In [ ]:

```
# IMPORTANT: RUN THIS CELL IN ORDER TO IMPORT YOUR KAGGLE DATA SOURCES
# TO THE CORRECT LOCATION (/kaggle/input) IN YOUR NOTEBOOK,
# THEN FEEL FREE TO DELETE THIS CELL.
# NOTE: THIS NOTEBOOK ENVIRONMENT DIFFERS FROM KAGGLE'S PYTHON
# ENVIRONMENT SO THERE MAY BE MISSING LIBRARIES USED BY YOUR
# NOTEBOOK.

import os
import sys
from tempfile import NamedTemporaryFile
from urllib.request import urlopen
from urllib.parse import unquote, urlparse
from urllib.error import HTTPError
from zipfile import ZipFile
import tarfile
import shutil

CHUNK_SIZE = 40960
DATA_SOURCE_MAPPING = 'recipe-for-rating-predict-food-ratings-using-ml:http

KAGGLE_INPUT_PATH='/kaggle/input'
KAGGLE_WORKING_PATH='/kaggle/working'
KAGGLE_SYMLINK='kaggle'

!umount /kaggle/input/ 2> /dev/null
shutil.rmtree('/kaggle/input', ignore_errors=True)
os.makedirs(KAGGLE_INPUT_PATH, 0o777, exist_ok=True)
os.makedirs(KAGGLE_WORKING_PATH, 0o777, exist_ok=True)

try:
  os.symlink(KAGGLE_INPUT_PATH, os.path.join("..", 'input'), target_is_dire
except FileExistsError:
  pass
try:
  os.symlink(KAGGLE_WORKING_PATH, os.path.join("..", 'working'), target_is_
except FileExistsError:
  pass

for data_source_mapping in DATA_SOURCE_MAPPING.split(','):
    directory, download_url_encoded = data_source_mapping.split(':')
    download_url = unquote(download_url_encoded)
    filename = urlparse(download_url).path
    destination_path = os.path.join(KAGGLE_INPUT_PATH, directory)
    try:
        with urlopen(download_url) as fileres, NamedTemporaryFile() as tfil
            total_length = fileres.headers['content-length']
            print(f'Downloading {directory}, {total_length} bytes compresse
            dl = 0
            data = fileres.read(CHUNK_SIZE)
            while len(data) > 0:
                dl += len(data)
                tfile.write(data)
                done = int(50 * dl / int(total_length))
                sys.stdout.write(f"\r[{'=' * done}{' ' * (50-done)}] {dl} b
                sys.stdout.flush()
                data = fileres.read(CHUNK_SIZE)
            if filename.endswith('.zip'):
              with ZipFile(tfile) as zfile:
                zfile.extractall(destination_path)
            else:
```

```
                with tarfile.open(tfile.name) as tarfile:
                    tarfile.extractall(destination_path)
                print(f'\nDownloaded and uncompressed: {directory}')
        except HTTPError as e:
            print(f'Failed to load (likely expired) {download_url} to path {des
            continue
        except OSError as e:
            print(f'Failed to load {download_url} to path {destination_path}')
            continue

print('Data source import complete.')
```

In [ ]:
```
# This Python 3 environment comes with many helpful analytics libraries ins
# It is defined by the kaggle/python Docker image: https://github.com/kaggl
# For example, here's several helpful packages to load

import numpy as np # linear algebra
import pandas as pd # data processing, CSV file I/O (e.g. pd.read_csv)

# Input data files are available in the read-only "../input/" directory
# For example, running this (by clicking run or pressing Shift+Enter) will

import os
for dirname, _, filenames in os.walk('/kaggle/input'):
    for filename in filenames:
        print(os.path.join(dirname, filename))

# You can write up to 20GB to the current directory (/kaggle/working/) that
# You can also write temporary files to /kaggle/temp/, but they won't be sa
```

```
/kaggle/input/recipe-for-rating-predict-food-ratings-using-ml/sample.csv
/kaggle/input/recipe-for-rating-predict-food-ratings-using-ml/train.csv
/kaggle/input/recipe-for-rating-predict-food-ratings-using-ml/test.csv
```

In [ ]:
```
# Importing all required libraries for EDA
import pandas as pd
import numpy as np
import matplotlib.pyplot as plt
import seaborn as sns
from statsmodels.stats.outliers_influence import variance_inflation_factor
from statsmodels.tools.tools import add_constant
```

In [ ]:
```
# Reading Train and Test files

train = pd.read_csv("/kaggle/input/recipe-for-rating-predict-food-ratings-u
test = pd.read_csv("/kaggle/input/recipe-for-rating-predict-food-ratings-us
```

About the Training Data

In [ ]:
```
train.head()
```

Out[4]:

	ID	RecipeNumber	RecipeCode	RecipeName	CommentID	
0	70	71	12259	Banana Bars with Cream Cheese Frosting	sp_aUSaElGf_12259_c_149978	u_1oKVaE
1	72	88	8202	Simple Taco Soup	sp_aUSaElGf_8202_c_310332	u_1oKZeRIX
2	458	3	2832	Cheeseburger Soup	sp_aUSaElGf_2832_c_206522	u_1oKYHUt
3	7	50	100276	Grilled Huli Huli Chicken	sp_aUSaElGf_100276_c_434088	u_1oKZCQc
4	60	12	19731	Cauliflower Soup	sp_aUSaElGf_19731_c_387011	u_1oKd4suc

In [ ]:
```
# Shape of Training Data
train.shape
```

Out[5]:
```
(13636, 15)
```

In [ ]:
```
# Info regarding training data
train.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 13636 entries, 0 to 13635
Data columns (total 15 columns):
 #   Column             Non-Null Count  Dtype 
---  ------             --------------  ----- 
 0   ID                 13636 non-null  int64 
 1   RecipeNumber       13636 non-null  int64 
 2   RecipeCode         13636 non-null  int64 
 3   RecipeName         13636 non-null  object
 4   CommentID          13636 non-null  object
 5   UserID             13636 non-null  object
 6   UserName           13636 non-null  object
 7   UserReputation     13636 non-null  int64 
 8   CreationTimestamp  13636 non-null  int64 
 9   ReplyCount         13636 non-null  int64 
 10  ThumbsUpCount      13636 non-null  int64 
 11  ThumbsDownCount    13636 non-null  int64 
 12  Rating             13636 non-null  int64 
 13  BestScore          13636 non-null  int64 
 14  Recipe_Review      13634 non-null  object
dtypes: int64(10), object(5)
memory usage: 1.6+ MB
```

In [ ]:
```
# descriptive statistics
train.describe()
```

Out[7]:

	ID	RecipeNumber	RecipeCode	UserReputation	CreationTimestamp	Re
count	13636.000000	13636.000000	13636.000000	13636.000000	1.363600e+04	136
mean	121.085289	38.624377	21785.990833	2.160311	1.623713e+09	
std	116.995633	29.672351	23883.189918	10.086424	5.444020e+06	
min	0.000000	1.000000	386.000000	0.000000	1.613035e+09	
25%	45.000000	12.000000	6504.000000	1.000000	1.622717e+09	
50%	91.000000	33.000000	14600.000000	1.000000	1.622718e+09	
75%	148.000000	63.000000	33121.000000	1.000000	1.622718e+09	
max	724.000000	100.000000	191775.000000	510.000000	1.665756e+09	

Data Cleaning

In [ ]:
```
# Columns in training dataset
train.columns.tolist()
```

Out[8]:
```
['ID',
 'RecipeNumber',
 'RecipeCode',
 'RecipeName',
 'CommentID',
 'UserID',
 'UserName',
 'UserReputation',
 'CreationTimestamp',
 'ReplyCount',
 'ThumbsUpCount',
 'ThumbsDownCount',
 'Rating',
 'BestScore',
 'Recipe_Review']
```

In [ ]:
```
# Checking for null values
train.isnull().sum()
```

Out[9]:
```
ID                  0
RecipeNumber        0
RecipeCode          0
RecipeName          0
CommentID           0
UserID              0
UserName            0
UserReputation      0
CreationTimestamp   0
ReplyCount          0
ThumbsUpCount       0
ThumbsDownCount     0
Rating              0
BestScore           0
Recipe_Review       2
dtype: int64
```

In [ ]:
```
# Checking for NaN values
train.isna().sum()
```

Out[10]:
```
ID                  0
RecipeNumber        0
RecipeCode          0
RecipeName          0
CommentID           0
UserID              0
UserName            0
UserReputation      0
CreationTimestamp   0
ReplyCount          0
ThumbsUpCount       0
ThumbsDownCount     0
Rating              0
BestScore           0
Recipe_Review       2
dtype: int64
```

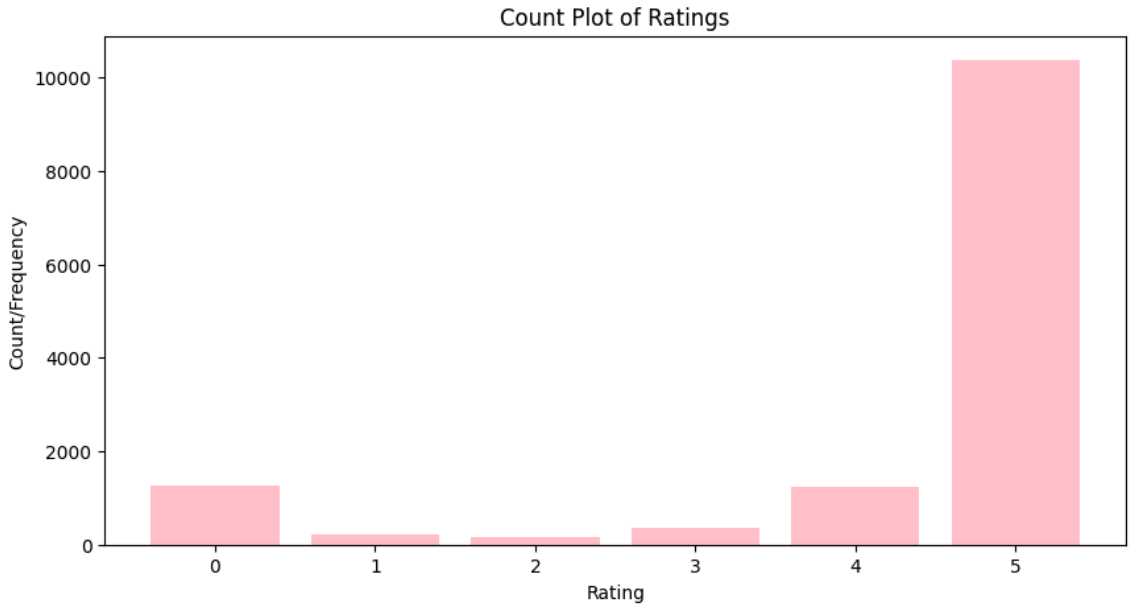
In [ ]:
```
# Checking unique values in each of the columns of the training dataset

# Checking for invalid inputs for the following:
# UserReputation: Non-negative numerical values.
# ReplyCount, ThumbsUpCount, ThumbsDownCount: Non-negative integer values.
# Rating: Numerical values within a specific range [0, 5].
# BestScore: Non-negative numerical values.

columns = ['UserReputation', 'ReplyCount', 'ThumbsUpCount', 'ThumbsDownCoun

for column in columns:
    unique_values = train[column].unique()
    print(f"Unique values for column '{column}': {unique_values}")
```

```
Unique values for column 'UserReputation': [ 20   1  10  80  30   0  60   9
0 160  40 510 100  50 140  70 220 110 130
 150 300]
Unique values for column 'ReplyCount': [0 1 2 3]
Unique values for column 'ThumbsUpCount': [ 0  1  3  2 23  5 36  4  8 31 1
0 20  7  6 12 18  9 22 13 11 15 32 26 16
 76 19 44 35 45 29 55 42 14 27 41 37 30 21 24 17 33 40 28 25 73 39 57 80
 69 43 47 79 46 50 68 34 48]
Unique values for column 'ThumbsDownCount': [  0   1  10  29   6   3   5
9   2   4  17   8  13  11   7  12  15  19
  78  26  21  41  16  40  62  31  55  14  24  20  71  25  49  37  39  18
  65  32 126  63  46  30  23 104  42  70  22  87  27  61  38]
Unique values for column 'Rating': [5 3 4 0 2 1]
Unique values for column 'BestScore': [100 193 136 253 485 556 530 859 329
354 120 259 840 381 720 623 323 522
 297 538 799 167 278 240 635 400 777 127 414 142 523 390 211 235 516 109
 203 854 767 404 348 484 303 779 588 830 848 770 467 143 757 810 415 819
 261 319 616 440 153 695 163 561 513 833 599 395 752 287 424 740 161 269
 728 196 672 788 527 793 637 714 628 244 496 473 673 432 185 631 152 486
 894 889 138 807 458 204 615 729 310 535 679 380 439 468 460 804 606 574
 184 296 113 744 108 745 116 667 618 212 498 376 526 412 456 771 610 687
 374 721 762 525 686 131 634 811 669 723 625 822 617 781 280 123 504 453
 645 885 844 462 922 229 918 818 543 736 759 812 459 750 284 107 643 402
 422 311 907 258 869 355 716 592 845 827 223 327 663 619 585 368 591 825
 775 111 879 581 220 866 717 813 275 794 648 536 693 338 846 410 703 683
 694 419 647 791 786 356 715 166 434 575 758 428 732 118 604 386 680 761
 785 171 697 832 274 505 712 730 408 867 104 593 479 700 331 684 768 797
 195 821 734 103 436 661 466 632 784 725 316 320 423 824 735 842 540 106
 433 766 360 668 105 906 495 214 555 455 175 216 839   0 518 689 888 782
 718 569 699 237 576 710 749 532 114 892 903 772 559 514 681 671 899 337
 605 642 731 377 480 863 713 393 739 851 134 580 644 820 595 489 769 135
 611 290 638  34 491 125 860 582 908 529 230 641 746 119 798 755 226 437
 388 260 856 763 488 387 747 490 912 773 911 154 472 652 751 724 321 690
 315 148 227 403 572 780 691 829 834 835 776 429 701 335 741 562 649 607
 520 272 493 873 865 598 396 121 685 367 726 678 550 347 406 188 463 891
   7 586 299 443 524 633 512 510 670  93 831 447 168 656 601 659 560 650
 129 828 565 492 706 189 225   1 722 748 566 231 905 887 295 177 449 934
 665 795 483 306 698 802 577 760 849 313 852 541 826 554 727 796 464 603
 692 521 660 101 742 626 334 624 640 454 425 808 657 805 898 627 474 708
 675 646 855 928 346 602 654 503 590  83 815 738 206 696 392 764 677 662
 533 255 307 537 877 707 765 792 816 399 389 858 126 914 608 621 234   4
 870 140 499 756 441 823 122 128 658  38 651 179 809 452 600 549 548 564
 563 664 597 197 910 702 162 183 817 506 841 110 801 847 837 361 442 838
 545 946 754]
```

In [ ]:
```
# Replace NaN values in 'Recipe_Review' column with 'NIL'
train['Recipe_Review'].fillna('NIL', inplace=True)
```

```
/tmp/ipykernel_34/300075851.py:2: FutureWarning: A value is trying to be s
et on a copy of a DataFrame or Series through chained assignment using an
inplace method.
The behavior will change in pandas 3.0. This inplace method will never wor
k because the intermediate object on which we are setting values always be
haves as a copy.

For example, when doing 'df[col].method(value, inplace=True)', try using
'df.method({col: value}, inplace=True)' or df[col] = df[col].method(value)
instead, to perform the operation inplace on the original object.


  train['Recipe_Review'].fillna('NIL', inplace=True)
```

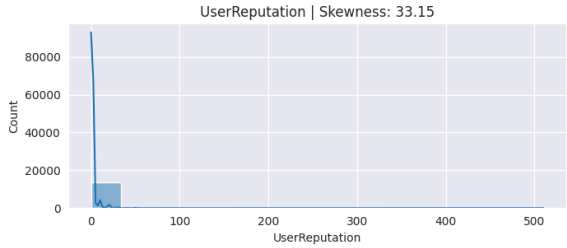
In [ ]:
```
# Assuming 'df' is your DataFrame
ratings = train['Rating'].value_counts()

# Using Matplotlib to create a count plot
plt.figure(figsize=(10, 5))
plt.bar(ratings.index, ratings, color='pink')
plt.title('Count Plot of Ratings')
plt.xlabel('Rating')
plt.ylabel('Count/Frequency')
plt.show()
```

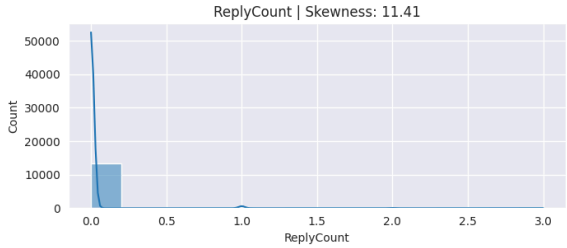


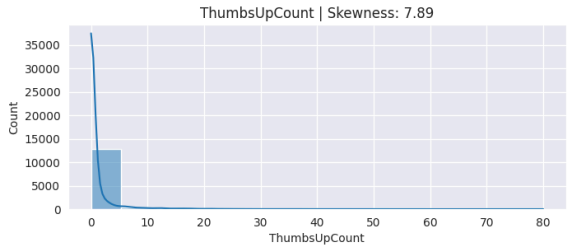
In [ ]:

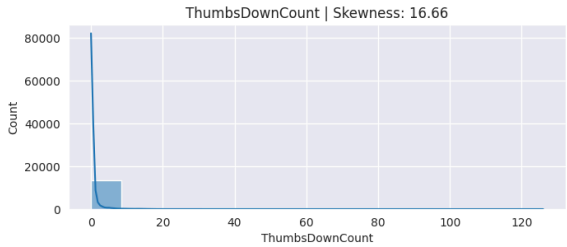
```
# Set Seaborn style
sns.set_style("darkgrid")

# All numerical columns
numerical_columns =['UserReputation', 'ReplyCount', 'ThumbsUpCount', 'Thumb

# Plotting distribution of each numerical feature
plt.figure(figsize=(14, len(numerical_columns) * 3))
for idx, feature in enumerate(numerical_columns, 1):
    plt.subplot(len(numerical_columns), 2, idx)
    sns.histplot(train[feature], kde=True)
    plt.title(f"{feature} | Skewness: {round(train[feature].skew(), 2)}")

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

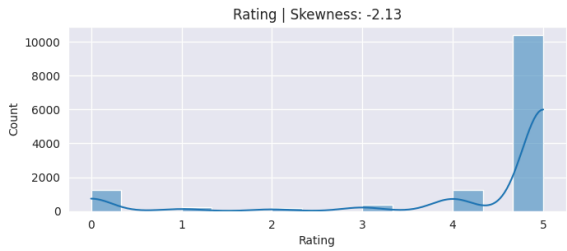
```
/opt/conda/lib/python3.10/site-packages/seaborn/_oldcore.py:1119: FutureWa
rning: use_inf_as_na option is deprecated and will be removed in a future
version. Convert inf values to NaN before operating instead.
  with pd.option_context('mode.use_inf_as_na', True):
/opt/conda/lib/python3.10/site-packages/seaborn/_oldcore.py:1119: FutureWa
rning: use_inf_as_na option is deprecated and will be removed in a future
version. Convert inf values to NaN before operating instead.
  with pd.option_context('mode.use_inf_as_na', True):
/opt/conda/lib/python3.10/site-packages/seaborn/_oldcore.py:1119: FutureWa
rning: use_inf_as_na option is deprecated and will be removed in a future
version. Convert inf values to NaN before operating instead.
  with pd.option_context('mode.use_inf_as_na', True):
/opt/conda/lib/python3.10/site-packages/seaborn/_oldcore.py:1119: FutureWa
rning: use_inf_as_na option is deprecated and will be removed in a future
version. Convert inf values to NaN before operating instead.
  with pd.option_context('mode.use_inf_as_na', True):
/opt/conda/lib/python3.10/site-packages/seaborn/_oldcore.py:1119: FutureWa
rning: use_inf_as_na option is deprecated and will be removed in a future
version. Convert inf values to NaN before operating instead.
  with pd.option_context('mode.use_inf_as_na', True):
/opt/conda/lib/python3.10/site-packages/seaborn/_oldcore.py:1119: FutureWa
rning: use_inf_as_na option is deprecated and will be removed in a future
version. Convert inf values to NaN before operating instead.
  with pd.option_context('mode.use_inf_as_na', True):
```

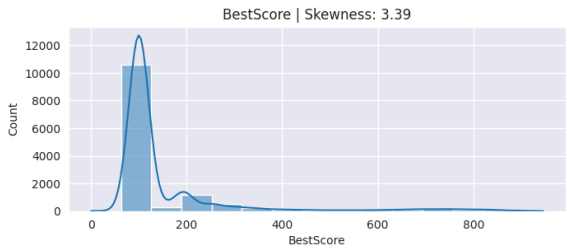

UserReputation | Skewness: 33.15
Count
UserReputation


ReplyCount | Skewness: 11.41
Count
ReplyCount

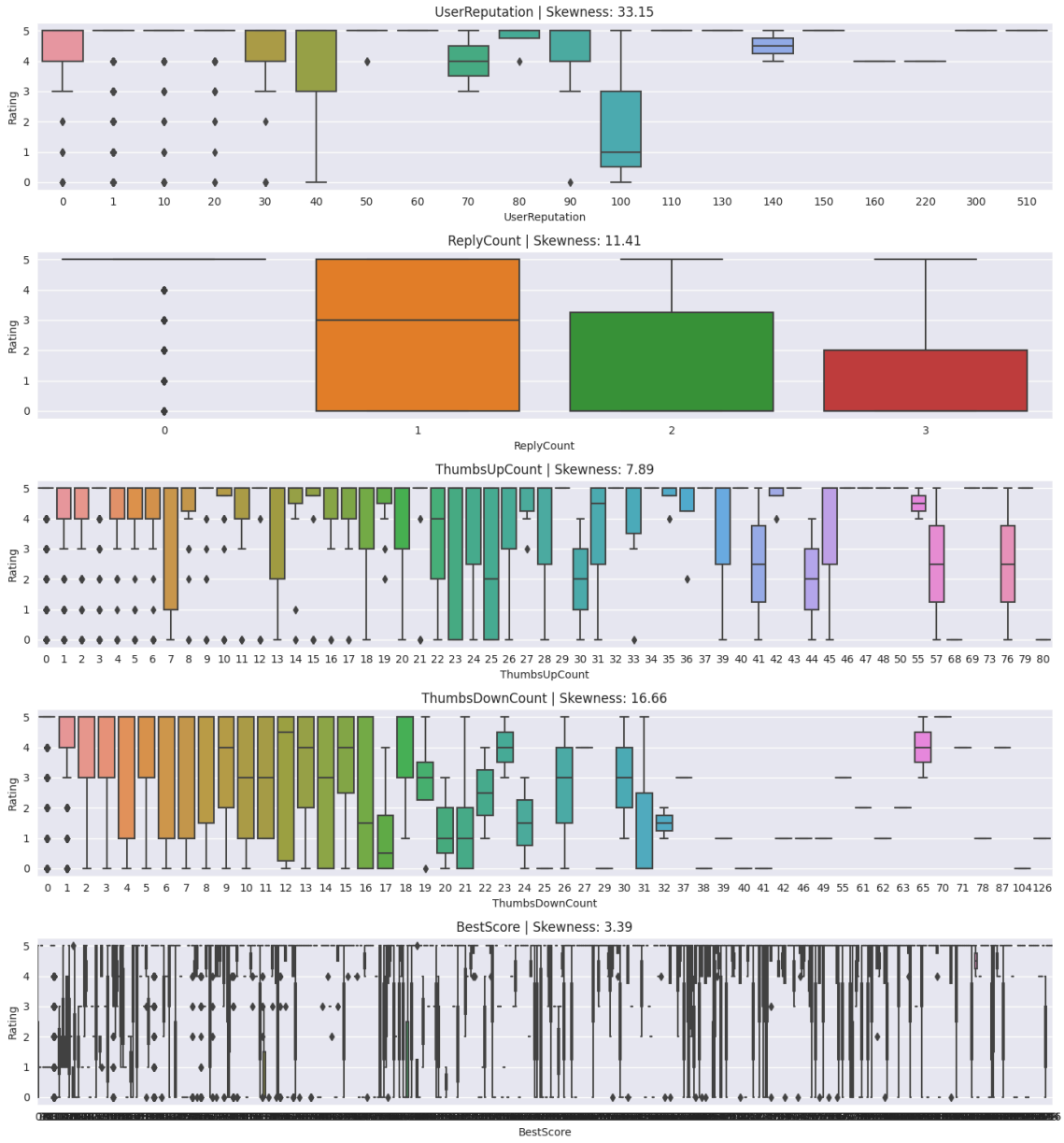

ThumbsUpCount | Skewness: 7.89
Count
ThumbsUpCount


ThumbsDownCount | Skewness: 16.66
Count
ThumbsDownCount


Rating | Skewness: -2.13
Count
Rating

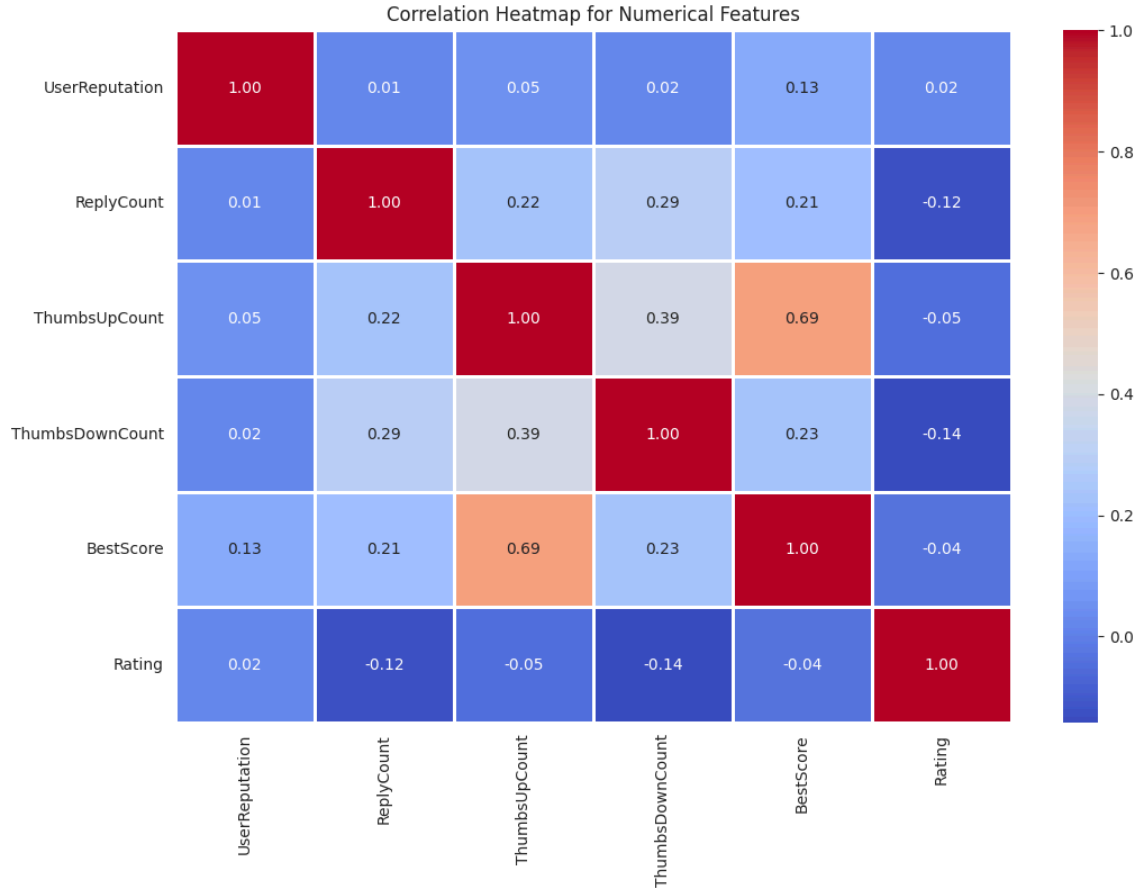

BestScore | Skewness: 3.39
Count
BestScore

In [ ]:
```
# Box Plot : Numerical Features vs Ratings

import seaborn as sns
import matplotlib.pyplot as plt
sns.set_style("darkgrid")
numerical_columns = ['UserReputation', 'ReplyCount', 'ThumbsUpCount', 'Thum
plt.figure(figsize=(14, len(numerical_columns) * 3))
for idx, feature in enumerate(numerical_columns, 1):
    plt.subplot(len(numerical_columns), 1, idx)
    sns.boxplot(x=train[feature], y=train['Rating'])
    plt.title(f"{feature} | Skewness: {round(train[feature].skew(), 2)}")
plt.tight_layout()
plt.show()
```



Checking for Multicolinearity and Importance of Variables

In [ ]:
```
# Correlation Heat Map

numerical_data = train[['UserReputation', 'ReplyCount', 'ThumbsUpCount', 'T
correlation_matrix = numerical_data.corr()
plt.figure(figsize=(12, 8))
sns.heatmap(correlation_matrix, annot=True, fmt='.2f', cmap='coolwarm', lin
plt.title('Correlation Heatmap for Numerical Features')
plt.show()
```



In [ ]:
```
numerical_data = train[['UserReputation', 'ReplyCount', 'ThumbsUpCount', 'T
X_with_const = add_constant(numerical_data)
vif_data = pd.DataFrame()
vif_data["feature"] = X_with_const.columns
vif_data["VIF"] = [variance_inflation_factor(X_with_const.values, i) for i

# Print VIF for each feature
print(vif_data)
```

```
          feature        VIF
0           const  10.761504
1   UserReputation   1.019257
2      ReplyCount   1.130503
3    ThumbsUpCount   2.176559
4  ThumbsDownCount   1.274163
5           Rating   1.029202
6       BestScore   1.986289
```

UserReputation: The VIF value of approximately 1.02 indicating low multicollinearity

ReplyCount: Similarly, with a VIF of around 1.13, indicating low multicollinearity

ThumbsUpCount: This feature has a VIF of about 2.18, indicating moderate multicollinearity.

ThumbsDownCount: The VIF value of approximately 1.27 indicating low multicollinearity.

Rating: Similarly, with a VIF of around 1.02, indicating low multicollinearity

BestScore: The VIF value of approximately 1.98 indicating low multicollinearity.

In [ ]:
```
from scipy.stats import chi2_contingency

X=numerical_data
# Perform Chi-square test for each categorical feature
chi2_results = {}
for column in X.columns:
    if X[column].dtype == 'int64':
        contingency_table = pd.crosstab(X[column], train['Rating'])
        chi2_result = chi2_contingency(contingency_table)
        chi2_results[column] = chi2_result

# Print Chi-square test results
for column, result in chi2_results.items():
    print(f"Feature: {column}, p-value: {result[1]}")
```

```
Feature: UserReputation, p-value: 0.041126549940447066
Feature: ReplyCount, p-value: 8.370622405816741e-51
Feature: ThumbsUpCount, p-value: 0.0027853743505592624
Feature: ThumbsDownCount, p-value: 0.0
Feature: Rating, p-value: 0.0
Feature: BestScore, p-value: 2.738423604626112e-216
```

UserReputation: The p-value is approximately 0.0411, which shows there is a statistically significant association between UserReputation and Rating.

ReplyCount: The p-value is very small (close to 0), indicating a very strong statistical association between ReplyCount and Rating.

ThumbsUpCount: The p-value is approximately 0.0028, indicating a statistically significant association between ThumbsUpCount and Rating.

ThumbsDownCount: The p-value is 0, which suggests a highly significant association between ThumbsDownCount and Rating.

BestScore: The p-value is extremely small (close to 0), indicating a very strong statistical association between BestScore and Rating.

The most important features and the best set of them are UserReputation,ReplyCount, ThumbsDownCount,BestScore

Modelling

Using Dummy Classifier

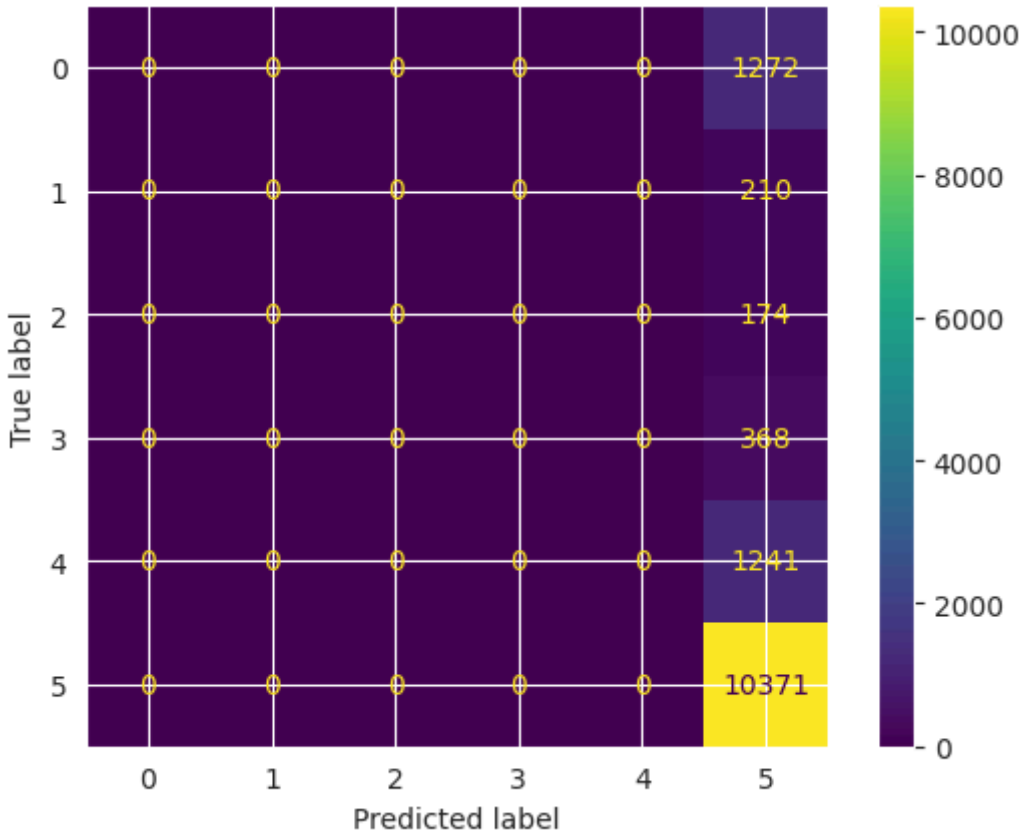
In [ ]:
```
from sklearn.dummy import DummyClassifier
from sklearn.metrics import accuracy_score, precision_score, recall_score
from sklearn.metrics import ConfusionMatrixDisplay
```

In [ ]:
```
X_train = train.drop(columns=['Rating'])
y_train = train['Rating']
```

In [ ]:
```
dc = DummyClassifier(strategy="most_frequent")
dc.fit(X_train,y_train)
y_pred = dc.predict(X_train)
accuracy = accuracy_score(y_train, y_pred)
precision = precision_score(y_train,y_pred, average = 'macro')
recall = recall_score(y_train,y_pred, average = 'macro')
print("Accuracy:", accuracy)
print("Precision:", precision)
print("Recall:", recall)
```

```
Accuracy: 0.7605602816075095
Precision: 0.12676004693458492
Recall: 0.16666666666666666

/opt/conda/lib/python3.10/site-packages/sklearn/metrics/_classification.p
y:1344: UndefinedMetricWarning: Precision is ill-defined and being set to
0.0 in labels with no predicted samples. Use `zero_division` parameter to
control this behavior.
  _warn_prf(average, modifier, msg_start, len(result))
```

In [ ]:
```
cm_display = ConfusionMatrixDisplay.from_predictions(y_train,y_pred,values_
```



Accuracy obtained on the training dataset through the use of dummy classifier is 76.05602%

Using K-Nearest Neighours

In [ ]:
```
from sklearn.neighbors import KNeighborsClassifier
from sklearn.model_selection import train_test_split
from sklearn.metrics import accuracy_score
```

In [ ]:
```
knn = KNeighborsClassifier(n_neighbors=5)
```

In [ ]:
```
X_train=train[[ 'UserReputation','ReplyCount', 'ThumbsDownCount','BestScore
```

In [ ]:
```
knn.fit(X_train, y_train)
y_pred = knn.predict(X_train)
accuracy = accuracy_score(y_train,y_pred)
precision = precision_score(y_train,y_pred, average = 'macro')
recall = recall_score(y_train,y_pred, average = 'macro')
print("Precision:", precision)
print("Recall:", recall)
print("Accuracy:", accuracy)
```

```
Precision: 0.5593908651359836
Recall: 0.23108452856951245
Accuracy: 0.7653270753886771
```

Accuracy obtained on the training dataset through the use of k-nearest neighbours classifier algorithm is 76.53270%

Using Decision Tree

In [ ]:
```
from sklearn.model_selection import train_test_split
from sklearn.metrics import classification_report, confusion_matrix, Confus
from sklearn.pipeline import Pipeline
from sklearn.preprocessing import StandardScaler, MinMaxScaler, FunctionTra
from sklearn.tree import DecisionTreeClassifier, export_text
from sklearn.compose import ColumnTransformer
from imblearn.under_sampling import RandomUnderSampler
from sklearn.model_selection import GridSearchCV
```

In [ ]:
```
dtc=DecisionTreeClassifier(random_state=0)
dtc.fit(X_train,y_train)
```

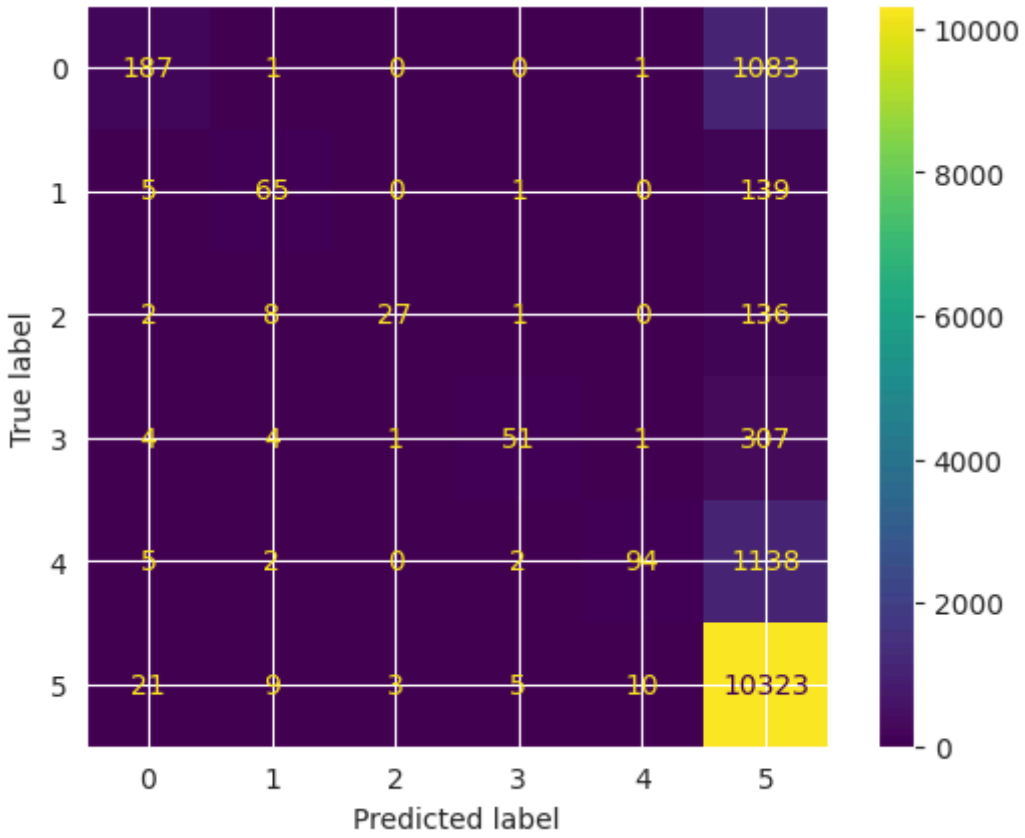
Out[28]:
```
DecisionTreeClassifier(random_state=0)
```

In a Jupyter environment, please rerun this cell to show the HTML representation or trust the notebook.
On GitHub, the HTML representation is unable to render, please try loading this page with nbviewer.org.

In [ ]:
```
y_pred = dtc.predict(X_train)
accuracy = accuracy_score(y_train,y_pred)
precision = precision_score(y_train,y_pred, average = 'macro')
recall = recall_score(y_train,y_pred, average = 'macro')
print("Precision:", precision)
print("Recall:", recall)
print("Accuracy:", accuracy)
```

```
Precision: 0.8265621778950786
Recall: 0.30356880577826445
Accuracy: 0.78813435024934
```

In [ ]:
```
cm_display = ConfusionMatrixDisplay.from_predictions(y_train,y_pred,values_
```



Accuracy obtained on the training dataset through the use of decision trees classifier algorithm is 78.81343%

Now, I use Grid Search CV to find the best parameters suiting the model to obtain the heighest percentage of training accuracy

1. With Feature Scaling

In [ ]:
```
pipeline = Pipeline([
    ('feature_scaling',StandardScaler()),
    ('dt_clf', DecisionTreeClassifier(random_state=1))
])
```

In [ ]:
```
dt_clf_search = GridSearchCV(pipeline, param_grid={'dt_clf__max_depth':[1,2
                                                   'dt_clf__min_samples_spl
                                                   "dt_clf__criterion":['gi
                                                   "dt_clf__min_samples_spl
                                                   "dt_clf__min_samples_lea
                             scoring = 'f1_macro',n_jobs=2, cv=5, return_tr

# Cross validation using 5 sets
```

In [ ]:
```
dt_clf_search.fit(X_train,y_train)
```

```
/opt/conda/lib/python3.10/site-packages/sklearn/model_selection/_valida
tion.py:378: FitFailedWarning:
400 fits failed out of a total of 3600.
The score on these train-test partitions for these parameters will be s
et to nan.
If these failures are not expected, you can try to debug them by settin
g error_score='raise'.

Below are more details about the failures:
--------------------------------------------------------------------------
---------
400 fits failed with the following error:
Traceback (most recent call last):
  File "/opt/conda/lib/python3.10/site-packages/sklearn/model_selectio
n/_validation.py", line 686, in _fit_and_score
    estimator.fit(X_train, y_train, **fit_params)
  File "/opt/conda/lib/python3.10/site-packages/sklearn/pipeline.py", l
ine 405, in fit
    self._final_estimator.fit(Xt, y, **fit_params_last_step)
```

In [ ]:
```
dt_clf_search.best_params_
```

Out[34]:
```
{'dt_clf__criterion': 'entropy',
 'dt_clf__max_depth': 10,
 'dt_clf__min_samples_leaf': 4,
 'dt_clf__min_samples_split': 9}
```

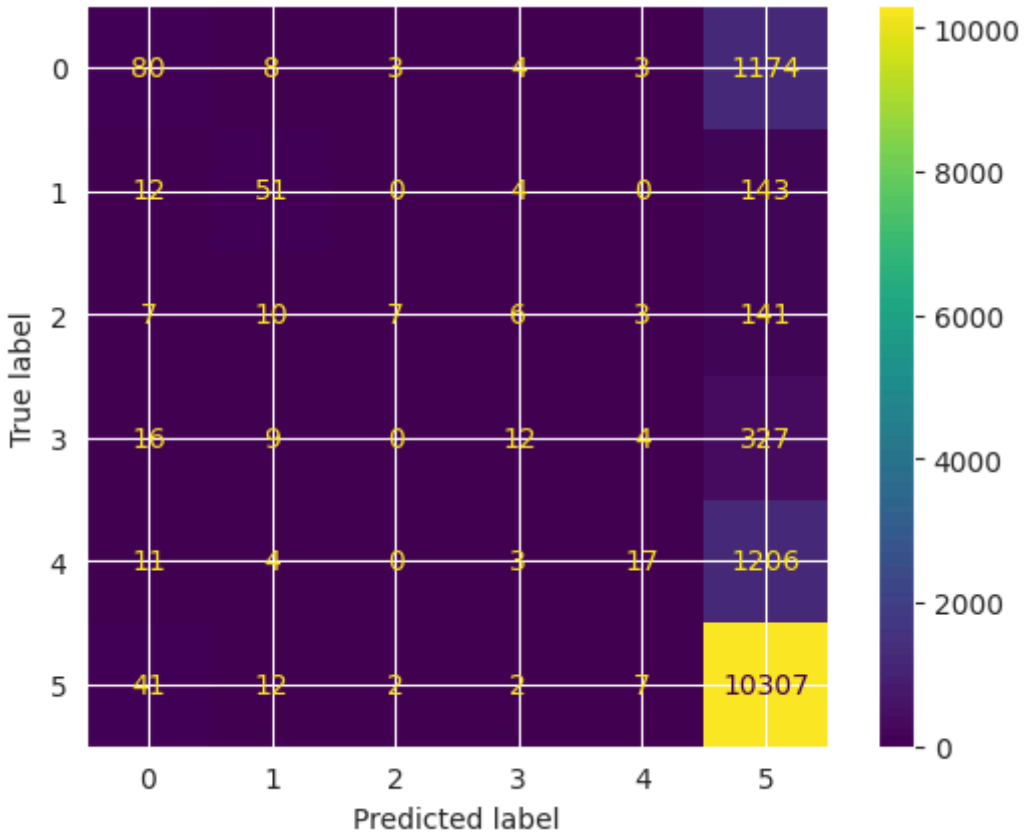
The best set of paramters for the model are:

1. Criterion : Entropy
2. Max depth : 10
3. Minimum Leaf Samples : 4
4. Minimum Split Samples : 9

In [ ]:
```
y_pred = dt_clf_search.predict(X_train)
accuracy = accuracy_score(y_train,y_pred)
precision = precision_score(y_train,y_pred, average = 'macro')
recall = recall_score(y_train,y_pred, average = 'macro')
print("Precision:", precision)
print("Recall:", recall)
print("Accuracy: ", accuracy)
```

```
Precision: 0.5445173624043166
Recall: 0.2310193969274136
Accuracy:  0.7681138163684365
```

In [ ]:
```
cm_display = ConfusionMatrixDisplay.from_predictions(y_train,y_pred,values_
```



Accuracy obtained on the training dataset through the use of decision trees classifier algorithm and Grid Search CV with scaling of variables using StandardScaler is 76.81138%

Clearly, decision tree with default parameter settings provide better training results

2. Without Feature Scaling

In [ ]:
```
pipeline = Pipeline([
    ('dt_clf', DecisionTreeClassifier(random_state=1))
])
```

In [ ]:
```
dt_clf_search = GridSearchCV(pipeline, param_grid={'dt_clf__max_depth':[1,2
                                                   'dt_clf__min_samples_spl
                                                   "dt_clf__criterion":['gi
                                                   "dt_clf__min_samples_spl
                                                   "dt_clf__min_samples_lea
                             scoring = 'f1_macro',n_jobs=2, cv=5, return_tr

# Cross validation using 5 sets
```

In [ ]:
```
dt_clf_search.fit(X_train,y_train)
```

```
/opt/conda/lib/python3.10/site-packages/sklearn/model_selection/_valida
tion.py:378: FitFailedWarning:
400 fits failed out of a total of 3600.
The score on these train-test partitions for these parameters will be s
et to nan.
If these failures are not expected, you can try to debug them by settin
g error_score='raise'.

Below are more details about the failures:
--------------------------------------------------------------------------
---------
400 fits failed with the following error:
Traceback (most recent call last):
  File "/opt/conda/lib/python3.10/site-packages/sklearn/model_selectio
n/_validation.py", line 686, in _fit_and_score
    estimator.fit(X_train, y_train, **fit_params)
  File "/opt/conda/lib/python3.10/site-packages/sklearn/pipeline.py", l
ine 405, in fit
    self._final_estimator.fit(Xt, y, **fit_params_last_step)
```

In [ ]:
```
dt_clf_search.best_params_
```

Out[40]:
```
{'dt_clf__criterion': 'entropy',
 'dt_clf__max_depth': 10,
 'dt_clf__min_samples_leaf': 4,
 'dt_clf__min_samples_split': 9}
```

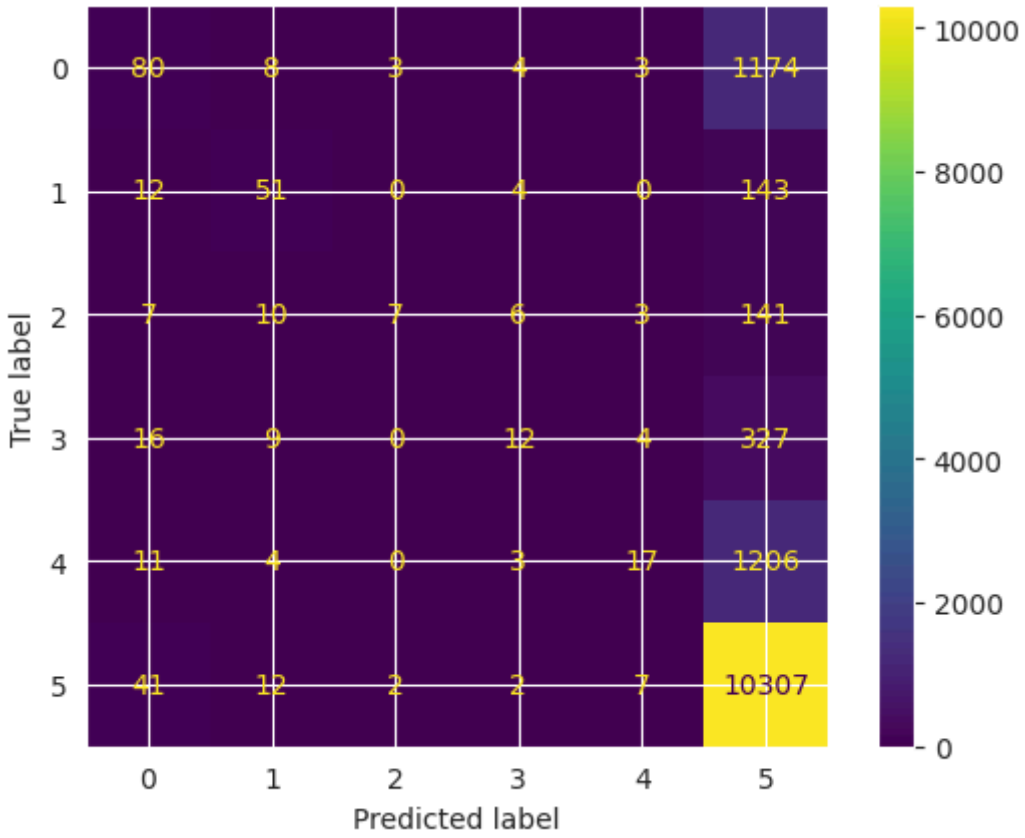
The best set of paramters for the model are:

1. Criterion : Entropy
2. Max depth : 10
3. Minimum Leaf Samples : 4
4. Minimum Split Samples : 9

In [ ]:
```
y_pred = dt_clf_search.predict(X_train)
accuracy = accuracy_score(y_train,y_pred)
precision = precision_score(y_train,y_pred, average = 'macro')
recall = recall_score(y_train,y_pred, average = 'macro')
print("Precision:", precision)
print("Recall:", recall)
print("Accuracy: ", accuracy)
```

```
Precision: 0.5445173624043166
Recall: 0.2310193969274136
Accuracy:  0.7681138163684365
```

In [ ]:
```
cm_display = ConfusionMatrixDisplay.from_predictions(y_train,y_pred,values_
```



Accuracy obtained on the training dataset through the use of decision trees classifier algorithm and Grid Search CV without scaling of variables is 76.81138%

Clearly, the accuracy score did not change due to scaling, and hence Scaling does not affect the model.

Using SGD Classifier

1. SGD with default parameters

In [ ]:
```
from sklearn.linear_model import SGDClassifier

SGDestimator = SGDClassifier(random_state=0)
pipe_sgd = Pipeline([
    ('minmaxscaler', MinMaxScaler()),
    ('SGD', SGDestimator)
])
pipe_sgd.fit(X_train,y_train)
```

Out[43]:
```
Pipeline(steps=[('minmaxscaler', MinMaxScaler()),
                ('SGD', SGDClassifier(random_state=0))])
```

In a Jupyter environment, please rerun this cell to show the HTML representation or trust the notebook.
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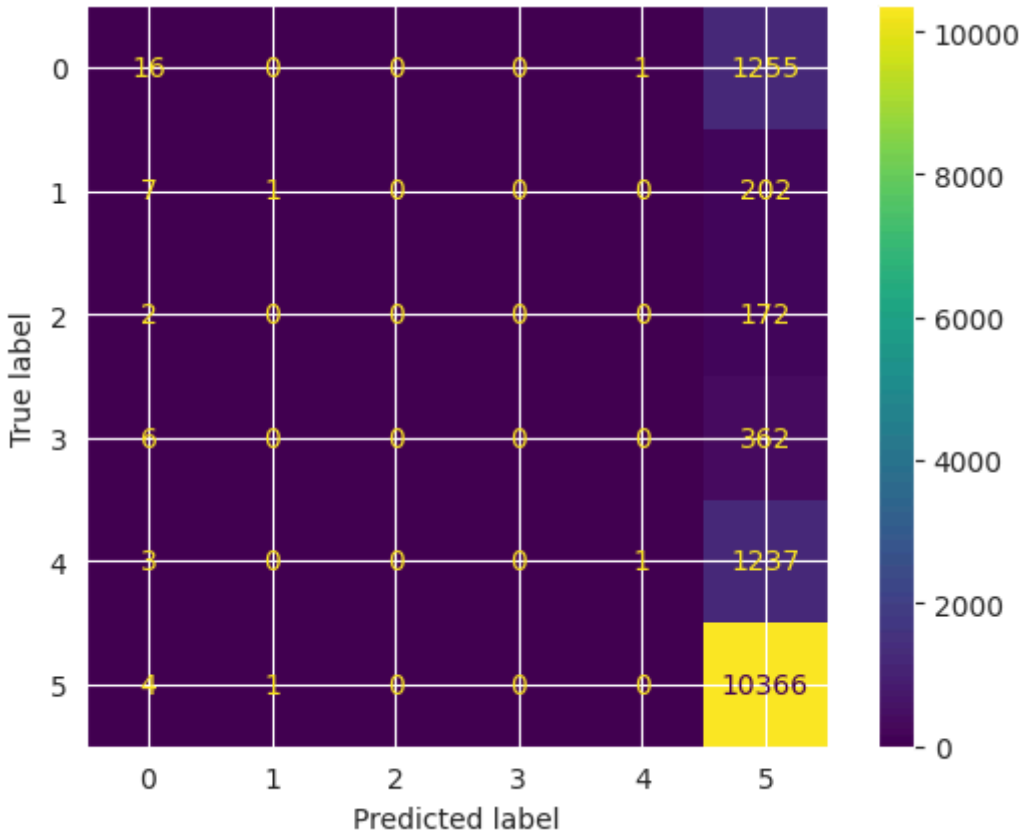
In [ ]:
```
y_pred = pipe_sgd.predict(X_train)
accuracy = accuracy_score(y_train,y_pred)
precision = precision_score(y_train,y_pred, average = 'macro')
recall = recall_score(y_train,y_pred, average = 'macro')
print("Precision:", precision)
print("Recall:", recall)
print("Accuracy: ", accuracy)
```

```
Precision: 0.3639324882752711
Recall: 0.16961070155015154
Accuracy:  0.761513640363743

/opt/conda/lib/python3.10/site-packages/sklearn/metrics/_classification.p
y:1344: UndefinedMetricWarning: Precision is ill-defined and being set to
0.0 in labels with no predicted samples. Use `zero_division` parameter to
control this behavior.
  _warn_prf(average, modifier, msg_start, len(result))
```

In [ ]:
```
cm_display = ConfusionMatrixDisplay.from_predictions(y_train,y_pred,values_
```



Accuracy obtained on the training dataset through the use of SGD Classifier with deafult parameters is 76.15136%

2. SGD with certain parameters

In [ ]:
```
SGDestimator = SGDClassifier(loss='log',
                             penalty='l2',
                             max_iter=1,
                             warm_start=True,
                             eta0=0.01,
                             alpha=0,
                             learning_rate='constant',
                             random_state=0)
pipe_sgd = Pipeline([
    ('minmaxscaler', MinMaxScaler()),
    ('SGD', SGDestimator)
])
```

In [ ]:
```
pipe_sgd.fit(X_train,y_train)
```

```
/opt/conda/lib/python3.10/site-packages/sklearn/linear_model/_stochastic_g
radient.py:163: FutureWarning: The loss 'log' was deprecated in v1.1 and w
ill be removed in version 1.3. Use `loss='log_loss'` which is equivalent.
  warnings.warn(
/opt/conda/lib/python3.10/site-packages/sklearn/linear_model/_stochastic_g
radient.py:702: ConvergenceWarning: Maximum number of iteration reached be
fore convergence. Consider increasing max_iter to improve the fit.
  warnings.warn(
```

Out[47]:
```
Pipeline(steps=[('minmaxscaler', MinMaxScaler()),
                ('SGD',
                 SGDClassifier(alpha=0, eta0=0.01, learning_rate='constan
t',
                               loss='log', max_iter=1, random_state=0,
                               warm_start=True))])
```

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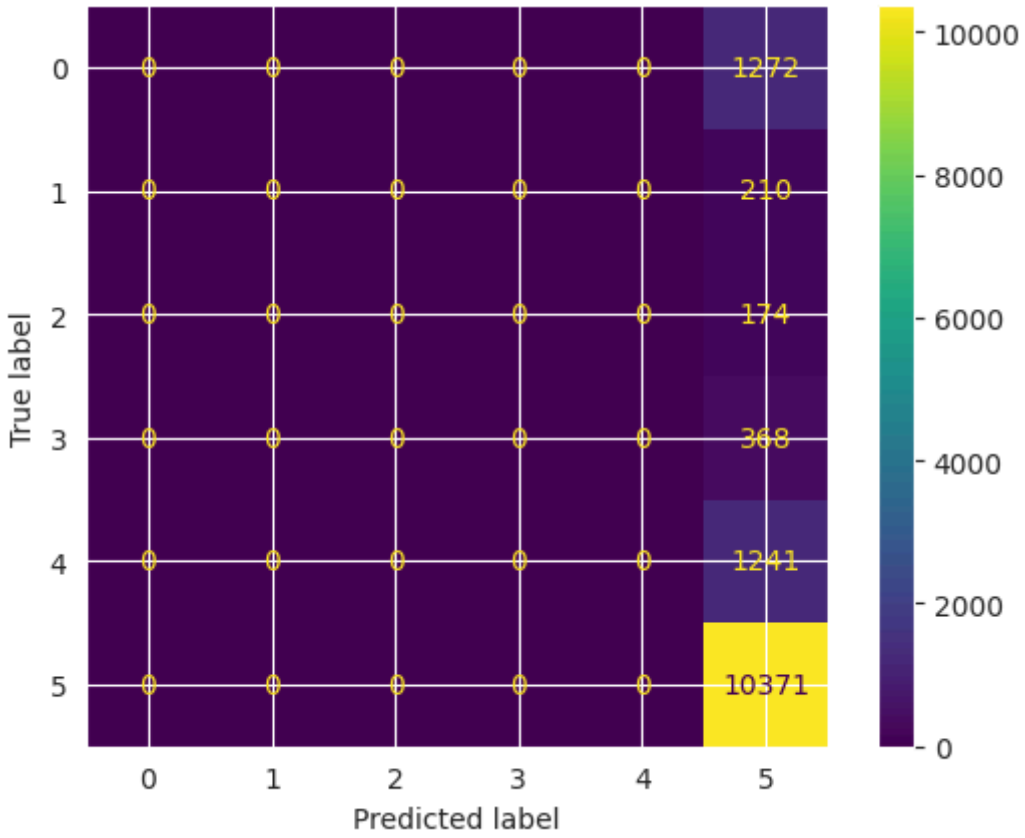
In [ ]:
```
y_pred = pipe_sgd.predict(X_train)
accuracy = accuracy_score(y_train,y_pred)
precision = precision_score(y_train,y_pred, average = 'macro')
recall = recall_score(y_train,y_pred, average = 'macro')
print("Precision:", precision)
print("Recall:", recall)
print("Accuracy: ", accuracy)
```

```
Precision: 0.12676004693458492
Recall: 0.16666666666666666
Accuracy:  0.7605602816075095

/opt/conda/lib/python3.10/site-packages/sklearn/metrics/_classification.p
y:1344: UndefinedMetricWarning: Precision is ill-defined and being set to
0.0 in labels with no predicted samples. Use `zero_division` parameter to
control this behavior.
  _warn_prf(average, modifier, msg_start, len(result))
```

In [ ]:
```
cm_display = ConfusionMatrixDisplay.from_predictions(y_train,y_pred,values_
```



Accuracy obtained on the training dataset through the use of the above specified SGD classifier is 76.05062%

Using Random Forest Classifier

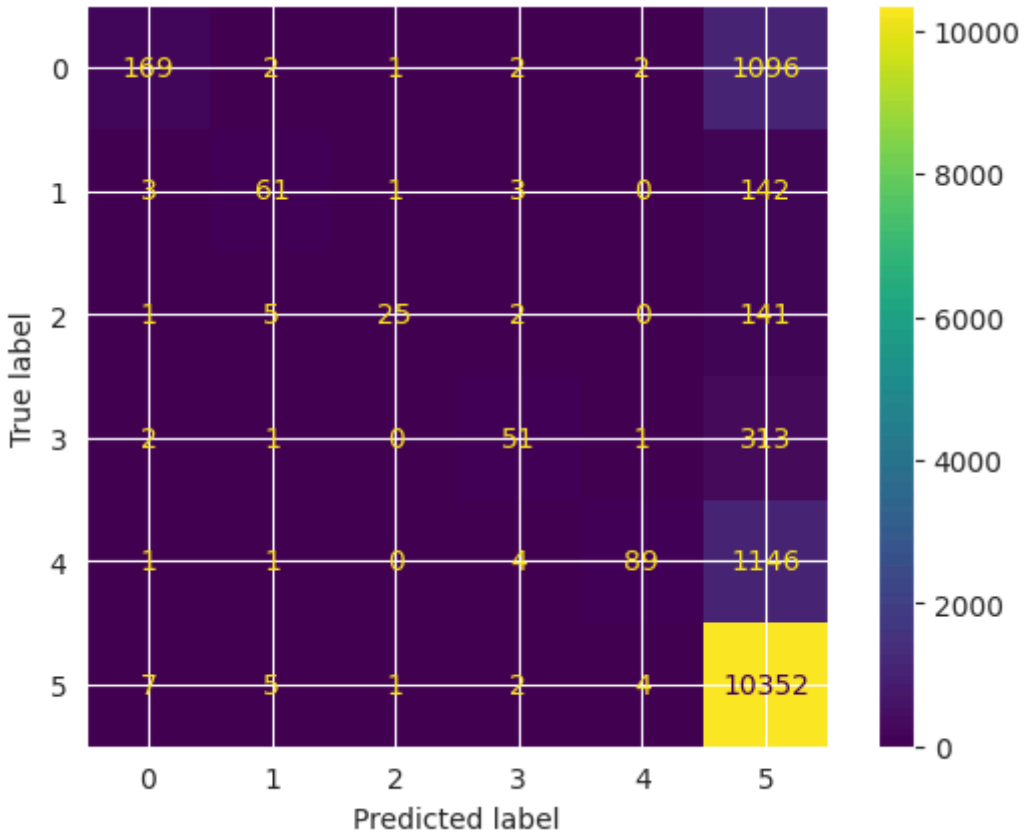
In [ ]:
```
from sklearn.ensemble import RandomForestClassifier

RFC_clf = Pipeline([("classifier", RandomForestClassifier())])

RFC_clf.fit(X_train, y_train)
print("Model score/accuracy:" , RFC_clf.score(X_train, y_train))
y_pred = RFC_clf.predict(X_train)
precision = precision_score(y_train,y_pred, average = 'macro')
recall = recall_score(y_train,y_pred, average = 'macro')
print("Precision:", precision)
print("Recall:", recall)
```

```
Model score/accuracy: 0.78813435024934
Precision: 0.8564138458348203
Recall: 0.29591454488115526
```

In [ ]:
```
y_pred=RFC_clf.predict(X_train)
cm_display = ConfusionMatrixDisplay.from_predictions(y_train,y_pred,values_
```



Accuracy obtained on the training dataset through the use of random forest classifier is 78.81343%

Algorithms with a New Feature based on the sentiment of words

In [ ]:
```
x_train = train[["UserReputation", "ReplyCount", "ThumbsDownCount", "BestSc
```

In [ ]:
```
def check_positive_words(review):
    positive_words = ['delicious', 'amazing', 'tasty', '!']

    count = 0
    for word in positive_words:
        if word in str(review).lower():
            count += 1

    return count

x_train['positive_feedback'] = x_train['Recipe_Review'].apply(check_positiv
```

```
/tmp/ipykernel_34/337253934.py:11: SettingWithCopyWarning:
A value is trying to be set on a copy of a slice from a DataFrame.
Try using .loc[row_indexer,col_indexer] = value instead

See the caveats in the documentation: https://pandas.pydata.org/pandas-doc
s/stable/user_guide/indexing.html#returning-a-view-versus-a-copy (https://
pandas.pydata.org/pandas-docs/stable/user_guide/indexing.html#returning-a-
view-versus-a-copy)
  x_train['positive_feedback'] = x_train['Recipe_Review'].apply(check_posi
tive_words)
```

In [ ]:
```
x_train.head()
```

Out[54]:

	UserReputation	ReplyCount	ThumbsDownCount	BestScore	Recipe_Review	positive_feed
0	20	0	0	100	great recipe! I have made them just as written...	
1	1	0	1	100	This is an easy and quick recipe that is great...	
2	1	0	0	100	I think I was looking for something extra spec...	
3	1	0	0	100	This is our favorite grilled chicken recipe. ...	
4	1	0	0	100	Great basic recipe. I added 2 teaspoons Tuscan...	

In [ ]:
```
x_train=x_train.drop(columns=['Recipe_Review'])
```

In [ ]:
```
clf_dtc=DecisionTreeClassifier(random_state=1)
clf_dtc.fit(x_train,y_train)
```

Out[56]:
```
DecisionTreeClassifier(random_state=1)
```

In a Jupyter environment, please rerun this cell to show the HTML representation or trust the notebook.
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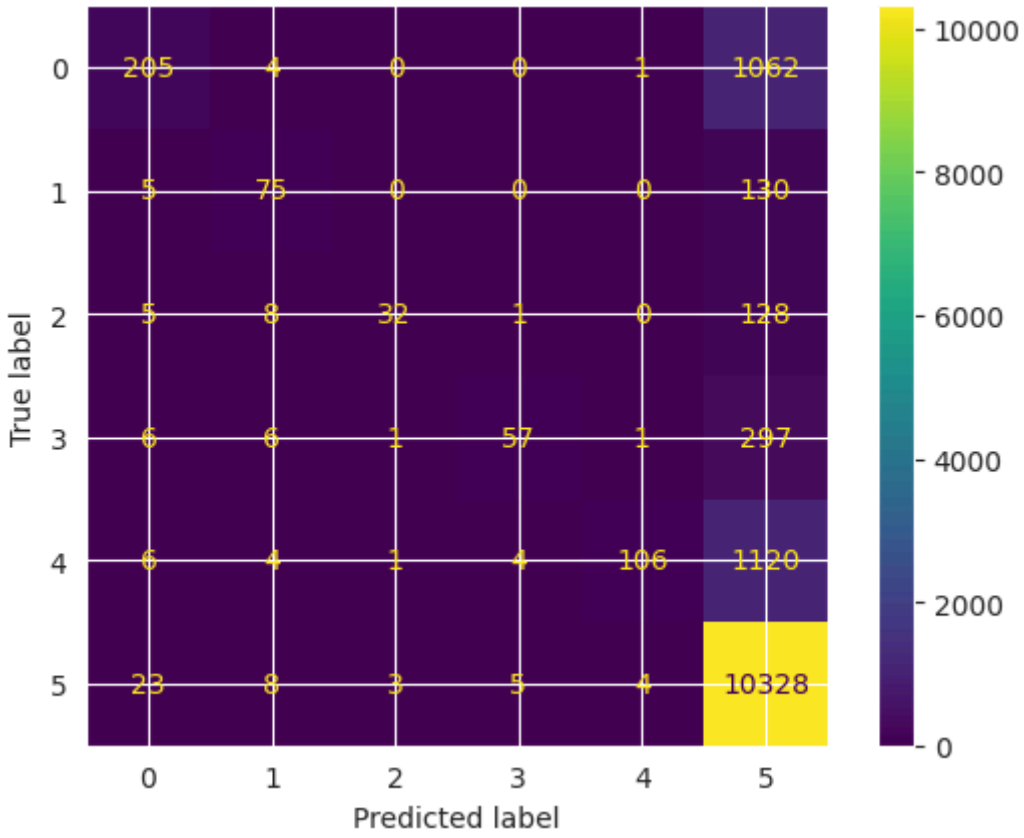
In [ ]:
```
y_pred = clf_dtc.predict(x_train)
accuracy = accuracy_score(y_train,y_pred)
precision = precision_score(y_train,y_pred, average = 'macro')
recall = recall_score(y_train,y_pred, average = 'macro')
print("Precision:", precision)
print("Recall:", recall)
print("Accuracy: ", accuracy)
```

```
Precision: 0.8311390687883226
Recall: 0.3230624234256639
Accuracy:  0.7922411264300382
```

In [ ]:
```
cm_display = ConfusionMatrixDisplay.from_predictions(y_train,y_pred,values_
```



In [ ]:
```
SGDestimator_2 = SGDClassifier(random_state=0)
```

In [ ]:
```
SGDestimator_2.fit(x_train, y_train)
```

Out[60]:
```
SGDClassifier(random_state=0)
```

In a Jupyter environment, please rerun this cell to show the HTML representation or trust the notebook.
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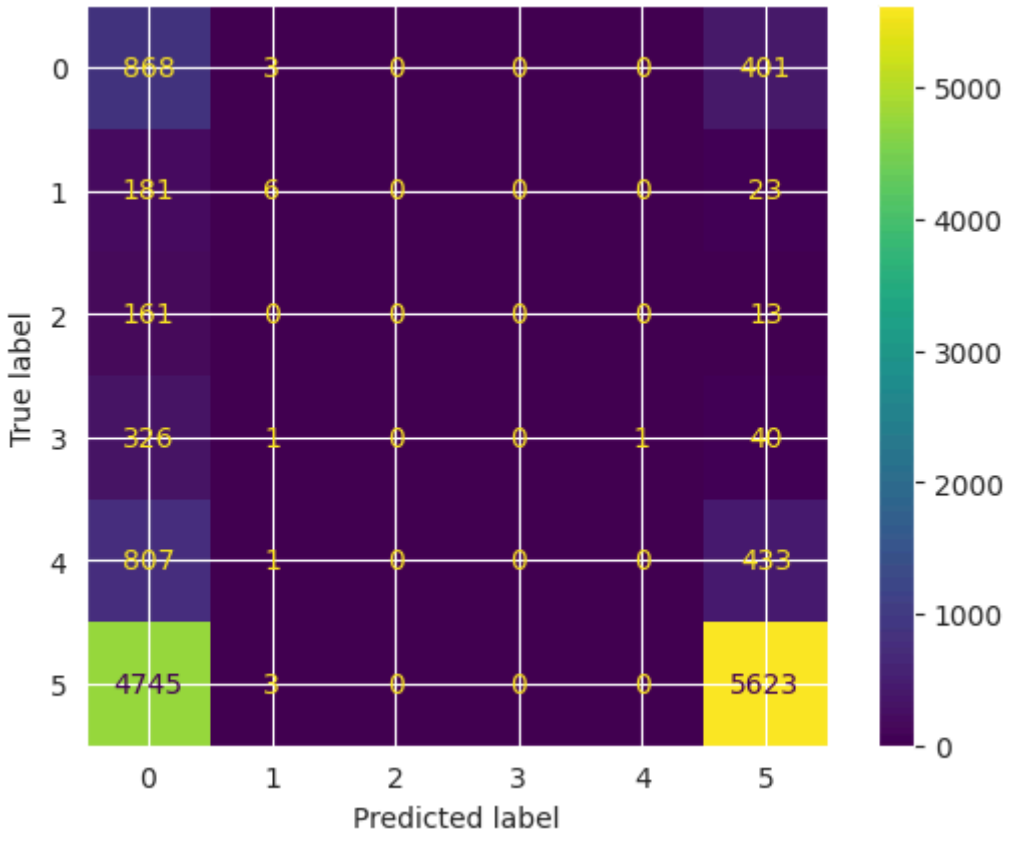
In [ ]:
```
y_pred = SGDestimator_2.predict(x_train)
accuracy = accuracy_score(y_train,y_pred)
precision = precision_score(y_train,y_pred, average = 'macro')
recall = recall_score(y_train,y_pred, average = 'macro')
print("Precision:", precision)
print("Recall:", recall)
print("Accuracy: ", accuracy)
```

```
Precision: 0.23528985068718747
Recall: 0.20885771740832024
Accuracy:  0.4764593722499267

/opt/conda/lib/python3.10/site-packages/sklearn/metrics/_classification.p
y:1344: UndefinedMetricWarning: Precision is ill-defined and being set to
0.0 in labels with no predicted samples. Use `zero_division` parameter to
control this behavior.
  _warn_prf(average, modifier, msg_start, len(result))
```

In [ ]:
```
cm_display = ConfusionMatrixDisplay.from_predictions(y_train,y_pred,values_
```



In [ ]:
```
knn_2=KNeighborsClassifier(n_neighbors=5)
```

In [ ]:
```
knn_2.fit(x_train,y_train)
```

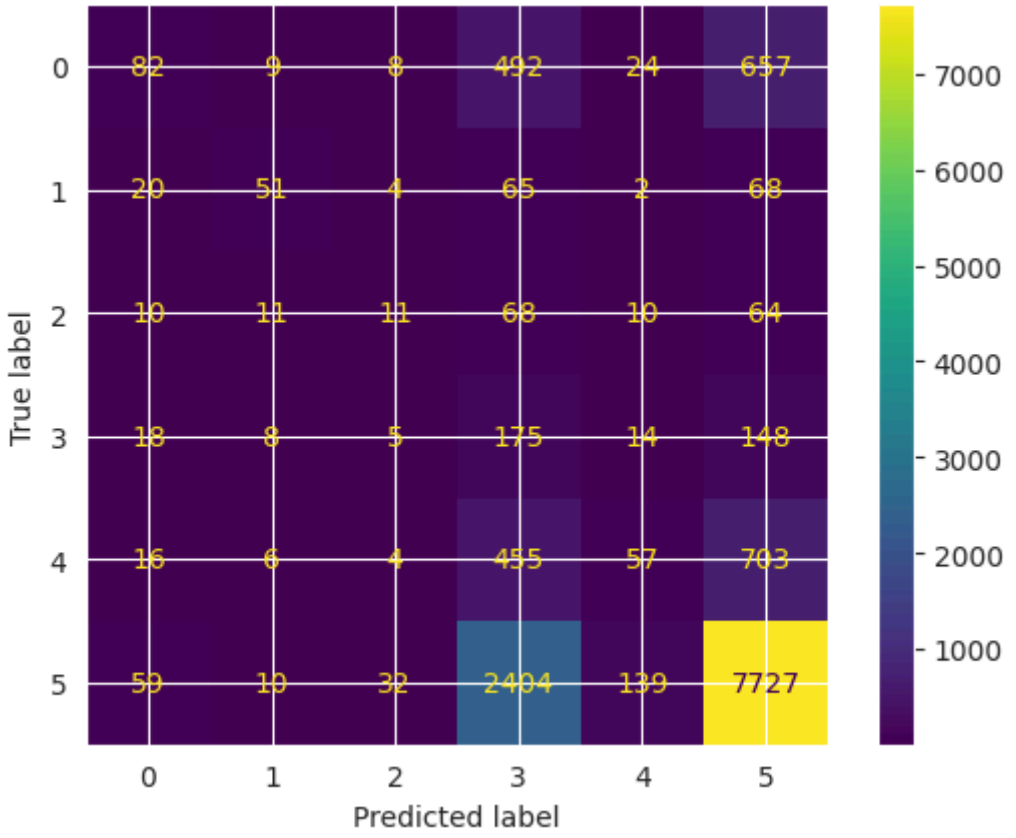
Out[64]:
```
KNeighborsClassifier()
```

In a Jupyter environment, please rerun this cell to show the HTML representation or trust the notebook.
On GitHub, the HTML representation is unable to render, please try loading this page with nbviewer.org.

In [ ]:
```
y_pred=knn_2.predict(x_train)
accuracy = accuracy_score(y_train,y_pred)
precision = precision_score(y_train,y_pred, average = 'macro')
recall = recall_score(y_train,y_pred, average = 'macro')
print("Precision:", precision)
print("Recall:", recall)
print("Accuracy: ", accuracy)
```

```
Precision: 0.36886149337983315
Recall: 0.2728455762531809
Accuracy:  0.5942358462892344
```

In [ ]:
```
cm_display = ConfusionMatrixDisplay.from_predictions(y_train,y_pred,values_
```



In [ ]:
```
from sklearn.ensemble import RandomForestClassifier
clf_RFC_pipeline = Pipeline(
    steps=[ ("rfclassifier", RandomForestClassifier())]
)
param_grid={'rfclassifier__max_features': ['sqrt', 'log2'],
            'rfclassifier__max_depth' : [4,5,6,7,8,9,10],
            'rfclassifier__criterion' :['gini', 'entropy']
                      }
gd=GridSearchCV(clf_RFC_pipeline,param_grid=param_grid,cv=5)
```

In [ ]:
```
gd.fit(x_train, y_train)
```

Out[68]:
```
GridSearchCV(cv=5,
             estimator=Pipeline(steps=[('rfclassifier',
                                        RandomForestClassifier())]),
             param_grid={'rfclassifier__criterion': ['gini', 'entropy'],
                         'rfclassifier__max_depth': [4, 5, 6, 7, 8, 9, 1
0],
                         'rfclassifier__max_features': ['sqrt', 'log2']})
```

In a Jupyter environment, please rerun this cell to show the HTML representation or trust the notebook.
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In [ ]:
```
print("model score:", gd.score(x_train, y_train))
y_pred=gd.predict(x_train)
precision = precision_score(y_train,y_pred, average = 'macro')
recall = recall_score(y_train,y_pred, average = 'macro')
print("Precision:", precision)
print("Recall:", recall)
```

```
model score: 0.7668671164564388
Precision: 0.8308849232849381
Recall: 0.21438997888474473
```

Using Balanced Data

In [ ]:
```
undersampler = RandomUnderSampler(random_state=42)
X_sampled_train, y_sampled_train = undersampler.fit_resample(X_train, y_tra
```

K-Nearest Neighbours

In [ ]:
```
knn = KNeighborsClassifier(n_neighbors=5)
```

In [ ]:
```
knn.fit(X_sampled_train, y_sampled_train)
y_pred = knn.predict(X_train)
accuracy = accuracy_score(y_train,y_pred)
precision = precision_score(y_train,y_pred, average = 'macro')
recall = recall_score(y_train,y_pred, average = 'macro')
print("Precision:", precision)
print("Recall:", recall)
print("Accuracy:", accuracy)
```

```
Precision: 0.21114377370778734
Recall: 0.26177112010187287
Accuracy: 0.10560281607509533
```

In [ ]:
```
dtc=DecisionTreeClassifier(random_state=0)
dtc.fit(X_sampled_train,y_sampled_train)
```

Out[73]:
```
DecisionTreeClassifier(random_state=0)
```
In a Jupyter environment, please rerun this cell to show the HTML representation or trust the notebook.
On GitHub, the HTML representation is unable to render, please try loading this page with nbviewer.org.

In [ ]:
```
y_pred=dtc.predict(X_train)
precision = precision_score(y_train,y_pred, average = 'macro')
recall = recall_score(y_train,y_pred, average = 'macro')
accuracy = accuracy_score(y_train, y_pred)
print("Precision:", precision)
print("Recall:", recall)
print("Accuracy:", accuracy)
```

```
Precision: 0.2325672575775228
Recall: 0.30514176923463765
Accuracy: 0.6041361102962746
```

SGD Classifier

In [ ]:
```
SGDestimator = SGDClassifier(random_state=0)
pipe_sgd = Pipeline([
    ('minmaxscaler', MinMaxScaler()),
    ('SGD', SGDestimator)
])
pipe_sgd.fit(X_sampled_train,y_sampled_train)
```

Out[75]:
```
Pipeline(steps=[('minmaxscaler', MinMaxScaler()),
                ('SGD', SGDClassifier(random_state=0))])
```
In a Jupyter environment, please rerun this cell to show the HTML representation or trust the notebook.
On GitHub, the HTML representation is unable to render, please try loading this page with nbviewer.org.

In [ ]:
```
y_pred = pipe_sgd.predict(X_train)
accuracy = accuracy_score(y_train,y_pred)
precision = precision_score(y_train,y_pred, average = 'macro')
recall = recall_score(y_train,y_pred, average = 'macro')
print("Precision:", precision)
print("Recall:", recall)
print("Accuracy: ", accuracy)
```

```
Precision: 0.2051610361701801
Recall: 0.21992558672700116
Accuracy:  0.1001760046934585

/opt/conda/lib/python3.10/site-packages/sklearn/metrics/_classification.p
y:1344: UndefinedMetricWarning: Precision is ill-defined and being set to
0.0 in labels with no predicted samples. Use `zero_division` parameter to
control this behavior.
  _warn_prf(average, modifier, msg_start, len(result))
```

Clearly, balancing the data is not providing best good results. It is poorer compared to the models which were trained on unbalanced data.

Using Bagging Classifier

In [ ]:
```
from sklearn.feature_extraction.text import CountVectorizer
from sklearn.ensemble import BaggingClassifier
from sklearn.tree import DecisionTreeClassifier
from sklearn.metrics import accuracy_score
```

In [ ]:
```
vectorizer = CountVectorizer()
vectorizer.fit(train['Recipe_Review'])
X = vectorizer.transform(train['Recipe_Review'])
```

In [ ]:
```
additional_features = train[[ 'UserReputation','ReplyCount', 'ThumbsDownCou
X_with_features = np.hstack((X.toarray(), additional_features.values))
X_train, y_train = X_with_features, train['Rating']
```

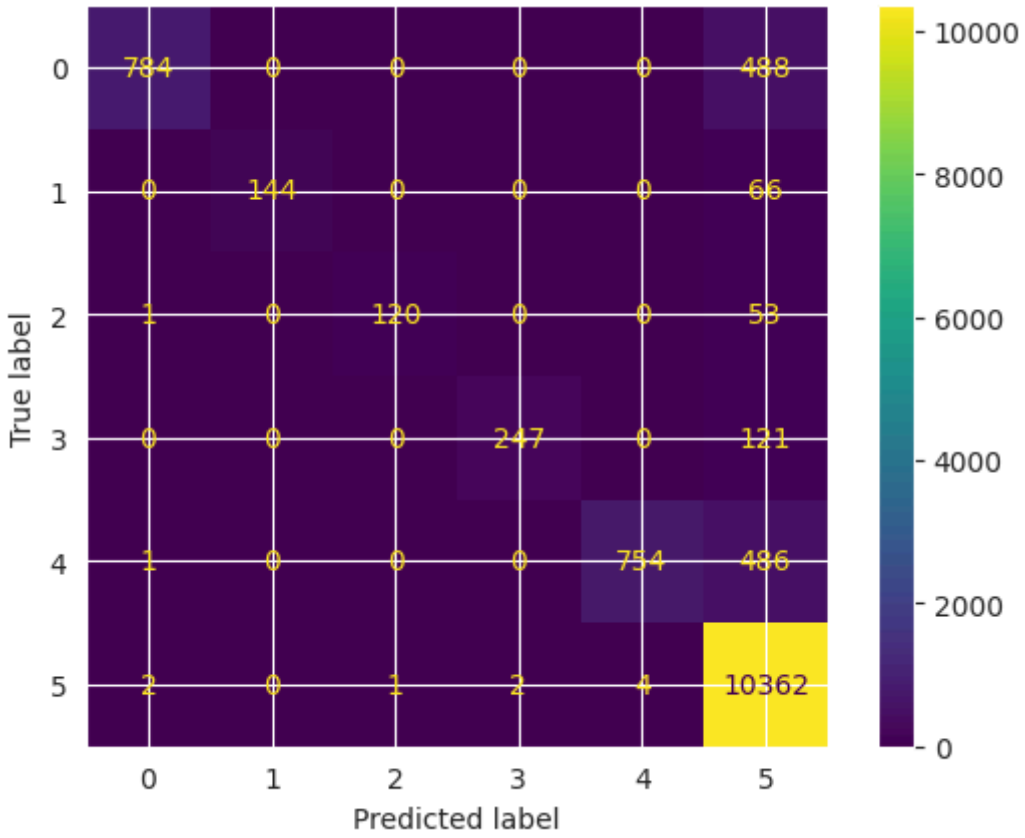
In [ ]:
```
base_classifier = RandomForestClassifier()
bagging_classifier = BaggingClassifier(base_estimator=base_classifier, n_es
bagging_classifier.fit(X_train, y_train)
predictions = bagging_classifier.predict(X_train)
accuracy = accuracy_score(y_train, predictions)
print("Accuracy:", accuracy)
```

```
/opt/conda/lib/python3.10/site-packages/sklearn/ensemble/_base.py:166: Fut
ureWarning: `base_estimator` was renamed to `estimator` in version 1.2 and
will be removed in 1.4.
  warnings.warn(

Accuracy: 0.910164271047228
```

The accuracy is 0.910

In [ ]:
```
cm_display = ConfusionMatrixDisplay.from_predictions(y_train,predictions,va
```



Random Forest Classifier

In [ ]:
```
RFC_clf = Pipeline([("classifier", RandomForestClassifier())])
X_train = train[[ 'UserReputation','ReplyCount', 'ThumbsDownCount','BestSco
RFC_clf.fit(X_train, y_train)
print("model score/accuracy:" , RFC_clf.score(X_train, y_train))
y_pred = RFC_clf.predict(X_train)
precision = precision_score(y_train,y_pred, average = 'macro')
recall = recall_score(y_train,y_pred, average = 'macro')
print("Precision:", precision)
print("Recall:", recall)
```

```
model score/accuracy: 0.78813435024934
Precision: 0.848231550427395
Recall: 0.30023600164114983
```

Using Count Vectorization and Random Forest

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

from sklearn.model_selection import train_test_split, cross_validate, Rando
from sklearn.datasets import make_classification, load_iris
from sklearn.preprocessing import MinMaxScaler, StandardScaler
from sklearn.linear_model import SGDClassifier, RidgeClassifier, LogisticRe
from sklearn.tree import DecisionTreeClassifier
from sklearn.metrics import log_loss, precision_score, recall_score, classi
from sklearn.pipeline import Pipeline
from sklearn.compose import ColumnTransformer
from sklearn.feature_extraction.text import CountVectorizer
from sklearn.ensemble import RandomForestClassifier
from sklearn.model_selection import train_test_split

from imblearn.over_sampling import RandomOverSampler
from imblearn.under_sampling import RandomUnderSampler

from collections import Counter
```

In [ ]:
```
vectorizer = CountVectorizer()
vectorizer.fit(train['Recipe_Review'])
X = vectorizer.transform(train['Recipe_Review'])
```

In [ ]:
```
print("Shape of X:", X.shape)
print("Sample of X:")
print(X[:10])
print("Sample of X (dense format):")
print(X[:10].toarray())
```

```
Shape of X: (13636, 10481)
Sample of X:
  (0, 459)      1
  (0, 651)      3
  (0, 792)      2
  (0, 2368)     1
  (0, 2494)     1
  (0, 2706)     1
  (0, 2835)     1
  (0, 3727)     1
  (0, 4134)     1
  (0, 4237)     1
  (0, 4413)     3
  (0, 5102)     1
  (0, 5593)     2
  (0, 6003)     2
  (0, 6231)     1
  (0, 6237)     1
  (0, 6298)     1
  (0, 6872)     1
  (0, 7481)     1
  (0, 7760)     1
  (0, 8478)     1
  (0, 8567)     1
  (0, 8779)     1
  (0, 8818)     1
  (0, 9279)     1
  :     :
  (7, 10029)    1
  (7, 10184)    1
  (7, 10275)    1
  (8, 515)      1
  (8, 651)      1
  (8, 1020)     1
  (8, 2679)     1
  (8, 2893)     1
  (8, 3391)     1
  (8, 3809)     1
  (8, 4237)     1
  (8, 5629)     1
  (8, 9147)     1
  (8, 10184)    1
  (9, 644)      1
  (9, 3653)     1
  (9, 4808)     1
  (9, 4939)     2
  (9, 4950)     1
  (9, 5622)     1
  (9, 8558)     1
  (9, 9336)     1
  (9, 9432)     1
  (9, 9920)     2
  (9, 10246)    1
Sample of X (dense format):
[[0 0 0 ... 0 0 0]
 [0 0 0 ... 0 0 0]
 [0 0 0 ... 0 0 0]
 ...
 [0 0 0 ... 0 0 0]
```

```
[0 0 0 ... 0 0 0]
[0 0 0 ... 0 0 0]]
```

Using Un-Balanced Data

In [ ]:
```
additional_features = train[[ 'UserReputation','ReplyCount', 'ThumbsDownCou
X_with_features = np.hstack((X.toarray(), additional_features.values))
X_train, y_train = X_with_features, train['Rating']

clf = RandomForestClassifier(random_state=42)
clf.fit(X_train, y_train)

y_pred = clf.predict(X_train)

accuracy = accuracy_score(y_train, y_pred)
print("Accuracy:", accuracy)
```

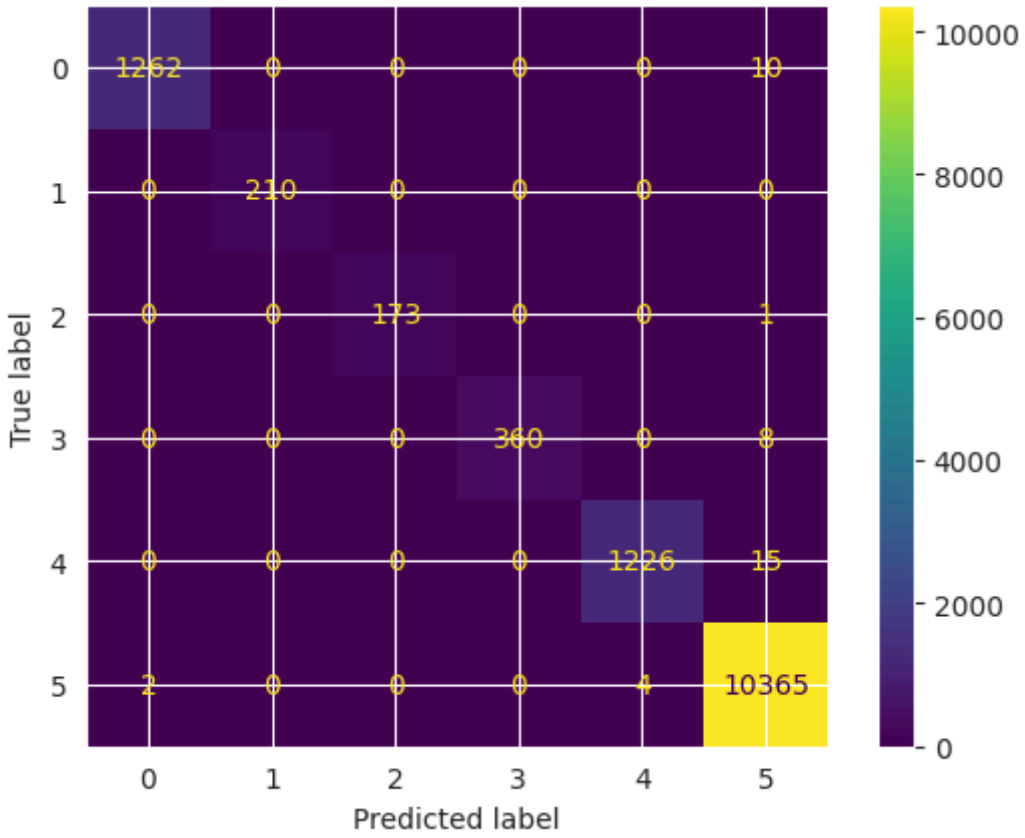
```
Accuracy: 0.9970665884423585
```

In [ ]:
```
precision = precision_score(y_train,y_pred, average = 'macro')
recall = recall_score(y_train,y_pred, average = 'macro')
print("Precision:", precision)
print("Recall:", recall)
```

```
Precision: 0.9986493573083485
Recall: 0.991997757502283
```

In [ ]:
```
X_sampled_train, y_sampled_train = undersampler.fit_resample(X_train, y_tra
```

In [ ]:
```
cm_display = ConfusionMatrixDisplay.from_predictions(y_train,y_pred,values_
```



Using Balanced Data

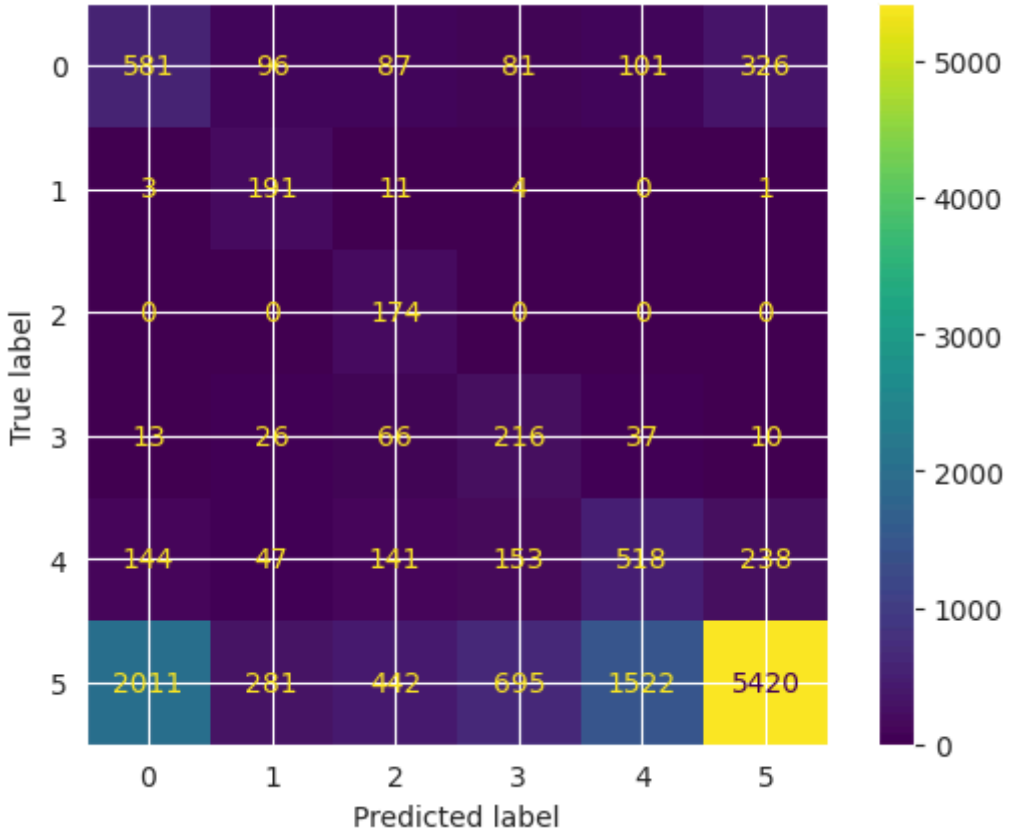
In [ ]:
```
clf2 = RandomForestClassifier(random_state=42)
clf2.fit(X_sampled_train, y_sampled_train)

y_pred = clf2.predict(X_train)

accuracy = accuracy_score(y_train, y_pred)
precision = precision_score(y_train,y_pred, average = 'macro')
recall = recall_score(y_train,y_pred, average = 'macro')
print("Precision:", precision)
print("Recall:", recall)
print("Accuracy:", accuracy)
```

```
Precision: 0.3379875592729828
Recall: 0.6488762971709187
Accuracy: 0.5206805514813728
```

In [ ]:
```
cm_display = ConfusionMatrixDisplay.from_predictions(y_train,y_pred,values_
```



Using Unbalanced dataset and Countvectorized cum Random Forest Classifier is found to be more accurate

Testing and Submission

Using the model - Random Forest Classifier using Unbiased dataset and with 5 features: UserReputation, ReplyCount, ThumbsDownCount, BestScore and CountVectorized Recipe Reviews.

In [ ]:
```
X_test=vectorizer.transform(test['Recipe_Review'])
additional_features = test[['UserReputation','ReplyCount', 'ThumbsDownCount
X_test_with_features = np.hstack((X_test.toarray(), additional_features.val
y_pred = clf.predict(X_test_with_features)
```

In [ ]:
```
submission = pd.DataFrame(columns = ["ID","Rating"])
submission["ID"] = [i for i in range(1,4547)]
submission["Rating"] = [i for i in y_pred]
submission.to_csv("submission.csv",index=False)
```