MB 3.9 MB/s eta 0:00:02
   ------------------------------- -------- 23.1/29.4 MB 3.8 MB/s eta 0:00:02
   ------------------------------- -------- 23.3/29.4 MB 3.9 MB/s eta 0:00:02
   ------------------------------- -------- 23.5/29.4 MB 3.8 MB/s eta 0:00:02
   -------------------------------- ------- 23.7/29.4 MB 3.9 MB/s eta 0:00:02
   -------------------------------- ------- 23.9/29.4 MB 3.9 MB/s eta 0:00:02
   -------------------------------- ------- 24.1/29.4 MB 3.9 MB/s eta 0:00:02
   -------------------------------- ------- 24.2/29.4 MB 3.9 MB/s eta 0:00:02
   --------------------------------- ------ 24.4/29.4 MB 3.8 MB/s eta 0:00:02
   --------------------------------- ------ 24.6/29.4 MB 3.9 MB/s eta 0:00:02
   --------------------------------- ------ 24.8/29.4 MB 3.9 MB/s eta 0:00:02
   --------------------------------- ------ 25.0/29.4 MB 3.9 MB/s eta 0:00:02
   ---------------------------------- ----- 25.1/29.4 MB 3.9 MB/s eta 0:00:02
   ---------------------------------- ----- 25.3/29.4 MB 3.8 MB/s eta 0:00:02
   ---------------------------------- ----- 25.5/29.4 MB 3.8 MB/s eta 0:00:02
   ---------------------------------- ----- 25.7/29.4 MB 3.8 MB/s eta 0:00:01
   ----------------------------------- ---- 25.8/29.4 MB 3.9 MB/s eta 0:00:01
   ----------------------------------- ---- 26.0/29.4 MB 3.8 MB/s eta 0:00:01
   ----------------------------------- ---- 26.2/29.4 MB 3.8 MB/s eta 0:00:01
   ----------------------------------- ---- 26.4/29.4 MB 3.9 MB/s eta 0:00:01
   ------------------------------------ --- 26.6/29.4 MB 3.9 MB/s eta 0:00:01
   ------------------------------------ --- 26.8/29.4 MB 3.9 MB/s eta 0:00:01
   ------------------------------------ --- 26.9/29.4 MB 3.9 MB/s eta 0:00:01
   ------------------------------------ --- 27.1/29.4 MB 3.9 MB/s eta 0:00:01
   ------------------------------------- -- 27.3/29.4 MB 3.9 MB/s eta 0:00:01
   ------------------------------------- -- 27.5/29.4 MB 3.9 MB/s eta 0:00:01
   ------------------------------------- -- 27.6/29.4 MB 3.9 MB/s eta 0:00:01
   ------------------------------------- -- 27.8/29.4 MB 3.9 MB/s eta 0:00:01
   ------------------------------------- -- 27.9/29.4 MB 3.9 MB/s eta 0:00:01
   -------------------------------------- - 28.1/29.4 MB 3.9 MB/s eta 0:00:01
   -------------------------------------- - 28.3/29.4 MB 3.9 MB/s eta 0:00:01
   -------------------------------------- - 28.4/29.4 MB 3.9 MB/s eta 0:00:01
   -------------------------------------- - 28.6/29.4 MB 3.9 MB/s eta 0:00:01
   ---------------------------------------  28.8/29.4 MB 3.9 MB/s eta 0:00:01
   ---------------------------------------  29.0/29.4 MB 3.9 MB/s eta 0:00:01
   ---------------------------------------  29.2/29.4 MB 3.9 MB/s eta 0:00:01
   ---------------------------------------  29.4/29.4 MB 3.9 MB/s eta 0:00:01
   ---------------------------------------  29.4/29.4 MB 3.9 MB/s eta 0:00:01
   ---------------------------------------- 29.4/29.4 MB 3.8 MB/s eta 0:00:00
Downloading greenlet-3.0.3-cp312-cp312-win_amd64.whl (293 kB)
   ---------------------------------------- 0.0/293.6 kB ? eta -:--:--
```

```
   --------------------------------------  286.7/293.6 kB 8.6 MB/s eta 0:00:01
   ---------------------------------------- 293.6/293.6 kB 4.5 MB/s eta 0:00:00
Downloading pyee-11.0.1-py3-none-any.whl (15 kB)
Downloading typing_extensions-4.10.0-py3-none-any.whl (33 kB)
Installing collected packages: typing-extensions, greenlet, pyee, playwright
Successfully installed greenlet-3.0.3 playwright-1.42.0 pyee-11.0.1 typing-extension
s-4.10.0
```

In [42]:

```
!playwright install chromium
```

```
Downloading Chromium 123.0.6312.4 (playwright build v1105) from https://playwright.a
zureedge.net/builds/chromium/1105/chromium-win64.zip
|                                                                                |
0% of 122.2 MiB
|â– â– â– â– â– â– â– â–
|  10% of 122.2 MiB
|â– â– â– â– â– â– â– â– â– â– â– â– â– â– â– â–
|  20% of 122.2 MiB
|â– â– â– â– â– â– â– â– â– â– â– â– â– â– â– â– â– â– â– â– â– â– â– â–
|  30% of 122.2 MiB
|â– â– â– â– â– â– â– â– â– â– â– â– â– â– â– â– â– â– â– â– â– â– â– â– â– â– â– â–
 â– â– â– â–                                                 |  40% of 122.2 MiB
|â– â– â– â– â– â– â– â– â– â– â– â– â– â– â– â– â– â– â– â– â– â– â– â– â– â– â– â–
 â– â– â– â– â– â– â– â– â– â– â– â–                                         |  50%
of 122.2 MiB
|â– â– â– â– â– â– â– â– â– â– â– â– â– â– â– â– â– â– â– â– â– â– â– â– â– â– â– â–
 â– â– â– â– â– â– â– â– â– â– â– â– â– â– â– â– â– â– â– â–
|  60% of 122.2 MiB
|â– â– â– â– â– â– â– â– â– â– â– â– â– â– â– â– â– â– â– â– â– â– â– â– â– â– â– â–
 â– â– â– â– â– â– â– â– â– â– â– â– â– â– â– â– â– â– â– â– â– â– â– â– â– â– â– â–
                         |  70% of 122.2 MiB
|â– â– â– â– â– â– â– â– â– â– â– â– â– â– â– â– â– â– â– â– â– â– â– â– â– â– â– â–
 â– â– â– â– â– â– â– â– â– â– â– â– â– â– â– â– â– â– â– â– â– â– â– â– â– â– â– â–
 â– â– â– â– â– â– â– â–                 |  80% of 122.2 MiB
|â– â– â– â– â– â– â– â– â– â– â– â– â– â– â– â– â– â– â– â– â– â– â– â– â– â– â– â–
 â– â– â– â– â– â– â– â– â– â– â– â– â– â– â– â– â– â– â– â– â– â– â– â– â– â– â– â–
 â– â– â– â– â– â– â– â– â– â– â– â– â– â– â– â–         |  90% of 122.2 MiB
|â– â– â– â– â– â– â– â– â– â– â– â– â– â– â– â– â– â– â– â– â– â– â– â– â– â– â– â–
 â– â– â– â– â– â– â– â– â– â– â– â– â– â– â– â– â– â– â– â– â– â– â– â– â– â– â– â–
 â– â– â– â– â– â– â– â– â– â– â– â– â– â– â– â– â– â– â– â– â– â– â– â– | 100% of 1
22.2 MiB
Chromium 123.0.6312.4 (playwright build v1105) downloaded to C:\Users\pavan\AppData
\Local\ms-playwright\chromium-1105
Downloading FFMPEG playwright build v1009 from https://playwright.azureedge.net/buil
ds/ffmpeg/1009/ffmpeg-win64.zip
|                                                                                |
1% of 1.4 MiB
|â– â– â– â– â– â– â– â–
|  10% of 1.4 MiB
|â– â– â– â– â– â– â– â– â– â– â– â– â– â– â– â–
|  20% of 1.4 MiB
|â– â– â– â– â– â– â– â– â– â– â– â– â– â– â– â– â– â– â– â– â– â– â– â–
|  30% of 1.4 MiB
|â– â– â– â– â– â– â– â– â– â– â– â– â– â– â– â– â– â– â– â– â– â– â– â– â– â– â– â–
 â– â– â– â–                                                 |  40% of 1.4 MiB
|â– â– â– â– â– â– â– â– â– â– â– â– â– â– â– â– â– â– â– â– â– â– â– â– â– â– â– â–
 â– â– â– â– â– â– â– â– â– â– â– â–                                         |  50%
of 1.4 MiB
|â– â– â– â– â– â– â– â– â– â– â– â– â– â– â– â– â– â– â– â– â– â– â– â– â– â– â– â–
 â– â– â– â– â– â– â– â– â– â– â– â– â– â– â– â– â– â– â– â–
|  60% of 1.4 MiB
|â– â– â– â– â– â– â– â– â– â– â– â– â– â– â– â– â– â– â– â– â– â– â– â– â– â– â– â–
 â– â– â– â– â– â– â– â– â– â– â– â– â– â– â– â– â– â– â– â– â– â– â– â– â– â– â– â–
                         |  70% of 1.4 MiB
|â– â– â– â– â– â– â– â– â– â– â– â– â– â– â– â– â– â– â– â– â– â– â– â– â– â– â– â–
 â– â– â– â– â– â– â– â– â– â– â– â– â– â– â– â– â– â– â– â– â– â– â– â– â– â– â– â–
```

```
 â– â– â– â– â– â– â– â–                  |  80% of 1.4 MiB
|â– â– â– â– â– â– â– â– â– â– â– â– â– â– â– â– â– â– â– â– â– â– â– â– â– â– â– â–
 â– â– â– â– â– â– â– â– â– â– â– â– â– â– â– â– â– â– â– â– â– â– â– â– â– â– â– â–
 â– â– â– â– â– â– â– â– â– â– â– â– â– â– â– â–          |  90% of 1.4 MiB
|â– â– â– â– â– â– â– â– â– â– â– â– â– â– â– â– â– â– â– â– â– â– â– â– â– â– â– â–
 â– â– â– â– â– â– â– â– â– â– â– â– â– â– â– â– â– â– â– â– â– â– â– â– â– â– â– â–
 â– â– â– â– â– â– â– â– â– â– â– â– â– â– â– â– â– â– â– â– â– â– â– â– â– | 100% of
1.4 MiB
FFMPEG playwright build v1009 downloaded to C:\Users\pavan\AppData\Local\ms-playwrig
ht\ffmpeg-1009
```

In [ ]: