CapStone B Final WB - Thad

June 6, 2021

0.1 ## Table of Contents

0.1.1 TASKS

1. predicting stage (SVM, Decision Trees, novel model)
2. determining if there is a correlation with the disease and any other characstic (SVM, Decision Trees, novel model)
3. determining whether or not there is any genetic ties (neural networks, novel model) (add this in)
4. determine what type of disease is?
5. Target the same dataset as the related works.

Walter

- ~~Neural Networks (parameter tuning + model + stats + feature reduction) EOW5~~
- statistics/metrics (p-value, t-value, AUC) EOW7

Kris

- ~~Decision Trees (parameter tuning + model + stats + feature reduction) EOW5~~
- discussion EOW7
- conclusion EOW7
- updates to PPT EOW8 (Jamie will help)

Thad

- ~~SVM (parameter tuning + model + stats + feature reduction) EOW5~~
- rewrite of other papers EOW7
- how this affects the community EOW7
- tie back to other papers EOW7

Jamie

- intro EOW4
- ~~explaining data points EOW4~~
- ~~data manipulation (all data related tasks) (reduction method) (reach if needed) EOW3~~
- ~~enhance pre-processing (feature correlations)~~
- ~~visualizations of ML Models (TBD if we have time) very novel EOW~~

- application build EOW8
- create new ML model and visualizations EOW5
- ~~just see if we can find antoher dataset: found a separate one, too late for change~~
- ~~create a repo EOW3~~
- ~~one (minimum) paper for baseline (Walter/Thad will find 2-3 each) EOD Thursday~~
- ~~feature comparison for Logit & Chi2~~
- ~~change SMOTE (X_train) & Scaling (X_train & X_Test) after split~~

0.2   ## Primary Dataset

Cross, Simon S. "Dataset of Observed Features on Endoscopic Colorectal Biopsies from Normal Subjects and Patients with Chronic Inflammatory Bowel Disease (Crohn's disease and Ulcerative Colitis)." Department of Pathology, University of Sheffield Medical School (1999): 1-15

Genetics Summary Statistics Dataset: https://www.ibdgenetics.org/downloads.html

East Asian DataSet: https://academic.oup.com/ecco-jcc/article/12/6/730/4951970#116848212

0.3   ### Libraries

```python
# general libraries
import pandas as pd
import numpy as np
import itertools
import scipy.stats as stats
import random
import statistics
import datetime
import re
import json
```

```python
# data cleaning libraries
from collections import Counter
#!pip install smote-variants
import smote_variants
from imblearn.over_sampling import SMOTE
from sklearn.feature_selection import SelectKBest, mutual_info_classif, chi2
from sklearn.preprocessing import LabelEncoder, OrdinalEncoder, MinMaxScaler,
 ↪MaxAbsScaler
```

```python
# ML libraries
from sklearn.ensemble import RandomForestClassifier, AdaBoostClassifier
from sklearn.linear_model import LogisticRegression
from sklearn.metrics import accuracy_score, f1_score, precision_score,
 ↪recall_score, roc_auc_score, confusion_matrix, classification_report
from sklearn.model_selection import KFold, train_test_split
from sklearn.naive_bayes import GaussianNB
from sklearn.neighbors import KNeighborsClassifier
from sklearn.neural_network import MLPClassifier
```

```python
from sklearn.svm import SVC
from sklearn.tree import DecisionTreeClassifier
#import xgboost as xgb
```

```python
[4]: # Visualization libraries
from matplotlib import pyplot
import matplotlib.pyplot as plt
import seaborn as sns
import plotly.express as px
```

```python
[5]: now = datetime.datetime.now()
print ("Current date and time : ")
print (now.strftime("%Y-%m-%d %H:%M:%S"))
```

```
Current date and time :
2021-06-04 16:47:53
```

0.4 ## Data

```python
[6]: # toggle to hide code
from IPython.display import HTML

HTML('''<script>
code_show=true;
function code_toggle() {
 if (code_show){
 $('div.input').hide();
 } else {
 $('div.input').show();
 }
 code_show = !code_show
}
$( document ).ready(code_toggle);
</script>
<form action="javascript:code_toggle()"><input type="submit" value="Click here␣
 ↪to toggle on/off the raw code."></form>''')
```

```
[6]: <IPython.core.display.HTML object>
```

```python
[7]: # center all images
from plotly.offline import download_plotlyjs, init_notebook_mode, plot, iplot
init_notebook_mode(connected=True)
HTML("""
<style>
.output_png {
    display: table-cell;
    text-align: center;
    vertical-align: middle;
```

```
}
</style>
""")
```

0.4.1 Pull in Data

ENDSC Data

```python
[8]: # all cases
     all_cases = pd.read_excel("../Data/dataset/ENDOSC_1.xls", sheet_name="All␣
      ↪cases")
     # cleaned cases
     cleaned_cases = pd.read_excel("../Data/dataset/ENDOSC_1_2_2.xls",␣
      ↪sheet_name="All IBD&normal")
     cleaned_cases_og = cleaned_cases
     cleaned_cases.head()
```

```
[8]:    Year  Lab No        Age  Sex  Active inflammation?  Mucosal surface  \
     0    92    5213  20.536986    0                     0                0
     1    90     805  55.575342    1                     1                1
     2    90    5957  58.698630    0                     1                1
     3    92    9207  65.934247    0                     0                1
     4    95   14469  23.391781    0                     0                0

        Crypt architecture  Crypt profiles  Increased lamina propria cellularity?  \
     0                   0               7                                      0
     1                   3               4                                      1
     2                   1               7                                      1
     3                   1               7                                      0
     4                   0               7                                      0

        Mild & superficial increase in lamina propria cellularity?  …  \
     0                                                  0           …
     1                                                  0           …
     2                                                  0           …
     3                                                  0           …
     4                                                  0           …

        Mucin depletion  Intraepithelial lymphocytes  Subepithelial collagen  \
     0                0                            0                       0
     1                1                            0                       0
     2                0                            0                       0
     3                0                            0                       0
     4                0                            0                       0
```

```
     Lamina propria granulomas  Submucosal granulomas  Basal histiocytic cells  \
0                            0                      0                        0
1                            0                      0                        0
2                            0                      0                        0
3                            0                      0                        0
4                            0                      0                        0


     Confirmed diagnosis  Method of confirmation  \
0                     UC               Endoscopy
1                     UC               Endoscopy
2                     UC               Endoscopy
3                     UC               Endoscopy
4                 Crohns               Endoscopy


         Initial pathologists diagnosis  \
0                                 Normal
1                                IBD ?UC
2              IBD indeterminate, active
3    Non-specific inflammation, chronic
4    Non-specific inflammation, chronic


                     Observing pathologists diagnosis
0                                               Normal
1    Chronic idiopathic IBD - highly suggestive of …
2                      Inflammation - unclassified
3           Chronic idiopathic IBD - indeterminate
4                                               Normal


[5 rows x 29 columns]
```

0.4.2 Data Definitions

```
[9]: IBD_def = pd.read_excel("../Data/Column_Definitions.xlsx", sheet_name="IBD")
```

```
[10]: IBD_def[["Data Column", "Definition", "In depth understanding"]]
```

```
[10]:                                         Data Column  \
     0                                              Year
     1                                            Lab No
     2                                               Age
     3                                               Sex
     4                               Active inflammation?
     5                                   Mucosal surface
     6                                 Crypt architecture
     7                                     Crypt profiles
     8               Increased lamina propria cellularity?
     9    Mild & superficial increase in lamina propria …
```

10	Increased lymphoid aggregates in lamina propria?
11	Patchy lamina propria cellularity?
12	Marked & transmucosal increase in lamina propr…
13	Cryptitis extent
14	Cryptitis polymorphs
15	Crypt abscesses extent
16	Crypt abscesses polymorphs
17	Lamina propria polymorphs
18	Epithelial changes
19	Mucin depletion
20	Intraepithelial lymphocytes
21	Subepithelial collagen
22	Lamina propria granulomas
23	Submucosal granulomas
24	Basal histiocytic cells
25	Confirmed diagnosis
26	Method of confirmation
27	Initial pathologists diagnosis
28	Observing pathologists diagnosis

	Definition \
0	Year the biopsy was taken
1	unique laboratory accession number for specifi…
2	Age of patient
3	Sex of patient
4	Boolean
5	is there mucous on the stomach wall?
6	is low stomach present? is there
7	NaN
8	Its layers increased inflammation by inflammat…
9	NaN
10	NaN
11	Blocks Worked
12	NaN
13	Cell inside it in the wall of the stomach
14	The difference in shape
15	how severe is the ascess?
16	The form of an abscess
17	Outputs has
18	The last layer is a layer in the wall of the s…
19	The layer of mucus secreted by the stomach
20	Lymphocytes occur with inflammation
21	is needed if it increased, it is not normal
22	Types of cells that are not present in Al-Tabi…
23	NaN
24	NaN
25	the confirmed and final diagnosis

```
26                        how the diagnosis was come about
27          intially, what the diagnosis was thought to be
28                                                     NaN

                                          In depth understanding
0                                                       NaN
1                                                       NaN
2                                                       NaN
3                                                       NaN
4                                                       NaN
5   flat, irregular, or villous projections\n\nThi…
6   prolific by crypt distortion ( branching, Basa…
7                                  no definition provided
8   a thin layer of connective tissue that forms p…
9                        Top layer only of mucus only?
10  A collection of B cells, T cells, and supporti…
11                                missingin some areas?
12    Increase in mucus? - usually a sign of early UC
13  inflammation of the intestinal crypts. The cry…
14                              changes in gland shapes
15            Typically only present in chrons disease
16                  what does the abscess look like?
17                    mutation in the lamina propria
18          changes in the first layer of the wlal?
19                      was the mucin layer depleted?
20  lymphocytes (white blood cells) found in the e…
21  below the outter layer of the outside wall of …
22  small lumps of immune cells that form in your …
23                                                     "
24  part of the immune system: vertebrate cell tha…
25                                                     NaN
26                                                     NaN
27                                                     NaN
28                                                     NaN
```

```python
[11]: cleaned_cases = cleaned_cases.drop(['Year', 'Lab No', 'Method of confirmation',␣
       ↪'Initial pathologists diagnosis', 'Observing pathologists diagnosis'],axis=1)
```

0.4.3 Data Manipulation

IBD Stages: Since the stages of UC is determined by the severity of symptoms, the classes are manually added based on symptoms.

Use decision trees to determine

Perhaps find a doctor who can provide some expertise into the stages? - check if this is possible (we would need multiple people to have statistically significance)

Data Transformation Since the data is already dummy coded, the transformation of it will be

required for understanding the outcome after modeling.

```
[12]: transform_dict = [{"data":["Mucin depletion", "Crypt architecture"],
                          "definitions":[{
                              0: "Normal",
                              1: "Mild",
                              2: "Moderate",
                              3: "Severe"}]},
                        {"data": ["Cryptitis extent", "Crypt abscesses extent"],
                         "definitions": [{
                              0: "None",
                              1: "Little",
                              2: "Moderate",
                              3: "Marked"}]},
                        {"data": ["Lamina propria polymorphs"],
                         "definitions": [{
                              0: "Absent",
                              1: "Focal",
                              2: "Diffuse"}]},
                        {"data": ["Cryptitis polymorphs", "Crypt abscesses␣
      ↪polymorphs"],
                         "definitions": [{
                              0: "None",
                              1: "Few",
                              2: "Several",
                              3: "Many"}]},
                        {"data": ["Epithelial changes"],
                         "definitions": [{
                              0: "Normal",
                              1: "Flattening ",
                              2:  "Degeneration",
                              3: "Erosion"}]},
                        {"data": ["Mucosal surface"],
                         "definitions": [{
                              0: "Flat",
                              1: "Irregular",
                              2: "Villous projections"}]}]
```

Set Seed for consistency

```
[13]: random.seed(123)
```

Crypt architecture measures the severity of the deformation of the colon, which will also signify at what severity stage the cases are at. This is the column that will be used for determining cases severities.

```
[14]: cleaned_cases['Crypt architecture'].unique()
```

```
crypt_dict = {0:"normal",
              1:"mild",
              2:"moderate",
              3:"severe"}

cleaned_cases['Severity of Crypt Arch'] = [crypt_dict[x] for x in␣
 ↪cleaned_cases['Crypt architecture']]

'Severity of Crypt Arch' + 'diagnoses'
```

[14]: 'Severity of Crypt Archdiagnoses'

convert data to object rather than int since these are categorical data.

[15]:
```
def change_to_object(df, data_col):
    df[data_col] = df[data_col].astype(object)

run = [change_to_object(cleaned_cases, c) for c in cleaned_cases.columns[3:]]
cleaned_cases['Crypt profiles'] = cleaned_cases['Crypt profiles'].astype('int')
cleaned_cases.dtypes
```

[15]:
```
Age                                                          float64
Sex                                                            int64
Active inflammation?                                           int64
Mucosal surface                                               object
Crypt architecture                                            object
Crypt profiles                                                 int32
Increased lamina propria cellularity?                         object
Mild & superficial increase in lamina propria cellularity?    object
Increased lymphoid aggregates in lamina propria?              object
Patchy lamina propria cellularity?                            object
Marked & transmucosal increase in lamina propria cellularity  object
Cryptitis extent                                              object
Cryptitis polymorphs                                          object
Crypt abscesses extent                                        object
Crypt abscesses polymorphs                                    object
Lamina propria polymorphs                                     object
Epithelial changes                                            object
Mucin depletion                                               object
Intraepithelial lymphocytes                                   object
Subepithelial collagen                                        object
Lamina propria granulomas                                     object
Submucosal granulomas                                         object
Basal histiocytic cells                                       object
Confirmed diagnosis                                           object
Severity of Crypt Arch                                        object
dtype: object
```

0.4.4 Data Cleaning

Clean Diagnosis: Strip data and Upper Case and ensure spelling of all are correct to prevent any separation of classes which are unnecessary.

```
[16]: print(cleaned_cases['Confirmed diagnosis'].unique())
      cleaned_cases['Confirmed diagnosis'] = [c.strip().upper() for c in␣
      ↪cleaned_cases['Confirmed diagnosis']]
      print( cleaned_cases['Confirmed diagnosis'].unique())
```

```
['UC' 'Crohns' 'Normal' 'Uc' 'Normal ' 'Crohns ']
['UC' 'CROHNS' 'NORMAL']
```

```
[17]: # cleaned_cases.columns
      # cleaned_cases["Method of confirmation"] = [x if x != "Endosocpy" else␣
      ↪"Endoscopy" for x in cleaned_cases["Method of confirmation"]]
      # cleaned_cases["Method of confirmation"].unique()
```

```
[18]: # cleaned_cases['Observing pathologists diagnosis'].unique()
```

```
[19]: # cleaned_cases['Initial pathologists diagnosis'].unique()
      # cleaned_cases['Initial pathologists diagnosis'] = [d if d != "IBD ?Crohn's"␣
      ↪else "IBD ?Crohns" for d in cleaned_cases['Initial pathologists diagnosis']]
      # cleaned_cases['Initial pathologists diagnosis'] = [d if d not in␣
      ↪["Non-specific inflammation,chronic", "Non-specific inflammaton, chronic"]␣
      ↪else "Non-specific inflammation, chronic" for d in cleaned_cases['Initial␣
      ↪pathologists diagnosis']]
      # cleaned_cases['Initial pathologists diagnosis'].sort_values().unique()
```

```
[20]: # cleaned_cases['Year'].sort_values().unique()
```

Missing/Duplicate Data Checks

There is no duplicates data

```
[21]: print(f'IBD duplicates: {cleaned_cases.duplicated().any()}')
```

```
IBD duplicates: True
```

There are no missing data values

```
[22]: print(f'IBD missing: {cleaned_cases.isnull().values.any()}')
```

```
IBD missing: False
```

0.4.5 Train Test Split

Cross and coworkers randomly shuffled the dataset and split the first 540 cases as the train set and the lasts 269 cases as the test set.

```
[23]: X = cleaned_cases.drop('Confirmed diagnosis',axis=1)
      y = cleaned_cases['Confirmed diagnosis']
      X_train,X_test,y_train,y_test = train_test_split(X,y,test_size=269,␣
        ↪random_state=123)
      print(f'Train set has {X_train.shape[0]} rows and test set has {X_test.
        ↪shape[0]} rows')
```

Train set has 540 rows and test set has 269 rows

Class Imbalance

The minority class of heatlhy was oversampled so that there were equal diseased as unhealthy classes. This is also reflected in graphs below.

```
[24]: Counter(y_train)
```

```
[24]: Counter({'UC': 305, 'CROHNS': 117, 'NORMAL': 118})
```

```
[25]: # Counter(cleaned_cases['Initial pathologists diagnosis'])
```

EDA

0.5 #### Jamie

The age is skewed towards the younger generations, and there are outliers of age under 15 and above 85. Since there is no proof that these age groups are errors opposed to only having a low count, they will be left in the data.

```
[26]: plt.figure(figsize=(10,10))
      sns.distplot(cleaned_cases.Age.values, bins=50, kde=True)
      plt.xlabel('Age', fontsize=12)
      plt.show()
```

C:\Users\thads\Anaconda3\lib\site-packages\seaborn\distributions.py:2551:
FutureWarning:

`distplot` is a deprecated function and will be removed in a future version.
Please adapt your code to use either `displot` (a figure-level function with
similar flexibility) or `histplot` (an axes-level function for histograms).
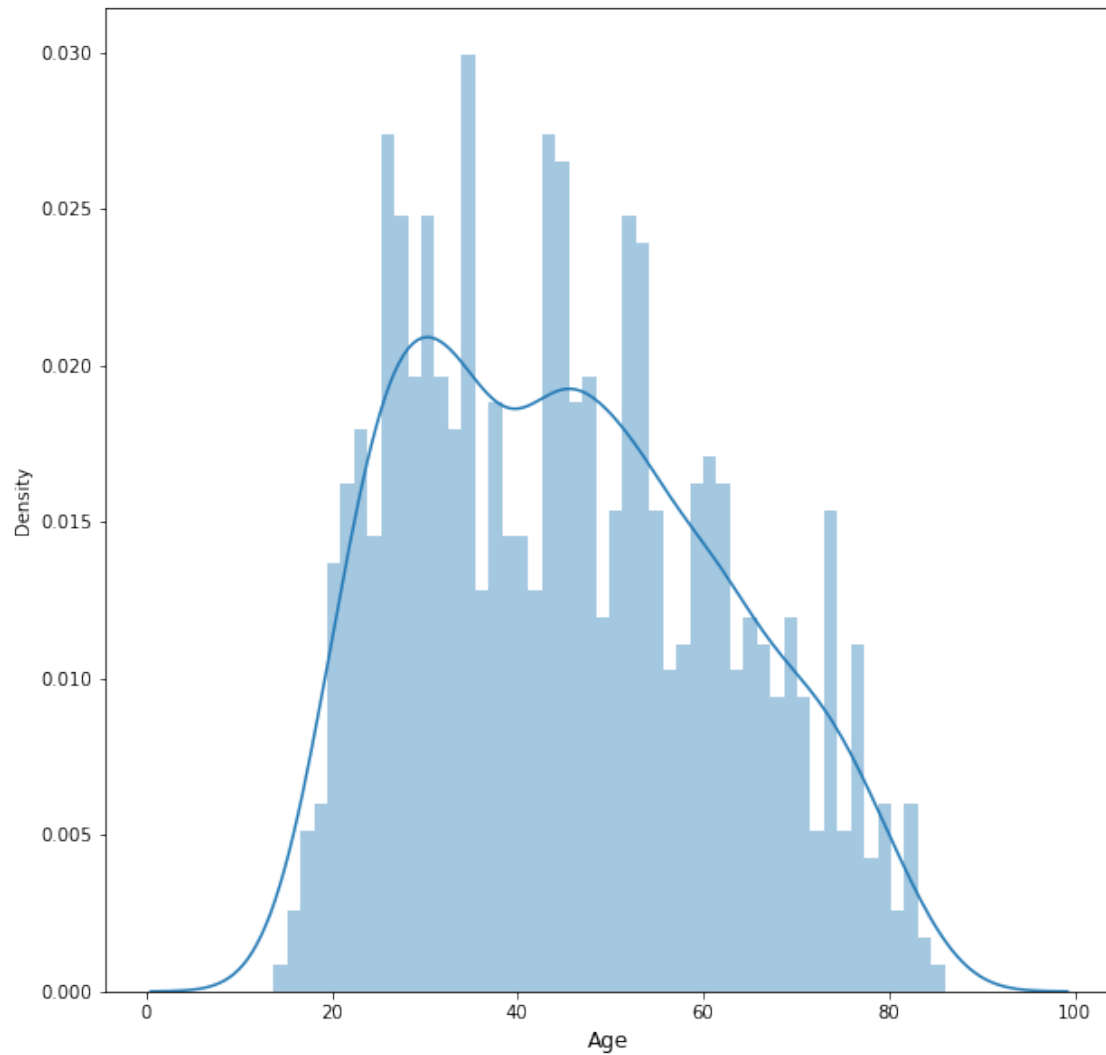
The data below shows that majority of the cases are from years 90-92 and 95-96. The other years have minimal contribution for years prior to year 90.

```
[27]:  # plt.figure(figsize=(10,10))
       # sns.distplot(cleaned_cases.Year.values, bins=50, kde=True)
       # plt.xlabel('Year', fontsize=12)
       # plt.show()
```

While the data is a mixture of both histology and endoscopy, but majority of the confirmation methods are endoscopy.

```
[28]:  fig = px.histogram(cleaned_cases, x="Age", color='Sex')
       fig.show()
```

Distribution of the dataset, where majority of the classes are UC and the remaining are split to normal and UC roughly evenly.

```
[30]: cd_gb = cleaned_cases.groupby("Confirmed diagnosis").count().reset_index()
      fig = px.bar(cd_gb, x='Confirmed diagnosis', y='Sex')
      fig.show()
      # cd_gb
```

```
[31]: fig = px.histogram(cleaned_cases, x="Age", color='Confirmed diagnosis')
      fig.show()
      plt.figure(figsize=(10,10))
```

[31]: <Figure size 720x720 with 0 Axes>

      <Figure size 720x720 with 0 Axes>

0.5.1 correlations

The correlation matrix is show below, which is no the same method which is used for continuous variable, but rather categorical variables.

```
[32]: corr_matrix = cleaned_cases.apply(lambda x : pd.factorize(x)[0]).
      →corr(method='pearson', min_periods=1)
      corr_matrix.head()
```

```
[32]:                         Age       Sex  Active inflammation?  \
      Age                1.000000 -0.001607             -0.025780
      Sex               -0.001607  1.000000             -0.064066
      Active inflammation? -0.025780 -0.064066              1.000000
      Mucosal surface   -0.009704 -0.122315              0.369577
      Crypt architecture -0.097190 -0.097119              0.494637

                         Mucosal surface  Crypt architecture  Crypt profiles  \
      Age                      -0.009704           -0.097190       -0.015083
      Sex                      -0.122315           -0.097119       -0.056975
      Active inflammation?      0.369577            0.494637        0.210146
      Mucosal surface           1.000000            0.634471        0.426973
      Crypt architecture        0.634471            1.000000        0.386788

                         Increased lamina propria cellularity?  \
      Age                                        -0.086089
      Sex                                        -0.084777
      Active inflammation?                        0.742688
      Mucosal surface                             0.368417
      Crypt architecture                          0.538834

                         Mild & superficial increase in lamina propria cellularity?
      \
      Age                                                        -0.005274
      Sex                                                        -0.014896
      Active inflammation?                                        0.085048
```

13

```
Mucosal surface                                                    -0.045606
Crypt architecture                                                 -0.066168


                          Increased lymphoid aggregates in lamina propria?  \
Age                                                         -0.086634
Sex                                                         -0.035824
Active inflammation?                                        -0.211781
Mucosal surface                                              0.012452
Crypt architecture                                           0.073752


                          Patchy lamina propria cellularity?  …  \
Age                                           0.005402  …
Sex                                          -0.014065  …
Active inflammation?                          0.460964  …
Mucosal surface                              -0.000388  …
Crypt architecture                            0.105566  …


                          Lamina propria polymorphs  Epithelial changes  \
Age                                       -0.005201            0.008588
Sex                                       -0.045439           -0.029285
Active inflammation?                       0.919666            0.574400
Mucosal surface                            0.285799            0.290749
Crypt architecture                         0.397373            0.356279


                          Mucin depletion  Intraepithelial lymphocytes  \
Age                              0.017317                     -0.019805
Sex                             -0.083639                      0.023621
Active inflammation?             0.645345                     -0.013979
Mucosal surface                  0.460885                     -0.009213
Crypt architecture               0.529146                     -0.037197


                          Subepithelial collagen  Lamina propria granulomas  \
Age                                          NaN                  -0.036528
Sex                                          NaN                  -0.005535
Active inflammation?                         NaN                   0.124816
Mucosal surface                              NaN                  -0.025154
Crypt architecture                           NaN                   0.063685


                          Submucosal granulomas  Basal histiocytic cells  \
Age                                  -0.045555                 -0.063514
Sex                                   0.000962                 -0.052319
Active inflammation?                  0.035432                  0.144034
Mucosal surface                      -0.026173                  0.057820
Crypt architecture                    0.000451                  0.144736


                          Confirmed diagnosis  Severity of Crypt Arch
Age                                  0.040530                -0.097190
```

```
Sex                          0.142636              -0.097119
Active inflammation?        -0.422155               0.494637
Mucosal surface             -0.349605               0.634471
Crypt architecture          -0.486360               1.000000
```

```
[5 rows x 25 columns]
```

We see strong correlations between the symptoms. Specifically, there is a strong correlation between active inflammation and lamina propria polymorphs, which is investigated further below.

Many of the correlations are intuitively connected. For example, cryptis polymorphs and extent, since they are both related to the the fact of where there is inflammation in the linings of the stomach to the morphed cells of the glands.

One interesting obervation is the correlation of epithelial changes and the mucin depletions since the epithelial layer concerns the outter layer of the intestine and the mucin depletion primarily concerns with the inner side of the organ.

```
[33]: fig = px.imshow(corr_matrix)
      fig.update_yaxes(visible=False, showticklabels=False)
      fig.update_xaxes(visible=False, showticklabels=False)
      fig.show()
```

Active inflammation and lamina propria polymorphs

Overall, the active inflamation makes sense considering if there is no inflammation, that there in turn would have no polymorphs. Since the inner linings are typically only shows to morph when there is inflammation, this is intuitive in the results.

```
[34]: sns.stripplot(x='Active inflammation?', y='Lamina propria polymorphs',␣
      ↪data=cleaned_cases, jitter=True)
      sns.despine()
```
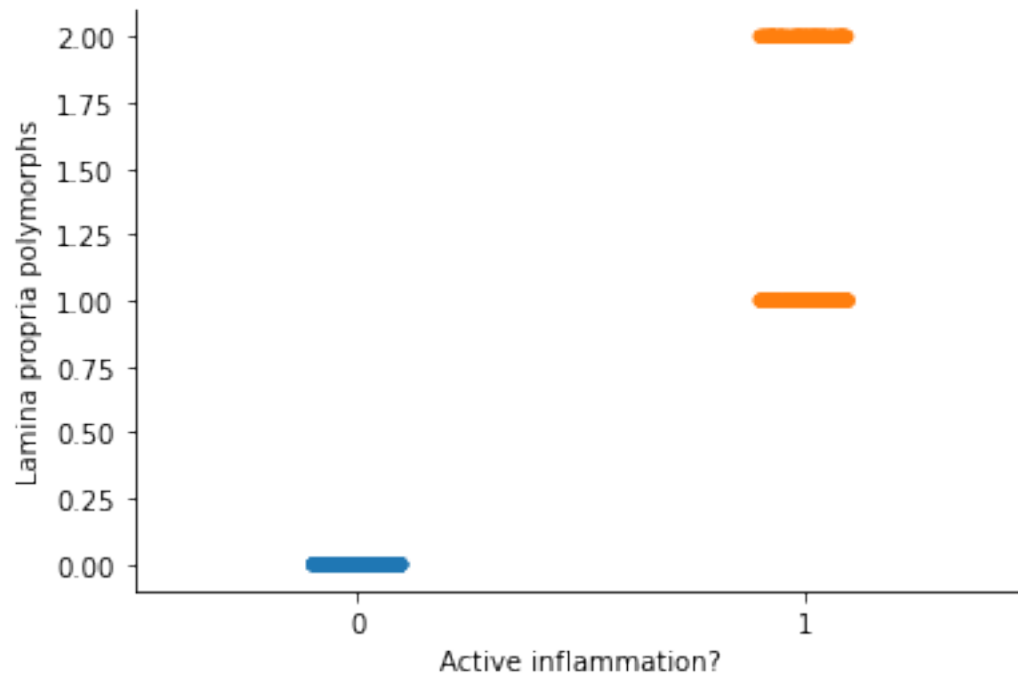
```
[35]: %%time
      sns.pairplot(cleaned_cases)
```

Wall time: 1min 46s

```
[35]: <seaborn.axisgrid.PairGrid at 0x23c23bbaf10>
```
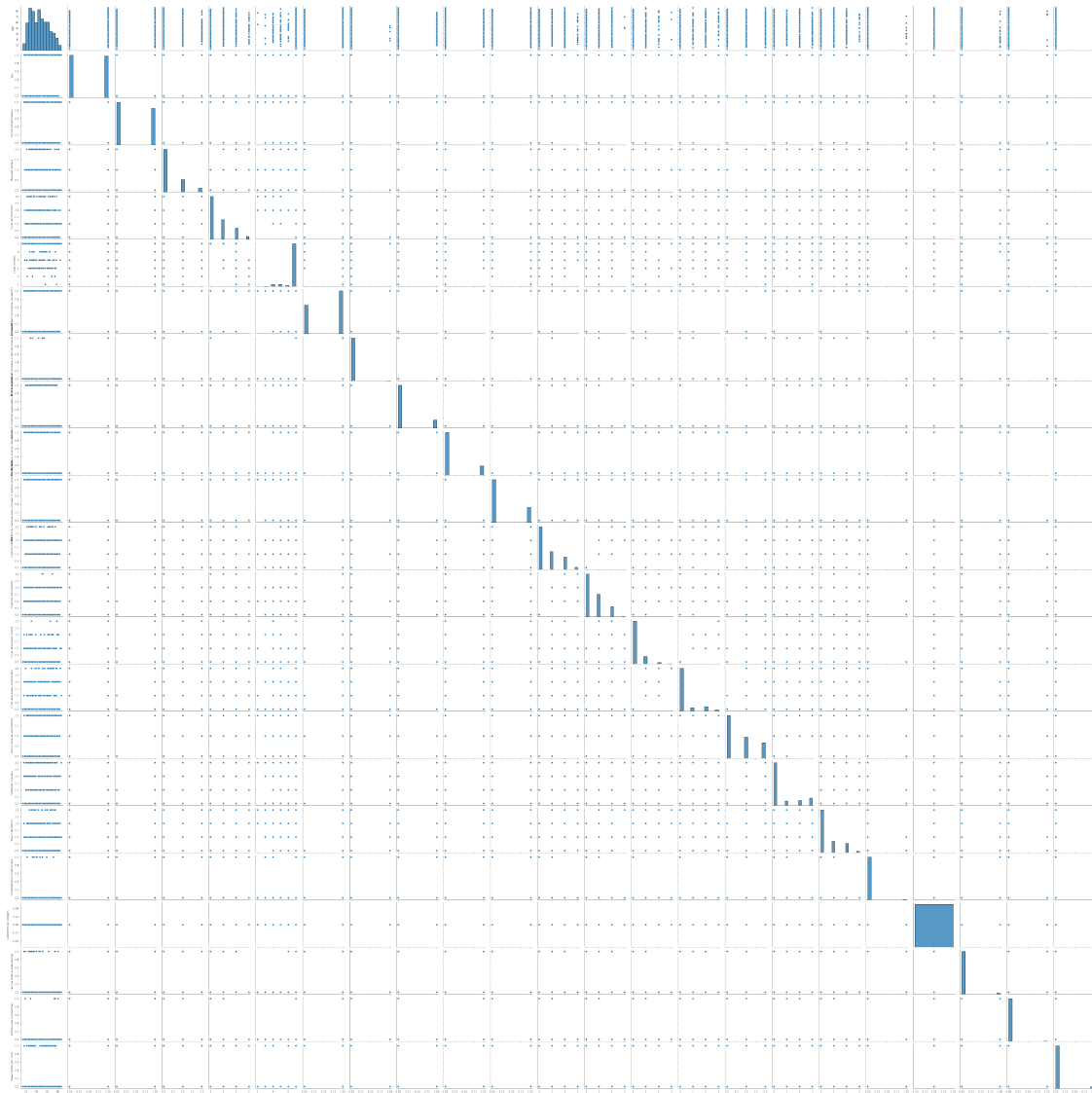
Odds Ratio Odds ratio is a measure of association between an exposure and an outcome. The OR represents the odds that an outcome will occur given a particular exposure, compared to the odds of the outcome occurring in the absence of that exposure. source

There is no strong correlations between the two, that if a patient is of a specified year and age, there is a 1:1 ratio of the patient being diagnosed with UC of chrohns.

```
[39]:  # odds ratio calc
       uc_ch = cleaned_cases.loc[cleaned_cases["Confirmed diagnosis"].isin(['UC',
        →'CROHNS'])]
       table_uc = uc_ch[["Confirmed diagnosis", "Age", "Active inflammation?"]].
        →groupby("Confirmed diagnosis").sum()#.values
       print(table_uc)
```

```
oddsratio_uc, pvalue_uc = stats.fisher_exact(table_uc)
print("OddsR: ", round(oddsratio_uc,4), "p-Value:", pvalue_uc)
```

```
                       Age  Active inflammation?
Confirmed diagnosis
CROHNS              7288.413699                    87
UC                 22326.134247                   283
OddsR:  1.0619 p-Value: 0.6708130443246765
```

*** Reducing categorical classes*** Since there isn't a high number of classes in each categorical columns, there is no need to reduce the number of classes in a categorical set.

0.6 #### Walter

Each column in the dataset is a symptom. SOme of the symptoms are rankings. When the column for Subepithelial collagen is 1 it means that the patient had that symptom and when it is 0 it means the patient did not have that symptom.

```
[40]: train = pd.concat([X_train,y_train],axis=1)
```

Supervised Learning

Get only the binary variables

```
[41]: binary_vars = X_train.columns[X_train.apply(lambda series: False if␣
      ↪set(series)-{0,1} else True)]
      binary_vars = list(set(binary_vars) - set(['Active inflammation?']))
      # binary_vars
```

Calculate the relative risk ratio of having IBD if patient has or doesnt have Patchy lamina propria cellularity

```
[42]: patchyVsIbd   = train.groupby(['Patchy lamina propria cellularity?','Confirmed␣
      ↪diagnosis']).size()
      patchySummary = X_train.groupby('Patchy lamina propria cellularity?').size()
      print(patchyVsIbd)
      print(patchySummary)
```

```
Patchy lamina propria cellularity?  Confirmed diagnosis
0                                   CROHNS                   82
                                    NORMAL                  114
                                    UC                      257
1                                   CROHNS                   35
                                    NORMAL                    4
                                    UC                       48
dtype: int64
Patchy lamina propria cellularity?
0    453
1     87
dtype: int64
```

What proportion of those with patchy lamina propria had Crohn's Disease?

```
[43]: proportions = patchyVsIbd/patchySummary
      proportions
```

```
[43]: Patchy lamina propria cellularity?  Confirmed diagnosis
      0                                    CROHNS                 0.181015
                                           NORMAL                 0.251656
                                           UC                     0.567329
      1                                    CROHNS                 0.402299
                                           NORMAL                 0.045977
                                           UC                     0.551724
      dtype: float64
```

How much more chance of getting Crohn's disease if you have patchy lamina propria cellularity VS if you dont have patch lamina prpria cellularity?

```
[44]: proportions.loc[1]/proportions.loc[0]
```

```
[44]: Confirmed diagnosis
      CROHNS    2.222456
      NORMAL    0.182698
      UC        0.972494
      dtype: float64
```

Observe above that the probabilit of getting Crohn's is twice as much if you have patchy lamina propria cellularity VS if you dont have patchy lamina.

Determine relative risk of Crohn's or UC for all the symptoms Calculation will require creating 3 tables:

Symptom, Is Symptom Present, Confirmed Diagnosis, Count

Symptom, Is Symptom Present, Count

Symptom, Is Symptom Present, Confirmed Diagnosis, Proportion

Symptom, Confirmed Diagnosis, Relative Risk (Final Table)

```
[45]: #1.Symptom, Is Symptom Present, Confirmed Diagnosis, Count
      #Column, Value, Value for Diagnosis Column
      binaryTrain = train[binary_vars+['Confirmed diagnosis']]
      symptomDiagnosis = binaryTrain.reset_index().melt(id_vars=['index','Confirmed␣
       ↪diagnosis'])
      #Column, Value, Value for Diagnosis Column, Count
      diseaseCountPerSymptom = symptomDiagnosis.
       ↪groupby(['variable','value','Confirmed diagnosis']).size()
      diseaseCountPerSymptom.head()
```

```
[45]: variable               value  Confirmed diagnosis
      Basal histiocytic cells  0      CROHNS                 113
```

```
                              NORMAL                 117
                              UC                     291
                    1         CROHNS                   4
                              NORMAL                   1
    dtype: int64
```

[46]:
```python
#2.Symptom, Is Symptom Present, Count
countPerSymptom = symptomDiagnosis.groupby(['variable','value']).size()
countPerSymptom.head()
```

[46]:
```
variable                              value
Basal histiocytic cells               0        521
                                      1         19
Increased lamina propria cellularity? 0        216
                                      1        324
Increased lymphoid aggregates in lamina propria? 0  453
dtype: int64
```

[47]:
```python
#3. Symptom, Is Symptom Present, Confirmed Diagnosis, Proportion
proportionIbdPerSymptom = diseaseCountPerSymptom/countPerSymptom
proportionIbdPerSymptom.head()
```

[47]:
```
variable                  value   Confirmed diagnosis
Basal histiocytic cells   0       CROHNS               0.216891
                                  NORMAL               0.224568
                                  UC                   0.558541
                          1       CROHNS               0.210526
                                  NORMAL               0.052632
    dtype: float64
```

[48]:
```python
#4.Symptom, Confirmed Diagnosis, Relative Risk (Final Table)
propDf = proportionIbdPerSymptom.reset_index()
noSymptom  = propDf.loc[propDf['value']==0].drop('value',axis=1).
 ↪set_index(['variable','Confirmed diagnosis'])
yesSymptom = propDf.loc[propDf['value']==1].drop('value',axis=1).
 ↪set_index(['variable','Confirmed diagnosis'])


'''
Some symptoms such as Submucosal granulomas are only present in Crohn's
 ↪pateints. this means there is no
patient who has both submucosal granuloma and UC.  So the risk of having UC
 ↪given u have submcuoal granulomas
is 0.  But currently in the yesSymptom df, the row Submucosal granulom and UC
 ↪does not even exist.  So if that row
is missing just add a row with 0
'''
noSymptom = noSymptom.reset_index()
```

```
varDxCombos= list(itertools.
 ↪product(set(noSymptom['variable']),set(noSymptom['Confirmed diagnosis']))))
allCombos  = pd.DataFrame(index=pd.MultiIndex.from_tuples(varDxCombos))
allCombos.index.names = ['variable','Confirmed diagnosis']
noSymptom  = noSymptom.set_index(['variable','Confirmed diagnosis'])
yesSymptom = pd.merge(yesSymptom, allCombos, left_index=True, right_index=True,
 ↪how='outer').fillna({0:0})
yesSymptom.head()
```

[48]:

		0
variable	Confirmed diagnosis	
Basal histiocytic cells	CROHNS	0.210526
	NORMAL	0.052632
	UC	0.736842
Increased lamina propria cellularity?	CROHNS	0.225309
	NORMAL	0.046296

Out of all the people that had Increased lamina propria cellularity, what percent of them had Crohn's disase? In below table see that 22.5% of patients with Increased lamina propria cellularity had Crohn's disease.

Out of all the people that did NOT have Increase lamina propria cellularity, how many had Crohn's disease?

[49]:
```
noSymptom = pd.merge(noSymptom, allCombos, left_index=True, right_index=True,
 ↪how='outer').fillna({0:0})
noSymptom.head()
```

[49]:

		0
variable	Confirmed diagnosis	
Basal histiocytic cells	CROHNS	0.216891
	NORMAL	0.224568
	UC	0.558541
Increased lamina propria cellularity?	CROHNS	0.203704
	NORMAL	0.476852

You have two people, one with increased lamina propria cellularity and the other one without increased lamina propria cellularity. How much more likely is the first person to have Crohn's disease compared to the second?

You have two people, one with increased lamina propria cellularity and the other one without increased lamina propria cellularity. How much more likely is the first person to have Crohn's disease compared to the second?

[50]:
```
relativeRiskIbd = (yesSymptom/noSymptom).reset_index()
relativeRiskIbd.head()
```

[50]:

	variable	Confirmed diagnosis	0
0	Basal histiocytic cells	CROHNS	0.970657

```
1              Basal histiocytic cells              NORMAL  0.234368
2              Basal histiocytic cells                  UC  1.319226
3  Increased lamina propria cellularity?          CROHNS  1.106061
4  Increased lamina propria cellularity?          NORMAL  0.097087
```

[51]:
```python
fig,ax = plt.subplots(nrows=1,ncols=3, sharey=True)
crohns = relativeRiskIbd[relativeRiskIbd['Confirmed diagnosis']=='CROHNS']
uc     = relativeRiskIbd[relativeRiskIbd['Confirmed diagnosis']=='UC']
normal = relativeRiskIbd[relativeRiskIbd['Confirmed diagnosis']=='NORMAL']
ax[0].barh(crohns['variable'],crohns[0])
ax[0].set(title='Crohns',
          ylabel='SYMPTOMS')
ax[1].barh(uc['variable'],uc[0])
ax[1].set(title='UC',xlabel='Relative Risk of Diagnosis Given That Patient has␣
 ↪this Symptom',)
ax[2].barh(normal['variable'],normal[0])
ax[2].set(title='Normal')
```

[51]: [Text(0.5, 1.0, 'Normal')]
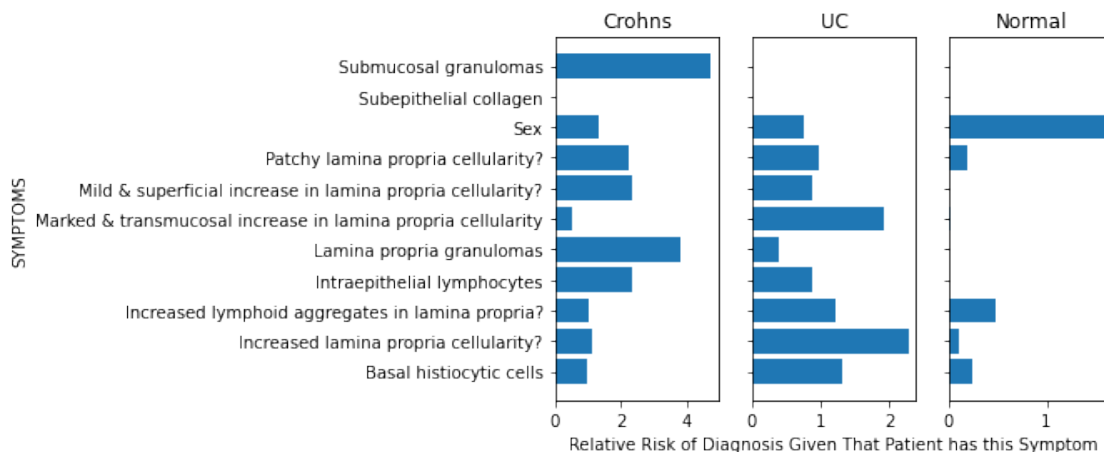
For unsupervised EDA, The objective is to find multiple symptoms that are all 1 for the same patients and are all 0 for other patients.

First, manually calculate the risk ratio between Symptom A and Symptom B

Next, create a cross tab where the row is Symptom A, the column is Symptom B and the cell value is the risk ratio of Symptom B / Symptom A

Finally, find the groups of symptoms that have highest risk ratios for one another. If 3 columns have high relative risk ratios, consider keeping only one of those columns and dropping the other 2

Risk Ratio

What is the risk of getting "Increased lamina propria cellularity" if you do have "Lamina propria

granulomas" versus the risk of getting "Increased lamina propria cellularity" if you do not have "Lamina propria granulomas"?

If two symptoms are both positive in 1000 patients. And in another 1000 patients the two symptoms are negative. This would indicate correlation between those 2 symptoms.

```
[52]: exposure = 'Lamina propria granulomas'
      disease  = 'Increased lamina propria cellularity?'
      risks = X_train.groupby([exposure,disease]
                      ).size()/X_train.groupby([exposure]).size()
      risks = risks.reset_index()
      riskGivenNoExposure = risks.loc[(risks[exposure] == 0)&
                                     (risks[disease] == 1),0].values[0]
      riskGivenExposure   = risks.loc[(risks[exposure] == 1)&
                                     (risks[disease] == 1),0].values[0]
      riskGivenExposure/riskGivenNoExposure
```

[52]: 1.5591715976331362

Get the cross tab of every symptom with every other symptom

```
[53]: def multicolumn_crosstab(df,cols):
          cols=sorted(cols)
          dummies = pd.get_dummies(df[cols])
          dfWithDummies = pd.concat([df,dummies],axis=1)
          dfWithDummies = dfWithDummies.reset_index()
          dfMelt = dfWithDummies.melt(id_vars=np.concatenate([np.
       ↪array(['index']),dummies.columns.values]),
                              value_vars=cols)
          dfMelt = dfMelt.drop('index',axis=1)
          levelGroup = dfMelt.groupby(['variable','value'])
          crosstab = levelGroup.sum()
          countPerLevel = levelGroup.size()
          crossTabProp = crosstab.divide(countPerLevel,axis=0)
          return crossTabProp
```

```
[54]: ct = multicolumn_crosstab(X_train.astype(str),binary_vars)
```

In the below cross tab, the value in the second row, and in the fourth column (Incerased Lamina propria cellularity_1) is the number 0.894737. This means that 89% of the patients (in the train set) had both Basal histocytic cells and Increased lamina propria cellularity. Notice how this number 89% adds up tihe the 10.5263 % on the left of it. That 10% number is the proportion of patients that had basal histocytic cells but did NOT have icnreased lamina propria cellularity.

```
[55]: ct.head()
```

```
[55]:                                                       Basal histiocytic
      cells_0  \
      variable                                            value
```

```
Basal histiocytic cells                        0
1.000000
                                               1
0.000000
Increased lamina propria cellularity?          0
0.990741
                                               1
0.947531
Increased lymphoid aggregates in lamina propria? 0
0.964680


                                               Basal histiocytic
cells_1  \
variable                                       value
Basal histiocytic cells                        0
0.000000
                                               1
1.000000
Increased lamina propria cellularity?          0
0.009259
                                               1
0.052469
Increased lymphoid aggregates in lamina propria? 0
0.035320


                                               Increased lamina propria
cellularity?_0  \
variable                                       value
Basal histiocytic cells                        0
0.410749
                                               1
0.105263
Increased lamina propria cellularity?          0
1.000000
                                               1
0.000000
Increased lymphoid aggregates in lamina propria? 0
0.476821


                                               Increased lamina propria
cellularity?_1  \
variable                                       value
Basal histiocytic cells                        0
0.589251
                                               1
0.894737
Increased lamina propria cellularity?          0
```

```
0.000000
                                                1
1.000000
Increased lymphoid aggregates in lamina propria? 0
0.523179


                                                    Increased lymphoid
aggregates in lamina propria?_0  \
variable                                        value
Basal histiocytic cells                         0
0.838772
                                                1
0.842105
Increased lamina propria cellularity?           0
1.000000
                                                1
0.731481
Increased lymphoid aggregates in lamina propria? 0
1.000000


                                                    Increased lymphoid
aggregates in lamina propria?_1  \
variable                                        value
Basal histiocytic cells                         0
0.161228
                                                1
0.157895
Increased lamina propria cellularity?           0
0.000000
                                                1
0.268519
Increased lymphoid aggregates in lamina propria? 0
0.000000


                                                    Intraepithelial
lymphocytes_0  \
variable                                        value
Basal histiocytic cells                         0
0.988484
                                                1
1.000000
Increased lamina propria cellularity?           0
0.995370
                                                1
0.984568
Increased lymphoid aggregates in lamina propria? 0
0.988962
```

```
                                                        Intraepithelial
lymphocytes_1  \
variable                                    value
Basal histiocytic cells                     0
0.011516
                                            1
0.000000
Increased lamina propria cellularity?       0
0.004630
                                            1
0.015432
Increased lymphoid aggregates in lamina propria? 0
0.011038


                                                        Lamina propria
granulomas_0  \
variable                                    value
Basal histiocytic cells                     0
0.976967
                                            1
0.947368
Increased lamina propria cellularity?       0
0.995370
                                            1
0.962963
Increased lymphoid aggregates in lamina propria? 0
0.971302


                                                        Lamina propria
granulomas_1  \
variable                                    value
Basal histiocytic cells                     0
0.023033
                                            1
0.052632
Increased lamina propria cellularity?       0
0.004630
                                            1
0.037037
Increased lymphoid aggregates in lamina propria? 0
0.028698


                                                        …  \
variable                                    value  …
Basal histiocytic cells                     0      …
                                            1      …
```

```
Increased lamina propria cellularity?          0      …
                                               1      …
Increased lymphoid aggregates in lamina propria? 0    …


                                             Marked & transmucosal
increase in lamina propria cellularity_1  \
variable                                     value
Basal histiocytic cells                      0
0.272553
                                             1
0.421053
Increased lamina propria cellularity?        0
0.000000
                                             1
0.462963
Increased lymphoid aggregates in lamina propria? 0
0.331126


                                             Mild & superficial
increase in lamina propria cellularity?_0  \
variable                                     value
Basal histiocytic cells                      0
0.996161
                                             1
1.000000
Increased lamina propria cellularity?        0
1.000000
                                             1
0.993827
Increased lymphoid aggregates in lamina propria? 0
0.995585


                                             Mild & superficial
increase in lamina propria cellularity?_1  \
variable                                     value
Basal histiocytic cells                      0
0.003839
                                             1
0.000000
Increased lamina propria cellularity?        0
0.000000
                                             1
0.006173
Increased lymphoid aggregates in lamina propria? 0
0.004415


                                             Patchy lamina propria
```

```
                                                cellularity?_0  \
variable                                   value
Basal histiocytic cells                        0
0.844530
                                               1
0.684211
Increased lamina propria cellularity?          0
1.000000
                                               1
0.731481
Increased lymphoid aggregates in lamina propria? 0
0.812362


                                                Patchy lamina propria
                                                cellularity?_1  \
variable                                   value
Basal histiocytic cells                        0
0.155470
                                               1
0.315789
Increased lamina propria cellularity?          0
0.000000
                                               1
0.268519
Increased lymphoid aggregates in lamina propria? 0
0.187638


                                                         Sex_0      Sex_1  \
variable                                   value
Basal histiocytic cells                        0    0.508637   0.491363
                                               1    0.684211   0.315789
Increased lamina propria cellularity?          0    0.462963   0.537037
                                               1    0.549383   0.450617
Increased lymphoid aggregates in lamina propria? 0  0.509934   0.490066


                                                Subepithelial collagen_0
\
variable                                   value
Basal histiocytic cells                        0                     1.0
                                               1                     1.0
Increased lamina propria cellularity?          0                     1.0
                                               1                     1.0
Increased lymphoid aggregates in lamina propria? 0                   1.0


                                                Submucosal granulomas_0
\
variable                                   value
```

```
Basal histiocytic cells                                    0                      0.992322
                                                           1                      1.000000
Increased lamina propria cellularity?                      0                      1.000000
                                                           1                      0.987654
Increased lymphoid aggregates in lamina propria? 0                                0.991170


                                                                   Submucosal granulomas_1
variable                                              value
Basal histiocytic cells                                    0                      0.007678
                                                           1                      0.000000
Increased lamina propria cellularity?                      0                      0.000000
                                                           1                      0.012346
Increased lymphoid aggregates in lamina propria? 0                                0.008830

[5 rows x 21 columns]
```

Which feature is most correlated with the other features? Observe that "Increased lamina propria cellularity" and "Active Inflammation" are the columns that is most correlated with the other symptoms.

noExposureDf: Get all the risks of getting Symptom B given that you dont have symptom A.
exposureDf: Get all the risks of getting Symptom B given that you do have symptom A.

```
[56]: crossTab      = ct.reset_index()
      noExposureDf = crossTab.loc[crossTab['value']=='0']
      exposureDf   = crossTab.loc[crossTab['value']=='1']
```

Divide all the risk-given-exposure/ risk-given-no-exposure to get the relative risk for every symptom pair

```
[57]: noExposureDf = noExposureDf.set_index('variable').drop('value',axis=1)
      exposureDf   = exposureDf.set_index('variable').drop('value',axis=1)
      relativeRisks= exposureDf/noExposureDf
      relativeRisks.head()
```

```
[57]:                                                  Basal histiocytic cells_0  \
      variable
      Basal histiocytic cells                                           0.000000
      Increased lamina propria cellularity?                             0.956386
      Increased lymphoid aggregates in lamina propria?                  1.000868
      Intraepithelial lymphocytes                                       1.036893
      Lamina propria granulomas                                         0.955720


                                                       Basal histiocytic cells_1  \
      variable
      Basal histiocytic cells                                                inf
      Increased lamina propria cellularity?                             5.666667
      Increased lymphoid aggregates in lamina propria?                  0.976293
      Intraepithelial lymphocytes                                       0.000000
```

```
Lamina propria granulomas                                    2.252137

                                          Increased lamina propria
cellularity?_0  \
variable
Basal histiocytic cells
0.256272
Increased lamina propria cellularity?
0.000000
Increased lymphoid aggregates in lamina propria?
0.000000
Intraepithelial lymphocytes
0.413953
Lamina propria granulomas
0.188551


                                          Increased lamina propria
cellularity?_1  \
variable
Basal histiocytic cells
1.518430
Increased lamina propria cellularity?
inf
Increased lymphoid aggregates in lamina propria?
1.911392
Intraepithelial lymphocytes
1.394984
Lamina propria granulomas
1.559172


                                          Increased lymphoid aggregates
in lamina propria?_0  \
variable
Basal histiocytic cells
1.003974
Increased lamina propria cellularity?
0.731481
Increased lymphoid aggregates in lamina propria?
0.000000
Intraepithelial lymphocytes
0.993304
Lamina propria granulomas
1.197727


                                          Increased lymphoid aggregates
in lamina propria?_1  \
variable
```

```
Basal histiocytic cells
0.979323
Increased lamina propria cellularity?
inf
Increased lymphoid aggregates in lamina propria?
inf
Intraepithelial lymphocytes
1.034884
Lamina propria granulomas
0.000000


                                          Intraepithelial lymphocytes_0
\
variable
Basal histiocytic cells                                       1.011650
Increased lamina propria cellularity?                         0.989147
Increased lymphoid aggregates in lamina propria?              0.999538
Intraepithelial lymphocytes                                   0.000000
Lamina propria granulomas                                     0.931919


                                          Intraepithelial lymphocytes_1
\
variable
Basal histiocytic cells                                       0.000000
Increased lamina propria cellularity?                         3.333333
Increased lymphoid aggregates in lamina propria?              1.041379
Intraepithelial lymphocytes                                        inf
Lamina propria granulomas                                     8.107692


                                          Lamina propria granulomas_0  \
variable
Basal histiocytic cells                                       0.969703
Increased lamina propria cellularity?                         0.967442
Increased lymphoid aggregates in lamina propria?              1.029545
Intraepithelial lymphocytes                                   0.852490
Lamina propria granulomas                                     0.000000


                                          Lamina propria granulomas_1  \
variable
Basal histiocytic cells                                       2.285088
Increased lamina propria cellularity?                         8.000000
Increased lymphoid aggregates in lamina propria?              0.000000
Intraepithelial lymphocytes                                   7.416667
Lamina propria granulomas                                          inf


                                          …   \
variable                                  …
```

```
Basal histiocytic cells                            …
Increased lamina propria cellularity?              …
Increased lymphoid aggregates in lamina propria?   …
Intraepithelial lymphocytes                        …
Lamina propria granulomas                          …


                                           Marked & transmucosal increase
in lamina propria cellularity_1  \
variable
Basal histiocytic cells
1.544848
Increased lamina propria cellularity?
inf
Increased lymphoid aggregates in lamina propria?
0.000000
Intraepithelial lymphocytes
1.202703
Lamina propria granulomas
0.000000


                                           Mild & superficial increase in
lamina propria cellularity?_0  \
variable
Basal histiocytic cells
1.003854
Increased lamina propria cellularity?
0.993827
Increased lymphoid aggregates in lamina propria?
1.004435
Intraepithelial lymphocytes
1.003759
Lamina propria granulomas
1.003810


                                           Mild & superficial increase in
lamina propria cellularity?_1  \
variable
Basal histiocytic cells
0.0
Increased lamina propria cellularity?
inf
Increased lymphoid aggregates in lamina propria?
0.0
Intraepithelial lymphocytes
0.0
Lamina propria granulomas
0.0
```

```
                                                    Patchy lamina propria
cellularity?_0  \
variable
Basal histiocytic cells
0.810167
Increased lamina propria cellularity?
0.731481
Increased lymphoid aggregates in lamina propria?
1.202680
Intraepithelial lymphocytes
0.792873
Lamina propria granulomas
0.089687


                                                    Patchy lamina propria
cellularity?_1  \
variable
Basal histiocytic cells
2.031189
Increased lamina propria cellularity?
inf
Increased lymphoid aggregates in lamina propria?
0.122515
Intraepithelial lymphocytes
2.094118
Lamina propria granulomas
6.486154
```

	Sex_0	Sex_1
variable		
Basal histiocytic cells	1.345184	0.642681
Increased lamina propria cellularity?	1.186667	0.839080
Increased lymphoid aggregates in lamina propria?	1.059412	0.938180
Intraepithelial lymphocytes	0.644928	1.379845
Lamina propria granulomas	1.356305	0.628503

	Subepithelial collagen_0
variable	
Basal histiocytic cells	1.0
Increased lamina propria cellularity?	1.0
Increased lymphoid aggregates in lamina propria?	1.0
Intraepithelial lymphocytes	1.0
Lamina propria granulomas	1.0

	Submucosal granulomas_0
variable	

```
Basal histiocytic cells                                          1.007737
Increased lamina propria cellularity?                            0.987654
Increased lymphoid aggregates in lamina propria?                 1.008909
Intraepithelial lymphocytes                                      1.007547
Lamina propria granulomas                                        0.770693

                                                  Submucosal granulomas_1
variable
Basal histiocytic cells                                          0.000000
Increased lamina propria cellularity?                                 inf
Increased lymphoid aggregates in lamina propria?                 0.000000
Intraepithelial lymphocytes                                      0.000000
Lamina propria granulomas                                      121.615385

[5 rows x 21 columns]
```

The relative risk from our risk matrix is the same as the one when we manually calculated it. 1.559171

```python
[58]: relativeRisks.loc['Lamina propria granulomas','Increased lamina propria
      ↪cellularity?_1' ]
```

```
[58]: 1.5591715976331362
```

Replace infinity values or abnormally high Relative risks with 0

```python
[59]: relativeRisks = relativeRisks.applymap(lambda cell:0 if cell>20 else cell)
```

Observe in heatmap below that Submucosal granulomas are highly correlated with lamina propria granulomas

```python
[60]: symptomPresent = [column for column in ct.columns if '1' in column]
      sns.heatmap(relativeRisks[symptomPresent])
```

```
[60]: <AxesSubplot:ylabel='variable'>
```
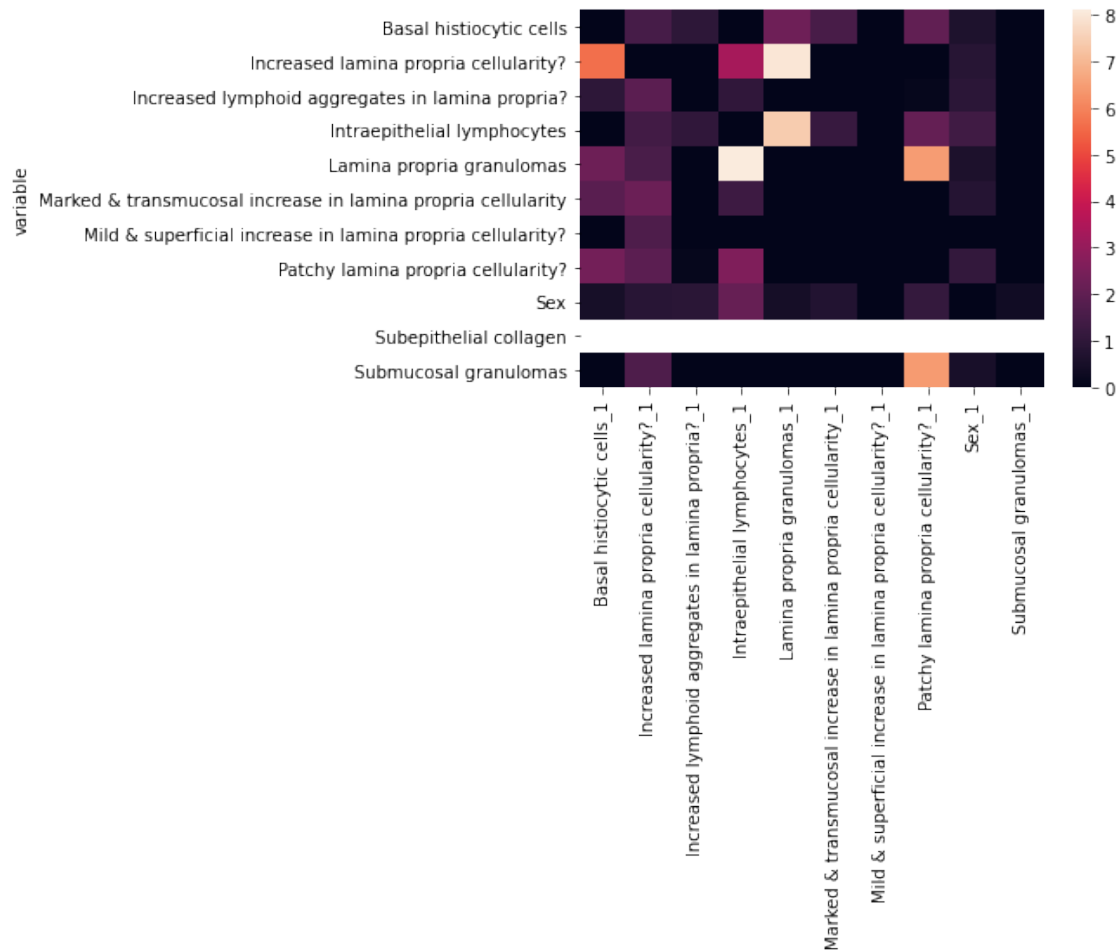
Out of the 453 patients that did not have patchy lamina propria cellularity none of those patients also had lamina propria granulomas. However, out of the 87 patients that had patchy laminap propria cellularity, 4 of those patients also had lamina propria granulomas. It looks like these 2 columns are correlated.

```
[61]: X_train.groupby(['Patchy lamina propria cellularity?','Submucosal granulomas']).
      ↪size()
```

```
[61]: Patchy lamina propria cellularity?  Submucosal granulomas
      0                                   0                        453
      1                                   0                         83
                                          1                          4
      dtype: int64
```

Out of the 453 patients that did not have patchy lamina propria cellularity only 1 of those patients also had lamina propria granulomas. However, out of the 87 patients that had patchy laminap propria cellularity, 12 of those patients also had lamina propria granulomas. It looks like these 2 columns are correlated.

```
[62]: X_train.groupby(['Patchy lamina propria cellularity?','Lamina propria␣
       ↪granulomas']).size()
```

```
[62]: Patchy lamina propria cellularity?  Lamina propria granulomas
      0                                    0                            452
                                           1                              1
      1                                    0                             75
                                           1                             12
      dtype: int64
```

You have two people, one with increased lamina propria cellularity and the other one without
increased lamina propria cellularity. How much more likely is the first person to have Crohn's
disease compared to the second?

```
[63]: train.groupby(['Submucosal granulomas','Confirmed diagnosis']).size()
```

```
[63]: Submucosal granulomas  Confirmed diagnosis
      0                      CROHNS                 113
                             NORMAL                 118
                             UC                     305
      1                      CROHNS                   4
      dtype: int64
```

0.6.1 Model Assumptions

The model assumptions for all models are not concerning to the data for visualization. The main
requirement is that the data doesn't have a linear correlation between features and that the data
is independent, assumed by the unique data points.

Due to the data primarily being categorical, the modifications/assumptions are difficult to decipher.

0.6.2 Data Prep for Modeling

Dummy coding the Data

There are two different set methods, dummy coding and ordinal. Before converting to dummy
code, the data is first returned to it original form, then dummy coded to understand the effects of
feature reduction and whether its required.

```
[64]: # convert it back to the original setup
      df_reset = cleaned_cases.copy()
      df_reset_od = cleaned_cases.copy()
      df_reset.head()
```

```
[64]:         Age  Sex  Active inflammation? Mucosal surface Crypt architecture  \
      0  20.536986    0                     0               0                  0
      1  55.575342    1                     1               1                  3
      2  58.698630    0                     1               1                  1
      3  65.934247    0                     0               1                  1
      4  23.391781    0                     0               0                  0
```

```
     Crypt profiles  Increased lamina propria cellularity?  \
0                 7                                       0
1                 4                                       1
2                 7                                       1
3                 7                                       0
4                 7                                       0

   Mild & superficial increase in lamina propria cellularity?  \
0                                                  0
1                                                  0
2                                                  0
3                                                  0
4                                                  0

   Increased lymphoid aggregates in lamina propria?  \
0                                                  0
1                                                  0
2                                                  0
3                                                  0
4                                                  0

   Patchy lamina propria cellularity?  … Lamina propria polymorphs  \
0                                    0  …                         0
1                                    0  …                         2
2                                    1  …                         1
3                                    0  …                         0
4                                    0  …                         0

   Epithelial changes  Mucin depletion  Intraepithelial lymphocytes  \
0                   0                0                            0
1                   3                1                            0
2                   2                0                            0
3                   0                0                            0
4                   0                0                            0

   Subepithelial collagen  Lamina propria granulomas  Submucosal granulomas  \
0                       0                          0                      0
1                       0                          0                      0
2                       0                          0                      0
3                       0                          0                      0
4                       0                          0                      0

   Basal histiocytic cells  Confirmed diagnosis  Severity of Crypt Arch
0                        0                   UC                  normal
1                        0                   UC                  severe
2                        0                   UC                    mild
```

```
3                     0              UC                mild
4                     0              CROHNS            normal

[5 rows x 25 columns]
```

[65]: `transform_dict`

[65]:
```
[{'data': ['Mucin depletion', 'Crypt architecture'],
  'definitions': [{0: 'Normal', 1: 'Mild', 2: 'Moderate', 3: 'Severe'}]},
 {'data': ['Cryptitis extent', 'Crypt abscesses extent'],
  'definitions': [{0: 'None', 1: 'Little', 2: 'Moderate', 3: 'Marked'}]},
 {'data': ['Lamina propria polymorphs'],
  'definitions': [{0: 'Absent', 1: 'Focal', 2: 'Diffuse'}]},
 {'data': ['Cryptitis polymorphs', 'Crypt abscesses polymorphs'],
  'definitions': [{0: 'None', 1: 'Few', 2: 'Several', 3: 'Many'}]},
 {'data': ['Epithelial changes'],
  'definitions': [{0: 'Normal',
    1: 'Flattening ',
    2: 'Degeneration',
    3: 'Erosion'}]},
 {'data': ['Mucosal surface'],
  'definitions': [{0: 'Flat', 1: 'Irregular', 2: 'Villous projections'}]}]
```

[66]:
```python
for val in transform_dict:
    print("===========new dictionary==========")
    cols = val['data']
    print(val['definitions'])
    for col in cols:
        try:
            df_reset[col] = [val['definitions'][0][v] for v in df_reset[col]]
        except:
            pass
```

```
===========new dictionary==========
[{0: 'Normal', 1: 'Mild', 2: 'Moderate', 3: 'Severe'}]
===========new dictionary==========
[{0: 'None', 1: 'Little', 2: 'Moderate', 3: 'Marked'}]
===========new dictionary==========
[{0: 'Absent', 1: 'Focal', 2: 'Diffuse'}]
===========new dictionary==========
[{0: 'None', 1: 'Few', 2: 'Several', 3: 'Many'}]
===========new dictionary==========
[{0: 'Normal', 1: 'Flattening ', 2: 'Degeneration', 3: 'Erosion'}]
===========new dictionary==========
[{0: 'Flat', 1: 'Irregular', 2: 'Villous projections'}]
```

[67]: `# review the data transformation`

```
df_reset[["Cryptitis extent","Cryptitis polymorphs","Crypt abscesses␣
 ↪extent","Crypt abscesses polymorphs","Lamina propria polymorphs","Epithelial␣
 ↪changes","Mucin depletion"]]

# get dummies
dummied = pd.get_dummies(df_reset[["Cryptitis extent","Cryptitis␣
 ↪polymorphs","Crypt abscesses extent","Crypt abscesses polymorphs","Lamina␣
 ↪propria polymorphs","Epithelial changes","Mucin depletion","Severity of␣
 ↪Crypt Arch"]])
# "Method of confirmation","Initial pathologists diagnosis","Observing␣
 ↪pathologists diagnosis",
df_dummy = pd.merge(dummied, cleaned_cases.drop(["Cryptitis extent","Cryptitis␣
 ↪polymorphs","Crypt abscesses extent","Crypt abscesses polymorphs","Lamina␣
 ↪propria polymorphs","Epithelial changes","Mucin depletion", "Severity of␣
 ↪Crypt Arch"], axis=1), how = "inner", left_index=True, right_index=True)
# "Method of confirmation","Initial pathologists diagnosis","Observing␣
 ↪pathologists diagnosis",
```

for column "Initial pathologists diagnosis_?IBD ?Infective", there is only one instance of this
observation. Due to this we will drop the column as it will error during analysis.

```
[68]: # df_dummy = df_dummy.drop(["Initial pathologists diagnosis_?IBD ?
 ↪Infective","Initial pathologists diagnosis_Pouchitis", "Initial pathologists␣
 ↪diagnosis_Diversion colitis", "Initial pathologists diagnosis_IBD␣
 ↪indeterminate, quiscent"] ,axis=1)
```

```
[69]: df_type = pd.DataFrame(df_dummy.dtypes)

for x in df_type.loc[df_type[0] == "uint8"].reset_index()['index']:
    df_dummy[x] = df_dummy[x].astype('object')

df_dummy.dtypes
```

```
[69]: Cryptitis extent_Little                        object
      Cryptitis extent_Marked                        object
      Cryptitis extent_Moderate                      object
      Cryptitis extent_None                          object
      Cryptitis polymorphs_Few                       object
      Cryptitis polymorphs_Many                      object
      Cryptitis polymorphs_None                      object
      Cryptitis polymorphs_Several                   object
      Crypt abscesses extent_Little                  object
      Crypt abscesses extent_Marked                  object
      Crypt abscesses extent_Moderate                object
      Crypt abscesses extent_None                    object
      Crypt abscesses polymorphs_Few                 object
      Crypt abscesses polymorphs_Many                object
```

```
Crypt abscesses polymorphs_None                                      object
Crypt abscesses polymorphs_Several                                   object
Lamina propria polymorphs_Absent                                     object
Lamina propria polymorphs_Diffuse                                    object
Lamina propria polymorphs_Focal                                      object
Epithelial changes_Degeneration                                      object
Epithelial changes_Erosion                                           object
Epithelial changes_Flattening                                        object
Epithelial changes_Normal                                            object
Mucin depletion_Mild                                                 object
Mucin depletion_Moderate                                             object
Mucin depletion_Normal                                               object
Mucin depletion_Severe                                               object
Severity of Crypt Arch_mild                                          object
Severity of Crypt Arch_moderate                                      object
Severity of Crypt Arch_normal                                        object
Severity of Crypt Arch_severe                                        object
Age                                                                 float64
Sex                                                                   int64
Active inflammation?                                                  int64
Mucosal surface                                                      object
Crypt architecture                                                   object
Crypt profiles                                                        int32
Increased lamina propria cellularity?                                object
Mild & superficial increase in lamina propria cellularity?           object
Increased lymphoid aggregates in lamina propria?                     object
Patchy lamina propria cellularity?                                   object
Marked & transmucosal increase in lamina propria cellularity         object
Intraepithelial lymphocytes                                          object
Subepithelial collagen                                               object
Lamina propria granulomas                                            object
Submucosal granulomas                                                object
Basal histiocytic cells                                              object
Confirmed diagnosis                                                  object
dtype: object
```

Ordinal Data

Ordinal data is the method of which the data is already set up in. This allows the researchers to put the remaining data types into an ordinal set up for analysis.

```
[70]: ord_cols = ["Severity of Crypt Arch"]
      # "Method of confirmation","Initial pathologists diagnosis","Observing
       →pathologists diagnosis",
```

```
[71]: for val in ord_cols:
          print(val)
          array_un = df_reset_od[val].unique().tolist()
```

```
        df_reset_od[val] = df_reset_od[val].apply(lambda x: array_un.index(x))
```

Severity of Crypt Arch

```
[72]: df_ordinal = df_reset_od
      df_ordinal.head()
```

[72]:

	Age	Sex	Active inflammation?	Mucosal surface	Crypt architecture	\
0	20.536986	0	0	0	0	
1	55.575342	1	1	1	3	
2	58.698630	0	1	1	1	
3	65.934247	0	0	1	1	
4	23.391781	0	0	0	0	

	Crypt profiles	Increased lamina propria cellularity?	\
0	7	0	
1	4	1	
2	7	1	
3	7	0	
4	7	0	

	Mild & superficial increase in lamina propria cellularity?	\
0	0	
1	0	
2	0	
3	0	
4	0	

	Increased lymphoid aggregates in lamina propria?	\
0	0	
1	0	
2	0	
3	0	
4	0	

	Patchy lamina propria cellularity?	…	Lamina propria polymorphs	\
0	0	…	0	
1	0	…	2	
2	1	…	1	
3	0	…	0	
4	0	…	0	

	Epithelial changes	Mucin depletion	Intraepithelial lymphocytes	\
0	0	0	0	
1	3	1	0	
2	2	0	0	
3	0	0	0	
4	0	0	0	

```
     Subepithelial collagen Lamina propria granulomas Submucosal granulomas  \
0                         0                            0                    0
1                         0                            0                    0
2                         0                            0                    0
3                         0                            0                    0
4                         0                            0                    0

     Basal histiocytic cells Confirmed diagnosis Severity of Crypt Arch
0                          0                  UC                      0
1                          0                  UC                      1
2                          0                  UC                      2
3                          0                  UC                      2
4                          0              CROHNS                      0

[5 rows x 25 columns]
```

Of the two differing methods, one of the two will be selected for analysis.

0.6.3 Train/Test Split

```
[73]: #X_ord = df_ordinal.drop(columns=["Observing pathologists diagnosis", "Initial␣
      ↪pathologists diagnosis", "Confirmed diagnosis"], axis=1)
      X_ord = df_ordinal.drop(columns=["Confirmed diagnosis"], axis=1)
      y_ord = df_ordinal['Confirmed diagnosis']


      X_train_ord , X_test_ord, y_train_ord, y_test_ord = train_test_split(X_ord,␣
      ↪y_ord, test_size=0.25, random_state=42)
```

```
[74]: X_train_ord[X_train_ord.isna().any(axis=1)]
```

```
[74]: Empty DataFrame
      Columns: [Age, Sex, Active inflammation?, Mucosal surface, Crypt architecture,
      Crypt profiles, Increased lamina propria cellularity?, Mild & superficial
      increase in lamina propria cellularity?, Increased lymphoid aggregates in lamina
      propria?, Patchy lamina propria cellularity?, Marked & transmucosal increase in
      lamina propria cellularity, Cryptitis extent, Cryptitis polymorphs, Crypt
      abscesses extent, Crypt abscesses polymorphs, Lamina propria polymorphs,
      Epithelial changes, Mucin depletion, Intraepithelial lymphocytes, Subepithelial
      collagen, Lamina propria granulomas, Submucosal granulomas, Basal histiocytic
      cells, Severity of Crypt Arch]
      Index: []

      [0 rows x 24 columns]
```

Max-Min Transformation

```
[75]: df_ord_scale = df_reset_od.drop("Confirmed diagnosis", 1)
      X_train_ord = X_train_ord.copy().reset_index().drop('index',axis=1)
      X_test_ord = X_test_ord.copy().reset_index().drop('index',axis=1)
      for val in X_train_ord.columns:
          X_train_ord[val] = X_train_ord[val].astype(int)
          X_test_ord[val] = X_test_ord[val].astype(int)
```

```
[76]: # Scale only columns that have values greater than 1
      to_scale = [col for col in X_train_ord.columns if X_train_ord[col].max() > 1]
      mms = MinMaxScaler()
      scaled = mms.fit_transform(X_train_ord[to_scale])
      scaled = pd.DataFrame(scaled, columns=to_scale)
      scaled_test = mms.fit_transform(X_test_ord[to_scale])
      scaled_test = pd.DataFrame(scaled_test, columns=to_scale)

      # Replace original columns with scaled ones
      for col in scaled:
          X_train_ord[col] = scaled[col]
          X_test_ord[col] = scaled_test[col]

      # df_ord_scale = X_train_ord.merge(df_reset_od["Confirmed diagnosis"],␣
       ↪how="inner", left_index=True, right_index=True)
```

```
[77]: # X_train_ord = X_train_ord.merge(df_reset_od["Confirmed diagnosis"],␣
       ↪how="inner", left_index=True, right_index=True)
      X_train_ord[X_train_ord.isna().any(axis=1)]
```

[77]: Empty DataFrame
      Columns: [Age, Sex, Active inflammation?, Mucosal surface, Crypt architecture,
      Crypt profiles, Increased lamina propria cellularity?, Mild & superficial
      increase in lamina propria cellularity?, Increased lymphoid aggregates in lamina
      propria?, Patchy lamina propria cellularity?, Marked & transmucosal increase in
      lamina propria cellularity, Cryptitis extent, Cryptitis polymorphs, Crypt
      abscesses extent, Crypt abscesses polymorphs, Lamina propria polymorphs,
      Epithelial changes, Mucin depletion, Intraepithelial lymphocytes, Subepithelial
      collagen, Lamina propria granulomas, Submucosal granulomas, Basal histiocytic
      cells, Severity of Crypt Arch]
      Index: []

      [0 rows x 24 columns]

```
[78]: X_test_ord[X_test_ord.isna().any(axis=1)]
```

[78]: Empty DataFrame
      Columns: [Age, Sex, Active inflammation?, Mucosal surface, Crypt architecture,
      Crypt profiles, Increased lamina propria cellularity?, Mild & superficial
      increase in lamina propria cellularity?, Increased lymphoid aggregates in lamina

propria?, Patchy lamina propria cellularity?, Marked & transmucosal increase in lamina propria cellularity, Cryptitis extent, Cryptitis polymorphs, Crypt abscesses extent, Crypt abscesses polymorphs, Lamina propria polymorphs, Epithelial changes, Mucin depletion, Intraepithelial lymphocytes, Subepithelial collagen, Lamina propria granulomas, Submucosal granulomas, Basal histiocytic cells, Severity of Crypt Arch]
Index: []

[0 rows x 24 columns]

SMOTE

```
[79]: sm = SMOTE(random_state=123)
```

```
[80]: X_sm, y_sm = sm.fit_resample(X_train_ord, y_train_ord)

      print('MixMax Scaler')
      print(f'''Shape of X before SMOTE: {X_ord.shape}
      Shape of X after SMOTE: {X_sm.shape}''')
```

```
MixMax Scaler
Shape of X before SMOTE: (809, 24)
Shape of X after SMOTE: (1044, 24)
```

```
[81]: print('\nBalance of positive and negative classes (%):')
      y_sm.value_counts(normalize=True) * 100
```

```
Balance of positive and negative classes (%):
```

```
[81]: UC        33.333333
      CROHNS    33.333333
      NORMAL    33.333333
      Name: Confirmed diagnosis, dtype: float64
```

```
[82]: # Final Sets
      data = [X_sm, X_test_ord, y_sm, y_test_ord]
```

```
[83]: msm = smote_variants.MSMOTE(proportion=28, random_state = 123)
      X_msm, y_msm = msm.sample(X_train_ord.values, y_train_ord.values)
      X_msm = pd.DataFrame(columns = X_train_ord.columns, data=X_msm)
      y_msm = pd.Series(data = y_msm)
      msm2 = smote_variants.MSMOTE(proportion=1, random_state = 123)
      X_msm, y_msm = msm2.sample(X_msm.values, y_msm.values)
      X_msm = pd.DataFrame(columns = X_train_ord.columns, data=X_msm)
      y_msm = pd.Series(data = y_msm)
```

```
2021-06-04 16:59:06,881:INFO:MSMOTE: Running sampling via ('MSMOTE',
"{'proportion': 28, 'n_neighbors': 5, 'n_jobs': 1, 'random_state': 123}")
```

```
2021-06-04 16:59:06,912:INFO:MSMOTE: Running sampling via ('MSMOTE',
"{'proportion': 1, 'n_neighbors': 5, 'n_jobs': 1, 'random_state': 123}")
```

[ ]:

0.6.4 Feature Importance

Chi-squared is used for determining feature importance. source

```python
[84]: fs = SelectKBest(score_func=chi2, k='all')
      fs.fit(X_sm.to_numpy() , y_sm.to_numpy() )
      X_train_fs = fs.transform(X_sm.to_numpy() )
      X_test_fs = fs.transform(X_test_ord.to_numpy())
```

```python
[85]: df_features = pd.DataFrame()
      df_features['Features'] = X_test_ord.columns
      df_features['Scores'] = np.round(fs.scores_,2)
      df_features = df_features.sort_values('Scores', ascending=False)
```

```python
[86]: # plot the scores
      ax = sns.barplot(x="Scores", y="Features", data=df_features)
```
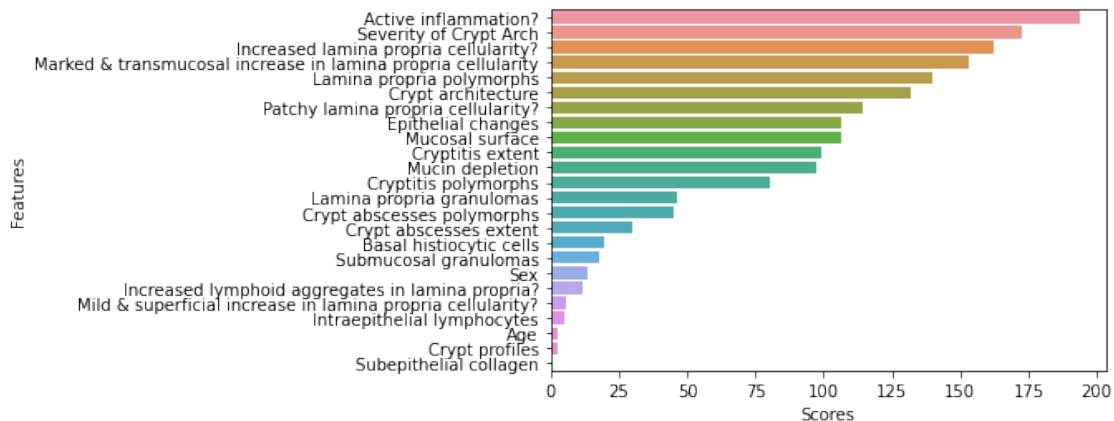


```python
[87]: # fit the model
      # data = [X_sm, X_test_ord, y_sm, y_test_ord]
      model = LogisticRegression(solver='lbfgs')
      t = model.fit(X_sm, y_sm)
      # evaluate the model
      yhat = model.predict(X_test_ord)
      # evaluate predictions
      accuracy = accuracy_score(y_test_ord, yhat)
      print('Accuracy: %.2f' % (accuracy*100))
```

```
Accuracy: 61.58
```

45

```
[88]:  assigned = y_sm.unique()
       assigned
```

```
[88]:  array(['UC', 'CROHNS', 'NORMAL'], dtype=object)
```

```
[89]:  df_logit = pd.DataFrame()
       df_logit['Attributes'] = X_sm.columns
       for l in range(0, len(model.coef_)):
           df_logit['data_'+str(assigned[l])] = abs(model.coef_[l])
       df_logit = df_logit.sort_values(by='data_UC', ascending = False)
       # plot the scores
       ax = sns.barplot(x="data_UC", y="Attributes", data=df_logit)
```
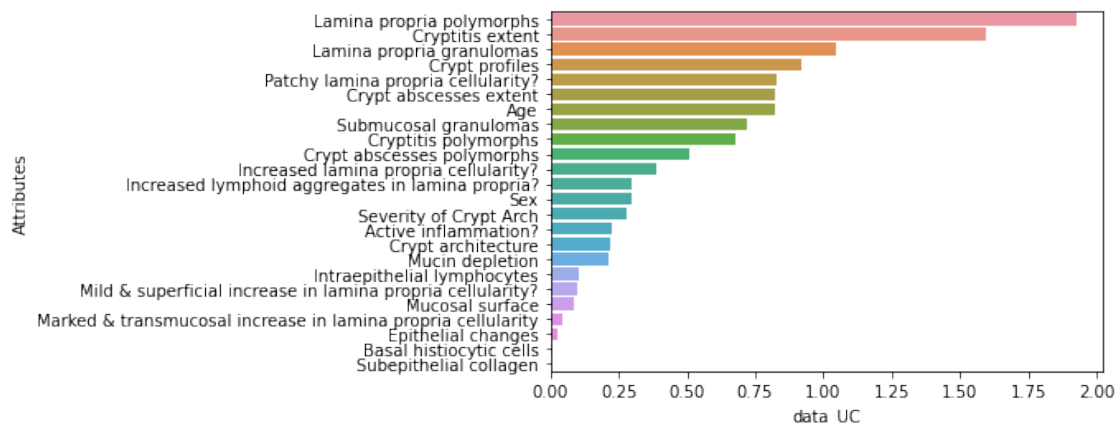


```
[90]:  ax = sns.barplot(x="data_CROHNS", y="Attributes", data=df_logit)
```
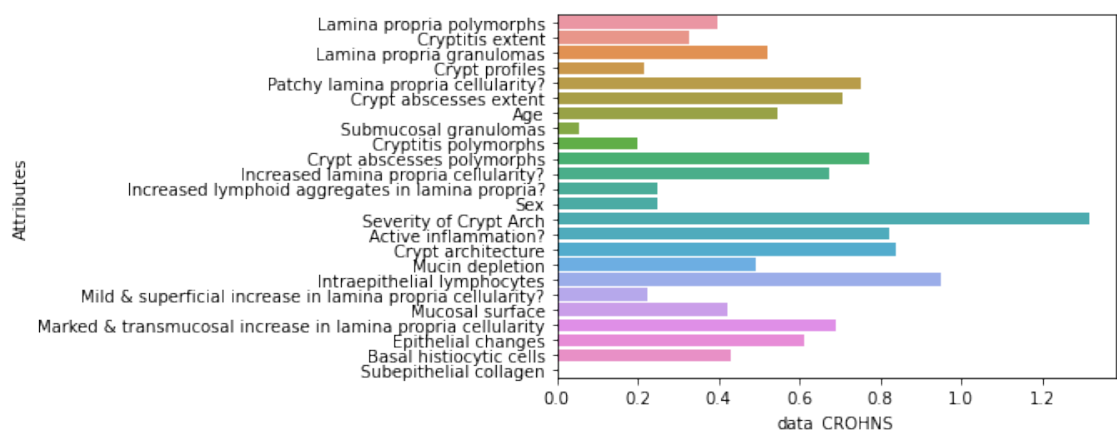


```
[91]:  ax = sns.barplot(x="data_NORMAL", y="Attributes", data=df_logit)
```
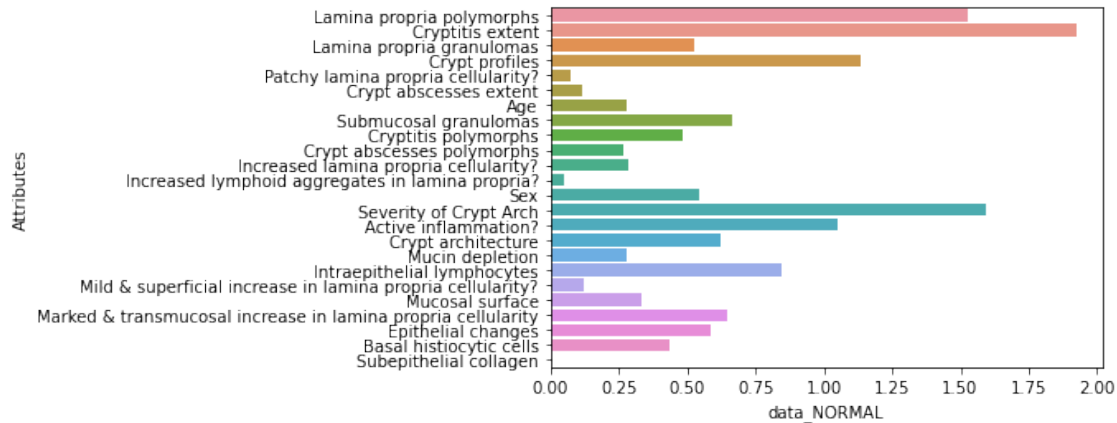
0.6.5 ETL PipeLine

confirmed to not be needed considering time constraint.

0.7 ## Machine Learning Models

0.7.1 Parameter Tuning

```python
[92]: modelCompare = {'model': [], 'features': [], 'accuracy': [], 'f1': [],
                     'precision': [], 'recall': [], 'params': []}
```

```python
[93]: def hyper_search(modelDictionary, modelParamDictionary, data, features):
          # define empty dictionaries to start
          modelAccuracy = 0
          bestModel = {}
          df_tmp = pd.DataFrame()
          modelCompare = pd.DataFrame()
          features1 = ', '.join(map(str, features))

          # iterate through the model dictionary to execute each model
          for key, value in modelDictionary.items():
              accuracyDics = {}
              finalResults = {}
              print(f'\r\nProcessing Model: {key}')

              # get the hyper parameter dictionary listings for the specific model
              paramDictionary = modelParamDictionary[key]

              # build out all permutations
              keys, values = zip(*paramDictionary.items())
              paramList = [dict(zip(keys, v)) for v in itertools.product(*values)]

              for dic in paramList:
```

```python
        finalResults = main(value, data, dic)
        accuracyDics.update(groupClassifiers(finalResults))

    bestScore = 0
    avgAccuracy = 0
    plotScore = {}
    for k in accuracyDics:
        for a in accuracyDics[k][0]:
            k1 = {}
            k1 = k[:k.index('(')]
            avgAccuracy = statistics.mean(accuracyDics[k][0]['accuracy'])
            avgF1 = statistics.mean(accuracyDics[k][0]['f1'])
            avgPrecision = statistics.mean(accuracyDics[k][0]['precision'])
            avgRecall = statistics.mean(accuracyDics[k][0]['recall'])
            param = accuracyDics[k][0]['params']
            if avgAccuracy > bestScore:
                bestScore = avgAccuracy
                plotScore.clear()
                plotScore = {'classifier': k1,
                             'features': features1,
                             'accuracy': accuracyDics[k][0]['accuracy'],
                             'avgAccuracy': avgAccuracy,
                             'f1': accuracyDics[k][0]['f1'],
                             'avgF1': avgF1,
                             'precision': accuracyDics[k][0]['precision'],
                             'avgPrecision': avgPrecision,
                             'recall': accuracyDics[k][0]['recall'],
                             'avgRecall': avgRecall,
                             'params': param}

    # plot_models(plotScore)

    df_tmp = pd.DataFrame({'model': plotScore['classifier'],
                'features': plotScore['features'],
                'accuracy': plotScore['avgAccuracy'],
                'f1': plotScore['avgF1'],
                'precision': plotScore['avgPrecision'],
                'recall': plotScore['avgRecall'],
                'params': plotScore['params']})
    modelCompare = modelCompare.append(df_tmp, ignore_index=True)
    df_tmp = df_tmp[0:0]

    print(f'***************************************************')
    print(f'* {key}')
    print(f'* Best Params Result: ')
    print(f'* {plotScore}')
    print(f'***************************************************')
```

```
        if bestScore > modelAccuracy:
            modelAccuracy = avgAccuracy
            bestModel.clear()
            bestModel = plotScore
    print(f'****************************************************')
    print(f'* Best Performing Model and Params is:')
    print(f'* {bestModel}')
    print(f'****************************************************')

    print(f'\r\n{modelCompare}')
```

```
[94]: def main(clfr, data, clfrHyperParams={}):
          X_, y_, n_folds = data
          kf = KFold(n_splits=n_folds)
          ret = {}

          for id, (trainIndex, testIndex) in enumerate(kf.split(X_, y_)):
              clf = clfr(**clfrHyperParams)
              clf.fit(X_[trainIndex], y_[trainIndex])
              pred = clf.predict(X_[testIndex])
              ret[id] = {'classifier': clf,
                         'accuracy': accuracy_score(y_[testIndex], pred),
                         'f1': f1_score(y_[testIndex], pred, average='weighted'),
                         'precision': precision_score(y_[testIndex], pred,
      →average='micro'),
                         'recall': recall_score(y_[testIndex], pred, average='micro'),
                         'params': clf.get_params(deep=True)}

          #print(classification_report(pred, y_[testIndex]))
          return ret
```

```
[95]: def groupClassifiers(resultsDict):
          accuraccyDict = {}

          for key in resultsDict:
              c = resultsDict[key]['classifier']
              a = resultsDict[key]['accuracy']
              f = resultsDict[key]['f1']
              p = resultsDict[key]['precision']
              r = resultsDict[key]['recall']
              params = resultsDict[key]['params']
              c_ = str(c).strip()

              # Then check if the string value 'c_' exists as a key in the dictionary
              if c_ in accuraccyDict:
                  accuraccyDict[c_][0]['accuracy'].append(a)
                  accuraccyDict[c_][0]['f1'].append(f)
```

```
                accuraccyDict[c_][0]['precision'].append(p)
                accuraccyDict[c_][0]['recall'].append(r)
            else:
                accuraccyDict[c_] = [{'accuracy': [a], 'f1': [f],
                                      'precision': [p], 'recall': [r],
                                      'params': [params]}]

        return(accuraccyDict)
```

```python
[96]: def plot_models(accuraccyDict):
          plt.rcParams.update ({'text.usetex': False,
                                'font.family': 'stixgeneral',
                                'mathtext.fontset': 'stix'})
          # create a new histogram with a given dictionary key's values
          fig = plt.figure(figsize=(8, 8))
          ax = fig.add_subplot(1, 1, 1)
          plt.hist(accuraccyDict['accuracy'], facecolor='green', alpha=0.75, bins=8)
          plt.text(.20, .5, 'Accuracy Score: ' + str(accuraccyDict['avgAccuracy']) +␣
      ↪'\nF1 Score: ' + str(accuraccyDict['avgF1']))
          ax.set_title(accuraccyDict['classifier'], fontsize=15)
          ax.set_xlabel('Classifer Accuracy (By K-Fold)', fontsize=15)
          ax.set_ylabel('Frequency', fontsize=15)
          ax.xaxis.set_ticks(np.arange(0, 1.1, 0.1))
          ax.yaxis.set_ticks(np.arange(0, .5, 1))
          ax.xaxis.set_tick_params(labelsize=15)
          ax.yaxis.set_tick_params(labelsize=15)
          plt.subplots_adjust(left=0.125, right=0.9, bottom=0.1,
                              top=0.6, wspace=0.2, hspace=0.2)
          plt.show()
```

```python
[97]: modelDictionary = {
          'RandomForestClassifier': RandomForestClassifier,
          'KNeighborsClassifier': KNeighborsClassifier,
          'LogisticRegression': LogisticRegression,
          'GaussianNB': GaussianNB,
          'AdaBoostClassifier': AdaBoostClassifier,
          'DecisionTreeClassifier': DecisionTreeClassifier,
          'SVC': SVC,
          'MLPClassifier': MLPClassifier
      }
```

```python
[98]: modelParamsDictionary = {
          'RandomForestClassifier': {   # https://sklearn.org/modules/generated/
      ↪sklearn.ensemble.RandomForestClassifier.html
              'n_estimators': [200, 500, 700],
              'criterion': ['gini', 'entropy'],
              'max_features': ["auto", "sqrt", "log2"],
```

```python
        'bootstrap': [True],
        'oob_score': [True, False],
        'n_jobs': [-1]
    },
    'KNeighborsClassifier': {  # https://sklearn.org/modules/generated/sklearn.
    ↪neighbors.KNeighborsClassifier.html
        'n_neighbors': np.arange(12, 18),
        'weights': ['uniform', 'distance'],
        'algorithm': ['auto', 'ball_tree', 'kd_tree', 'brute'],
        'n_jobs': [-1]
    },
    'LogisticRegression': {  # https://sklearn.org/modules/generated/sklearn.
    ↪linear_model.LogisticRegression.html
        'C': [0.0001, 0.001, 1],
        'solver': ['newton-cg', 'lbfgs'],
        'multi_class': ['ovr', 'multinomial'],
        'max_iter': [100, 1000],
        'n_jobs': [-1]
    },
    'GaussianNB': {  # https://sklearn.org/modules/naive_bayes.
    ↪html#gaussian-naive-bayes
        'var_smoothing': [1e-9]
    },
    'AdaBoostClassifier': {   # https://sklearn.org/modules/generated/sklearn.
    ↪ensemble.AdaBoostClassifier.html
        'n_estimators': [20, 50, 100, 300],
        'learning_rate': [1]
    },
    'DecisionTreeClassifier': {   # https://sklearn.org/modules/generated/
    ↪sklearn.tree.DecisionTreeClassifier.html
        'criterion': ['gini', 'entropy'],
        'splitter': ['best', 'random'],
        'max_features': ["auto", "sqrt", "log2"]
    },
    'SVC': {     # https://sklearn.org/modules/generated/sklearn.svm.SVC.html
        'C': [0.0001, 0.001, 1.0],
        'kernel': ['linear'],
        'gamma': ['scale', 'auto'],
        'cache_size': [4000]
    },
    'MLPClassifier': {     # https://sklearn.org/modules/generated/sklearn.
    ↪neural_network.MLPClassifier.html
        'activation': ['identity', 'logistic'],
        'solver': ['adam'],
        'learning_rate': ['constant', 'invscaling', 'adaptive'],
        'max_iter': [5000, 7000, 9000]
```

```
        }
    }
```

```
[99]:  now = datetime.datetime.now()
       print ("Current date and time : ")
       print (now.strftime("%Y-%m-%d %H:%M:%S"))
```

Current date and time :
2021-06-04 16:59:22

```
[100]:  n_folds = 5
        l = len(df_features['Features']) - 1
        df = df_features['Features']

        # SMOTE Dataset
        X = pd.concat([X_sm, X_test_ord]) #.to_numpy()
        y = pd.concat([y_sm, y_test_ord]).to_numpy()
        #data = (X, y, n_folds)

        print('*******************************************')
        print('Starting SMOTE data set....')
        print('*******************************************')

        for i in range(l ,6 , -1):
            col = []
            col = df[:i]
            nX = X.loc[:, col]
            nX = nX.to_numpy()
            data = (nX, y, n_folds)
            hyper_search(modelDictionary, modelParamsDictionary, data, col)
```

****
Starting SMOTE data set…
****

Processing Model: RandomForestClassifier
****
* RandomForestClassifier
* Best Params Result:
* {'classifier': 'RandomForestClassifier', 'features': 'Active inflammation?,
Severity of Crypt Arch, Increased lamina propria cellularity?, Marked &
transmucosal increase in lamina propria cellularity, Lamina propria polymorphs,
Crypt architecture, Patchy lamina propria cellularity?, Epithelial changes,
Mucosal surface, Cryptitis extent, Mucin depletion, Cryptitis polymorphs, Lamina
propria granulomas, Crypt abscesses polymorphs, Crypt abscesses extent, Basal
histiocytic cells, Submucosal granulomas, Sex, Increased lymphoid aggregates in
lamina propria?, Mild & superficial increase in lamina propria cellularity?,
Intraepithelial lymphocytes, Age, Crypt profiles', 'accuracy': [0.676, 0.68,

0.751004016064257, 0.7389558232931727, 0.6385542168674698], 'avgAccuracy':
0.6969028112449799, 'f1': [0.6843477817457303, 0.6797455863079177,
0.7736924970509405, 0.7884248433552893, 0.6514853306686885], 'avgF1':
0.7155392078257132, 'precision': [0.676, 0.68, 0.751004016064257,
0.7389558232931727, 0.6385542168674698], 'avgPrecision': 0.6969028112449799,
'recall': [0.676, 0.68, 0.751004016064257, 0.7389558232931727,
0.6385542168674698], 'avgRecall': 0.6969028112449799, 'params': [{'bootstrap':
True, 'ccp_alpha': 0.0, 'class_weight': None, 'criterion': 'entropy',
'max_depth': None, 'max_features': 'auto', 'max_leaf_nodes': None,
'max_samples': None, 'min_impurity_decrease': 0.0, 'min_impurity_split': None,
'min_samples_leaf': 1, 'min_samples_split': 2, 'min_weight_fraction_leaf': 0.0,
'n_estimators': 200, 'n_jobs': -1, 'oob_score': True, 'random_state': None,
'verbose': 0, 'warm_start': False}]}
****

Processing Model: KNeighborsClassifier
****
* KNeighborsClassifier
* Best Params Result:
* {'classifier': 'KNeighborsClassifier', 'features': 'Active inflammation?,
Severity of Crypt Arch, Increased lamina propria cellularity?, Marked &
transmucosal increase in lamina propria cellularity, Lamina propria polymorphs,
Crypt architecture, Patchy lamina propria cellularity?, Epithelial changes,
Mucosal surface, Cryptitis extent, Mucin depletion, Cryptitis polymorphs, Lamina
propria granulomas, Crypt abscesses polymorphs, Crypt abscesses extent, Basal
histiocytic cells, Submucosal granulomas, Sex, Increased lymphoid aggregates in
lamina propria?, Mild & superficial increase in lamina propria cellularity?,
Intraepithelial lymphocytes, Age, Crypt profiles', 'accuracy': [0.608, 0.672,
0.6626506024096386, 0.7269076305220884, 0.5983935742971888], 'avgAccuracy':
0.6535903614457832, 'f1': [0.6212027094772695, 0.6792143367366666,
0.6874540387823533, 0.7730423174031303, 0.6165403629259051], 'avgF1':
0.675490753065065, 'precision': [0.608, 0.672, 0.6626506024096386,
0.7269076305220884, 0.5983935742971888], 'avgPrecision': 0.6535903614457832,
'recall': [0.608, 0.672, 0.6626506024096386, 0.7269076305220884,
0.5983935742971888], 'avgRecall': 0.6535903614457832, 'params': [{'algorithm':
'auto', 'leaf_size': 30, 'metric': 'minkowski', 'metric_params': None, 'n_jobs':
-1, 'n_neighbors': 14, 'p': 2, 'weights': 'distance'}]}
****

Processing Model: LogisticRegression
****
* LogisticRegression
* Best Params Result:
* {'classifier': 'LogisticRegression', 'features': 'Active inflammation?,
Severity of Crypt Arch, Increased lamina propria cellularity?, Marked &
transmucosal increase in lamina propria cellularity, Lamina propria polymorphs,
Crypt architecture, Patchy lamina propria cellularity?, Epithelial changes,
Mucosal surface, Cryptitis extent, Mucin depletion, Cryptitis polymorphs, Lamina

propria granulomas, Crypt abscesses polymorphs, Crypt abscesses extent, Basal histiocytic cells, Submucosal granulomas, Sex, Increased lymphoid aggregates in lamina propria?, Mild & superficial increase in lamina propria cellularity?, Intraepithelial lymphocytes, Age, Crypt profiles', 'accuracy': [0.616, 0.66, 0.46184738955823296, 0.7670682730923695, 0.6827309236947792], 'avgAccuracy': 0.6375293172690764, 'f1': [0.6257197926880516, 0.6625024282542604, 0.46907030347764483, 0.816511500547645, 0.681610328835315], 'avgF1': 0.6510828707605834, 'precision': [0.616, 0.66, 0.46184738955823296, 0.7670682730923695, 0.6827309236947792], 'avgPrecision': 0.6375293172690764, 'recall': [0.616, 0.66, 0.46184738955823296, 0.7670682730923695, 0.6827309236947792], 'avgRecall': 0.6375293172690764, 'params': [{'C': 1, 'class_weight': None, 'dual': False, 'fit_intercept': True, 'intercept_scaling': 1, 'l1_ratio': None, 'max_iter': 100, 'multi_class': 'ovr', 'n_jobs': -1, 'penalty': 'l2', 'random_state': None, 'solver': 'newton-cg', 'tol': 0.0001, 'verbose': 0, 'warm_start': False}]}
****

Processing Model: GaussianNB
****
* GaussianNB
* Best Params Result:
* {'classifier': 'GaussianNB', 'features': 'Active inflammation?, Severity of Crypt Arch, Increased lamina propria cellularity?, Marked & transmucosal increase in lamina propria cellularity, Lamina propria polymorphs, Crypt architecture, Patchy lamina propria cellularity?, Epithelial changes, Mucosal surface, Cryptitis extent, Mucin depletion, Cryptitis polymorphs, Lamina propria granulomas, Crypt abscesses polymorphs, Crypt abscesses extent, Basal histiocytic cells, Submucosal granulomas, Sex, Increased lymphoid aggregates in lamina propria?, Mild & superficial increase in lamina propria cellularity?, Intraepithelial lymphocytes, Age, Crypt profiles', 'accuracy': [0.588, 0.672, 0.3453815261044177, 0.751004016064257, 0.6867469879518072], 'avgAccuracy': 0.6086265060240964, 'f1': [0.5576104106761041, 0.6295500532815145, 0.2694793077375823, 0.7316619027678241, 0.6426737440139134], 'avgF1': 0.5661950836953876, 'precision': [0.588, 0.672, 0.3453815261044177, 0.751004016064257, 0.6867469879518072], 'avgPrecision': 0.6086265060240964, 'recall': [0.588, 0.672, 0.3453815261044177, 0.751004016064257, 0.6867469879518072], 'avgRecall': 0.6086265060240964, 'params': [{'priors': None, 'var_smoothing': 1e-09}]}
****

Processing Model: AdaBoostClassifier
****
* AdaBoostClassifier
* Best Params Result:
* {'classifier': 'AdaBoostClassifier', 'features': 'Active inflammation?, Severity of Crypt Arch, Increased lamina propria cellularity?, Marked & transmucosal increase in lamina propria cellularity, Lamina propria polymorphs, Crypt architecture, Patchy lamina propria cellularity?, Epithelial changes,

Mucosal surface, Cryptitis extent, Mucin depletion, Cryptitis polymorphs, Lamina propria granulomas, Crypt abscesses polymorphs, Crypt abscesses extent, Basal histiocytic cells, Submucosal granulomas, Sex, Increased lymphoid aggregates in lamina propria?, Mild & superficial increase in lamina propria cellularity?, Intraepithelial lymphocytes, Age, Crypt profiles', 'accuracy': [0.636, 0.672, 0.4578313253012048, 0.7951807228915663, 0.4819277108433735], 'avgAccuracy': 0.6085879518072289, 'f1': [0.6360818176736339, 0.6714914665821983, 0.46987316235799836, 0.8232521148585252, 0.46934052126617612], 'avgF1': 0.6140078165468233, 'precision': [0.636, 0.672, 0.4578313253012048, 0.7951807228915663, 0.4819277108433735], 'avgPrecision': 0.6085879518072289, 'recall': [0.636, 0.672, 0.4578313253012048, 0.7951807228915663, 0.4819277108433735], 'avgRecall': 0.6085879518072289, 'params': [{'algorithm': 'SAMME.R', 'base_estimator': None, 'learning_rate': 1, 'n_estimators': 50, 'random_state': None}]}
****

Processing Model: DecisionTreeClassifier
****
* DecisionTreeClassifier
* Best Params Result:
* {'classifier': 'DecisionTreeClassifier', 'features': 'Active inflammation?, Severity of Crypt Arch, Increased lamina propria cellularity?, Marked & transmucosal increase in lamina propria cellularity, Lamina propria polymorphs, Crypt architecture, Patchy lamina propria cellularity?, Epithelial changes, Mucosal surface, Cryptitis extent, Mucin depletion, Cryptitis polymorphs, Lamina propria granulomas, Crypt abscesses polymorphs, Crypt abscesses extent, Basal histiocytic cells, Submucosal granulomas, Sex, Increased lymphoid aggregates in lamina propria?, Mild & superficial increase in lamina propria cellularity?, Intraepithelial lymphocytes, Age, Crypt profiles', 'accuracy': [0.632, 0.632, 0.7349397590361446, 0.7108433734939759, 0.6345381526104418], 'avgAccuracy': 0.6688642570281125, 'f1': [0.6447027106556809, 0.633489226029003, 0.7561257665369766, 0.7573898399349978, 0.6441466486943892], 'avgF1': 0.6871708383702095, 'precision': [0.632, 0.632, 0.7349397590361446, 0.7108433734939759, 0.6345381526104418], 'avgPrecision': 0.6688642570281125, 'recall': [0.632, 0.632, 0.7349397590361446, 0.7108433734939759, 0.6345381526104418], 'avgRecall': 0.6688642570281125, 'params': [{'ccp_alpha': 0.0, 'class_weight': None, 'criterion': 'gini', 'max_depth': None, 'max_features': 'auto', 'max_leaf_nodes': None, 'min_impurity_decrease': 0.0, 'min_impurity_split': None, 'min_samples_leaf': 1, 'min_samples_split': 2, 'min_weight_fraction_leaf': 0.0, 'random_state': None, 'splitter': 'best'}]}
****

Processing Model: SVC
****
* SVC
* Best Params Result:
* {'classifier': 'SVC', 'features': 'Active inflammation?, Severity of Crypt Arch, Increased lamina propria cellularity?, Marked & transmucosal increase in

lamina propria cellularity, Lamina propria polymorphs, Crypt architecture,
Patchy lamina propria cellularity?, Epithelial changes, Mucosal surface,
Cryptitis extent, Mucin depletion, Cryptitis polymorphs, Lamina propria
granulomas, Crypt abscesses polymorphs, Crypt abscesses extent, Basal
histiocytic cells, Submucosal granulomas, Sex, Increased lymphoid aggregates in
lamina propria?, Mild & superficial increase in lamina propria cellularity?,
Intraepithelial lymphocytes, Age, Crypt profiles', 'accuracy': [0.608, 0.656,
0.4738955823293173, 0.7791164658634538, 0.6586345381526104], 'avgAccuracy':
0.6351293172690763, 'f1': [0.6175624349659438, 0.646012858517298,
0.48412622791240895, 0.8094126773397294, 0.6489388470434405], 'avgF1':
0.6412106091557641, 'precision': [0.608, 0.656, 0.4738955823293173,
0.7791164658634538, 0.6586345381526104], 'avgPrecision': 0.6351293172690763,
'recall': [0.608, 0.656, 0.4738955823293173, 0.7791164658634538,
0.6586345381526104], 'avgRecall': 0.6351293172690763, 'params': [{'C': 1.0,
'break_ties': False, 'cache_size': 4000, 'class_weight': None, 'coef0': 0.0,
'decision_function_shape': 'ovr', 'degree': 3, 'gamma': 'scale', 'kernel':
'linear', 'max_iter': -1, 'probability': False, 'random_state': None,
'shrinking': True, 'tol': 0.001, 'verbose': False}]}
****

Processing Model: MLPClassifier
****
* MLPClassifier
* Best Params Result:
* {'classifier': 'MLPClassifier', 'features': 'Active inflammation?, Severity of
Crypt Arch, Increased lamina propria cellularity?, Marked & transmucosal
increase in lamina propria cellularity, Lamina propria polymorphs, Crypt
architecture, Patchy lamina propria cellularity?, Epithelial changes, Mucosal
surface, Cryptitis extent, Mucin depletion, Cryptitis polymorphs, Lamina propria
granulomas, Crypt abscesses polymorphs, Crypt abscesses extent, Basal
histiocytic cells, Submucosal granulomas, Sex, Increased lymphoid aggregates in
lamina propria?, Mild & superficial increase in lamina propria cellularity?,
Intraepithelial lymphocytes, Age, Crypt profiles', 'accuracy': [0.652, 0.664,
0.46586345381526106, 0.7751004016064257, 0.6706827309236948], 'avgAccuracy':
0.6455293172690764, 'f1': [0.6627413454270596, 0.6596856712241074,
0.476705161193113, 0.8158712159562621, 0.6688274956274098], 'avgF1':
0.6567661778855904, 'precision': [0.652, 0.664, 0.46586345381526106,
0.7751004016064257, 0.6706827309236948], 'avgPrecision': 0.6455293172690764,
'recall': [0.652, 0.664, 0.46586345381526106, 0.7751004016064257,
0.6706827309236948], 'avgRecall': 0.6455293172690764, 'params': [{'activation':
'logistic', 'alpha': 0.0001, 'batch_size': 'auto', 'beta_1': 0.9, 'beta_2':
0.999, 'early_stopping': False, 'epsilon': 1e-08, 'hidden_layer_sizes': (100,),
'learning_rate': 'adaptive', 'learning_rate_init': 0.001, 'max_fun': 15000,
'max_iter': 7000, 'momentum': 0.9, 'n_iter_no_change': 10, 'nesterovs_momentum':
True, 'power_t': 0.5, 'random_state': None, 'shuffle': True, 'solver': 'adam',
'tol': 0.0001, 'validation_fraction': 0.1, 'verbose': False, 'warm_start':
False}]}
****

```
****************************************************
* Best Performing Model and Params is:
* {'classifier': 'RandomForestClassifier', 'features': 'Active inflammation?,
Severity of Crypt Arch, Increased lamina propria cellularity?, Marked &
transmucosal increase in lamina propria cellularity, Lamina propria polymorphs,
Crypt architecture, Patchy lamina propria cellularity?, Epithelial changes,
Mucosal surface, Cryptitis extent, Mucin depletion, Cryptitis polymorphs, Lamina
propria granulomas, Crypt abscesses polymorphs, Crypt abscesses extent, Basal
histiocytic cells, Submucosal granulomas, Sex, Increased lymphoid aggregates in
lamina propria?, Mild & superficial increase in lamina propria cellularity?,
Intraepithelial lymphocytes, Age, Crypt profiles', 'accuracy': [0.676, 0.68,
0.751004016064257, 0.7389558232931727, 0.6385542168674698], 'avgAccuracy':
0.6969028112449799, 'f1': [0.6843477817457303, 0.6797455863079177,
0.7736924970509405, 0.7884248433552893, 0.6514853306686885], 'avgF1':
0.7155392078257132, 'precision': [0.676, 0.68, 0.751004016064257,
0.7389558232931727, 0.6385542168674698], 'avgPrecision': 0.6969028112449799,
'recall': [0.676, 0.68, 0.751004016064257, 0.7389558232931727,
0.6385542168674698], 'avgRecall': 0.6969028112449799, 'params': [{'bootstrap':
True, 'ccp_alpha': 0.0, 'class_weight': None, 'criterion': 'entropy',
'max_depth': None, 'max_features': 'auto', 'max_leaf_nodes': None,
'max_samples': None, 'min_impurity_decrease': 0.0, 'min_impurity_split': None,
'min_samples_leaf': 1, 'min_samples_split': 2, 'min_weight_fraction_leaf': 0.0,
'n_estimators': 200, 'n_jobs': -1, 'oob_score': True, 'random_state': None,
'verbose': 0, 'warm_start': False}]}
****************************************************

                    model                                          features  \
0  RandomForestClassifier  Active inflammation?, Severity of Crypt Arch, …
1    KNeighborsClassifier  Active inflammation?, Severity of Crypt Arch, …
2      LogisticRegression  Active inflammation?, Severity of Crypt Arch, …
3              GaussianNB  Active inflammation?, Severity of Crypt Arch, …
4       AdaBoostClassifier  Active inflammation?, Severity of Crypt Arch, …
5  DecisionTreeClassifier  Active inflammation?, Severity of Crypt Arch, …
6                     SVC  Active inflammation?, Severity of Crypt Arch, …
7           MLPClassifier  Active inflammation?, Severity of Crypt Arch, …

   accuracy        f1  precision    recall  \
0  0.696903  0.715539   0.696903  0.696903
1  0.653590  0.675491   0.653590  0.653590
2  0.637529  0.651083   0.637529  0.637529
3  0.608627  0.566195   0.608627  0.608627
4  0.608588  0.614008   0.608588  0.608588
5  0.668864  0.687171   0.668864  0.668864
6  0.635129  0.641211   0.635129  0.635129
7  0.645529  0.656766   0.645529  0.645529


                                               params
0  {'bootstrap': True, 'ccp_alpha': 0.0, 'class_w…
```

```
1  {'algorithm': 'auto', 'leaf_size': 30, 'metric…
2  {'C': 1, 'class_weight': None, 'dual': False, …
3          {'priors': None, 'var_smoothing': 1e-09}
4  {'algorithm': 'SAMME.R', 'base_estimator': Non…
5  {'ccp_alpha': 0.0, 'class_weight': None, 'crit…
6  {'C': 1.0, 'break_ties': False, 'cache_size': …
7  {'activation': 'logistic', 'alpha': 0.0001, 'b…
```

Processing Model: RandomForestClassifier
****
* RandomForestClassifier
* Best Params Result:
* {'classifier': 'RandomForestClassifier', 'features': 'Active inflammation?,
Severity of Crypt Arch, Increased lamina propria cellularity?, Marked &
transmucosal increase in lamina propria cellularity, Lamina propria polymorphs,
Crypt architecture, Patchy lamina propria cellularity?, Epithelial changes,
Mucosal surface, Cryptitis extent, Mucin depletion, Cryptitis polymorphs, Lamina
propria granulomas, Crypt abscesses polymorphs, Crypt abscesses extent, Basal
histiocytic cells, Submucosal granulomas, Sex, Increased lymphoid aggregates in
lamina propria?, Mild & superficial increase in lamina propria cellularity?,
Intraepithelial lymphocytes, Age', 'accuracy': [0.668, 0.676,
0.7469879518072289, 0.751004016064257, 0.6345381526104418], 'avgAccuracy':
0.6953060240963855, 'f1': [0.6775274295828614, 0.6761017063249318,
0.7687731731922938, 0.7955317510644079, 0.6472418997664489], 'avgF1':
0.7130351919861887, 'precision': [0.668, 0.676, 0.7469879518072289,
0.751004016064257, 0.6345381526104418], 'avgPrecision': 0.6953060240963855,
'recall': [0.668, 0.676, 0.7469879518072289, 0.751004016064257,
0.6345381526104418], 'avgRecall': 0.6953060240963855, 'params': [{'bootstrap':
True, 'ccp_alpha': 0.0, 'class_weight': None, 'criterion': 'gini', 'max_depth':
None, 'max_features': 'auto', 'max_leaf_nodes': None, 'max_samples': None,
'min_impurity_decrease': 0.0, 'min_impurity_split': None, 'min_samples_leaf': 1,
'min_samples_split': 2, 'min_weight_fraction_leaf': 0.0, 'n_estimators': 700,
'n_jobs': -1, 'oob_score': False, 'random_state': None, 'verbose': 0,
'warm_start': False}]}
****

Processing Model: KNeighborsClassifier
****
* KNeighborsClassifier
* Best Params Result:
* {'classifier': 'KNeighborsClassifier', 'features': 'Active inflammation?,
Severity of Crypt Arch, Increased lamina propria cellularity?, Marked &
transmucosal increase in lamina propria cellularity, Lamina propria polymorphs,
Crypt architecture, Patchy lamina propria cellularity?, Epithelial changes,
Mucosal surface, Cryptitis extent, Mucin depletion, Cryptitis polymorphs, Lamina
propria granulomas, Crypt abscesses polymorphs, Crypt abscesses extent, Basal
histiocytic cells, Submucosal granulomas, Sex, Increased lymphoid aggregates in
lamina propria?, Mild & superficial increase in lamina propria cellularity?,

Intraepithelial lymphocytes, Age', 'accuracy': [0.616, 0.684,
0.6666666666666666, 0.7269076305220884, 0.606425702811245], 'avgAccuracy': 0.66,
'f1': [0.629412841918661, 0.6902711385861512, 0.6910229007765621,
0.7717906474233048, 0.6234106183546803], 'avgF1': 0.6811816294118719,
'precision': [0.616, 0.684, 0.6666666666666666, 0.7269076305220884,
0.606425702811245], 'avgPrecision': 0.66, 'recall': [0.616, 0.684,
0.6666666666666666, 0.7269076305220884, 0.606425702811245], 'avgRecall': 0.66,
'params': [{'algorithm': 'auto', 'leaf_size': 30, 'metric': 'minkowski',
'metric_params': None, 'n_jobs': -1, 'n_neighbors': 14, 'p': 2, 'weights':
'distance'}]}
****

Processing Model: LogisticRegression
****
* LogisticRegression
* Best Params Result:
* {'classifier': 'LogisticRegression', 'features': 'Active inflammation?,
Severity of Crypt Arch, Increased lamina propria cellularity?, Marked &
transmucosal increase in lamina propria cellularity, Lamina propria polymorphs,
Crypt architecture, Patchy lamina propria cellularity?, Epithelial changes,
Mucosal surface, Cryptitis extent, Mucin depletion, Cryptitis polymorphs, Lamina
propria granulomas, Crypt abscesses polymorphs, Crypt abscesses extent, Basal
histiocytic cells, Submucosal granulomas, Sex, Increased lymphoid aggregates in
lamina propria?, Mild & superficial increase in lamina propria cellularity?,
Intraepithelial lymphocytes, Age', 'accuracy': [0.616, 0.664,
0.46184738955823296, 0.7670682730923695, 0.6827309236947792], 'avgAccuracy':
0.6383293172690763, 'f1': [0.6257197926880516, 0.6660364541463114,
0.46907030347764483, 0.816511500547645, 0.680455880458457], 'avgF1':
0.651558786263622, 'precision': [0.616, 0.664, 0.46184738955823296,
0.7670682730923695, 0.6827309236947792], 'avgPrecision': 0.6383293172690763,
'recall': [0.616, 0.664, 0.46184738955823296, 0.7670682730923695,
0.6827309236947792], 'avgRecall': 0.6383293172690763, 'params': [{'C': 1,
'class_weight': None, 'dual': False, 'fit_intercept': True, 'intercept_scaling':
1, 'l1_ratio': None, 'max_iter': 100, 'multi_class': 'ovr', 'n_jobs': -1,
'penalty': 'l2', 'random_state': None, 'solver': 'newton-cg', 'tol': 0.0001,
'verbose': 0, 'warm_start': False}]}
****

Processing Model: GaussianNB
****
* GaussianNB
* Best Params Result:
* {'classifier': 'GaussianNB', 'features': 'Active inflammation?, Severity of
Crypt Arch, Increased lamina propria cellularity?, Marked & transmucosal
increase in lamina propria cellularity, Lamina propria polymorphs, Crypt
architecture, Patchy lamina propria cellularity?, Epithelial changes, Mucosal
surface, Cryptitis extent, Mucin depletion, Cryptitis polymorphs, Lamina propria
granulomas, Crypt abscesses polymorphs, Crypt abscesses extent, Basal

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histiocytic cells, Submucosal granulomas, Sex, Increased lymphoid aggregates in lamina propria?, Mild & superficial increase in lamina propria cellularity?, Intraepithelial lymphocytes, Age', 'accuracy': [0.584, 0.672, 0.3453815261044177, 0.751004016064257, 0.6867469879518072], 'avgAccuracy': 0.6078265060240964, 'f1': [0.5542710465162077, 0.6295500532815145, 0.2694793077375823, 0.7316619027678241, 0.6426737440139134], 'avgF1': 0.5655272108634084, 'precision': [0.584, 0.672, 0.3453815261044177, 0.751004016064257, 0.6867469879518072], 'avgPrecision': 0.6078265060240964, 'recall': [0.584, 0.672, 0.3453815261044177, 0.751004016064257, 0.6867469879518072], 'avgRecall': 0.6078265060240964, 'params': [{'priors': None, 'var_smoothing': 1e-09}]}
****

Processing Model: AdaBoostClassifier
****
* AdaBoostClassifier
* Best Params Result:
* {'classifier': 'AdaBoostClassifier', 'features': 'Active inflammation?, Severity of Crypt Arch, Increased lamina propria cellularity?, Marked & transmucosal increase in lamina propria cellularity, Lamina propria polymorphs, Crypt architecture, Patchy lamina propria cellularity?, Epithelial changes, Mucosal surface, Cryptitis extent, Mucin depletion, Cryptitis polymorphs, Lamina propria granulomas, Crypt abscesses polymorphs, Crypt abscesses extent, Basal histiocytic cells, Submucosal granulomas, Sex, Increased lymphoid aggregates in lamina propria?, Mild & superficial increase in lamina propria cellularity?, Intraepithelial lymphocytes, Age', 'accuracy': [0.644, 0.636, 0.4738955823293173, 0.6626506024096386, 0.46987951807228917], 'avgAccuracy': 0.577285140562249, 'f1': [0.6469777204983312, 0.6496758391619376, 0.48827599901848495, 0.7192253175598321, 0.4725989195652984], 'avgF1': 0.5953507591607768, 'precision': [0.644, 0.636, 0.4738955823293173, 0.6626506024096386, 0.46987951807228917], 'avgPrecision': 0.577285140562249, 'recall': [0.644, 0.636, 0.4738955823293173, 0.6626506024096386, 0.46987951807228917], 'avgRecall': 0.577285140562249, 'params': [{'algorithm': 'SAMME.R', 'base_estimator': None, 'learning_rate': 1, 'n_estimators': 100, 'random_state': None}]}
****

Processing Model: DecisionTreeClassifier
****
* DecisionTreeClassifier
* Best Params Result:
* {'classifier': 'DecisionTreeClassifier', 'features': 'Active inflammation?, Severity of Crypt Arch, Increased lamina propria cellularity?, Marked & transmucosal increase in lamina propria cellularity, Lamina propria polymorphs, Crypt architecture, Patchy lamina propria cellularity?, Epithelial changes, Mucosal surface, Cryptitis extent, Mucin depletion, Cryptitis polymorphs, Lamina propria granulomas, Crypt abscesses polymorphs, Crypt abscesses extent, Basal histiocytic cells, Submucosal granulomas, Sex, Increased lymphoid aggregates in

lamina propria?, Mild & superficial increase in lamina propria cellularity?,
Intraepithelial lymphocytes, Age', 'accuracy': [0.644, 0.66, 0.7469879518072289,
0.7108433734939759, 0.5943775100401606], 'avgAccuracy': 0.6712417670682731,
'f1': [0.6531057930599261, 0.6603718250056866, 0.7691996290133664,
0.7647194723284316, 0.6129387680592501], 'avgF1': 0.6920670974933322,
'precision': [0.644, 0.66, 0.7469879518072289, 0.7108433734939759,
0.5943775100401606], 'avgPrecision': 0.6712417670682731, 'recall': [0.644, 0.66,
0.7469879518072289, 0.7108433734939759, 0.5943775100401606], 'avgRecall':
0.6712417670682731, 'params': [{'ccp_alpha': 0.0, 'class_weight': None,
'criterion': 'entropy', 'max_depth': None, 'max_features': 'log2',
'max_leaf_nodes': None, 'min_impurity_decrease': 0.0, 'min_impurity_split':
None, 'min_samples_leaf': 1, 'min_samples_split': 2, 'min_weight_fraction_leaf':
0.0, 'random_state': None, 'splitter': 'best'}]}
****

Processing Model: SVC
****
* SVC
* Best Params Result:
* {'classifier': 'SVC', 'features': 'Active inflammation?, Severity of Crypt
Arch, Increased lamina propria cellularity?, Marked & transmucosal increase in
lamina propria cellularity, Lamina propria polymorphs, Crypt architecture,
Patchy lamina propria cellularity?, Epithelial changes, Mucosal surface,
Cryptitis extent, Mucin depletion, Cryptitis polymorphs, Lamina propria
granulomas, Crypt abscesses polymorphs, Crypt abscesses extent, Basal
histiocytic cells, Submucosal granulomas, Sex, Increased lymphoid aggregates in
lamina propria?, Mild & superficial increase in lamina propria cellularity?,
Intraepithelial lymphocytes, Age', 'accuracy': [0.608, 0.656,
0.4779116465863454, 0.7791164658634538, 0.6586345381526104], 'avgAccuracy':
0.6359325301204819, 'f1': [0.6175624349659438, 0.646012858517298,
0.48783238857968164, 0.8094126773397294, 0.6489388470434405], 'avgF1':
0.6419518412892187, 'precision': [0.608, 0.656, 0.4779116465863454,
0.7791164658634538, 0.6586345381526104], 'avgPrecision': 0.6359325301204819,
'recall': [0.608, 0.656, 0.4779116465863454, 0.7791164658634538,
0.6586345381526104], 'avgRecall': 0.6359325301204819, 'params': [{'C': 1.0,
'break_ties': False, 'cache_size': 4000, 'class_weight': None, 'coef0': 0.0,
'decision_function_shape': 'ovr', 'degree': 3, 'gamma': 'scale', 'kernel':
'linear', 'max_iter': -1, 'probability': False, 'random_state': None,
'shrinking': True, 'tol': 0.001, 'verbose': False}]}
****

Processing Model: MLPClassifier
****
* MLPClassifier
* Best Params Result:
* {'classifier': 'MLPClassifier', 'features': 'Active inflammation?, Severity of
Crypt Arch, Increased lamina propria cellularity?, Marked & transmucosal
increase in lamina propria cellularity, Lamina propria polymorphs, Crypt

architecture, Patchy lamina propria cellularity?, Epithelial changes, Mucosal surface, Cryptitis extent, Mucin depletion, Cryptitis polymorphs, Lamina propria granulomas, Crypt abscesses polymorphs, Crypt abscesses extent, Basal histiocytic cells, Submucosal granulomas, Sex, Increased lymphoid aggregates in lamina propria?, Mild & superficial increase in lamina propria cellularity?, Intraepithelial lymphocytes, Age', 'accuracy': [0.64, 0.664, 0.46987951807228917, 0.7630522088353414, 0.678714859437751], 'avgAccuracy': 0.6431293172690763, 'f1': [0.6495362903225806, 0.6594448749767229, 0.4784778373684325, 0.8091783676057615, 0.6771190777153777], 'avgF1': 0.6547512895977751, 'precision': [0.64, 0.664, 0.46987951807228917, 0.7630522088353414, 0.678714859437751], 'avgPrecision': 0.6431293172690763, 'recall': [0.64, 0.664, 0.46987951807228917, 0.7630522088353414, 0.678714859437751], 'avgRecall': 0.6431293172690763, 'params': [{'activation': 'logistic', 'alpha': 0.0001, 'batch_size': 'auto', 'beta_1': 0.9, 'beta_2': 0.999, 'early_stopping': False, 'epsilon': 1e-08, 'hidden_layer_sizes': (100,), 'learning_rate': 'adaptive', 'learning_rate_init': 0.001, 'max_fun': 15000, 'max_iter': 9000, 'momentum': 0.9, 'n_iter_no_change': 10, 'nesterovs_momentum': True, 'power_t': 0.5, 'random_state': None, 'shuffle': True, 'solver': 'adam', 'tol': 0.0001, 'validation_fraction': 0.1, 'verbose': False, 'warm_start': False}]}
****
****
* Best Performing Model and Params is:
* {'classifier': 'RandomForestClassifier', 'features': 'Active inflammation?, Severity of Crypt Arch, Increased lamina propria cellularity?, Marked & transmucosal increase in lamina propria cellularity, Lamina propria polymorphs, Crypt architecture, Patchy lamina propria cellularity?, Epithelial changes, Mucosal surface, Cryptitis extent, Mucin depletion, Cryptitis polymorphs, Lamina propria granulomas, Crypt abscesses polymorphs, Crypt abscesses extent, Basal histiocytic cells, Submucosal granulomas, Sex, Increased lymphoid aggregates in lamina propria?, Mild & superficial increase in lamina propria cellularity?, Intraepithelial lymphocytes, Age', 'accuracy': [0.668, 0.676, 0.7469879518072289, 0.751004016064257, 0.6345381526104418], 'avgAccuracy': 0.6953060240963855, 'f1': [0.6775274295828614, 0.6761017063249318, 0.7687731731922938, 0.7955317510644079, 0.6472418997664489], 'avgF1': 0.7130351919861887, 'precision': [0.668, 0.676, 0.7469879518072289, 0.751004016064257, 0.6345381526104418], 'avgPrecision': 0.6953060240963855, 'recall': [0.668, 0.676, 0.7469879518072289, 0.751004016064257, 0.6345381526104418], 'avgRecall': 0.6953060240963855, 'params': [{'bootstrap': True, 'ccp_alpha': 0.0, 'class_weight': None, 'criterion': 'gini', 'max_depth': None, 'max_features': 'auto', 'max_leaf_nodes': None, 'max_samples': None, 'min_impurity_decrease': 0.0, 'min_impurity_split': None, 'min_samples_leaf': 1, 'min_samples_split': 2, 'min_weight_fraction_leaf': 0.0, 'n_estimators': 700, 'n_jobs': -1, 'oob_score': False, 'random_state': None, 'verbose': 0, 'warm_start': False}]}
****

                  model   features \

```
0   RandomForestClassifier   Active inflammation?, Severity of Crypt Arch, …
1     KNeighborsClassifier   Active inflammation?, Severity of Crypt Arch, …
2       LogisticRegression   Active inflammation?, Severity of Crypt Arch, …
3                GaussianNB   Active inflammation?, Severity of Crypt Arch, …
4        AdaBoostClassifier   Active inflammation?, Severity of Crypt Arch, …
5     DecisionTreeClassifier Active inflammation?, Severity of Crypt Arch, …
6                       SVC   Active inflammation?, Severity of Crypt Arch, …
7             MLPClassifier   Active inflammation?, Severity of Crypt Arch, …

    accuracy         f1  precision    recall  \
0   0.695306   0.713035   0.695306  0.695306
1   0.660000   0.681182   0.660000  0.660000
2   0.638329   0.651559   0.638329  0.638329
3   0.607827   0.565527   0.607827  0.607827
4   0.577285   0.595351   0.577285  0.577285
5   0.671242   0.692067   0.671242  0.671242
6   0.635933   0.641952   0.635933  0.635933
7   0.643129   0.654751   0.643129  0.643129


                                                params
0   {'bootstrap': True, 'ccp_alpha': 0.0, 'class_w…
1   {'algorithm': 'auto', 'leaf_size': 30, 'metric…
2   {'C': 1, 'class_weight': None, 'dual': False, …
3             {'priors': None, 'var_smoothing': 1e-09}
4   {'algorithm': 'SAMME.R', 'base_estimator': Non…
5   {'ccp_alpha': 0.0, 'class_weight': None, 'crit…
6   {'C': 1.0, 'break_ties': False, 'cache_size': …
7   {'activation': 'logistic', 'alpha': 0.0001, 'b…
```

```
Processing Model: RandomForestClassifier
*****************************************************
* RandomForestClassifier
* Best Params Result:
* {'classifier': 'RandomForestClassifier', 'features': 'Active inflammation?,
Severity of Crypt Arch, Increased lamina propria cellularity?, Marked &
transmucosal increase in lamina propria cellularity, Lamina propria polymorphs,
Crypt architecture, Patchy lamina propria cellularity?, Epithelial changes,
Mucosal surface, Cryptitis extent, Mucin depletion, Cryptitis polymorphs, Lamina
propria granulomas, Crypt abscesses polymorphs, Crypt abscesses extent, Basal
histiocytic cells, Submucosal granulomas, Sex, Increased lymphoid aggregates in
lamina propria?, Mild & superficial increase in lamina propria cellularity?,
Intraepithelial lymphocytes', 'accuracy': [0.652, 0.692, 0.6305220883534136,
0.8835341365461847, 0.6827309236947792], 'avgAccuracy': 0.7081574297188755,
'f1': [0.6526693005560432, 0.6854867461430575, 0.6748757417442345,
0.8883668953744133, 0.6733917423272952], 'avgF1': 0.7149580852290087,
'precision': [0.652, 0.692, 0.6305220883534136, 0.8835341365461847,
0.6827309236947792], 'avgPrecision': 0.7081574297188755, 'recall': [0.652,
0.692, 0.6305220883534136, 0.8835341365461847, 0.6827309236947792], 'avgRecall':
```

0.7081574297188755, 'params': [{'bootstrap': True, 'ccp_alpha': 0.0,
'class_weight': None, 'criterion': 'entropy', 'max_depth': None, 'max_features':
'sqrt', 'max_leaf_nodes': None, 'max_samples': None, 'min_impurity_decrease':
0.0, 'min_impurity_split': None, 'min_samples_leaf': 1, 'min_samples_split': 2,
'min_weight_fraction_leaf': 0.0, 'n_estimators': 700, 'n_jobs': -1, 'oob_score':
True, 'random_state': None, 'verbose': 0, 'warm_start': False}]}
****

Processing Model: KNeighborsClassifier
****
* KNeighborsClassifier
* Best Params Result:
* {'classifier': 'KNeighborsClassifier', 'features': 'Active inflammation?,
Severity of Crypt Arch, Increased lamina propria cellularity?, Marked &
transmucosal increase in lamina propria cellularity, Lamina propria polymorphs,
Crypt architecture, Patchy lamina propria cellularity?, Epithelial changes,
Mucosal surface, Cryptitis extent, Mucin depletion, Cryptitis polymorphs, Lamina
propria granulomas, Crypt abscesses polymorphs, Crypt abscesses extent, Basal
histiocytic cells, Submucosal granulomas, Sex, Increased lymphoid aggregates in
lamina propria?, Mild & superficial increase in lamina propria cellularity?,
Intraepithelial lymphocytes', 'accuracy': [0.604, 0.68, 0.5461847389558233,
0.8714859437751004, 0.6506024096385542], 'avgAccuracy': 0.6704546184738955,
'f1': [0.613414617507027, 0.6826815751474069, 0.5773646565298485,
0.8821782928876869, 0.6481273821693223], 'avgF1': 0.6807533048482584,
'precision': [0.604, 0.68, 0.5461847389558233, 0.8714859437751004,
0.6506024096385542], 'avgPrecision': 0.6704546184738955, 'recall': [0.604, 0.68,
0.5461847389558233, 0.8714859437751004, 0.6506024096385542], 'avgRecall':
0.6704546184738955, 'params': [{'algorithm': 'auto', 'leaf_size': 30, 'metric':
'minkowski', 'metric_params': None, 'n_jobs': -1, 'n_neighbors': 14, 'p': 2,
'weights': 'distance'}]}
****

Processing Model: LogisticRegression
****
* LogisticRegression
* Best Params Result:
* {'classifier': 'LogisticRegression', 'features': 'Active inflammation?,
Severity of Crypt Arch, Increased lamina propria cellularity?, Marked &
transmucosal increase in lamina propria cellularity, Lamina propria polymorphs,
Crypt architecture, Patchy lamina propria cellularity?, Epithelial changes,
Mucosal surface, Cryptitis extent, Mucin depletion, Cryptitis polymorphs, Lamina
propria granulomas, Crypt abscesses polymorphs, Crypt abscesses extent, Basal
histiocytic cells, Submucosal granulomas, Sex, Increased lymphoid aggregates in
lamina propria?, Mild & superficial increase in lamina propria cellularity?,
Intraepithelial lymphocytes', 'accuracy': [0.612, 0.652, 0.46184738955823296,
0.7590361445783133, 0.6586345381526104], 'avgAccuracy': 0.6287036144578313,
'f1': [0.621179352010362, 0.6451157608223418, 0.4711800670804737,
0.8059228623828161, 0.6498469578715089], 'avgF1': 0.6386490000335006,

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'precision': [0.612, 0.652, 0.46184738955823296, 0.7590361445783133, 0.6586345381526104], 'avgPrecision': 0.6287036144578313, 'recall': [0.612, 0.652, 0.46184738955823296, 0.7590361445783133, 0.6586345381526104], 'avgRecall': 0.6287036144578313, 'params': [{'C': 1, 'class_weight': None, 'dual': False, 'fit_intercept': True, 'intercept_scaling': 1, 'l1_ratio': None, 'max_iter': 100, 'multi_class': 'ovr', 'n_jobs': -1, 'penalty': 'l2', 'random_state': None, 'solver': 'newton-cg', 'tol': 0.0001, 'verbose': 0, 'warm_start': False}]}
****

Processing Model: GaussianNB
****
* GaussianNB
* Best Params Result:
* {'classifier': 'GaussianNB', 'features': 'Active inflammation?, Severity of Crypt Arch, Increased lamina propria cellularity?, Marked & transmucosal increase in lamina propria cellularity, Lamina propria polymorphs, Crypt architecture, Patchy lamina propria cellularity?, Epithelial changes, Mucosal surface, Cryptitis extent, Mucin depletion, Cryptitis polymorphs, Lamina propria granulomas, Crypt abscesses polymorphs, Crypt abscesses extent, Basal histiocytic cells, Submucosal granulomas, Sex, Increased lymphoid aggregates in lamina propria?, Mild & superficial increase in lamina propria cellularity?, Intraepithelial lymphocytes', 'accuracy': [0.584, 0.672, 0.3453815261044177, 0.751004016064257, 0.6867469879518072], 'avgAccuracy': 0.6078265060240964, 'f1': [0.5542710465162077, 0.6295500532815145, 0.2694793077375823, 0.7316619027678241, 0.64267374440139134], 'avgF1': 0.5655272108634084, 'precision': [0.584, 0.672, 0.3453815261044177, 0.751004016064257, 0.6867469879518072], 'avgPrecision': 0.6078265060240964, 'recall': [0.584, 0.672, 0.3453815261044177, 0.751004016064257, 0.6867469879518072], 'avgRecall': 0.6078265060240964, 'params': [{'priors': None, 'var_smoothing': 1e-09}]}
****

Processing Model: AdaBoostClassifier
****
* AdaBoostClassifier
* Best Params Result:
* {'classifier': 'AdaBoostClassifier', 'features': 'Active inflammation?, Severity of Crypt Arch, Increased lamina propria cellularity?, Marked & transmucosal increase in lamina propria cellularity, Lamina propria polymorphs, Crypt architecture, Patchy lamina propria cellularity?, Epithelial changes, Mucosal surface, Cryptitis extent, Mucin depletion, Cryptitis polymorphs, Lamina propria granulomas, Crypt abscesses polymorphs, Crypt abscesses extent, Basal histiocytic cells, Submucosal granulomas, Sex, Increased lymphoid aggregates in lamina propria?, Mild & superficial increase in lamina propria cellularity?, Intraepithelial lymphocytes', 'accuracy': [0.62, 0.572, 0.5301204819277109, 0.7670682730923695, 0.4939759036144578], 'avgAccuracy': 0.5966329317269077, 'f1': [0.6212598110572578, 0.5743026098456187, 0.568555651267756, 0.8086520724044503, 0.4716864185620555], 'avgF1': 0.6088913126274277,

'precision': [0.62, 0.572, 0.5301204819277109, 0.7670682730923695, 0.4939759036144578], 'avgPrecision': 0.5966329317269077, 'recall': [0.62, 0.572, 0.5301204819277109, 0.7670682730923695, 0.4939759036144578], 'avgRecall': 0.5966329317269077, 'params': [{'algorithm': 'SAMME.R', 'base_estimator': None, 'learning_rate': 1, 'n_estimators': 50, 'random_state': None}]}
****

Processing Model: DecisionTreeClassifier
****
* DecisionTreeClassifier
* Best Params Result:
* {'classifier': 'DecisionTreeClassifier', 'features': 'Active inflammation?, Severity of Crypt Arch, Increased lamina propria cellularity?, Marked & transmucosal increase in lamina propria cellularity, Lamina propria polymorphs, Crypt architecture, Patchy lamina propria cellularity?, Epithelial changes, Mucosal surface, Cryptitis extent, Mucin depletion, Cryptitis polymorphs, Lamina propria granulomas, Crypt abscesses polymorphs, Crypt abscesses extent, Basal histiocytic cells, Submucosal granulomas, Sex, Increased lymphoid aggregates in lamina propria?, Mild & superficial increase in lamina propria cellularity?, Intraepithelial lymphocytes', 'accuracy': [0.612, 0.68, 0.5863453815261044, 0.8674698795180723, 0.6465863453815262], 'avgAccuracy': 0.6784803212851406, 'f1': [0.6174108309990664, 0.6746173469387756, 0.6288487470007048, 0.8748818648470137, 0.643668244385571], 'avgF1': 0.6878854068342263, 'precision': [0.612, 0.68, 0.5863453815261044, 0.8674698795180723, 0.6465863453815262], 'avgPrecision': 0.6784803212851406, 'recall': [0.612, 0.68, 0.5863453815261044, 0.8674698795180723, 0.6465863453815262], 'avgRecall': 0.6784803212851406, 'params': [{'ccp_alpha': 0.0, 'class_weight': None, 'criterion': 'entropy', 'max_depth': None, 'max_features': 'auto', 'max_leaf_nodes': None, 'min_impurity_decrease': 0.0, 'min_impurity_split': None, 'min_samples_leaf': 1, 'min_samples_split': 2, 'min_weight_fraction_leaf': 0.0, 'random_state': None, 'splitter': 'best'}]}
****

Processing Model: SVC
****
* SVC
* Best Params Result:
* {'classifier': 'SVC', 'features': 'Active inflammation?, Severity of Crypt Arch, Increased lamina propria cellularity?, Marked & transmucosal increase in lamina propria cellularity, Lamina propria polymorphs, Crypt architecture, Patchy lamina propria cellularity?, Epithelial changes, Mucosal surface, Cryptitis extent, Mucin depletion, Cryptitis polymorphs, Lamina propria granulomas, Crypt abscesses polymorphs, Crypt abscesses extent, Basal histiocytic cells, Submucosal granulomas, Sex, Increased lymphoid aggregates in lamina propria?, Mild & superficial increase in lamina propria cellularity?, Intraepithelial lymphocytes', 'accuracy': [0.616, 0.664, 0.46586345381526106, 0.7630522088353414, 0.6546184738955824], 'avgAccuracy': 0.632706827309237, 'f1': [0.6249728376886272, 0.6553296010189229, 0.47666160863119533,

0.7833109813173641, 0.6442690048841054], 'avgF1': 0.636908806708043,
'precision': [0.616, 0.664, 0.46586345381526106, 0.7630522088353414,
0.6546184738955824], 'avgPrecision': 0.632706827309237, 'recall': [0.616, 0.664,
0.46586345381526106, 0.7630522088353414, 0.6546184738955824], 'avgRecall':
0.632706827309237, 'params': [{'C': 1.0, 'break_ties': False, 'cache_size':
4000, 'class_weight': None, 'coef0': 0.0, 'decision_function_shape': 'ovr',
'degree': 3, 'gamma': 'scale', 'kernel': 'linear', 'max_iter': -1,
'probability': False, 'random_state': None, 'shrinking': True, 'tol': 0.001,
'verbose': False}]}
****

Processing Model: MLPClassifier
****
* MLPClassifier
* Best Params Result:
* {'classifier': 'MLPClassifier', 'features': 'Active inflammation?, Severity of
Crypt Arch, Increased lamina propria cellularity?, Marked & transmucosal
increase in lamina propria cellularity, Lamina propria polymorphs, Crypt
architecture, Patchy lamina propria cellularity?, Epithelial changes, Mucosal
surface, Cryptitis extent, Mucin depletion, Cryptitis polymorphs, Lamina propria
granulomas, Crypt abscesses polymorphs, Crypt abscesses extent, Basal
histiocytic cells, Submucosal granulomas, Sex, Increased lymphoid aggregates in
lamina propria?, Mild & superficial increase in lamina propria cellularity?,
Intraepithelial lymphocytes', 'accuracy': [0.612, 0.66, 0.4738955823293173,
0.7670682730923695, 0.6586345381526104], 'avgAccuracy': 0.6343196787148594,
'f1': [0.6185257859290159, 0.6526294346170655, 0.48218015362141187,
0.8125750205792113, 0.6526921490460773], 'avgF1': 0.6437205087585564,
'precision': [0.612, 0.66, 0.4738955823293173, 0.7670682730923695,
0.6586345381526104], 'avgPrecision': 0.6343196787148594, 'recall': [0.612, 0.66,
0.4738955823293173, 0.7670682730923695, 0.6586345381526104], 'avgRecall':
0.6343196787148594, 'params': [{'activation': 'logistic', 'alpha': 0.0001,
'batch_size': 'auto', 'beta_1': 0.9, 'beta_2': 0.999, 'early_stopping': False,
'epsilon': 1e-08, 'hidden_layer_sizes': (100,), 'learning_rate': 'invscaling',
'learning_rate_init': 0.001, 'max_fun': 15000, 'max_iter': 5000, 'momentum':
0.9, 'n_iter_no_change': 10, 'nesterovs_momentum': True, 'power_t': 0.5,
'random_state': None, 'shuffle': True, 'solver': 'adam', 'tol': 0.0001,
'validation_fraction': 0.1, 'verbose': False, 'warm_start': False}]}
****
****
* Best Performing Model and Params is:
* {'classifier': 'RandomForestClassifier', 'features': 'Active inflammation?,
Severity of Crypt Arch, Increased lamina propria cellularity?, Marked &
transmucosal increase in lamina propria cellularity, Lamina propria polymorphs,
Crypt architecture, Patchy lamina propria cellularity?, Epithelial changes,
Mucosal surface, Cryptitis extent, Mucin depletion, Cryptitis polymorphs, Lamina
propria granulomas, Crypt abscesses polymorphs, Crypt abscesses extent, Basal
histiocytic cells, Submucosal granulomas, Sex, Increased lymphoid aggregates in
lamina propria?, Mild & superficial increase in lamina propria cellularity?,

```
Intraepithelial lymphocytes', 'accuracy': [0.652, 0.692, 0.6305220883534136,
0.8835341365461847, 0.6827309236947792], 'avgAccuracy': 0.7081574297188755,
'f1': [0.6526693005560432, 0.6854867461430575, 0.6748757417442345,
0.8883668953744133, 0.6733917423272952], 'avgF1': 0.7149580852290087,
'precision': [0.652, 0.692, 0.6305220883534136, 0.8835341365461847,
0.6827309236947792], 'avgPrecision': 0.7081574297188755, 'recall': [0.652,
0.692, 0.6305220883534136, 0.8835341365461847, 0.6827309236947792], 'avgRecall':
0.7081574297188755, 'params': [{'bootstrap': True, 'ccp_alpha': 0.0,
'class_weight': None, 'criterion': 'entropy', 'max_depth': None, 'max_features':
'sqrt', 'max_leaf_nodes': None, 'max_samples': None, 'min_impurity_decrease':
0.0, 'min_impurity_split': None, 'min_samples_leaf': 1, 'min_samples_split': 2,
'min_weight_fraction_leaf': 0.0, 'n_estimators': 700, 'n_jobs': -1, 'oob_score':
True, 'random_state': None, 'verbose': 0, 'warm_start': False}]}
********************************************************

                    model                                      features  \
0   RandomForestClassifier  Active inflammation?, Severity of Crypt Arch, …
1     KNeighborsClassifier  Active inflammation?, Severity of Crypt Arch, …
2       LogisticRegression  Active inflammation?, Severity of Crypt Arch, …
3               GaussianNB  Active inflammation?, Severity of Crypt Arch, …
4           AdaBoostClassifier  Active inflammation?, Severity of Crypt Arch, …
5   DecisionTreeClassifier  Active inflammation?, Severity of Crypt Arch, …
6                      SVC  Active inflammation?, Severity of Crypt Arch, …
7            MLPClassifier  Active inflammation?, Severity of Crypt Arch, …

   accuracy        f1  precision    recall  \
0  0.708157  0.714958   0.708157  0.708157
1  0.670455  0.680753   0.670455  0.670455
2  0.628704  0.638649   0.628704  0.628704
3  0.607827  0.565527   0.607827  0.607827
4  0.596633  0.608891   0.596633  0.596633
5  0.678480  0.687885   0.678480  0.678480
6  0.632707  0.636909   0.632707  0.632707
7  0.634320  0.643721   0.634320  0.634320

                                             params
0  {'bootstrap': True, 'ccp_alpha': 0.0, 'class_w…
1  {'algorithm': 'auto', 'leaf_size': 30, 'metric…
2  {'C': 1, 'class_weight': None, 'dual': False, …
3           {'priors': None, 'var_smoothing': 1e-09}
4  {'algorithm': 'SAMME.R', 'base_estimator': Non…
5  {'ccp_alpha': 0.0, 'class_weight': None, 'crit…
6  {'C': 1.0, 'break_ties': False, 'cache_size': …
7  {'activation': 'logistic', 'alpha': 0.0001, 'b…

Processing Model: RandomForestClassifier
********************************************************
* RandomForestClassifier
```

* Best Params Result:
* {'classifier': 'RandomForestClassifier', 'features': 'Active inflammation?,
Severity of Crypt Arch, Increased lamina propria cellularity?, Marked &
transmucosal increase in lamina propria cellularity, Lamina propria polymorphs,
Crypt architecture, Patchy lamina propria cellularity?, Epithelial changes,
Mucosal surface, Cryptitis extent, Mucin depletion, Cryptitis polymorphs, Lamina
propria granulomas, Crypt abscesses polymorphs, Crypt abscesses extent, Basal
histiocytic cells, Submucosal granulomas, Sex, Increased lymphoid aggregates in
lamina propria?, Mild & superficial increase in lamina propria cellularity?',
'accuracy': [0.648, 0.692, 0.6345381526104418, 0.8835341365461847,
0.6907630522088354], 'avgAccuracy': 0.7097670682730923, 'f1':
[0.6496947795027489, 0.6854867461430575, 0.6798521258529968, 0.8883668953744133,
0.6841814544338194], 'avgF1': 0.7175164002614072, 'precision': [0.648, 0.692,
0.6345381526104418, 0.8835341365461847, 0.6907630522088354], 'avgPrecision':
0.7097670682730923, 'recall': [0.648, 0.692, 0.6345381526104418,
0.8835341365461847, 0.6907630522088354], 'avgRecall': 0.7097670682730923,
'params': [{'bootstrap': True, 'ccp_alpha': 0.0, 'class_weight': None,
'criterion': 'entropy', 'max_depth': None, 'max_features': 'log2',
'max_leaf_nodes': None, 'max_samples': None, 'min_impurity_decrease': 0.0,
'min_impurity_split': None, 'min_samples_leaf': 1, 'min_samples_split': 2,
'min_weight_fraction_leaf': 0.0, 'n_estimators': 700, 'n_jobs': -1, 'oob_score':
False, 'random_state': None, 'verbose': 0, 'warm_start': False}]}
****

Processing Model: KNeighborsClassifier
****
* KNeighborsClassifier
* Best Params Result:
* {'classifier': 'KNeighborsClassifier', 'features': 'Active inflammation?,
Severity of Crypt Arch, Increased lamina propria cellularity?, Marked &
transmucosal increase in lamina propria cellularity, Lamina propria polymorphs,
Crypt architecture, Patchy lamina propria cellularity?, Epithelial changes,
Mucosal surface, Cryptitis extent, Mucin depletion, Cryptitis polymorphs, Lamina
propria granulomas, Crypt abscesses polymorphs, Crypt abscesses extent, Basal
histiocytic cells, Submucosal granulomas, Sex, Increased lymphoid aggregates in
lamina propria?, Mild & superficial increase in lamina propria cellularity?',
'accuracy': [0.616, 0.684, 0.5461847389558233, 0.8674698795180723,
0.6546184738955824], 'avgAccuracy': 0.6736546184738956, 'f1':
[0.6251282477339091, 0.6877330066160254, 0.5602368292662759, 0.8801262529854125,
0.6535101659436285], 'avgF1': 0.6813469005090503, 'precision': [0.616, 0.684,
0.5461847389558233, 0.8674698795180723, 0.6546184738955824], 'avgPrecision':
0.6736546184738956, 'recall': [0.616, 0.684, 0.5461847389558233,
0.8674698795180723, 0.6546184738955824], 'avgRecall': 0.6736546184738956,
'params': [{'algorithm': 'auto', 'leaf_size': 30, 'metric': 'minkowski',
'metric_params': None, 'n_jobs': -1, 'n_neighbors': 12, 'p': 2, 'weights':
'distance'}]}
****

```
Processing Model: LogisticRegression
*******************************************************
* LogisticRegression
* Best Params Result:
* {'classifier': 'LogisticRegression', 'features': 'Active inflammation?,
Severity of Crypt Arch, Increased lamina propria cellularity?, Marked &
transmucosal increase in lamina propria cellularity, Lamina propria polymorphs,
Crypt architecture, Patchy lamina propria cellularity?, Epithelial changes,
Mucosal surface, Cryptitis extent, Mucin depletion, Cryptitis polymorphs, Lamina
propria granulomas, Crypt abscesses polymorphs, Crypt abscesses extent, Basal
histiocytic cells, Submucosal granulomas, Sex, Increased lymphoid aggregates in
lamina propria?, Mild & superficial increase in lamina propria cellularity?',
'accuracy': [0.616, 0.652, 0.46586345381526106, 0.7590361445783133,
0.6586345381526104], 'avgAccuracy': 0.6303068273092369, 'f1':
[0.6263389726802395, 0.6458157220334942, 0.47379827270619024,
0.8076422782726752, 0.6552236826169174], 'avgF1': 0.6417637856619033,
'precision': [0.616, 0.652, 0.46586345381526106, 0.7590361445783133,
0.6586345381526104], 'avgPrecision': 0.6303068273092369, 'recall': [0.616,
0.652, 0.46586345381526106, 0.7590361445783133, 0.6586345381526104],
'avgRecall': 0.6303068273092369, 'params': [{'C': 1, 'class_weight': None,
'dual': False, 'fit_intercept': True, 'intercept_scaling': 1, 'l1_ratio': None,
'max_iter': 100, 'multi_class': 'ovr', 'n_jobs': -1, 'penalty': 'l2',
'random_state': None, 'solver': 'newton-cg', 'tol': 0.0001, 'verbose': 0,
'warm_start': False}]}
*******************************************************

Processing Model: GaussianNB
*******************************************************
* GaussianNB
* Best Params Result:
* {'classifier': 'GaussianNB', 'features': 'Active inflammation?, Severity of
Crypt Arch, Increased lamina propria cellularity?, Marked & transmucosal
increase in lamina propria cellularity, Lamina propria polymorphs, Crypt
architecture, Patchy lamina propria cellularity?, Epithelial changes, Mucosal
surface, Cryptitis extent, Mucin depletion, Cryptitis polymorphs, Lamina propria
granulomas, Crypt abscesses polymorphs, Crypt abscesses extent, Basal
histiocytic cells, Submucosal granulomas, Sex, Increased lymphoid aggregates in
lamina propria?, Mild & superficial increase in lamina propria cellularity?',
'accuracy': [0.584, 0.672, 0.3413654618473896, 0.751004016064257,
0.6867469879518072], 'avgAccuracy': 0.6070232931726908, 'f1':
[0.5552131724484666, 0.6302043390135875, 0.2671813325185434, 0.7316619027678241,
0.6426737440139134], 'avgF1': 0.565386898152467, 'precision': [0.584, 0.672,
0.3413654618473896, 0.751004016064257, 0.6867469879518072], 'avgPrecision':
0.6070232931726908, 'recall': [0.584, 0.672, 0.3413654618473896,
0.751004016064257, 0.6867469879518072], 'avgRecall': 0.6070232931726908,
'params': [{'priors': None, 'var_smoothing': 1e-09}]}
*******************************************************
```

```
Processing Model: AdaBoostClassifier
*******************************************************
* AdaBoostClassifier
* Best Params Result:
* {'classifier': 'AdaBoostClassifier', 'features': 'Active inflammation?,
Severity of Crypt Arch, Increased lamina propria cellularity?, Marked &
transmucosal increase in lamina propria cellularity, Lamina propria polymorphs,
Crypt architecture, Patchy lamina propria cellularity?, Epithelial changes,
Mucosal surface, Cryptitis extent, Mucin depletion, Cryptitis polymorphs, Lamina
propria granulomas, Crypt abscesses polymorphs, Crypt abscesses extent, Basal
histiocytic cells, Submucosal granulomas, Sex, Increased lymphoid aggregates in
lamina propria?, Mild & superficial increase in lamina propria cellularity?',
'accuracy': [0.608, 0.588, 0.5261044176706827, 0.7630522088353414,
0.4819277108433735], 'avgAccuracy': 0.5934168674698795, 'f1':
[0.6152886089938472, 0.5916346583623374, 0.5624659655571439, 0.8000422743606003,
0.45737827059561476], 'avgF1': 0.6053619555739087, 'precision': [0.608, 0.588,
0.5261044176706827, 0.7630522088353414, 0.4819277108433735], 'avgPrecision':
0.5934168674698795, 'recall': [0.608, 0.588, 0.5261044176706827,
0.7630522088353414, 0.4819277108433735], 'avgRecall': 0.5934168674698795,
'params': [{'algorithm': 'SAMME.R', 'base_estimator': None, 'learning_rate': 1,
'n_estimators': 50, 'random_state': None}]}
*******************************************************

Processing Model: DecisionTreeClassifier
*******************************************************
* DecisionTreeClassifier
* Best Params Result:
* {'classifier': 'DecisionTreeClassifier', 'features': 'Active inflammation?,
Severity of Crypt Arch, Increased lamina propria cellularity?, Marked &
transmucosal increase in lamina propria cellularity, Lamina propria polymorphs,
Crypt architecture, Patchy lamina propria cellularity?, Epithelial changes,
Mucosal surface, Cryptitis extent, Mucin depletion, Cryptitis polymorphs, Lamina
propria granulomas, Crypt abscesses polymorphs, Crypt abscesses extent, Basal
histiocytic cells, Submucosal granulomas, Sex, Increased lymphoid aggregates in
lamina propria?, Mild & superficial increase in lamina propria cellularity?',
'accuracy': [0.64, 0.664, 0.5542168674698795, 0.8795180722891566,
0.678714859437751], 'avgAccuracy': 0.6832899598393575, 'f1':
[0.6471059368191723, 0.6649588845743352, 0.5882310634853631, 0.8872760931410898,
0.67083333761302671], 'avgF1': 0.6916810708300455, 'precision': [0.64, 0.664,
0.5542168674698795, 0.8795180722891566, 0.678714859437751], 'avgPrecision':
0.6832899598393575, 'recall': [0.64, 0.664, 0.5542168674698795,
0.8795180722891566, 0.678714859437751], 'avgRecall': 0.6832899598393575,
'params': [{'ccp_alpha': 0.0, 'class_weight': None, 'criterion': 'gini',
'max_depth': None, 'max_features': 'auto', 'max_leaf_nodes': None,
'min_impurity_decrease': 0.0, 'min_impurity_split': None, 'min_samples_leaf': 1,
'min_samples_split': 2, 'min_weight_fraction_leaf': 0.0, 'random_state': None,
'splitter': 'random'}]}
*******************************************************
```

```
Processing Model: SVC
******************************************************
* SVC
* Best Params Result:
* {'classifier': 'SVC', 'features': 'Active inflammation?, Severity of Crypt
Arch, Increased lamina propria cellularity?, Marked & transmucosal increase in
lamina propria cellularity, Lamina propria polymorphs, Crypt architecture,
Patchy lamina propria cellularity?, Epithelial changes, Mucosal surface,
Cryptitis extent, Mucin depletion, Cryptitis polymorphs, Lamina propria
granulomas, Crypt abscesses polymorphs, Crypt abscesses extent, Basal
histiocytic cells, Submucosal granulomas, Sex, Increased lymphoid aggregates in
lamina propria?, Mild & superficial increase in lamina propria cellularity?',
'accuracy': [0.62, 0.664, 0.46586345381526106, 0.7590361445783133,
0.6465863453815262], 'avgAccuracy': 0.6310971887550201, 'f1':
[0.6301081479280416, 0.6559203169497994, 0.47777095288365645,
0.7810597227620159, 0.6383488146538953], 'avgF1': 0.6366415910354817,
'precision': [0.62, 0.664, 0.46586345381526106, 0.7590361445783133,
0.6465863453815262], 'avgPrecision': 0.6310971887550201, 'recall': [0.62, 0.664,
0.46586345381526106, 0.7590361445783133, 0.6465863453815262], 'avgRecall':
0.6310971887550201, 'params': [{'C': 1.0, 'break_ties': False, 'cache_size':
4000, 'class_weight': None, 'coef0': 0.0, 'decision_function_shape': 'ovr',
'degree': 3, 'gamma': 'scale', 'kernel': 'linear', 'max_iter': -1,
'probability': False, 'random_state': None, 'shrinking': True, 'tol': 0.001,
'verbose': False}]}
******************************************************

Processing Model: MLPClassifier
******************************************************
* MLPClassifier
* Best Params Result:
* {'classifier': 'MLPClassifier', 'features': 'Active inflammation?, Severity of
Crypt Arch, Increased lamina propria cellularity?, Marked & transmucosal
increase in lamina propria cellularity, Lamina propria polymorphs, Crypt
architecture, Patchy lamina propria cellularity?, Epithelial changes, Mucosal
surface, Cryptitis extent, Mucin depletion, Cryptitis polymorphs, Lamina propria
granulomas, Crypt abscesses polymorphs, Crypt abscesses extent, Basal
histiocytic cells, Submucosal granulomas, Sex, Increased lymphoid aggregates in
lamina propria?, Mild & superficial increase in lamina propria cellularity?',
'accuracy': [0.616, 0.664, 0.46586345381526106, 0.7670682730923695,
0.6586345381526104], 'avgAccuracy': 0.6343132530120482, 'f1':
[0.623562700991328, 0.6588260786359267, 0.4758473874670071, 0.8160320364552766,
0.6526921490460773], 'avgF1': 0.6453920705191232, 'precision': [0.616, 0.664,
0.46586345381526106, 0.7670682730923695, 0.6586345381526104], 'avgPrecision':
0.6343132530120482, 'recall': [0.616, 0.664, 0.46586345381526106,
0.7670682730923695, 0.6586345381526104], 'avgRecall': 0.6343132530120482,
'params': [{'activation': 'logistic', 'alpha': 0.0001, 'batch_size': 'auto',
'beta_1': 0.9, 'beta_2': 0.999, 'early_stopping': False, 'epsilon': 1e-08,
```

'hidden_layer_sizes': (100,), 'learning_rate': 'adaptive', 'learning_rate_init':
0.001, 'max_fun': 15000, 'max_iter': 9000, 'momentum': 0.9, 'n_iter_no_change':
10, 'nesterovs_momentum': True, 'power_t': 0.5, 'random_state': None, 'shuffle':
True, 'solver': 'adam', 'tol': 0.0001, 'validation_fraction': 0.1, 'verbose':
False, 'warm_start': False}]}
****
****
* Best Performing Model and Params is:
* {'classifier': 'RandomForestClassifier', 'features': 'Active inflammation?,
Severity of Crypt Arch, Increased lamina propria cellularity?, Marked &
transmucosal increase in lamina propria cellularity, Lamina propria polymorphs,
Crypt architecture, Patchy lamina propria cellularity?, Epithelial changes,
Mucosal surface, Cryptitis extent, Mucin depletion, Cryptitis polymorphs, Lamina
propria granulomas, Crypt abscesses polymorphs, Crypt abscesses extent, Basal
histiocytic cells, Submucosal granulomas, Sex, Increased lymphoid aggregates in
lamina propria?, Mild & superficial increase in lamina propria cellularity?',
'accuracy': [0.648, 0.692, 0.6345381526104418, 0.8835341365461847,
0.6907630522088354], 'avgAccuracy': 0.7097670682730923, 'f1':
[0.6496947795027489, 0.6854867461430575, 0.6798521258529968, 0.8883668953744133,
0.6841814544338194], 'avgF1': 0.7175164002614072, 'precision': [0.648, 0.692,
0.6345381526104418, 0.8835341365461847, 0.6907630522088354], 'avgPrecision':
0.7097670682730923, 'recall': [0.648, 0.692, 0.6345381526104418,
0.8835341365461847, 0.6907630522088354], 'avgRecall': 0.7097670682730923,
'params': [{'bootstrap': True, 'ccp_alpha': 0.0, 'class_weight': None,
'criterion': 'entropy', 'max_depth': None, 'max_features': 'log2',
'max_leaf_nodes': None, 'max_samples': None, 'min_impurity_decrease': 0.0,
'min_impurity_split': None, 'min_samples_leaf': 1, 'min_samples_split': 2,
'min_weight_fraction_leaf': 0.0, 'n_estimators': 700, 'n_jobs': -1, 'oob_score':
False, 'random_state': None, 'verbose': 0, 'warm_start': False}]}
****

```
                     model                                          features  \
0  RandomForestClassifier  Active inflammation?, Severity of Crypt Arch, …
1      KNeighborsClassifier  Active inflammation?, Severity of Crypt Arch, …
2        LogisticRegression  Active inflammation?, Severity of Crypt Arch, …
3                GaussianNB  Active inflammation?, Severity of Crypt Arch, …
4         AdaBoostClassifier  Active inflammation?, Severity of Crypt Arch, …
5     DecisionTreeClassifier  Active inflammation?, Severity of Crypt Arch, …
6                       SVC  Active inflammation?, Severity of Crypt Arch, …
7              MLPClassifier  Active inflammation?, Severity of Crypt Arch, …


   accuracy        f1  precision    recall  \
0  0.709767  0.717516   0.709767  0.709767
1  0.673655  0.681347   0.673655  0.673655
2  0.630307  0.641764   0.630307  0.630307
3  0.607023  0.565387   0.607023  0.607023
4  0.593417  0.605362   0.593417  0.593417
5  0.683290  0.691681   0.683290  0.683290
```

```
6  0.631097  0.636642    0.631097  0.631097
7  0.634313  0.645392    0.634313  0.634313


                                                      params
0  {'bootstrap': True, 'ccp_alpha': 0.0, 'class_w…
1  {'algorithm': 'auto', 'leaf_size': 30, 'metric…
2  {'C': 1, 'class_weight': None, 'dual': False, …
3            {'priors': None, 'var_smoothing': 1e-09}
4  {'algorithm': 'SAMME.R', 'base_estimator': Non…
5  {'ccp_alpha': 0.0, 'class_weight': None, 'crit…
6  {'C': 1.0, 'break_ties': False, 'cache_size': …
7  {'activation': 'logistic', 'alpha': 0.0001, 'b…
```

Processing Model: RandomForestClassifier
****
* RandomForestClassifier
* Best Params Result:
* {'classifier': 'RandomForestClassifier', 'features': 'Active inflammation?,
Severity of Crypt Arch, Increased lamina propria cellularity?, Marked &
transmucosal increase in lamina propria cellularity, Lamina propria polymorphs,
Crypt architecture, Patchy lamina propria cellularity?, Epithelial changes,
Mucosal surface, Cryptitis extent, Mucin depletion, Cryptitis polymorphs, Lamina
propria granulomas, Crypt abscesses polymorphs, Crypt abscesses extent, Basal
histiocytic cells, Submucosal granulomas, Sex, Increased lymphoid aggregates in
lamina propria?', 'accuracy': [0.644, 0.692, 0.642570281124498,
0.8835341365461847, 0.6827309236947792], 'avgAccuracy': 0.7089670682730924,
'f1': [0.6457962983678529, 0.6854867461430575, 0.6897954606589943,
0.890157800932128, 0.6760007630159505], 'avgF1': 0.7174474138235967,
'precision': [0.644, 0.692, 0.642570281124498, 0.8835341365461847,
0.6827309236947792], 'avgPrecision': 0.7089670682730924, 'recall': [0.644,
0.692, 0.642570281124498, 0.8835341365461847, 0.6827309236947792], 'avgRecall':
0.7089670682730924, 'params': [{'bootstrap': True, 'ccp_alpha': 0.0,
'class_weight': None, 'criterion': 'gini', 'max_depth': None, 'max_features':
'log2', 'max_leaf_nodes': None, 'max_samples': None, 'min_impurity_decrease':
0.0, 'min_impurity_split': None, 'min_samples_leaf': 1, 'min_samples_split': 2,
'min_weight_fraction_leaf': 0.0, 'n_estimators': 500, 'n_jobs': -1, 'oob_score':
True, 'random_state': None, 'verbose': 0, 'warm_start': False}]}
****

Processing Model: KNeighborsClassifier
****
* KNeighborsClassifier
* Best Params Result:
* {'classifier': 'KNeighborsClassifier', 'features': 'Active inflammation?,
Severity of Crypt Arch, Increased lamina propria cellularity?, Marked &
transmucosal increase in lamina propria cellularity, Lamina propria polymorphs,
Crypt architecture, Patchy lamina propria cellularity?, Epithelial changes,
Mucosal surface, Cryptitis extent, Mucin depletion, Cryptitis polymorphs, Lamina

                                    74
```

propria granulomas, Crypt abscesses polymorphs, Crypt abscesses extent, Basal histiocytic cells, Submucosal granulomas, Sex, Increased lymphoid aggregates in lamina propria?', 'accuracy': [0.616, 0.684, 0.5461847389558233, 0.8674698795180723, 0.6586345381526104], 'avgAccuracy': 0.6744578313253012, 'f1': [0.6251282477339091, 0.6877330066160254, 0.5750717596950399, 0.8801262529854125, 0.6572592594829572], 'avgF1': 0.6850637053026688, 'precision': [0.616, 0.684, 0.5461847389558233, 0.8674698795180723, 0.6586345381526104], 'avgPrecision': 0.6744578313253012, 'recall': [0.616, 0.684, 0.5461847389558233, 0.8674698795180723, 0.6586345381526104], 'avgRecall': 0.6744578313253012, 'params': [{'algorithm': 'auto', 'leaf_size': 30, 'metric': 'minkowski', 'metric_params': None, 'n_jobs': -1, 'n_neighbors': 12, 'p': 2, 'weights': 'distance'}]}
********************************************************

Processing Model: LogisticRegression
********************************************************
* LogisticRegression
* Best Params Result:
* {'classifier': 'LogisticRegression', 'features': 'Active inflammation?, Severity of Crypt Arch, Increased lamina propria cellularity?, Marked & transmucosal increase in lamina propria cellularity, Lamina propria polymorphs, Crypt architecture, Patchy lamina propria cellularity?, Epithelial changes, Mucosal surface, Cryptitis extent, Mucin depletion, Cryptitis polymorphs, Lamina propria granulomas, Crypt abscesses polymorphs, Crypt abscesses extent, Basal histiocytic cells, Submucosal granulomas, Sex, Increased lymphoid aggregates in lamina propria?', 'accuracy': [0.616, 0.652, 0.46586345381526106, 0.7590361445783133, 0.6586345381526104], 'avgAccuracy': 0.6303068273092369, 'f1': [0.6263389726802395, 0.6458157220334942, 0.47379827270619024, 0.8076422782726752, 0.6552236826169174], 'avgF1': 0.6417637856619033, 'precision': [0.616, 0.652, 0.46586345381526106, 0.7590361445783133, 0.6586345381526104], 'avgPrecision': 0.6303068273092369, 'recall': [0.616, 0.652, 0.46586345381526106, 0.7590361445783133, 0.6586345381526104], 'avgRecall': 0.6303068273092369, 'params': [{'C': 1, 'class_weight': None, 'dual': False, 'fit_intercept': True, 'intercept_scaling': 1, 'l1_ratio': None, 'max_iter': 100, 'multi_class': 'ovr', 'n_jobs': -1, 'penalty': 'l2', 'random_state': None, 'solver': 'newton-cg', 'tol': 0.0001, 'verbose': 0, 'warm_start': False}]}
********************************************************

Processing Model: GaussianNB
********************************************************
* GaussianNB
* Best Params Result:
* {'classifier': 'GaussianNB', 'features': 'Active inflammation?, Severity of Crypt Arch, Increased lamina propria cellularity?, Marked & transmucosal increase in lamina propria cellularity, Lamina propria polymorphs, Crypt architecture, Patchy lamina propria cellularity?, Epithelial changes, Mucosal surface, Cryptitis extent, Mucin depletion, Cryptitis polymorphs, Lamina propria

granulomas, Crypt abscesses polymorphs, Crypt abscesses extent, Basal histiocytic cells, Submucosal granulomas, Sex, Increased lymphoid aggregates in lamina propria?', 'accuracy': [0.58, 0.68, 0.3333333333333333, 0.7389558232931727, 0.6987951807228916], 'avgAccuracy': 0.6062168674698796, 'f1': [0.5473806944229479, 0.6364746795444975, 0.251344699636217, 0.7172627517945799, 0.6530581291264153], 'avgF1': 0.5611041909049315, 'precision': [0.58, 0.68, 0.3333333333333333, 0.7389558232931727, 0.6987951807228916], 'avgPrecision': 0.6062168674698796, 'recall': [0.58, 0.68, 0.3333333333333333, 0.7389558232931727, 0.6987951807228916], 'avgRecall': 0.6062168674698796, 'params': [{'priors': None, 'var_smoothing': 1e-09}]}
********************************************************

Processing Model: AdaBoostClassifier
********************************************************
* AdaBoostClassifier
* Best Params Result:
* {'classifier': 'AdaBoostClassifier', 'features': 'Active inflammation?, Severity of Crypt Arch, Increased lamina propria cellularity?, Marked & transmucosal increase in lamina propria cellularity, Lamina propria polymorphs, Crypt architecture, Patchy lamina propria cellularity?, Epithelial changes, Mucosal surface, Cryptitis extent, Mucin depletion, Cryptitis polymorphs, Lamina propria granulomas, Crypt abscesses polymorphs, Crypt abscesses extent, Basal histiocytic cells, Submucosal granulomas, Sex, Increased lymphoid aggregates in lamina propria?', 'accuracy': [0.62, 0.588, 0.5261044176706827, 0.7670682730923695, 0.4819277108433735], 'avgAccuracy': 0.5966200803212851, 'f1': [0.6247121349238997, 0.5916346583623374, 0.5624659655571439, 0.8035271520866073, 0.45978459730624915], 'avgF1': 0.6084249016472475, 'precision': [0.62, 0.588, 0.5261044176706827, 0.7670682730923695, 0.4819277108433735], 'avgPrecision': 0.5966200803212851, 'recall': [0.62, 0.588, 0.5261044176706827, 0.7670682730923695, 0.4819277108433735], 'avgRecall': 0.5966200803212851, 'params': [{'algorithm': 'SAMME.R', 'base_estimator': None, 'learning_rate': 1, 'n_estimators': 50, 'random_state': None}]}
********************************************************

Processing Model: DecisionTreeClassifier
********************************************************
* DecisionTreeClassifier
* Best Params Result:
* {'classifier': 'DecisionTreeClassifier', 'features': 'Active inflammation?, Severity of Crypt Arch, Increased lamina propria cellularity?, Marked & transmucosal increase in lamina propria cellularity, Lamina propria polymorphs, Crypt architecture, Patchy lamina propria cellularity?, Epithelial changes, Mucosal surface, Cryptitis extent, Mucin depletion, Cryptitis polymorphs, Lamina propria granulomas, Crypt abscesses polymorphs, Crypt abscesses extent, Basal histiocytic cells, Submucosal granulomas, Sex, Increased lymphoid aggregates in lamina propria?', 'accuracy': [0.596, 0.652, 0.5983935742971888, 0.8795180722891566, 0.6546184738955824], 'avgAccuracy': 0.6761060240963855, 'f1': [0.5961695857137728, 0.6494267266389085, 0.6388227289664363,

0.8854939843755792, 0.647121607787802], 'avgF1': 0.6834069266964998,
'precision': [0.596, 0.652, 0.5983935742971888, 0.8795180722891566,
0.6546184738955824], 'avgPrecision': 0.6761060240963855, 'recall': [0.596,
0.652, 0.5983935742971888, 0.8795180722891566, 0.6546184738955824], 'avgRecall':
0.6761060240963855, 'params': [{'ccp_alpha': 0.0, 'class_weight': None,
'criterion': 'gini', 'max_depth': None, 'max_features': 'sqrt',
'max_leaf_nodes': None, 'min_impurity_decrease': 0.0, 'min_impurity_split':
None, 'min_samples_leaf': 1, 'min_samples_split': 2, 'min_weight_fraction_leaf':
0.0, 'random_state': None, 'splitter': 'best'}]}
**********************************************

Processing Model: SVC
**********************************************
* SVC
* Best Params Result:
* {'classifier': 'SVC', 'features': 'Active inflammation?, Severity of Crypt
Arch, Increased lamina propria cellularity?, Marked & transmucosal increase in
lamina propria cellularity, Lamina propria polymorphs, Crypt architecture,
Patchy lamina propria cellularity?, Epithelial changes, Mucosal surface,
Cryptitis extent, Mucin depletion, Cryptitis polymorphs, Lamina propria
granulomas, Crypt abscesses polymorphs, Crypt abscesses extent, Basal
histiocytic cells, Submucosal granulomas, Sex, Increased lymphoid aggregates in
lamina propria?', 'accuracy': [0.62, 0.664, 0.46987951807228917,
0.7590361445783133, 0.6465863453815262], 'avgAccuracy': 0.6319004016064257,
'f1': [0.6301081479280416, 0.6559203169497994, 0.48352647762867934,
0.7810597227620159, 0.6383488146538953], 'avgF1': 0.6377926959844863,
'precision': [0.62, 0.664, 0.46987951807228917, 0.7590361445783133,
0.6465863453815262], 'avgPrecision': 0.6319004016064257, 'recall': [0.62, 0.664,
0.46987951807228917, 0.7590361445783133, 0.6465863453815262], 'avgRecall':
0.6319004016064257, 'params': [{'C': 1.0, 'break_ties': False, 'cache_size':
4000, 'class_weight': None, 'coef0': 0.0, 'decision_function_shape': 'ovr',
'degree': 3, 'gamma': 'scale', 'kernel': 'linear', 'max_iter': -1,
'probability': False, 'random_state': None, 'shrinking': True, 'tol': 0.001,
'verbose': False}]}
**********************************************

Processing Model: MLPClassifier
**********************************************
* MLPClassifier
* Best Params Result:
* {'classifier': 'MLPClassifier', 'features': 'Active inflammation?, Severity of
Crypt Arch, Increased lamina propria cellularity?, Marked & transmucosal
increase in lamina propria cellularity, Lamina propria polymorphs, Crypt
architecture, Patchy lamina propria cellularity?, Epithelial changes, Mucosal
surface, Cryptitis extent, Mucin depletion, Cryptitis polymorphs, Lamina propria
granulomas, Crypt abscesses polymorphs, Crypt abscesses extent, Basal
histiocytic cells, Submucosal granulomas, Sex, Increased lymphoid aggregates in
lamina propria?', 'accuracy': [0.612, 0.66, 0.46586345381526106,

0.7550200803212851, 0.6626506024096386], 'avgAccuracy': 0.631106827309237, 'f1':
[0.619483292718186, 0.6533076105852811, 0.47379827270619024, 0.8054889688624629,
0.6563268057243961], 'avgF1': 0.6416809901193032, 'precision': [0.612, 0.66,
0.46586345381526106, 0.7550200803212851, 0.6626506024096386], 'avgPrecision':
0.631106827309237, 'recall': [0.612, 0.66, 0.46586345381526106,
0.7550200803212851, 0.6626506024096386], 'avgRecall': 0.631106827309237,
'params': [{'activation': 'logistic', 'alpha': 0.0001, 'batch_size': 'auto',
'beta_1': 0.9, 'beta_2': 0.999, 'early_stopping': False, 'epsilon': 1e-08,
'hidden_layer_sizes': (100,), 'learning_rate': 'invscaling',
'learning_rate_init': 0.001, 'max_fun': 15000, 'max_iter': 7000, 'momentum':
0.9, 'n_iter_no_change': 10, 'nesterovs_momentum': True, 'power_t': 0.5,
'random_state': None, 'shuffle': True, 'solver': 'adam', 'tol': 0.0001,
'validation_fraction': 0.1, 'verbose': False, 'warm_start': False}]}
*****************************************************
*****************************************************
* Best Performing Model and Params is:
* {'classifier': 'RandomForestClassifier', 'features': 'Active inflammation?,
Severity of Crypt Arch, Increased lamina propria cellularity?, Marked &
transmucosal increase in lamina propria cellularity, Lamina propria polymorphs,
Crypt architecture, Patchy lamina propria cellularity?, Epithelial changes,
Mucosal surface, Cryptitis extent, Mucin depletion, Cryptitis polymorphs, Lamina
propria granulomas, Crypt abscesses polymorphs, Crypt abscesses extent, Basal
histiocytic cells, Submucosal granulomas, Sex, Increased lymphoid aggregates in
lamina propria?', 'accuracy': [0.644, 0.692, 0.642570281124498,
0.8835341365461847, 0.6827309236947792], 'avgAccuracy': 0.7089670682730924,
'f1': [0.6457962983678529, 0.6854867461430575, 0.6897954606589943,
0.890157800932128, 0.6760007630159505], 'avgF1': 0.7174474138235967,
'precision': [0.644, 0.692, 0.642570281124498, 0.8835341365461847,
0.6827309236947792], 'avgPrecision': 0.7089670682730924, 'recall': [0.644,
0.692, 0.642570281124498, 0.8835341365461847, 0.6827309236947792], 'avgRecall':
0.7089670682730924, 'params': [{'bootstrap': True, 'ccp_alpha': 0.0,
'class_weight': None, 'criterion': 'gini', 'max_depth': None, 'max_features':
'log2', 'max_leaf_nodes': None, 'max_samples': None, 'min_impurity_decrease':
0.0, 'min_impurity_split': None, 'min_samples_leaf': 1, 'min_samples_split': 2,
'min_weight_fraction_leaf': 0.0, 'n_estimators': 500, 'n_jobs': -1, 'oob_score':
True, 'random_state': None, 'verbose': 0, 'warm_start': False}]}
*****************************************************

```
                   model                                             features  \
0  RandomForestClassifier  Active inflammation?, Severity of Crypt Arch, …
1    KNeighborsClassifier  Active inflammation?, Severity of Crypt Arch, …
2      LogisticRegression  Active inflammation?, Severity of Crypt Arch, …
3              GaussianNB  Active inflammation?, Severity of Crypt Arch, …
4      AdaBoostClassifier  Active inflammation?, Severity of Crypt Arch, …
5  DecisionTreeClassifier  Active inflammation?, Severity of Crypt Arch, …
6                     SVC  Active inflammation?, Severity of Crypt Arch, …
7           MLPClassifier  Active inflammation?, Severity of Crypt Arch, …
```

```
     accuracy         f1  precision    recall  \
0    0.708967   0.717447   0.708967  0.708967
1    0.674458   0.685064   0.674458  0.674458
2    0.630307   0.641764   0.630307  0.630307
3    0.606217   0.561104   0.606217  0.606217
4    0.596620   0.608425   0.596620  0.596620
5    0.676106   0.683407   0.676106  0.676106
6    0.631900   0.637793   0.631900  0.631900
7    0.631107   0.641681   0.631107  0.631107


                                              params
0  {'bootstrap': True, 'ccp_alpha': 0.0, 'class_w…
1  {'algorithm': 'auto', 'leaf_size': 30, 'metric…
2  {'C': 1, 'class_weight': None, 'dual': False, …
3            {'priors': None, 'var_smoothing': 1e-09}
4  {'algorithm': 'SAMME.R', 'base_estimator': Non…
5  {'ccp_alpha': 0.0, 'class_weight': None, 'crit…
6  {'C': 1.0, 'break_ties': False, 'cache_size': …
7  {'activation': 'logistic', 'alpha': 0.0001, 'b…
```

Processing Model: RandomForestClassifier
****
* RandomForestClassifier
* Best Params Result:
* {'classifier': 'RandomForestClassifier', 'features': 'Active inflammation?,
Severity of Crypt Arch, Increased lamina propria cellularity?, Marked &
transmucosal increase in lamina propria cellularity, Lamina propria polymorphs,
Crypt architecture, Patchy lamina propria cellularity?, Epithelial changes,
Mucosal surface, Cryptitis extent, Mucin depletion, Cryptitis polymorphs, Lamina
propria granulomas, Crypt abscesses polymorphs, Crypt abscesses extent, Basal
histiocytic cells, Submucosal granulomas, Sex', 'accuracy': [0.64, 0.692,
0.6265060240963856, 0.8795180722891566, 0.6867469879518072], 'avgAccuracy':
0.7049542168674698, 'f1': [0.6401903999972842, 0.6888418032786885,
0.6727352696313285, 0.8872760931410898, 0.676875434941756], 'avgF1':
0.7131838001980294, 'precision': [0.64, 0.692, 0.6265060240963856,
0.8795180722891566, 0.6867469879518072], 'avgPrecision': 0.7049542168674698,
'recall': [0.64, 0.692, 0.6265060240963856, 0.8795180722891566,
0.6867469879518072], 'avgRecall': 0.7049542168674698, 'params': [{'bootstrap':
True, 'ccp_alpha': 0.0, 'class_weight': None, 'criterion': 'entropy',
'max_depth': None, 'max_features': 'sqrt', 'max_leaf_nodes': None,
'max_samples': None, 'min_impurity_decrease': 0.0, 'min_impurity_split': None,
'min_samples_leaf': 1, 'min_samples_split': 2, 'min_weight_fraction_leaf': 0.0,
'n_estimators': 200, 'n_jobs': -1, 'oob_score': False, 'random_state': None,
'verbose': 0, 'warm_start': False}]}
****

Processing Model: KNeighborsClassifier
****

* KNeighborsClassifier
* Best Params Result:
* {'classifier': 'KNeighborsClassifier', 'features': 'Active inflammation?,
Severity of Crypt Arch, Increased lamina propria cellularity?, Marked &
transmucosal increase in lamina propria cellularity, Lamina propria polymorphs,
Crypt architecture, Patchy lamina propria cellularity?, Epithelial changes,
Mucosal surface, Cryptitis extent, Mucin depletion, Cryptitis polymorphs, Lamina
propria granulomas, Crypt abscesses polymorphs, Crypt abscesses extent, Basal
histiocytic cells, Submucosal granulomas, Sex', 'accuracy': [0.616, 0.676,
0.5461847389558233, 0.8393574297188755, 0.6546184738955824], 'avgAccuracy':
0.6664321285140562, 'f1': [0.6258613852624932, 0.679591676471393,
0.573081654813609, 0.8622017423173, 0.6535101659436285], 'avgF1':
0.6788493249616847, 'precision': [0.616, 0.676, 0.5461847389558233,
0.8393574297188755, 0.6546184738955824], 'avgPrecision': 0.6664321285140562,
'recall': [0.616, 0.676, 0.5461847389558233, 0.8393574297188755,
0.6546184738955824], 'avgRecall': 0.6664321285140562, 'params': [{'algorithm':
'auto', 'leaf_size': 30, 'metric': 'minkowski', 'metric_params': None, 'n_jobs':
-1, 'n_neighbors': 12, 'p': 2, 'weights': 'distance'}]}
****

Processing Model: LogisticRegression
****
* LogisticRegression
* Best Params Result:
* {'classifier': 'LogisticRegression', 'features': 'Active inflammation?,
Severity of Crypt Arch, Increased lamina propria cellularity?, Marked &
transmucosal increase in lamina propria cellularity, Lamina propria polymorphs,
Crypt architecture, Patchy lamina propria cellularity?, Epithelial changes,
Mucosal surface, Cryptitis extent, Mucin depletion, Cryptitis polymorphs, Lamina
propria granulomas, Crypt abscesses polymorphs, Crypt abscesses extent, Basal
histiocytic cells, Submucosal granulomas, Sex', 'accuracy': [0.62, 0.676,
0.46586345381526106, 0.7590361445783133, 0.6626506024096386], 'avgAccuracy':
0.6367100401606426, 'f1': [0.630510777058092, 0.6766915009041591,
0.47379827270619024, 0.8076422782726752, 0.6588608176288667], 'avgF1':
0.6495007293139966, 'precision': [0.62, 0.676, 0.46586345381526106,
0.7590361445783133, 0.6626506024096386], 'avgPrecision': 0.6367100401606426,
'recall': [0.62, 0.676, 0.46586345381526106, 0.7590361445783133,
0.6626506024096386], 'avgRecall': 0.6367100401606426, 'params': [{'C': 1,
'class_weight': None, 'dual': False, 'fit_intercept': True, 'intercept_scaling':
1, 'l1_ratio': None, 'max_iter': 100, 'multi_class': 'ovr', 'n_jobs': -1,
'penalty': 'l2', 'random_state': None, 'solver': 'newton-cg', 'tol': 0.0001,
'verbose': 0, 'warm_start': False}]}
****

Processing Model: GaussianNB
****
* GaussianNB
* Best Params Result:

* {'classifier': 'GaussianNB', 'features': 'Active inflammation?, Severity of
Crypt Arch, Increased lamina propria cellularity?, Marked & transmucosal
increase in lamina propria cellularity, Lamina propria polymorphs, Crypt
architecture, Patchy lamina propria cellularity?, Epithelial changes, Mucosal
surface, Cryptitis extent, Mucin depletion, Cryptitis polymorphs, Lamina propria
granulomas, Crypt abscesses polymorphs, Crypt abscesses extent, Basal
histiocytic cells, Submucosal granulomas, Sex', 'accuracy': [0.58, 0.68,
0.3333333333333333, 0.7389558232931727, 0.7028112449799196], 'avgAccuracy':
0.6070200803212851, 'f1': [0.5473806944229479, 0.6364746795444975,
0.2518635368708986, 0.7172627517945799, 0.6566738738031556], 'avgF1':
0.5619311072872158, 'precision': [0.58, 0.68, 0.3333333333333333,
0.7389558232931727, 0.7028112449799196], 'avgPrecision': 0.6070200803212851,
'recall': [0.58, 0.68, 0.3333333333333333, 0.7389558232931727,
0.7028112449799196], 'avgRecall': 0.6070200803212851, 'params': [{'priors':
None, 'var_smoothing': 1e-09}]}
****

Processing Model: AdaBoostClassifier
****
* AdaBoostClassifier
* Best Params Result:
* {'classifier': 'AdaBoostClassifier', 'features': 'Active inflammation?,
Severity of Crypt Arch, Increased lamina propria cellularity?, Marked &
transmucosal increase in lamina propria cellularity, Lamina propria polymorphs,
Crypt architecture, Patchy lamina propria cellularity?, Epithelial changes,
Mucosal surface, Cryptitis extent, Mucin depletion, Cryptitis polymorphs, Lamina
propria granulomas, Crypt abscesses polymorphs, Crypt abscesses extent, Basal
histiocytic cells, Submucosal granulomas, Sex', 'accuracy': [0.62, 0.588,
0.5261044176706827, 0.7670682730923695, 0.4819277108433735], 'avgAccuracy':
0.5966200803212851, 'f1': [0.6247121349238997, 0.5916346583623374,
0.5624659655571439, 0.8035271520866073, 0.45978459730624915], 'avgF1':
0.6084249016472475, 'precision': [0.62, 0.588, 0.5261044176706827,
0.7670682730923695, 0.4819277108433735], 'avgPrecision': 0.5966200803212851,
'recall': [0.62, 0.588, 0.5261044176706827, 0.7670682730923695,
0.4819277108433735], 'avgRecall': 0.5966200803212851, 'params': [{'algorithm':
'SAMME.R', 'base_estimator': None, 'learning_rate': 1, 'n_estimators': 50,
'random_state': None}]}
****

Processing Model: DecisionTreeClassifier
****
* DecisionTreeClassifier
* Best Params Result:
* {'classifier': 'DecisionTreeClassifier', 'features': 'Active inflammation?,
Severity of Crypt Arch, Increased lamina propria cellularity?, Marked &
transmucosal increase in lamina propria cellularity, Lamina propria polymorphs,
Crypt architecture, Patchy lamina propria cellularity?, Epithelial changes,
Mucosal surface, Cryptitis extent, Mucin depletion, Cryptitis polymorphs, Lamina

propria granulomas, Crypt abscesses polymorphs, Crypt abscesses extent, Basal histiocytic cells, Submucosal granulomas, Sex', 'accuracy': [0.604, 0.672, 0.5903614457831325, 0.8674698795180723, 0.6746987951807228], 'avgAccuracy': 0.6817060240963856, 'f1': [0.6067941287788433, 0.6745175342245558, 0.6305403385271772, 0.8819368361544827, 0.6576588909686004], 'avgF1': 0.6902895457307319, 'precision': [0.604, 0.672, 0.5903614457831325, 0.8674698795180723, 0.6746987951807228], 'avgPrecision': 0.6817060240963856, 'recall': [0.604, 0.672, 0.5903614457831325, 0.8674698795180723, 0.6746987951807228], 'avgRecall': 0.6817060240963856, 'params': [{'ccp_alpha': 0.0, 'class_weight': None, 'criterion': 'gini', 'max_depth': None, 'max_features': 'auto', 'max_leaf_nodes': None, 'min_impurity_decrease': 0.0, 'min_impurity_split': None, 'min_samples_leaf': 1, 'min_samples_split': 2, 'min_weight_fraction_leaf': 0.0, 'random_state': None, 'splitter': 'random'}]}
****

Processing Model: SVC
****
* SVC
* Best Params Result:
* {'classifier': 'SVC', 'features': 'Active inflammation?, Severity of Crypt Arch, Increased lamina propria cellularity?, Marked & transmucosal increase in lamina propria cellularity, Lamina propria polymorphs, Crypt architecture, Patchy lamina propria cellularity?, Epithelial changes, Mucosal surface, Cryptitis extent, Mucin depletion, Cryptitis polymorphs, Lamina propria granulomas, Crypt abscesses polymorphs, Crypt abscesses extent, Basal histiocytic cells, Submucosal granulomas, Sex', 'accuracy': [0.62, 0.668, 0.46586345381526106, 0.7590361445783133, 0.6465863453815262], 'avgAccuracy': 0.6318971887550201, 'f1': [0.6301081479280416, 0.6616833891845719, 0.47777095288365645, 0.7810597227620159, 0.6398844467422584], 'avgF1': 0.6381013319001089, 'precision': [0.62, 0.668, 0.46586345381526106, 0.7590361445783133, 0.6465863453815262], 'avgPrecision': 0.6318971887550201, 'recall': [0.62, 0.668, 0.46586345381526106, 0.7590361445783133, 0.6465863453815262], 'avgRecall': 0.6318971887550201, 'params': [{'C': 1.0, 'break_ties': False, 'cache_size': 4000, 'class_weight': None, 'coef0': 0.0, 'decision_function_shape': 'ovr', 'degree': 3, 'gamma': 'scale', 'kernel': 'linear', 'max_iter': -1, 'probability': False, 'random_state': None, 'shrinking': True, 'tol': 0.001, 'verbose': False}]}
****

Processing Model: MLPClassifier
****
* MLPClassifier
* Best Params Result:
* {'classifier': 'MLPClassifier', 'features': 'Active inflammation?, Severity of Crypt Arch, Increased lamina propria cellularity?, Marked & transmucosal increase in lamina propria cellularity, Lamina propria polymorphs, Crypt architecture, Patchy lamina propria cellularity?, Epithelial changes, Mucosal surface, Cryptitis extent, Mucin depletion, Cryptitis polymorphs, Lamina propria

granulomas, Crypt abscesses polymorphs, Crypt abscesses extent, Basal histiocytic cells, Submucosal granulomas, Sex', 'accuracy': [0.616, 0.66, 0.46586345381526106, 0.7590361445783133, 0.6626506024096386], 'avgAccuracy': 0.6327100401606426, 'f1': [0.623562700991328, 0.6561116122186007, 0.4758473874670071, 0.8090412615713821, 0.6563268057243961], 'avgF1': 0.6441779535945428, 'precision': [0.616, 0.66, 0.46586345381526106, 0.7590361445783133, 0.6626506024096386], 'avgPrecision': 0.6327100401606426, 'recall': [0.616, 0.66, 0.46586345381526106, 0.7590361445783133, 0.6626506024096386], 'avgRecall': 0.6327100401606426, 'params': [{'activation': 'logistic', 'alpha': 0.0001, 'batch_size': 'auto', 'beta_1': 0.9, 'beta_2': 0.999, 'early_stopping': False, 'epsilon': 1e-08, 'hidden_layer_sizes': (100,), 'learning_rate': 'constant', 'learning_rate_init': 0.001, 'max_fun': 15000, 'max_iter': 9000, 'momentum': 0.9, 'n_iter_no_change': 10, 'nesterovs_momentum': True, 'power_t': 0.5, 'random_state': None, 'shuffle': True, 'solver': 'adam', 'tol': 0.0001, 'validation_fraction': 0.1, 'verbose': False, 'warm_start': False}]}
****
****
* Best Performing Model and Params is:
* {'classifier': 'RandomForestClassifier', 'features': 'Active inflammation?, Severity of Crypt Arch, Increased lamina propria cellularity?, Marked & transmucosal increase in lamina propria cellularity, Lamina propria polymorphs, Crypt architecture, Patchy lamina propria cellularity?, Epithelial changes, Mucosal surface, Cryptitis extent, Mucin depletion, Cryptitis polymorphs, Lamina propria granulomas, Crypt abscesses polymorphs, Crypt abscesses extent, Basal histiocytic cells, Submucosal granulomas, Sex', 'accuracy': [0.64, 0.692, 0.6265060240963856, 0.8795180722891566, 0.6867469879518072], 'avgAccuracy': 0.7049542168674698, 'f1': [0.6401903999972842, 0.6888418032786885, 0.6727352696313285, 0.8872760931410898, 0.676875434941756], 'avgF1': 0.7131838001980294, 'precision': [0.64, 0.692, 0.6265060240963856, 0.8795180722891566, 0.6867469879518072], 'avgPrecision': 0.7049542168674698, 'recall': [0.64, 0.692, 0.6265060240963856, 0.8795180722891566, 0.6867469879518072], 'avgRecall': 0.7049542168674698, 'params': [{'bootstrap': True, 'ccp_alpha': 0.0, 'class_weight': None, 'criterion': 'entropy', 'max_depth': None, 'max_features': 'sqrt', 'max_leaf_nodes': None, 'max_samples': None, 'min_impurity_decrease': 0.0, 'min_impurity_split': None, 'min_samples_leaf': 1, 'min_samples_split': 2, 'min_weight_fraction_leaf': 0.0, 'n_estimators': 200, 'n_jobs': -1, 'oob_score': False, 'random_state': None, 'verbose': 0, 'warm_start': False}]}
****

```
                  model                                      features  \
0  RandomForestClassifier  Active inflammation?, Severity of Crypt Arch, …
1    KNeighborsClassifier  Active inflammation?, Severity of Crypt Arch, …
2      LogisticRegression  Active inflammation?, Severity of Crypt Arch, …
3              GaussianNB  Active inflammation?, Severity of Crypt Arch, …
4       AdaBoostClassifier  Active inflammation?, Severity of Crypt Arch, …
5  DecisionTreeClassifier  Active inflammation?, Severity of Crypt Arch, …
```

```
6                     SVC   Active inflammation?, Severity of Crypt Arch, …
7           MLPClassifier   Active inflammation?, Severity of Crypt Arch, …


   accuracy          f1  precision    recall  \
0  0.704954   0.713184   0.704954  0.704954
1  0.666432   0.678849   0.666432  0.666432
2  0.636710   0.649501   0.636710  0.636710
3  0.607020   0.561931   0.607020  0.607020
4  0.596620   0.608425   0.596620  0.596620
5  0.681706   0.690290   0.681706  0.681706
6  0.631897   0.638101   0.631897  0.631897
7  0.632710   0.644178   0.632710  0.632710


                                                params
0  {'bootstrap': True, 'ccp_alpha': 0.0, 'class_w…
1  {'algorithm': 'auto', 'leaf_size': 30, 'metric…
2  {'C': 1, 'class_weight': None, 'dual': False, …
3          {'priors': None, 'var_smoothing': 1e-09}
4  {'algorithm': 'SAMME.R', 'base_estimator': Non…
5  {'ccp_alpha': 0.0, 'class_weight': None, 'crit…
6  {'C': 1.0, 'break_ties': False, 'cache_size': …
7  {'activation': 'logistic', 'alpha': 0.0001, 'b…


Processing Model: RandomForestClassifier
*******************************************************
* RandomForestClassifier
* Best Params Result:
* {'classifier': 'RandomForestClassifier', 'features': 'Active inflammation?,
Severity of Crypt Arch, Increased lamina propria cellularity?, Marked &
transmucosal increase in lamina propria cellularity, Lamina propria polymorphs,
Crypt architecture, Patchy lamina propria cellularity?, Epithelial changes,
Mucosal surface, Cryptitis extent, Mucin depletion, Cryptitis polymorphs, Lamina
propria granulomas, Crypt abscesses polymorphs, Crypt abscesses extent, Basal
histiocytic cells, Submucosal granulomas', 'accuracy': [0.628, 0.684,
0.5863453815261044, 0.8273092369477911, 0.6746987951807228], 'avgAccuracy':
0.6800706827309236, 'f1': [0.6238280944671196, 0.6663567602965595,
0.6335107817215849, 0.8366137291502381, 0.6641178159478851], 'avgF1':
0.6848854363166774, 'precision': [0.628, 0.684, 0.5863453815261044,
0.8273092369477911, 0.6746987951807228], 'avgPrecision': 0.6800706827309236,
'recall': [0.628, 0.684, 0.5863453815261044, 0.8273092369477911,
0.6746987951807228], 'avgRecall': 0.6800706827309236, 'params': [{'bootstrap':
True, 'ccp_alpha': 0.0, 'class_weight': None, 'criterion': 'entropy',
'max_depth': None, 'max_features': 'sqrt', 'max_leaf_nodes': None,
'max_samples': None, 'min_impurity_decrease': 0.0, 'min_impurity_split': None,
'min_samples_leaf': 1, 'min_samples_split': 2, 'min_weight_fraction_leaf': 0.0,
'n_estimators': 200, 'n_jobs': -1, 'oob_score': False, 'random_state': None,
'verbose': 0, 'warm_start': False}]}
*******************************************************
```

```
Processing Model: KNeighborsClassifier
********************************************************
* KNeighborsClassifier
* Best Params Result:
* {'classifier': 'KNeighborsClassifier', 'features': 'Active inflammation?,
Severity of Crypt Arch, Increased lamina propria cellularity?, Marked &
transmucosal increase in lamina propria cellularity, Lamina propria polymorphs,
Crypt architecture, Patchy lamina propria cellularity?, Epithelial changes,
Mucosal surface, Cryptitis extent, Mucin depletion, Cryptitis polymorphs, Lamina
propria granulomas, Crypt abscesses polymorphs, Crypt abscesses extent, Basal
histiocytic cells, Submucosal granulomas', 'accuracy': [0.616, 0.628,
0.5301204819277109, 0.8393574297188755, 0.6385542168674698], 'avgAccuracy':
0.6504064257028113, 'f1': [0.6237338974087785, 0.6300622208687046,
0.549816422993329, 0.8486276952976995, 0.6338154085675457], 'avgF1':
0.6572111290272115, 'precision': [0.616, 0.628, 0.5301204819277109,
0.8393574297188755, 0.6385542168674698], 'avgPrecision': 0.6504064257028113,
'recall': [0.616, 0.628, 0.5301204819277109, 0.8393574297188755,
0.6385542168674698], 'avgRecall': 0.6504064257028113, 'params': [{'algorithm':
'ball_tree', 'leaf_size': 30, 'metric': 'minkowski', 'metric_params': None,
'n_jobs': -1, 'n_neighbors': 12, 'p': 2, 'weights': 'distance'}]}
********************************************************

Processing Model: LogisticRegression
********************************************************
* LogisticRegression
* Best Params Result:
* {'classifier': 'LogisticRegression', 'features': 'Active inflammation?,
Severity of Crypt Arch, Increased lamina propria cellularity?, Marked &
transmucosal increase in lamina propria cellularity, Lamina propria polymorphs,
Crypt architecture, Patchy lamina propria cellularity?, Epithelial changes,
Mucosal surface, Cryptitis extent, Mucin depletion, Cryptitis polymorphs, Lamina
propria granulomas, Crypt abscesses polymorphs, Crypt abscesses extent, Basal
histiocytic cells, Submucosal granulomas', 'accuracy': [0.616, 0.66,
0.4538152610441767, 0.7429718875502008, 0.6626506024096386], 'avgAccuracy':
0.6270875502008032, 'f1': [0.6255191955780194, 0.6545657289002558,
0.4562571593648378, 0.7696235366394758, 0.6643848119751734], 'avgF1':
0.6340700864915524, 'precision': [0.616, 0.66, 0.4538152610441767,
0.7429718875502008, 0.6626506024096386], 'avgPrecision': 0.6270875502008032,
'recall': [0.616, 0.66, 0.4538152610441767, 0.7429718875502008,
0.6626506024096386], 'avgRecall': 0.6270875502008032, 'params': [{'C': 1,
'class_weight': None, 'dual': False, 'fit_intercept': True, 'intercept_scaling':
1, 'l1_ratio': None, 'max_iter': 100, 'multi_class': 'ovr', 'n_jobs': -1,
'penalty': 'l2', 'random_state': None, 'solver': 'newton-cg', 'tol': 0.0001,
'verbose': 0, 'warm_start': False}]}
********************************************************

Processing Model: GaussianNB
```

```
****************************************************
* GaussianNB
* Best Params Result:
* {'classifier': 'GaussianNB', 'features': 'Active inflammation?, Severity of
Crypt Arch, Increased lamina propria cellularity?, Marked & transmucosal
increase in lamina propria cellularity, Lamina propria polymorphs, Crypt
architecture, Patchy lamina propria cellularity?, Epithelial changes, Mucosal
surface, Cryptitis extent, Mucin depletion, Cryptitis polymorphs, Lamina propria
granulomas, Crypt abscesses polymorphs, Crypt abscesses extent, Basal
histiocytic cells, Submucosal granulomas', 'accuracy': [0.58, 0.68,
0.3333333333333333, 0.7389558232931727, 0.7028112449799196], 'avgAccuracy':
0.6070200803212851, 'f1': [0.5473806944229479, 0.6364746795444975,
0.2518635368708986, 0.7172627517945799, 0.6566738738031556], 'avgF1':
0.5619311072872158, 'precision': [0.58, 0.68, 0.3333333333333333,
0.7389558232931727, 0.7028112449799196], 'avgPrecision': 0.6070200803212851,
'recall': [0.58, 0.68, 0.3333333333333333, 0.7389558232931727,
0.7028112449799196], 'avgRecall': 0.6070200803212851, 'params': [{'priors':
None, 'var_smoothing': 1e-09}]}
****************************************************

Processing Model: AdaBoostClassifier
****************************************************
* AdaBoostClassifier
* Best Params Result:
* {'classifier': 'AdaBoostClassifier', 'features': 'Active inflammation?,
Severity of Crypt Arch, Increased lamina propria cellularity?, Marked &
transmucosal increase in lamina propria cellularity, Lamina propria polymorphs,
Crypt architecture, Patchy lamina propria cellularity?, Epithelial changes,
Mucosal surface, Cryptitis extent, Mucin depletion, Cryptitis polymorphs, Lamina
propria granulomas, Crypt abscesses polymorphs, Crypt abscesses extent, Basal
histiocytic cells, Submucosal granulomas', 'accuracy': [0.608, 0.548,
0.5261044176706827, 0.7831325301204819, 0.5381526104417671], 'avgAccuracy':
0.6006779116465863, 'f1': [0.6097409861178426, 0.54890569637022,
0.5652999595280346, 0.7999556325095323, 0.5340065432929797], 'avgF1':
0.6115817635637218, 'precision': [0.608, 0.548, 0.5261044176706827,
0.7831325301204819, 0.5381526104417671], 'avgPrecision': 0.6006779116465863,
'recall': [0.608, 0.548, 0.5261044176706827, 0.7831325301204819,
0.5381526104417671], 'avgRecall': 0.6006779116465863, 'params': [{'algorithm':
'SAMME.R', 'base_estimator': None, 'learning_rate': 1, 'n_estimators': 50,
'random_state': None}]}
****************************************************

Processing Model: DecisionTreeClassifier
****************************************************
* DecisionTreeClassifier
* Best Params Result:
* {'classifier': 'DecisionTreeClassifier', 'features': 'Active inflammation?,
Severity of Crypt Arch, Increased lamina propria cellularity?, Marked &
```

transmucosal increase in lamina propria cellularity, Lamina propria polymorphs, Crypt architecture, Patchy lamina propria cellularity?, Epithelial changes, Mucosal surface, Cryptitis extent, Mucin depletion, Cryptitis polymorphs, Lamina propria granulomas, Crypt abscesses polymorphs, Crypt abscesses extent, Basal histiocytic cells, Submucosal granulomas', 'accuracy': [0.592, 0.632, 0.5823293172690763, 0.8192771084337349, 0.6506024096385542], 'avgAccuracy': 0.6552417670682731, 'f1': [0.5914066666666666, 0.6241120479346717, 0.6292531428179979, 0.8319416643410837, 0.6340345584549889], 'avgF1': 0.6621496160430818, 'precision': [0.592, 0.632, 0.5823293172690763, 0.8192771084337349, 0.6506024096385542], 'avgPrecision': 0.6552417670682731, 'recall': [0.592, 0.632, 0.5823293172690763, 0.8192771084337349, 0.6506024096385542], 'avgRecall': 0.6552417670682731, 'params': [{'ccp_alpha': 0.0, 'class_weight': None, 'criterion': 'entropy', 'max_depth': None, 'max_features': 'log2', 'max_leaf_nodes': None, 'min_impurity_decrease': 0.0, 'min_impurity_split': None, 'min_samples_leaf': 1, 'min_samples_split': 2, 'min_weight_fraction_leaf': 0.0, 'random_state': None, 'splitter': 'best'}]}
****

Processing Model: SVC
****
* SVC
* Best Params Result:
* {'classifier': 'SVC', 'features': 'Active inflammation?, Severity of Crypt Arch, Increased lamina propria cellularity?, Marked & transmucosal increase in lamina propria cellularity, Lamina propria polymorphs, Crypt architecture, Patchy lamina propria cellularity?, Epithelial changes, Mucosal surface, Cryptitis extent, Mucin depletion, Cryptitis polymorphs, Lamina propria granulomas, Crypt abscesses polymorphs, Crypt abscesses extent, Basal histiocytic cells, Submucosal granulomas', 'accuracy': [0.624, 0.66, 0.4538152610441767, 0.7590361445783133, 0.6586345381526104], 'avgAccuracy': 0.6310971887550201, 'f1': [0.6331277987421384, 0.6523294566003022, 0.4603152350337419, 0.7785427423981641, 0.6494206999036916], 'avgF1': 0.6347471865356076, 'precision': [0.624, 0.66, 0.4538152610441767, 0.7590361445783133, 0.6586345381526104], 'avgPrecision': 0.6310971887550201, 'recall': [0.624, 0.66, 0.4538152610441767, 0.7590361445783133, 0.6586345381526104], 'avgRecall': 0.6310971887550201, 'params': [{'C': 1.0, 'break_ties': False, 'cache_size': 4000, 'class_weight': None, 'coef0': 0.0, 'decision_function_shape': 'ovr', 'degree': 3, 'gamma': 'scale', 'kernel': 'linear', 'max_iter': -1, 'probability': False, 'random_state': None, 'shrinking': True, 'tol': 0.001, 'verbose': False}]}
****

Processing Model: MLPClassifier
****
* MLPClassifier
* Best Params Result:
* {'classifier': 'MLPClassifier', 'features': 'Active inflammation?, Severity of Crypt Arch, Increased lamina propria cellularity?, Marked & transmucosal

increase in lamina propria cellularity, Lamina propria polymorphs, Crypt architecture, Patchy lamina propria cellularity?, Epithelial changes, Mucosal surface, Cryptitis extent, Mucin depletion, Cryptitis polymorphs, Lamina propria granulomas, Crypt abscesses polymorphs, Crypt abscesses extent, Basal histiocytic cells, Submucosal granulomas', 'accuracy': [0.616, 0.656, 0.4497991967871486, 0.7429718875502008, 0.6546184738955824], 'avgAccuracy': 0.6238779116465863, 'f1': [0.6263389726802395, 0.6506462860214997, 0.45688094749259156, 0.7696377911048067, 0.6505061595423042], 'avgF1': 0.6308020313682883, 'precision': [0.616, 0.656, 0.4497991967871486, 0.7429718875502008, 0.6546184738955824], 'avgPrecision': 0.6238779116465863, 'recall': [0.616, 0.656, 0.4497991967871486, 0.7429718875502008, 0.6546184738955824], 'avgRecall': 0.6238779116465863, 'params': [{'activation': 'logistic', 'alpha': 0.0001, 'batch_size': 'auto', 'beta_1': 0.9, 'beta_2': 0.999, 'early_stopping': False, 'epsilon': 1e-08, 'hidden_layer_sizes': (100,), 'learning_rate': 'invscaling', 'learning_rate_init': 0.001, 'max_fun': 15000, 'max_iter': 7000, 'momentum': 0.9, 'n_iter_no_change': 10, 'nesterovs_momentum': True, 'power_t': 0.5, 'random_state': None, 'shuffle': True, 'solver': 'adam', 'tol': 0.0001, 'validation_fraction': 0.1, 'verbose': False, 'warm_start': False}]}
****
****
* Best Performing Model and Params is:
* {'classifier': 'RandomForestClassifier', 'features': 'Active inflammation?, Severity of Crypt Arch, Increased lamina propria cellularity?, Marked & transmucosal increase in lamina propria cellularity, Lamina propria polymorphs, Crypt architecture, Patchy lamina propria cellularity?, Epithelial changes, Mucosal surface, Cryptitis extent, Mucin depletion, Cryptitis polymorphs, Lamina propria granulomas, Crypt abscesses polymorphs, Crypt abscesses extent, Basal histiocytic cells, Submucosal granulomas', 'accuracy': [0.628, 0.684, 0.5863453815261044, 0.8273092369477911, 0.6746987951807228], 'avgAccuracy': 0.6800706827309236, 'f1': [0.6238280944671196, 0.6663567602965595, 0.6335107817215849, 0.8366137291502381, 0.66411781159478851], 'avgF1': 0.6848854363166774, 'precision': [0.628, 0.684, 0.5863453815261044, 0.8273092369477911, 0.6746987951807228], 'avgPrecision': 0.6800706827309236, 'recall': [0.628, 0.684, 0.5863453815261044, 0.8273092369477911, 0.6746987951807228], 'avgRecall': 0.6800706827309236, 'params': [{'bootstrap': True, 'ccp_alpha': 0.0, 'class_weight': None, 'criterion': 'entropy', 'max_depth': None, 'max_features': 'sqrt', 'max_leaf_nodes': None, 'max_samples': None, 'min_impurity_decrease': 0.0, 'min_impurity_split': None, 'min_samples_leaf': 1, 'min_samples_split': 2, 'min_weight_fraction_leaf': 0.0, 'n_estimators': 200, 'n_jobs': -1, 'oob_score': False, 'random_state': None, 'verbose': 0, 'warm_start': False}]}
****

```
                model                                      features  \
0  RandomForestClassifier  Active inflammation?, Severity of Crypt Arch, …
1     KNeighborsClassifier  Active inflammation?, Severity of Crypt Arch, …
2       LogisticRegression  Active inflammation?, Severity of Crypt Arch, …
```

```
3              GaussianNB  Active inflammation?, Severity of Crypt Arch, …
4       AdaBoostClassifier  Active inflammation?, Severity of Crypt Arch, …
5  DecisionTreeClassifier  Active inflammation?, Severity of Crypt Arch, …
6                     SVC  Active inflammation?, Severity of Crypt Arch, …
7           MLPClassifier  Active inflammation?, Severity of Crypt Arch, …

   accuracy        f1  precision    recall  \
0  0.680071  0.684885   0.680071  0.680071
1  0.650406  0.657211   0.650406  0.650406
2  0.627088  0.634070   0.627088  0.627088
3  0.607020  0.561931   0.607020  0.607020
4  0.600678  0.611582   0.600678  0.600678
5  0.655242  0.662150   0.655242  0.655242
6  0.631097  0.634747   0.631097  0.631097
7  0.623878  0.630802   0.623878  0.623878


                                                params
0  {'bootstrap': True, 'ccp_alpha': 0.0, 'class_w…
1  {'algorithm': 'ball_tree', 'leaf_size': 30, 'm…
2  {'C': 1, 'class_weight': None, 'dual': False, …
3            {'priors': None, 'var_smoothing': 1e-09}
4  {'algorithm': 'SAMME.R', 'base_estimator': Non…
5  {'ccp_alpha': 0.0, 'class_weight': None, 'crit…
6  {'C': 1.0, 'break_ties': False, 'cache_size': …
7  {'activation': 'logistic', 'alpha': 0.0001, 'b…


Processing Model: RandomForestClassifier
*******************************************************
* RandomForestClassifier
* Best Params Result:
* {'classifier': 'RandomForestClassifier', 'features': 'Active inflammation?,
Severity of Crypt Arch, Increased lamina propria cellularity?, Marked &
transmucosal increase in lamina propria cellularity, Lamina propria polymorphs,
Crypt architecture, Patchy lamina propria cellularity?, Epithelial changes,
Mucosal surface, Cryptitis extent, Mucin depletion, Cryptitis polymorphs, Lamina
propria granulomas, Crypt abscesses polymorphs, Crypt abscesses extent, Basal
histiocytic cells', 'accuracy': [0.624, 0.676, 0.5823293172690763,
0.8313253012048193, 0.678714859437751], 'avgAccuracy': 0.6784738955823293, 'f1':
[0.6199823747979869, 0.6565495240545407, 0.6292531428179979, 0.8393761743798469,
0.6677313786205541], 'avgF1': 0.6825785189341853, 'precision': [0.624, 0.676,
0.5823293172690763, 0.8313253012048193, 0.678714859437751], 'avgPrecision':
0.6784738955823293, 'recall': [0.624, 0.676, 0.5823293172690763,
0.8313253012048193, 0.678714859437751], 'avgRecall': 0.6784738955823293,
'params': [{'bootstrap': True, 'ccp_alpha': 0.0, 'class_weight': None,
'criterion': 'gini', 'max_depth': None, 'max_features': 'log2',
'max_leaf_nodes': None, 'max_samples': None, 'min_impurity_decrease': 0.0,
'min_impurity_split': None, 'min_samples_leaf': 1, 'min_samples_split': 2,
'min_weight_fraction_leaf': 0.0, 'n_estimators': 700, 'n_jobs': -1, 'oob_score':
```

```
False, 'random_state': None, 'verbose': 0, 'warm_start': False}]]}
********************************************************

Processing Model: KNeighborsClassifier
********************************************************
* KNeighborsClassifier
* Best Params Result:
* {'classifier': 'KNeighborsClassifier', 'features': 'Active inflammation?,
Severity of Crypt Arch, Increased lamina propria cellularity?, Marked &
transmucosal increase in lamina propria cellularity, Lamina propria polymorphs,
Crypt architecture, Patchy lamina propria cellularity?, Epithelial changes,
Mucosal surface, Cryptitis extent, Mucin depletion, Cryptitis polymorphs, Lamina
propria granulomas, Crypt abscesses polymorphs, Crypt abscesses extent, Basal
histiocytic cells', 'accuracy': [0.612, 0.628, 0.5261044176706827,
0.8433734939759037, 0.6385542168674698], 'avgAccuracy': 0.6496064257028112,
'f1': [0.6202971428571429, 0.6300622208687046, 0.5471469555686584,
0.8521487017589073, 0.6346563071060718], 'avgF1': 0.656862265631897,
'precision': [0.612, 0.628, 0.5261044176706827, 0.8433734939759037,
0.6385542168674698], 'avgPrecision': 0.6496064257028112, 'recall': [0.612,
0.628, 0.5261044176706827, 0.8433734939759037, 0.6385542168674698], 'avgRecall':
0.6496064257028112, 'params': [{'algorithm': 'ball_tree', 'leaf_size': 30,
'metric': 'minkowski', 'metric_params': None, 'n_jobs': -1, 'n_neighbors': 12,
'p': 2, 'weights': 'distance'}]]}
********************************************************

Processing Model: LogisticRegression
********************************************************
* LogisticRegression
* Best Params Result:
* {'classifier': 'LogisticRegression', 'features': 'Active inflammation?,
Severity of Crypt Arch, Increased lamina propria cellularity?, Marked &
transmucosal increase in lamina propria cellularity, Lamina propria polymorphs,
Crypt architecture, Patchy lamina propria cellularity?, Epithelial changes,
Mucosal surface, Cryptitis extent, Mucin depletion, Cryptitis polymorphs, Lamina
propria granulomas, Crypt abscesses polymorphs, Crypt abscesses extent, Basal
histiocytic cells', 'accuracy': [0.616, 0.66, 0.4538152610441767,
0.7429718875502008, 0.6626506024096386], 'avgAccuracy': 0.6270875502008032,
'f1': [0.6255191955780194, 0.6545657289002558, 0.4562571593648378,
0.7696235366394758, 0.6643848119751734], 'avgF1': 0.6340700864915524,
'precision': [0.616, 0.66, 0.4538152610441767, 0.7429718875502008,
0.6626506024096386], 'avgPrecision': 0.6270875502008032, 'recall': [0.616, 0.66,
0.4538152610441767, 0.7429718875502008, 0.6626506024096386], 'avgRecall':
0.6270875502008032, 'params': [{'C': 1, 'class_weight': None, 'dual': False,
'fit_intercept': True, 'intercept_scaling': 1, 'l1_ratio': None, 'max_iter':
100, 'multi_class': 'ovr', 'n_jobs': -1, 'penalty': 'l2', 'random_state': None,
'solver': 'newton-cg', 'tol': 0.0001, 'verbose': 0, 'warm_start': False}]]}
********************************************************
```

```
Processing Model: GaussianNB
*****************************************************
* GaussianNB
* Best Params Result:
* {'classifier': 'GaussianNB', 'features': 'Active inflammation?, Severity of
Crypt Arch, Increased lamina propria cellularity?, Marked & transmucosal
increase in lamina propria cellularity, Lamina propria polymorphs, Crypt
architecture, Patchy lamina propria cellularity?, Epithelial changes, Mucosal
surface, Cryptitis extent, Mucin depletion, Cryptitis polymorphs, Lamina propria
granulomas, Crypt abscesses polymorphs, Crypt abscesses extent, Basal
histiocytic cells', 'accuracy': [0.584, 0.664, 0.42570281124497994,
0.8232931726907631, 0.6666666666666666], 'avgAccuracy': 0.6327325301204819,
'f1': [0.5887656423546834, 0.6548835528478816, 0.43457399809002395,
0.8198268543586824, 0.6585598641196853], 'avgF1': 0.6313219823541913,
'precision': [0.584, 0.664, 0.42570281124497994, 0.8232931726907631,
0.6666666666666666], 'avgPrecision': 0.6327325301204819, 'recall': [0.584,
0.664, 0.42570281124497994, 0.8232931726907631, 0.6666666666666666],
'avgRecall': 0.6327325301204819, 'params': [{'priors': None, 'var_smoothing':
1e-09}]}
*****************************************************

Processing Model: AdaBoostClassifier
*****************************************************
* AdaBoostClassifier
* Best Params Result:
* {'classifier': 'AdaBoostClassifier', 'features': 'Active inflammation?,
Severity of Crypt Arch, Increased lamina propria cellularity?, Marked &
transmucosal increase in lamina propria cellularity, Lamina propria polymorphs,
Crypt architecture, Patchy lamina propria cellularity?, Epithelial changes,
Mucosal surface, Cryptitis extent, Mucin depletion, Cryptitis polymorphs, Lamina
propria granulomas, Crypt abscesses polymorphs, Crypt abscesses extent, Basal
histiocytic cells', 'accuracy': [0.64, 0.572, 0.4738955823293173,
0.7831325301204819, 0.5421686746987951], 'avgAccuracy': 0.6022393574297189,
'f1': [0.6428632657820283, 0.5728996950834258, 0.5005174757343005,
0.7999556325095323, 0.5386397701769002], 'avgF1': 0.6109751678572374,
'precision': [0.64, 0.572, 0.4738955823293173, 0.7831325301204819,
0.5421686746987951], 'avgPrecision': 0.6022393574297189, 'recall': [0.64, 0.572,
0.4738955823293173, 0.7831325301204819, 0.5421686746987951], 'avgRecall':
0.6022393574297189, 'params': [{'algorithm': 'SAMME.R', 'base_estimator': None,
'learning_rate': 1, 'n_estimators': 100, 'random_state': None}]}
*****************************************************

Processing Model: DecisionTreeClassifier
*****************************************************
* DecisionTreeClassifier
* Best Params Result:
* {'classifier': 'DecisionTreeClassifier', 'features': 'Active inflammation?,
Severity of Crypt Arch, Increased lamina propria cellularity?, Marked &
```

transmucosal increase in lamina propria cellularity, Lamina propria polymorphs, Crypt architecture, Patchy lamina propria cellularity?, Epithelial changes, Mucosal surface, Cryptitis extent, Mucin depletion, Cryptitis polymorphs, Lamina propria granulomas, Crypt abscesses polymorphs, Crypt abscesses extent, Basal histiocytic cells', 'accuracy': [0.608, 0.616, 0.5783132530120482, 0.8072289156626506, 0.6867469879518072], 'avgAccuracy': 0.6592578313253012, 'f1': [0.6111970039498041, 0.6080710407239818, 0.6245418507232154, 0.8239676262301112, 0.674555525093811], 'avgF1': 0.6684665545130445, 'precision': [0.608, 0.616, 0.5783132530120482, 0.8072289156626506, 0.6867469879518072], 'avgPrecision': 0.6592578313253012, 'recall': [0.608, 0.616, 0.5783132530120482, 0.8072289156626506, 0.6867469879518072], 'avgRecall': 0.6592578313253012, 'params': [{'ccp_alpha': 0.0, 'class_weight': None, 'criterion': 'gini', 'max_depth': None, 'max_features': 'auto', 'max_leaf_nodes': None, 'min_impurity_decrease': 0.0, 'min_impurity_split': None, 'min_samples_leaf': 1, 'min_samples_split': 2, 'min_weight_fraction_leaf': 0.0, 'random_state': None, 'splitter': 'best'}]}
****

Processing Model: SVC
****
* SVC
* Best Params Result:
* {'classifier': 'SVC', 'features': 'Active inflammation?, Severity of Crypt Arch, Increased lamina propria cellularity?, Marked & transmucosal increase in lamina propria cellularity, Lamina propria polymorphs, Crypt architecture, Patchy lamina propria cellularity?, Epithelial changes, Mucosal surface, Cryptitis extent, Mucin depletion, Cryptitis polymorphs, Lamina propria granulomas, Crypt abscesses polymorphs, Crypt abscesses extent, Basal histiocytic cells', 'accuracy': [0.624, 0.66, 0.4538152610441767, 0.7590361445783133, 0.6586345381526104], 'avgAccuracy': 0.6310971887550201, 'f1': [0.6331277987421384, 0.6523294566003022, 0.46244409231947825, 0.7785427423981641, 0.6494206999036916], 'avgF1': 0.6351729579927549, 'precision': [0.624, 0.66, 0.4538152610441767, 0.7590361445783133, 0.6586345381526104], 'avgPrecision': 0.6310971887550201, 'recall': [0.624, 0.66, 0.4538152610441767, 0.7590361445783133, 0.6586345381526104], 'avgRecall': 0.6310971887550201, 'params': [{'C': 1.0, 'break_ties': False, 'cache_size': 4000, 'class_weight': None, 'coef0': 0.0, 'decision_function_shape': 'ovr', 'degree': 3, 'gamma': 'scale', 'kernel': 'linear', 'max_iter': -1, 'probability': False, 'random_state': None, 'shrinking': True, 'tol': 0.001, 'verbose': False}]}
****

Processing Model: MLPClassifier
****
* MLPClassifier
* Best Params Result:
* {'classifier': 'MLPClassifier', 'features': 'Active inflammation?, Severity of Crypt Arch, Increased lamina propria cellularity?, Marked & transmucosal

increase in lamina propria cellularity, Lamina propria polymorphs, Crypt architecture, Patchy lamina propria cellularity?, Epithelial changes, Mucosal surface, Cryptitis extent, Mucin depletion, Cryptitis polymorphs, Lamina propria granulomas, Crypt abscesses polymorphs, Crypt abscesses extent, Basal histiocytic cells', 'accuracy': [0.616, 0.66, 0.4538152610441767, 0.7429718875502008, 0.6546184738955824], 'avgAccuracy': 0.625481124497992, 'f1': [0.6263389726802395, 0.653823113844776, 0.4562571593648378, 0.7696377911048067, 0.6505061595423042], 'avgF1': 0.6313126393073928, 'precision': [0.616, 0.66, 0.4538152610441767, 0.7429718875502008, 0.6546184738955824], 'avgPrecision': 0.625481124497992, 'recall': [0.616, 0.66, 0.4538152610441767, 0.7429718875502008, 0.6546184738955824], 'avgRecall': 0.625481124497992, 'params': [{'activation': 'logistic', 'alpha': 0.0001, 'batch_size': 'auto', 'beta_1': 0.9, 'beta_2': 0.999, 'early_stopping': False, 'epsilon': 1e-08, 'hidden_layer_sizes': (100,), 'learning_rate': 'constant', 'learning_rate_init': 0.001, 'max_fun': 15000, 'max_iter': 7000, 'momentum': 0.9, 'n_iter_no_change': 10, 'nesterovs_momentum': True, 'power_t': 0.5, 'random_state': None, 'shuffle': True, 'solver': 'adam', 'tol': 0.0001, 'validation_fraction': 0.1, 'verbose': False, 'warm_start': False}]}
****
****
* Best Performing Model and Params is:
* {'classifier': 'RandomForestClassifier', 'features': 'Active inflammation?, Severity of Crypt Arch, Increased lamina propria cellularity?, Marked & transmucosal increase in lamina propria cellularity, Lamina propria polymorphs, Crypt architecture, Patchy lamina propria cellularity?, Epithelial changes, Mucosal surface, Cryptitis extent, Mucin depletion, Cryptitis polymorphs, Lamina propria granulomas, Crypt abscesses polymorphs, Crypt abscesses extent, Basal histiocytic cells', 'accuracy': [0.624, 0.676, 0.5823293172690763, 0.8313253012048193, 0.678714859437751], 'avgAccuracy': 0.6784738955823293, 'f1': [0.6199823747979869, 0.6565495240545407, 0.6292531428179979, 0.8393761743798469, 0.6677313786205541], 'avgF1': 0.6825785189341853, 'precision': [0.624, 0.676, 0.5823293172690763, 0.8313253012048193, 0.678714859437751], 'avgPrecision': 0.6784738955823293, 'recall': [0.624, 0.676, 0.5823293172690763, 0.8313253012048193, 0.678714859437751], 'avgRecall': 0.6784738955823293, 'params': [{'bootstrap': True, 'ccp_alpha': 0.0, 'class_weight': None, 'criterion': 'gini', 'max_depth': None, 'max_features': 'log2', 'max_leaf_nodes': None, 'max_samples': None, 'min_impurity_decrease': 0.0, 'min_impurity_split': None, 'min_samples_leaf': 1, 'min_samples_split': 2, 'min_weight_fraction_leaf': 0.0, 'n_estimators': 700, 'n_jobs': -1, 'oob_score': False, 'random_state': None, 'verbose': 0, 'warm_start': False}]}
****

```
                  model                                    features  \
0  RandomForestClassifier  Active inflammation?, Severity of Crypt Arch, …
1     KNeighborsClassifier  Active inflammation?, Severity of Crypt Arch, …
2       LogisticRegression  Active inflammation?, Severity of Crypt Arch, …
3               GaussianNB  Active inflammation?, Severity of Crypt Arch, …
4       AdaBoostClassifier  Active inflammation?, Severity of Crypt Arch, …
```

```
5  DecisionTreeClassifier  Active inflammation?, Severity of Crypt Arch, …
6                      SVC  Active inflammation?, Severity of Crypt Arch, …
7            MLPClassifier  Active inflammation?, Severity of Crypt Arch, …

   accuracy        f1  precision    recall  \
0  0.678474  0.682579   0.678474  0.678474
1  0.649606  0.656862   0.649606  0.649606
2  0.627088  0.634070   0.627088  0.627088
3  0.632733  0.631322   0.632733  0.632733
4  0.602239  0.610975   0.602239  0.602239
5  0.659258  0.668467   0.659258  0.659258
6  0.631097  0.635173   0.631097  0.631097
7  0.625481  0.631313   0.625481  0.625481


                                               params
0  {'bootstrap': True, 'ccp_alpha': 0.0, 'class_w…
1  {'algorithm': 'ball_tree', 'leaf_size': 30, 'm…
2  {'C': 1, 'class_weight': None, 'dual': False, …
3            {'priors': None, 'var_smoothing': 1e-09}
4  {'algorithm': 'SAMME.R', 'base_estimator': Non…
5  {'ccp_alpha': 0.0, 'class_weight': None, 'crit…
6  {'C': 1.0, 'break_ties': False, 'cache_size': …
7  {'activation': 'logistic', 'alpha': 0.0001, 'b…
```

Processing Model: RandomForestClassifier
****
* RandomForestClassifier
* Best Params Result:
* {'classifier': 'RandomForestClassifier', 'features': 'Active inflammation?,
Severity of Crypt Arch, Increased lamina propria cellularity?, Marked &
transmucosal increase in lamina propria cellularity, Lamina propria polymorphs,
Crypt architecture, Patchy lamina propria cellularity?, Epithelial changes,
Mucosal surface, Cryptitis extent, Mucin depletion, Cryptitis polymorphs, Lamina
propria granulomas, Crypt abscesses polymorphs, Crypt abscesses extent',
'accuracy': [0.636, 0.676, 0.5903614457831325, 0.8313253012048193,
0.678714859437751], 'avgAccuracy': 0.6824803212851406, 'f1':
[0.6374394597321773, 0.6651779986926218, 0.6387253117362499, 0.8393761743798469,
0.6655675002580436], 'avgF1': 0.6892572889597879, 'precision': [0.636, 0.676,
0.5903614457831325, 0.8313253012048193, 0.678714859437751], 'avgPrecision':
0.6824803212851406, 'recall': [0.636, 0.676, 0.5903614457831325,
0.8313253012048193, 0.678714859437751], 'avgRecall': 0.6824803212851406,
'params': [{'bootstrap': True, 'ccp_alpha': 0.0, 'class_weight': None,
'criterion': 'entropy', 'max_depth': None, 'max_features': 'log2',
'max_leaf_nodes': None, 'max_samples': None, 'min_impurity_decrease': 0.0,
'min_impurity_split': None, 'min_samples_leaf': 1, 'min_samples_split': 2,
'min_weight_fraction_leaf': 0.0, 'n_estimators': 200, 'n_jobs': -1, 'oob_score':
False, 'random_state': None, 'verbose': 0, 'warm_start': False}]}
****

```
Processing Model: KNeighborsClassifier
********************************************************
* KNeighborsClassifier
* Best Params Result:
* {'classifier': 'KNeighborsClassifier', 'features': 'Active inflammation?,
Severity of Crypt Arch, Increased lamina propria cellularity?, Marked &
transmucosal increase in lamina propria cellularity, Lamina propria polymorphs,
Crypt architecture, Patchy lamina propria cellularity?, Epithelial changes,
Mucosal surface, Cryptitis extent, Mucin depletion, Cryptitis polymorphs, Lamina
propria granulomas, Crypt abscesses polymorphs, Crypt abscesses extent',
'accuracy': [0.612, 0.636, 0.5461847389558233, 0.8473895582329317,
0.6506024096385542], 'avgAccuracy': 0.6584353413654619, 'f1':
[0.6202971428571429, 0.6395339319235555, 0.5703539614278291, 0.8556062666622553,
0.6473329646731756], 'avgF1': 0.6666248535087916, 'precision': [0.612, 0.636,
0.5461847389558233, 0.8473895582329317, 0.6506024096385542], 'avgPrecision':
0.6584353413654619, 'recall': [0.612, 0.636, 0.5461847389558233,
0.8473895582329317, 0.6506024096385542], 'avgRecall': 0.6584353413654619,
'params': [{'algorithm': 'ball_tree', 'leaf_size': 30, 'metric': 'minkowski',
'metric_params': None, 'n_jobs': -1, 'n_neighbors': 12, 'p': 2, 'weights':
'distance'}]}
********************************************************

Processing Model: LogisticRegression
********************************************************
* LogisticRegression
* Best Params Result:
* {'classifier': 'LogisticRegression', 'features': 'Active inflammation?,
Severity of Crypt Arch, Increased lamina propria cellularity?, Marked &
transmucosal increase in lamina propria cellularity, Lamina propria polymorphs,
Crypt architecture, Patchy lamina propria cellularity?, Epithelial changes,
Mucosal surface, Cryptitis extent, Mucin depletion, Cryptitis polymorphs, Lamina
propria granulomas, Crypt abscesses polymorphs, Crypt abscesses extent',
'accuracy': [0.612, 0.66, 0.4538152610441767, 0.7429718875502008,
0.6626506024096386], 'avgAccuracy': 0.6262875502008032, 'f1':
[0.621373014619208, 0.6564861840011879, 0.4562571593648378, 0.7696235366394758,
0.6643848119751734], 'avgF1': 0.6336249413199766, 'precision': [0.612, 0.66,
0.4538152610441767, 0.7429718875502008, 0.6626506024096386], 'avgPrecision':
0.6262875502008032, 'recall': [0.612, 0.66, 0.4538152610441767,
0.7429718875502008, 0.6626506024096386], 'avgRecall': 0.6262875502008032,
'params': [{'C': 1, 'class_weight': None, 'dual': False, 'fit_intercept': True,
'intercept_scaling': 1, 'l1_ratio': None, 'max_iter': 100, 'multi_class': 'ovr',
'n_jobs': -1, 'penalty': 'l2', 'random_state': None, 'solver': 'newton-cg',
'tol': 0.0001, 'verbose': 0, 'warm_start': False}]}
********************************************************

Processing Model: GaussianNB
********************************************************
```

* GaussianNB
* Best Params Result:
* {'classifier': 'GaussianNB', 'features': 'Active inflammation?, Severity of
Crypt Arch, Increased lamina propria cellularity?, Marked & transmucosal
increase in lamina propria cellularity, Lamina propria polymorphs, Crypt
architecture, Patchy lamina propria cellularity?, Epithelial changes, Mucosal
surface, Cryptitis extent, Mucin depletion, Cryptitis polymorphs, Lamina propria
granulomas, Crypt abscesses polymorphs, Crypt abscesses extent', 'accuracy':
[0.584, 0.652, 0.41767068273092367, 0.8192771084337349, 0.6586345381526104],
'avgAccuracy': 0.6263164658634538, 'f1': [0.5900035556093657,
0.6418762107897128, 0.4249765497511347, 0.8158317852097942, 0.6497941130942347],
'avgF1': 0.6244964430908484, 'precision': [0.584, 0.652, 0.41767068273092367,
0.8192771084337349, 0.6586345381526104], 'avgPrecision': 0.6263164658634538,
'recall': [0.584, 0.652, 0.41767068273092367, 0.8192771084337349,
0.6586345381526104], 'avgRecall': 0.6263164658634538, 'params': [{'priors':
None, 'var_smoothing': 1e-09}]}
****

Processing Model: AdaBoostClassifier
****
* AdaBoostClassifier
* Best Params Result:
* {'classifier': 'AdaBoostClassifier', 'features': 'Active inflammation?,
Severity of Crypt Arch, Increased lamina propria cellularity?, Marked &
transmucosal increase in lamina propria cellularity, Lamina propria polymorphs,
Crypt architecture, Patchy lamina propria cellularity?, Epithelial changes,
Mucosal surface, Cryptitis extent, Mucin depletion, Cryptitis polymorphs, Lamina
propria granulomas, Crypt abscesses polymorphs, Crypt abscesses extent',
'accuracy': [0.64, 0.548, 0.4939759036144578, 0.7911646586345381,
0.5381526104417671], 'avgAccuracy': 0.6022586345381526, 'f1':
[0.646655615714592, 0.5484498369254006, 0.5295057975913227, 0.8077300655613908,
0.5331916421066528], 'avgF1': 0.6131065915798718, 'precision': [0.64, 0.548,
0.4939759036144578, 0.7911646586345381, 0.5381526104417671], 'avgPrecision':
0.6022586345381526, 'recall': [0.64, 0.548, 0.4939759036144578,
0.7911646586345381, 0.5381526104417671], 'avgRecall': 0.6022586345381526,
'params': [{'algorithm': 'SAMME.R', 'base_estimator': None, 'learning_rate': 1,
'n_estimators': 100, 'random_state': None}]}
****

Processing Model: DecisionTreeClassifier
****
* DecisionTreeClassifier
* Best Params Result:
* {'classifier': 'DecisionTreeClassifier', 'features': 'Active inflammation?,
Severity of Crypt Arch, Increased lamina propria cellularity?, Marked &
transmucosal increase in lamina propria cellularity, Lamina propria polymorphs,
Crypt architecture, Patchy lamina propria cellularity?, Epithelial changes,
Mucosal surface, Cryptitis extent, Mucin depletion, Cryptitis polymorphs, Lamina

propria granulomas, Crypt abscesses polymorphs, Crypt abscesses extent',
'accuracy': [0.592, 0.636, 0.5783132530120482, 0.8353413654618473,
0.6586345381526104], 'avgAccuracy': 0.6600578313253012, 'f1':
[0.5909062413697874, 0.6217940500534133, 0.6258217327811308, 0.8438973284442116,
0.657406343125523], 'avgF1': 0.6679651391548133, 'precision': [0.592, 0.636,
0.5783132530120482, 0.8353413654618473, 0.6586345381526104], 'avgPrecision':
0.6600578313253012, 'recall': [0.592, 0.636, 0.5783132530120482,
0.8353413654618473, 0.6586345381526104], 'avgRecall': 0.6600578313253012,
'params': [{'ccp_alpha': 0.0, 'class_weight': None, 'criterion': 'gini',
'max_depth': None, 'max_features': 'auto', 'max_leaf_nodes': None,
'min_impurity_decrease': 0.0, 'min_impurity_split': None, 'min_samples_leaf': 1,
'min_samples_split': 2, 'min_weight_fraction_leaf': 0.0, 'random_state': None,
'splitter': 'best'}]}
****

Processing Model: SVC
****
* SVC
* Best Params Result:
* {'classifier': 'SVC', 'features': 'Active inflammation?, Severity of Crypt
Arch, Increased lamina propria cellularity?, Marked & transmucosal increase in
lamina propria cellularity, Lamina propria polymorphs, Crypt architecture,
Patchy lamina propria cellularity?, Epithelial changes, Mucosal surface,
Cryptitis extent, Mucin depletion, Cryptitis polymorphs, Lamina propria
granulomas, Crypt abscesses polymorphs, Crypt abscesses extent', 'accuracy':
[0.616, 0.66, 0.4538152610441767, 0.7550200803212851, 0.6586345381526104],
'avgAccuracy': 0.6286939759036144, 'f1': [0.6249330943847073,
0.6523294566003022, 0.4635244273798491, 0.7762787288368366, 0.6494206999036916],
'avgF1': 0.6332972814210773, 'precision': [0.616, 0.66, 0.4538152610441767,
0.7550200803212851, 0.6586345381526104], 'avgPrecision': 0.6286939759036144,
'recall': [0.616, 0.66, 0.4538152610441767, 0.7550200803212851,
0.6586345381526104], 'avgRecall': 0.6286939759036144, 'params': [{'C': 1.0,
'break_ties': False, 'cache_size': 4000, 'class_weight': None, 'coef0': 0.0,
'decision_function_shape': 'ovr', 'degree': 3, 'gamma': 'scale', 'kernel':
'linear', 'max_iter': -1, 'probability': False, 'random_state': None,
'shrinking': True, 'tol': 0.001, 'verbose': False}]}
****

Processing Model: MLPClassifier
****
* MLPClassifier
* Best Params Result:
* {'classifier': 'MLPClassifier', 'features': 'Active inflammation?, Severity of
Crypt Arch, Increased lamina propria cellularity?, Marked & transmucosal
increase in lamina propria cellularity, Lamina propria polymorphs, Crypt
architecture, Patchy lamina propria cellularity?, Epithelial changes, Mucosal
surface, Cryptitis extent, Mucin depletion, Cryptitis polymorphs, Lamina propria
granulomas, Crypt abscesses polymorphs, Crypt abscesses extent', 'accuracy':

[0.624, 0.66, 0.4497991967871486, 0.7550200803212851, 0.6385542168674698],
'avgAccuracy': 0.6254746987951807, 'f1': [0.6337922878115612,
0.6575005665365731, 0.4479536599793008, 0.7816373185047885, 0.6350041184094378],
'avgF1': 0.6311775902483323, 'precision': [0.624, 0.66, 0.4497991967871486,
0.7550200803212851, 0.6385542168674698], 'avgPrecision': 0.6254746987951807,
'recall': [0.624, 0.66, 0.4497991967871486, 0.7550200803212851,
0.6385542168674698], 'avgRecall': 0.6254746987951807, 'params': [{'activation':
'logistic', 'alpha': 0.0001, 'batch_size': 'auto', 'beta_1': 0.9, 'beta_2':
0.999, 'early_stopping': False, 'epsilon': 1e-08, 'hidden_layer_sizes': (100,),
'learning_rate': 'invscaling', 'learning_rate_init': 0.001, 'max_fun': 15000,
'max_iter': 5000, 'momentum': 0.9, 'n_iter_no_change': 10, 'nesterovs_momentum':
True, 'power_t': 0.5, 'random_state': None, 'shuffle': True, 'solver': 'adam',
'tol': 0.0001, 'validation_fraction': 0.1, 'verbose': False, 'warm_start':
False}]}
****
****
* Best Performing Model and Params is:
* {'classifier': 'RandomForestClassifier', 'features': 'Active inflammation?,
Severity of Crypt Arch, Increased lamina propria cellularity?, Marked &
transmucosal increase in lamina propria cellularity, Lamina propria polymorphs,
Crypt architecture, Patchy lamina propria cellularity?, Epithelial changes,
Mucosal surface, Cryptitis extent, Mucin depletion, Cryptitis polymorphs, Lamina
propria granulomas, Crypt abscesses polymorphs, Crypt abscesses extent',
'accuracy': [0.636, 0.676, 0.5903614457831325, 0.8313253012048193,
0.678714859437751], 'avgAccuracy': 0.6824803212851406, 'f1':
[0.6374394597321773, 0.6651779986926218, 0.6387253117362499, 0.8393761743798469,
0.6655675002580436], 'avgF1': 0.6892572889597879, 'precision': [0.636, 0.676,
0.5903614457831325, 0.8313253012048193, 0.678714859437751], 'avgPrecision':
0.6824803212851406, 'recall': [0.636, 0.676, 0.5903614457831325,
0.8313253012048193, 0.678714859437751], 'avgRecall': 0.6824803212851406,
'params': [{'bootstrap': True, 'ccp_alpha': 0.0, 'class_weight': None,
'criterion': 'entropy', 'max_depth': None, 'max_features': 'log2',
'max_leaf_nodes': None, 'max_samples': None, 'min_impurity_decrease': 0.0,
'min_impurity_split': None, 'min_samples_leaf': 1, 'min_samples_split': 2,
'min_weight_fraction_leaf': 0.0, 'n_estimators': 200, 'n_jobs': -1, 'oob_score':
False, 'random_state': None, 'verbose': 0, 'warm_start': False}]}
****

```
                     model                                       features  \
0  RandomForestClassifier   Active inflammation?, Severity of Crypt Arch, …
1    KNeighborsClassifier   Active inflammation?, Severity of Crypt Arch, …
2      LogisticRegression   Active inflammation?, Severity of Crypt Arch, …
3              GaussianNB   Active inflammation?, Severity of Crypt Arch, …
4      AdaBoostClassifier   Active inflammation?, Severity of Crypt Arch, …
5  DecisionTreeClassifier   Active inflammation?, Severity of Crypt Arch, …
6                     SVC   Active inflammation?, Severity of Crypt Arch, …
7           MLPClassifier   Active inflammation?, Severity of Crypt Arch, …
```

```
   accuracy          f1  precision     recall  \
0  0.682480  0.689257   0.682480   0.682480
1  0.658435  0.666625   0.658435   0.658435
2  0.626288  0.633625   0.626288   0.626288
3  0.626316  0.624496   0.626316   0.626316
4  0.602259  0.613107   0.602259   0.602259
5  0.660058  0.667965   0.660058   0.660058
6  0.628694  0.633297   0.628694   0.628694
7  0.625475  0.631178   0.625475   0.625475


                                                params
0  {'bootstrap': True, 'ccp_alpha': 0.0, 'class_w…
1  {'algorithm': 'ball_tree', 'leaf_size': 30, 'm…
2  {'C': 1, 'class_weight': None, 'dual': False, …
3          {'priors': None, 'var_smoothing': 1e-09}
4  {'algorithm': 'SAMME.R', 'base_estimator': Non…
5  {'ccp_alpha': 0.0, 'class_weight': None, 'crit…
6  {'C': 1.0, 'break_ties': False, 'cache_size': …
7  {'activation': 'logistic', 'alpha': 0.0001, 'b…
```

Processing Model: RandomForestClassifier
****
* RandomForestClassifier
* Best Params Result:
* {'classifier': 'RandomForestClassifier', 'features': 'Active inflammation?,
Severity of Crypt Arch, Increased lamina propria cellularity?, Marked &
transmucosal increase in lamina propria cellularity, Lamina propria polymorphs,
Crypt architecture, Patchy lamina propria cellularity?, Epithelial changes,
Mucosal surface, Cryptitis extent, Mucin depletion, Cryptitis polymorphs, Lamina
propria granulomas, Crypt abscesses polymorphs', 'accuracy': [0.628, 0.668,
0.5903614457831325, 0.8273092369477911, 0.6827309236947792], 'avgAccuracy':
0.6792803212851406, 'f1': [0.6277773424618152, 0.6557054018490063,
0.636697425937512, 0.8366137291502381, 0.6733361167324509], 'avgF1':
0.6860260032262044, 'precision': [0.628, 0.668, 0.5903614457831325,
0.8273092369477911, 0.6827309236947792], 'avgPrecision': 0.6792803212851406,
'recall': [0.628, 0.668, 0.5903614457831325, 0.8273092369477911,
0.6827309236947792], 'avgRecall': 0.6792803212851406, 'params': [{'bootstrap':
True, 'ccp_alpha': 0.0, 'class_weight': None, 'criterion': 'gini', 'max_depth':
None, 'max_features': 'auto', 'max_leaf_nodes': None, 'max_samples': None,
'min_impurity_decrease': 0.0, 'min_impurity_split': None, 'min_samples_leaf': 1,
'min_samples_split': 2, 'min_weight_fraction_leaf': 0.0, 'n_estimators': 500,
'n_jobs': -1, 'oob_score': False, 'random_state': None, 'verbose': 0,
'warm_start': False}]}
****

Processing Model: KNeighborsClassifier
****
* KNeighborsClassifier

* Best Params Result:
* {'classifier': 'KNeighborsClassifier', 'features': 'Active inflammation?,
Severity of Crypt Arch, Increased lamina propria cellularity?, Marked &
transmucosal increase in lamina propria cellularity, Lamina propria polymorphs,
Crypt architecture, Patchy lamina propria cellularity?, Epithelial changes,
Mucosal surface, Cryptitis extent, Mucin depletion, Cryptitis polymorphs, Lamina
propria granulomas, Crypt abscesses polymorphs', 'accuracy': [0.616, 0.632,
0.5461847389558233, 0.8473895582329317, 0.6465863453815262], 'avgAccuracy':
0.6576321285140563, 'f1': [0.6243772357723577, 0.6348199999999999,
0.5703539614278291, 0.8556062666622553, 0.6434388422568632], 'avgF1':
0.665719261223861, 'precision': [0.616, 0.632, 0.5461847389558233,
0.8473895582329317, 0.6465863453815262], 'avgPrecision': 0.6576321285140563,
'recall': [0.616, 0.632, 0.5461847389558233, 0.8473895582329317,
0.6465863453815262], 'avgRecall': 0.6576321285140563, 'params': [{'algorithm':
'ball_tree', 'leaf_size': 30, 'metric': 'minkowski', 'metric_params': None,
'n_jobs': -1, 'n_neighbors': 12, 'p': 2, 'weights': 'distance'}]}
****

Processing Model: LogisticRegression
****
* LogisticRegression
* Best Params Result:
* {'classifier': 'LogisticRegression', 'features': 'Active inflammation?,
Severity of Crypt Arch, Increased lamina propria cellularity?, Marked &
transmucosal increase in lamina propria cellularity, Lamina propria polymorphs,
Crypt architecture, Patchy lamina propria cellularity?, Epithelial changes,
Mucosal surface, Cryptitis extent, Mucin depletion, Cryptitis polymorphs, Lamina
propria granulomas, Crypt abscesses polymorphs', 'accuracy': [0.612, 0.668,
0.4538152610441767, 0.7469879518072289, 0.6626506024096386], 'avgAccuracy':
0.6286907630522088, 'f1': [0.621373014619208, 0.6673787330316742,
0.4562571593648378, 0.7731682941820427, 0.6643848119751734], 'avgF1':
0.6365124026345872, 'precision': [0.612, 0.668, 0.4538152610441767,
0.7469879518072289, 0.6626506024096386], 'avgPrecision': 0.6286907630522088,
'recall': [0.612, 0.668, 0.4538152610441767, 0.7469879518072289,
0.6626506024096386], 'avgRecall': 0.6286907630522088, 'params': [{'C': 1,
'class_weight': None, 'dual': False, 'fit_intercept': True, 'intercept_scaling':
1, 'l1_ratio': None, 'max_iter': 100, 'multi_class': 'ovr', 'n_jobs': -1,
'penalty': 'l2', 'random_state': None, 'solver': 'newton-cg', 'tol': 0.0001,
'verbose': 0, 'warm_start': False}]}
****

Processing Model: GaussianNB
****
* GaussianNB
* Best Params Result:
* {'classifier': 'GaussianNB', 'features': 'Active inflammation?, Severity of
Crypt Arch, Increased lamina propria cellularity?, Marked & transmucosal
increase in lamina propria cellularity, Lamina propria polymorphs, Crypt

architecture, Patchy lamina propria cellularity?, Epithelial changes, Mucosal
surface, Cryptitis extent, Mucin depletion, Cryptitis polymorphs, Lamina propria
granulomas, Crypt abscesses polymorphs', 'accuracy': [0.58, 0.652,
0.43373493975903615, 0.8112449799196787, 0.6666666666666666], 'avgAccuracy':
0.6287293172690763, 'f1': [0.5848904772541137, 0.6427385588132477,
0.44063791029986865, 0.8076043160714896, 0.65688602765154], 'avgF1':
0.6265514580180519, 'precision': [0.58, 0.652, 0.43373493975903615,
0.8112449799196787, 0.6666666666666666], 'avgPrecision': 0.6287293172690763,
'recall': [0.58, 0.652, 0.43373493975903615, 0.8112449799196787,
0.6666666666666666], 'avgRecall': 0.6287293172690763, 'params': [{'priors':
None, 'var_smoothing': 1e-09}]}
****

Processing Model: AdaBoostClassifier
****
* AdaBoostClassifier
* Best Params Result:
* {'classifier': 'AdaBoostClassifier', 'features': 'Active inflammation?,
Severity of Crypt Arch, Increased lamina propria cellularity?, Marked &
transmucosal increase in lamina propria cellularity, Lamina propria polymorphs,
Crypt architecture, Patchy lamina propria cellularity?, Epithelial changes,
Mucosal surface, Cryptitis extent, Mucin depletion, Cryptitis polymorphs, Lamina
propria granulomas, Crypt abscesses polymorphs', 'accuracy': [0.536, 0.56,
0.5140562248995983, 0.7630522088353414, 0.5381526104417671], 'avgAccuracy':
0.5822522088353413, 'f1': [0.5400804597701149, 0.5609249845447319,
0.5524811666594021, 0.7841593647316538, 0.5331916421066528], 'avgF1':
0.5941675235625111, 'precision': [0.536, 0.56, 0.5140562248995983,
0.7630522088353414, 0.5381526104417671], 'avgPrecision': 0.5822522088353413,
'recall': [0.536, 0.56, 0.5140562248995983, 0.7630522088353414,
0.5381526104417671], 'avgRecall': 0.5822522088353413, 'params': [{'algorithm':
'SAMME.R', 'base_estimator': None, 'learning_rate': 1, 'n_estimators': 100,
'random_state': None}]}
****

Processing Model: DecisionTreeClassifier
****
* DecisionTreeClassifier
* Best Params Result:
* {'classifier': 'DecisionTreeClassifier', 'features': 'Active inflammation?,
Severity of Crypt Arch, Increased lamina propria cellularity?, Marked &
transmucosal increase in lamina propria cellularity, Lamina propria polymorphs,
Crypt architecture, Patchy lamina propria cellularity?, Epithelial changes,
Mucosal surface, Cryptitis extent, Mucin depletion, Cryptitis polymorphs, Lamina
propria granulomas, Crypt abscesses polymorphs', 'accuracy': [0.62, 0.632,
0.5622489959839357, 0.8152610441767069, 0.6586345381526104], 'avgAccuracy':
0.6576289156626506, 'f1': [0.6274681908334467, 0.6283319545176308,
0.6075462765214883, 0.8305453856353918, 0.6553726135449255], 'avgF1':
0.6698528842105766, 'precision': [0.62, 0.632, 0.5622489959839357,

101

0.8152610441767069, 0.6586345381526104], 'avgPrecision': 0.6576289156626506,
'recall': [0.62, 0.632, 0.5622489959839357, 0.8152610441767069,
0.6586345381526104], 'avgRecall': 0.6576289156626506, 'params': [{'ccp_alpha':
0.0, 'class_weight': None, 'criterion': 'entropy', 'max_depth': None,
'max_features': 'auto', 'max_leaf_nodes': None, 'min_impurity_decrease': 0.0,
'min_impurity_split': None, 'min_samples_leaf': 1, 'min_samples_split': 2,
'min_weight_fraction_leaf': 0.0, 'random_state': None, 'splitter': 'best'}]}
****

Processing Model: SVC
****
* SVC
* Best Params Result:
* {'classifier': 'SVC', 'features': 'Active inflammation?, Severity of Crypt
Arch, Increased lamina propria cellularity?, Marked & transmucosal increase in
lamina propria cellularity, Lamina propria polymorphs, Crypt architecture,
Patchy lamina propria cellularity?, Epithelial changes, Mucosal surface,
Cryptitis extent, Mucin depletion, Cryptitis polymorphs, Lamina propria
granulomas, Crypt abscesses polymorphs', 'accuracy': [0.624, 0.66,
0.4538152610441767, 0.7550200803212851, 0.6586345381526104], 'avgAccuracy':
0.6302939759036145, 'f1': [0.6331277987421384, 0.6523294566003022,
0.4613911667442246, 0.7762787288368366, 0.6494206999036916], 'avgF1':
0.6345095701654386, 'precision': [0.624, 0.66, 0.4538152610441767,
0.7550200803212851, 0.6586345381526104], 'avgPrecision': 0.6302939759036145,
'recall': [0.624, 0.66, 0.4538152610441767, 0.7550200803212851,
0.6586345381526104], 'avgRecall': 0.6302939759036145, 'params': [{'C': 1.0,
'break_ties': False, 'cache_size': 4000, 'class_weight': None, 'coef0': 0.0,
'decision_function_shape': 'ovr', 'degree': 3, 'gamma': 'scale', 'kernel':
'linear', 'max_iter': -1, 'probability': False, 'random_state': None,
'shrinking': True, 'tol': 0.001, 'verbose': False}]}
****

Processing Model: MLPClassifier
****
* MLPClassifier
* Best Params Result:
* {'classifier': 'MLPClassifier', 'features': 'Active inflammation?, Severity of
Crypt Arch, Increased lamina propria cellularity?, Marked & transmucosal
increase in lamina propria cellularity, Lamina propria polymorphs, Crypt
architecture, Patchy lamina propria cellularity?, Epithelial changes, Mucosal
surface, Cryptitis extent, Mucin depletion, Cryptitis polymorphs, Lamina propria
granulomas, Crypt abscesses polymorphs', 'accuracy': [0.608, 0.668,
0.4538152610441767, 0.7469879518072289, 0.6586345381526104], 'avgAccuracy':
0.6270875502008032, 'f1': [0.6172193448398389, 0.6656581998684796,
0.45848015224776334, 0.7731062832260305, 0.6521600605112736], 'avgF1':
0.6333248081386772, 'precision': [0.608, 0.668, 0.4538152610441767,
0.7469879518072289, 0.6586345381526104], 'avgPrecision': 0.6270875502008032,
'recall': [0.608, 0.668, 0.4538152610441767, 0.7469879518072289,

0.6586345381526104], 'avgRecall': 0.6270875502008032, 'params': [{'activation': 'identity', 'alpha': 0.0001, 'batch_size': 'auto', 'beta_1': 0.9, 'beta_2': 0.999, 'early_stopping': False, 'epsilon': 1e-08, 'hidden_layer_sizes': (100,), 'learning_rate': 'invscaling', 'learning_rate_init': 0.001, 'max_fun': 15000, 'max_iter': 5000, 'momentum': 0.9, 'n_iter_no_change': 10, 'nesterovs_momentum': True, 'power_t': 0.5, 'random_state': None, 'shuffle': True, 'solver': 'adam', 'tol': 0.0001, 'validation_fraction': 0.1, 'verbose': False, 'warm_start': False}]}
****
****
* Best Performing Model and Params is:
* {'classifier': 'RandomForestClassifier', 'features': 'Active inflammation?, Severity of Crypt Arch, Increased lamina propria cellularity?, Marked & transmucosal increase in lamina propria cellularity, Lamina propria polymorphs, Crypt architecture, Patchy lamina propria cellularity?, Epithelial changes, Mucosal surface, Cryptitis extent, Mucin depletion, Cryptitis polymorphs, Lamina propria granulomas, Crypt abscesses polymorphs', 'accuracy': [0.628, 0.668, 0.5903614457831325, 0.8273092369477911, 0.6827309236947792], 'avgAccuracy': 0.6792803212851406, 'f1': [0.6277773424618152, 0.6557054018490063, 0.636697425937512, 0.8366137291502381, 0.6733361167324509], 'avgF1': 0.6860260032262044, 'precision': [0.628, 0.668, 0.5903614457831325, 0.8273092369477911, 0.6827309236947792], 'avgPrecision': 0.6792803212851406, 'recall': [0.628, 0.668, 0.5903614457831325, 0.8273092369477911, 0.6827309236947792], 'avgRecall': 0.6792803212851406, 'params': [{'bootstrap': True, 'ccp_alpha': 0.0, 'class_weight': None, 'criterion': 'gini', 'max_depth': None, 'max_features': 'auto', 'max_leaf_nodes': None, 'max_samples': None, 'min_impurity_decrease': 0.0, 'min_impurity_split': None, 'min_samples_leaf': 1, 'min_samples_split': 2, 'min_weight_fraction_leaf': 0.0, 'n_estimators': 500, 'n_jobs': -1, 'oob_score': False, 'random_state': None, 'verbose': 0, 'warm_start': False}]}
****

	model	features \
0	RandomForestClassifier	Active inflammation?, Severity of Crypt Arch, …
1	KNeighborsClassifier	Active inflammation?, Severity of Crypt Arch, …
2	LogisticRegression	Active inflammation?, Severity of Crypt Arch, …
3	GaussianNB	Active inflammation?, Severity of Crypt Arch, …
4	AdaBoostClassifier	Active inflammation?, Severity of Crypt Arch, …
5	DecisionTreeClassifier	Active inflammation?, Severity of Crypt Arch, …
6	SVC	Active inflammation?, Severity of Crypt Arch, …
7	MLPClassifier	Active inflammation?, Severity of Crypt Arch, …

	accuracy	f1	precision	recall \
0	0.679280	0.686026	0.679280	0.679280
1	0.657632	0.665719	0.657632	0.657632
2	0.628691	0.636512	0.628691	0.628691
3	0.628729	0.626551	0.628729	0.628729
4	0.582252	0.594168	0.582252	0.582252

```
5  0.657629  0.669853   0.657629  0.657629
6  0.630294  0.634510   0.630294  0.630294
7  0.627088  0.633325   0.627088  0.627088


                                                   params
0  {'bootstrap': True, 'ccp_alpha': 0.0, 'class_w…
1  {'algorithm': 'ball_tree', 'leaf_size': 30, 'm…
2  {'C': 1, 'class_weight': None, 'dual': False, …
3           {'priors': None, 'var_smoothing': 1e-09}
4  {'algorithm': 'SAMME.R', 'base_estimator': Non…
5  {'ccp_alpha': 0.0, 'class_weight': None, 'crit…
6  {'C': 1.0, 'break_ties': False, 'cache_size': …
7  {'activation': 'identity', 'alpha': 0.0001, 'b…
```

Processing Model: RandomForestClassifier
****
* RandomForestClassifier
* Best Params Result:
* {'classifier': 'RandomForestClassifier', 'features': 'Active inflammation?,
Severity of Crypt Arch, Increased lamina propria cellularity?, Marked &
transmucosal increase in lamina propria cellularity, Lamina propria polymorphs,
Crypt architecture, Patchy lamina propria cellularity?, Epithelial changes,
Mucosal surface, Cryptitis extent, Mucin depletion, Cryptitis polymorphs, Lamina
propria granulomas', 'accuracy': [0.628, 0.68, 0.5742971887550201,
0.8192771084337349, 0.6666666666666666], 'avgAccuracy': 0.6736481927710843,
'f1': [0.6311436426366004, 0.6767145415745958, 0.6226795370943433,
0.8291765081456128, 0.658641095225659], 'avgF1': 0.6836710649353622,
'precision': [0.628, 0.68, 0.5742971887550201, 0.8192771084337349,
0.6666666666666666], 'avgPrecision': 0.6736481927710843, 'recall': [0.628, 0.68,
0.5742971887550201, 0.8192771084337349, 0.6666666666666666], 'avgRecall':
0.6736481927710843, 'params': [{'bootstrap': True, 'ccp_alpha': 0.0,
'class_weight': None, 'criterion': 'gini', 'max_depth': None, 'max_features':
'sqrt', 'max_leaf_nodes': None, 'max_samples': None, 'min_impurity_decrease':
0.0, 'min_impurity_split': None, 'min_samples_leaf': 1, 'min_samples_split': 2,
'min_weight_fraction_leaf': 0.0, 'n_estimators': 200, 'n_jobs': -1, 'oob_score':
False, 'random_state': None, 'verbose': 0, 'warm_start': False}]}
****

Processing Model: KNeighborsClassifier
****
* KNeighborsClassifier
* Best Params Result:
* {'classifier': 'KNeighborsClassifier', 'features': 'Active inflammation?,
Severity of Crypt Arch, Increased lamina propria cellularity?, Marked &
transmucosal increase in lamina propria cellularity, Lamina propria polymorphs,
Crypt architecture, Patchy lamina propria cellularity?, Epithelial changes,
Mucosal surface, Cryptitis extent, Mucin depletion, Cryptitis polymorphs, Lamina
propria granulomas', 'accuracy': [0.612, 0.656, 0.5261044176706827,

0.8514056224899599, 0.6465863453815262], 'avgAccuracy': 0.6584192771084337,
'f1': [0.6181824366399946, 0.6573486645804527, 0.5483621537360679,
0.8572484222604704, 0.6444739003636868], 'avgF1': 0.6651231155161345,
'precision': [0.612, 0.656, 0.5261044176706827, 0.8514056224899599,
0.6465863453815262], 'avgPrecision': 0.6584192771084337, 'recall': [0.612,
0.656, 0.5261044176706827, 0.8514056224899599, 0.6465863453815262], 'avgRecall':
0.6584192771084337, 'params': [{'algorithm': 'ball_tree', 'leaf_size': 30,
'metric': 'minkowski', 'metric_params': None, 'n_jobs': -1, 'n_neighbors': 13,
'p': 2, 'weights': 'distance'}]]
****

Processing Model: LogisticRegression
****
* LogisticRegression
* Best Params Result:
* {'classifier': 'LogisticRegression', 'features': 'Active inflammation?,
Severity of Crypt Arch, Increased lamina propria cellularity?, Marked &
transmucosal increase in lamina propria cellularity, Lamina propria polymorphs,
Crypt architecture, Patchy lamina propria cellularity?, Epithelial changes,
Mucosal surface, Cryptitis extent, Mucin depletion, Cryptitis polymorphs, Lamina
propria granulomas', 'accuracy': [0.608, 0.668, 0.4497991967871486,
0.7429718875502008, 0.6546184738955824], 'avgAccuracy': 0.6246779116465864,
'f1': [0.6172193448398389, 0.6637991962002192, 0.45034183094208835,
0.7696377911048067, 0.6461976077091388], 'avgF1': 0.6294391541592184,
'precision': [0.608, 0.668, 0.4497991967871486, 0.7429718875502008,
0.6546184738955824], 'avgPrecision': 0.6246779116465864, 'recall': [0.608,
0.668, 0.4497991967871486, 0.7429718875502008, 0.6546184738955824], 'avgRecall':
0.6246779116465864, 'params': [{'C': 1, 'class_weight': None, 'dual': False,
'fit_intercept': True, 'intercept_scaling': 1, 'l1_ratio': None, 'max_iter':
100, 'multi_class': 'multinomial', 'n_jobs': -1, 'penalty': 'l2',
'random_state': None, 'solver': 'newton-cg', 'tol': 0.0001, 'verbose': 0,
'warm_start': False}]]
****

Processing Model: GaussianNB
****
* GaussianNB
* Best Params Result:
* {'classifier': 'GaussianNB', 'features': 'Active inflammation?, Severity of
Crypt Arch, Increased lamina propria cellularity?, Marked & transmucosal
increase in lamina propria cellularity, Lamina propria polymorphs, Crypt
architecture, Patchy lamina propria cellularity?, Epithelial changes, Mucosal
surface, Cryptitis extent, Mucin depletion, Cryptitis polymorphs, Lamina propria
granulomas', 'accuracy': [0.572, 0.648, 0.42570281124497994, 0.8152610441767069,
0.6626506024096386], 'avgAccuracy': 0.624722891566265, 'f1':
[0.5773897273059215, 0.6376801198163471, 0.4337648150086774, 0.811758381371712,
0.653344810475696], 'avgF1': 0.6227875707956708, 'precision': [0.572, 0.648,
0.42570281124497994, 0.8152610441767069, 0.6626506024096386], 'avgPrecision':

```
0.624722891566265, 'recall': [0.572, 0.648, 0.42570281124497994,
0.8152610441767069, 0.6626506024096386], 'avgRecall': 0.624722891566265,
'params': [{'priors': None, 'var_smoothing': 1e-09}]}
******************************************************


Processing Model: AdaBoostClassifier
******************************************************
* AdaBoostClassifier
* Best Params Result:
* {'classifier': 'AdaBoostClassifier', 'features': 'Active inflammation?,
Severity of Crypt Arch, Increased lamina propria cellularity?, Marked &
transmucosal increase in lamina propria cellularity, Lamina propria polymorphs,
Crypt architecture, Patchy lamina propria cellularity?, Epithelial changes,
Mucosal surface, Cryptitis extent, Mucin depletion, Cryptitis polymorphs, Lamina
propria granulomas', 'accuracy': [0.616, 0.536, 0.4738955823293173,
0.7550200803212851, 0.6104417670682731], 'avgAccuracy': 0.5982714859437751,
'f1': [0.6192143772069515, 0.5359710407239819, 0.5060785793680436,
0.7757163823241164, 0.6093685733253041], 'avgF1': 0.6092697905896796,
'precision': [0.616, 0.536, 0.4738955823293173, 0.7550200803212851,
0.6104417670682731], 'avgPrecision': 0.5982714859437751, 'recall': [0.616,
0.536, 0.4738955823293173, 0.7550200803212851, 0.6104417670682731], 'avgRecall':
0.5982714859437751, 'params': [{'algorithm': 'SAMME.R', 'base_estimator': None,
'learning_rate': 1, 'n_estimators': 100, 'random_state': None}]}
******************************************************


Processing Model: DecisionTreeClassifier
******************************************************
* DecisionTreeClassifier
* Best Params Result:
* {'classifier': 'DecisionTreeClassifier', 'features': 'Active inflammation?,
Severity of Crypt Arch, Increased lamina propria cellularity?, Marked &
transmucosal increase in lamina propria cellularity, Lamina propria polymorphs,
Crypt architecture, Patchy lamina propria cellularity?, Epithelial changes,
Mucosal surface, Cryptitis extent, Mucin depletion, Cryptitis polymorphs, Lamina
propria granulomas', 'accuracy': [0.58, 0.644, 0.5622489959839357,
0.8152610441767069, 0.6626506024096386], 'avgAccuracy': 0.6528321285140563,
'f1': [0.579177532653099, 0.6400325791855204, 0.609767961137074,
0.8277379179639908, 0.6537806573563855], 'avgF1': 0.6620993296592139,
'precision': [0.58, 0.644, 0.5622489959839357, 0.8152610441767069,
0.6626506024096386], 'avgPrecision': 0.6528321285140563, 'recall': [0.58, 0.644,
0.5622489959839357, 0.8152610441767069, 0.6626506024096386], 'avgRecall':
0.6528321285140563, 'params': [{'ccp_alpha': 0.0, 'class_weight': None,
'criterion': 'entropy', 'max_depth': None, 'max_features': 'auto',
'max_leaf_nodes': None, 'min_impurity_decrease': 0.0, 'min_impurity_split':
None, 'min_samples_leaf': 1, 'min_samples_split': 2, 'min_weight_fraction_leaf':
0.0, 'random_state': None, 'splitter': 'best'}]}
******************************************************
```

```
Processing Model: SVC
*****************************************************
* SVC
* Best Params Result:
* {'classifier': 'SVC', 'features': 'Active inflammation?, Severity of Crypt
Arch, Increased lamina propria cellularity?, Marked & transmucosal increase in
lamina propria cellularity, Lamina propria polymorphs, Crypt architecture,
Patchy lamina propria cellularity?, Epithelial changes, Mucosal surface,
Cryptitis extent, Mucin depletion, Cryptitis polymorphs, Lamina propria
granulomas', 'accuracy': [0.628, 0.66, 0.4578313253012048, 0.7590361445783133,
0.6586345381526104], 'avgAccuracy': 0.6327004016064257, 'f1':
[0.6383587058514432, 0.6523294566003022, 0.4672590544014557, 0.7796036144309566,
0.6494206999036916], 'avgF1': 0.6373943062375699, 'precision': [0.628, 0.66,
0.4578313253012048, 0.7590361445783133, 0.6586345381526104], 'avgPrecision':
0.6327004016064257, 'recall': [0.628, 0.66, 0.4578313253012048,
0.7590361445783133, 0.6586345381526104], 'avgRecall': 0.6327004016064257,
'params': [{'C': 1.0, 'break_ties': False, 'cache_size': 4000, 'class_weight':
None, 'coef0': 0.0, 'decision_function_shape': 'ovr', 'degree': 3, 'gamma':
'scale', 'kernel': 'linear', 'max_iter': -1, 'probability': False,
'random_state': None, 'shrinking': True, 'tol': 0.001, 'verbose': False}]}
*****************************************************

Processing Model: MLPClassifier
*****************************************************
* MLPClassifier
* Best Params Result:
* {'classifier': 'MLPClassifier', 'features': 'Active inflammation?, Severity of
Crypt Arch, Increased lamina propria cellularity?, Marked & transmucosal
increase in lamina propria cellularity, Lamina propria polymorphs, Crypt
architecture, Patchy lamina propria cellularity?, Epithelial changes, Mucosal
surface, Cryptitis extent, Mucin depletion, Cryptitis polymorphs, Lamina propria
granulomas', 'accuracy': [0.612, 0.66, 0.4457831325301205, 0.7389558232931727,
0.6586345381526104], 'avgAccuracy': 0.6230746987951807, 'f1':
[0.620482144901932, 0.6582633484162895, 0.444390839585254, 0.7678725071934273,
0.65369367429219751], 'avgF1': 0.6289405028778201, 'precision': [0.612, 0.66,
0.4457831325301205, 0.7389558232931727, 0.6586345381526104], 'avgPrecision':
0.6230746987951807, 'recall': [0.612, 0.66, 0.4457831325301205,
0.7389558232931727, 0.6586345381526104], 'avgRecall': 0.6230746987951807,
'params': [{'activation': 'logistic', 'alpha': 0.0001, 'batch_size': 'auto',
'beta_1': 0.9, 'beta_2': 0.999, 'early_stopping': False, 'epsilon': 1e-08,
'hidden_layer_sizes': (100,), 'learning_rate': 'adaptive', 'learning_rate_init':
0.001, 'max_fun': 15000, 'max_iter': 7000, 'momentum': 0.9, 'n_iter_no_change':
10, 'nesterovs_momentum': True, 'power_t': 0.5, 'random_state': None, 'shuffle':
True, 'solver': 'adam', 'tol': 0.0001, 'validation_fraction': 0.1, 'verbose':
False, 'warm_start': False}]}
*****************************************************
*****************************************************
* Best Performing Model and Params is:
```

```
* {'classifier': 'RandomForestClassifier', 'features': 'Active inflammation?,
Severity of Crypt Arch, Increased lamina propria cellularity?, Marked &
transmucosal increase in lamina propria cellularity, Lamina propria polymorphs,
Crypt architecture, Patchy lamina propria cellularity?, Epithelial changes,
Mucosal surface, Cryptitis extent, Mucin depletion, Cryptitis polymorphs, Lamina
propria granulomas', 'accuracy': [0.628, 0.68, 0.5742971887550201,
0.8192771084337349, 0.6666666666666666], 'avgAccuracy': 0.6736481927710843,
'f1': [0.6311436426366004, 0.6767145415745958, 0.6226795370943433,
0.8291765081456128, 0.658641095225659], 'avgF1': 0.6836710649353622,
'precision': [0.628, 0.68, 0.5742971887550201, 0.8192771084337349,
0.6666666666666666], 'avgPrecision': 0.6736481927710843, 'recall': [0.628, 0.68,
0.5742971887550201, 0.8192771084337349, 0.6666666666666666], 'avgRecall':
0.6736481927710843, 'params': [{'bootstrap': True, 'ccp_alpha': 0.0,
'class_weight': None, 'criterion': 'gini', 'max_depth': None, 'max_features':
'sqrt', 'max_leaf_nodes': None, 'max_samples': None, 'min_impurity_decrease':
0.0, 'min_impurity_split': None, 'min_samples_leaf': 1, 'min_samples_split': 2,
'min_weight_fraction_leaf': 0.0, 'n_estimators': 200, 'n_jobs': -1, 'oob_score':
False, 'random_state': None, 'verbose': 0, 'warm_start': False}]}
****************************************************
```

```
                    model                                      features  \
0   RandomForestClassifier  Active inflammation?, Severity of Crypt Arch, …
1     KNeighborsClassifier  Active inflammation?, Severity of Crypt Arch, …
2       LogisticRegression  Active inflammation?, Severity of Crypt Arch, …
3               GaussianNB  Active inflammation?, Severity of Crypt Arch, …
4         AdaBoostClassifier  Active inflammation?, Severity of Crypt Arch, …
5   DecisionTreeClassifier  Active inflammation?, Severity of Crypt Arch, …
6                      SVC  Active inflammation?, Severity of Crypt Arch, …
7            MLPClassifier  Active inflammation?, Severity of Crypt Arch, …

   accuracy        f1  precision    recall  \
0  0.673648  0.683671   0.673648  0.673648
1  0.658419  0.665123   0.658419  0.658419
2  0.624678  0.629439   0.624678  0.624678
3  0.624723  0.622788   0.624723  0.624723
4  0.598271  0.609270   0.598271  0.598271
5  0.652832  0.662099   0.652832  0.652832
6  0.632700  0.637394   0.632700  0.632700
7  0.623075  0.628941   0.623075  0.623075

                                               params
0  {'bootstrap': True, 'ccp_alpha': 0.0, 'class_w…
1  {'algorithm': 'ball_tree', 'leaf_size': 30, 'm…
2  {'C': 1, 'class_weight': None, 'dual': False, …
3           {'priors': None, 'var_smoothing': 1e-09}
4  {'algorithm': 'SAMME.R', 'base_estimator': Non…
5  {'ccp_alpha': 0.0, 'class_weight': None, 'crit…
6  {'C': 1.0, 'break_ties': False, 'cache_size': …
```

```
7  {'activation': 'logistic', 'alpha': 0.0001, 'b…
```

Processing Model: RandomForestClassifier
```
*******************************************************
* RandomForestClassifier
* Best Params Result:
* {'classifier': 'RandomForestClassifier', 'features': 'Active inflammation?,
Severity of Crypt Arch, Increased lamina propria cellularity?, Marked &
transmucosal increase in lamina propria cellularity, Lamina propria polymorphs,
Crypt architecture, Patchy lamina propria cellularity?, Epithelial changes,
Mucosal surface, Cryptitis extent, Mucin depletion, Cryptitis polymorphs',
'accuracy': [0.612, 0.656, 0.570281124497992, 0.8313253012048193,
0.6586345381526104], 'avgAccuracy': 0.6656481927710843, 'f1':
[0.6121041355970933, 0.6545560618088215, 0.6173887534624601, 0.8375875354118845,
0.6496120258835385], 'avgF1': 0.6742497024327596, 'precision': [0.612, 0.656,
0.570281124497992, 0.8313253012048193, 0.6586345381526104], 'avgPrecision':
0.6656481927710843, 'recall': [0.612, 0.656, 0.570281124497992,
0.8313253012048193, 0.6586345381526104], 'avgRecall': 0.6656481927710843,
'params': [{'bootstrap': True, 'ccp_alpha': 0.0, 'class_weight': None,
'criterion': 'entropy', 'max_depth': None, 'max_features': 'log2',
'max_leaf_nodes': None, 'max_samples': None, 'min_impurity_decrease': 0.0,
'min_impurity_split': None, 'min_samples_leaf': 1, 'min_samples_split': 2,
'min_weight_fraction_leaf': 0.0, 'n_estimators': 200, 'n_jobs': -1, 'oob_score':
True, 'random_state': None, 'verbose': 0, 'warm_start': False}]}
*******************************************************
```

Processing Model: KNeighborsClassifier
```
*******************************************************
* KNeighborsClassifier
* Best Params Result:
* {'classifier': 'KNeighborsClassifier', 'features': 'Active inflammation?,
Severity of Crypt Arch, Increased lamina propria cellularity?, Marked &
transmucosal increase in lamina propria cellularity, Lamina propria polymorphs,
Crypt architecture, Patchy lamina propria cellularity?, Epithelial changes,
Mucosal surface, Cryptitis extent, Mucin depletion, Cryptitis polymorphs',
'accuracy': [0.604, 0.628, 0.5180722891566265, 0.8514056224899599,
0.6465863453815262], 'avgAccuracy': 0.6496128514056225, 'f1':
[0.6085713548499865, 0.6305505498511452, 0.5404662327470804, 0.8572484222604704,
0.643387452795201], 'avgF1': 0.6560448025007767, 'precision': [0.604, 0.628,
0.5180722891566265, 0.8514056224899599, 0.6465863453815262], 'avgPrecision':
0.6496128514056225, 'recall': [0.604, 0.628, 0.5180722891566265,
0.8514056224899599, 0.6465863453815262], 'avgRecall': 0.6496128514056225,
'params': [{'algorithm': 'ball_tree', 'leaf_size': 30, 'metric': 'minkowski',
'metric_params': None, 'n_jobs': -1, 'n_neighbors': 12, 'p': 2, 'weights':
'distance'}]}
*******************************************************
```

Processing Model: LogisticRegression

```
*******************************************************
* LogisticRegression
* Best Params Result:
* {'classifier': 'LogisticRegression', 'features': 'Active inflammation?,
Severity of Crypt Arch, Increased lamina propria cellularity?, Marked &
transmucosal increase in lamina propria cellularity, Lamina propria polymorphs,
Crypt architecture, Patchy lamina propria cellularity?, Epithelial changes,
Mucosal surface, Cryptitis extent, Mucin depletion, Cryptitis polymorphs',
'accuracy': [0.608, 0.66, 0.42168674698795183, 0.714859437751004,
0.6546184738955824], 'avgAccuracy': 0.6118329317269077, 'f1':
[0.6183170636774872, 0.6614158567774936, 0.4050242238441793, 0.7447721508041736,
0.6461976077091388], 'avgF1': 0.6151453805624945, 'precision': [0.608, 0.66,
0.42168674698795183, 0.714859437751004, 0.6546184738955824], 'avgPrecision':
0.6118329317269077, 'recall': [0.608, 0.66, 0.42168674698795183,
0.714859437751004, 0.6546184738955824], 'avgRecall': 0.6118329317269077,
'params': [{'C': 1, 'class_weight': None, 'dual': False, 'fit_intercept': True,
'intercept_scaling': 1, 'l1_ratio': None, 'max_iter': 100, 'multi_class':
'multinomial', 'n_jobs': -1, 'penalty': 'l2', 'random_state': None, 'solver':
'newton-cg', 'tol': 0.0001, 'verbose': 0, 'warm_start': False}]}
*******************************************************

Processing Model: GaussianNB
*******************************************************
* GaussianNB
* Best Params Result:
* {'classifier': 'GaussianNB', 'features': 'Active inflammation?, Severity of
Crypt Arch, Increased lamina propria cellularity?, Marked & transmucosal
increase in lamina propria cellularity, Lamina propria polymorphs, Crypt
architecture, Patchy lamina propria cellularity?, Epithelial changes, Mucosal
surface, Cryptitis extent, Mucin depletion, Cryptitis polymorphs', 'accuracy':
[0.584, 0.64, 0.4497991967871486, 0.8353413654618473, 0.6465863453815262],
'avgAccuracy': 0.6311453815261044, 'f1': [0.5914591462137333,
0.6331520065987755, 0.4709295957081216, 0.8348185226708494, 0.6383609406661498],
'avgF1': 0.6337440423715259, 'precision': [0.584, 0.64, 0.4497991967871486,
0.8353413654618473, 0.6465863453815262], 'avgPrecision': 0.6311453815261044,
'recall': [0.584, 0.64, 0.4497991967871486, 0.8353413654618473,
0.6465863453815262], 'avgRecall': 0.6311453815261044, 'params': [{'priors':
None, 'var_smoothing': 1e-09}]}
*******************************************************

Processing Model: AdaBoostClassifier
*******************************************************
* AdaBoostClassifier
* Best Params Result:
* {'classifier': 'AdaBoostClassifier', 'features': 'Active inflammation?,
Severity of Crypt Arch, Increased lamina propria cellularity?, Marked &
transmucosal increase in lamina propria cellularity, Lamina propria polymorphs,
Crypt architecture, Patchy lamina propria cellularity?, Epithelial changes,
```

Mucosal surface, Cryptitis extent, Mucin depletion, Cryptitis polymorphs',
'accuracy': [0.612, 0.532, 0.46987951807228917, 0.7670682730923695,
0.5943775100401606], 'avgAccuracy': 0.5950650602409638, 'f1':
[0.6171024853857273, 0.5309941176470588, 0.5021405011470501, 0.7874165796377901,
0.5941878021294277], 'avgF1': 0.6063682971894108, 'precision': [0.612, 0.532,
0.46987951807228917, 0.7670682730923695, 0.5943775100401606], 'avgPrecision':
0.5950650602409638, 'recall': [0.612, 0.532, 0.46987951807228917,
0.7670682730923695, 0.5943775100401606], 'avgRecall': 0.5950650602409638,
'params': [{'algorithm': 'SAMME.R', 'base_estimator': None, 'learning_rate': 1,
'n_estimators': 100, 'random_state': None}]}
****

Processing Model: DecisionTreeClassifier
****
* DecisionTreeClassifier
* Best Params Result:
* {'classifier': 'DecisionTreeClassifier', 'features': 'Active inflammation?,
Severity of Crypt Arch, Increased lamina propria cellularity?, Marked &
transmucosal increase in lamina propria cellularity, Lamina propria polymorphs,
Crypt architecture, Patchy lamina propria cellularity?, Epithelial changes,
Mucosal surface, Cryptitis extent, Mucin depletion, Cryptitis polymorphs',
'accuracy': [0.568, 0.616, 0.570281124497992, 0.8273092369477911,
0.6385542168674698], 'avgAccuracy': 0.6440289156626505, 'f1':
[0.5686797736566023, 0.6142176538516694, 0.6196812206284014, 0.8366137291502381,
0.635309789640257], 'avgF1': 0.6549004333854336, 'precision': [0.568, 0.616,
0.570281124497992, 0.8273092369477911, 0.6385542168674698], 'avgPrecision':
0.6440289156626505, 'recall': [0.568, 0.616, 0.570281124497992,
0.8273092369477911, 0.6385542168674698], 'avgRecall': 0.6440289156626505,
'params': [{'ccp_alpha': 0.0, 'class_weight': None, 'criterion': 'gini',
'max_depth': None, 'max_features': 'sqrt', 'max_leaf_nodes': None,
'min_impurity_decrease': 0.0, 'min_impurity_split': None, 'min_samples_leaf': 1,
'min_samples_split': 2, 'min_weight_fraction_leaf': 0.0, 'random_state': None,
'splitter': 'best'}]}
****

Processing Model: SVC
****
* SVC
* Best Params Result:
* {'classifier': 'SVC', 'features': 'Active inflammation?, Severity of Crypt
Arch, Increased lamina propria cellularity?, Marked & transmucosal increase in
lamina propria cellularity, Lamina propria polymorphs, Crypt architecture,
Patchy lamina propria cellularity?, Epithelial changes, Mucosal surface,
Cryptitis extent, Mucin depletion, Cryptitis polymorphs', 'accuracy': [0.592,
0.648, 0.46184738955823296, 0.7309236947791165, 0.642570281124498],
'avgAccuracy': 0.6150682730923694, 'f1': [0.6017632341072021,
0.6498739272817095, 0.478845753383906, 0.754050500694041, 0.6374939129133477],
'avgF1': 0.6244054656760413, 'precision': [0.592, 0.648, 0.46184738955823296,

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0.7309236947791165, 0.642570281124498], 'avgPrecision': 0.6150682730923694,
'recall': [0.592, 0.648, 0.46184738955823296, 0.7309236947791165,
0.642570281124498], 'avgRecall': 0.6150682730923694, 'params': [{'C': 1.0,
'break_ties': False, 'cache_size': 4000, 'class_weight': None, 'coef0': 0.0,
'decision_function_shape': 'ovr', 'degree': 3, 'gamma': 'scale', 'kernel':
'linear', 'max_iter': -1, 'probability': False, 'random_state': None,
'shrinking': True, 'tol': 0.001, 'verbose': False}]}
****

Processing Model: MLPClassifier
****
* MLPClassifier
* Best Params Result:
* {'classifier': 'MLPClassifier', 'features': 'Active inflammation?, Severity of
Crypt Arch, Increased lamina propria cellularity?, Marked & transmucosal
increase in lamina propria cellularity, Lamina propria polymorphs, Crypt
architecture, Patchy lamina propria cellularity?, Epithelial changes, Mucosal
surface, Cryptitis extent, Mucin depletion, Cryptitis polymorphs', 'accuracy':
[0.604, 0.66, 0.43373493975903615, 0.7269076305220884, 0.6465863453815262],
'avgAccuracy': 0.6142457831325301, 'f1': [0.615243074337065, 0.6614158567774936,
0.4263146255153084, 0.7581093605189991, 0.6411472188278042], 'avgF1':
0.620446027195334, 'precision': [0.604, 0.66, 0.43373493975903615,
0.7269076305220884, 0.6465863453815262], 'avgPrecision': 0.6142457831325301,
'recall': [0.604, 0.66, 0.43373493975903615, 0.7269076305220884,
0.6465863453815262], 'avgRecall': 0.6142457831325301, 'params': [{'activation':
'identity', 'alpha': 0.0001, 'batch_size': 'auto', 'beta_1': 0.9, 'beta_2':
0.999, 'early_stopping': False, 'epsilon': 1e-08, 'hidden_layer_sizes': (100,),
'learning_rate': 'invscaling', 'learning_rate_init': 0.001, 'max_fun': 15000,
'max_iter': 7000, 'momentum': 0.9, 'n_iter_no_change': 10, 'nesterovs_momentum':
True, 'power_t': 0.5, 'random_state': None, 'shuffle': True, 'solver': 'adam',
'tol': 0.0001, 'validation_fraction': 0.1, 'verbose': False, 'warm_start':
False}]}
****
****
* Best Performing Model and Params is:
* {'classifier': 'RandomForestClassifier', 'features': 'Active inflammation?,
Severity of Crypt Arch, Increased lamina propria cellularity?, Marked &
transmucosal increase in lamina propria cellularity, Lamina propria polymorphs,
Crypt architecture, Patchy lamina propria cellularity?, Epithelial changes,
Mucosal surface, Cryptitis extent, Mucin depletion, Cryptitis polymorphs',
'accuracy': [0.612, 0.656, 0.570281124497992, 0.8313253012048193,
0.6586345381526104], 'avgAccuracy': 0.6656481927710843, 'f1':
[0.6121041355970933, 0.6545560618088215, 0.6173887534624601, 0.8375875354118845,
0.6496120258835385], 'avgF1': 0.6742497024327596, 'precision': [0.612, 0.656,
0.570281124497992, 0.8313253012048193, 0.6586345381526104], 'avgPrecision':
0.6656481927710843, 'recall': [0.612, 0.656, 0.570281124497992,
0.8313253012048193, 0.6586345381526104], 'avgRecall': 0.6656481927710843,
'params': [{'bootstrap': True, 'ccp_alpha': 0.0, 'class_weight': None,

```
'criterion': 'entropy', 'max_depth': None, 'max_features': 'log2',
'max_leaf_nodes': None, 'max_samples': None, 'min_impurity_decrease': 0.0,
'min_impurity_split': None, 'min_samples_leaf': 1, 'min_samples_split': 2,
'min_weight_fraction_leaf': 0.0, 'n_estimators': 200, 'n_jobs': -1, 'oob_score':
True, 'random_state': None, 'verbose': 0, 'warm_start': False}]}
*******************************************************
```

```
                  model                                    features  \
0   RandomForestClassifier  Active inflammation?, Severity of Crypt Arch, …
1     KNeighborsClassifier  Active inflammation?, Severity of Crypt Arch, …
2       LogisticRegression  Active inflammation?, Severity of Crypt Arch, …
3               GaussianNB  Active inflammation?, Severity of Crypt Arch, …
4        AdaBoostClassifier  Active inflammation?, Severity of Crypt Arch, …
5   DecisionTreeClassifier  Active inflammation?, Severity of Crypt Arch, …
6                      SVC  Active inflammation?, Severity of Crypt Arch, …
7            MLPClassifier  Active inflammation?, Severity of Crypt Arch, …

   accuracy        f1  precision    recall  \
0  0.665648  0.674250   0.665648  0.665648
1  0.649613  0.656045   0.649613  0.649613
2  0.611833  0.615145   0.611833  0.611833
3  0.631145  0.633744   0.631145  0.631145
4  0.595065  0.606368   0.595065  0.595065
5  0.644029  0.654900   0.644029  0.644029
6  0.615068  0.624405   0.615068  0.615068
7  0.614246  0.620446   0.614246  0.614246

                                              params
0  {'bootstrap': True, 'ccp_alpha': 0.0, 'class_w…
1  {'algorithm': 'ball_tree', 'leaf_size': 30, 'm…
2  {'C': 1, 'class_weight': None, 'dual': False, …
3           {'priors': None, 'var_smoothing': 1e-09}
4  {'algorithm': 'SAMME.R', 'base_estimator': Non…
5  {'ccp_alpha': 0.0, 'class_weight': None, 'crit…
6  {'C': 1.0, 'break_ties': False, 'cache_size': …
7  {'activation': 'identity', 'alpha': 0.0001, 'b…
```

```
Processing Model: RandomForestClassifier
*******************************************************
* RandomForestClassifier
* Best Params Result:
* {'classifier': 'RandomForestClassifier', 'features': 'Active inflammation?,
Severity of Crypt Arch, Increased lamina propria cellularity?, Marked &
transmucosal increase in lamina propria cellularity, Lamina propria polymorphs,
Crypt architecture, Patchy lamina propria cellularity?, Epithelial changes,
Mucosal surface, Cryptitis extent, Mucin depletion', 'accuracy': [0.612, 0.652,
0.5783132530120482, 0.8313253012048193, 0.6746987951807228], 'avgAccuracy':
0.6696674698795181, 'f1': [0.6121041355970933, 0.6431941176470589,
```

0.6269281391889471, 0.8375875354118845, 0.657062889441737], 'avgF1':
0.6753753634573442, 'precision': [0.612, 0.652, 0.5783132530120482,
0.8313253012048193, 0.6746987951807228], 'avgPrecision': 0.6696674698795181,
'recall': [0.612, 0.652, 0.5783132530120482, 0.8313253012048193,
0.6746987951807228], 'avgRecall': 0.6696674698795181, 'params': [{'bootstrap':
True, 'ccp_alpha': 0.0, 'class_weight': None, 'criterion': 'entropy',
'max_depth': None, 'max_features': 'sqrt', 'max_leaf_nodes': None,
'max_samples': None, 'min_impurity_decrease': 0.0, 'min_impurity_split': None,
'min_samples_leaf': 1, 'min_samples_split': 2, 'min_weight_fraction_leaf': 0.0,
'n_estimators': 200, 'n_jobs': -1, 'oob_score': False, 'random_state': None,
'verbose': 0, 'warm_start': False}]}
****

Processing Model: KNeighborsClassifier
****
* KNeighborsClassifier
* Best Params Result:
* {'classifier': 'KNeighborsClassifier', 'features': 'Active inflammation?,
Severity of Crypt Arch, Increased lamina propria cellularity?, Marked &
transmucosal increase in lamina propria cellularity, Lamina propria polymorphs,
Crypt architecture, Patchy lamina propria cellularity?, Epithelial changes,
Mucosal surface, Cryptitis extent, Mucin depletion', 'accuracy': [0.608, 0.636,
0.5341365461847389, 0.8473895582329317, 0.6465863453815262], 'avgAccuracy':
0.6544224899598393, 'f1': [0.6102471695910361, 0.6337467749338488,
0.5587203988367263, 0.8538525995875392, 0.6406986338658828], 'avgF1':
0.65945311536630067, 'precision': [0.608, 0.636, 0.5341365461847389,
0.8473895582329317, 0.6465863453815262], 'avgPrecision': 0.6544224899598393,
'recall': [0.608, 0.636, 0.5341365461847389, 0.8473895582329317,
0.6465863453815262], 'avgRecall': 0.6544224899598393, 'params': [{'algorithm':
'ball_tree', 'leaf_size': 30, 'metric': 'minkowski', 'metric_params': None,
'n_jobs': -1, 'n_neighbors': 12, 'p': 2, 'weights': 'distance'}]}
****

Processing Model: LogisticRegression
****
* LogisticRegression
* Best Params Result:
* {'classifier': 'LogisticRegression', 'features': 'Active inflammation?,
Severity of Crypt Arch, Increased lamina propria cellularity?, Marked &
transmucosal increase in lamina propria cellularity, Lamina propria polymorphs,
Crypt architecture, Patchy lamina propria cellularity?, Epithelial changes,
Mucosal surface, Cryptitis extent, Mucin depletion', 'accuracy': [0.616, 0.66,
0.42168674698795183, 0.7108433734939759, 0.6666666666666666], 'avgAccuracy':
0.6150393574297188, 'f1': [0.6267198965210661, 0.6614158567774936,
0.40204719152137497, 0.7396992275321381, 0.668041566784715], 'avgF1':
0.6195847478273575, 'precision': [0.616, 0.66, 0.42168674698795183,
0.7108433734939759, 0.6666666666666666], 'avgPrecision': 0.6150393574297188,
'recall': [0.616, 0.66, 0.42168674698795183, 0.7108433734939759,

0.6666666666666666], 'avgRecall': 0.6150393574297188, 'params': [{'C': 1,
'class_weight': None, 'dual': False, 'fit_intercept': True, 'intercept_scaling':
1, 'l1_ratio': None, 'max_iter': 100, 'multi_class': 'ovr', 'n_jobs': -1,
'penalty': 'l2', 'random_state': None, 'solver': 'newton-cg', 'tol': 0.0001,
'verbose': 0, 'warm_start': False}]}
****

Processing Model: GaussianNB
****
* GaussianNB
* Best Params Result:
* {'classifier': 'GaussianNB', 'features': 'Active inflammation?, Severity of
Crypt Arch, Increased lamina propria cellularity?, Marked & transmucosal
increase in lamina propria cellularity, Lamina propria polymorphs, Crypt
architecture, Patchy lamina propria cellularity?, Epithelial changes, Mucosal
surface, Cryptitis extent, Mucin depletion', 'accuracy': [0.584, 0.644,
0.4538152610441767, 0.8273092369477911, 0.642570281124498], 'avgAccuracy':
0.6303389558232931, 'f1': [0.5907148328135997, 0.6366821622265927,
0.4740432110578162, 0.8273807289683881, 0.6365740273316377], 'avgF1':
0.6330789924796069, 'precision': [0.584, 0.644, 0.4538152610441767,
0.8273092369477911, 0.642570281124498], 'avgPrecision': 0.6303389558232931,
'recall': [0.584, 0.644, 0.4538152610441767, 0.8273092369477911,
0.642570281124498], 'avgRecall': 0.6303389558232931, 'params': [{'priors': None,
'var_smoothing': 1e-09}]}
****

Processing Model: AdaBoostClassifier
****
* AdaBoostClassifier
* Best Params Result:
* {'classifier': 'AdaBoostClassifier', 'features': 'Active inflammation?,
Severity of Crypt Arch, Increased lamina propria cellularity?, Marked &
transmucosal increase in lamina propria cellularity, Lamina propria polymorphs,
Crypt architecture, Patchy lamina propria cellularity?, Epithelial changes,
Mucosal surface, Cryptitis extent, Mucin depletion', 'accuracy': [0.54, 0.584,
0.46987951807228917, 0.7751004016064257, 0.5903614457831325], 'avgAccuracy':
0.5918682730923694, 'f1': [0.5431455184893714, 0.5837346280793604,
0.5024089931441313, 0.81193740479158, 0.5905574808539767], 'avgF1':
0.606356805071684, 'precision': [0.54, 0.584, 0.46987951807228917,
0.7751004016064257, 0.5903614457831325], 'avgPrecision': 0.5918682730923694,
'recall': [0.54, 0.584, 0.46987951807228917, 0.7751004016064257,
0.5903614457831325], 'avgRecall': 0.5918682730923694, 'params': [{'algorithm':
'SAMME.R', 'base_estimator': None, 'learning_rate': 1, 'n_estimators': 300,
'random_state': None}]}
****

Processing Model: DecisionTreeClassifier
****

* DecisionTreeClassifier
* Best Params Result:
* {'classifier': 'DecisionTreeClassifier', 'features': 'Active inflammation?, Severity of Crypt Arch, Increased lamina propria cellularity?, Marked & transmucosal increase in lamina propria cellularity, Lamina propria polymorphs, Crypt architecture, Patchy lamina propria cellularity?, Epithelial changes, Mucosal surface, Cryptitis extent, Mucin depletion', 'accuracy': [0.596, 0.62, 0.5662650602409639, 0.8192771084337349, 0.6546184738955824], 'avgAccuracy': 0.6512321285140562, 'f1': [0.600680153403045, 0.6160184915516723, 0.6128095845377716, 0.8273978895640256, 0.6421651887507505], 'avgF1': 0.659814261561453, 'precision': [0.596, 0.62, 0.5662650602409639, 0.8192771084337349, 0.6546184738955824], 'avgPrecision': 0.6512321285140562, 'recall': [0.596, 0.62, 0.5662650602409639, 0.8192771084337349, 0.6546184738955824], 'avgRecall': 0.6512321285140562, 'params': [{'ccp_alpha': 0.0, 'class_weight': None, 'criterion': 'entropy', 'max_depth': None, 'max_features': 'log2', 'max_leaf_nodes': None, 'min_impurity_decrease': 0.0, 'min_impurity_split': None, 'min_samples_leaf': 1, 'min_samples_split': 2, 'min_weight_fraction_leaf': 0.0, 'random_state': None, 'splitter': 'best'}]}
****

Processing Model: SVC
****
* SVC
* Best Params Result:
* {'classifier': 'SVC', 'features': 'Active inflammation?, Severity of Crypt Arch, Increased lamina propria cellularity?, Marked & transmucosal increase in lamina propria cellularity, Lamina propria polymorphs, Crypt architecture, Patchy lamina propria cellularity?, Epithelial changes, Mucosal surface, Cryptitis extent, Mucin depletion', 'accuracy': [0.596, 0.648, 0.46586345381526106, 0.7309236947791165, 0.6626506024096386], 'avgAccuracy': 0.6206875502008032, 'f1': [0.6059775775131424, 0.6498739272817095, 0.4844840242008042, 0.754050500694041, 0.6530974058233268], 'avgF1': 0.6294966871026048, 'precision': [0.596, 0.648, 0.46586345381526106, 0.7309236947791165, 0.6626506024096386], 'avgPrecision': 0.6206875502008032, 'recall': [0.596, 0.648, 0.46586345381526106, 0.7309236947791165, 0.6626506024096386], 'avgRecall': 0.6206875502008032, 'params': [{'C': 1.0, 'break_ties': False, 'cache_size': 4000, 'class_weight': None, 'coef0': 0.0, 'decision_function_shape': 'ovr', 'degree': 3, 'gamma': 'scale', 'kernel': 'linear', 'max_iter': -1, 'probability': False, 'random_state': None, 'shrinking': True, 'tol': 0.001, 'verbose': False}]}
****

Processing Model: MLPClassifier
****
* MLPClassifier
* Best Params Result:
* {'classifier': 'MLPClassifier', 'features': 'Active inflammation?, Severity of Crypt Arch, Increased lamina propria cellularity?, Marked & transmucosal

increase in lamina propria cellularity, Lamina propria polymorphs, Crypt
architecture, Patchy lamina propria cellularity?, Epithelial changes, Mucosal
surface, Cryptitis extent, Mucin depletion', 'accuracy': [0.62, 0.656,
0.44176706827309237, 0.7108433734939759, 0.6626506024096386], 'avgAccuracy':
0.6182522088353414, 'f1': [0.6300574837160202, 0.6576281917531595,
0.4431128356011487, 0.7396992275321381, 0.6558142980353562], 'avgF1':
0.6252624073275646, 'precision': [0.62, 0.656, 0.44176706827309237,
0.7108433734939759, 0.6626506024096386], 'avgPrecision': 0.6182522088353414,
'recall': [0.62, 0.656, 0.44176706827309237, 0.7108433734939759,
0.6626506024096386], 'avgRecall': 0.6182522088353414, 'params': [{'activation':
'logistic', 'alpha': 0.0001, 'batch_size': 'auto', 'beta_1': 0.9, 'beta_2':
0.999, 'early_stopping': False, 'epsilon': 1e-08, 'hidden_layer_sizes': (100,),
'learning_rate': 'adaptive', 'learning_rate_init': 0.001, 'max_fun': 15000,
'max_iter': 5000, 'momentum': 0.9, 'n_iter_no_change': 10, 'nesterovs_momentum':
True, 'power_t': 0.5, 'random_state': None, 'shuffle': True, 'solver': 'adam',
'tol': 0.0001, 'validation_fraction': 0.1, 'verbose': False, 'warm_start':
False}]}
****
****
* Best Performing Model and Params is:
* {'classifier': 'RandomForestClassifier', 'features': 'Active inflammation?,
Severity of Crypt Arch, Increased lamina propria cellularity?, Marked &
transmucosal increase in lamina propria cellularity, Lamina propria polymorphs,
Crypt architecture, Patchy lamina propria cellularity?, Epithelial changes,
Mucosal surface, Cryptitis extent, Mucin depletion', 'accuracy': [0.612, 0.652,
0.5783132530120482, 0.8313253012048193, 0.6746987951807228], 'avgAccuracy':
0.6696674698795181, 'f1': [0.6121041355970933, 0.6431941176470589,
0.6269281391889471, 0.8375875354118845, 0.657062889441737], 'avgF1':
0.6753753634573442, 'precision': [0.612, 0.652, 0.5783132530120482,
0.8313253012048193, 0.6746987951807228], 'avgPrecision': 0.6696674698795181,
'recall': [0.612, 0.652, 0.5783132530120482, 0.8313253012048193,
0.6746987951807228], 'avgRecall': 0.6696674698795181, 'params': [{'bootstrap':
True, 'ccp_alpha': 0.0, 'class_weight': None, 'criterion': 'entropy',
'max_depth': None, 'max_features': 'sqrt', 'max_leaf_nodes': None,
'max_samples': None, 'min_impurity_decrease': 0.0, 'min_impurity_split': None,
'min_samples_leaf': 1, 'min_samples_split': 2, 'min_weight_fraction_leaf': 0.0,
'n_estimators': 200, 'n_jobs': -1, 'oob_score': False, 'random_state': None,
'verbose': 0, 'warm_start': False}]}
****

```
                model                                       features  \
0  RandomForestClassifier  Active inflammation?, Severity of Crypt Arch, …
1    KNeighborsClassifier  Active inflammation?, Severity of Crypt Arch, …
2      LogisticRegression  Active inflammation?, Severity of Crypt Arch, …
3              GaussianNB  Active inflammation?, Severity of Crypt Arch, …
4      AdaBoostClassifier  Active inflammation?, Severity of Crypt Arch, …
5  DecisionTreeClassifier  Active inflammation?, Severity of Crypt Arch, …
6                     SVC  Active inflammation?, Severity of Crypt Arch, …
```

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```
7           MLPClassifier  Active inflammation?, Severity of Crypt Arch, …

    accuracy          f1  precision    recall  \
0   0.669667   0.675375   0.669667  0.669667
1   0.654422   0.659453   0.654422  0.654422
2   0.615039   0.619585   0.615039  0.615039
3   0.630339   0.633079   0.630339  0.630339
4   0.591868   0.606357   0.591868  0.591868
5   0.651232   0.659814   0.651232  0.651232
6   0.620688   0.629497   0.620688  0.620688
7   0.618252   0.625262   0.618252  0.618252


                                                     params
0  {'bootstrap': True, 'ccp_alpha': 0.0, 'class_w…
1  {'algorithm': 'ball_tree', 'leaf_size': 30, 'm…
2  {'C': 1, 'class_weight': None, 'dual': False, …
3           {'priors': None, 'var_smoothing': 1e-09}
4  {'algorithm': 'SAMME.R', 'base_estimator': Non…
5  {'ccp_alpha': 0.0, 'class_weight': None, 'crit…
6  {'C': 1.0, 'break_ties': False, 'cache_size': …
7  {'activation': 'logistic', 'alpha': 0.0001, 'b…
```

```
Processing Model: RandomForestClassifier
****************************************************
* RandomForestClassifier
* Best Params Result:
* {'classifier': 'RandomForestClassifier', 'features': 'Active inflammation?,
Severity of Crypt Arch, Increased lamina propria cellularity?, Marked &
transmucosal increase in lamina propria cellularity, Lamina propria polymorphs,
Crypt architecture, Patchy lamina propria cellularity?, Epithelial changes,
Mucosal surface, Cryptitis extent', 'accuracy': [0.616, 0.656,
0.5461847389558233, 0.8273092369477911, 0.6827309236947792], 'avgAccuracy':
0.6656449799196787, 'f1': [0.6191819766639051, 0.6528206574006983,
0.5897268561425189, 0.8348250901822757, 0.6747401268883424], 'avgF1':
0.6742589414555481, 'precision': [0.616, 0.656, 0.5461847389558233,
0.8273092369477911, 0.6827309236947792], 'avgPrecision': 0.6656449799196787,
'recall': [0.616, 0.656, 0.5461847389558233, 0.8273092369477911,
0.6827309236947792], 'avgRecall': 0.6656449799196787, 'params': [{'bootstrap':
True, 'ccp_alpha': 0.0, 'class_weight': None, 'criterion': 'gini', 'max_depth':
None, 'max_features': 'auto', 'max_leaf_nodes': None, 'max_samples': None,
'min_impurity_decrease': 0.0, 'min_impurity_split': None, 'min_samples_leaf': 1,
'min_samples_split': 2, 'min_weight_fraction_leaf': 0.0, 'n_estimators': 200,
'n_jobs': -1, 'oob_score': True, 'random_state': None, 'verbose': 0,
'warm_start': False}]}
****************************************************

Processing Model: KNeighborsClassifier
****************************************************
```

```
* KNeighborsClassifier
* Best Params Result:
* {'classifier': 'KNeighborsClassifier', 'features': 'Active inflammation?,
Severity of Crypt Arch, Increased lamina propria cellularity?, Marked &
transmucosal increase in lamina propria cellularity, Lamina propria polymorphs,
Crypt architecture, Patchy lamina propria cellularity?, Epithelial changes,
Mucosal surface, Cryptitis extent', 'accuracy': [0.6, 0.648, 0.5100401606425703,
0.8393574297188755, 0.642570281124498], 'avgAccuracy': 0.6479935742971887, 'f1':
[0.6084460097609812, 0.6474218112480267, 0.5343738784958955, 0.8503962373558405,
0.6409315741259254], 'avgF1': 0.6563139021973339, 'precision': [0.6, 0.648,
0.5100401606425703, 0.8393574297188755, 0.642570281124498], 'avgPrecision':
0.6479935742971887, 'recall': [0.6, 0.648, 0.5100401606425703,
0.8393574297188755, 0.642570281124498], 'avgRecall': 0.6479935742971887,
'params': [{'algorithm': 'ball_tree', 'leaf_size': 30, 'metric': 'minkowski',
'metric_params': None, 'n_jobs': -1, 'n_neighbors': 14, 'p': 2, 'weights':
'distance'}]}
*******************************************************

Processing Model: LogisticRegression
*******************************************************
* LogisticRegression
* Best Params Result:
* {'classifier': 'LogisticRegression', 'features': 'Active inflammation?,
Severity of Crypt Arch, Increased lamina propria cellularity?, Marked &
transmucosal increase in lamina propria cellularity, Lamina propria polymorphs,
Crypt architecture, Patchy lamina propria cellularity?, Epithelial changes,
Mucosal surface, Cryptitis extent', 'accuracy': [0.62, 0.66,
0.42168674698795183, 0.7108433734939759, 0.6666666666666666], 'avgAccuracy':
0.6158393574297188, 'f1': [0.6309104503504619, 0.6614158567774936,
0.40204719152137497, 0.7396992275321381, 0.668041566784715], 'avgF1':
0.6204228585932368, 'precision': [0.62, 0.66, 0.42168674698795183,
0.7108433734939759, 0.6666666666666666], 'avgPrecision': 0.6158393574297188,
'recall': [0.62, 0.66, 0.42168674698795183, 0.7108433734939759,
0.6666666666666666], 'avgRecall': 0.6158393574297188, 'params': [{'C': 1,
'class_weight': None, 'dual': False, 'fit_intercept': True, 'intercept_scaling':
1, 'l1_ratio': None, 'max_iter': 100, 'multi_class': 'ovr', 'n_jobs': -1,
'penalty': 'l2', 'random_state': None, 'solver': 'newton-cg', 'tol': 0.0001,
'verbose': 0, 'warm_start': False}]}
*******************************************************

Processing Model: GaussianNB
*******************************************************
* GaussianNB
* Best Params Result:
* {'classifier': 'GaussianNB', 'features': 'Active inflammation?, Severity of
Crypt Arch, Increased lamina propria cellularity?, Marked & transmucosal
increase in lamina propria cellularity, Lamina propria polymorphs, Crypt
architecture, Patchy lamina propria cellularity?, Epithelial changes, Mucosal
```

surface, Cryptitis extent', 'accuracy': [0.58, 0.632, 0.43775100401606426,
0.8232931726907631, 0.6465863453815262], 'avgAccuracy': 0.6239261044176707,
'f1': [0.5865654969364207, 0.6240476761524063, 0.4539824959971821,
0.823556580319481, 0.6425676499553911], 'avgF1': 0.6261439798721762,
'precision': [0.58, 0.632, 0.43775100401606426, 0.8232931726907631,
0.6465863453815262], 'avgPrecision': 0.6239261044176707, 'recall': [0.58, 0.632,
0.43775100401606426, 0.8232931726907631, 0.6465863453815262], 'avgRecall':
0.6239261044176707, 'params': [{'priors': None, 'var_smoothing': 1e-09}]}
****

Processing Model: AdaBoostClassifier
****
* AdaBoostClassifier
* Best Params Result:
* {'classifier': 'AdaBoostClassifier', 'features': 'Active inflammation?,
Severity of Crypt Arch, Increased lamina propria cellularity?, Marked &
transmucosal increase in lamina propria cellularity, Lamina propria polymorphs,
Crypt architecture, Patchy lamina propria cellularity?, Epithelial changes,
Mucosal surface, Cryptitis extent', 'accuracy': [0.588, 0.52,
0.4497991967871486, 0.7429718875502008, 0.5461847389558233], 'avgAccuracy':
0.5693911646586345, 'f1': [0.5938374105694301, 0.530273773085393,
0.4797256887413515, 0.7866694048922964, 0.54708516674621421], 'avgF1':
0.5875182889501226, 'precision': [0.588, 0.52, 0.4497991967871486,
0.7429718875502008, 0.5461847389558233], 'avgPrecision': 0.5693911646586345,
'recall': [0.588, 0.52, 0.4497991967871486, 0.7429718875502008,
0.5461847389558233], 'avgRecall': 0.5693911646586345, 'params': [{'algorithm':
'SAMME.R', 'base_estimator': None, 'learning_rate': 1, 'n_estimators': 100,
'random_state': None}]}
****

Processing Model: DecisionTreeClassifier
****
* DecisionTreeClassifier
* Best Params Result:
* {'classifier': 'DecisionTreeClassifier', 'features': 'Active inflammation?,
Severity of Crypt Arch, Increased lamina propria cellularity?, Marked &
transmucosal increase in lamina propria cellularity, Lamina propria polymorphs,
Crypt architecture, Patchy lamina propria cellularity?, Epithelial changes,
Mucosal surface, Cryptitis extent', 'accuracy': [0.592, 0.64,
0.5341365461847389, 0.8232931726907631, 0.6666666666666666], 'avgAccuracy':
0.6512192771084337, 'f1': [0.5938814100536131, 0.6418469563661997,
0.5773417007873999, 0.8320217198381541, 0.6606433024647211], 'avgF1':
0.6611470179020176, 'precision': [0.592, 0.64, 0.5341365461847389,
0.8232931726907631, 0.6666666666666666], 'avgPrecision': 0.6512192771084337,
'recall': [0.592, 0.64, 0.5341365461847389, 0.8232931726907631,
0.6666666666666666], 'avgRecall': 0.6512192771084337, 'params': [{'ccp_alpha':
0.0, 'class_weight': None, 'criterion': 'gini', 'max_depth': None,
'max_features': 'auto', 'max_leaf_nodes': None, 'min_impurity_decrease': 0.0,

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'min_impurity_split': None, 'min_samples_leaf': 1, 'min_samples_split': 2,
'min_weight_fraction_leaf': 0.0, 'random_state': None, 'splitter': 'best'}]]
*******************************************************

Processing Model: SVC
*******************************************************
* SVC
* Best Params Result:
* {'classifier': 'SVC', 'features': 'Active inflammation?, Severity of Crypt
Arch, Increased lamina propria cellularity?, Marked & transmucosal increase in
lamina propria cellularity, Lamina propria polymorphs, Crypt architecture,
Patchy lamina propria cellularity?, Epithelial changes, Mucosal surface,
Cryptitis extent', 'accuracy': [0.596, 0.648, 0.46586345381526106,
0.7309236947791165, 0.6626506024096386], 'avgAccuracy': 0.6206875502008032,
'f1': [0.6059775775131424, 0.6498739272817095, 0.4844840242008042,
0.7551657053141745, 0.6530974058233268], 'avgF1': 0.6297197280266315,
'precision': [0.596, 0.648, 0.46586345381526106, 0.7309236947791165,
0.6626506024096386], 'avgPrecision': 0.6206875502008032, 'recall': [0.596,
0.648, 0.46586345381526106, 0.7309236947791165, 0.6626506024096386],
'avgRecall': 0.6206875502008032, 'params': [{'C': 1.0, 'break_ties': False,
'cache_size': 4000, 'class_weight': None, 'coef0': 0.0,
'decision_function_shape': 'ovr', 'degree': 3, 'gamma': 'scale', 'kernel':
'linear', 'max_iter': -1, 'probability': False, 'random_state': None,
'shrinking': True, 'tol': 0.001, 'verbose': False}]]
*******************************************************

Processing Model: MLPClassifier
*******************************************************
* MLPClassifier
* Best Params Result:
* {'classifier': 'MLPClassifier', 'features': 'Active inflammation?, Severity of
Crypt Arch, Increased lamina propria cellularity?, Marked & transmucosal
increase in lamina propria cellularity, Lamina propria polymorphs, Crypt
architecture, Patchy lamina propria cellularity?, Epithelial changes, Mucosal
surface, Cryptitis extent', 'accuracy': [0.612, 0.656, 0.43373493975903615,
0.7429718875502008, 0.6586345381526104], 'avgAccuracy': 0.6206682730923695,
'f1': [0.6225223693302745, 0.6576281917531595, 0.4358113017255011,
0.7713983297629358, 0.6516590540385542], 'avgF1': 0.627803849322085,
'precision': [0.612, 0.656, 0.43373493975903615, 0.7429718875502008,
0.6586345381526104], 'avgPrecision': 0.6206682730923695, 'recall': [0.612,
0.656, 0.43373493975903615, 0.7429718875502008, 0.6586345381526104],
'avgRecall': 0.6206682730923695, 'params': [{'activation': 'logistic', 'alpha':
0.0001, 'batch_size': 'auto', 'beta_1': 0.9, 'beta_2': 0.999, 'early_stopping':
False, 'epsilon': 1e-08, 'hidden_layer_sizes': (100,), 'learning_rate':
'invscaling', 'learning_rate_init': 0.001, 'max_fun': 15000, 'max_iter': 9000,
'momentum': 0.9, 'n_iter_no_change': 10, 'nesterovs_momentum': True, 'power_t':
0.5, 'random_state': None, 'shuffle': True, 'solver': 'adam', 'tol': 0.0001,
'validation_fraction': 0.1, 'verbose': False, 'warm_start': False}]]
```

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**************************************************
**************************************************
* Best Performing Model and Params is:
* {'classifier': 'RandomForestClassifier', 'features': 'Active inflammation?,
Severity of Crypt Arch, Increased lamina propria cellularity?, Marked &
transmucosal increase in lamina propria cellularity, Lamina propria polymorphs,
Crypt architecture, Patchy lamina propria cellularity?, Epithelial changes,
Mucosal surface, Cryptitis extent', 'accuracy': [0.616, 0.656,
0.5461847389558233, 0.8273092369477911, 0.6827309236947792], 'avgAccuracy':
0.6656449799196787, 'f1': [0.6191819766639051, 0.6528206574006983,
0.5897268561425189, 0.8348250901822757, 0.6747401268883424], 'avgF1':
0.6742589414555481, 'precision': [0.616, 0.656, 0.5461847389558233,
0.8273092369477911, 0.6827309236947792], 'avgPrecision': 0.6656449799196787,
'recall': [0.616, 0.656, 0.5461847389558233, 0.8273092369477911,
0.6827309236947792], 'avgRecall': 0.6656449799196787, 'params': [{'bootstrap':
True, 'ccp_alpha': 0.0, 'class_weight': None, 'criterion': 'gini', 'max_depth':
None, 'max_features': 'auto', 'max_leaf_nodes': None, 'max_samples': None,
'min_impurity_decrease': 0.0, 'min_impurity_split': None, 'min_samples_leaf': 1,
'min_samples_split': 2, 'min_weight_fraction_leaf': 0.0, 'n_estimators': 200,
'n_jobs': -1, 'oob_score': True, 'random_state': None, 'verbose': 0,
'warm_start': False}]}
**************************************************
```

	model	features
0	RandomForestClassifier	Active inflammation?, Severity of Crypt Arch, …
1	KNeighborsClassifier	Active inflammation?, Severity of Crypt Arch, …
2	LogisticRegression	Active inflammation?, Severity of Crypt Arch, …
3	GaussianNB	Active inflammation?, Severity of Crypt Arch, …
4	AdaBoostClassifier	Active inflammation?, Severity of Crypt Arch, …
5	DecisionTreeClassifier	Active inflammation?, Severity of Crypt Arch, …
6	SVC	Active inflammation?, Severity of Crypt Arch, …
7	MLPClassifier	Active inflammation?, Severity of Crypt Arch, …

	accuracy	f1	precision	recall
0	0.665645	0.674259	0.665645	0.665645
1	0.647994	0.656314	0.647994	0.647994
2	0.615839	0.620423	0.615839	0.615839
3	0.623926	0.626144	0.623926	0.623926
4	0.569391	0.587518	0.569391	0.569391
5	0.651219	0.661147	0.651219	0.651219
6	0.620688	0.629720	0.620688	0.620688
7	0.620668	0.627804	0.620668	0.620668

	params
0	{'bootstrap': True, 'ccp_alpha': 0.0, 'class_w…
1	{'algorithm': 'ball_tree', 'leaf_size': 30, 'm…
2	{'C': 1, 'class_weight': None, 'dual': False, …
3	{'priors': None, 'var_smoothing': 1e-09}

```
4  {'algorithm': 'SAMME.R', 'base_estimator': Non…
5  {'ccp_alpha': 0.0, 'class_weight': None, 'crit…
6  {'C': 1.0, 'break_ties': False, 'cache_size': …
7  {'activation': 'logistic', 'alpha': 0.0001, 'b…
```

Processing Model: RandomForestClassifier
****
* RandomForestClassifier
* Best Params Result:
* {'classifier': 'RandomForestClassifier', 'features': 'Active inflammation?,
Severity of Crypt Arch, Increased lamina propria cellularity?, Marked &
transmucosal increase in lamina propria cellularity, Lamina propria polymorphs,
Crypt architecture, Patchy lamina propria cellularity?, Epithelial changes,
Mucosal surface', 'accuracy': [0.62, 0.668, 0.5341365461847389,
0.8232931726907631, 0.6746987951807228], 'avgAccuracy': 0.664025702811245, 'f1':
[0.6208806286497008, 0.6608294078588902, 0.574233209229603, 0.8320217198381541,
0.6664388723295162], 'avgF1': 0.6708807675811729, 'precision': [0.62, 0.668,
0.5341365461847389, 0.8232931726907631, 0.6746987951807228], 'avgPrecision':
0.664025702811245, 'recall': [0.62, 0.668, 0.5341365461847389,
0.8232931726907631, 0.6746987951807228], 'avgRecall': 0.664025702811245,
'params': [{'bootstrap': True, 'ccp_alpha': 0.0, 'class_weight': None,
'criterion': 'entropy', 'max_depth': None, 'max_features': 'sqrt',
'max_leaf_nodes': None, 'max_samples': None, 'min_impurity_decrease': 0.0,
'min_impurity_split': None, 'min_samples_leaf': 1, 'min_samples_split': 2,
'min_weight_fraction_leaf': 0.0, 'n_estimators': 200, 'n_jobs': -1, 'oob_score':
True, 'random_state': None, 'verbose': 0, 'warm_start': False}]}
****

Processing Model: KNeighborsClassifier
****
* KNeighborsClassifier
* Best Params Result:
* {'classifier': 'KNeighborsClassifier', 'features': 'Active inflammation?,
Severity of Crypt Arch, Increased lamina propria cellularity?, Marked &
transmucosal increase in lamina propria cellularity, Lamina propria polymorphs,
Crypt architecture, Patchy lamina propria cellularity?, Epithelial changes,
Mucosal surface', 'accuracy': [0.628, 0.664, 0.4899598393574297,
0.7751004016064257, 0.6546184738955824], 'avgAccuracy': 0.6423357429718876,
'f1': [0.627315186361626, 0.6578621542553191, 0.5077645928106594,
0.8171216486499356, 0.6470047324624717], 'avgF1': 0.6514136629080024,
'precision': [0.628, 0.664, 0.4899598393574297, 0.7751004016064257,
0.6546184738955824], 'avgPrecision': 0.6423357429718876, 'recall': [0.628,
0.664, 0.4899598393574297, 0.7751004016064257, 0.6546184738955824], 'avgRecall':
0.6423357429718876, 'params': [{'algorithm': 'auto', 'leaf_size': 30, 'metric':
'minkowski', 'metric_params': None, 'n_jobs': -1, 'n_neighbors': 14, 'p': 2,
'weights': 'distance'}]}
****

```
Processing Model: LogisticRegression
*******************************************************
* LogisticRegression
* Best Params Result:
* {'classifier': 'LogisticRegression', 'features': 'Active inflammation?,
Severity of Crypt Arch, Increased lamina propria cellularity?, Marked &
transmucosal increase in lamina propria cellularity, Lamina propria polymorphs,
Crypt architecture, Patchy lamina propria cellularity?, Epithelial changes,
Mucosal surface', 'accuracy': [0.604, 0.64, 0.40562248995983935,
0.7108433734939759, 0.6586345381526104], 'avgAccuracy': 0.6038200803212851,
'f1': [0.6116246118197338, 0.6423798319327729, 0.3886636495986239,
0.7585047883843066, 0.6537010300024361], 'avgF1': 0.6109747823475746,
'precision': [0.604, 0.64, 0.40562248995983935, 0.7108433734939759,
0.6586345381526104], 'avgPrecision': 0.6038200803212851, 'recall': [0.604, 0.64,
0.40562248995983935, 0.7108433734939759, 0.6586345381526104], 'avgRecall':
0.6038200803212851, 'params': [{'C': 1, 'class_weight': None, 'dual': False,
'fit_intercept': True, 'intercept_scaling': 1, 'l1_ratio': None, 'max_iter':
100, 'multi_class': 'multinomial', 'n_jobs': -1, 'penalty': 'l2',
'random_state': None, 'solver': 'newton-cg', 'tol': 0.0001, 'verbose': 0,
'warm_start': False}]}
*******************************************************

Processing Model: GaussianNB
*******************************************************
* GaussianNB
* Best Params Result:
* {'classifier': 'GaussianNB', 'features': 'Active inflammation?, Severity of
Crypt Arch, Increased lamina propria cellularity?, Marked & transmucosal
increase in lamina propria cellularity, Lamina propria polymorphs, Crypt
architecture, Patchy lamina propria cellularity?, Epithelial changes, Mucosal
surface', 'accuracy': [0.58, 0.62, 0.42971887550200805, 0.8232931726907631,
0.6465863453815262], 'avgAccuracy': 0.6199196787148594, 'f1':
[0.5865654969364207, 0.6126864253393665, 0.4432596610526392, 0.8252924615734346,
0.6425676499553911], 'avgF1': 0.6220743389714504, 'precision': [0.58, 0.62,
0.42971887550200805, 0.8232931726907631, 0.6465863453815262], 'avgPrecision':
0.6199196787148594, 'recall': [0.58, 0.62, 0.42971887550200805,
0.8232931726907631, 0.6465863453815262], 'avgRecall': 0.6199196787148594,
'params': [{'priors': None, 'var_smoothing': 1e-09}]}
*******************************************************

Processing Model: AdaBoostClassifier
*******************************************************
* AdaBoostClassifier
* Best Params Result:
* {'classifier': 'AdaBoostClassifier', 'features': 'Active inflammation?,
Severity of Crypt Arch, Increased lamina propria cellularity?, Marked &
transmucosal increase in lamina propria cellularity, Lamina propria polymorphs,
Crypt architecture, Patchy lamina propria cellularity?, Epithelial changes,
```

Mucosal surface', 'accuracy': [0.596, 0.52, 0.46987951807228917,
0.7590361445783133, 0.6104417670682731], 'avgAccuracy': 0.5910714859437751,
'f1': [0.6042809583628728, 0.5175907314554885, 0.5026429113019376,
0.80003259215462, 0.607595854130062], 'avgF1': 0.6064286094809962, 'precision':
[0.596, 0.52, 0.46987951807228917, 0.7590361445783133, 0.6104417670682731],
'avgPrecision': 0.5910714859437751, 'recall': [0.596, 0.52, 0.46987951807228917,
0.7590361445783133, 0.6104417670682731], 'avgRecall': 0.5910714859437751,
'params': [{'algorithm': 'SAMME.R', 'base_estimator': None, 'learning_rate': 1,
'n_estimators': 100, 'random_state': None}]}
****

Processing Model: DecisionTreeClassifier
****
* DecisionTreeClassifier
* Best Params Result:
* {'classifier': 'DecisionTreeClassifier', 'features': 'Active inflammation?,
Severity of Crypt Arch, Increased lamina propria cellularity?, Marked &
transmucosal increase in lamina propria cellularity, Lamina propria polymorphs,
Crypt architecture, Patchy lamina propria cellularity?, Epithelial changes,
Mucosal surface', 'accuracy': [0.62, 0.656, 0.5341365461847389,
0.8232931726907631, 0.6626506024096386], 'avgAccuracy': 0.6592160642570282,
'f1': [0.6225710413617391, 0.6517763453649614, 0.5759634692616621,
0.832608977750272, 0.6578487492648215], 'avgF1': 0.6681537166006912,
'precision': [0.62, 0.656, 0.5341365461847389, 0.8232931726907631,
0.6626506024096386], 'avgPrecision': 0.6592160642570282, 'recall': [0.62, 0.656,
0.5341365461847389, 0.8232931726907631, 0.6626506024096386], 'avgRecall':
0.6592160642570282, 'params': [{'ccp_alpha': 0.0, 'class_weight': None,
'criterion': 'entropy', 'max_depth': None, 'max_features': 'auto',
'max_leaf_nodes': None, 'min_impurity_decrease': 0.0, 'min_impurity_split':
None, 'min_samples_leaf': 1, 'min_samples_split': 2, 'min_weight_fraction_leaf':
0.0, 'random_state': None, 'splitter': 'best'}]}
****

Processing Model: SVC
****
* SVC
* Best Params Result:
* {'classifier': 'SVC', 'features': 'Active inflammation?, Severity of Crypt
Arch, Increased lamina propria cellularity?, Marked & transmucosal increase in
lamina propria cellularity, Lamina propria polymorphs, Crypt architecture,
Patchy lamina propria cellularity?, Epithelial changes, Mucosal surface',
'accuracy': [0.608, 0.628, 0.44176706827309237, 0.7309236947791165,
0.6506024096385542], 'avgAccuracy': 0.6118586345381526, 'f1':
[0.6176947697111632, 0.6305924557119835, 0.4481056113236864, 0.7551657053141745,
0.6357684074956541], 'avgF1': 0.6174653899113324, 'precision': [0.608, 0.628,
0.44176706827309237, 0.7309236947791165, 0.6506024096385542], 'avgPrecision':
0.6118586345381526, 'recall': [0.608, 0.628, 0.44176706827309237,
0.7309236947791165, 0.6506024096385542], 'avgRecall': 0.6118586345381526,

'params': [{'C': 1.0, 'break_ties': False, 'cache_size': 4000, 'class_weight':
None, 'coef0': 0.0, 'decision_function_shape': 'ovr', 'degree': 3, 'gamma':
'scale', 'kernel': 'linear', 'max_iter': -1, 'probability': False,
'random_state': None, 'shrinking': True, 'tol': 0.001, 'verbose': False}]}
****

Processing Model: MLPClassifier
****
* MLPClassifier
* Best Params Result:
* {'classifier': 'MLPClassifier', 'features': 'Active inflammation?, Severity of
Crypt Arch, Increased lamina propria cellularity?, Marked & transmucosal
increase in lamina propria cellularity, Lamina propria polymorphs, Crypt
architecture, Patchy lamina propria cellularity?, Epithelial changes, Mucosal
surface', 'accuracy': [0.604, 0.64, 0.40562248995983935, 0.7228915662650602,
0.6626506024096386], 'avgAccuracy': 0.6070329317269076, 'f1':
[0.6125579187967117, 0.6423798319327729, 0.3886636495986239, 0.7531665122026568,
0.6592528459687443], 'avgF1': 0.6112041516999019, 'precision': [0.604, 0.64,
0.40562248995983935, 0.7228915662650602, 0.6626506024096386], 'avgPrecision':
0.6070329317269076, 'recall': [0.604, 0.64, 0.40562248995983935,
0.7228915662650602, 0.6626506024096386], 'avgRecall': 0.6070329317269076,
'params': [{'activation': 'identity', 'alpha': 0.0001, 'batch_size': 'auto',
'beta_1': 0.9, 'beta_2': 0.999, 'early_stopping': False, 'epsilon': 1e-08,
'hidden_layer_sizes': (100,), 'learning_rate': 'constant', 'learning_rate_init':
0.001, 'max_fun': 15000, 'max_iter': 9000, 'momentum': 0.9, 'n_iter_no_change':
10, 'nesterovs_momentum': True, 'power_t': 0.5, 'random_state': None, 'shuffle':
True, 'solver': 'adam', 'tol': 0.0001, 'validation_fraction': 0.1, 'verbose':
False, 'warm_start': False}]}
****
****
* Best Performing Model and Params is:
* {'classifier': 'RandomForestClassifier', 'features': 'Active inflammation?,
Severity of Crypt Arch, Increased lamina propria cellularity?, Marked &
transmucosal increase in lamina propria cellularity, Lamina propria polymorphs,
Crypt architecture, Patchy lamina propria cellularity?, Epithelial changes,
Mucosal surface', 'accuracy': [0.62, 0.668, 0.5341365461847389,
0.8232931726907631, 0.6746987951807228], 'avgAccuracy': 0.664025702811245, 'f1':
[0.6208806286497008, 0.6608294078588902, 0.574233209229603, 0.8320217198381541,
0.6664388723295162], 'avgF1': 0.6708807675811729, 'precision': [0.62, 0.668,
0.5341365461847389, 0.8232931726907631, 0.6746987951807228], 'avgPrecision':
0.664025702811245, 'recall': [0.62, 0.668, 0.5341365461847389,
0.8232931726907631, 0.6746987951807228], 'avgRecall': 0.664025702811245,
'params': [{'bootstrap': True, 'ccp_alpha': 0.0, 'class_weight': None,
'criterion': 'entropy', 'max_depth': None, 'max_features': 'sqrt',
'max_leaf_nodes': None, 'max_samples': None, 'min_impurity_decrease': 0.0,
'min_impurity_split': None, 'min_samples_leaf': 1, 'min_samples_split': 2,
'min_weight_fraction_leaf': 0.0, 'n_estimators': 200, 'n_jobs': -1, 'oob_score':
True, 'random_state': None, 'verbose': 0, 'warm_start': False}]}

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

                   model                               features  \
0   RandomForestClassifier   Active inflammation?, Severity of Crypt Arch, …
1     KNeighborsClassifier   Active inflammation?, Severity of Crypt Arch, …
2       LogisticRegression   Active inflammation?, Severity of Crypt Arch, …
3               GaussianNB   Active inflammation?, Severity of Crypt Arch, …
4        AdaBoostClassifier   Active inflammation?, Severity of Crypt Arch, …
5   DecisionTreeClassifier   Active inflammation?, Severity of Crypt Arch, …
6                      SVC   Active inflammation?, Severity of Crypt Arch, …
7            MLPClassifier   Active inflammation?, Severity of Crypt Arch, …


   accuracy        f1  precision    recall  \
0  0.664026  0.670881   0.664026  0.664026
1  0.642336  0.651414   0.642336  0.642336
2  0.603820  0.610975   0.603820  0.603820
3  0.619920  0.622074   0.619920  0.619920
4  0.591071  0.606429   0.591071  0.591071
5  0.659216  0.668154   0.659216  0.659216
6  0.611859  0.617465   0.611859  0.611859
7  0.607033  0.611204   0.607033  0.607033


                                              params
0  {'bootstrap': True, 'ccp_alpha': 0.0, 'class_w…
1  {'algorithm': 'auto', 'leaf_size': 30, 'metric…
2  {'C': 1, 'class_weight': None, 'dual': False, …
3          {'priors': None, 'var_smoothing': 1e-09}
4  {'algorithm': 'SAMME.R', 'base_estimator': Non…
5  {'ccp_alpha': 0.0, 'class_weight': None, 'crit…
6  {'C': 1.0, 'break_ties': False, 'cache_size': …
7  {'activation': 'identity', 'alpha': 0.0001, 'b…


Processing Model: RandomForestClassifier
********************************************************
* RandomForestClassifier
* Best Params Result:
* {'classifier': 'RandomForestClassifier', 'features': 'Active inflammation?,
Severity of Crypt Arch, Increased lamina propria cellularity?, Marked &
transmucosal increase in lamina propria cellularity, Lamina propria polymorphs,
Crypt architecture, Patchy lamina propria cellularity?, Epithelial changes',
'accuracy': [0.624, 0.692, 0.5381526104417671, 0.8192771084337349,
0.678714859437751], 'avgAccuracy': 0.6704289156626506, 'f1':
[0.6248030972858559, 0.6849490392648286, 0.5818898366172208, 0.8256292073990952,
0.6678193726592254], 'avgF1': 0.6770181106452452, 'precision': [0.624, 0.692,
0.5381526104417671, 0.8192771084337349, 0.678714859437751], 'avgPrecision':
0.6704289156626506, 'recall': [0.624, 0.692, 0.5381526104417671,
0.8192771084337349, 0.678714859437751], 'avgRecall': 0.6704289156626506,
'params': [{'bootstrap': True, 'ccp_alpha': 0.0, 'class_weight': None,
```

```
'criterion': 'gini', 'max_depth': None, 'max_features': 'auto',
'max_leaf_nodes': None, 'max_samples': None, 'min_impurity_decrease': 0.0,
'min_impurity_split': None, 'min_samples_leaf': 1, 'min_samples_split': 2,
'min_weight_fraction_leaf': 0.0, 'n_estimators': 500, 'n_jobs': -1, 'oob_score':
True, 'random_state': None, 'verbose': 0, 'warm_start': False}]}
******************************************************

Processing Model: KNeighborsClassifier
******************************************************
* KNeighborsClassifier
* Best Params Result:
* {'classifier': 'KNeighborsClassifier', 'features': 'Active inflammation?,
Severity of Crypt Arch, Increased lamina propria cellularity?, Marked &
transmucosal increase in lamina propria cellularity, Lamina propria polymorphs,
Crypt architecture, Patchy lamina propria cellularity?, Epithelial changes',
'accuracy': [0.64, 0.692, 0.5020080321285141, 0.7630522088353414,
0.678714859437751], 'avgAccuracy': 0.6551550200803213, 'f1':
[0.6395593325239829, 0.6802445283018868, 0.5204908897972271, 0.810237922191023,
0.6705375935413606], 'avgF1': 0.6642140532710961, 'precision': [0.64, 0.692,
0.5020080321285141, 0.7630522088353414, 0.678714859437751], 'avgPrecision':
0.6551550200803213, 'recall': [0.64, 0.692, 0.5020080321285141,
0.7630522088353414, 0.678714859437751], 'avgRecall': 0.6551550200803213,
'params': [{'algorithm': 'ball_tree', 'leaf_size': 30, 'metric': 'minkowski',
'metric_params': None, 'n_jobs': -1, 'n_neighbors': 15, 'p': 2, 'weights':
'distance'}]}
******************************************************

Processing Model: LogisticRegression
******************************************************
* LogisticRegression
* Best Params Result:
* {'classifier': 'LogisticRegression', 'features': 'Active inflammation?,
Severity of Crypt Arch, Increased lamina propria cellularity?, Marked &
transmucosal increase in lamina propria cellularity, Lamina propria polymorphs,
Crypt architecture, Patchy lamina propria cellularity?, Epithelial changes',
'accuracy': [0.604, 0.632, 0.40562248995983935, 0.7108433734939759,
0.6546184738955824], 'avgAccuracy': 0.6014168674698795, 'f1':
[0.6116246118197338, 0.6334655462184875, 0.38574882346541817,
0.7585047883843066, 0.6596405194859234], 'avgF1': 0.6097968578747739,
'precision': [0.604, 0.632, 0.40562248995983935, 0.7108433734939759,
0.6546184738955824], 'avgPrecision': 0.6014168674698795, 'recall': [0.604,
0.632, 0.40562248995983935, 0.7108433734939759, 0.6546184738955824],
'avgRecall': 0.6014168674698795, 'params': [{'C': 1, 'class_weight': None,
'dual': False, 'fit_intercept': True, 'intercept_scaling': 1, 'l1_ratio': None,
'max_iter': 100, 'multi_class': 'ovr', 'n_jobs': -1, 'penalty': 'l2',
'random_state': None, 'solver': 'newton-cg', 'tol': 0.0001, 'verbose': 0,
'warm_start': False}]}
******************************************************
```

```
Processing Model: GaussianNB
********************************************************
* GaussianNB
* Best Params Result:
* {'classifier': 'GaussianNB', 'features': 'Active inflammation?, Severity of
Crypt Arch, Increased lamina propria cellularity?, Marked & transmucosal
increase in lamina propria cellularity, Lamina propria polymorphs, Crypt
architecture, Patchy lamina propria cellularity?, Epithelial changes',
'accuracy': [0.588, 0.632, 0.4538152610441767, 0.8232931726907631,
0.6506024096385542], 'avgAccuracy': 0.6295421686746988, 'f1':
[0.5914949682178599, 0.627289657667412, 0.4734027684001329, 0.8232727948530474,
0.64466581183131594], 'avgF1': 0.6324236614903223, 'precision': [0.588, 0.632,
0.4538152610441767, 0.8232931726907631, 0.6506024096385542], 'avgPrecision':
0.6295421686746988, 'recall': [0.588, 0.632, 0.4538152610441767,
0.8232931726907631, 0.6506024096385542], 'avgRecall': 0.6295421686746988,
'params': [{'priors': None, 'var_smoothing': 1e-09}]}
********************************************************

Processing Model: AdaBoostClassifier
********************************************************
* AdaBoostClassifier
* Best Params Result:
* {'classifier': 'AdaBoostClassifier', 'features': 'Active inflammation?,
Severity of Crypt Arch, Increased lamina propria cellularity?, Marked &
transmucosal increase in lamina propria cellularity, Lamina propria polymorphs,
Crypt architecture, Patchy lamina propria cellularity?, Epithelial changes',
'accuracy': [0.584, 0.496, 0.4457831325301205, 0.7188755020080321,
0.5823293172690763], 'avgAccuracy': 0.5653975903614458, 'f1':
[0.5898247968915578, 0.5058552787621287, 0.4728522923902711, 0.7590059901312116,
0.5765624394573409], 'avgF1': 0.580820159526502, 'precision': [0.584, 0.496,
0.4457831325301205, 0.7188755020080321, 0.5823293172690763], 'avgPrecision':
0.5653975903614458, 'recall': [0.584, 0.496, 0.4457831325301205,
0.7188755020080321, 0.5823293172690763], 'avgRecall': 0.5653975903614458,
'params': [{'algorithm': 'SAMME.R', 'base_estimator': None, 'learning_rate': 1,
'n_estimators': 100, 'random_state': None}]}
********************************************************

Processing Model: DecisionTreeClassifier
********************************************************
* DecisionTreeClassifier
* Best Params Result:
* {'classifier': 'DecisionTreeClassifier', 'features': 'Active inflammation?,
Severity of Crypt Arch, Increased lamina propria cellularity?, Marked &
transmucosal increase in lamina propria cellularity, Lamina propria polymorphs,
Crypt architecture, Patchy lamina propria cellularity?, Epithelial changes',
'accuracy': [0.624, 0.68, 0.5261044176706827, 0.8112449799196787,
0.6746987951807228], 'avgAccuracy': 0.6632096385542169, 'f1':
```

[0.6275027685492802, 0.6725424532603738, 0.568167119828637, 0.8198094562098063, 0.6660958583805936], 'avgF1': 0.6708235312457381, 'precision': [0.624, 0.68, 0.5261044176706827, 0.8112449799196787, 0.6746987951807228], 'avgPrecision': 0.6632096385542169, 'recall': [0.624, 0.68, 0.5261044176706827, 0.8112449799196787, 0.6746987951807228], 'avgRecall': 0.6632096385542169, 'params': [{'ccp_alpha': 0.0, 'class_weight': None, 'criterion': 'gini', 'max_depth': None, 'max_features': 'log2', 'max_leaf_nodes': None, 'min_impurity_decrease': 0.0, 'min_impurity_split': None, 'min_samples_leaf': 1, 'min_samples_split': 2, 'min_weight_fraction_leaf': 0.0, 'random_state': None, 'splitter': 'best'}]}
****

Processing Model: SVC
****
* SVC
* Best Params Result:
* {'classifier': 'SVC', 'features': 'Active inflammation?, Severity of Crypt Arch, Increased lamina propria cellularity?, Marked & transmucosal increase in lamina propria cellularity, Lamina propria polymorphs, Crypt architecture, Patchy lamina propria cellularity?, Epithelial changes', 'accuracy': [0.608, 0.628, 0.44176706827309237, 0.7309236947791165, 0.6506024096385542], 'avgAccuracy': 0.6118586345381526, 'f1': [0.6199851398186392, 0.6305924557119835, 0.4481056113236864, 0.7551657053141745, 0.6357684074956541], 'avgF1': 0.6179234639328276, 'precision': [0.608, 0.628, 0.44176706827309237, 0.7309236947791165, 0.6506024096385542], 'avgPrecision': 0.6118586345381526, 'recall': [0.608, 0.628, 0.44176706827309237, 0.7309236947791165, 0.6506024096385542], 'avgRecall': 0.6118586345381526, 'params': [{'C': 1.0, 'break_ties': False, 'cache_size': 4000, 'class_weight': None, 'coef0': 0.0, 'decision_function_shape': 'ovr', 'degree': 3, 'gamma': 'scale', 'kernel': 'linear', 'max_iter': -1, 'probability': False, 'random_state': None, 'shrinking': True, 'tol': 0.001, 'verbose': False}]}
****

Processing Model: MLPClassifier
****
* MLPClassifier
* Best Params Result:
* {'classifier': 'MLPClassifier', 'features': 'Active inflammation?, Severity of Crypt Arch, Increased lamina propria cellularity?, Marked & transmucosal increase in lamina propria cellularity, Lamina propria polymorphs, Crypt architecture, Patchy lamina propria cellularity?, Epithelial changes', 'accuracy': [0.604, 0.636, 0.40562248995983935, 0.7269076305220884, 0.6546184738955824], 'avgAccuracy': 0.605429718875502, 'f1': [0.6116246118197338, 0.6385392658950373, 0.3886636495986239, 0.7569364812574941, 0.6492958877594937], 'avgF1': 0.6090119792660765, 'precision': [0.604, 0.636, 0.40562248995983935, 0.7269076305220884, 0.6546184738955824], 'avgPrecision': 0.605429718875502, 'recall': [0.604, 0.636, 0.40562248995983935, 0.7269076305220884, 0.6546184738955824], 'avgRecall': 0.605429718875502,

'params': [{'activation': 'identity', 'alpha': 0.0001, 'batch_size': 'auto',
'beta_1': 0.9, 'beta_2': 0.999, 'early_stopping': False, 'epsilon': 1e-08,
'hidden_layer_sizes': (100,), 'learning_rate': 'adaptive', 'learning_rate_init':
0.001, 'max_fun': 15000, 'max_iter': 5000, 'momentum': 0.9, 'n_iter_no_change':
10, 'nesterovs_momentum': True, 'power_t': 0.5, 'random_state': None, 'shuffle':
True, 'solver': 'adam', 'tol': 0.0001, 'validation_fraction': 0.1, 'verbose':
False, 'warm_start': False}]}
****
****
* Best Performing Model and Params is:
* {'classifier': 'RandomForestClassifier', 'features': 'Active inflammation?,
Severity of Crypt Arch, Increased lamina propria cellularity?, Marked &
transmucosal increase in lamina propria cellularity, Lamina propria polymorphs,
Crypt architecture, Patchy lamina propria cellularity?, Epithelial changes',
'accuracy': [0.624, 0.692, 0.5381526104417671, 0.8192771084337349,
0.678714859437751], 'avgAccuracy': 0.6704289156626506, 'f1':
[0.6248030972858559, 0.6849490392648286, 0.5818898366172208, 0.8256292073990952,
0.6678193726592254], 'avgF1': 0.6770181106452452, 'precision': [0.624, 0.692,
0.5381526104417671, 0.8192771084337349, 0.678714859437751], 'avgPrecision':
0.6704289156626506, 'recall': [0.624, 0.692, 0.5381526104417671,
0.8192771084337349, 0.678714859437751], 'avgRecall': 0.6704289156626506,
'params': [{'bootstrap': True, 'ccp_alpha': 0.0, 'class_weight': None,
'criterion': 'gini', 'max_depth': None, 'max_features': 'auto',
'max_leaf_nodes': None, 'max_samples': None, 'min_impurity_decrease': 0.0,
'min_impurity_split': None, 'min_samples_leaf': 1, 'min_samples_split': 2,
'min_weight_fraction_leaf': 0.0, 'n_estimators': 500, 'n_jobs': -1, 'oob_score':
True, 'random_state': None, 'verbose': 0, 'warm_start': False}]}
****

```
                    model                                          features  \
0  RandomForestClassifier  Active inflammation?, Severity of Crypt Arch, …
1    KNeighborsClassifier  Active inflammation?, Severity of Crypt Arch, …
2      LogisticRegression  Active inflammation?, Severity of Crypt Arch, …
3              GaussianNB  Active inflammation?, Severity of Crypt Arch, …
4      AdaBoostClassifier  Active inflammation?, Severity of Crypt Arch, …
5  DecisionTreeClassifier  Active inflammation?, Severity of Crypt Arch, …
6                     SVC  Active inflammation?, Severity of Crypt Arch, …
7           MLPClassifier  Active inflammation?, Severity of Crypt Arch, …

   accuracy        f1  precision    recall  \
0  0.670429  0.677018   0.670429  0.670429
1  0.655155  0.664214   0.655155  0.655155
2  0.601417  0.609797   0.601417  0.601417
3  0.629542  0.632424   0.629542  0.629542
4  0.565398  0.580820   0.565398  0.565398
5  0.663210  0.670824   0.663210  0.663210
6  0.611859  0.617923   0.611859  0.611859
7  0.605430  0.609012   0.605430  0.605430
```

```
                                       params
0  {'bootstrap': True, 'ccp_alpha': 0.0, 'class_w…
1  {'algorithm': 'ball_tree', 'leaf_size': 30, 'm…
2  {'C': 1, 'class_weight': None, 'dual': False, …
3            {'priors': None, 'var_smoothing': 1e-09}
4  {'algorithm': 'SAMME.R', 'base_estimator': Non…
5  {'ccp_alpha': 0.0, 'class_weight': None, 'crit…
6  {'C': 1.0, 'break_ties': False, 'cache_size': …
7  {'activation': 'identity', 'alpha': 0.0001, 'b…
```

Processing Model: RandomForestClassifier
****
* RandomForestClassifier
* Best Params Result:
* {'classifier': 'RandomForestClassifier', 'features': 'Active inflammation?,
Severity of Crypt Arch, Increased lamina propria cellularity?, Marked &
transmucosal increase in lamina propria cellularity, Lamina propria polymorphs,
Crypt architecture, Patchy lamina propria cellularity?', 'accuracy': [0.6,
0.656, 0.5140562248995983, 0.8192771084337349, 0.6506024096385542],
'avgAccuracy': 0.6479871485943774, 'f1': [0.6084049734108214,
0.6566192820655063, 0.5499885304217723, 0.8256292073990952, 0.6462243847183605],
'avgF1': 0.6573732756031112, 'precision': [0.6, 0.656, 0.5140562248995983,
0.8192771084337349, 0.6506024096385542], 'avgPrecision': 0.6479871485943774,
'recall': [0.6, 0.656, 0.5140562248995983, 0.8192771084337349,
0.6506024096385542], 'avgRecall': 0.6479871485943774, 'params': [{'bootstrap':
True, 'ccp_alpha': 0.0, 'class_weight': None, 'criterion': 'gini', 'max_depth':
None, 'max_features': 'log2', 'max_leaf_nodes': None, 'max_samples': None,
'min_impurity_decrease': 0.0, 'min_impurity_split': None, 'min_samples_leaf': 1,
'min_samples_split': 2, 'min_weight_fraction_leaf': 0.0, 'n_estimators': 200,
'n_jobs': -1, 'oob_score': True, 'random_state': None, 'verbose': 0,
'warm_start': False}]}
****

Processing Model: KNeighborsClassifier
****
* KNeighborsClassifier
* Best Params Result:
* {'classifier': 'KNeighborsClassifier', 'features': 'Active inflammation?,
Severity of Crypt Arch, Increased lamina propria cellularity?, Marked &
transmucosal increase in lamina propria cellularity, Lamina propria polymorphs,
Crypt architecture, Patchy lamina propria cellularity?', 'accuracy': [0.62,
0.636, 0.43775100401606426, 0.7309236947791165, 0.6706827309236948],
'avgAccuracy': 0.6190714859437751, 'f1': [0.6271431939532626,
0.6369376306835757, 0.42054203932060186, 0.7781712651121877,
0.65356396200059319], 'avgF1': 0.6232716182151119, 'precision': [0.62, 0.636,
0.43775100401606426, 0.7309236947791165, 0.6706827309236948], 'avgPrecision':
0.6190714859437751, 'recall': [0.62, 0.636, 0.43775100401606426,

0.7309236947791165, 0.6706827309236948], 'avgRecall': 0.6190714859437751,
'params': [{'algorithm': 'ball_tree', 'leaf_size': 30, 'metric': 'minkowski',
'metric_params': None, 'n_jobs': -1, 'n_neighbors': 15, 'p': 2, 'weights':
'distance'}]}
****

Processing Model: LogisticRegression
****
* LogisticRegression
* Best Params Result:
* {'classifier': 'LogisticRegression', 'features': 'Active inflammation?,
Severity of Crypt Arch, Increased lamina propria cellularity?, Marked &
transmucosal increase in lamina propria cellularity, Lamina propria polymorphs,
Crypt architecture, Patchy lamina propria cellularity?', 'accuracy': [0.604,
0.636, 0.41365461847389556, 0.7108433734939759, 0.6385542168674698],
'avgAccuracy': 0.6006104417670682, 'f1': [0.6141031857031857,
0.6385392658950373, 0.3892514492902138, 0.7585047883843066, 0.6358902660022634],
'avgF1': 0.6072577910550013, 'precision': [0.604, 0.636, 0.41365461847389556,
0.7108433734939759, 0.6385542168674698], 'avgPrecision': 0.6006104417670682,
'recall': [0.604, 0.636, 0.41365461847389556, 0.7108433734939759,
0.6385542168674698], 'avgRecall': 0.6006104417670682, 'params': [{'C': 1,
'class_weight': None, 'dual': False, 'fit_intercept': True, 'intercept_scaling':
1, 'l1_ratio': None, 'max_iter': 100, 'multi_class': 'multinomial', 'n_jobs':
-1, 'penalty': 'l2', 'random_state': None, 'solver': 'newton-cg', 'tol': 0.0001,
'verbose': 0, 'warm_start': False}]}
****

Processing Model: GaussianNB
****
* GaussianNB
* Best Params Result:
* {'classifier': 'GaussianNB', 'features': 'Active inflammation?, Severity of
Crypt Arch, Increased lamina propria cellularity?, Marked & transmucosal
increase in lamina propria cellularity, Lamina propria polymorphs, Crypt
architecture, Patchy lamina propria cellularity?', 'accuracy': [0.588, 0.636,
0.41767068273092367, 0.7791164658634538, 0.6465863453815262], 'avgAccuracy':
0.6134746987951807, 'f1': [0.5948966346627165, 0.6327143850643705,
0.40447134233700144, 0.7775938998961197, 0.6421547729379055], 'avgF1':
0.6103662069796227, 'precision': [0.588, 0.636, 0.41767068273092367,
0.7791164658634538, 0.6465863453815262], 'avgPrecision': 0.6134746987951807,
'recall': [0.588, 0.636, 0.41767068273092367, 0.7791164658634538,
0.6465863453815262], 'avgRecall': 0.6134746987951807, 'params': [{'priors':
None, 'var_smoothing': 1e-09}]}
****

Processing Model: AdaBoostClassifier
****
* AdaBoostClassifier

* Best Params Result:
* {'classifier': 'AdaBoostClassifier', 'features': 'Active inflammation?,
Severity of Crypt Arch, Increased lamina propria cellularity?, Marked &
transmucosal increase in lamina propria cellularity, Lamina propria polymorphs,
Crypt architecture, Patchy lamina propria cellularity?', 'accuracy': [0.472,
0.5, 0.4538152610441767, 0.7309236947791165, 0.4859437751004016], 'avgAccuracy':
0.5285365461847389, 'f1': [0.468475756501563, 0.5104181724315953,
0.4841696115174653, 0.7715595934435266, 0.4749915930553976], 'avgF1':
0.5419229453899096, 'precision': [0.472, 0.5, 0.4538152610441767,
0.7309236947791165, 0.4859437751004016], 'avgPrecision': 0.5285365461847389,
'recall': [0.472, 0.5, 0.4538152610441767, 0.7309236947791165,
0.4859437751004016], 'avgRecall': 0.5285365461847389, 'params': [{'algorithm':
'SAMME.R', 'base_estimator': None, 'learning_rate': 1, 'n_estimators': 100,
'random_state': None}]}
****

Processing Model: DecisionTreeClassifier
****
* DecisionTreeClassifier
* Best Params Result:
* {'classifier': 'DecisionTreeClassifier', 'features': 'Active inflammation?,
Severity of Crypt Arch, Increased lamina propria cellularity?, Marked &
transmucosal increase in lamina propria cellularity, Lamina propria polymorphs,
Crypt architecture, Patchy lamina propria cellularity?', 'accuracy': [0.6,
0.632, 0.5140562248995983, 0.8152610441767069, 0.6506024096385542],
'avgAccuracy': 0.6423839357429719, 'f1': [0.6093845150065247,
0.6344738479868622, 0.5511240363753867, 0.8227412105683204, 0.6471839047009292],
'avgF1': 0.6529815029276046, 'precision': [0.6, 0.632, 0.5140562248995983,
0.8152610441767069, 0.6506024096385542], 'avgPrecision': 0.6423839357429719,
'recall': [0.6, 0.632, 0.5140562248995983, 0.8152610441767069,
0.6506024096385542], 'avgRecall': 0.6423839357429719, 'params': [{'ccp_alpha':
0.0, 'class_weight': None, 'criterion': 'entropy', 'max_depth': None,
'max_features': 'log2', 'max_leaf_nodes': None, 'min_impurity_decrease': 0.0,
'min_impurity_split': None, 'min_samples_leaf': 1, 'min_samples_split': 2,
'min_weight_fraction_leaf': 0.0, 'random_state': None, 'splitter': 'best'}]}
****

Processing Model: SVC
****
* SVC
* Best Params Result:
* {'classifier': 'SVC', 'features': 'Active inflammation?, Severity of Crypt
Arch, Increased lamina propria cellularity?, Marked & transmucosal increase in
lamina propria cellularity, Lamina propria polymorphs, Crypt architecture,
Patchy lamina propria cellularity?', 'accuracy': [0.6, 0.628,
0.44176706827309237, 0.7309236947791165, 0.6345381526104418], 'avgAccuracy':
0.6070457831325301, 'f1': [0.6114655367231637, 0.6305924557119835,
0.4481056113236864, 0.7551657053141745, 0.6326745711139015], 'avgF1':

0.615600776037382, 'precision': [0.6, 0.628, 0.44176706827309237,
0.7309236947791165, 0.6345381526104418], 'avgPrecision': 0.6070457831325301,
'recall': [0.6, 0.628, 0.44176706827309237, 0.7309236947791165,
0.6345381526104418], 'avgRecall': 0.6070457831325301, 'params': [{'C': 1.0,
'break_ties': False, 'cache_size': 4000, 'class_weight': None, 'coef0': 0.0,
'decision_function_shape': 'ovr', 'degree': 3, 'gamma': 'scale', 'kernel':
'linear', 'max_iter': -1, 'probability': False, 'random_state': None,
'shrinking': True, 'tol': 0.001, 'verbose': False}]}
****

Processing Model: MLPClassifier
****
* MLPClassifier
* Best Params Result:
* {'classifier': 'MLPClassifier', 'features': 'Active inflammation?, Severity of
Crypt Arch, Increased lamina propria cellularity?, Marked & transmucosal
increase in lamina propria cellularity, Lamina propria polymorphs, Crypt
architecture, Patchy lamina propria cellularity?', 'accuracy': [0.604, 0.636,
0.41365461847389556, 0.7068273092369478, 0.6546184738955824], 'avgAccuracy':
0.6030200803212852, 'f1': [0.6141031857031857, 0.6385392658950373,
0.3892514492902138, 0.7540652118965372, 0.639829289887328], 'avgF1':
0.6071576805344604, 'precision': [0.604, 0.636, 0.41365461847389556,
0.7068273092369478, 0.6546184738955824], 'avgPrecision': 0.6030200803212852,
'recall': [0.604, 0.636, 0.41365461847389556, 0.7068273092369478,
0.6546184738955824], 'avgRecall': 0.6030200803212852, 'params': [{'activation':
'identity', 'alpha': 0.0001, 'batch_size': 'auto', 'beta_1': 0.9, 'beta_2':
0.999, 'early_stopping': False, 'epsilon': 1e-08, 'hidden_layer_sizes': (100,),
'learning_rate': 'adaptive', 'learning_rate_init': 0.001, 'max_fun': 15000,
'max_iter': 7000, 'momentum': 0.9, 'n_iter_no_change': 10, 'nesterovs_momentum':
True, 'power_t': 0.5, 'random_state': None, 'shuffle': True, 'solver': 'adam',
'tol': 0.0001, 'validation_fraction': 0.1, 'verbose': False, 'warm_start':
False}]}
****
****
* Best Performing Model and Params is:
* {'classifier': 'RandomForestClassifier', 'features': 'Active inflammation?,
Severity of Crypt Arch, Increased lamina propria cellularity?, Marked &
transmucosal increase in lamina propria cellularity, Lamina propria polymorphs,
Crypt architecture, Patchy lamina propria cellularity?', 'accuracy': [0.6,
0.656, 0.5140562248995983, 0.8192771084337349, 0.6506024096385542],
'avgAccuracy': 0.6479871485943774, 'f1': [0.6084049734108214,
0.6566192820655063, 0.5499885304217723, 0.8256292073990952, 0.6462243847183605],
'avgF1': 0.6573732756031112, 'precision': [0.6, 0.656, 0.5140562248995983,
0.8192771084337349, 0.6506024096385542], 'avgPrecision': 0.6479871485943774,
'recall': [0.6, 0.656, 0.5140562248995983, 0.8192771084337349,
0.6506024096385542], 'avgRecall': 0.6479871485943774, 'params': [{'bootstrap':
True, 'ccp_alpha': 0.0, 'class_weight': None, 'criterion': 'gini', 'max_depth':
None, 'max_features': 'log2', 'max_leaf_nodes': None, 'max_samples': None,

```
'min_impurity_decrease': 0.0, 'min_impurity_split': None, 'min_samples_leaf': 1,
'min_samples_split': 2, 'min_weight_fraction_leaf': 0.0, 'n_estimators': 200,
'n_jobs': -1, 'oob_score': True, 'random_state': None, 'verbose': 0,
'warm_start': False}]}
****************************************************

                     model                                          features  \
0  RandomForestClassifier  Active inflammation?, Severity of Crypt Arch, …
1    KNeighborsClassifier  Active inflammation?, Severity of Crypt Arch, …
2      LogisticRegression  Active inflammation?, Severity of Crypt Arch, …
3              GaussianNB  Active inflammation?, Severity of Crypt Arch, …
4      AdaBoostClassifier  Active inflammation?, Severity of Crypt Arch, …
5  DecisionTreeClassifier  Active inflammation?, Severity of Crypt Arch, …
6                     SVC  Active inflammation?, Severity of Crypt Arch, …
7           MLPClassifier  Active inflammation?, Severity of Crypt Arch, …

   accuracy        f1  precision    recall  \
0  0.647987  0.657373   0.647987  0.647987
1  0.619071  0.623272   0.619071  0.619071
2  0.600610  0.607258   0.600610  0.600610
3  0.613475  0.610366   0.613475  0.613475
4  0.528537  0.541923   0.528537  0.528537
5  0.642384  0.652982   0.642384  0.642384
6  0.607046  0.615601   0.607046  0.607046
7  0.603020  0.607158   0.603020  0.603020

                                            params
0  {'bootstrap': True, 'ccp_alpha': 0.0, 'class_w…
1  {'algorithm': 'ball_tree', 'leaf_size': 30, 'm…
2  {'C': 1, 'class_weight': None, 'dual': False, …
3            {'priors': None, 'var_smoothing': 1e-09}
4  {'algorithm': 'SAMME.R', 'base_estimator': Non…
5  {'ccp_alpha': 0.0, 'class_weight': None, 'crit…
6  {'C': 1.0, 'break_ties': False, 'cache_size': …
7  {'activation': 'identity', 'alpha': 0.0001, 'b…
```

```python
[101]: now = datetime.datetime.now()
       print ("Current date and time : ")
       print (now.strftime("%Y-%m-%d %H:%M:%S"))
```

```
Current date and time :
2021-06-04 18:54:23
```

```python
[102]: # Original Dataset
       X2 = pd.concat([X_train_ord, X_test_ord]) #.to_numpy()
       y2 = pd.concat([y_train_ord, y_test_ord]).to_numpy()
       #data2 = (X2, y2, n_folds)
```

```python
print('*******************************************')
print('Starting Original data set....')
print('*******************************************')

for i in range(l ,6 , -1):
    col = []
    col = df[:i]
    nX2 = X2.loc[:, col]
    nX2 = nX2.to_numpy()
    data2 = (nX2, y2, n_folds)
    hyper_search(modelDictionary, modelParamsDictionary, data2, col)
```

```
*********************************************
Starting Original data set…
*********************************************

Processing Model: RandomForestClassifier
*****************************************************
* RandomForestClassifier
* Best Params Result:
* {'classifier': 'RandomForestClassifier', 'features': 'Active inflammation?,
Severity of Crypt Arch, Increased lamina propria cellularity?, Marked &
transmucosal increase in lamina propria cellularity, Lamina propria polymorphs,
Crypt architecture, Patchy lamina propria cellularity?, Epithelial changes,
Mucosal surface, Cryptitis extent, Mucin depletion, Cryptitis polymorphs, Lamina
propria granulomas, Crypt abscesses polymorphs, Crypt abscesses extent, Basal
histiocytic cells, Submucosal granulomas, Sex, Increased lymphoid aggregates in
lamina propria?, Mild & superficial increase in lamina propria cellularity?,
Intraepithelial lymphocytes, Age, Crypt profiles', 'accuracy':
[0.6296296296296297, 0.6296296296296297, 0.6419753086419753, 0.654320987654321,
0.6211180124223602], 'avgAccuracy': 0.6353347135955831, 'f1':
[0.6199877823229989, 0.6158285814963944, 0.6207480658854263, 0.6377533545227542,
0.6197760788908807], 'avgF1': 0.6228187726236909, 'precision':
[0.6296296296296297, 0.6296296296296297, 0.6419753086419753, 0.654320987654321,
0.6211180124223602], 'avgPrecision': 0.6353347135955831, 'recall':
[0.6296296296296297, 0.6296296296296297, 0.6419753086419753, 0.654320987654321,
0.6211180124223602], 'avgRecall': 0.6353347135955831, 'params': [{'bootstrap':
True, 'ccp_alpha': 0.0, 'class_weight': None, 'criterion': 'gini', 'max_depth':
None, 'max_features': 'sqrt', 'max_leaf_nodes': None, 'max_samples': None,
'min_impurity_decrease': 0.0, 'min_impurity_split': None, 'min_samples_leaf': 1,
'min_samples_split': 2, 'min_weight_fraction_leaf': 0.0, 'n_estimators': 200,
'n_jobs': -1, 'oob_score': False, 'random_state': None, 'verbose': 0,
'warm_start': False}]}
*****************************************************

Processing Model: KNeighborsClassifier
*****************************************************
* KNeighborsClassifier
```

* Best Params Result:
* {'classifier': 'KNeighborsClassifier', 'features': 'Active inflammation?,
Severity of Crypt Arch, Increased lamina propria cellularity?, Marked &
transmucosal increase in lamina propria cellularity, Lamina propria polymorphs,
Crypt architecture, Patchy lamina propria cellularity?, Epithelial changes,
Mucosal surface, Cryptitis extent, Mucin depletion, Cryptitis polymorphs, Lamina
propria granulomas, Crypt abscesses polymorphs, Crypt abscesses extent, Basal
histiocytic cells, Submucosal granulomas, Sex, Increased lymphoid aggregates in
lamina propria?, Mild & superficial increase in lamina propria cellularity?,
Intraepithelial lymphocytes, Age, Crypt profiles', 'accuracy':
[0.6666666666666666, 0.6604938271604939, 0.6975308641975309, 0.6790123456790124,
0.6273291925465838], 'avgAccuracy': 0.6662065792500576, 'f1':
[0.6494770233196161, 0.6469972896873482, 0.680887699406218, 0.6638412388997185,
0.619303057191256], 'avgF1': 0.6521012617008314, 'precision':
[0.6666666666666666, 0.6604938271604939, 0.6975308641975309, 0.6790123456790124,
0.6273291925465838], 'avgPrecision': 0.6662065792500576, 'recall':
[0.6666666666666666, 0.6604938271604939, 0.6975308641975309, 0.6790123456790124,
0.6273291925465838], 'avgRecall': 0.6662065792500576, 'params': [{'algorithm':
'ball_tree', 'leaf_size': 30, 'metric': 'minkowski', 'metric_params': None,
'n_jobs': -1, 'n_neighbors': 14, 'p': 2, 'weights': 'uniform'}]}
****

Processing Model: LogisticRegression
****
* LogisticRegression
* Best Params Result:
* {'classifier': 'LogisticRegression', 'features': 'Active inflammation?,
Severity of Crypt Arch, Increased lamina propria cellularity?, Marked &
transmucosal increase in lamina propria cellularity, Lamina propria polymorphs,
Crypt architecture, Patchy lamina propria cellularity?, Epithelial changes,
Mucosal surface, Cryptitis extent, Mucin depletion, Cryptitis polymorphs, Lamina
propria granulomas, Crypt abscesses polymorphs, Crypt abscesses extent, Basal
histiocytic cells, Submucosal granulomas, Sex, Increased lymphoid aggregates in
lamina propria?, Mild & superficial increase in lamina propria cellularity?,
Intraepithelial lymphocytes, Age, Crypt profiles', 'accuracy':
[0.6790123456790124, 0.654320987654321, 0.6666666666666666, 0.7283950617283951,
0.6956521739130435], 'avgAccuracy': 0.6848094471282877, 'f1':
[0.6632113467454833, 0.6303212643081925, 0.6366648268850583, 0.7044761533837689,
0.6815527107545277], 'avgF1': 0.6632452604154061, 'precision':
[0.6790123456790124, 0.654320987654321, 0.6666666666666666, 0.7283950617283951,
0.6956521739130435], 'avgPrecision': 0.6848094471282877, 'recall':
[0.6790123456790124, 0.654320987654321, 0.6666666666666666, 0.7283950617283951,
0.6956521739130435], 'avgRecall': 0.6848094471282877, 'params': [{'C': 1,
'class_weight': None, 'dual': False, 'fit_intercept': True, 'intercept_scaling':
1, 'l1_ratio': None, 'max_iter': 100, 'multi_class': 'multinomial', 'n_jobs':
-1, 'penalty': 'l2', 'random_state': None, 'solver': 'newton-cg', 'tol': 0.0001,
'verbose': 0, 'warm_start': False}]}
****

```
Processing Model: GaussianNB
*******************************************************
* GaussianNB
* Best Params Result:
* {'classifier': 'GaussianNB', 'features': 'Active inflammation?, Severity of
Crypt Arch, Increased lamina propria cellularity?, Marked & transmucosal
increase in lamina propria cellularity, Lamina propria polymorphs, Crypt
architecture, Patchy lamina propria cellularity?, Epithelial changes, Mucosal
surface, Cryptitis extent, Mucin depletion, Cryptitis polymorphs, Lamina propria
granulomas, Crypt abscesses polymorphs, Crypt abscesses extent, Basal
histiocytic cells, Submucosal granulomas, Sex, Increased lymphoid aggregates in
lamina propria?, Mild & superficial increase in lamina propria cellularity?,
Intraepithelial lymphocytes, Age, Crypt profiles', 'accuracy':
[0.5555555555555556, 0.5987654320987654, 0.6419753086419753, 0.6604938271604939,
0.6024844720496895], 'avgAccuracy': 0.611854919101296, 'f1': [0.529924316148074,
0.5574033232752517, 0.6055838002070772, 0.6454301242881489, 0.5882887984553336],
'avgF1': 0.5853260724747771, 'precision': [0.5555555555555556,
0.5987654320987654, 0.6419753086419753, 0.6604938271604939, 0.6024844720496895],
'avgPrecision': 0.611854919101296, 'recall': [0.5555555555555556,
0.5987654320987654, 0.6419753086419753, 0.6604938271604939, 0.6024844720496895],
'avgRecall': 0.611854919101296, 'params': [{'priors': None, 'var_smoothing':
1e-09}]}
*******************************************************

Processing Model: AdaBoostClassifier
*******************************************************
* AdaBoostClassifier
* Best Params Result:
* {'classifier': 'AdaBoostClassifier', 'features': 'Active inflammation?,
Severity of Crypt Arch, Increased lamina propria cellularity?, Marked &
transmucosal increase in lamina propria cellularity, Lamina propria polymorphs,
Crypt architecture, Patchy lamina propria cellularity?, Epithelial changes,
Mucosal surface, Cryptitis extent, Mucin depletion, Cryptitis polymorphs, Lamina
propria granulomas, Crypt abscesses polymorphs, Crypt abscesses extent, Basal
histiocytic cells, Submucosal granulomas, Sex, Increased lymphoid aggregates in
lamina propria?, Mild & superficial increase in lamina propria cellularity?,
Intraepithelial lymphocytes, Age, Crypt profiles', 'accuracy':
[0.6790123456790124, 0.6049382716049383, 0.6234567901234568, 0.6111111111111112,
0.6273291925465838], 'avgAccuracy': 0.6291695422130205, 'f1':
[0.6833385800187969, 0.5812566361405355, 0.6146254724824807, 0.6115059093463426,
0.615872622386787], 'avgF1': 0.6213198440749885, 'precision':
[0.6790123456790124, 0.6049382716049383, 0.6234567901234568, 0.6111111111111112,
0.6273291925465838], 'avgPrecision': 0.6291695422130205, 'recall':
[0.6790123456790124, 0.6049382716049383, 0.6234567901234568, 0.6111111111111112,
0.6273291925465838], 'avgRecall': 0.6291695422130205, 'params': [{'algorithm':
'SAMME.R', 'base_estimator': None, 'learning_rate': 1, 'n_estimators': 100,
'random_state': None}]}
```

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

Processing Model: DecisionTreeClassifier
****************************************************
* DecisionTreeClassifier
* Best Params Result:
* {'classifier': 'DecisionTreeClassifier', 'features': 'Active inflammation?,
Severity of Crypt Arch, Increased lamina propria cellularity?, Marked &
transmucosal increase in lamina propria cellularity, Lamina propria polymorphs,
Crypt architecture, Patchy lamina propria cellularity?, Epithelial changes,
Mucosal surface, Cryptitis extent, Mucin depletion, Cryptitis polymorphs, Lamina
propria granulomas, Crypt abscesses polymorphs, Crypt abscesses extent, Basal
histiocytic cells, Submucosal granulomas, Sex, Increased lymphoid aggregates in
lamina propria?, Mild & superficial increase in lamina propria cellularity?,
Intraepithelial lymphocytes, Age, Crypt profiles', 'accuracy':
[0.5925925925925926, 0.6111111111111112, 0.6358024691358025, 0.6172839506172839,
0.5838509316770186], 'avgAccuracy': 0.6081282110267617, 'f1':
[0.5977206933828401, 0.6081830734243014, 0.6279279386146763, 0.6192798466743251,
0.6023185964574767], 'avgF1': 0.6110860297107239, 'precision':
[0.5925925925925926, 0.6111111111111112, 0.6358024691358025, 0.6172839506172839,
0.5838509316770186], 'avgPrecision': 0.6081282110267617, 'recall':
[0.5925925925925926, 0.6111111111111112, 0.6358024691358025, 0.6172839506172839,
0.5838509316770186], 'avgRecall': 0.6081282110267617, 'params': [{'ccp_alpha':
0.0, 'class_weight': None, 'criterion': 'gini', 'max_depth': None,
'max_features': 'sqrt', 'max_leaf_nodes': None, 'min_impurity_decrease': 0.0,
'min_impurity_split': None, 'min_samples_leaf': 1, 'min_samples_split': 2,
'min_weight_fraction_leaf': 0.0, 'random_state': None, 'splitter': 'best'}]}
****************************************************

Processing Model: SVC
****************************************************
* SVC
* Best Params Result:
* {'classifier': 'SVC', 'features': 'Active inflammation?, Severity of Crypt
Arch, Increased lamina propria cellularity?, Marked & transmucosal increase in
lamina propria cellularity, Lamina propria polymorphs, Crypt architecture,
Patchy lamina propria cellularity?, Epithelial changes, Mucosal surface,
Cryptitis extent, Mucin depletion, Cryptitis polymorphs, Lamina propria
granulomas, Crypt abscesses polymorphs, Crypt abscesses extent, Basal
histiocytic cells, Submucosal granulomas, Sex, Increased lymphoid aggregates in
lamina propria?, Mild & superficial increase in lamina propria cellularity?,
Intraepithelial lymphocytes, Age, Crypt profiles', 'accuracy':
[0.6481481481481481, 0.654320987654321, 0.6975308641975309, 0.7160493827160493,
0.6770186335403726], 'avgAccuracy': 0.6786136032512844, 'f1':
[0.5985818977999863, 0.5998934814568833, 0.6486253136287456, 0.689521710879453,
0.6449718205763514], 'avgF1': 0.6363188448682839, 'precision':
[0.6481481481481481, 0.654320987654321, 0.6975308641975309, 0.7160493827160493,
0.6770186335403726], 'avgPrecision': 0.6786136032512844, 'recall':
```

```
[0.6481481481481481, 0.654320987654321, 0.6975308641975309, 0.7160493827160493,
0.6770186335403726], 'avgRecall': 0.6786136032512844, 'params': [{'C': 1.0,
'break_ties': False, 'cache_size': 4000, 'class_weight': None, 'coef0': 0.0,
'decision_function_shape': 'ovr', 'degree': 3, 'gamma': 'scale', 'kernel':
'linear', 'max_iter': -1, 'probability': False, 'random_state': None,
'shrinking': True, 'tol': 0.001, 'verbose': False}]}
********************************************************
```

```
Processing Model: MLPClassifier
********************************************************
* MLPClassifier
* Best Params Result:
* {'classifier': 'MLPClassifier', 'features': 'Active inflammation?, Severity of
Crypt Arch, Increased lamina propria cellularity?, Marked & transmucosal
increase in lamina propria cellularity, Lamina propria polymorphs, Crypt
architecture, Patchy lamina propria cellularity?, Epithelial changes, Mucosal
surface, Cryptitis extent, Mucin depletion, Cryptitis polymorphs, Lamina propria
granulomas, Crypt abscesses polymorphs, Crypt abscesses extent, Basal
histiocytic cells, Submucosal granulomas, Sex, Increased lymphoid aggregates in
lamina propria?, Mild & superficial increase in lamina propria cellularity?,
Intraepithelial lymphocytes, Age, Crypt profiles', 'accuracy':
[0.6728395061728395, 0.6481481481481481, 0.6851851851851852, 0.7283950617283951,
0.6956521739130435], 'avgAccuracy': 0.6860440150295223, 'f1':
[0.656557170492415, 0.6250847917514584, 0.660281954121338, 0.7044761533837689,
0.6815527107545277], 'avgF1': 0.6655905561007016, 'precision':
[0.6728395061728395, 0.6481481481481481, 0.6851851851851852, 0.7283950617283951,
0.6956521739130435], 'avgPrecision': 0.6860440150295223, 'recall':
[0.6728395061728395, 0.6481481481481481, 0.6851851851851852, 0.7283950617283951,
0.6956521739130435], 'avgRecall': 0.6860440150295223, 'params': [{'activation':
'logistic', 'alpha': 0.0001, 'batch_size': 'auto', 'beta_1': 0.9, 'beta_2':
0.999, 'early_stopping': False, 'epsilon': 1e-08, 'hidden_layer_sizes': (100,),
'learning_rate': 'adaptive', 'learning_rate_init': 0.001, 'max_fun': 15000,
'max_iter': 9000, 'momentum': 0.9, 'n_iter_no_change': 10, 'nesterovs_momentum':
True, 'power_t': 0.5, 'random_state': None, 'shuffle': True, 'solver': 'adam',
'tol': 0.0001, 'validation_fraction': 0.1, 'verbose': False, 'warm_start':
False}]}
********************************************************
********************************************************
* Best Performing Model and Params is:
* {'classifier': 'MLPClassifier', 'features': 'Active inflammation?, Severity of
Crypt Arch, Increased lamina propria cellularity?, Marked & transmucosal
increase in lamina propria cellularity, Lamina propria polymorphs, Crypt
architecture, Patchy lamina propria cellularity?, Epithelial changes, Mucosal
surface, Cryptitis extent, Mucin depletion, Cryptitis polymorphs, Lamina propria
granulomas, Crypt abscesses polymorphs, Crypt abscesses extent, Basal
histiocytic cells, Submucosal granulomas, Sex, Increased lymphoid aggregates in
lamina propria?, Mild & superficial increase in lamina propria cellularity?,
Intraepithelial lymphocytes, Age, Crypt profiles', 'accuracy':
```

[0.6728395061728395, 0.6481481481481481, 0.6851851851851852, 0.7283950617283951, 0.6956521739130435], 'avgAccuracy': 0.6860440150295223, 'f1': [0.656557170492415, 0.6250847917514584, 0.660281954121338, 0.7044761533837689, 0.6815527107545277], 'avgF1': 0.6655905561007016, 'precision': [0.6728395061728395, 0.6481481481481481, 0.6851851851851852, 0.7283950617283951, 0.6956521739130435], 'avgPrecision': 0.6860440150295223, 'recall': [0.6728395061728395, 0.6481481481481481, 0.6851851851851852, 0.7283950617283951, 0.6956521739130435], 'avgRecall': 0.6860440150295223, 'params': [{'activation': 'logistic', 'alpha': 0.0001, 'batch_size': 'auto', 'beta_1': 0.9, 'beta_2': 0.999, 'early_stopping': False, 'epsilon': 1e-08, 'hidden_layer_sizes': (100,), 'learning_rate': 'adaptive', 'learning_rate_init': 0.001, 'max_fun': 15000, 'max_iter': 9000, 'momentum': 0.9, 'n_iter_no_change': 10, 'nesterovs_momentum': True, 'power_t': 0.5, 'random_state': None, 'shuffle': True, 'solver': 'adam', 'tol': 0.0001, 'validation_fraction': 0.1, 'verbose': False, 'warm_start': False}]}
****

	model	features \
0	RandomForestClassifier	Active inflammation?, Severity of Crypt Arch, …
1	KNeighborsClassifier	Active inflammation?, Severity of Crypt Arch, …
2	LogisticRegression	Active inflammation?, Severity of Crypt Arch, …
3	GaussianNB	Active inflammation?, Severity of Crypt Arch, …
4	AdaBoostClassifier	Active inflammation?, Severity of Crypt Arch, …
5	DecisionTreeClassifier	Active inflammation?, Severity of Crypt Arch, …
6	SVC	Active inflammation?, Severity of Crypt Arch, …
7	MLPClassifier	Active inflammation?, Severity of Crypt Arch, …

	accuracy	f1	precision	recall \
0	0.635335	0.622819	0.635335	0.635335
1	0.666207	0.652101	0.666207	0.666207
2	0.684809	0.663245	0.684809	0.684809
3	0.611855	0.585326	0.611855	0.611855
4	0.629170	0.621320	0.629170	0.629170
5	0.608128	0.611086	0.608128	0.608128
6	0.678614	0.636319	0.678614	0.678614
7	0.686044	0.665591	0.686044	0.686044

	params
0	{'bootstrap': True, 'ccp_alpha': 0.0, 'class_w…
1	{'algorithm': 'ball_tree', 'leaf_size': 30, 'm…
2	{'C': 1, 'class_weight': None, 'dual': False, …
3	{'priors': None, 'var_smoothing': 1e-09}
4	{'algorithm': 'SAMME.R', 'base_estimator': Non…
5	{'ccp_alpha': 0.0, 'class_weight': None, 'crit…
6	{'C': 1.0, 'break_ties': False, 'cache_size': …
7	{'activation': 'logistic', 'alpha': 0.0001, 'b…

Processing Model: RandomForestClassifier

```
*******************************************************
* RandomForestClassifier
* Best Params Result:
* {'classifier': 'RandomForestClassifier', 'features': 'Active inflammation?,
Severity of Crypt Arch, Increased lamina propria cellularity?, Marked &
transmucosal increase in lamina propria cellularity, Lamina propria polymorphs,
Crypt architecture, Patchy lamina propria cellularity?, Epithelial changes,
Mucosal surface, Cryptitis extent, Mucin depletion, Cryptitis polymorphs, Lamina
propria granulomas, Crypt abscesses polymorphs, Crypt abscesses extent, Basal
histiocytic cells, Submucosal granulomas, Sex, Increased lymphoid aggregates in
lamina propria?, Mild & superficial increase in lamina propria cellularity?,
Intraepithelial lymphocytes, Age', 'accuracy': [0.6234567901234568,
0.6358024691358025, 0.6419753086419753, 0.6419753086419753, 0.6211180124223602],
'avgAccuracy': 0.632865577793114, 'f1': [0.6187748964097057, 0.6272410316962492,
0.6207480658854263, 0.6223960605654341, 0.6237433452484104], 'avgF1':
0.6225806799610452, 'precision': [0.6234567901234568, 0.6358024691358025,
0.6419753086419753, 0.6419753086419753, 0.6211180124223602], 'avgPrecision':
0.632865577793114, 'recall': [0.6234567901234568, 0.6358024691358025,
0.6419753086419753, 0.6419753086419753, 0.6211180124223602], 'avgRecall':
0.632865577793114, 'params': [{'bootstrap': True, 'ccp_alpha': 0.0,
'class_weight': None, 'criterion': 'gini', 'max_depth': None, 'max_features':
'log2', 'max_leaf_nodes': None, 'max_samples': None, 'min_impurity_decrease':
0.0, 'min_impurity_split': None, 'min_samples_leaf': 1, 'min_samples_split': 2,
'min_weight_fraction_leaf': 0.0, 'n_estimators': 500, 'n_jobs': -1, 'oob_score':
True, 'random_state': None, 'verbose': 0, 'warm_start': False}]}
*******************************************************

Processing Model: KNeighborsClassifier
*******************************************************
* KNeighborsClassifier
* Best Params Result:
* {'classifier': 'KNeighborsClassifier', 'features': 'Active inflammation?,
Severity of Crypt Arch, Increased lamina propria cellularity?, Marked &
transmucosal increase in lamina propria cellularity, Lamina propria polymorphs,
Crypt architecture, Patchy lamina propria cellularity?, Epithelial changes,
Mucosal surface, Cryptitis extent, Mucin depletion, Cryptitis polymorphs, Lamina
propria granulomas, Crypt abscesses polymorphs, Crypt abscesses extent, Basal
histiocytic cells, Submucosal granulomas, Sex, Increased lymphoid aggregates in
lamina propria?, Mild & superficial increase in lamina propria cellularity?,
Intraepithelial lymphocytes, Age', 'accuracy': [0.6666666666666666,
0.6728395061728395, 0.6790123456790124, 0.6790123456790124, 0.639751552795031],
'avgAccuracy': 0.6674564833985124, 'f1': [0.6398530751690379,
0.6555088479311553, 0.6555973680156686, 0.6574957975138642, 0.6237531600006697],
'avgF1': 0.6464416497260791, 'precision': [0.6666666666666666,
0.6728395061728395, 0.6790123456790124, 0.6790123456790124, 0.639751552795031],
'avgPrecision': 0.6674564833985124, 'recall': [0.6666666666666666,
0.6728395061728395, 0.6790123456790124, 0.6790123456790124, 0.639751552795031],
'avgRecall': 0.6674564833985124, 'params': [{'algorithm': 'auto', 'leaf_size':
```

```
30, 'metric': 'minkowski', 'metric_params': None, 'n_jobs': -1, 'n_neighbors':
15, 'p': 2, 'weights': 'uniform'}]}
*****************************************************

Processing Model: LogisticRegression
*****************************************************
* LogisticRegression
* Best Params Result:
* {'classifier': 'LogisticRegression', 'features': 'Active inflammation?,
Severity of Crypt Arch, Increased lamina propria cellularity?, Marked &
transmucosal increase in lamina propria cellularity, Lamina propria polymorphs,
Crypt architecture, Patchy lamina propria cellularity?, Epithelial changes,
Mucosal surface, Cryptitis extent, Mucin depletion, Cryptitis polymorphs, Lamina
propria granulomas, Crypt abscesses polymorphs, Crypt abscesses extent, Basal
histiocytic cells, Submucosal granulomas, Sex, Increased lymphoid aggregates in
lamina propria?, Mild & superficial increase in lamina propria cellularity?,
Intraepithelial lymphocytes, Age', 'accuracy': [0.6728395061728395,
0.654320987654321, 0.6666666666666666, 0.7222222222222222, 0.6956521739130435],
'avgAccuracy': 0.6823403113258185, 'f1': [0.656557170492415, 0.6303212643081925,
0.6366648268850583, 0.6992022167412685, 0.6815527107545277], 'avgF1':
0.6608596378362924, 'precision': [0.6728395061728395, 0.654320987654321,
0.6666666666666666, 0.7222222222222222, 0.6956521739130435], 'avgPrecision':
0.6823403113258185, 'recall': [0.6728395061728395, 0.654320987654321,
0.6666666666666666, 0.7222222222222222, 0.6956521739130435], 'avgRecall':
0.6823403113258185, 'params': [{'C': 1, 'class_weight': None, 'dual': False,
'fit_intercept': True, 'intercept_scaling': 1, 'l1_ratio': None, 'max_iter':
100, 'multi_class': 'multinomial', 'n_jobs': -1, 'penalty': 'l2',
'random_state': None, 'solver': 'newton-cg', 'tol': 0.0001, 'verbose': 0,
'warm_start': False}]}
*****************************************************

Processing Model: GaussianNB
*****************************************************
* GaussianNB
* Best Params Result:
* {'classifier': 'GaussianNB', 'features': 'Active inflammation?, Severity of
Crypt Arch, Increased lamina propria cellularity?, Marked & transmucosal
increase in lamina propria cellularity, Lamina propria polymorphs, Crypt
architecture, Patchy lamina propria cellularity?, Epithelial changes, Mucosal
surface, Cryptitis extent, Mucin depletion, Cryptitis polymorphs, Lamina propria
granulomas, Crypt abscesses polymorphs, Crypt abscesses extent, Basal
histiocytic cells, Submucosal granulomas, Sex, Increased lymphoid aggregates in
lamina propria?, Mild & superficial increase in lamina propria cellularity?,
Intraepithelial lymphocytes, Age', 'accuracy': [0.5617283950617284,
0.6234567901234568, 0.6358024691358025, 0.6666666666666666, 0.6273291925465838],
'avgAccuracy': 0.6229967027068476, 'f1': [0.5322852843497189,
0.5766598710310114, 0.6005835487055659, 0.6508552474187759, 0.6091665431317664],
'avgF1': 0.5939100989273677, 'precision': [0.5617283950617284,
```

0.6234567901234568, 0.6358024691358025, 0.6666666666666666, 0.6273291925465838],
'avgPrecision': 0.6229967027068476, 'recall': [0.5617283950617284,
0.6234567901234568, 0.6358024691358025, 0.6666666666666666, 0.6273291925465838],
'avgRecall': 0.6229967027068476, 'params': [{'priors': None, 'var_smoothing':
1e-09}]}
****

Processing Model: AdaBoostClassifier
****
* AdaBoostClassifier
* Best Params Result:
* {'classifier': 'AdaBoostClassifier', 'features': 'Active inflammation?,
Severity of Crypt Arch, Increased lamina propria cellularity?, Marked &
transmucosal increase in lamina propria cellularity, Lamina propria polymorphs,
Crypt architecture, Patchy lamina propria cellularity?, Epithelial changes,
Mucosal surface, Cryptitis extent, Mucin depletion, Cryptitis polymorphs, Lamina
propria granulomas, Crypt abscesses polymorphs, Crypt abscesses extent, Basal
histiocytic cells, Submucosal granulomas, Sex, Increased lymphoid aggregates in
lamina propria?, Mild & superficial increase in lamina propria cellularity?,
Intraepithelial lymphocytes, Age', 'accuracy': [0.6419753086419753,
0.6296296296296297, 0.6234567901234568, 0.654320987654321, 0.6149068322981367],
'avgAccuracy': 0.6328579096695038, 'f1': [0.6436167296513009,
0.5989660049610155, 0.6101243634495368, 0.6325835541972483, 0.6097714642337068],
'avgF1': 0.6190124232985617, 'precision': [0.6419753086419753,
0.6296296296296297, 0.6234567901234568, 0.654320987654321, 0.6149068322981367],
'avgPrecision': 0.6328579096695038, 'recall': [0.6419753086419753,
0.6296296296296297, 0.6234567901234568, 0.654320987654321, 0.6149068322981367],
'avgRecall': 0.6328579096695038, 'params': [{'algorithm': 'SAMME.R',
'base_estimator': None, 'learning_rate': 1, 'n_estimators': 50, 'random_state':
None}]}
****

Processing Model: DecisionTreeClassifier
****
* DecisionTreeClassifier
* Best Params Result:
* {'classifier': 'DecisionTreeClassifier', 'features': 'Active inflammation?,
Severity of Crypt Arch, Increased lamina propria cellularity?, Marked &
transmucosal increase in lamina propria cellularity, Lamina propria polymorphs,
Crypt architecture, Patchy lamina propria cellularity?, Epithelial changes,
Mucosal surface, Cryptitis extent, Mucin depletion, Cryptitis polymorphs, Lamina
propria granulomas, Crypt abscesses polymorphs, Crypt abscesses extent, Basal
histiocytic cells, Submucosal granulomas, Sex, Increased lymphoid aggregates in
lamina propria?, Mild & superficial increase in lamina propria cellularity?,
Intraepithelial lymphocytes, Age', 'accuracy': [0.5987654320987654,
0.6111111111111112, 0.6358024691358025, 0.6234567901234568, 0.6024844720496895],
'avgAccuracy': 0.6143240549037651, 'f1': [0.5966660390950872, 0.608145501106525,
0.6256961441123503, 0.6141975308641975, 0.6179910827677275], 'avgF1':

0.6125392595891775, 'precision': [0.5987654320987654, 0.6111111111111112, 0.6358024691358025, 0.6234567901234568, 0.6024844720496895], 'avgPrecision': 0.6143240549037651, 'recall': [0.5987654320987654, 0.6111111111111112, 0.6358024691358025, 0.6234567901234568, 0.6024844720496895], 'avgRecall': 0.6143240549037651, 'params': [{'ccp_alpha': 0.0, 'class_weight': None, 'criterion': 'gini', 'max_depth': None, 'max_features': 'log2', 'max_leaf_nodes': None, 'min_impurity_decrease': 0.0, 'min_impurity_split': None, 'min_samples_leaf': 1, 'min_samples_split': 2, 'min_weight_fraction_leaf': 0.0, 'random_state': None, 'splitter': 'random'}]}
****

Processing Model: SVC
****
* SVC
* Best Params Result:
* {'classifier': 'SVC', 'features': 'Active inflammation?, Severity of Crypt Arch, Increased lamina propria cellularity?, Marked & transmucosal increase in lamina propria cellularity, Lamina propria polymorphs, Crypt architecture, Patchy lamina propria cellularity?, Epithelial changes, Mucosal surface, Cryptitis extent, Mucin depletion, Cryptitis polymorphs, Lamina propria granulomas, Crypt abscesses polymorphs, Crypt abscesses extent, Basal histiocytic cells, Submucosal granulomas, Sex, Increased lymphoid aggregates in lamina propria?, Mild & superficial increase in lamina propria cellularity?, Intraepithelial lymphocytes, Age', 'accuracy': [0.6481481481481481, 0.654320987654321, 0.6975308641975309, 0.7160493827160493, 0.6770186335403726], 'avgAccuracy': 0.6786136032512844, 'f1': [0.5985818977999863, 0.5998934814568833, 0.6486253136287456, 0.689521710879453, 0.6449718205763514], 'avgF1': 0.6363188448682839, 'precision': [0.6481481481481481, 0.654320987654321, 0.6975308641975309, 0.7160493827160493, 0.6770186335403726], 'avgPrecision': 0.6786136032512844, 'recall': [0.6481481481481481, 0.654320987654321, 0.6975308641975309, 0.7160493827160493, 0.6770186335403726], 'avgRecall': 0.6786136032512844, 'params': [{'C': 1.0, 'break_ties': False, 'cache_size': 4000, 'class_weight': None, 'coef0': 0.0, 'decision_function_shape': 'ovr', 'degree': 3, 'gamma': 'scale', 'kernel': 'linear', 'max_iter': -1, 'probability': False, 'random_state': None, 'shrinking': True, 'tol': 0.001, 'verbose': False}]}
****

Processing Model: MLPClassifier
****
* MLPClassifier
* Best Params Result:
* {'classifier': 'MLPClassifier', 'features': 'Active inflammation?, Severity of Crypt Arch, Increased lamina propria cellularity?, Marked & transmucosal increase in lamina propria cellularity, Lamina propria polymorphs, Crypt architecture, Patchy lamina propria cellularity?, Epithelial changes, Mucosal surface, Cryptitis extent, Mucin depletion, Cryptitis polymorphs, Lamina propria granulomas, Crypt abscesses polymorphs, Crypt abscesses extent, Basal

histiocytic cells, Submucosal granulomas, Sex, Increased lymphoid aggregates in
lamina propria?, Mild & superficial increase in lamina propria cellularity?,
Intraepithelial lymphocytes, Age', 'accuracy': [0.6666666666666666,
0.6604938271604939, 0.691358024691358, 0.7345679012345679, 0.6956521739130435],
'avgAccuracy': 0.6897477187332259, 'f1': [0.6470123789819567,
0.6402794736128069, 0.6681095786078853, 0.7190435438959267, 0.6812094168968614],
'avgF1': 0.6711308783990875, 'precision': [0.6666666666666666,
0.6604938271604939, 0.691358024691358, 0.7345679012345679, 0.6956521739130435],
'avgPrecision': 0.6897477187332259, 'recall': [0.6666666666666666,
0.6604938271604939, 0.691358024691358, 0.7345679012345679, 0.6956521739130435],
'avgRecall': 0.6897477187332259, 'params': [{'activation': 'identity', 'alpha':
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False, 'epsilon': 1e-08, 'hidden_layer_sizes': (100,), 'learning_rate':
'invscaling', 'learning_rate_init': 0.001, 'max_fun': 15000, 'max_iter': 7000,
'momentum': 0.9, 'n_iter_no_change': 10, 'nesterovs_momentum': True, 'power_t':
0.5, 'random_state': None, 'shuffle': True, 'solver': 'adam', 'tol': 0.0001,
'validation_fraction': 0.1, 'verbose': False, 'warm_start': False}]}
****
****
* Best Performing Model and Params is:
* {'classifier': 'MLPClassifier', 'features': 'Active inflammation?, Severity of
Crypt Arch, Increased lamina propria cellularity?, Marked & transmucosal
increase in lamina propria cellularity, Lamina propria polymorphs, Crypt
architecture, Patchy lamina propria cellularity?, Epithelial changes, Mucosal
surface, Cryptitis extent, Mucin depletion, Cryptitis polymorphs, Lamina propria
granulomas, Crypt abscesses polymorphs, Crypt abscesses extent, Basal
histiocytic cells, Submucosal granulomas, Sex, Increased lymphoid aggregates in
lamina propria?, Mild & superficial increase in lamina propria cellularity?,
Intraepithelial lymphocytes, Age', 'accuracy': [0.6666666666666666,
0.6604938271604939, 0.691358024691358, 0.7345679012345679, 0.6956521739130435],
'avgAccuracy': 0.6897477187332259, 'f1': [0.6470123789819567,
0.6402794736128069, 0.6681095786078853, 0.7190435438959267, 0.6812094168968614],
'avgF1': 0.6711308783990875, 'precision': [0.6666666666666666,
0.6604938271604939, 0.691358024691358, 0.7345679012345679, 0.6956521739130435],
'avgPrecision': 0.6897477187332259, 'recall': [0.6666666666666666,
0.6604938271604939, 0.691358024691358, 0.7345679012345679, 0.6956521739130435],
'avgRecall': 0.6897477187332259, 'params': [{'activation': 'identity', 'alpha':
0.0001, 'batch_size': 'auto', 'beta_1': 0.9, 'beta_2': 0.999, 'early_stopping':
False, 'epsilon': 1e-08, 'hidden_layer_sizes': (100,), 'learning_rate':
'invscaling', 'learning_rate_init': 0.001, 'max_fun': 15000, 'max_iter': 7000,
'momentum': 0.9, 'n_iter_no_change': 10, 'nesterovs_momentum': True, 'power_t':
0.5, 'random_state': None, 'shuffle': True, 'solver': 'adam', 'tol': 0.0001,
'validation_fraction': 0.1, 'verbose': False, 'warm_start': False}]}
****

                  model   features \
0 RandomForestClassifier Active inflammation?, Severity of Crypt Arch, …
1   KNeighborsClassifier Active inflammation?, Severity of Crypt Arch, …

```
2        LogisticRegression  Active inflammation?, Severity of Crypt Arch, …
3                  GaussianNB  Active inflammation?, Severity of Crypt Arch, …
4         AdaBoostClassifier  Active inflammation?, Severity of Crypt Arch, …
5  DecisionTreeClassifier  Active inflammation?, Severity of Crypt Arch, …
6                        SVC  Active inflammation?, Severity of Crypt Arch, …
7              MLPClassifier  Active inflammation?, Severity of Crypt Arch, …

   accuracy        f1  precision    recall  \
0  0.632866  0.622581   0.632866  0.632866
1  0.667456  0.646442   0.667456  0.667456
2  0.682340  0.660860   0.682340  0.682340
3  0.622997  0.593910   0.622997  0.622997
4  0.632858  0.619012   0.632858  0.632858
5  0.614324  0.612539   0.614324  0.614324
6  0.678614  0.636319   0.678614  0.678614
7  0.689748  0.671131   0.689748  0.689748

                                                params
0  {'bootstrap': True, 'ccp_alpha': 0.0, 'class_w…
1  {'algorithm': 'auto', 'leaf_size': 30, 'metric…
2  {'C': 1, 'class_weight': None, 'dual': False, …
3          {'priors': None, 'var_smoothing': 1e-09}
4  {'algorithm': 'SAMME.R', 'base_estimator': Non…
5  {'ccp_alpha': 0.0, 'class_weight': None, 'crit…
6  {'C': 1.0, 'break_ties': False, 'cache_size': …
7  {'activation': 'identity', 'alpha': 0.0001, 'b…
```

Processing Model: RandomForestClassifier
****
* RandomForestClassifier
* Best Params Result:
* {'classifier': 'RandomForestClassifier', 'features': 'Active inflammation?, Severity of Crypt Arch, Increased lamina propria cellularity?, Marked & transmucosal increase in lamina propria cellularity, Lamina propria polymorphs, Crypt architecture, Patchy lamina propria cellularity?, Epithelial changes, Mucosal surface, Cryptitis extent, Mucin depletion, Cryptitis polymorphs, Lamina propria granulomas, Crypt abscesses polymorphs, Crypt abscesses extent, Basal histiocytic cells, Submucosal granulomas, Sex, Increased lymphoid aggregates in lamina propria?, Mild & superficial increase in lamina propria cellularity?, Intraepithelial lymphocytes', 'accuracy': [0.6296296296296297, 0.6172839506172839, 0.7098765432098766, 0.7160493827160493, 0.6645962732919255], 'avgAccuracy': 0.667487155892953, 'f1': [0.6025673969842119, 0.5903700521521644, 0.6729814876344742, 0.6939683436387685, 0.6503890329125815], 'avgF1': 0.64205526266444401, 'precision': [0.6296296296296297, 0.6172839506172839, 0.7098765432098766, 0.7160493827160493, 0.6645962732919255], 'avgPrecision': 0.667487155892953, 'recall': [0.6296296296296297, 0.6172839506172839, 0.7098765432098766, 0.7160493827160493, 0.6645962732919255], 'avgRecall': 0.667487155892953, 'params': [{'bootstrap': True, 'ccp_alpha': 0.0,

```
'class_weight': None, 'criterion': 'gini', 'max_depth': None, 'max_features':
'log2', 'max_leaf_nodes': None, 'max_samples': None, 'min_impurity_decrease':
0.0, 'min_impurity_split': None, 'min_samples_leaf': 1, 'min_samples_split': 2,
'min_weight_fraction_leaf': 0.0, 'n_estimators': 500, 'n_jobs': -1, 'oob_score':
False, 'random_state': None, 'verbose': 0, 'warm_start': False}]}
********************************************************

Processing Model: KNeighborsClassifier
********************************************************
* KNeighborsClassifier
* Best Params Result:
* {'classifier': 'KNeighborsClassifier', 'features': 'Active inflammation?,
Severity of Crypt Arch, Increased lamina propria cellularity?, Marked &
transmucosal increase in lamina propria cellularity, Lamina propria polymorphs,
Crypt architecture, Patchy lamina propria cellularity?, Epithelial changes,
Mucosal surface, Cryptitis extent, Mucin depletion, Cryptitis polymorphs, Lamina
propria granulomas, Crypt abscesses polymorphs, Crypt abscesses extent, Basal
histiocytic cells, Submucosal granulomas, Sex, Increased lymphoid aggregates in
lamina propria?, Mild & superficial increase in lamina propria cellularity?,
Intraepithelial lymphocytes', 'accuracy': [0.6666666666666666,
0.6604938271604939, 0.6851851851851852, 0.6851851851851852, 0.6521739130434783],
'avgAccuracy': 0.6699409554482019, 'f1': [0.6258005796700502,
0.6211081940608095, 0.6835958146170091, 0.6447337748707612, 0.6172993914298261],
'avgF1': 0.6385075509296912, 'precision': [0.6666666666666666,
0.6604938271604939, 0.6851851851851852, 0.6851851851851852, 0.6521739130434783],
'avgPrecision': 0.6699409554482019, 'recall': [0.6666666666666666,
0.6604938271604939, 0.6851851851851852, 0.6851851851851852, 0.6521739130434783],
'avgRecall': 0.6699409554482019, 'params': [{'algorithm': 'kd_tree',
'leaf_size': 30, 'metric': 'minkowski', 'metric_params': None, 'n_jobs': -1,
'n_neighbors': 15, 'p': 2, 'weights': 'uniform'}]}
********************************************************

Processing Model: LogisticRegression
********************************************************
* LogisticRegression
* Best Params Result:
* {'classifier': 'LogisticRegression', 'features': 'Active inflammation?,
Severity of Crypt Arch, Increased lamina propria cellularity?, Marked &
transmucosal increase in lamina propria cellularity, Lamina propria polymorphs,
Crypt architecture, Patchy lamina propria cellularity?, Epithelial changes,
Mucosal surface, Cryptitis extent, Mucin depletion, Cryptitis polymorphs, Lamina
propria granulomas, Crypt abscesses polymorphs, Crypt abscesses extent, Basal
histiocytic cells, Submucosal granulomas, Sex, Increased lymphoid aggregates in
lamina propria?, Mild & superficial increase in lamina propria cellularity?,
Intraepithelial lymphocytes', 'accuracy': [0.6790123456790124,
0.6481481481481481, 0.6975308641975309, 0.7222222222222222, 0.6894409937888198],
'avgAccuracy': 0.6872709148071466, 'f1': [0.6632113467454833,
0.6260798025503908, 0.6688400306544482, 0.7039060307367728, 0.6762015478128011],
```

'avgF1': 0.6676477516999793, 'precision': [0.6790123456790124,
0.6481481481481481, 0.6975308641975309, 0.7222222222222222, 0.6894409937888198],
'avgPrecision': 0.6872709148071466, 'recall': [0.6790123456790124,
0.6481481481481481, 0.6975308641975309, 0.7222222222222222, 0.6894409937888198],
'avgRecall': 0.6872709148071466, 'params': [{'C': 1, 'class_weight': None,
'dual': False, 'fit_intercept': True, 'intercept_scaling': 1, 'l1_ratio': None,
'max_iter': 100, 'multi_class': 'multinomial', 'n_jobs': -1, 'penalty': 'l2',
'random_state': None, 'solver': 'newton-cg', 'tol': 0.0001, 'verbose': 0,
'warm_start': False}]}
****

Processing Model: GaussianNB
****
* GaussianNB
* Best Params Result:
* {'classifier': 'GaussianNB', 'features': 'Active inflammation?, Severity of
Crypt Arch, Increased lamina propria cellularity?, Marked & transmucosal
increase in lamina propria cellularity, Lamina propria polymorphs, Crypt
architecture, Patchy lamina propria cellularity?, Epithelial changes, Mucosal
surface, Cryptitis extent, Mucin depletion, Cryptitis polymorphs, Lamina propria
granulomas, Crypt abscesses polymorphs, Crypt abscesses extent, Basal
histiocytic cells, Submucosal granulomas, Sex, Increased lymphoid aggregates in
lamina propria?, Mild & superficial increase in lamina propria cellularity?,
Intraepithelial lymphocytes', 'accuracy': [0.5617283950617284,
0.6234567901234568, 0.6419753086419753, 0.6666666666666666, 0.6273291925465838],
'avgAccuracy': 0.6242312706080821, 'f1': [0.5322852843497189,
0.5766598710310114, 0.6055838002070772, 0.6508552474187759, 0.6091665431317664],
'avgF1': 0.5949101492276699, 'precision': [0.5617283950617284,
0.6234567901234568, 0.6419753086419753, 0.6666666666666666, 0.6273291925465838],
'avgPrecision': 0.6242312706080821, 'recall': [0.5617283950617284,
0.6234567901234568, 0.6419753086419753, 0.6666666666666666, 0.6273291925465838],
'avgRecall': 0.6242312706080821, 'params': [{'priors': None, 'var_smoothing':
1e-09}]}
****

Processing Model: AdaBoostClassifier
****
* AdaBoostClassifier
* Best Params Result:
* {'classifier': 'AdaBoostClassifier', 'features': 'Active inflammation?,
Severity of Crypt Arch, Increased lamina propria cellularity?, Marked &
transmucosal increase in lamina propria cellularity, Lamina propria polymorphs,
Crypt architecture, Patchy lamina propria cellularity?, Epithelial changes,
Mucosal surface, Cryptitis extent, Mucin depletion, Cryptitis polymorphs, Lamina
propria granulomas, Crypt abscesses polymorphs, Crypt abscesses extent, Basal
histiocytic cells, Submucosal granulomas, Sex, Increased lymphoid aggregates in
lamina propria?, Mild & superficial increase in lamina propria cellularity?,
Intraepithelial lymphocytes', 'accuracy': [0.6604938271604939,

0.6296296296296297, 0.6975308641975309, 0.691358024691358, 0.6149068322981367],
'avgAccuracy': 0.6587838355954299, 'f1': [0.6395814515440051,
0.5732556588526883, 0.6688400306544482, 0.6505922458303411, 0.6100951923553735],
'avgF1': 0.6284729158473712, 'precision': [0.6604938271604939,
0.6296296296296297, 0.6975308641975309, 0.691358024691358, 0.6149068322981367],
'avgPrecision': 0.6587838355954299, 'recall': [0.6604938271604939,
0.6296296296296297, 0.6975308641975309, 0.691358024691358, 0.6149068322981367],
'avgRecall': 0.6587838355954299, 'params': [{'algorithm': 'SAMME.R',
'base_estimator': None, 'learning_rate': 1, 'n_estimators': 20, 'random_state':
None}]}
****

Processing Model: DecisionTreeClassifier
****
* DecisionTreeClassifier
* Best Params Result:
* {'classifier': 'DecisionTreeClassifier', 'features': 'Active inflammation?,
Severity of Crypt Arch, Increased lamina propria cellularity?, Marked &
transmucosal increase in lamina propria cellularity, Lamina propria polymorphs,
Crypt architecture, Patchy lamina propria cellularity?, Epithelial changes,
Mucosal surface, Cryptitis extent, Mucin depletion, Cryptitis polymorphs, Lamina
propria granulomas, Crypt abscesses polymorphs, Crypt abscesses extent, Basal
histiocytic cells, Submucosal granulomas, Sex, Increased lymphoid aggregates in
lamina propria?, Mild & superficial increase in lamina propria cellularity?,
Intraepithelial lymphocytes', 'accuracy': [0.6172839506172839,
0.5740740740740741, 0.7160493827160493, 0.6481481481481481, 0.6459627329192547],
'avgAccuracy': 0.640303657694962, 'f1': [0.6011108535699728, 0.5591954315953878,
0.6941303492196135, 0.6390462357782619, 0.6442419200544504], 'avgF1':
0.6275449580435373, 'precision': [0.6172839506172839, 0.5740740740740741,
0.7160493827160493, 0.6481481481481481, 0.6459627329192547], 'avgPrecision':
0.640303657694962, 'recall': [0.6172839506172839, 0.5740740740740741,
0.7160493827160493, 0.6481481481481481, 0.6459627329192547], 'avgRecall':
0.640303657694962, 'params': [{'ccp_alpha': 0.0, 'class_weight': None,
'criterion': 'entropy', 'max_depth': None, 'max_features': 'log2',
'max_leaf_nodes': None, 'min_impurity_decrease': 0.0, 'min_impurity_split':
None, 'min_samples_leaf': 1, 'min_samples_split': 2, 'min_weight_fraction_leaf':
0.0, 'random_state': None, 'splitter': 'random'}]}
****

Processing Model: SVC
****
* SVC
* Best Params Result:
* {'classifier': 'SVC', 'features': 'Active inflammation?, Severity of Crypt
Arch, Increased lamina propria cellularity?, Marked & transmucosal increase in
lamina propria cellularity, Lamina propria polymorphs, Crypt architecture,
Patchy lamina propria cellularity?, Epithelial changes, Mucosal surface,
Cryptitis extent, Mucin depletion, Cryptitis polymorphs, Lamina propria

granulomas, Crypt abscesses polymorphs, Crypt abscesses extent, Basal histiocytic cells, Submucosal granulomas, Sex, Increased lymphoid aggregates in lamina propria?, Mild & superficial increase in lamina propria cellularity?, Intraepithelial lymphocytes', 'accuracy': [0.6481481481481481, 0.654320987654321, 0.691358024691358, 0.7160493827160493, 0.6770186335403726], 'avgAccuracy': 0.6773790353500498, 'f1': [0.5985818977999863, 0.5989199252922087, 0.6440760081630835, 0.6895265228598562, 0.6449718205763514], 'avgF1': 0.6352152349382972, 'precision': [0.6481481481481481, 0.654320987654321, 0.691358024691358, 0.7160493827160493, 0.6770186335403726], 'avgPrecision': 0.6773790353500498, 'recall': [0.6481481481481481, 0.654320987654321, 0.691358024691358, 0.7160493827160493, 0.6770186335403726], 'avgRecall': 0.6773790353500498, 'params': [{'C': 1.0, 'break_ties': False, 'cache_size': 4000, 'class_weight': None, 'coef0': 0.0, 'decision_function_shape': 'ovr', 'degree': 3, 'gamma': 'scale', 'kernel': 'linear', 'max_iter': -1, 'probability': False, 'random_state': None, 'shrinking': True, 'tol': 0.001, 'verbose': False}]}
****

Processing Model: MLPClassifier
****
* MLPClassifier
* Best Params Result:
* {'classifier': 'MLPClassifier', 'features': 'Active inflammation?, Severity of Crypt Arch, Increased lamina propria cellularity?, Marked & transmucosal increase in lamina propria cellularity, Lamina propria polymorphs, Crypt architecture, Patchy lamina propria cellularity?, Epithelial changes, Mucosal surface, Cryptitis extent, Mucin depletion, Cryptitis polymorphs, Lamina propria granulomas, Crypt abscesses polymorphs, Crypt abscesses extent, Basal histiocytic cells, Submucosal granulomas, Sex, Increased lymphoid aggregates in lamina propria?, Mild & superficial increase in lamina propria cellularity?, Intraepithelial lymphocytes', 'accuracy': [0.6728395061728395, 0.6358024691358025, 0.691358024691358, 0.7345679012345679, 0.6894409937888198], 'avgAccuracy': 0.6848017790046775, 'f1': [0.6524192989998824, 0.6108521108521109, 0.6638536063360331, 0.7147095940372638, 0.6762015478128011], 'avgF1': 0.6636072316076183, 'precision': [0.6728395061728395, 0.6358024691358025, 0.691358024691358, 0.7345679012345679, 0.6894409937888198], 'avgPrecision': 0.6848017790046775, 'recall': [0.6728395061728395, 0.6358024691358025, 0.691358024691358, 0.7345679012345679, 0.6894409937888198], 'avgRecall': 0.6848017790046775, 'params': [{'activation': 'logistic', 'alpha': 0.0001, 'batch_size': 'auto', 'beta_1': 0.9, 'beta_2': 0.999, 'early_stopping': False, 'epsilon': 1e-08, 'hidden_layer_sizes': (100,), 'learning_rate': 'invscaling', 'learning_rate_init': 0.001, 'max_fun': 15000, 'max_iter': 5000, 'momentum': 0.9, 'n_iter_no_change': 10, 'nesterovs_momentum': True, 'power_t': 0.5, 'random_state': None, 'shuffle': True, 'solver': 'adam', 'tol': 0.0001, 'validation_fraction': 0.1, 'verbose': False, 'warm_start': False}]}
****
****
* Best Performing Model and Params is:

```
* {'classifier': 'LogisticRegression', 'features': 'Active inflammation?,
Severity of Crypt Arch, Increased lamina propria cellularity?, Marked &
transmucosal increase in lamina propria cellularity, Lamina propria polymorphs,
Crypt architecture, Patchy lamina propria cellularity?, Epithelial changes,
Mucosal surface, Cryptitis extent, Mucin depletion, Cryptitis polymorphs, Lamina
propria granulomas, Crypt abscesses polymorphs, Crypt abscesses extent, Basal
histiocytic cells, Submucosal granulomas, Sex, Increased lymphoid aggregates in
lamina propria?, Mild & superficial increase in lamina propria cellularity?,
Intraepithelial lymphocytes', 'accuracy': [0.6790123456790124,
0.6481481481481481, 0.6975308641975309, 0.7222222222222222, 0.6894409937888198],
'avgAccuracy': 0.6872709148071466, 'f1': [0.6632113467454833,
0.6260798025503908, 0.6688400306544482, 0.7039060307367728, 0.6762015478128011],
'avgF1': 0.6676477516999793, 'precision': [0.6790123456790124,
0.6481481481481481, 0.6975308641975309, 0.7222222222222222, 0.6894409937888198],
'avgPrecision': 0.6872709148071466, 'recall': [0.6790123456790124,
0.6481481481481481, 0.6975308641975309, 0.7222222222222222, 0.6894409937888198],
'avgRecall': 0.6872709148071466, 'params': [{'C': 1, 'class_weight': None,
'dual': False, 'fit_intercept': True, 'intercept_scaling': 1, 'l1_ratio': None,
'max_iter': 100, 'multi_class': 'multinomial', 'n_jobs': -1, 'penalty': 'l2',
'random_state': None, 'solver': 'newton-cg', 'tol': 0.0001, 'verbose': 0,
'warm_start': False}]}
******************************************************
```

```
                  model                                    features  \
0  RandomForestClassifier  Active inflammation?, Severity of Crypt Arch, …
1    KNeighborsClassifier  Active inflammation?, Severity of Crypt Arch, …
2      LogisticRegression  Active inflammation?, Severity of Crypt Arch, …
3              GaussianNB  Active inflammation?, Severity of Crypt Arch, …
4      AdaBoostClassifier  Active inflammation?, Severity of Crypt Arch, …
5  DecisionTreeClassifier  Active inflammation?, Severity of Crypt Arch, …
6                     SVC  Active inflammation?, Severity of Crypt Arch, …
7           MLPClassifier  Active inflammation?, Severity of Crypt Arch, …

   accuracy        f1  precision    recall  \
0  0.667487  0.642055   0.667487  0.667487
1  0.669941  0.638508   0.669941  0.669941
2  0.687271  0.667648   0.687271  0.687271
3  0.624231  0.594910   0.624231  0.624231
4  0.658784  0.628473   0.658784  0.658784
5  0.640304  0.627545   0.640304  0.640304
6  0.677379  0.635215   0.677379  0.677379
7  0.684802  0.663607   0.684802  0.684802

                                               params
0  {'bootstrap': True, 'ccp_alpha': 0.0, 'class_w…
1  {'algorithm': 'kd_tree', 'leaf_size': 30, 'met…
2  {'C': 1, 'class_weight': None, 'dual': False, …
3          {'priors': None, 'var_smoothing': 1e-09}
```

```
4  {'algorithm': 'SAMME.R', 'base_estimator': Non…
5  {'ccp_alpha': 0.0, 'class_weight': None, 'crit…
6  {'C': 1.0, 'break_ties': False, 'cache_size': …
7  {'activation': 'logistic', 'alpha': 0.0001, 'b…
```

```
Processing Model: RandomForestClassifier
*******************************************************
* RandomForestClassifier
* Best Params Result:
* {'classifier': 'RandomForestClassifier', 'features': 'Active inflammation?,
Severity of Crypt Arch, Increased lamina propria cellularity?, Marked &
transmucosal increase in lamina propria cellularity, Lamina propria polymorphs,
Crypt architecture, Patchy lamina propria cellularity?, Epithelial changes,
Mucosal surface, Cryptitis extent, Mucin depletion, Cryptitis polymorphs, Lamina
propria granulomas, Crypt abscesses polymorphs, Crypt abscesses extent, Basal
histiocytic cells, Submucosal granulomas, Sex, Increased lymphoid aggregates in
lamina propria?, Mild & superficial increase in lamina propria cellularity?',
'accuracy': [0.6234567901234568, 0.6296296296296297, 0.7037037037037037,
0.7037037037037037, 0.6708074534161491], 'avgAccuracy': 0.6662602561153286,
'f1': [0.5973061295653338, 0.6015743389204401, 0.6680972171671394,
0.6783602264475277, 0.6606341875315818], 'avgF1': 0.6411944199264046,
'precision': [0.6234567901234568, 0.6296296296296297, 0.7037037037037037,
0.7037037037037037, 0.6708074534161491], 'avgPrecision': 0.6662602561153286,
'recall': [0.6234567901234568, 0.6296296296296297, 0.7037037037037037,
0.7037037037037037, 0.6708074534161491], 'avgRecall': 0.6662602561153286,
'params': [{'bootstrap': True, 'ccp_alpha': 0.0, 'class_weight': None,
'criterion': 'entropy', 'max_depth': None, 'max_features': 'log2',
'max_leaf_nodes': None, 'max_samples': None, 'min_impurity_decrease': 0.0,
'min_impurity_split': None, 'min_samples_leaf': 1, 'min_samples_split': 2,
'min_weight_fraction_leaf': 0.0, 'n_estimators': 500, 'n_jobs': -1, 'oob_score':
False, 'random_state': None, 'verbose': 0, 'warm_start': False}]}
*******************************************************
```

```
Processing Model: KNeighborsClassifier
*******************************************************
* KNeighborsClassifier
* Best Params Result:
* {'classifier': 'KNeighborsClassifier', 'features': 'Active inflammation?,
Severity of Crypt Arch, Increased lamina propria cellularity?, Marked &
transmucosal increase in lamina propria cellularity, Lamina propria polymorphs,
Crypt architecture, Patchy lamina propria cellularity?, Epithelial changes,
Mucosal surface, Cryptitis extent, Mucin depletion, Cryptitis polymorphs, Lamina
propria granulomas, Crypt abscesses polymorphs, Crypt abscesses extent, Basal
histiocytic cells, Submucosal granulomas, Sex, Increased lymphoid aggregates in
lamina propria?, Mild & superficial increase in lamina propria cellularity?',
'accuracy': [0.6666666666666666, 0.6604938271604939, 0.6851851851851852,
0.6851851851851852, 0.6335403726708074], 'avgAccuracy': 0.6662142473736676,
'f1': [0.6258005796700502, 0.6211081940608095, 0.6840721659843106,
```

0.6451232714634524, 0.6104967496271844], 'avgF1': 0.6373201921611614,
'precision': [0.6666666666666666, 0.6604938271604939, 0.6851851851851852,
0.6851851851851852, 0.6335403726708074], 'avgPrecision': 0.6662142473736676,
'recall': [0.6666666666666666, 0.6604938271604939, 0.6851851851851852,
0.6851851851851852, 0.6335403726708074], 'avgRecall': 0.6662142473736676,
'params': [{'algorithm': 'ball_tree', 'leaf_size': 30, 'metric': 'minkowski',
'metric_params': None, 'n_jobs': -1, 'n_neighbors': 15, 'p': 2, 'weights':
'uniform'}]}
****

Processing Model: LogisticRegression
****
* LogisticRegression
* Best Params Result:
* {'classifier': 'LogisticRegression', 'features': 'Active inflammation?,
Severity of Crypt Arch, Increased lamina propria cellularity?, Marked &
transmucosal increase in lamina propria cellularity, Lamina propria polymorphs,
Crypt architecture, Patchy lamina propria cellularity?, Epithelial changes,
Mucosal surface, Cryptitis extent, Mucin depletion, Cryptitis polymorphs, Lamina
propria granulomas, Crypt abscesses polymorphs, Crypt abscesses extent, Basal
histiocytic cells, Submucosal granulomas, Sex, Increased lymphoid aggregates in
lamina propria?, Mild & superficial increase in lamina propria cellularity?',
'accuracy': [0.6790123456790124, 0.6419753086419753, 0.6975308641975309,
0.7222222222222222, 0.6894409937888198], 'avgAccuracy': 0.6860363469059121,
'f1': [0.6632113467454833, 0.6169789294884294, 0.6688400306544482,
0.703976827356457, 0.6762015478128011], 'avgF1': 0.6658417364115238,
'precision': [0.6790123456790124, 0.6419753086419753, 0.6975308641975309,
0.7222222222222222, 0.6894409937888198], 'avgPrecision': 0.6860363469059121,
'recall': [0.6790123456790124, 0.6419753086419753, 0.6975308641975309,
0.7222222222222222, 0.6894409937888198], 'avgRecall': 0.6860363469059121,
'params': [{'C': 1, 'class_weight': None, 'dual': False, 'fit_intercept': True,
'intercept_scaling': 1, 'l1_ratio': None, 'max_iter': 100, 'multi_class':
'multinomial', 'n_jobs': -1, 'penalty': 'l2', 'random_state': None, 'solver':
'newton-cg', 'tol': 0.0001, 'verbose': 0, 'warm_start': False}]}
****

Processing Model: GaussianNB
****
* GaussianNB
* Best Params Result:
* {'classifier': 'GaussianNB', 'features': 'Active inflammation?, Severity of
Crypt Arch, Increased lamina propria cellularity?, Marked & transmucosal
increase in lamina propria cellularity, Lamina propria polymorphs, Crypt
architecture, Patchy lamina propria cellularity?, Epithelial changes, Mucosal
surface, Cryptitis extent, Mucin depletion, Cryptitis polymorphs, Lamina propria
granulomas, Crypt abscesses polymorphs, Crypt abscesses extent, Basal
histiocytic cells, Submucosal granulomas, Sex, Increased lymphoid aggregates in
lamina propria?, Mild & superficial increase in lamina propria cellularity?',

'accuracy': [0.5740740740740741, 0.6358024691358025, 0.6419753086419753,
0.6728395061728395, 0.6335403726708074], 'avgAccuracy': 0.6316463461390998,
'f1': [0.5428386270752047, 0.5893428636775743, 0.6051257577565294,
0.6567847424853653, 0.6140284070341975], 'avgF1': 0.6016240796057742,
'precision': [0.5740740740740741, 0.6358024691358025, 0.6419753086419753,
0.6728395061728395, 0.6335403726708074], 'avgPrecision': 0.6316463461390998,
'recall': [0.5740740740740741, 0.6358024691358025, 0.6419753086419753,
0.6728395061728395, 0.6335403726708074], 'avgRecall': 0.6316463461390998,
'params': [{'priors': None, 'var_smoothing': 1e-09}]}
****

Processing Model: AdaBoostClassifier
****
* AdaBoostClassifier
* Best Params Result:
* {'classifier': 'AdaBoostClassifier', 'features': 'Active inflammation?,
Severity of Crypt Arch, Increased lamina propria cellularity?, Marked &
transmucosal increase in lamina propria cellularity, Lamina propria polymorphs,
Crypt architecture, Patchy lamina propria cellularity?, Epithelial changes,
Mucosal surface, Cryptitis extent, Mucin depletion, Cryptitis polymorphs, Lamina
propria granulomas, Crypt abscesses polymorphs, Crypt abscesses extent, Basal
histiocytic cells, Submucosal granulomas, Sex, Increased lymphoid aggregates in
lamina propria?, Mild & superficial increase in lamina propria cellularity?',
'accuracy': [0.6728395061728395, 0.6358024691358025, 0.6975308641975309,
0.691358024691358, 0.6086956521739131], 'avgAccuracy': 0.6612453032742888, 'f1':
[0.6549016235126287, 0.5691429076872659, 0.6688400306544482, 0.6498999492443247,
0.6088672045256988], 'avgF1': 0.6303303431248732, 'precision':
[0.6728395061728395, 0.6358024691358025, 0.6975308641975309, 0.691358024691358,
0.6086956521739131], 'avgPrecision': 0.6612453032742888, 'recall':
[0.6728395061728395, 0.6358024691358025, 0.6975308641975309, 0.691358024691358,
0.6086956521739131], 'avgRecall': 0.6612453032742888, 'params': [{'algorithm':
'SAMME.R', 'base_estimator': None, 'learning_rate': 1, 'n_estimators': 20,
'random_state': None}]}
****

Processing Model: DecisionTreeClassifier
****
* DecisionTreeClassifier
* Best Params Result:
* {'classifier': 'DecisionTreeClassifier', 'features': 'Active inflammation?,
Severity of Crypt Arch, Increased lamina propria cellularity?, Marked &
transmucosal increase in lamina propria cellularity, Lamina propria polymorphs,
Crypt architecture, Patchy lamina propria cellularity?, Epithelial changes,
Mucosal surface, Cryptitis extent, Mucin depletion, Cryptitis polymorphs, Lamina
propria granulomas, Crypt abscesses polymorphs, Crypt abscesses extent, Basal
histiocytic cells, Submucosal granulomas, Sex, Increased lymphoid aggregates in
lamina propria?, Mild & superficial increase in lamina propria cellularity?',
'accuracy': [0.6296296296296297, 0.5802469135802469, 0.6851851851851852,

```
0.6666666666666666, 0.6211180124223602], 'avgAccuracy': 0.6365692814968177,
'f1': [0.6119248943418305, 0.5753843695633034, 0.6596553121466259,
0.6484800212398778, 0.621627307049302], 'avgF1': 0.6234143808681879,
'precision': [0.6296296296296297, 0.5802469135802469, 0.6851851851851852,
0.6666666666666666, 0.6211180124223602], 'avgPrecision': 0.6365692814968177,
'recall': [0.6296296296296297, 0.5802469135802469, 0.6851851851851852,
0.6666666666666666, 0.6211180124223602], 'avgRecall': 0.6365692814968177,
'params': [{'ccp_alpha': 0.0, 'class_weight': None, 'criterion': 'gini',
'max_depth': None, 'max_features': 'log2', 'max_leaf_nodes': None,
'min_impurity_decrease': 0.0, 'min_impurity_split': None, 'min_samples_leaf': 1,
'min_samples_split': 2, 'min_weight_fraction_leaf': 0.0, 'random_state': None,
'splitter': 'random'}]}
********************************************************

Processing Model: SVC
********************************************************
* SVC
* Best Params Result:
* {'classifier': 'SVC', 'features': 'Active inflammation?, Severity of Crypt
Arch, Increased lamina propria cellularity?, Marked & transmucosal increase in
lamina propria cellularity, Lamina propria polymorphs, Crypt architecture,
Patchy lamina propria cellularity?, Epithelial changes, Mucosal surface,
Cryptitis extent, Mucin depletion, Cryptitis polymorphs, Lamina propria
granulomas, Crypt abscesses polymorphs, Crypt abscesses extent, Basal
histiocytic cells, Submucosal granulomas, Sex, Increased lymphoid aggregates in
lamina propria?, Mild & superficial increase in lamina propria cellularity?',
'accuracy': [0.6481481481481481, 0.654320987654321, 0.6975308641975309,
0.7160493827160493, 0.6770186335403726], 'avgAccuracy': 0.6786136032512844,
'f1': [0.5985818977999863, 0.5998934814568833, 0.6486253136287456,
0.689521710879453, 0.6449718205763514], 'avgF1': 0.6363188448682839,
'precision': [0.6481481481481481, 0.654320987654321, 0.6975308641975309,
0.7160493827160493, 0.6770186335403726], 'avgPrecision': 0.6786136032512844,
'recall': [0.6481481481481481, 0.654320987654321, 0.6975308641975309,
0.7160493827160493, 0.6770186335403726], 'avgRecall': 0.6786136032512844,
'params': [{'C': 1.0, 'break_ties': False, 'cache_size': 4000, 'class_weight':
None, 'coef0': 0.0, 'decision_function_shape': 'ovr', 'degree': 3, 'gamma':
'scale', 'kernel': 'linear', 'max_iter': -1, 'probability': False,
'random_state': None, 'shrinking': True, 'tol': 0.001, 'verbose': False}]}
********************************************************

Processing Model: MLPClassifier
********************************************************
* MLPClassifier
* Best Params Result:
* {'classifier': 'MLPClassifier', 'features': 'Active inflammation?, Severity of
Crypt Arch, Increased lamina propria cellularity?, Marked & transmucosal
increase in lamina propria cellularity, Lamina propria polymorphs, Crypt
architecture, Patchy lamina propria cellularity?, Epithelial changes, Mucosal
```

surface, Cryptitis extent, Mucin depletion, Cryptitis polymorphs, Lamina propria granulomas, Crypt abscesses polymorphs, Crypt abscesses extent, Basal histiocytic cells, Submucosal granulomas, Sex, Increased lymphoid aggregates in lamina propria?, Mild & superficial increase in lamina propria cellularity?', 'accuracy': [0.6790123456790124, 0.6358024691358025, 0.691358024691358, 0.7283950617283951, 0.6956521739130435], 'avgAccuracy': 0.6860440150295223, 'f1': [0.6632113467454833, 0.6065403387884009, 0.6638536063360331, 0.7094389482882866, 0.6815527107545277], 'avgF1': 0.6649193901825463, 'precision': [0.6790123456790124, 0.6358024691358025, 0.691358024691358, 0.7283950617283951, 0.6956521739130435], 'avgPrecision': 0.6860440150295223, 'recall': [0.6790123456790124, 0.6358024691358025, 0.691358024691358, 0.7283950617283951, 0.6956521739130435], 'avgRecall': 0.6860440150295223, 'params': [{'activation': 'logistic', 'alpha': 0.0001, 'batch_size': 'auto', 'beta_1': 0.9, 'beta_2': 0.999, 'early_stopping': False, 'epsilon': 1e-08, 'hidden_layer_sizes': (100,), 'learning_rate': 'constant', 'learning_rate_init': 0.001, 'max_fun': 15000, 'max_iter': 5000, 'momentum': 0.9, 'n_iter_no_change': 10, 'nesterovs_momentum': True, 'power_t': 0.5, 'random_state': None, 'shuffle': True, 'solver': 'adam', 'tol': 0.0001, 'validation_fraction': 0.1, 'verbose': False, 'warm_start': False}]}
****
****
* Best Performing Model and Params is:
* {'classifier': 'MLPClassifier', 'features': 'Active inflammation?, Severity of Crypt Arch, Increased lamina propria cellularity?, Marked & transmucosal increase in lamina propria cellularity, Lamina propria polymorphs, Crypt architecture, Patchy lamina propria cellularity?, Epithelial changes, Mucosal surface, Cryptitis extent, Mucin depletion, Cryptitis polymorphs, Lamina propria granulomas, Crypt abscesses polymorphs, Crypt abscesses extent, Basal histiocytic cells, Submucosal granulomas, Sex, Increased lymphoid aggregates in lamina propria?, Mild & superficial increase in lamina propria cellularity?', 'accuracy': [0.6790123456790124, 0.6358024691358025, 0.691358024691358, 0.7283950617283951, 0.6956521739130435], 'avgAccuracy': 0.6860440150295223, 'f1': [0.6632113467454833, 0.6065403387884009, 0.6638536063360331, 0.7094389482882866, 0.6815527107545277], 'avgF1': 0.6649193901825463, 'precision': [0.6790123456790124, 0.6358024691358025, 0.691358024691358, 0.7283950617283951, 0.6956521739130435], 'avgPrecision': 0.6860440150295223, 'recall': [0.6790123456790124, 0.6358024691358025, 0.691358024691358, 0.7283950617283951, 0.6956521739130435], 'avgRecall': 0.6860440150295223, 'params': [{'activation': 'logistic', 'alpha': 0.0001, 'batch_size': 'auto', 'beta_1': 0.9, 'beta_2': 0.999, 'early_stopping': False, 'epsilon': 1e-08, 'hidden_layer_sizes': (100,), 'learning_rate': 'constant', 'learning_rate_init': 0.001, 'max_fun': 15000, 'max_iter': 5000, 'momentum': 0.9, 'n_iter_no_change': 10, 'nesterovs_momentum': True, 'power_t': 0.5, 'random_state': None, 'shuffle': True, 'solver': 'adam', 'tol': 0.0001, 'validation_fraction': 0.1, 'verbose': False, 'warm_start': False}]}
****

                    model   features \

```
0   RandomForestClassifier   Active inflammation?, Severity of Crypt Arch, …
1     KNeighborsClassifier   Active inflammation?, Severity of Crypt Arch, …
2       LogisticRegression   Active inflammation?, Severity of Crypt Arch, …
3                GaussianNB   Active inflammation?, Severity of Crypt Arch, …
4        AdaBoostClassifier   Active inflammation?, Severity of Crypt Arch, …
5   DecisionTreeClassifier   Active inflammation?, Severity of Crypt Arch, …
6                      SVC   Active inflammation?, Severity of Crypt Arch, …
7            MLPClassifier   Active inflammation?, Severity of Crypt Arch, …

   accuracy         f1  precision    recall  \
0  0.666260   0.641194   0.666260  0.666260
1  0.666214   0.637320   0.666214  0.666214
2  0.686036   0.665842   0.686036  0.686036
3  0.631646   0.601624   0.631646  0.631646
4  0.661245   0.630330   0.661245  0.661245
5  0.636569   0.623414   0.636569  0.636569
6  0.678614   0.636319   0.678614  0.678614
7  0.686044   0.664919   0.686044  0.686044


                                                params
0  {'bootstrap': True, 'ccp_alpha': 0.0, 'class_w…
1  {'algorithm': 'ball_tree', 'leaf_size': 30, 'm…
2  {'C': 1, 'class_weight': None, 'dual': False, …
3            {'priors': None, 'var_smoothing': 1e-09}
4  {'algorithm': 'SAMME.R', 'base_estimator': Non…
5  {'ccp_alpha': 0.0, 'class_weight': None, 'crit…
6  {'C': 1.0, 'break_ties': False, 'cache_size': …
7  {'activation': 'logistic', 'alpha': 0.0001, 'b…
```

```
Processing Model: RandomForestClassifier
*****************************************************
* RandomForestClassifier
* Best Params Result:
* {'classifier': 'RandomForestClassifier', 'features': 'Active inflammation?,
Severity of Crypt Arch, Increased lamina propria cellularity?, Marked &
transmucosal increase in lamina propria cellularity, Lamina propria polymorphs,
Crypt architecture, Patchy lamina propria cellularity?, Epithelial changes,
Mucosal surface, Cryptitis extent, Mucin depletion, Cryptitis polymorphs, Lamina
propria granulomas, Crypt abscesses polymorphs, Crypt abscesses extent, Basal
histiocytic cells, Submucosal granulomas, Sex, Increased lymphoid aggregates in
lamina propria?', 'accuracy': [0.6358024691358025, 0.6296296296296297,
0.7098765432098766, 0.7098765432098766, 0.6770186335403726], 'avgAccuracy':
0.6724407637451116, 'f1': [0.6129999628692301, 0.6015743389204401,
0.6729814876344742, 0.6834705075445816, 0.6657403228634138], 'avgF1':
0.647353323966428, 'precision': [0.6358024691358025, 0.6296296296296297,
0.7098765432098766, 0.7098765432098766, 0.6770186335403726], 'avgPrecision':
0.6724407637451116, 'recall': [0.6358024691358025, 0.6296296296296297,
0.7098765432098766, 0.7098765432098766, 0.6770186335403726], 'avgRecall':
```

0.6724407637451116, 'params': [{'bootstrap': True, 'ccp_alpha': 0.0, 'class_weight': None, 'criterion': 'entropy', 'max_depth': None, 'max_features': 'auto', 'max_leaf_nodes': None, 'max_samples': None, 'min_impurity_decrease': 0.0, 'min_impurity_split': None, 'min_samples_leaf': 1, 'min_samples_split': 2, 'min_weight_fraction_leaf': 0.0, 'n_estimators': 500, 'n_jobs': -1, 'oob_score': True, 'random_state': None, 'verbose': 0, 'warm_start': False}]}
****

Processing Model: KNeighborsClassifier
****
* KNeighborsClassifier
* Best Params Result:
* {'classifier': 'KNeighborsClassifier', 'features': 'Active inflammation?, Severity of Crypt Arch, Increased lamina propria cellularity?, Marked & transmucosal increase in lamina propria cellularity, Lamina propria polymorphs, Crypt architecture, Patchy lamina propria cellularity?, Epithelial changes, Mucosal surface, Cryptitis extent, Mucin depletion, Cryptitis polymorphs, Lamina propria granulomas, Crypt abscesses polymorphs, Crypt abscesses extent, Basal histiocytic cells, Submucosal granulomas, Sex, Increased lymphoid aggregates in lamina propria?', 'accuracy': [0.6666666666666666, 0.6604938271604939, 0.6851851851851852, 0.6851851851851852, 0.6335403726708074], 'avgAccuracy': 0.6662142473736676, 'f1': [0.6258005796700502, 0.6211081940608095, 0.6840721659843106, 0.6451232714634524, 0.6104967496271844], 'avgF1': 0.6373201921611614, 'precision': [0.6666666666666666, 0.6604938271604939, 0.6851851851851852, 0.6851851851851852, 0.6335403726708074], 'avgPrecision': 0.6662142473736676, 'recall': [0.6666666666666666, 0.6604938271604939, 0.6851851851851852, 0.6851851851851852, 0.6335403726708074], 'avgRecall': 0.6662142473736676, 'params': [{'algorithm': 'ball_tree', 'leaf_size': 30, 'metric': 'minkowski', 'metric_params': None, 'n_jobs': -1, 'n_neighbors': 15, 'p': 2, 'weights': 'uniform'}]}
****

Processing Model: LogisticRegression
****
* LogisticRegression
* Best Params Result:
* {'classifier': 'LogisticRegression', 'features': 'Active inflammation?, Severity of Crypt Arch, Increased lamina propria cellularity?, Marked & transmucosal increase in lamina propria cellularity, Lamina propria polymorphs, Crypt architecture, Patchy lamina propria cellularity?, Epithelial changes, Mucosal surface, Cryptitis extent, Mucin depletion, Cryptitis polymorphs, Lamina propria granulomas, Crypt abscesses polymorphs, Crypt abscesses extent, Basal histiocytic cells, Submucosal granulomas, Sex, Increased lymphoid aggregates in lamina propria?', 'accuracy': [0.6790123456790124, 0.6419753086419753, 0.7037037037037037, 0.7222222222222222, 0.6894409937888198], 'avgAccuracy': 0.6872709148071466, 'f1': [0.6632113467454833, 0.6169789294884294, 0.6738421079914458, 0.703976827356457, 0.6762015478128011], 'avgF1': 0.6668421518789233, 'precision': [0.6790123456790124, 0.6419753086419753,

0.7037037037037037, 0.7222222222222222, 0.6894409937888198], 'avgPrecision': 0.6872709148071466, 'recall': [0.6790123456790124, 0.6419753086419753, 0.7037037037037037, 0.7222222222222222, 0.6894409937888198], 'avgRecall': 0.6872709148071466, 'params': [{'C': 1, 'class_weight': None, 'dual': False, 'fit_intercept': True, 'intercept_scaling': 1, 'l1_ratio': None, 'max_iter': 100, 'multi_class': 'multinomial', 'n_jobs': -1, 'penalty': 'l2', 'random_state': None, 'solver': 'newton-cg', 'tol': 0.0001, 'verbose': 0, 'warm_start': False}]}
****

Processing Model: GaussianNB
****
* GaussianNB
* Best Params Result:
* {'classifier': 'GaussianNB', 'features': 'Active inflammation?, Severity of Crypt Arch, Increased lamina propria cellularity?, Marked & transmucosal increase in lamina propria cellularity, Lamina propria polymorphs, Crypt architecture, Patchy lamina propria cellularity?, Epithelial changes, Mucosal surface, Cryptitis extent, Mucin depletion, Cryptitis polymorphs, Lamina propria granulomas, Crypt abscesses polymorphs, Crypt abscesses extent, Basal histiocytic cells, Submucosal granulomas, Sex, Increased lymphoid aggregates in lamina propria?', 'accuracy': [0.5802469135802469, 0.6358024691358025, 0.654320987654321, 0.6975308641975309, 0.639751552795031], 'avgAccuracy': 0.6415305574725865, 'f1': [0.5480665058248149, 0.5893428636775743, 0.6152045175846284, 0.6766916899261395, 0.6188975483103929], 'avgF1': 0.60964062506471, 'precision': [0.5802469135802469, 0.6358024691358025, 0.654320987654321, 0.6975308641975309, 0.639751552795031], 'avgPrecision': 0.6415305574725865, 'recall': [0.5802469135802469, 0.6358024691358025, 0.654320987654321, 0.6975308641975309, 0.639751552795031], 'avgRecall': 0.6415305574725865, 'params': [{'priors': None, 'var_smoothing': 1e-09}]}
****

Processing Model: AdaBoostClassifier
****
* AdaBoostClassifier
* Best Params Result:
* {'classifier': 'AdaBoostClassifier', 'features': 'Active inflammation?, Severity of Crypt Arch, Increased lamina propria cellularity?, Marked & transmucosal increase in lamina propria cellularity, Lamina propria polymorphs, Crypt architecture, Patchy lamina propria cellularity?, Epithelial changes, Mucosal surface, Cryptitis extent, Mucin depletion, Cryptitis polymorphs, Lamina propria granulomas, Crypt abscesses polymorphs, Crypt abscesses extent, Basal histiocytic cells, Submucosal granulomas, Sex, Increased lymphoid aggregates in lamina propria?', 'accuracy': [0.6728395061728395, 0.6358024691358025, 0.6975308641975309, 0.691358024691358, 0.6086956521739131], 'avgAccuracy': 0.6612453032742888, 'f1': [0.6549016235126287, 0.5691429076872659, 0.6688400306544482, 0.6498999492443247, 0.6088672045256988], 'avgF1': 0.6303303431248732, 'precision': [0.6728395061728395, 0.6358024691358025,

0.6975308641975309, 0.691358024691358, 0.6086956521739131], 'avgPrecision':
0.6612453032742888, 'recall': [0.6728395061728395, 0.6358024691358025,
0.6975308641975309, 0.691358024691358, 0.6086956521739131], 'avgRecall':
0.6612453032742888, 'params': [{'algorithm': 'SAMME.R', 'base_estimator': None,
'learning_rate': 1, 'n_estimators': 20, 'random_state': None}]}
****

Processing Model: DecisionTreeClassifier
****
* DecisionTreeClassifier
* Best Params Result:
* {'classifier': 'DecisionTreeClassifier', 'features': 'Active inflammation?,
Severity of Crypt Arch, Increased lamina propria cellularity?, Marked &
transmucosal increase in lamina propria cellularity, Lamina propria polymorphs,
Crypt architecture, Patchy lamina propria cellularity?, Epithelial changes,
Mucosal surface, Cryptitis extent, Mucin depletion, Cryptitis polymorphs, Lamina
propria granulomas, Crypt abscesses polymorphs, Crypt abscesses extent, Basal
histiocytic cells, Submucosal granulomas, Sex, Increased lymphoid aggregates in
lamina propria?', 'accuracy': [0.6234567901234568, 0.5802469135802469,
0.6790123456790124, 0.6728395061728395, 0.6521739130434783], 'avgAccuracy':
0.6415458937198067, 'f1': [0.6105661879165339, 0.5611754437285805,
0.6585763377040635, 0.6571150688820176, 0.6620757944009361], 'avgF1':
0.6299017665264264, 'precision': [0.6234567901234568, 0.5802469135802469,
0.6790123456790124, 0.6728395061728395, 0.6521739130434783], 'avgPrecision':
0.6415458937198067, 'recall': [0.6234567901234568, 0.5802469135802469,
0.6790123456790124, 0.6728395061728395, 0.6521739130434783], 'avgRecall':
0.6415458937198067, 'params': [{'ccp_alpha': 0.0, 'class_weight': None,
'criterion': 'gini', 'max_depth': None, 'max_features': 'sqrt',
'max_leaf_nodes': None, 'min_impurity_decrease': 0.0, 'min_impurity_split':
None, 'min_samples_leaf': 1, 'min_samples_split': 2, 'min_weight_fraction_leaf':
0.0, 'random_state': None, 'splitter': 'random'}]}
****

Processing Model: SVC
****
* SVC
* Best Params Result:
* {'classifier': 'SVC', 'features': 'Active inflammation?, Severity of Crypt
Arch, Increased lamina propria cellularity?, Marked & transmucosal increase in
lamina propria cellularity, Lamina propria polymorphs, Crypt architecture,
Patchy lamina propria cellularity?, Epithelial changes, Mucosal surface,
Cryptitis extent, Mucin depletion, Cryptitis polymorphs, Lamina propria
granulomas, Crypt abscesses polymorphs, Crypt abscesses extent, Basal
histiocytic cells, Submucosal granulomas, Sex, Increased lymphoid aggregates in
lamina propria?', 'accuracy': [0.6481481481481481, 0.654320987654321,
0.6975308641975309, 0.7160493827160493, 0.6770186335403726], 'avgAccuracy':
0.6786136032512844, 'f1': [0.5985818977999863, 0.5998934814568833,
0.6486253136287456, 0.689521710879453, 0.6449718205763514], 'avgF1':

0.6363188448682839, 'precision': [0.6481481481481481, 0.654320987654321,
0.6975308641975309, 0.7160493827160493, 0.6770186335403726], 'avgPrecision':
0.6786136032512844, 'recall': [0.6481481481481481, 0.654320987654321,
0.6975308641975309, 0.7160493827160493, 0.6770186335403726], 'avgRecall':
0.6786136032512844, 'params': [{'C': 1.0, 'break_ties': False, 'cache_size':
4000, 'class_weight': None, 'coef0': 0.0, 'decision_function_shape': 'ovr',
'degree': 3, 'gamma': 'scale', 'kernel': 'linear', 'max_iter': -1,
'probability': False, 'random_state': None, 'shrinking': True, 'tol': 0.001,
'verbose': False}]}
****

Processing Model: MLPClassifier
****
* MLPClassifier
* Best Params Result:
* {'classifier': 'MLPClassifier', 'features': 'Active inflammation?, Severity of
Crypt Arch, Increased lamina propria cellularity?, Marked & transmucosal
increase in lamina propria cellularity, Lamina propria polymorphs, Crypt
architecture, Patchy lamina propria cellularity?, Epithelial changes, Mucosal
surface, Cryptitis extent, Mucin depletion, Cryptitis polymorphs, Lamina propria
granulomas, Crypt abscesses polymorphs, Crypt abscesses extent, Basal
histiocytic cells, Submucosal granulomas, Sex, Increased lymphoid aggregates in
lamina propria?', 'accuracy': [0.6666666666666666, 0.6481481481481481,
0.7037037037037037, 0.7160493827160493, 0.7080745341614907], 'avgAccuracy':
0.6885284870792117, 'f1': [0.6470123789819567, 0.6271313792360721,
0.6738421079914458, 0.6985588273266795, 0.6917123480801775], 'avgF1':
0.6676514083232663, 'precision': [0.6666666666666666, 0.6481481481481481,
0.7037037037037037, 0.7160493827160493, 0.7080745341614907], 'avgPrecision':
0.6885284870792117, 'recall': [0.6666666666666666, 0.6481481481481481,
0.7037037037037037, 0.7160493827160493, 0.7080745341614907], 'avgRecall':
0.6885284870792117, 'params': [{'activation': 'identity', 'alpha': 0.0001,
'batch_size': 'auto', 'beta_1': 0.9, 'beta_2': 0.999, 'early_stopping': False,
'epsilon': 1e-08, 'hidden_layer_sizes': (100,), 'learning_rate': 'invscaling',
'learning_rate_init': 0.001, 'max_fun': 15000, 'max_iter': 9000, 'momentum':
0.9, 'n_iter_no_change': 10, 'nesterovs_momentum': True, 'power_t': 0.5,
'random_state': None, 'shuffle': True, 'solver': 'adam', 'tol': 0.0001,
'validation_fraction': 0.1, 'verbose': False, 'warm_start': False}]}
****
****
* Best Performing Model and Params is:
* {'classifier': 'MLPClassifier', 'features': 'Active inflammation?, Severity of
Crypt Arch, Increased lamina propria cellularity?, Marked & transmucosal
increase in lamina propria cellularity, Lamina propria polymorphs, Crypt
architecture, Patchy lamina propria cellularity?, Epithelial changes, Mucosal
surface, Cryptitis extent, Mucin depletion, Cryptitis polymorphs, Lamina propria
granulomas, Crypt abscesses polymorphs, Crypt abscesses extent, Basal
histiocytic cells, Submucosal granulomas, Sex, Increased lymphoid aggregates in
lamina propria?', 'accuracy': [0.6666666666666666, 0.6481481481481481,

```
0.7037037037037037, 0.7160493827160493, 0.7080745341614907], 'avgAccuracy':
0.6885284870792117, 'f1': [0.6470123789819567, 0.6271313792360721,
0.6738421079914458, 0.6985588273266795, 0.6917123480801775], 'avgF1':
0.6676514083232663, 'precision': [0.6666666666666666, 0.6481481481481481,
0.7037037037037037, 0.7160493827160493, 0.7080745341614907], 'avgPrecision':
0.6885284870792117, 'recall': [0.6666666666666666, 0.6481481481481481,
0.7037037037037037, 0.7160493827160493, 0.7080745341614907], 'avgRecall':
0.6885284870792117, 'params': [{'activation': 'identity', 'alpha': 0.0001,
'batch_size': 'auto', 'beta_1': 0.9, 'beta_2': 0.999, 'early_stopping': False,
'epsilon': 1e-08, 'hidden_layer_sizes': (100,), 'learning_rate': 'invscaling',
'learning_rate_init': 0.001, 'max_fun': 15000, 'max_iter': 9000, 'momentum':
0.9, 'n_iter_no_change': 10, 'nesterovs_momentum': True, 'power_t': 0.5,
'random_state': None, 'shuffle': True, 'solver': 'adam', 'tol': 0.0001,
'validation_fraction': 0.1, 'verbose': False, 'warm_start': False}]}
*******************************************************
```

	model	features \
0	RandomForestClassifier	Active inflammation?, Severity of Crypt Arch, …
1	KNeighborsClassifier	Active inflammation?, Severity of Crypt Arch, …
2	LogisticRegression	Active inflammation?, Severity of Crypt Arch, …
3	GaussianNB	Active inflammation?, Severity of Crypt Arch, …
4	AdaBoostClassifier	Active inflammation?, Severity of Crypt Arch, …
5	DecisionTreeClassifier	Active inflammation?, Severity of Crypt Arch, …
6	SVC	Active inflammation?, Severity of Crypt Arch, …
7	MLPClassifier	Active inflammation?, Severity of Crypt Arch, …

	accuracy	f1	precision	recall \
0	0.672441	0.647353	0.672441	0.672441
1	0.666214	0.637320	0.666214	0.666214
2	0.687271	0.666842	0.687271	0.687271
3	0.641531	0.609641	0.641531	0.641531
4	0.661245	0.630330	0.661245	0.661245
5	0.641546	0.629902	0.641546	0.641546
6	0.678614	0.636319	0.678614	0.678614
7	0.688528	0.667651	0.688528	0.688528

	params
0	{'bootstrap': True, 'ccp_alpha': 0.0, 'class_w…
1	{'algorithm': 'ball_tree', 'leaf_size': 30, 'm…
2	{'C': 1, 'class_weight': None, 'dual': False, …
3	{'priors': None, 'var_smoothing': 1e-09}
4	{'algorithm': 'SAMME.R', 'base_estimator': Non…
5	{'ccp_alpha': 0.0, 'class_weight': None, 'crit…
6	{'C': 1.0, 'break_ties': False, 'cache_size': …
7	{'activation': 'identity', 'alpha': 0.0001, 'b…

```
Processing Model: RandomForestClassifier
*******************************************************
```

* RandomForestClassifier
* Best Params Result:
* {'classifier': 'RandomForestClassifier', 'features': 'Active inflammation?,
Severity of Crypt Arch, Increased lamina propria cellularity?, Marked &
transmucosal increase in lamina propria cellularity, Lamina propria polymorphs,
Crypt architecture, Patchy lamina propria cellularity?, Epithelial changes,
Mucosal surface, Cryptitis extent, Mucin depletion, Cryptitis polymorphs, Lamina
propria granulomas, Crypt abscesses polymorphs, Crypt abscesses extent, Basal
histiocytic cells, Submucosal granulomas, Sex', 'accuracy': [0.6419753086419753,
0.6296296296296297, 0.7098765432098766, 0.7160493827160493, 0.6583850931677019],
'avgAccuracy': 0.6711831914730465, 'f1': [0.6184055694708362,
0.6015743389204401, 0.6729814876344742, 0.6985588273266795, 0.6417862253007904],
'avgF1': 0.6466612897306441, 'precision': [0.6419753086419753,
0.6296296296296297, 0.7098765432098766, 0.7160493827160493, 0.6583850931677019],
'avgPrecision': 0.6711831914730465, 'recall': [0.6419753086419753,
0.6296296296296297, 0.7098765432098766, 0.7160493827160493, 0.6583850931677019],
'avgRecall': 0.6711831914730465, 'params': [{'bootstrap': True, 'ccp_alpha':
0.0, 'class_weight': None, 'criterion': 'entropy', 'max_depth': None,
'max_features': 'log2', 'max_leaf_nodes': None, 'max_samples': None,
'min_impurity_decrease': 0.0, 'min_impurity_split': None, 'min_samples_leaf': 1,
'min_samples_split': 2, 'min_weight_fraction_leaf': 0.0, 'n_estimators': 700,
'n_jobs': -1, 'oob_score': True, 'random_state': None, 'verbose': 0,
'warm_start': False}]}
****

Processing Model: KNeighborsClassifier
****
* KNeighborsClassifier
* Best Params Result:
* {'classifier': 'KNeighborsClassifier', 'features': 'Active inflammation?,
Severity of Crypt Arch, Increased lamina propria cellularity?, Marked &
transmucosal increase in lamina propria cellularity, Lamina propria polymorphs,
Crypt architecture, Patchy lamina propria cellularity?, Epithelial changes,
Mucosal surface, Cryptitis extent, Mucin depletion, Cryptitis polymorphs, Lamina
propria granulomas, Crypt abscesses polymorphs, Crypt abscesses extent, Basal
histiocytic cells, Submucosal granulomas, Sex', 'accuracy': [0.6666666666666666,
0.6604938271604939, 0.6851851851851852, 0.6851851851851852, 0.6459627329192547],
'avgAccuracy': 0.6686987194233571, 'f1': [0.6258005796700502,
0.6211081940608095, 0.6858061258646054, 0.6384033318316152, 0.6195512282468805],
'avgF1': 0.6381338919347922, 'precision': [0.6666666666666666,
0.6604938271604939, 0.6851851851851852, 0.6851851851851852, 0.6459627329192547],
'avgPrecision': 0.6686987194233571, 'recall': [0.6666666666666666,
0.6604938271604939, 0.6851851851851852, 0.6851851851851852, 0.6459627329192547],
'avgRecall': 0.6686987194233571, 'params': [{'algorithm': 'ball_tree',
'leaf_size': 30, 'metric': 'minkowski', 'metric_params': None, 'n_jobs': -1,
'n_neighbors': 15, 'p': 2, 'weights': 'uniform'}]}
****

```
Processing Model: LogisticRegression
*****************************************************
* LogisticRegression
* Best Params Result:
* {'classifier': 'LogisticRegression', 'features': 'Active inflammation?,
Severity of Crypt Arch, Increased lamina propria cellularity?, Marked &
transmucosal increase in lamina propria cellularity, Lamina propria polymorphs,
Crypt architecture, Patchy lamina propria cellularity?, Epithelial changes,
Mucosal surface, Cryptitis extent, Mucin depletion, Cryptitis polymorphs, Lamina
propria granulomas, Crypt abscesses polymorphs, Crypt abscesses extent, Basal
histiocytic cells, Submucosal granulomas, Sex', 'accuracy': [0.6790123456790124,
0.6481481481481481, 0.7037037037037037, 0.7283950617283951, 0.6894409937888198],
'avgAccuracy': 0.6897400506096159, 'f1': [0.6632113467454833,
0.6271313792360721, 0.6738421079914458, 0.7094389482882866, 0.6762015478128011],
'avgF1': 0.6699650660148178, 'precision': [0.6790123456790124,
0.6481481481481481, 0.7037037037037037, 0.7283950617283951, 0.6894409937888198],
'avgPrecision': 0.6897400506096159, 'recall': [0.6790123456790124,
0.6481481481481481, 0.7037037037037037, 0.7283950617283951, 0.6894409937888198],
'avgRecall': 0.6897400506096159, 'params': [{'C': 1, 'class_weight': None,
'dual': False, 'fit_intercept': True, 'intercept_scaling': 1, 'l1_ratio': None,
'max_iter': 100, 'multi_class': 'multinomial', 'n_jobs': -1, 'penalty': 'l2',
'random_state': None, 'solver': 'newton-cg', 'tol': 0.0001, 'verbose': 0,
'warm_start': False}]}
*****************************************************

Processing Model: GaussianNB
*****************************************************
* GaussianNB
* Best Params Result:
* {'classifier': 'GaussianNB', 'features': 'Active inflammation?, Severity of
Crypt Arch, Increased lamina propria cellularity?, Marked & transmucosal
increase in lamina propria cellularity, Lamina propria polymorphs, Crypt
architecture, Patchy lamina propria cellularity?, Epithelial changes, Mucosal
surface, Cryptitis extent, Mucin depletion, Cryptitis polymorphs, Lamina propria
granulomas, Crypt abscesses polymorphs, Crypt abscesses extent, Basal
histiocytic cells, Submucosal granulomas, Sex', 'accuracy': [0.5802469135802469,
0.6358024691358025, 0.654320987654321, 0.6975308641975309, 0.639751552795031],
'avgAccuracy': 0.6415305574725865, 'f1': [0.5480665058248149,
0.5893428636775743, 0.6152045175846284, 0.6766916899261395, 0.6188975483103929],
'avgF1': 0.60964062506471, 'precision': [0.5802469135802469, 0.6358024691358025,
0.654320987654321, 0.6975308641975309, 0.639751552795031], 'avgPrecision':
0.6415305574725865, 'recall': [0.5802469135802469, 0.6358024691358025,
0.654320987654321, 0.6975308641975309, 0.639751552795031], 'avgRecall':
0.6415305574725865, 'params': [{'priors': None, 'var_smoothing': 1e-09}]}
*****************************************************

Processing Model: AdaBoostClassifier
*****************************************************
```

* AdaBoostClassifier
* Best Params Result:
* {'classifier': 'AdaBoostClassifier', 'features': 'Active inflammation?,
Severity of Crypt Arch, Increased lamina propria cellularity?, Marked &
transmucosal increase in lamina propria cellularity, Lamina propria polymorphs,
Crypt architecture, Patchy lamina propria cellularity?, Epithelial changes,
Mucosal surface, Cryptitis extent, Mucin depletion, Cryptitis polymorphs, Lamina
propria granulomas, Crypt abscesses polymorphs, Crypt abscesses extent, Basal
histiocytic cells, Submucosal granulomas, Sex', 'accuracy': [0.6728395061728395,
0.6358024691358025, 0.6975308641975309, 0.691358024691358, 0.6086956521739131],
'avgAccuracy': 0.6612453032742888, 'f1': [0.6549016235126287,
0.5691429076872659, 0.6688400306544482, 0.6417539673199425, 0.6088672045256988],
'avgF1': 0.6287011467399968, 'precision': [0.6728395061728395,
0.6358024691358025, 0.6975308641975309, 0.691358024691358, 0.6086956521739131],
'avgPrecision': 0.6612453032742888, 'recall': [0.6728395061728395,
0.6358024691358025, 0.6975308641975309, 0.691358024691358, 0.6086956521739131],
'avgRecall': 0.6612453032742888, 'params': [{'algorithm': 'SAMME.R',
'base_estimator': None, 'learning_rate': 1, 'n_estimators': 20, 'random_state':
None}]}
****

Processing Model: DecisionTreeClassifier
****
* DecisionTreeClassifier
* Best Params Result:
* {'classifier': 'DecisionTreeClassifier', 'features': 'Active inflammation?,
Severity of Crypt Arch, Increased lamina propria cellularity?, Marked &
transmucosal increase in lamina propria cellularity, Lamina propria polymorphs,
Crypt architecture, Patchy lamina propria cellularity?, Epithelial changes,
Mucosal surface, Cryptitis extent, Mucin depletion, Cryptitis polymorphs, Lamina
propria granulomas, Crypt abscesses polymorphs, Crypt abscesses extent, Basal
histiocytic cells, Submucosal granulomas, Sex', 'accuracy': [0.6296296296296297,
0.6358024691358025, 0.6666666666666666, 0.6666666666666666, 0.6273291925465838],
'avgAccuracy': 0.6452189249290698, 'f1': [0.6230559429527809,
0.6249515160115415, 0.6314517779438369, 0.6554508237127115, 0.6342356572628415],
'avgF1': 0.6338291435767425, 'precision': [0.6296296296296297,
0.6358024691358025, 0.6666666666666666, 0.6666666666666666, 0.6273291925465838],
'avgPrecision': 0.6452189249290698, 'recall': [0.6296296296296297,
0.6358024691358025, 0.6666666666666666, 0.6666666666666666, 0.6273291925465838],
'avgRecall': 0.6452189249290698, 'params': [{'ccp_alpha': 0.0, 'class_weight':
None, 'criterion': 'gini', 'max_depth': None, 'max_features': 'sqrt',
'max_leaf_nodes': None, 'min_impurity_decrease': 0.0, 'min_impurity_split':
None, 'min_samples_leaf': 1, 'min_samples_split': 2, 'min_weight_fraction_leaf':
0.0, 'random_state': None, 'splitter': 'random'}]}
****

Processing Model: SVC
****

* SVC
* Best Params Result:
* {'classifier': 'SVC', 'features': 'Active inflammation?, Severity of Crypt Arch, Increased lamina propria cellularity?, Marked & transmucosal increase in lamina propria cellularity, Lamina propria polymorphs, Crypt architecture, Patchy lamina propria cellularity?, Epithelial changes, Mucosal surface, Cryptitis extent, Mucin depletion, Cryptitis polymorphs, Lamina propria granulomas, Crypt abscesses polymorphs, Crypt abscesses extent, Basal histiocytic cells, Submucosal granulomas, Sex', 'accuracy': [0.6481481481481481, 0.654320987654321, 0.691358024691358, 0.7160493827160493, 0.6770186335403726], 'avgAccuracy': 0.6773790353500498, 'f1': [0.5985818977999863, 0.5998934814568833, 0.636954082706332, 0.689521710879453, 0.6449718205763514], 'avgF1': 0.6339845986838012, 'precision': [0.6481481481481481, 0.654320987654321, 0.691358024691358, 0.7160493827160493, 0.6770186335403726], 'avgPrecision': 0.6773790353500498, 'recall': [0.6481481481481481, 0.654320987654321, 0.691358024691358, 0.7160493827160493, 0.6770186335403726], 'avgRecall': 0.6773790353500498, 'params': [{'C': 1.0, 'break_ties': False, 'cache_size': 4000, 'class_weight': None, 'coef0': 0.0, 'decision_function_shape': 'ovr', 'degree': 3, 'gamma': 'scale', 'kernel': 'linear', 'max_iter': -1, 'probability': False, 'random_state': None, 'shrinking': True, 'tol': 0.001, 'verbose': False}]}
****

Processing Model: MLPClassifier
****
* MLPClassifier
* Best Params Result:
* {'classifier': 'MLPClassifier', 'features': 'Active inflammation?, Severity of Crypt Arch, Increased lamina propria cellularity?, Marked & transmucosal increase in lamina propria cellularity, Lamina propria polymorphs, Crypt architecture, Patchy lamina propria cellularity?, Epithelial changes, Mucosal surface, Cryptitis extent, Mucin depletion, Cryptitis polymorphs, Lamina propria granulomas, Crypt abscesses polymorphs, Crypt abscesses extent, Basal histiocytic cells, Submucosal granulomas, Sex', 'accuracy': [0.6728395061728395, 0.6481481481481481, 0.7037037037037037, 0.7222222222222222, 0.6894409937888198], 'avgAccuracy': 0.6872709148071466, 'f1': [0.6576912503532791, 0.6271313792360721, 0.6738421079914458, 0.703976827356457, 0.6760219557995089], 'avgF1': 0.6677327041473525, 'precision': [0.6728395061728395, 0.6481481481481481, 0.7037037037037037, 0.7222222222222222, 0.6894409937888198], 'avgPrecision': 0.6872709148071466, 'recall': [0.6728395061728395, 0.6481481481481481, 0.7037037037037037, 0.7222222222222222, 0.6894409937888198], 'avgRecall': 0.6872709148071466, 'params': [{'activation': 'identity', 'alpha': 0.0001, 'batch_size': 'auto', 'beta_1': 0.9, 'beta_2': 0.999, 'early_stopping': False, 'epsilon': 1e-08, 'hidden_layer_sizes': (100,), 'learning_rate': 'constant', 'learning_rate_init': 0.001, 'max_fun': 15000, 'max_iter': 7000, 'momentum': 0.9, 'n_iter_no_change': 10, 'nesterovs_momentum': True, 'power_t': 0.5, 'random_state': None, 'shuffle': True, 'solver': 'adam', 'tol': 0.0001, 'validation_fraction': 0.1, 'verbose': False, 'warm_start': False}]}

```
**************************************************
**************************************************
* Best Performing Model and Params is:
* {'classifier': 'LogisticRegression', 'features': 'Active inflammation?,
Severity of Crypt Arch, Increased lamina propria cellularity?, Marked &
transmucosal increase in lamina propria cellularity, Lamina propria polymorphs,
Crypt architecture, Patchy lamina propria cellularity?, Epithelial changes,
Mucosal surface, Cryptitis extent, Mucin depletion, Cryptitis polymorphs, Lamina
propria granulomas, Crypt abscesses polymorphs, Crypt abscesses extent, Basal
histiocytic cells, Submucosal granulomas, Sex', 'accuracy': [0.6790123456790124,
0.6481481481481481, 0.7037037037037037, 0.7283950617283951, 0.6894409937888198],
'avgAccuracy': 0.6897400506096159, 'f1': [0.6632113467454833,
0.6271313792360721, 0.6738421079914458, 0.7094389482882866, 0.6762015478128011],
'avgF1': 0.6699650660148178, 'precision': [0.6790123456790124,
0.6481481481481481, 0.7037037037037037, 0.7283950617283951, 0.6894409937888198],
'avgPrecision': 0.6897400506096159, 'recall': [0.6790123456790124,
0.6481481481481481, 0.7037037037037037, 0.7283950617283951, 0.6894409937888198],
'avgRecall': 0.6897400506096159, 'params': [{'C': 1, 'class_weight': None,
'dual': False, 'fit_intercept': True, 'intercept_scaling': 1, 'l1_ratio': None,
'max_iter': 100, 'multi_class': 'multinomial', 'n_jobs': -1, 'penalty': 'l2',
'random_state': None, 'solver': 'newton-cg', 'tol': 0.0001, 'verbose': 0,
'warm_start': False}]}
**************************************************
```

	model	features \
0	RandomForestClassifier	Active inflammation?, Severity of Crypt Arch, …
1	KNeighborsClassifier	Active inflammation?, Severity of Crypt Arch, …
2	LogisticRegression	Active inflammation?, Severity of Crypt Arch, …
3	GaussianNB	Active inflammation?, Severity of Crypt Arch, …
4	AdaBoostClassifier	Active inflammation?, Severity of Crypt Arch, …
5	DecisionTreeClassifier	Active inflammation?, Severity of Crypt Arch, …
6	SVC	Active inflammation?, Severity of Crypt Arch, …
7	MLPClassifier	Active inflammation?, Severity of Crypt Arch, …

	accuracy	f1	precision	recall \
0	0.671183	0.646661	0.671183	0.671183
1	0.668699	0.638134	0.668699	0.668699
2	0.689740	0.669965	0.689740	0.689740
3	0.641531	0.609641	0.641531	0.641531
4	0.661245	0.628701	0.661245	0.661245
5	0.645219	0.633829	0.645219	0.645219
6	0.677379	0.633985	0.677379	0.677379
7	0.687271	0.667733	0.687271	0.687271

	params
0	{'bootstrap': True, 'ccp_alpha': 0.0, 'class_w…
1	{'algorithm': 'ball_tree', 'leaf_size': 30, 'm…
2	{'C': 1, 'class_weight': None, 'dual': False, …

```
3          {'priors': None, 'var_smoothing': 1e-09}
4  {'algorithm': 'SAMME.R', 'base_estimator': Non…
5  {'ccp_alpha': 0.0, 'class_weight': None, 'crit…
6  {'C': 1.0, 'break_ties': False, 'cache_size': …
7  {'activation': 'identity', 'alpha': 0.0001, 'b…
```

Processing Model: RandomForestClassifier
****
* RandomForestClassifier
* Best Params Result:
* {'classifier': 'RandomForestClassifier', 'features': 'Active inflammation?,
Severity of Crypt Arch, Increased lamina propria cellularity?, Marked &
transmucosal increase in lamina propria cellularity, Lamina propria polymorphs,
Crypt architecture, Patchy lamina propria cellularity?, Epithelial changes,
Mucosal surface, Cryptitis extent, Mucin depletion, Cryptitis polymorphs, Lamina
propria granulomas, Crypt abscesses polymorphs, Crypt abscesses extent, Basal
histiocytic cells, Submucosal granulomas', 'accuracy': [0.654320987654321,
0.6358024691358025, 0.691358024691358, 0.7160493827160493, 0.6521739130434783],
'avgAccuracy': 0.6699409554482019, 'f1': [0.6364135526199495,
0.6118703227563778, 0.6440760081630835, 0.6886145404663924, 0.6344583645932971],
'avgF1': 0.64308655771982, 'precision': [0.654320987654321, 0.6358024691358025,
0.691358024691358, 0.7160493827160493, 0.6521739130434783], 'avgPrecision':
0.6699409554482019, 'recall': [0.654320987654321, 0.6358024691358025,
0.691358024691358, 0.7160493827160493, 0.6521739130434783], 'avgRecall':
0.6699409554482019, 'params': [{'bootstrap': True, 'ccp_alpha': 0.0,
'class_weight': None, 'criterion': 'entropy', 'max_depth': None, 'max_features':
'auto', 'max_leaf_nodes': None, 'max_samples': None, 'min_impurity_decrease':
0.0, 'min_impurity_split': None, 'min_samples_leaf': 1, 'min_samples_split': 2,
'min_weight_fraction_leaf': 0.0, 'n_estimators': 200, 'n_jobs': -1, 'oob_score':
False, 'random_state': None, 'verbose': 0, 'warm_start': False}]}
****

Processing Model: KNeighborsClassifier
****
* KNeighborsClassifier
* Best Params Result:
* {'classifier': 'KNeighborsClassifier', 'features': 'Active inflammation?,
Severity of Crypt Arch, Increased lamina propria cellularity?, Marked &
transmucosal increase in lamina propria cellularity, Lamina propria polymorphs,
Crypt architecture, Patchy lamina propria cellularity?, Epithelial changes,
Mucosal surface, Cryptitis extent, Mucin depletion, Cryptitis polymorphs, Lamina
propria granulomas, Crypt abscesses polymorphs, Crypt abscesses extent, Basal
histiocytic cells, Submucosal granulomas', 'accuracy': [0.6358024691358025,
0.6481481481481481, 0.6975308641975309, 0.6975308641975309, 0.6645962732919255],
'avgAccuracy': 0.6687217237941876, 'f1': [0.6091191593199624,
0.6032656676786782, 0.6557509326564364, 0.6614359237305492, 0.6357670528499859],
'avgF1': 0.6330677472471224, 'precision': [0.6358024691358025,
0.6481481481481481, 0.6975308641975309, 0.6975308641975309, 0.6645962732919255],

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```

'avgPrecision': 0.6687217237941876, 'recall': [0.6358024691358025,
0.6481481481481481, 0.6975308641975309, 0.6975308641975309, 0.6645962732919255],
'avgRecall': 0.6687217237941876, 'params': [{'algorithm': 'ball_tree',
'leaf_size': 30, 'metric': 'minkowski', 'metric_params': None, 'n_jobs': -1,
'n_neighbors': 16, 'p': 2, 'weights': 'uniform'}]}
****

Processing Model: LogisticRegression
****
* LogisticRegression
* Best Params Result:
* {'classifier': 'LogisticRegression', 'features': 'Active inflammation?,
Severity of Crypt Arch, Increased lamina propria cellularity?, Marked &
transmucosal increase in lamina propria cellularity, Lamina propria polymorphs,
Crypt architecture, Patchy lamina propria cellularity?, Epithelial changes,
Mucosal surface, Cryptitis extent, Mucin depletion, Cryptitis polymorphs, Lamina
propria granulomas, Crypt abscesses polymorphs, Crypt abscesses extent, Basal
histiocytic cells, Submucosal granulomas', 'accuracy': [0.6666666666666666,
0.6358024691358025, 0.691358024691358, 0.7098765432098766, 0.7018633540372671],
'avgAccuracy': 0.6811134115481942, 'f1': [0.6510616642898064,
0.6065403387884009, 0.6638536063360331, 0.6941883284553896, 0.6921004803720588],
'avgF1': 0.6615488836483377, 'precision': [0.6666666666666666,
0.6358024691358025, 0.691358024691358, 0.7098765432098766, 0.7018633540372671],
'avgPrecision': 0.6811134115481942, 'recall': [0.6666666666666666,
0.6358024691358025, 0.691358024691358, 0.7098765432098766, 0.7018633540372671],
'avgRecall': 0.6811134115481942, 'params': [{'C': 1, 'class_weight': None,
'dual': False, 'fit_intercept': True, 'intercept_scaling': 1, 'l1_ratio': None,
'max_iter': 100, 'multi_class': 'multinomial', 'n_jobs': -1, 'penalty': 'l2',
'random_state': None, 'solver': 'newton-cg', 'tol': 0.0001, 'verbose': 0,
'warm_start': False}]}
****

Processing Model: GaussianNB
****
* GaussianNB
* Best Params Result:
* {'classifier': 'GaussianNB', 'features': 'Active inflammation?, Severity of
Crypt Arch, Increased lamina propria cellularity?, Marked & transmucosal
increase in lamina propria cellularity, Lamina propria polymorphs, Crypt
architecture, Patchy lamina propria cellularity?, Epithelial changes, Mucosal
surface, Cryptitis extent, Mucin depletion, Cryptitis polymorphs, Lamina propria
granulomas, Crypt abscesses polymorphs, Crypt abscesses extent, Basal
histiocytic cells, Submucosal granulomas', 'accuracy': [0.5802469135802469,
0.6358024691358025, 0.654320987654321, 0.6975308641975309, 0.639751552795031],
'avgAccuracy': 0.6415305574725865, 'f1': [0.5480665058248149,
0.5893428636775743, 0.6152045175846284, 0.6766916899261395, 0.6188975483103929],
'avgF1': 0.60964062506471, 'precision': [0.5802469135802469, 0.6358024691358025,
0.654320987654321, 0.6975308641975309, 0.639751552795031], 'avgPrecision':

0.6415305574725865, 'recall': [0.5802469135802469, 0.6358024691358025,
0.654320987654321, 0.6975308641975309, 0.639751552795031], 'avgRecall':
0.6415305574725865, 'params': [{'priors': None, 'var_smoothing': 1e-09}]}
****

Processing Model: AdaBoostClassifier
****
* AdaBoostClassifier
* Best Params Result:
* {'classifier': 'AdaBoostClassifier', 'features': 'Active inflammation?,
Severity of Crypt Arch, Increased lamina propria cellularity?, Marked &
transmucosal increase in lamina propria cellularity, Lamina propria polymorphs,
Crypt architecture, Patchy lamina propria cellularity?, Epithelial changes,
Mucosal surface, Cryptitis extent, Mucin depletion, Cryptitis polymorphs, Lamina
propria granulomas, Crypt abscesses polymorphs, Crypt abscesses extent, Basal
histiocytic cells, Submucosal granulomas', 'accuracy': [0.654320987654321,
0.6358024691358025, 0.6975308641975309, 0.6975308641975309, 0.6024844720496895],
'avgAccuracy': 0.6575339314469749, 'f1': [0.6373323483270715,
0.5691429076872659, 0.6688400306544482, 0.6460528949665453, 0.6020174604636147],
'avgF1': 0.6246771284197892, 'precision': [0.654320987654321,
0.6358024691358025, 0.6975308641975309, 0.6975308641975309, 0.6024844720496895],
'avgPrecision': 0.6575339314469749, 'recall': [0.654320987654321,
0.6358024691358025, 0.6975308641975309, 0.6975308641975309, 0.6024844720496895],
'avgRecall': 0.6575339314469749, 'params': [{'algorithm': 'SAMME.R',
'base_estimator': None, 'learning_rate': 1, 'n_estimators': 20, 'random_state':
None}]}
****

Processing Model: DecisionTreeClassifier
****
* DecisionTreeClassifier
* Best Params Result:
* {'classifier': 'DecisionTreeClassifier', 'features': 'Active inflammation?,
Severity of Crypt Arch, Increased lamina propria cellularity?, Marked &
transmucosal increase in lamina propria cellularity, Lamina propria polymorphs,
Crypt architecture, Patchy lamina propria cellularity?, Epithelial changes,
Mucosal surface, Cryptitis extent, Mucin depletion, Cryptitis polymorphs, Lamina
propria granulomas, Crypt abscesses polymorphs, Crypt abscesses extent, Basal
histiocytic cells, Submucosal granulomas', 'accuracy': [0.6419753086419753,
0.6111111111111112, 0.6790123456790124, 0.654320987654321, 0.6645962732919255],
'avgAccuracy': 0.6502032052756691, 'f1': [0.6291816279373467,
0.5995990154425831, 0.6350039217232006, 0.6456349844715589, 0.6613312778949427],
'avgF1': 0.6341501654939264, 'precision': [0.6419753086419753,
0.6111111111111112, 0.6790123456790124, 0.654320987654321, 0.6645962732919255],
'avgPrecision': 0.6502032052756691, 'recall': [0.6419753086419753,
0.6111111111111112, 0.6790123456790124, 0.654320987654321, 0.6645962732919255],
'avgRecall': 0.6502032052756691, 'params': [{'ccp_alpha': 0.0, 'class_weight':
None, 'criterion': 'gini', 'max_depth': None, 'max_features': 'log2',

'max_leaf_nodes': None, 'min_impurity_decrease': 0.0, 'min_impurity_split':
None, 'min_samples_leaf': 1, 'min_samples_split': 2, 'min_weight_fraction_leaf':
0.0, 'random_state': None, 'splitter': 'random'}]}
****

Processing Model: SVC
****
* SVC
* Best Params Result:
* {'classifier': 'SVC', 'features': 'Active inflammation?, Severity of Crypt
Arch, Increased lamina propria cellularity?, Marked & transmucosal increase in
lamina propria cellularity, Lamina propria polymorphs, Crypt architecture,
Patchy lamina propria cellularity?, Epithelial changes, Mucosal surface,
Cryptitis extent, Mucin depletion, Cryptitis polymorphs, Lamina propria
granulomas, Crypt abscesses polymorphs, Crypt abscesses extent, Basal
histiocytic cells, Submucosal granulomas', 'accuracy': [0.6481481481481481,
0.654320987654321, 0.691358024691358, 0.7160493827160493, 0.6770186335403726],
'avgAccuracy': 0.6773790353500498, 'f1': [0.5985818977999863,
0.5998934814568833, 0.636954082706332, 0.689521710879453, 0.6449718205763514],
'avgF1': 0.6339845986838012, 'precision': [0.6481481481481481,
0.654320987654321, 0.691358024691358, 0.7160493827160493, 0.6770186335403726],
'avgPrecision': 0.6773790353500498, 'recall': [0.6481481481481481,
0.654320987654321, 0.691358024691358, 0.7160493827160493, 0.6770186335403726],
'avgRecall': 0.6773790353500498, 'params': [{'C': 1.0, 'break_ties': False,
'cache_size': 4000, 'class_weight': None, 'coef0': 0.0,
'decision_function_shape': 'ovr', 'degree': 3, 'gamma': 'scale', 'kernel':
'linear', 'max_iter': -1, 'probability': False, 'random_state': None,
'shrinking': True, 'tol': 0.001, 'verbose': False}]}
****

Processing Model: MLPClassifier
****
* MLPClassifier
* Best Params Result:
* {'classifier': 'MLPClassifier', 'features': 'Active inflammation?, Severity of
Crypt Arch, Increased lamina propria cellularity?, Marked & transmucosal
increase in lamina propria cellularity, Lamina propria polymorphs, Crypt
architecture, Patchy lamina propria cellularity?, Epithelial changes, Mucosal
surface, Cryptitis extent, Mucin depletion, Cryptitis polymorphs, Lamina propria
granulomas, Crypt abscesses polymorphs, Crypt abscesses extent, Basal
histiocytic cells, Submucosal granulomas', 'accuracy': [0.6666666666666666,
0.6358024691358025, 0.691358024691358, 0.7160493827160493, 0.7080745341614907],
'avgAccuracy': 0.6835902154742735, 'f1': [0.6510616642898064,
0.6118703227563778, 0.6638536063360331, 0.6938995873679071, 0.6853201559744578],
'avgF1': 0.6612010673449165, 'precision': [0.6666666666666666,
0.6358024691358025, 0.691358024691358, 0.7160493827160493, 0.7080745341614907],
'avgPrecision': 0.6835902154742735, 'recall': [0.6666666666666666,
0.6358024691358025, 0.691358024691358, 0.7160493827160493, 0.7080745341614907],

```
'avgRecall': 0.6835902154742735, 'params': [{'activation': 'logistic', 'alpha':
0.0001, 'batch_size': 'auto', 'beta_1': 0.9, 'beta_2': 0.999, 'early_stopping':
False, 'epsilon': 1e-08, 'hidden_layer_sizes': (100,), 'learning_rate':
'adaptive', 'learning_rate_init': 0.001, 'max_fun': 15000, 'max_iter': 9000,
'momentum': 0.9, 'n_iter_no_change': 10, 'nesterovs_momentum': True, 'power_t':
0.5, 'random_state': None, 'shuffle': True, 'solver': 'adam', 'tol': 0.0001,
'validation_fraction': 0.1, 'verbose': False, 'warm_start': False}]}
********************************************************
********************************************************
* Best Performing Model and Params is:
* {'classifier': 'MLPClassifier', 'features': 'Active inflammation?, Severity of
Crypt Arch, Increased lamina propria cellularity?, Marked & transmucosal
increase in lamina propria cellularity, Lamina propria polymorphs, Crypt
architecture, Patchy lamina propria cellularity?, Epithelial changes, Mucosal
surface, Cryptitis extent, Mucin depletion, Cryptitis polymorphs, Lamina propria
granulomas, Crypt abscesses polymorphs, Crypt abscesses extent, Basal
histiocytic cells, Submucosal granulomas', 'accuracy': [0.6666666666666666,
0.6358024691358025, 0.691358024691358, 0.7160493827160493, 0.7080745341614907],
'avgAccuracy': 0.6835902154742735, 'f1': [0.6510616642898064,
0.6118703227563778, 0.6638536063360331, 0.6938995873679071, 0.6853201559744578],
'avgF1': 0.6612010673449165, 'precision': [0.6666666666666666,
0.6358024691358025, 0.691358024691358, 0.7160493827160493, 0.7080745341614907],
'avgPrecision': 0.6835902154742735, 'recall': [0.6666666666666666,
0.6358024691358025, 0.691358024691358, 0.7160493827160493, 0.7080745341614907],
'avgRecall': 0.6835902154742735, 'params': [{'activation': 'logistic', 'alpha':
0.0001, 'batch_size': 'auto', 'beta_1': 0.9, 'beta_2': 0.999, 'early_stopping':
False, 'epsilon': 1e-08, 'hidden_layer_sizes': (100,), 'learning_rate':
'adaptive', 'learning_rate_init': 0.001, 'max_fun': 15000, 'max_iter': 9000,
'momentum': 0.9, 'n_iter_no_change': 10, 'nesterovs_momentum': True, 'power_t':
0.5, 'random_state': None, 'shuffle': True, 'solver': 'adam', 'tol': 0.0001,
'validation_fraction': 0.1, 'verbose': False, 'warm_start': False}]}
********************************************************

                   model                                       features  \
0  RandomForestClassifier   Active inflammation?, Severity of Crypt Arch, …
1     KNeighborsClassifier   Active inflammation?, Severity of Crypt Arch, …
2       LogisticRegression   Active inflammation?, Severity of Crypt Arch, …
3               GaussianNB   Active inflammation?, Severity of Crypt Arch, …
4       AdaBoostClassifier   Active inflammation?, Severity of Crypt Arch, …
5   DecisionTreeClassifier   Active inflammation?, Severity of Crypt Arch, …
6                      SVC   Active inflammation?, Severity of Crypt Arch, …
7            MLPClassifier   Active inflammation?, Severity of Crypt Arch, …

   accuracy        f1  precision    recall  \
0  0.669941  0.643087   0.669941  0.669941
1  0.668722  0.633068   0.668722  0.668722
2  0.681113  0.661549   0.681113  0.681113
3  0.641531  0.609641   0.641531  0.641531
```

```
4  0.657534  0.624677   0.657534  0.657534
5  0.650203  0.634150   0.650203  0.650203
6  0.677379  0.633985   0.677379  0.677379
7  0.683590  0.661201   0.683590  0.683590


                                                 params
0  {'bootstrap': True, 'ccp_alpha': 0.0, 'class_w…
1  {'algorithm': 'ball_tree', 'leaf_size': 30, 'm…
2  {'C': 1, 'class_weight': None, 'dual': False, …
3            {'priors': None, 'var_smoothing': 1e-09}
4  {'algorithm': 'SAMME.R', 'base_estimator': Non…
5  {'ccp_alpha': 0.0, 'class_weight': None, 'crit…
6  {'C': 1.0, 'break_ties': False, 'cache_size': …
7  {'activation': 'logistic', 'alpha': 0.0001, 'b…
```

Processing Model: RandomForestClassifier
****
* RandomForestClassifier
* Best Params Result:
* {'classifier': 'RandomForestClassifier', 'features': 'Active inflammation?,
Severity of Crypt Arch, Increased lamina propria cellularity?, Marked &
transmucosal increase in lamina propria cellularity, Lamina propria polymorphs,
Crypt architecture, Patchy lamina propria cellularity?, Epithelial changes,
Mucosal surface, Cryptitis extent, Mucin depletion, Cryptitis polymorphs, Lamina
propria granulomas, Crypt abscesses polymorphs, Crypt abscesses extent, Basal
histiocytic cells', 'accuracy': [0.6481481481481481, 0.6358024691358025,
0.6851851851851852, 0.7098765432098766, 0.6645962732919255], 'avgAccuracy':
0.6687217237941876, 'f1': [0.6220598745119486, 0.6118703227563778,
0.639536940886889, 0.6834705075445816, 0.6500482062700954], 'avgF1':
0.6413971703939785, 'precision': [0.6481481481481481, 0.6358024691358025,
0.6851851851851852, 0.7098765432098766, 0.6645962732919255], 'avgPrecision':
0.6687217237941876, 'recall': [0.6481481481481481, 0.6358024691358025,
0.6851851851851852, 0.7098765432098766, 0.6645962732919255], 'avgRecall':
0.6687217237941876, 'params': [{'bootstrap': True, 'ccp_alpha': 0.0,
'class_weight': None, 'criterion': 'entropy', 'max_depth': None, 'max_features':
'auto', 'max_leaf_nodes': None, 'max_samples': None, 'min_impurity_decrease':
0.0, 'min_impurity_split': None, 'min_samples_leaf': 1, 'min_samples_split': 2,
'min_weight_fraction_leaf': 0.0, 'n_estimators': 200, 'n_jobs': -1, 'oob_score':
True, 'random_state': None, 'verbose': 0, 'warm_start': False}]}
****

Processing Model: KNeighborsClassifier
****
* KNeighborsClassifier
* Best Params Result:
* {'classifier': 'KNeighborsClassifier', 'features': 'Active inflammation?,
Severity of Crypt Arch, Increased lamina propria cellularity?, Marked &
transmucosal increase in lamina propria cellularity, Lamina propria polymorphs,

Crypt architecture, Patchy lamina propria cellularity?, Epithelial changes,
Mucosal surface, Cryptitis extent, Mucin depletion, Cryptitis polymorphs, Lamina
propria granulomas, Crypt abscesses polymorphs, Crypt abscesses extent, Basal
histiocytic cells', 'accuracy': [0.6296296296296297, 0.654320987654321,
0.6975308641975309, 0.7037037037037037, 0.6708074534161491], 'avgAccuracy':
0.6711985277202669, 'f1': [0.6088357070591092, 0.615067741647026,
0.6557509326564364, 0.6726601245119763, 0.6480859234082917], 'avgF1':
0.640080085856568, 'precision': [0.6296296296296297, 0.654320987654321,
0.6975308641975309, 0.7037037037037037, 0.6708074534161491], 'avgPrecision':
0.6711985277202669, 'recall': [0.6296296296296297, 0.654320987654321,
0.6975308641975309, 0.7037037037037037, 0.6708074534161491], 'avgRecall':
0.6711985277202669, 'params': [{'algorithm': 'kd_tree', 'leaf_size': 30,
'metric': 'minkowski', 'metric_params': None, 'n_jobs': -1, 'n_neighbors': 16,
'p': 2, 'weights': 'uniform'}]}
****

Processing Model: LogisticRegression
****
* LogisticRegression
* Best Params Result:
* {'classifier': 'LogisticRegression', 'features': 'Active inflammation?,
Severity of Crypt Arch, Increased lamina propria cellularity?, Marked &
transmucosal increase in lamina propria cellularity, Lamina propria polymorphs,
Crypt architecture, Patchy lamina propria cellularity?, Epithelial changes,
Mucosal surface, Cryptitis extent, Mucin depletion, Cryptitis polymorphs, Lamina
propria granulomas, Crypt abscesses polymorphs, Crypt abscesses extent, Basal
histiocytic cells', 'accuracy': [0.6666666666666666, 0.6358024691358025,
0.691358024691358, 0.7037037037037037, 0.7018633540372671], 'avgAccuracy':
0.6798788436469596, 'f1': [0.6510616642898064, 0.6065403387884009,
0.6638536063360331, 0.6887616529152143, 0.6921004803720588], 'avgF1':
0.6604635485403026, 'precision': [0.6666666666666666, 0.6358024691358025,
0.691358024691358, 0.7037037037037037, 0.7018633540372671], 'avgPrecision':
0.6798788436469596, 'recall': [0.6666666666666666, 0.6358024691358025,
0.691358024691358, 0.7037037037037037, 0.7018633540372671], 'avgRecall':
0.6798788436469596, 'params': [{'C': 1, 'class_weight': None, 'dual': False,
'fit_intercept': True, 'intercept_scaling': 1, 'l1_ratio': None, 'max_iter':
100, 'multi_class': 'multinomial', 'n_jobs': -1, 'penalty': 'l2',
'random_state': None, 'solver': 'newton-cg', 'tol': 0.0001, 'verbose': 0,
'warm_start': False}]}
****

Processing Model: GaussianNB
****
* GaussianNB
* Best Params Result:
* {'classifier': 'GaussianNB', 'features': 'Active inflammation?, Severity of
Crypt Arch, Increased lamina propria cellularity?, Marked & transmucosal
increase in lamina propria cellularity, Lamina propria polymorphs, Crypt

architecture, Patchy lamina propria cellularity?, Epithelial changes, Mucosal
surface, Cryptitis extent, Mucin depletion, Cryptitis polymorphs, Lamina propria
granulomas, Crypt abscesses polymorphs, Crypt abscesses extent, Basal
histiocytic cells', 'accuracy': [0.5679012345679012, 0.5864197530864198,
0.654320987654321, 0.6728395061728395, 0.6086956521739131], 'avgAccuracy':
0.6180354267310789, 'f1': [0.5650815045622625, 0.5674323776887878,
0.6441439547285203, 0.6671800162678345, 0.6216820796960366], 'avgF1':
0.6131039865886884, 'precision': [0.5679012345679012, 0.5864197530864198,
0.654320987654321, 0.6728395061728395, 0.6086956521739131], 'avgPrecision':
0.6180354267310789, 'recall': [0.5679012345679012, 0.5864197530864198,
0.654320987654321, 0.6728395061728395, 0.6086956521739131], 'avgRecall':
0.6180354267310789, 'params': [{'priors': None, 'var_smoothing': 1e-09}]}
****

Processing Model: AdaBoostClassifier
****
* AdaBoostClassifier
* Best Params Result:
* {'classifier': 'AdaBoostClassifier', 'features': 'Active inflammation?,
Severity of Crypt Arch, Increased lamina propria cellularity?, Marked &
transmucosal increase in lamina propria cellularity, Lamina propria polymorphs,
Crypt architecture, Patchy lamina propria cellularity?, Epithelial changes,
Mucosal surface, Cryptitis extent, Mucin depletion, Cryptitis polymorphs, Lamina
propria granulomas, Crypt abscesses polymorphs, Crypt abscesses extent, Basal
histiocytic cells', 'accuracy': [0.654320987654321, 0.6358024691358025,
0.6975308641975309, 0.6975308641975309, 0.6211180124223602], 'avgAccuracy':
0.661260639521509, 'f1': [0.6373323483270715, 0.5691429076872659,
0.6688400306544482, 0.6460528949665453, 0.61774810887692], 'avgF1':
0.6278232581024502, 'precision': [0.654320987654321, 0.6358024691358025,
0.6975308641975309, 0.6975308641975309, 0.6211180124223602], 'avgPrecision':
0.661260639521509, 'recall': [0.654320987654321, 0.6358024691358025,
0.6975308641975309, 0.6975308641975309, 0.6211180124223602], 'avgRecall':
0.661260639521509, 'params': [{'algorithm': 'SAMME.R', 'base_estimator': None,
'learning_rate': 1, 'n_estimators': 20, 'random_state': None}]}
****

Processing Model: DecisionTreeClassifier
****
* DecisionTreeClassifier
* Best Params Result:
* {'classifier': 'DecisionTreeClassifier', 'features': 'Active inflammation?,
Severity of Crypt Arch, Increased lamina propria cellularity?, Marked &
transmucosal increase in lamina propria cellularity, Lamina propria polymorphs,
Crypt architecture, Patchy lamina propria cellularity?, Epithelial changes,
Mucosal surface, Cryptitis extent, Mucin depletion, Cryptitis polymorphs, Lamina
propria granulomas, Crypt abscesses polymorphs, Crypt abscesses extent, Basal
histiocytic cells', 'accuracy': [0.6481481481481481, 0.5740740740740741,
0.6604938271604939, 0.6975308641975309, 0.6273291925465838], 'avgAccuracy':

0.6415152212253662, 'f1': [0.6382392267051827, 0.5708570390927834, 0.6335435018537801, 0.6781778145325902, 0.6161028200591527], 'avgF1': 0.6273840804486979, 'precision': [0.6481481481481481, 0.5740740740740741, 0.6604938271604939, 0.6975308641975309, 0.6273291925465838], 'avgPrecision': 0.6415152212253662, 'recall': [0.6481481481481481, 0.5740740740740741, 0.6604938271604939, 0.6975308641975309, 0.6273291925465838], 'avgRecall': 0.6415152212253662, 'params': [{'ccp_alpha': 0.0, 'class_weight': None, 'criterion': 'gini', 'max_depth': None, 'max_features': 'sqrt', 'max_leaf_nodes': None, 'min_impurity_decrease': 0.0, 'min_impurity_split': None, 'min_samples_leaf': 1, 'min_samples_split': 2, 'min_weight_fraction_leaf': 0.0, 'random_state': None, 'splitter': 'random'}]}
****

Processing Model: SVC
****
* SVC
* Best Params Result:
* {'classifier': 'SVC', 'features': 'Active inflammation?, Severity of Crypt Arch, Increased lamina propria cellularity?, Marked & transmucosal increase in lamina propria cellularity, Lamina propria polymorphs, Crypt architecture, Patchy lamina propria cellularity?, Epithelial changes, Mucosal surface, Cryptitis extent, Mucin depletion, Cryptitis polymorphs, Lamina propria granulomas, Crypt abscesses polymorphs, Crypt abscesses extent, Basal histiocytic cells', 'accuracy': [0.6481481481481481, 0.654320987654321, 0.691358024691358, 0.7160493827160493, 0.6770186335403726], 'avgAccuracy': 0.6773790353500498, 'f1': [0.5985818977999863, 0.5998934814568833, 0.636954082706332, 0.689521710879453, 0.6449718205763514], 'avgF1': 0.6339845986838012, 'precision': [0.6481481481481481, 0.654320987654321, 0.691358024691358, 0.7160493827160493, 0.6770186335403726], 'avgPrecision': 0.6773790353500498, 'recall': [0.6481481481481481, 0.654320987654321, 0.691358024691358, 0.7160493827160493, 0.6770186335403726], 'avgRecall': 0.6773790353500498, 'params': [{'C': 1.0, 'break_ties': False, 'cache_size': 4000, 'class_weight': None, 'coef0': 0.0, 'decision_function_shape': 'ovr', 'degree': 3, 'gamma': 'scale', 'kernel': 'linear', 'max_iter': -1, 'probability': False, 'random_state': None, 'shrinking': True, 'tol': 0.001, 'verbose': False}]}
****

Processing Model: MLPClassifier
****
* MLPClassifier
* Best Params Result:
* {'classifier': 'MLPClassifier', 'features': 'Active inflammation?, Severity of Crypt Arch, Increased lamina propria cellularity?, Marked & transmucosal increase in lamina propria cellularity, Lamina propria polymorphs, Crypt architecture, Patchy lamina propria cellularity?, Epithelial changes, Mucosal surface, Cryptitis extent, Mucin depletion, Cryptitis polymorphs, Lamina propria granulomas, Crypt abscesses polymorphs, Crypt abscesses extent, Basal

histiocytic cells', 'accuracy': [0.6666666666666666, 0.6358024691358025,
0.691358024691358, 0.7160493827160493, 0.7142857142857143], 'avgAccuracy':
0.6848324514991182, 'f1': [0.6510616642898064, 0.616659223104816,
0.6638536063360331, 0.6985588273266795, 0.7026974731868341], 'avgF1':
0.6665661588488339, 'precision': [0.6666666666666666, 0.6358024691358025,
0.691358024691358, 0.7160493827160493, 0.7142857142857143], 'avgPrecision':
0.6848324514991182, 'recall': [0.6666666666666666, 0.6358024691358025,
0.691358024691358, 0.7160493827160493, 0.7142857142857143], 'avgRecall':
0.6848324514991182, 'params': [{'activation': 'logistic', 'alpha': 0.0001,
'batch_size': 'auto', 'beta_1': 0.9, 'beta_2': 0.999, 'early_stopping': False,
'epsilon': 1e-08, 'hidden_layer_sizes': (100,), 'learning_rate': 'invscaling',
'learning_rate_init': 0.001, 'max_fun': 15000, 'max_iter': 7000, 'momentum':
0.9, 'n_iter_no_change': 10, 'nesterovs_momentum': True, 'power_t': 0.5,
'random_state': None, 'shuffle': True, 'solver': 'adam', 'tol': 0.0001,
'validation_fraction': 0.1, 'verbose': False, 'warm_start': False}]}
****
****
* Best Performing Model and Params is:
* {'classifier': 'MLPClassifier', 'features': 'Active inflammation?, Severity of
Crypt Arch, Increased lamina propria cellularity?, Marked & transmucosal
increase in lamina propria cellularity, Lamina propria polymorphs, Crypt
architecture, Patchy lamina propria cellularity?, Epithelial changes, Mucosal
surface, Cryptitis extent, Mucin depletion, Cryptitis polymorphs, Lamina propria
granulomas, Crypt abscesses polymorphs, Crypt abscesses extent, Basal
histiocytic cells', 'accuracy': [0.6666666666666666, 0.6358024691358025,
0.691358024691358, 0.7160493827160493, 0.7142857142857143], 'avgAccuracy':
0.6848324514991182, 'f1': [0.6510616642898064, 0.616659223104816,
0.6638536063360331, 0.6985588273266795, 0.7026974731868341], 'avgF1':
0.6665661588488339, 'precision': [0.6666666666666666, 0.6358024691358025,
0.691358024691358, 0.7160493827160493, 0.7142857142857143], 'avgPrecision':
0.6848324514991182, 'recall': [0.6666666666666666, 0.6358024691358025,
0.691358024691358, 0.7160493827160493, 0.7142857142857143], 'avgRecall':
0.6848324514991182, 'params': [{'activation': 'logistic', 'alpha': 0.0001,
'batch_size': 'auto', 'beta_1': 0.9, 'beta_2': 0.999, 'early_stopping': False,
'epsilon': 1e-08, 'hidden_layer_sizes': (100,), 'learning_rate': 'invscaling',
'learning_rate_init': 0.001, 'max_fun': 15000, 'max_iter': 7000, 'momentum':
0.9, 'n_iter_no_change': 10, 'nesterovs_momentum': True, 'power_t': 0.5,
'random_state': None, 'shuffle': True, 'solver': 'adam', 'tol': 0.0001,
'validation_fraction': 0.1, 'verbose': False, 'warm_start': False}]}
****

                 model   features \
0 RandomForestClassifier Active inflammation?, Severity of Crypt Arch, …
1   KNeighborsClassifier Active inflammation?, Severity of Crypt Arch, …
2   LogisticRegression Active inflammation?, Severity of Crypt Arch, …
3   GaussianNB Active inflammation?, Severity of Crypt Arch, …
4   AdaBoostClassifier Active inflammation?, Severity of Crypt Arch, …
5 DecisionTreeClassifier Active inflammation?, Severity of Crypt Arch, …

```
6                   SVC   Active inflammation?, Severity of Crypt Arch, …
7           MLPClassifier   Active inflammation?, Severity of Crypt Arch, …


   accuracy        f1  precision    recall  \
0  0.668722  0.641397   0.668722  0.668722
1  0.671199  0.640080   0.671199  0.671199
2  0.679879  0.660464   0.679879  0.679879
3  0.618035  0.613104   0.618035  0.618035
4  0.661261  0.627823   0.661261  0.661261
5  0.641515  0.627384   0.641515  0.641515
6  0.677379  0.633985   0.677379  0.677379
7  0.684832  0.666566   0.684832  0.684832


                                                  params
0  {'bootstrap': True, 'ccp_alpha': 0.0, 'class_w…
1  {'algorithm': 'kd_tree', 'leaf_size': 30, 'met…
2  {'C': 1, 'class_weight': None, 'dual': False, …
3          {'priors': None, 'var_smoothing': 1e-09}
4  {'algorithm': 'SAMME.R', 'base_estimator': Non…
5  {'ccp_alpha': 0.0, 'class_weight': None, 'crit…
6  {'C': 1.0, 'break_ties': False, 'cache_size': …
7  {'activation': 'logistic', 'alpha': 0.0001, 'b…


Processing Model: RandomForestClassifier
*******************************************************
* RandomForestClassifier
* Best Params Result:
* {'classifier': 'RandomForestClassifier', 'features': 'Active inflammation?,
Severity of Crypt Arch, Increased lamina propria cellularity?, Marked &
transmucosal increase in lamina propria cellularity, Lamina propria polymorphs,
Crypt architecture, Patchy lamina propria cellularity?, Epithelial changes,
Mucosal surface, Cryptitis extent, Mucin depletion, Cryptitis polymorphs, Lamina
propria granulomas, Crypt abscesses polymorphs, Crypt abscesses extent',
'accuracy': [0.6481481481481481, 0.6358024691358025, 0.691358024691358,
0.6975308641975309, 0.6645962732919255], 'avgAccuracy': 0.667487155892953, 'f1':
[0.6267558436233135, 0.6209603632084253, 0.6440760081630835, 0.6677297668038409,
0.6500482062700954], 'avgF1': 0.6419140376137518, 'precision':
[0.6481481481481481, 0.6358024691358025, 0.691358024691358, 0.6975308641975309,
0.6645962732919255], 'avgPrecision': 0.667487155892953, 'recall':
[0.6481481481481481, 0.6358024691358025, 0.691358024691358, 0.6975308641975309,
0.6645962732919255], 'avgRecall': 0.667487155892953, 'params': [{'bootstrap':
True, 'ccp_alpha': 0.0, 'class_weight': None, 'criterion': 'entropy',
'max_depth': None, 'max_features': 'log2', 'max_leaf_nodes': None,
'max_samples': None, 'min_impurity_decrease': 0.0, 'min_impurity_split': None,
'min_samples_leaf': 1, 'min_samples_split': 2, 'min_weight_fraction_leaf': 0.0,
'n_estimators': 700, 'n_jobs': -1, 'oob_score': False, 'random_state': None,
'verbose': 0, 'warm_start': False}]}
*******************************************************
```

```
Processing Model: KNeighborsClassifier
********************************************************
* KNeighborsClassifier
* Best Params Result:
* {'classifier': 'KNeighborsClassifier', 'features': 'Active inflammation?,
Severity of Crypt Arch, Increased lamina propria cellularity?, Marked &
transmucosal increase in lamina propria cellularity, Lamina propria polymorphs,
Crypt architecture, Patchy lamina propria cellularity?, Epithelial changes,
Mucosal surface, Cryptitis extent, Mucin depletion, Cryptitis polymorphs, Lamina
propria granulomas, Crypt abscesses polymorphs, Crypt abscesses extent',
'accuracy': [0.6666666666666666, 0.654320987654321, 0.6851851851851852,
0.7037037037037037, 0.6583850931677019], 'avgAccuracy': 0.6736523272755157,
'f1': [0.6332339153746949, 0.6400893823374444, 0.6388409336768265,
0.6723625302572672, 0.63064361622064], 'avgF1': 0.6430340755733746, 'precision':
[0.6666666666666666, 0.654320987654321, 0.6851851851851852, 0.7037037037037037,
0.6583850931677019], 'avgPrecision': 0.6736523272755157, 'recall':
[0.6666666666666666, 0.654320987654321, 0.6851851851851852, 0.7037037037037037,
0.6583850931677019], 'avgRecall': 0.6736523272755157, 'params': [{'algorithm':
'brute', 'leaf_size': 30, 'metric': 'minkowski', 'metric_params': None,
'n_jobs': -1, 'n_neighbors': 14, 'p': 2, 'weights': 'uniform'}]}
********************************************************

Processing Model: LogisticRegression
********************************************************
* LogisticRegression
* Best Params Result:
* {'classifier': 'LogisticRegression', 'features': 'Active inflammation?,
Severity of Crypt Arch, Increased lamina propria cellularity?, Marked &
transmucosal increase in lamina propria cellularity, Lamina propria polymorphs,
Crypt architecture, Patchy lamina propria cellularity?, Epithelial changes,
Mucosal surface, Cryptitis extent, Mucin depletion, Cryptitis polymorphs, Lamina
propria granulomas, Crypt abscesses polymorphs, Crypt abscesses extent',
'accuracy': [0.6604938271604939, 0.6358024691358025, 0.691358024691358,
0.6975308641975309, 0.7018633540372671], 'avgAccuracy': 0.6774097078444905,
'f1': [0.6455797537300906, 0.6065403387884009, 0.6638536063360331,
0.6789518130753198, 0.6921004803720588], 'avgF1': 0.6574051984603806,
'precision': [0.6604938271604939, 0.6358024691358025, 0.691358024691358,
0.6975308641975309, 0.7018633540372671], 'avgPrecision': 0.6774097078444905,
'recall': [0.6604938271604939, 0.6358024691358025, 0.691358024691358,
0.6975308641975309, 0.7018633540372671], 'avgRecall': 0.6774097078444905,
'params': [{'C': 1, 'class_weight': None, 'dual': False, 'fit_intercept': True,
'intercept_scaling': 1, 'l1_ratio': None, 'max_iter': 100, 'multi_class':
'multinomial', 'n_jobs': -1, 'penalty': 'l2', 'random_state': None, 'solver':
'newton-cg', 'tol': 0.0001, 'verbose': 0, 'warm_start': False}]}
********************************************************

Processing Model: GaussianNB
```

```
*******************************************************
* GaussianNB
* Best Params Result:
* {'classifier': 'GaussianNB', 'features': 'Active inflammation?, Severity of
Crypt Arch, Increased lamina propria cellularity?, Marked & transmucosal
increase in lamina propria cellularity, Lamina propria polymorphs, Crypt
architecture, Patchy lamina propria cellularity?, Epithelial changes, Mucosal
surface, Cryptitis extent, Mucin depletion, Cryptitis polymorphs, Lamina propria
granulomas, Crypt abscesses polymorphs, Crypt abscesses extent', 'accuracy':
[0.5679012345679012, 0.5864197530864198, 0.6481481481481481, 0.6728395061728395,
0.6086956521739131], 'avgAccuracy': 0.6168008588298444, 'f1':
[0.5650815045622625, 0.567280016773684, 0.6384252325112539, 0.6673745083329801,
0.6218175896729878], 'avgF1': 0.6119957703706337, 'precision':
[0.5679012345679012, 0.5864197530864198, 0.6481481481481481, 0.6728395061728395,
0.6086956521739131], 'avgPrecision': 0.6168008588298444, 'recall':
[0.5679012345679012, 0.5864197530864198, 0.6481481481481481, 0.6728395061728395,
0.6086956521739131], 'avgRecall': 0.6168008588298444, 'params': [{'priors':
None, 'var_smoothing': 1e-09}]}
*******************************************************

Processing Model: AdaBoostClassifier
*******************************************************
* AdaBoostClassifier
* Best Params Result:
* {'classifier': 'AdaBoostClassifier', 'features': 'Active inflammation?,
Severity of Crypt Arch, Increased lamina propria cellularity?, Marked &
transmucosal increase in lamina propria cellularity, Lamina propria polymorphs,
Crypt architecture, Patchy lamina propria cellularity?, Epithelial changes,
Mucosal surface, Cryptitis extent, Mucin depletion, Cryptitis polymorphs, Lamina
propria granulomas, Crypt abscesses polymorphs, Crypt abscesses extent',
'accuracy': [0.6234567901234568, 0.6358024691358025, 0.691358024691358,
0.6851851851851852, 0.6459627329192547], 'avgAccuracy': 0.6563530404110114,
'f1': [0.5806747534417762, 0.5691429076872659, 0.6362838847000001,
0.6441046039154786, 0.63992345358805], 'avgF1': 0.6140259206665142, 'precision':
[0.6234567901234568, 0.6358024691358025, 0.691358024691358, 0.6851851851851852,
0.6459627329192547], 'avgPrecision': 0.6563530404110114, 'recall':
[0.6234567901234568, 0.6358024691358025, 0.691358024691358, 0.6851851851851852,
0.6459627329192547], 'avgRecall': 0.6563530404110114, 'params': [{'algorithm':
'SAMME.R', 'base_estimator': None, 'learning_rate': 1, 'n_estimators': 20,
'random_state': None}]}
*******************************************************

Processing Model: DecisionTreeClassifier
*******************************************************
* DecisionTreeClassifier
* Best Params Result:
* {'classifier': 'DecisionTreeClassifier', 'features': 'Active inflammation?,
Severity of Crypt Arch, Increased lamina propria cellularity?, Marked &
```

transmucosal increase in lamina propria cellularity, Lamina propria polymorphs, Crypt architecture, Patchy lamina propria cellularity?, Epithelial changes, Mucosal surface, Cryptitis extent, Mucin depletion, Cryptitis polymorphs, Lamina propria granulomas, Crypt abscesses polymorphs, Crypt abscesses extent', 'accuracy': [0.6296296296296297, 0.5864197530864198, 0.6728395061728395, 0.6481481481481481, 0.6645962732919255], 'avgAccuracy': 0.6403266620657925, 'f1': [0.6148148148148148, 0.5781149450038117, 0.6425789210656214, 0.629505711450156, 0.6613312778949427], 'avgF1': 0.6252691340458694, 'precision': [0.6296296296296297, 0.5864197530864198, 0.6728395061728395, 0.6481481481481481, 0.6645962732919255], 'avgPrecision': 0.6403266620657925, 'recall': [0.6296296296296297, 0.5864197530864198, 0.6728395061728395, 0.6481481481481481, 0.6645962732919255], 'avgRecall': 0.6403266620657925, 'params': [{'ccp_alpha': 0.0, 'class_weight': None, 'criterion': 'entropy', 'max_depth': None, 'max_features': 'sqrt', 'max_leaf_nodes': None, 'min_impurity_decrease': 0.0, 'min_impurity_split': None, 'min_samples_leaf': 1, 'min_samples_split': 2, 'min_weight_fraction_leaf': 0.0, 'random_state': None, 'splitter': 'best'}]}
****

Processing Model: SVC
****
* SVC
* Best Params Result:
* {'classifier': 'SVC', 'features': 'Active inflammation?, Severity of Crypt Arch, Increased lamina propria cellularity?, Marked & transmucosal increase in lamina propria cellularity, Lamina propria polymorphs, Crypt architecture, Patchy lamina propria cellularity?, Epithelial changes, Mucosal surface, Cryptitis extent, Mucin depletion, Cryptitis polymorphs, Lamina propria granulomas, Crypt abscesses polymorphs, Crypt abscesses extent', 'accuracy': [0.6481481481481481, 0.654320987654321, 0.691358024691358, 0.7160493827160493, 0.6770186335403726], 'avgAccuracy': 0.6773790353500498, 'f1': [0.5985818977999863, 0.5998934814568833, 0.636954082706332, 0.689521710879453, 0.6449718205763514], 'avgF1': 0.6339845986838012, 'precision': [0.6481481481481481, 0.654320987654321, 0.691358024691358, 0.7160493827160493, 0.6770186335403726], 'avgPrecision': 0.6773790353500498, 'recall': [0.6481481481481481, 0.654320987654321, 0.691358024691358, 0.7160493827160493, 0.6770186335403726], 'avgRecall': 0.6773790353500498, 'params': [{'C': 1.0, 'break_ties': False, 'cache_size': 4000, 'class_weight': None, 'coef0': 0.0, 'decision_function_shape': 'ovr', 'degree': 3, 'gamma': 'scale', 'kernel': 'linear', 'max_iter': -1, 'probability': False, 'random_state': None, 'shrinking': True, 'tol': 0.001, 'verbose': False}]}
****

Processing Model: MLPClassifier
****
* MLPClassifier
* Best Params Result:
* {'classifier': 'MLPClassifier', 'features': 'Active inflammation?, Severity of

Crypt Arch, Increased lamina propria cellularity?, Marked & transmucosal
increase in lamina propria cellularity, Lamina propria polymorphs, Crypt
architecture, Patchy lamina propria cellularity?, Epithelial changes, Mucosal
surface, Cryptitis extent, Mucin depletion, Cryptitis polymorphs, Lamina propria
granulomas, Crypt abscesses polymorphs, Crypt abscesses extent', 'accuracy':
[0.6666666666666666, 0.6419753086419753, 0.691358024691358, 0.7098765432098766,
0.7018633540372671], 'avgAccuracy': 0.6823479794494287, 'f1':
[0.6510616642898064, 0.6169789294884294, 0.6638536063360331, 0.693178700586108,
0.6921004803720588], 'avgF1': 0.6634346762144872, 'precision':
[0.6666666666666666, 0.6419753086419753, 0.691358024691358, 0.7098765432098766,
0.7018633540372671], 'avgPrecision': 0.6823479794494287, 'recall':
[0.6666666666666666, 0.6419753086419753, 0.691358024691358, 0.7098765432098766,
0.7018633540372671], 'avgRecall': 0.6823479794494287, 'params': [{'activation':
'logistic', 'alpha': 0.0001, 'batch_size': 'auto', 'beta_1': 0.9, 'beta_2':
0.999, 'early_stopping': False, 'epsilon': 1e-08, 'hidden_layer_sizes': (100,),
'learning_rate': 'constant', 'learning_rate_init': 0.001, 'max_fun': 15000,
'max_iter': 7000, 'momentum': 0.9, 'n_iter_no_change': 10, 'nesterovs_momentum':
True, 'power_t': 0.5, 'random_state': None, 'shuffle': True, 'solver': 'adam',
'tol': 0.0001, 'validation_fraction': 0.1, 'verbose': False, 'warm_start':
False}]}
****
****
* Best Performing Model and Params is:
* {'classifier': 'MLPClassifier', 'features': 'Active inflammation?, Severity of
Crypt Arch, Increased lamina propria cellularity?, Marked & transmucosal
increase in lamina propria cellularity, Lamina propria polymorphs, Crypt
architecture, Patchy lamina propria cellularity?, Epithelial changes, Mucosal
surface, Cryptitis extent, Mucin depletion, Cryptitis polymorphs, Lamina propria
granulomas, Crypt abscesses polymorphs, Crypt abscesses extent', 'accuracy':
[0.6666666666666666, 0.6419753086419753, 0.691358024691358, 0.7098765432098766,
0.7018633540372671], 'avgAccuracy': 0.6823479794494287, 'f1':
[0.6510616642898064, 0.6169789294884294, 0.6638536063360331, 0.693178700586108,
0.6921004803720588], 'avgF1': 0.6634346762144872, 'precision':
[0.6666666666666666, 0.6419753086419753, 0.691358024691358, 0.7098765432098766,
0.7018633540372671], 'avgPrecision': 0.6823479794494287, 'recall':
[0.6666666666666666, 0.6419753086419753, 0.691358024691358, 0.7098765432098766,
0.7018633540372671], 'avgRecall': 0.6823479794494287, 'params': [{'activation':
'logistic', 'alpha': 0.0001, 'batch_size': 'auto', 'beta_1': 0.9, 'beta_2':
0.999, 'early_stopping': False, 'epsilon': 1e-08, 'hidden_layer_sizes': (100,),
'learning_rate': 'constant', 'learning_rate_init': 0.001, 'max_fun': 15000,
'max_iter': 7000, 'momentum': 0.9, 'n_iter_no_change': 10, 'nesterovs_momentum':
True, 'power_t': 0.5, 'random_state': None, 'shuffle': True, 'solver': 'adam',
'tol': 0.0001, 'validation_fraction': 0.1, 'verbose': False, 'warm_start':
False}]}
****

                 model   features \
0 RandomForestClassifier Active inflammation?, Severity of Crypt Arch, …

```
1       KNeighborsClassifier  Active inflammation?, Severity of Crypt Arch, …
2         LogisticRegression  Active inflammation?, Severity of Crypt Arch, …
3                 GaussianNB  Active inflammation?, Severity of Crypt Arch, …
4         AdaBoostClassifier  Active inflammation?, Severity of Crypt Arch, …
5     DecisionTreeClassifier  Active inflammation?, Severity of Crypt Arch, …
6                        SVC  Active inflammation?, Severity of Crypt Arch, …
7              MLPClassifier  Active inflammation?, Severity of Crypt Arch, …


     accuracy        f1  precision    recall  \
0   0.667487  0.641914   0.667487  0.667487
1   0.673652  0.643034   0.673652  0.673652
2   0.677410  0.657405   0.677410  0.677410
3   0.616801  0.611996   0.616801  0.616801
4   0.656353  0.614026   0.656353  0.656353
5   0.640327  0.625269   0.640327  0.640327
6   0.677379  0.633985   0.677379  0.677379
7   0.682348  0.663435   0.682348  0.682348


                                                params
0  {'bootstrap': True, 'ccp_alpha': 0.0, 'class_w…
1  {'algorithm': 'brute', 'leaf_size': 30, 'metri…
2  {'C': 1, 'class_weight': None, 'dual': False, …
3          {'priors': None, 'var_smoothing': 1e-09}
4  {'algorithm': 'SAMME.R', 'base_estimator': Non…
5  {'ccp_alpha': 0.0, 'class_weight': None, 'crit…
6  {'C': 1.0, 'break_ties': False, 'cache_size': …
7  {'activation': 'logistic', 'alpha': 0.0001, 'b…
```

Processing Model: RandomForestClassifier
****
* RandomForestClassifier
* Best Params Result:
* {'classifier': 'RandomForestClassifier', 'features': 'Active inflammation?,
Severity of Crypt Arch, Increased lamina propria cellularity?, Marked &
transmucosal increase in lamina propria cellularity, Lamina propria polymorphs,
Crypt architecture, Patchy lamina propria cellularity?, Epithelial changes,
Mucosal surface, Cryptitis extent, Mucin depletion, Cryptitis polymorphs, Lamina
propria granulomas, Crypt abscesses polymorphs', 'accuracy':
[0.6419753086419753, 0.6481481481481481, 0.691358024691358, 0.7037037037037037,
0.6832298136645962], 'avgAccuracy': 0.6736829997699563, 'f1':
[0.611779051916962, 0.6316539548198913, 0.6440760081630835, 0.6661844397508996,
0.6708316695923395], 'avgF1': 0.6449050248486352, 'precision':
[0.6419753086419753, 0.6481481481481481, 0.691358024691358, 0.7037037037037037,
0.6832298136645962], 'avgPrecision': 0.6736829997699563, 'recall':
[0.6419753086419753, 0.6481481481481481, 0.691358024691358, 0.7037037037037037,
0.6832298136645962], 'avgRecall': 0.6736829997699563, 'params': [{'bootstrap':
True, 'ccp_alpha': 0.0, 'class_weight': None, 'criterion': 'entropy',
'max_depth': None, 'max_features': 'log2', 'max_leaf_nodes': None,

```
'max_samples': None, 'min_impurity_decrease': 0.0, 'min_impurity_split': None,
'min_samples_leaf': 1, 'min_samples_split': 2, 'min_weight_fraction_leaf': 0.0,
'n_estimators': 200, 'n_jobs': -1, 'oob_score': True, 'random_state': None,
'verbose': 0, 'warm_start': False}]}
******************************************************

Processing Model: KNeighborsClassifier
******************************************************
* KNeighborsClassifier
* Best Params Result:
* {'classifier': 'KNeighborsClassifier', 'features': 'Active inflammation?,
Severity of Crypt Arch, Increased lamina propria cellularity?, Marked &
transmucosal increase in lamina propria cellularity, Lamina propria polymorphs,
Crypt architecture, Patchy lamina propria cellularity?, Epithelial changes,
Mucosal surface, Cryptitis extent, Mucin depletion, Cryptitis polymorphs, Lamina
propria granulomas, Crypt abscesses polymorphs', 'accuracy':
[0.6358024691358025, 0.6419753086419753, 0.691358024691358, 0.7098765432098766,
0.6770186335403726], 'avgAccuracy': 0.671206195843877, 'f1':
[0.6223093183021561, 0.6218911613090347, 0.6440760081630835, 0.677389451198975,
0.6449718205763514], 'avgF1': 0.6421275519099201, 'precision':
[0.6358024691358025, 0.6419753086419753, 0.691358024691358, 0.7098765432098766,
0.6770186335403726], 'avgPrecision': 0.671206195843877, 'recall':
[0.6358024691358025, 0.6419753086419753, 0.691358024691358, 0.7098765432098766,
0.6770186335403726], 'avgRecall': 0.671206195843877, 'params': [{'algorithm':
'auto', 'leaf_size': 30, 'metric': 'minkowski', 'metric_params': None, 'n_jobs':
-1, 'n_neighbors': 16, 'p': 2, 'weights': 'uniform'}]}
******************************************************

Processing Model: LogisticRegression
******************************************************
* LogisticRegression
* Best Params Result:
* {'classifier': 'LogisticRegression', 'features': 'Active inflammation?,
Severity of Crypt Arch, Increased lamina propria cellularity?, Marked &
transmucosal increase in lamina propria cellularity, Lamina propria polymorphs,
Crypt architecture, Patchy lamina propria cellularity?, Epithelial changes,
Mucosal surface, Cryptitis extent, Mucin depletion, Cryptitis polymorphs, Lamina
propria granulomas, Crypt abscesses polymorphs', 'accuracy':
[0.6604938271604939, 0.6358024691358025, 0.691358024691358, 0.7098765432098766,
0.6956521739130435], 'avgAccuracy': 0.6786366076221149, 'f1':
[0.6455797537300906, 0.6065403387884009, 0.6638536063360331, 0.6941883284553896,
0.6866405275467077], 'avgF1': 0.6593605109713243, 'precision':
[0.6604938271604939, 0.6358024691358025, 0.691358024691358, 0.7098765432098766,
0.6956521739130435], 'avgPrecision': 0.6786366076221149, 'recall':
[0.6604938271604939, 0.6358024691358025, 0.691358024691358, 0.7098765432098766,
0.6956521739130435], 'avgRecall': 0.6786366076221149, 'params': [{'C': 1,
'class_weight': None, 'dual': False, 'fit_intercept': True, 'intercept_scaling':
1, 'l1_ratio': None, 'max_iter': 100, 'multi_class': 'multinomial', 'n_jobs':
```

-1, 'penalty': 'l2', 'random_state': None, 'solver': 'newton-cg', 'tol': 0.0001,
'verbose': 0, 'warm_start': False}]}
****

Processing Model: GaussianNB
****
* GaussianNB
* Best Params Result:
* {'classifier': 'GaussianNB', 'features': 'Active inflammation?, Severity of
Crypt Arch, Increased lamina propria cellularity?, Marked & transmucosal
increase in lamina propria cellularity, Lamina propria polymorphs, Crypt
architecture, Patchy lamina propria cellularity?, Epithelial changes, Mucosal
surface, Cryptitis extent, Mucin depletion, Cryptitis polymorphs, Lamina propria
granulomas, Crypt abscesses polymorphs', 'accuracy': [0.5740740740740741,
0.5864197530864198, 0.6419753086419753, 0.6666666666666666, 0.6335403726708074],
'avgAccuracy': 0.6205352350279887, 'f1': [0.5741734407821273,
0.5623110294235301, 0.6300491341014217, 0.6615414982663045, 0.6409670984340171],
'avgF1': 0.6138084402014802, 'precision': [0.5740740740740741,
0.5864197530864198, 0.6419753086419753, 0.6666666666666666, 0.6335403726708074],
'avgPrecision': 0.6205352350279887, 'recall': [0.5740740740740741,
0.5864197530864198, 0.6419753086419753, 0.6666666666666666, 0.6335403726708074],
'avgRecall': 0.6205352350279887, 'params': [{'priors': None, 'var_smoothing':
1e-09}]}
****

Processing Model: AdaBoostClassifier
****
* AdaBoostClassifier
* Best Params Result:
* {'classifier': 'AdaBoostClassifier', 'features': 'Active inflammation?,
Severity of Crypt Arch, Increased lamina propria cellularity?, Marked &
transmucosal increase in lamina propria cellularity, Lamina propria polymorphs,
Crypt architecture, Patchy lamina propria cellularity?, Epithelial changes,
Mucosal surface, Cryptitis extent, Mucin depletion, Cryptitis polymorphs, Lamina
propria granulomas, Crypt abscesses polymorphs', 'accuracy':
[0.6419753086419753, 0.6358024691358025, 0.6975308641975309, 0.6851851851851852,
0.6459627329192547], 'avgAccuracy': 0.6612913120159497, 'f1':
[0.6129149270953962, 0.5691429076872659, 0.6688400306544482, 0.6374573047051529,
0.63992345358805], 'avgF1': 0.6256557247460627, 'precision':
[0.6419753086419753, 0.6358024691358025, 0.6975308641975309, 0.6851851851851852,
0.6459627329192547], 'avgPrecision': 0.6612913120159497, 'recall':
[0.6419753086419753, 0.6358024691358025, 0.6975308641975309, 0.6851851851851852,
0.6459627329192547], 'avgRecall': 0.6612913120159497, 'params': [{'algorithm':
'SAMME.R', 'base_estimator': None, 'learning_rate': 1, 'n_estimators': 20,
'random_state': None}]}
****

Processing Model: DecisionTreeClassifier

```
**********************************************
* DecisionTreeClassifier
* Best Params Result:
* {'classifier': 'DecisionTreeClassifier', 'features': 'Active inflammation?,
Severity of Crypt Arch, Increased lamina propria cellularity?, Marked &
transmucosal increase in lamina propria cellularity, Lamina propria polymorphs,
Crypt architecture, Patchy lamina propria cellularity?, Epithelial changes,
Mucosal surface, Cryptitis extent, Mucin depletion, Cryptitis polymorphs, Lamina
propria granulomas, Crypt abscesses polymorphs', 'accuracy':
[0.6296296296296297, 0.5987654320987654, 0.6790123456790124, 0.691358024691358,
0.6459627329192547], 'avgAccuracy': 0.648945633003604, 'f1':
[0.6108389978121779, 0.5997443364368429, 0.6409636609177234, 0.6628208655271481,
0.6368915114984625], 'avgF1': 0.630251874438471, 'precision':
[0.6296296296296297, 0.5987654320987654, 0.6790123456790124, 0.691358024691358,
0.6459627329192547], 'avgPrecision': 0.648945633003604, 'recall':
[0.6296296296296297, 0.5987654320987654, 0.6790123456790124, 0.691358024691358,
0.6459627329192547], 'avgRecall': 0.648945633003604, 'params': [{'ccp_alpha':
0.0, 'class_weight': None, 'criterion': 'entropy', 'max_depth': None,
'max_features': 'auto', 'max_leaf_nodes': None, 'min_impurity_decrease': 0.0,
'min_impurity_split': None, 'min_samples_leaf': 1, 'min_samples_split': 2,
'min_weight_fraction_leaf': 0.0, 'random_state': None, 'splitter': 'best'}]}
**********************************************

Processing Model: SVC
**********************************************
* SVC
* Best Params Result:
* {'classifier': 'SVC', 'features': 'Active inflammation?, Severity of Crypt
Arch, Increased lamina propria cellularity?, Marked & transmucosal increase in
lamina propria cellularity, Lamina propria polymorphs, Crypt architecture,
Patchy lamina propria cellularity?, Epithelial changes, Mucosal surface,
Cryptitis extent, Mucin depletion, Cryptitis polymorphs, Lamina propria
granulomas, Crypt abscesses polymorphs', 'accuracy': [0.6481481481481481,
0.654320987654321, 0.691358024691358, 0.7160493827160493, 0.6770186335403726],
'avgAccuracy': 0.6773790353500498, 'f1': [0.5985818977999863,
0.5998934814568833, 0.636954082706332, 0.689521710879453, 0.6449718205763514],
'avgF1': 0.6339845986838012, 'precision': [0.6481481481481481,
0.654320987654321, 0.691358024691358, 0.7160493827160493, 0.6770186335403726],
'avgPrecision': 0.6773790353500498, 'recall': [0.6481481481481481,
0.654320987654321, 0.691358024691358, 0.7160493827160493, 0.6770186335403726],
'avgRecall': 0.6773790353500498, 'params': [{'C': 1.0, 'break_ties': False,
'cache_size': 4000, 'class_weight': None, 'coef0': 0.0,
'decision_function_shape': 'ovr', 'degree': 3, 'gamma': 'scale', 'kernel':
'linear', 'max_iter': -1, 'probability': False, 'random_state': None,
'shrinking': True, 'tol': 0.001, 'verbose': False}]}
**********************************************

Processing Model: MLPClassifier
```

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****************************************************
* MLPClassifier
* Best Params Result:
* {'classifier': 'MLPClassifier', 'features': 'Active inflammation?, Severity of
Crypt Arch, Increased lamina propria cellularity?, Marked & transmucosal
increase in lamina propria cellularity, Lamina propria polymorphs, Crypt
architecture, Patchy lamina propria cellularity?, Epithelial changes, Mucosal
surface, Cryptitis extent, Mucin depletion, Cryptitis polymorphs, Lamina propria
granulomas, Crypt abscesses polymorphs', 'accuracy': [0.6666666666666666,
0.6296296296296297, 0.691358024691358, 0.7160493827160493, 0.7080745341614907],
'avgAccuracy': 0.6823556475730389, 'f1': [0.6510616642898064,
0.6114321224415687, 0.6638536063360331, 0.6938995873679071, 0.6976159480776356],
'avgF1': 0.6635725857025901, 'precision': [0.6666666666666666,
0.6296296296296297, 0.691358024691358, 0.7160493827160493, 0.7080745341614907],
'avgPrecision': 0.6823556475730389, 'recall': [0.6666666666666666,
0.6296296296296297, 0.691358024691358, 0.7160493827160493, 0.7080745341614907],
'avgRecall': 0.6823556475730389, 'params': [{'activation': 'logistic', 'alpha':
0.0001, 'batch_size': 'auto', 'beta_1': 0.9, 'beta_2': 0.999, 'early_stopping':
False, 'epsilon': 1e-08, 'hidden_layer_sizes': (100,), 'learning_rate':
'invscaling', 'learning_rate_init': 0.001, 'max_fun': 15000, 'max_iter': 9000,
'momentum': 0.9, 'n_iter_no_change': 10, 'nesterovs_momentum': True, 'power_t':
0.5, 'random_state': None, 'shuffle': True, 'solver': 'adam', 'tol': 0.0001,
'validation_fraction': 0.1, 'verbose': False, 'warm_start': False}]}
****************************************************
****************************************************
* Best Performing Model and Params is:
* {'classifier': 'MLPClassifier', 'features': 'Active inflammation?, Severity of
Crypt Arch, Increased lamina propria cellularity?, Marked & transmucosal
increase in lamina propria cellularity, Lamina propria polymorphs, Crypt
architecture, Patchy lamina propria cellularity?, Epithelial changes, Mucosal
surface, Cryptitis extent, Mucin depletion, Cryptitis polymorphs, Lamina propria
granulomas, Crypt abscesses polymorphs', 'accuracy': [0.6666666666666666,
0.6296296296296297, 0.691358024691358, 0.7160493827160493, 0.7080745341614907],
'avgAccuracy': 0.6823556475730389, 'f1': [0.6510616642898064,
0.6114321224415687, 0.6638536063360331, 0.6938995873679071, 0.6976159480776356],
'avgF1': 0.6635725857025901, 'precision': [0.6666666666666666,
0.6296296296296297, 0.691358024691358, 0.7160493827160493, 0.7080745341614907],
'avgPrecision': 0.6823556475730389, 'recall': [0.6666666666666666,
0.6296296296296297, 0.691358024691358, 0.7160493827160493, 0.7080745341614907],
'avgRecall': 0.6823556475730389, 'params': [{'activation': 'logistic', 'alpha':
0.0001, 'batch_size': 'auto', 'beta_1': 0.9, 'beta_2': 0.999, 'early_stopping':
False, 'epsilon': 1e-08, 'hidden_layer_sizes': (100,), 'learning_rate':
'invscaling', 'learning_rate_init': 0.001, 'max_fun': 15000, 'max_iter': 9000,
'momentum': 0.9, 'n_iter_no_change': 10, 'nesterovs_momentum': True, 'power_t':
0.5, 'random_state': None, 'shuffle': True, 'solver': 'adam', 'tol': 0.0001,
'validation_fraction': 0.1, 'verbose': False, 'warm_start': False}]}
****************************************************
```

```
                   model                                       features  \
0   RandomForestClassifier  Active inflammation?, Severity of Crypt Arch, …
1     KNeighborsClassifier  Active inflammation?, Severity of Crypt Arch, …
2       LogisticRegression  Active inflammation?, Severity of Crypt Arch, …
3               GaussianNB  Active inflammation?, Severity of Crypt Arch, …
4        AdaBoostClassifier  Active inflammation?, Severity of Crypt Arch, …
5   DecisionTreeClassifier  Active inflammation?, Severity of Crypt Arch, …
6                      SVC  Active inflammation?, Severity of Crypt Arch, …
7            MLPClassifier  Active inflammation?, Severity of Crypt Arch, …


   accuracy        f1  precision    recall  \
0  0.673683  0.644905   0.673683  0.673683
1  0.671206  0.642128   0.671206  0.671206
2  0.678637  0.659361   0.678637  0.678637
3  0.620535  0.613808   0.620535  0.620535
4  0.661291  0.625656   0.661291  0.661291
5  0.648946  0.630252   0.648946  0.648946
6  0.677379  0.633985   0.677379  0.677379
7  0.682356  0.663573   0.682356  0.682356


                                                params
0  {'bootstrap': True, 'ccp_alpha': 0.0, 'class_w…
1  {'algorithm': 'auto', 'leaf_size': 30, 'metric…
2  {'C': 1, 'class_weight': None, 'dual': False, …
3          {'priors': None, 'var_smoothing': 1e-09}
4  {'algorithm': 'SAMME.R', 'base_estimator': Non…
5  {'ccp_alpha': 0.0, 'class_weight': None, 'crit…
6  {'C': 1.0, 'break_ties': False, 'cache_size': …
7  {'activation': 'logistic', 'alpha': 0.0001, 'b…


Processing Model: RandomForestClassifier
********************************************************
* RandomForestClassifier
* Best Params Result:
* {'classifier': 'RandomForestClassifier', 'features': 'Active inflammation?,
Severity of Crypt Arch, Increased lamina propria cellularity?, Marked &
transmucosal increase in lamina propria cellularity, Lamina propria polymorphs,
Crypt architecture, Patchy lamina propria cellularity?, Epithelial changes,
Mucosal surface, Cryptitis extent, Mucin depletion, Cryptitis polymorphs, Lamina
propria granulomas', 'accuracy': [0.6481481481481481, 0.6296296296296297,
0.691358024691358, 0.7098765432098766, 0.6645962732919255], 'avgAccuracy':
0.6687217237941876, 'f1': [0.6046815034718288, 0.6114321224415687,
0.6440760081630835, 0.6834705075445816, 0.6553240536045052], 'avgF1':
0.6397968390451135, 'precision': [0.6481481481481481, 0.6296296296296297,
0.691358024691358, 0.7098765432098766, 0.6645962732919255], 'avgPrecision':
0.6687217237941876, 'recall': [0.6481481481481481, 0.6296296296296297,
0.691358024691358, 0.7098765432098766, 0.6645962732919255], 'avgRecall':
0.6687217237941876, 'params': [{'bootstrap': True, 'ccp_alpha': 0.0,
```

'class_weight': None, 'criterion': 'gini', 'max_depth': None, 'max_features':
'sqrt', 'max_leaf_nodes': None, 'max_samples': None, 'min_impurity_decrease':
0.0, 'min_impurity_split': None, 'min_samples_leaf': 1, 'min_samples_split': 2,
'min_weight_fraction_leaf': 0.0, 'n_estimators': 700, 'n_jobs': -1, 'oob_score':
True, 'random_state': None, 'verbose': 0, 'warm_start': False}]}
****

Processing Model: KNeighborsClassifier
****
* KNeighborsClassifier
* Best Params Result:
* {'classifier': 'KNeighborsClassifier', 'features': 'Active inflammation?,
Severity of Crypt Arch, Increased lamina propria cellularity?, Marked &
transmucosal increase in lamina propria cellularity, Lamina propria polymorphs,
Crypt architecture, Patchy lamina propria cellularity?, Epithelial changes,
Mucosal surface, Cryptitis extent, Mucin depletion, Cryptitis polymorphs, Lamina
propria granulomas', 'accuracy': [0.6296296296296297, 0.6419753086419753,
0.6975308641975309, 0.7222222222222222, 0.6645962732919255], 'avgAccuracy':
0.6711908595966567, 'f1': [0.6169657193929062, 0.6169789294884294,
0.6688400306544482, 0.6993397548953104, 0.649617436943838], 'avgF1':
0.6503483742749865, 'precision': [0.6296296296296297, 0.6419753086419753,
0.6975308641975309, 0.7222222222222222, 0.6645962732919255], 'avgPrecision':
0.6711908595966567, 'recall': [0.6296296296296297, 0.6419753086419753,
0.6975308641975309, 0.7222222222222222, 0.6645962732919255], 'avgRecall':
0.6711908595966567, 'params': [{'algorithm': 'auto', 'leaf_size': 30, 'metric':
'minkowski', 'metric_params': None, 'n_jobs': -1, 'n_neighbors': 16, 'p': 2,
'weights': 'uniform'}]}
****

Processing Model: LogisticRegression
****
* LogisticRegression
* Best Params Result:
* {'classifier': 'LogisticRegression', 'features': 'Active inflammation?,
Severity of Crypt Arch, Increased lamina propria cellularity?, Marked &
transmucosal increase in lamina propria cellularity, Lamina propria polymorphs,
Crypt architecture, Patchy lamina propria cellularity?, Epithelial changes,
Mucosal surface, Cryptitis extent, Mucin depletion, Cryptitis polymorphs, Lamina
propria granulomas', 'accuracy': [0.654320987654321, 0.6358024691358025,
0.691358024691358, 0.7098765432098766, 0.6832298136645962], 'avgAccuracy':
0.6749175676711908, 'f1': [0.6401079598911578, 0.6065403387884009,
0.6638536063360331, 0.693178700586108, 0.6708316695923395], 'avgF1':
0.6549024550388078, 'precision': [0.654320987654321, 0.6358024691358025,
0.691358024691358, 0.7098765432098766, 0.6832298136645962], 'avgPrecision':
0.6749175676711908, 'recall': [0.654320987654321, 0.6358024691358025,
0.691358024691358, 0.7098765432098766, 0.6832298136645962], 'avgRecall':
0.6749175676711908, 'params': [{'C': 1, 'class_weight': None, 'dual': False,
'fit_intercept': True, 'intercept_scaling': 1, 'l1_ratio': None, 'max_iter':

```
100, 'multi_class': 'multinomial', 'n_jobs': -1, 'penalty': 'l2',
'random_state': None, 'solver': 'newton-cg', 'tol': 0.0001, 'verbose': 0,
'warm_start': False}]}
****************************************************

Processing Model: GaussianNB
****************************************************
* GaussianNB
* Best Params Result:
* {'classifier': 'GaussianNB', 'features': 'Active inflammation?, Severity of
Crypt Arch, Increased lamina propria cellularity?, Marked & transmucosal
increase in lamina propria cellularity, Lamina propria polymorphs, Crypt
architecture, Patchy lamina propria cellularity?, Epithelial changes, Mucosal
surface, Cryptitis extent, Mucin depletion, Cryptitis polymorphs, Lamina propria
granulomas', 'accuracy': [0.5802469135802469, 0.5864197530864198,
0.6419753086419753, 0.6728395061728395, 0.6335403726708074], 'avgAccuracy':
0.6230043708304578, 'f1': [0.5854167726695931, 0.567280016773684,
0.6300491341014217, 0.6637486244893653, 0.640468000209957], 'avgF1':
0.6173925096488042, 'precision': [0.5802469135802469, 0.5864197530864198,
0.6419753086419753, 0.6728395061728395, 0.6335403726708074], 'avgPrecision':
0.6230043708304578, 'recall': [0.5802469135802469, 0.5864197530864198,
0.6419753086419753, 0.6728395061728395, 0.6335403726708074], 'avgRecall':
0.6230043708304578, 'params': [{'priors': None, 'var_smoothing': 1e-09}]]}
****************************************************

Processing Model: AdaBoostClassifier
****************************************************
* AdaBoostClassifier
* Best Params Result:
* {'classifier': 'AdaBoostClassifier', 'features': 'Active inflammation?,
Severity of Crypt Arch, Increased lamina propria cellularity?, Marked &
transmucosal increase in lamina propria cellularity, Lamina propria polymorphs,
Crypt architecture, Patchy lamina propria cellularity?, Epithelial changes,
Mucosal surface, Cryptitis extent, Mucin depletion, Cryptitis polymorphs, Lamina
propria granulomas', 'accuracy': [0.6358024691358025, 0.6234567901234568,
0.6975308641975309, 0.6851851851851852, 0.6645962732919255], 'avgAccuracy':
0.6613143163867802, 'f1': [0.602461558322739, 0.57095301374975,
0.6688400306544482, 0.6374573047051529, 0.6374108982804636], 'avgF1':
0.6234245611425108, 'precision': [0.6358024691358025, 0.6234567901234568,
0.6975308641975309, 0.6851851851851852, 0.6645962732919255], 'avgPrecision':
0.6613143163867802, 'recall': [0.6358024691358025, 0.6234567901234568,
0.6975308641975309, 0.6851851851851852, 0.6645962732919255], 'avgRecall':
0.6613143163867802, 'params': [{'algorithm': 'SAMME.R', 'base_estimator': None,
'learning_rate': 1, 'n_estimators': 20, 'random_state': None}]]}
****************************************************

Processing Model: DecisionTreeClassifier
****************************************************
```

* DecisionTreeClassifier
* Best Params Result:
* {'classifier': 'DecisionTreeClassifier', 'features': 'Active inflammation?, Severity of Crypt Arch, Increased lamina propria cellularity?, Marked & transmucosal increase in lamina propria cellularity, Lamina propria polymorphs, Crypt architecture, Patchy lamina propria cellularity?, Epithelial changes, Mucosal surface, Cryptitis extent, Mucin depletion, Cryptitis polymorphs, Lamina propria granulomas', 'accuracy': [0.6358024691358025, 0.6296296296296297, 0.6666666666666666, 0.6728395061728395, 0.6149068322981367], 'avgAccuracy': 0.643969020780615, 'f1': [0.6066277939505218, 0.6307646579549678, 0.632152195551928, 0.648176042425555, 0.6143463222795896], 'avgF1': 0.6264134024325124, 'precision': [0.6358024691358025, 0.6296296296296297, 0.6666666666666666, 0.6728395061728395, 0.6149068322981367], 'avgPrecision': 0.643969020780615, 'recall': [0.6358024691358025, 0.6296296296296297, 0.6666666666666666, 0.6728395061728395, 0.6149068322981367], 'avgRecall': 0.643969020780615, 'params': [{'ccp_alpha': 0.0, 'class_weight': None, 'criterion': 'gini', 'max_depth': None, 'max_features': 'sqrt', 'max_leaf_nodes': None, 'min_impurity_decrease': 0.0, 'min_impurity_split': None, 'min_samples_leaf': 1, 'min_samples_split': 2, 'min_weight_fraction_leaf': 0.0, 'random_state': None, 'splitter': 'best'}]}
****

Processing Model: SVC
****
* SVC
* Best Params Result:
* {'classifier': 'SVC', 'features': 'Active inflammation?, Severity of Crypt Arch, Increased lamina propria cellularity?, Marked & transmucosal increase in lamina propria cellularity, Lamina propria polymorphs, Crypt architecture, Patchy lamina propria cellularity?, Epithelial changes, Mucosal surface, Cryptitis extent, Mucin depletion, Cryptitis polymorphs, Lamina propria granulomas', 'accuracy': [0.6481481481481481, 0.654320987654321, 0.691358024691358, 0.7160493827160493, 0.6770186335403726], 'avgAccuracy': 0.6773790353500498, 'f1': [0.5985818977999863, 0.5998934814568833, 0.636954082706332, 0.689521710879453, 0.6449718205763514], 'avgF1': 0.6339845986838012, 'precision': [0.6481481481481481, 0.654320987654321, 0.691358024691358, 0.7160493827160493, 0.6770186335403726], 'avgPrecision': 0.6773790353500498, 'recall': [0.6481481481481481, 0.654320987654321, 0.691358024691358, 0.7160493827160493, 0.6770186335403726], 'avgRecall': 0.6773790353500498, 'params': [{'C': 1.0, 'break_ties': False, 'cache_size': 4000, 'class_weight': None, 'coef0': 0.0, 'decision_function_shape': 'ovr', 'degree': 3, 'gamma': 'scale', 'kernel': 'linear', 'max_iter': -1, 'probability': False, 'random_state': None, 'shrinking': True, 'tol': 0.001, 'verbose': False}]}
****

Processing Model: MLPClassifier
****

```
* MLPClassifier
* Best Params Result:
* {'classifier': 'MLPClassifier', 'features': 'Active inflammation?, Severity of
Crypt Arch, Increased lamina propria cellularity?, Marked & transmucosal
increase in lamina propria cellularity, Lamina propria polymorphs, Crypt
architecture, Patchy lamina propria cellularity?, Epithelial changes, Mucosal
surface, Cryptitis extent, Mucin depletion, Cryptitis polymorphs, Lamina propria
granulomas', 'accuracy': [0.6666666666666666, 0.6296296296296297,
0.691358024691358, 0.7160493827160493, 0.7018633540372671], 'avgAccuracy':
0.6811134115481942, 'f1': [0.6510616642898064, 0.6114321224415687,
0.6638536063360331, 0.6985588273266795, 0.6866366225399579], 'avgF1':
0.6623085685868091, 'precision': [0.6666666666666666, 0.6296296296296297,
0.691358024691358, 0.7160493827160493, 0.7018633540372671], 'avgPrecision':
0.6811134115481942, 'recall': [0.6666666666666666, 0.6296296296296297,
0.691358024691358, 0.7160493827160493, 0.7018633540372671], 'avgRecall':
0.6811134115481942, 'params': [{'activation': 'logistic', 'alpha': 0.0001,
'batch_size': 'auto', 'beta_1': 0.9, 'beta_2': 0.999, 'early_stopping': False,
'epsilon': 1e-08, 'hidden_layer_sizes': (100,), 'learning_rate': 'invscaling',
'learning_rate_init': 0.001, 'max_fun': 15000, 'max_iter': 5000, 'momentum':
0.9, 'n_iter_no_change': 10, 'nesterovs_momentum': True, 'power_t': 0.5,
'random_state': None, 'shuffle': True, 'solver': 'adam', 'tol': 0.0001,
'validation_fraction': 0.1, 'verbose': False, 'warm_start': False}]}
****************************************************
****************************************************
* Best Performing Model and Params is:
* {'classifier': 'MLPClassifier', 'features': 'Active inflammation?, Severity of
Crypt Arch, Increased lamina propria cellularity?, Marked & transmucosal
increase in lamina propria cellularity, Lamina propria polymorphs, Crypt
architecture, Patchy lamina propria cellularity?, Epithelial changes, Mucosal
surface, Cryptitis extent, Mucin depletion, Cryptitis polymorphs, Lamina propria
granulomas', 'accuracy': [0.6666666666666666, 0.6296296296296297,
0.691358024691358, 0.7160493827160493, 0.7018633540372671], 'avgAccuracy':
0.6811134115481942, 'f1': [0.6510616642898064, 0.6114321224415687,
0.6638536063360331, 0.6985588273266795, 0.6866366225399579], 'avgF1':
0.6623085685868091, 'precision': [0.6666666666666666, 0.6296296296296297,
0.691358024691358, 0.7160493827160493, 0.7018633540372671], 'avgPrecision':
0.6811134115481942, 'recall': [0.6666666666666666, 0.6296296296296297,
0.691358024691358, 0.7160493827160493, 0.7018633540372671], 'avgRecall':
0.6811134115481942, 'params': [{'activation': 'logistic', 'alpha': 0.0001,
'batch_size': 'auto', 'beta_1': 0.9, 'beta_2': 0.999, 'early_stopping': False,
'epsilon': 1e-08, 'hidden_layer_sizes': (100,), 'learning_rate': 'invscaling',
'learning_rate_init': 0.001, 'max_fun': 15000, 'max_iter': 5000, 'momentum':
0.9, 'n_iter_no_change': 10, 'nesterovs_momentum': True, 'power_t': 0.5,
'random_state': None, 'shuffle': True, 'solver': 'adam', 'tol': 0.0001,
'validation_fraction': 0.1, 'verbose': False, 'warm_start': False}]}
****************************************************

                    model                                          features  \
```

```
0   RandomForestClassifier   Active inflammation?, Severity of Crypt Arch, …
1     KNeighborsClassifier   Active inflammation?, Severity of Crypt Arch, …
2       LogisticRegression   Active inflammation?, Severity of Crypt Arch, …
3                GaussianNB   Active inflammation?, Severity of Crypt Arch, …
4         AdaBoostClassifier   Active inflammation?, Severity of Crypt Arch, …
5     DecisionTreeClassifier   Active inflammation?, Severity of Crypt Arch, …
6                      SVC   Active inflammation?, Severity of Crypt Arch, …
7            MLPClassifier   Active inflammation?, Severity of Crypt Arch, …

    accuracy         f1   precision     recall  \
0   0.668722   0.639797    0.668722   0.668722
1   0.671191   0.650348    0.671191   0.671191
2   0.674918   0.654902    0.674918   0.674918
3   0.623004   0.617393    0.623004   0.623004
4   0.661314   0.623425    0.661314   0.661314
5   0.643969   0.626413    0.643969   0.643969
6   0.677379   0.633985    0.677379   0.677379
7   0.681113   0.662309    0.681113   0.681113

                                                  params
0  {'bootstrap': True, 'ccp_alpha': 0.0, 'class_w…
1  {'algorithm': 'auto', 'leaf_size': 30, 'metric…
2  {'C': 1, 'class_weight': None, 'dual': False, …
3          {'priors': None, 'var_smoothing': 1e-09}
4  {'algorithm': 'SAMME.R', 'base_estimator': Non…
5  {'ccp_alpha': 0.0, 'class_weight': None, 'crit…
6  {'C': 1.0, 'break_ties': False, 'cache_size': …
7  {'activation': 'logistic', 'alpha': 0.0001, 'b…

Processing Model: RandomForestClassifier
*****************************************************
* RandomForestClassifier
* Best Params Result:
* {'classifier': 'RandomForestClassifier', 'features': 'Active inflammation?,
Severity of Crypt Arch, Increased lamina propria cellularity?, Marked &
transmucosal increase in lamina propria cellularity, Lamina propria polymorphs,
Crypt architecture, Patchy lamina propria cellularity?, Epithelial changes,
Mucosal surface, Cryptitis extent, Mucin depletion, Cryptitis polymorphs',
'accuracy': [0.6481481481481481, 0.6172839506172839, 0.6790123456790124,
0.6851851851851852, 0.6583850931677019], 'avgAccuracy': 0.6576029445594663,
'f1': [0.6220598745119486, 0.5965608842552121, 0.6415722233700611,
0.6631769284790726, 0.6546373635641732], 'avgF1': 0.6356014548360935,
'precision': [0.6481481481481481, 0.6172839506172839, 0.6790123456790124,
0.6851851851851852, 0.6583850931677019], 'avgPrecision': 0.6576029445594663,
'recall': [0.6481481481481481, 0.6172839506172839, 0.6790123456790124,
0.6851851851851852, 0.6583850931677019], 'avgRecall': 0.6576029445594663,
'params': [{'bootstrap': True, 'ccp_alpha': 0.0, 'class_weight': None,
'criterion': 'gini', 'max_depth': None, 'max_features': 'sqrt',
```

```
'max_leaf_nodes': None, 'max_samples': None, 'min_impurity_decrease': 0.0,
'min_impurity_split': None, 'min_samples_leaf': 1, 'min_samples_split': 2,
'min_weight_fraction_leaf': 0.0, 'n_estimators': 500, 'n_jobs': -1, 'oob_score':
False, 'random_state': None, 'verbose': 0, 'warm_start': False}]}
```
****

Processing Model: KNeighborsClassifier
****
* KNeighborsClassifier
* Best Params Result:
```
* {'classifier': 'KNeighborsClassifier', 'features': 'Active inflammation?,
Severity of Crypt Arch, Increased lamina propria cellularity?, Marked &
transmucosal increase in lamina propria cellularity, Lamina propria polymorphs,
Crypt architecture, Patchy lamina propria cellularity?, Epithelial changes,
Mucosal surface, Cryptitis extent, Mucin depletion, Cryptitis polymorphs',
'accuracy': [0.6419753086419753, 0.5925925925925926, 0.6851851851851852,
0.6790123456790124, 0.6583850931677019], 'avgAccuracy': 0.6514301050532935,
'f1': [0.6358359336137114, 0.5841237075978233, 0.65354622203565,
0.6399372124518324, 0.6573215095433612], 'avgF1': 0.6341529170484757,
'precision': [0.6419753086419753, 0.5925925925925926, 0.6851851851851852,
0.6790123456790124, 0.6583850931677019], 'avgPrecision': 0.6514301050532935,
'recall': [0.6419753086419753, 0.5925925925925926, 0.6851851851851852,
0.6790123456790124, 0.6583850931677019], 'avgRecall': 0.6514301050532935,
'params': [{'algorithm': 'brute', 'leaf_size': 30, 'metric': 'minkowski',
'metric_params': None, 'n_jobs': -1, 'n_neighbors': 16, 'p': 2, 'weights':
'uniform'}]}
```
****

Processing Model: LogisticRegression
****
* LogisticRegression
* Best Params Result:
```
* {'classifier': 'LogisticRegression', 'features': 'Active inflammation?,
Severity of Crypt Arch, Increased lamina propria cellularity?, Marked &
transmucosal increase in lamina propria cellularity, Lamina propria polymorphs,
Crypt architecture, Patchy lamina propria cellularity?, Epithelial changes,
Mucosal surface, Cryptitis extent, Mucin depletion, Cryptitis polymorphs',
'accuracy': [0.6481481481481481, 0.6111111111111112, 0.6851851851851852,
0.691358024691358, 0.6770186335403726], 'avgAccuracy': 0.662564220535235, 'f1':
[0.6220598745119486, 0.5813482097969886, 0.65354622203565, 0.6567057085575605,
0.6685069665212248], 'avgF1': 0.6364333962846745, 'precision':
[0.6481481481481481, 0.6111111111111112, 0.6851851851851852, 0.691358024691358,
0.6770186335403726], 'avgPrecision': 0.662564220535235, 'recall':
[0.6481481481481481, 0.6111111111111112, 0.6851851851851852, 0.691358024691358,
0.6770186335403726], 'avgRecall': 0.662564220535235, 'params': [{'C': 1,
'class_weight': None, 'dual': False, 'fit_intercept': True, 'intercept_scaling':
1, 'l1_ratio': None, 'max_iter': 100, 'multi_class': 'multinomial', 'n_jobs':
-1, 'penalty': 'l2', 'random_state': None, 'solver': 'newton-cg', 'tol': 0.0001,
```

```
'verbose': 0, 'warm_start': False}]}
********************************************************

Processing Model: GaussianNB
********************************************************
* GaussianNB
* Best Params Result:
* {'classifier': 'GaussianNB', 'features': 'Active inflammation?, Severity of
Crypt Arch, Increased lamina propria cellularity?, Marked & transmucosal
increase in lamina propria cellularity, Lamina propria polymorphs, Crypt
architecture, Patchy lamina propria cellularity?, Epithelial changes, Mucosal
surface, Cryptitis extent, Mucin depletion, Cryptitis polymorphs', 'accuracy':
[0.6049382716049383, 0.5679012345679012, 0.6296296296296297, 0.6358024691358025,
0.5838509316770186], 'avgAccuracy': 0.6044245073230581, 'f1':
[0.6106853352716236, 0.5570668212645697, 0.6234567901234568, 0.6368392145326249,
0.593124084025403], 'avgF1': 0.6042344490435356, 'precision':
[0.6049382716049383, 0.5679012345679012, 0.6296296296296297, 0.6358024691358025,
0.5838509316770186], 'avgPrecision': 0.6044245073230581, 'recall':
[0.6049382716049383, 0.5679012345679012, 0.6296296296296297, 0.6358024691358025,
0.5838509316770186], 'avgRecall': 0.6044245073230581, 'params': [{'priors':
None, 'var_smoothing': 1e-09}]}
********************************************************

Processing Model: AdaBoostClassifier
********************************************************
* AdaBoostClassifier
* Best Params Result:
* {'classifier': 'AdaBoostClassifier', 'features': 'Active inflammation?,
Severity of Crypt Arch, Increased lamina propria cellularity?, Marked &
transmucosal increase in lamina propria cellularity, Lamina propria polymorphs,
Crypt architecture, Patchy lamina propria cellularity?, Epithelial changes,
Mucosal surface, Cryptitis extent, Mucin depletion, Cryptitis polymorphs',
'accuracy': [0.6296296296296297, 0.5740740740740741, 0.691358024691358,
0.6728395061728395, 0.6708074534161491], 'avgAccuracy': 0.6477417375968101,
'f1': [0.6158427357153329, 0.5570805354232851, 0.6638536063360331,
0.636239970887414, 0.6330211201019699], 'avgF1': 0.621207593692807, 'precision':
[0.6296296296296297, 0.5740740740740741, 0.691358024691358, 0.6728395061728395,
0.6708074534161491], 'avgPrecision': 0.6477417375968101, 'recall':
[0.6296296296296297, 0.5740740740740741, 0.691358024691358, 0.6728395061728395,
0.6708074534161491], 'avgRecall': 0.6477417375968101, 'params': [{'algorithm':
'SAMME.R', 'base_estimator': None, 'learning_rate': 1, 'n_estimators': 50,
'random_state': None}]}
********************************************************

Processing Model: DecisionTreeClassifier
********************************************************
* DecisionTreeClassifier
* Best Params Result:
```

```
* {'classifier': 'DecisionTreeClassifier', 'features': 'Active inflammation?,
Severity of Crypt Arch, Increased lamina propria cellularity?, Marked &
transmucosal increase in lamina propria cellularity, Lamina propria polymorphs,
Crypt architecture, Patchy lamina propria cellularity?, Epithelial changes,
Mucosal surface, Cryptitis extent, Mucin depletion, Cryptitis polymorphs',
'accuracy': [0.6049382716049383, 0.5802469135802469, 0.654320987654321,
0.654320987654321, 0.639751552795031], 'avgAccuracy': 0.6267157426577716, 'f1':
[0.5856692370236528, 0.572705053970457, 0.6227233018510278, 0.638930073453883,
0.64539534991274223], 'avgF1': 0.6130846032423526, 'precision':
[0.6049382716049383, 0.5802469135802469, 0.654320987654321, 0.654320987654321,
0.639751552795031], 'avgPrecision': 0.6267157426577716, 'recall':
[0.6049382716049383, 0.5802469135802469, 0.654320987654321, 0.654320987654321,
0.639751552795031], 'avgRecall': 0.6267157426577716, 'params': [{'ccp_alpha':
0.0, 'class_weight': None, 'criterion': 'entropy', 'max_depth': None,
'max_features': 'sqrt', 'max_leaf_nodes': None, 'min_impurity_decrease': 0.0,
'min_impurity_split': None, 'min_samples_leaf': 1, 'min_samples_split': 2,
'min_weight_fraction_leaf': 0.0, 'random_state': None, 'splitter': 'best'}]}
******************************************************

Processing Model: SVC
******************************************************
* SVC
* Best Params Result:
* {'classifier': 'SVC', 'features': 'Active inflammation?, Severity of Crypt
Arch, Increased lamina propria cellularity?, Marked & transmucosal increase in
lamina propria cellularity, Lamina propria polymorphs, Crypt architecture,
Patchy lamina propria cellularity?, Epithelial changes, Mucosal surface,
Cryptitis extent, Mucin depletion, Cryptitis polymorphs', 'accuracy':
[0.6358024691358025, 0.6358024691358025, 0.6790123456790124, 0.6851851851851852,
0.6645962732919255], 'avgAccuracy': 0.6600797484855456, 'f1':
[0.5537860082304527, 0.5587625610106229, 0.6001226483969817, 0.6180677396698739,
0.616860233879694], 'avgF1': 0.5895198382375251, 'precision':
[0.6358024691358025, 0.6358024691358025, 0.6790123456790124, 0.6851851851851852,
0.6645962732919255], 'avgPrecision': 0.6600797484855456, 'recall':
[0.6358024691358025, 0.6358024691358025, 0.6790123456790124, 0.6851851851851852,
0.6645962732919255], 'avgRecall': 0.6600797484855456, 'params': [{'C': 1.0,
'break_ties': False, 'cache_size': 4000, 'class_weight': None, 'coef0': 0.0,
'decision_function_shape': 'ovr', 'degree': 3, 'gamma': 'scale', 'kernel':
'linear', 'max_iter': -1, 'probability': False, 'random_state': None,
'shrinking': True, 'tol': 0.001, 'verbose': False}]}
******************************************************

Processing Model: MLPClassifier
******************************************************
* MLPClassifier
* Best Params Result:
* {'classifier': 'MLPClassifier', 'features': 'Active inflammation?, Severity of
Crypt Arch, Increased lamina propria cellularity?, Marked & transmucosal
```

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increase in lamina propria cellularity, Lamina propria polymorphs, Crypt architecture, Patchy lamina propria cellularity?, Epithelial changes, Mucosal surface, Cryptitis extent, Mucin depletion, Cryptitis polymorphs', 'accuracy': [0.6604938271604939, 0.6172839506172839, 0.6851851851851852, 0.6975308641975309, 0.6894409937888198], 'avgAccuracy': 0.6699869641898627, 'f1': [0.6418471253812619, 0.5916420442674649, 0.65354622203565, 0.6614359237305492, 0.6786878001270805], 'avgF1': 0.6454318231084013, 'precision': [0.6604938271604939, 0.6172839506172839, 0.6851851851851852, 0.6975308641975309, 0.6894409937888198], 'avgPrecision': 0.6699869641898627, 'recall': [0.6604938271604939, 0.6172839506172839, 0.6851851851851852, 0.6975308641975309, 0.6894409937888198], 'avgRecall': 0.6699869641898627, 'params': [{'activation': 'logistic', 'alpha': 0.0001, 'batch_size': 'auto', 'beta_1': 0.9, 'beta_2': 0.999, 'early_stopping': False, 'epsilon': 1e-08, 'hidden_layer_sizes': (100,), 'learning_rate': 'adaptive', 'learning_rate_init': 0.001, 'max_fun': 15000, 'max_iter': 9000, 'momentum': 0.9, 'n_iter_no_change': 10, 'nesterovs_momentum': True, 'power_t': 0.5, 'random_state': None, 'shuffle': True, 'solver': 'adam', 'tol': 0.0001, 'validation_fraction': 0.1, 'verbose': False, 'warm_start': False}]}
****
****
* Best Performing Model and Params is:
* {'classifier': 'MLPClassifier', 'features': 'Active inflammation?, Severity of Crypt Arch, Increased lamina propria cellularity?, Marked & transmucosal increase in lamina propria cellularity, Lamina propria polymorphs, Crypt architecture, Patchy lamina propria cellularity?, Epithelial changes, Mucosal surface, Cryptitis extent, Mucin depletion, Cryptitis polymorphs', 'accuracy': [0.6604938271604939, 0.6172839506172839, 0.6851851851851852, 0.6975308641975309, 0.6894409937888198], 'avgAccuracy': 0.6699869641898627, 'f1': [0.6418471253812619, 0.5916420442674649, 0.65354622203565, 0.6614359237305492, 0.6786878001270805], 'avgF1': 0.6454318231084013, 'precision': [0.6604938271604939, 0.6172839506172839, 0.6851851851851852, 0.6975308641975309, 0.6894409937888198], 'avgPrecision': 0.6699869641898627, 'recall': [0.6604938271604939, 0.6172839506172839, 0.6851851851851852, 0.6975308641975309, 0.6894409937888198], 'avgRecall': 0.6699869641898627, 'params': [{'activation': 'logistic', 'alpha': 0.0001, 'batch_size': 'auto', 'beta_1': 0.9, 'beta_2': 0.999, 'early_stopping': False, 'epsilon': 1e-08, 'hidden_layer_sizes': (100,), 'learning_rate': 'adaptive', 'learning_rate_init': 0.001, 'max_fun': 15000, 'max_iter': 9000, 'momentum': 0.9, 'n_iter_no_change': 10, 'nesterovs_momentum': True, 'power_t': 0.5, 'random_state': None, 'shuffle': True, 'solver': 'adam', 'tol': 0.0001, 'validation_fraction': 0.1, 'verbose': False, 'warm_start': False}]}
****

```
              model                                    features  \
0  RandomForestClassifier  Active inflammation?, Severity of Crypt Arch, …
1    KNeighborsClassifier  Active inflammation?, Severity of Crypt Arch, …
2      LogisticRegression  Active inflammation?, Severity of Crypt Arch, …
3              GaussianNB  Active inflammation?, Severity of Crypt Arch, …
```

```
4        AdaBoostClassifier  Active inflammation?, Severity of Crypt Arch, …
5  DecisionTreeClassifier  Active inflammation?, Severity of Crypt Arch, …
6                     SVC  Active inflammation?, Severity of Crypt Arch, …
7           MLPClassifier  Active inflammation?, Severity of Crypt Arch, …

   accuracy        f1  precision    recall  \
0  0.657603  0.635601   0.657603  0.657603
1  0.651430  0.634153   0.651430  0.651430
2  0.662564  0.636433   0.662564  0.662564
3  0.604425  0.604234   0.604425  0.604425
4  0.647742  0.621208   0.647742  0.647742
5  0.626716  0.613085   0.626716  0.626716
6  0.660080  0.589520   0.660080  0.660080
7  0.669987  0.645432   0.669987  0.669987


                                                 params
0  {'bootstrap': True, 'ccp_alpha': 0.0, 'class_w…
1  {'algorithm': 'brute', 'leaf_size': 30, 'metri…
2  {'C': 1, 'class_weight': None, 'dual': False, …
3          {'priors': None, 'var_smoothing': 1e-09}
4  {'algorithm': 'SAMME.R', 'base_estimator': Non…
5  {'ccp_alpha': 0.0, 'class_weight': None, 'crit…
6  {'C': 1.0, 'break_ties': False, 'cache_size': …
7  {'activation': 'logistic', 'alpha': 0.0001, 'b…


Processing Model: RandomForestClassifier
********************************************************
* RandomForestClassifier
* Best Params Result:
* {'classifier': 'RandomForestClassifier', 'features': 'Active inflammation?,
Severity of Crypt Arch, Increased lamina propria cellularity?, Marked &
transmucosal increase in lamina propria cellularity, Lamina propria polymorphs,
Crypt architecture, Patchy lamina propria cellularity?, Epithelial changes,
Mucosal surface, Cryptitis extent, Mucin depletion', 'accuracy':
[0.6481481481481481, 0.6172839506172839, 0.6851851851851852, 0.7037037037037037,
0.639751552795031], 'avgAccuracy': 0.6588145080898704, 'f1':
[0.6220598745119486, 0.5965608842552121, 0.6718269188558792, 0.6833886589847105,
0.6423627092228963], 'avgF1': 0.6432398091661293, 'precision':
[0.6481481481481481, 0.6172839506172839, 0.6851851851851852, 0.7037037037037037,
0.639751552795031], 'avgPrecision': 0.6588145080898704, 'recall':
[0.6481481481481481, 0.6172839506172839, 0.6851851851851852, 0.7037037037037037,
0.639751552795031], 'avgRecall': 0.6588145080898704, 'params': [{'bootstrap':
True, 'ccp_alpha': 0.0, 'class_weight': None, 'criterion': 'entropy',
'max_depth': None, 'max_features': 'auto', 'max_leaf_nodes': None,
'max_samples': None, 'min_impurity_decrease': 0.0, 'min_impurity_split': None,
'min_samples_leaf': 1, 'min_samples_split': 2, 'min_weight_fraction_leaf': 0.0,
'n_estimators': 200, 'n_jobs': -1, 'oob_score': True, 'random_state': None,
'verbose': 0, 'warm_start': False}]}
```

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

Processing Model: KNeighborsClassifier
**************************************************
* KNeighborsClassifier
* Best Params Result:
* {'classifier': 'KNeighborsClassifier', 'features': 'Active inflammation?,
Severity of Crypt Arch, Increased lamina propria cellularity?, Marked &
transmucosal increase in lamina propria cellularity, Lamina propria polymorphs,
Crypt architecture, Patchy lamina propria cellularity?, Epithelial changes,
Mucosal surface, Cryptitis extent, Mucin depletion', 'accuracy':
[0.6419753086419753, 0.6172839506172839, 0.6666666666666666, 0.691358024691358,
0.6645962732919255], 'avgAccuracy': 0.6563760447818419, 'f1':
[0.6071860843102673, 0.5800817663333556, 0.6593946748267736, 0.6409072183040061,
0.643212303085288], 'avgF1': 0.6261564093719382, 'precision':
[0.6419753086419753, 0.6172839506172839, 0.6666666666666666, 0.691358024691358,
0.6645962732919255], 'avgPrecision': 0.6563760447818419, 'recall':
[0.6419753086419753, 0.6172839506172839, 0.6666666666666666, 0.691358024691358,
0.6645962732919255], 'avgRecall': 0.6563760447818419, 'params': [{'algorithm':
'brute', 'leaf_size': 30, 'metric': 'minkowski', 'metric_params': None,
'n_jobs': -1, 'n_neighbors': 17, 'p': 2, 'weights': 'uniform'}]}
**************************************************

Processing Model: LogisticRegression
**************************************************
* LogisticRegression
* Best Params Result:
* {'classifier': 'LogisticRegression', 'features': 'Active inflammation?,
Severity of Crypt Arch, Increased lamina propria cellularity?, Marked &
transmucosal increase in lamina propria cellularity, Lamina propria polymorphs,
Crypt architecture, Patchy lamina propria cellularity?, Epithelial changes,
Mucosal surface, Cryptitis extent, Mucin depletion', 'accuracy':
[0.6481481481481481, 0.6111111111111112, 0.6851851851851852, 0.691358024691358,
0.6832298136645962], 'avgAccuracy': 0.6638064565600797, 'f1':
[0.6220598745119486, 0.5813482097969886, 0.65354622203565, 0.6567057085575605,
0.6708316695923395], 'avgF1': 0.6368983368988974, 'precision':
[0.6481481481481481, 0.6111111111111112, 0.6851851851851852, 0.691358024691358,
0.6832298136645962], 'avgPrecision': 0.6638064565600797, 'recall':
[0.6481481481481481, 0.6111111111111112, 0.6851851851851852, 0.691358024691358,
0.6832298136645962], 'avgRecall': 0.6638064565600797, 'params': [{'C': 1,
'class_weight': None, 'dual': False, 'fit_intercept': True, 'intercept_scaling':
1, 'l1_ratio': None, 'max_iter': 100, 'multi_class': 'multinomial', 'n_jobs':
-1, 'penalty': 'l2', 'random_state': None, 'solver': 'newton-cg', 'tol': 0.0001,
'verbose': 0, 'warm_start': False}]}
**************************************************

Processing Model: GaussianNB
**************************************************
```

* GaussianNB
* Best Params Result:
* {'classifier': 'GaussianNB', 'features': 'Active inflammation?, Severity of Crypt Arch, Increased lamina propria cellularity?, Marked & transmucosal increase in lamina propria cellularity, Lamina propria polymorphs, Crypt architecture, Patchy lamina propria cellularity?, Epithelial changes, Mucosal surface, Cryptitis extent, Mucin depletion', 'accuracy': [0.5987654320987654, 0.5864197530864198, 0.6296296296296297, 0.6172839506172839, 0.577639751552795], 'avgAccuracy': 0.6019477033969788, 'f1': [0.6023155128419906, 0.5766398411125934, 0.6234567901234568, 0.6176832971128625, 0.5876954108309288], 'avgF1': 0.6015581704043664, 'precision': [0.5987654320987654, 0.5864197530864198, 0.6296296296296297, 0.6172839506172839, 0.577639751552795], 'avgPrecision': 0.6019477033969788, 'recall': [0.5987654320987654, 0.5864197530864198, 0.6296296296296297, 0.6172839506172839, 0.577639751552795], 'avgRecall': 0.6019477033969788, 'params': [{'priors': None, 'var_smoothing': 1e-09}]}
****

Processing Model: AdaBoostClassifier
****
* AdaBoostClassifier
* Best Params Result:
* {'classifier': 'AdaBoostClassifier', 'features': 'Active inflammation?, Severity of Crypt Arch, Increased lamina propria cellularity?, Marked & transmucosal increase in lamina propria cellularity, Lamina propria polymorphs, Crypt architecture, Patchy lamina propria cellularity?, Epithelial changes, Mucosal surface, Cryptitis extent, Mucin depletion', 'accuracy': [0.6604938271604939, 0.6111111111111112, 0.6728395061728395, 0.6851851851851852, 0.6086956521739131], 'avgAccuracy': 0.6476650563607086, 'f1': [0.6429785548143035, 0.562470364585014, 0.6452686872706647, 0.6446818613485281, 0.6204832277738682], 'avgF1': 0.6231765391584757, 'precision': [0.6604938271604939, 0.6111111111111112, 0.6728395061728395, 0.6851851851851852, 0.6086956521739131], 'avgPrecision': 0.6476650563607086, 'recall': [0.6604938271604939, 0.6111111111111112, 0.6728395061728395, 0.6851851851851852, 0.6086956521739131], 'avgRecall': 0.6476650563607086, 'params': [{'algorithm': 'SAMME.R', 'base_estimator': None, 'learning_rate': 1, 'n_estimators': 20, 'random_state': None}]}
****

Processing Model: DecisionTreeClassifier
****
* DecisionTreeClassifier
* Best Params Result:
* {'classifier': 'DecisionTreeClassifier', 'features': 'Active inflammation?, Severity of Crypt Arch, Increased lamina propria cellularity?, Marked & transmucosal increase in lamina propria cellularity, Lamina propria polymorphs, Crypt architecture, Patchy lamina propria cellularity?, Epithelial changes, Mucosal surface, Cryptitis extent, Mucin depletion', 'accuracy':

[0.6296296296296297, 0.6111111111111112, 0.6604938271604939, 0.6481481481481481,
0.6273291925465838], 'avgAccuracy': 0.6353423817191933, 'f1':
[0.6147546673234122, 0.60304354287225, 0.6479532390777134, 0.6403749428440786,
0.6359734922666572], 'avgF1': 0.6284199768768223, 'precision':
[0.6296296296296297, 0.6111111111111112, 0.6604938271604939, 0.6481481481481481,
0.6273291925465838], 'avgPrecision': 0.6353423817191933, 'recall':
[0.6296296296296297, 0.6111111111111112, 0.6604938271604939, 0.6481481481481481,
0.6273291925465838], 'avgRecall': 0.6353423817191933, 'params': [{'ccp_alpha':
0.0, 'class_weight': None, 'criterion': 'entropy', 'max_depth': None,
'max_features': 'sqrt', 'max_leaf_nodes': None, 'min_impurity_decrease': 0.0,
'min_impurity_split': None, 'min_samples_leaf': 1, 'min_samples_split': 2,
'min_weight_fraction_leaf': 0.0, 'random_state': None, 'splitter': 'random'}]}
****

Processing Model: SVC
****
* SVC
* Best Params Result:
* {'classifier': 'SVC', 'features': 'Active inflammation?, Severity of Crypt
Arch, Increased lamina propria cellularity?, Marked & transmucosal increase in
lamina propria cellularity, Lamina propria polymorphs, Crypt architecture,
Patchy lamina propria cellularity?, Epithelial changes, Mucosal surface,
Cryptitis extent, Mucin depletion', 'accuracy': [0.6358024691358025,
0.6358024691358025, 0.6790123456790124, 0.6851851851851852, 0.6645962732919255],
'avgAccuracy': 0.6600797484855456, 'f1': [0.5537860082304527,
0.5587625610106229, 0.6001226483969817, 0.6180677396698739, 0.616860233879694],
'avgF1': 0.5895198382375251, 'precision': [0.6358024691358025,
0.6358024691358025, 0.6790123456790124, 0.6851851851851852, 0.6645962732919255],
'avgPrecision': 0.6600797484855456, 'recall': [0.6358024691358025,
0.6358024691358025, 0.6790123456790124, 0.6851851851851852, 0.6645962732919255],
'avgRecall': 0.6600797484855456, 'params': [{'C': 1.0, 'break_ties': False,
'cache_size': 4000, 'class_weight': None, 'coef0': 0.0,
'decision_function_shape': 'ovr', 'degree': 3, 'gamma': 'scale', 'kernel':
'linear', 'max_iter': -1, 'probability': False, 'random_state': None,
'shrinking': True, 'tol': 0.001, 'verbose': False}]}
****

Processing Model: MLPClassifier
****
* MLPClassifier
* Best Params Result:
* {'classifier': 'MLPClassifier', 'features': 'Active inflammation?, Severity of
Crypt Arch, Increased lamina propria cellularity?, Marked & transmucosal
increase in lamina propria cellularity, Lamina propria polymorphs, Crypt
architecture, Patchy lamina propria cellularity?, Epithelial changes, Mucosal
surface, Cryptitis extent, Mucin depletion', 'accuracy': [0.6604938271604939,
0.6172839506172839, 0.6851851851851852, 0.6975308641975309, 0.6894409937888198],
'avgAccuracy': 0.6699869641898627, 'f1': [0.6418471253812619,

0.5916420442674649, 0.65354622203565, 0.6614359237305492, 0.6786878001270805],
'avgF1': 0.6454318231084013, 'precision': [0.6604938271604939,
0.6172839506172839, 0.6851851851851852, 0.6975308641975309, 0.6894409937888198],
'avgPrecision': 0.6699869641898627, 'recall': [0.6604938271604939,
0.6172839506172839, 0.6851851851851852, 0.6975308641975309, 0.6894409937888198],
'avgRecall': 0.6699869641898627, 'params': [{'activation': 'logistic', 'alpha':
0.0001, 'batch_size': 'auto', 'beta_1': 0.9, 'beta_2': 0.999, 'early_stopping':
False, 'epsilon': 1e-08, 'hidden_layer_sizes': (100,), 'learning_rate':
'invscaling', 'learning_rate_init': 0.001, 'max_fun': 15000, 'max_iter': 5000,
'momentum': 0.9, 'n_iter_no_change': 10, 'nesterovs_momentum': True, 'power_t':
0.5, 'random_state': None, 'shuffle': True, 'solver': 'adam', 'tol': 0.0001,
'validation_fraction': 0.1, 'verbose': False, 'warm_start': False}]}
****
****
* Best Performing Model and Params is:
* {'classifier': 'MLPClassifier', 'features': 'Active inflammation?, Severity of
Crypt Arch, Increased lamina propria cellularity?, Marked & transmucosal
increase in lamina propria cellularity, Lamina propria polymorphs, Crypt
architecture, Patchy lamina propria cellularity?, Epithelial changes, Mucosal
surface, Cryptitis extent, Mucin depletion', 'accuracy': [0.6604938271604939,
0.6172839506172839, 0.6851851851851852, 0.6975308641975309, 0.6894409937888198],
'avgAccuracy': 0.6699869641898627, 'f1': [0.6418471253812619,
0.5916420442674649, 0.65354622203565, 0.6614359237305492, 0.6786878001270805],
'avgF1': 0.6454318231084013, 'precision': [0.6604938271604939,
0.6172839506172839, 0.6851851851851852, 0.6975308641975309, 0.6894409937888198],
'avgPrecision': 0.6699869641898627, 'recall': [0.6604938271604939,
0.6172839506172839, 0.6851851851851852, 0.6975308641975309, 0.6894409937888198],
'avgRecall': 0.6699869641898627, 'params': [{'activation': 'logistic', 'alpha':
0.0001, 'batch_size': 'auto', 'beta_1': 0.9, 'beta_2': 0.999, 'early_stopping':
False, 'epsilon': 1e-08, 'hidden_layer_sizes': (100,), 'learning_rate':
'invscaling', 'learning_rate_init': 0.001, 'max_fun': 15000, 'max_iter': 5000,
'momentum': 0.9, 'n_iter_no_change': 10, 'nesterovs_momentum': True, 'power_t':
0.5, 'random_state': None, 'shuffle': True, 'solver': 'adam', 'tol': 0.0001,
'validation_fraction': 0.1, 'verbose': False, 'warm_start': False}]}
****

```
                  model                                    features  \
0  RandomForestClassifier  Active inflammation?, Severity of Crypt Arch, …
1    KNeighborsClassifier  Active inflammation?, Severity of Crypt Arch, …
2      LogisticRegression  Active inflammation?, Severity of Crypt Arch, …
3              GaussianNB  Active inflammation?, Severity of Crypt Arch, …
4      AdaBoostClassifier  Active inflammation?, Severity of Crypt Arch, …
5  DecisionTreeClassifier  Active inflammation?, Severity of Crypt Arch, …
6                     SVC  Active inflammation?, Severity of Crypt Arch, …
7           MLPClassifier  Active inflammation?, Severity of Crypt Arch, …

   accuracy       f1  precision    recall  \
0  0.658815  0.643240   0.658815  0.658815
```

```
1  0.656376   0.626156    0.656376   0.656376
2  0.663806   0.636898    0.663806   0.663806
3  0.601948   0.601558    0.601948   0.601948
4  0.647665   0.623177    0.647665   0.647665
5  0.635342   0.628420    0.635342   0.635342
6  0.660080   0.589520    0.660080   0.660080
7  0.669987   0.645432    0.669987   0.669987


                                                    params
0  {'bootstrap': True, 'ccp_alpha': 0.0, 'class_w…
1  {'algorithm': 'brute', 'leaf_size': 30, 'metri…
2  {'C': 1, 'class_weight': None, 'dual': False, …
3           {'priors': None, 'var_smoothing': 1e-09}
4  {'algorithm': 'SAMME.R', 'base_estimator': Non…
5  {'ccp_alpha': 0.0, 'class_weight': None, 'crit…
6  {'C': 1.0, 'break_ties': False, 'cache_size': …
7  {'activation': 'logistic', 'alpha': 0.0001, 'b…
```

Processing Model: RandomForestClassifier
****
* RandomForestClassifier
* Best Params Result:
* {'classifier': 'RandomForestClassifier', 'features': 'Active inflammation?,
Severity of Crypt Arch, Increased lamina propria cellularity?, Marked &
transmucosal increase in lamina propria cellularity, Lamina propria polymorphs,
Crypt architecture, Patchy lamina propria cellularity?, Epithelial changes,
Mucosal surface, Cryptitis extent', 'accuracy': [0.6419753086419753,
0.6049382716049383, 0.6790123456790124, 0.691358024691358, 0.6770186335403726],
'avgAccuracy': 0.6588605168315314, 'f1': [0.6168593856981818,
0.5863375331589531, 0.6487152348942429, 0.6636881323534439, 0.6760109952425711],
'avgF1': 0.6383222562694786, 'precision': [0.6419753086419753,
0.6049382716049383, 0.6790123456790124, 0.691358024691358, 0.6770186335403726],
'avgPrecision': 0.6588605168315314, 'recall': [0.6419753086419753,
0.6049382716049383, 0.6790123456790124, 0.691358024691358, 0.6770186335403726],
'avgRecall': 0.6588605168315314, 'params': [{'bootstrap': True, 'ccp_alpha':
0.0, 'class_weight': None, 'criterion': 'gini', 'max_depth': None,
'max_features': 'log2', 'max_leaf_nodes': None, 'max_samples': None,
'min_impurity_decrease': 0.0, 'min_impurity_split': None, 'min_samples_leaf': 1,
'min_samples_split': 2, 'min_weight_fraction_leaf': 0.0, 'n_estimators': 200,
'n_jobs': -1, 'oob_score': True, 'random_state': None, 'verbose': 0,
'warm_start': False}]}
****

Processing Model: KNeighborsClassifier
****
* KNeighborsClassifier
* Best Params Result:
* {'classifier': 'KNeighborsClassifier', 'features': 'Active inflammation?,

Severity of Crypt Arch, Increased lamina propria cellularity?, Marked & transmucosal increase in lamina propria cellularity, Lamina propria polymorphs, Crypt architecture, Patchy lamina propria cellularity?, Epithelial changes, Mucosal surface, Cryptitis extent', 'accuracy': [0.654320987654321, 0.6234567901234568, 0.6728395061728395, 0.691358024691358, 0.6708074534161491], 'avgAccuracy': 0.6625565524116249, 'f1': [0.627269385017358, 0.5909847832328452, 0.6432898948331047, 0.6409072183040061, 0.6604707455058395], 'avgF1': 0.6325844053786307, 'precision': [0.654320987654321, 0.6234567901234568, 0.6728395061728395, 0.691358024691358, 0.6708074534161491], 'avgPrecision': 0.6625565524116249, 'recall': [0.654320987654321, 0.6234567901234568, 0.6728395061728395, 0.691358024691358, 0.6708074534161491], 'avgRecall': 0.6625565524116249, 'params': [{'algorithm': 'auto', 'leaf_size': 30, 'metric': 'minkowski', 'metric_params': None, 'n_jobs': -1, 'n_neighbors': 16, 'p': 2, 'weights': 'uniform'}]}
****

Processing Model: LogisticRegression
****
* LogisticRegression
* Best Params Result:
* {'classifier': 'LogisticRegression', 'features': 'Active inflammation?, Severity of Crypt Arch, Increased lamina propria cellularity?, Marked & transmucosal increase in lamina propria cellularity, Lamina propria polymorphs, Crypt architecture, Patchy lamina propria cellularity?, Epithelial changes, Mucosal surface, Cryptitis extent', 'accuracy': [0.6481481481481481, 0.6111111111111112, 0.6851851851851852, 0.691358024691358, 0.6894409937888198], 'avgAccuracy': 0.6650486925849245, 'f1': [0.6220598745119486, 0.5813482097969886, 0.65354622203565, 0.6567057085575605, 0.6760578894226357], 'avgF1': 0.6379435808649567, 'precision': [0.6481481481481481, 0.6111111111111112, 0.6851851851851852, 0.691358024691358, 0.6894409937888198], 'avgPrecision': 0.6650486925849245, 'recall': [0.6481481481481481, 0.6111111111111112, 0.6851851851851852, 0.691358024691358, 0.6894409937888198], 'avgRecall': 0.6650486925849245, 'params': [{'C': 1, 'class_weight': None, 'dual': False, 'fit_intercept': True, 'intercept_scaling': 1, 'l1_ratio': None, 'max_iter': 100, 'multi_class': 'multinomial', 'n_jobs': -1, 'penalty': 'l2', 'random_state': None, 'solver': 'newton-cg', 'tol': 0.0001, 'verbose': 0, 'warm_start': False}]}
****

Processing Model: GaussianNB
****
* GaussianNB
* Best Params Result:
* {'classifier': 'GaussianNB', 'features': 'Active inflammation?, Severity of Crypt Arch, Increased lamina propria cellularity?, Marked & transmucosal increase in lamina propria cellularity, Lamina propria polymorphs, Crypt architecture, Patchy lamina propria cellularity?, Epithelial changes, Mucosal surface, Cryptitis extent', 'accuracy': [0.5987654320987654, 0.5740740740740741,

0.6481481481481481, 0.6296296296296297, 0.6086956521739131], 'avgAccuracy':
0.611862587224906, 'f1': [0.6023155128419906, 0.5621240697878593,
0.6402425817630496, 0.6331430465525587, 0.6185176168914422], 'avgF1':
0.6112685655673801, 'precision': [0.5987654320987654, 0.5740740740740741,
0.6481481481481481, 0.6296296296296297, 0.6086956521739131], 'avgPrecision':
0.611862587224906, 'recall': [0.5987654320987654, 0.5740740740740741,
0.6481481481481481, 0.6296296296296297, 0.6086956521739131], 'avgRecall':
0.611862587224906, 'params': [{'priors': None, 'var_smoothing': 1e-09}]}
****

Processing Model: AdaBoostClassifier
****
* AdaBoostClassifier
* Best Params Result:
* {'classifier': 'AdaBoostClassifier', 'features': 'Active inflammation?,
Severity of Crypt Arch, Increased lamina propria cellularity?, Marked &
transmucosal increase in lamina propria cellularity, Lamina propria polymorphs,
Crypt architecture, Patchy lamina propria cellularity?, Epithelial changes,
Mucosal surface, Cryptitis extent', 'accuracy': [0.6666666666666666,
0.5679012345679012, 0.6851851851851852, 0.6790123456790124, 0.6956521739130435],
'avgAccuracy': 0.6588835212023618, 'f1': [0.6525421020675551,
0.5591001998496505, 0.6530456650961214, 0.6407887674096675, 0.6760710318205834],
'avgF1': 0.6363095532487156, 'precision': [0.6666666666666666,
0.5679012345679012, 0.6851851851851852, 0.6790123456790124, 0.6956521739130435],
'avgPrecision': 0.6588835212023618, 'recall': [0.6666666666666666,
0.5679012345679012, 0.6851851851851852, 0.6790123456790124, 0.6956521739130435],
'avgRecall': 0.6588835212023618, 'params': [{'algorithm': 'SAMME.R',
'base_estimator': None, 'learning_rate': 1, 'n_estimators': 100, 'random_state':
None}]}
****

Processing Model: DecisionTreeClassifier
****
* DecisionTreeClassifier
* Best Params Result:
* {'classifier': 'DecisionTreeClassifier', 'features': 'Active inflammation?,
Severity of Crypt Arch, Increased lamina propria cellularity?, Marked &
transmucosal increase in lamina propria cellularity, Lamina propria polymorphs,
Crypt architecture, Patchy lamina propria cellularity?, Epithelial changes,
Mucosal surface, Cryptitis extent', 'accuracy': [0.6296296296296297,
0.6111111111111112, 0.6296296296296297, 0.6604938271604939, 0.6521739130434783],
'avgAccuracy': 0.6366076221148685, 'f1': [0.6108293192222127, 0.611246221141342,
0.6140099536234743, 0.6481010873360599, 0.6592870215884251], 'avgF1':
0.6286947205823028, 'precision': [0.6296296296296297, 0.6111111111111112,
0.6296296296296297, 0.6604938271604939, 0.6521739130434783], 'avgPrecision':
0.6366076221148685, 'recall': [0.6296296296296297, 0.6111111111111112,
0.6296296296296297, 0.6604938271604939, 0.6521739130434783], 'avgRecall':
0.6366076221148685, 'params': [{'ccp_alpha': 0.0, 'class_weight': None,

'criterion': 'entropy', 'max_depth': None, 'max_features': 'sqrt',
'max_leaf_nodes': None, 'min_impurity_decrease': 0.0, 'min_impurity_split':
None, 'min_samples_leaf': 1, 'min_samples_split': 2, 'min_weight_fraction_leaf':
0.0, 'random_state': None, 'splitter': 'best'}]}
****

Processing Model: SVC
****
* SVC
* Best Params Result:
* {'classifier': 'SVC', 'features': 'Active inflammation?, Severity of Crypt
Arch, Increased lamina propria cellularity?, Marked & transmucosal increase in
lamina propria cellularity, Lamina propria polymorphs, Crypt architecture,
Patchy lamina propria cellularity?, Epithelial changes, Mucosal surface,
Cryptitis extent', 'accuracy': [0.6358024691358025, 0.6358024691358025,
0.6790123456790124, 0.6851851851851852, 0.6645962732919255], 'avgAccuracy':
0.6600797484855456, 'f1': [0.5537860082304527, 0.5587625610106229,
0.6001226483969817, 0.6180677396698739, 0.616860233879694], 'avgF1':
0.5895198382375251, 'precision': [0.6358024691358025, 0.6358024691358025,
0.6790123456790124, 0.6851851851851852, 0.6645962732919255], 'avgPrecision':
0.6600797484855456, 'recall': [0.6358024691358025, 0.6358024691358025,
0.6790123456790124, 0.6851851851851852, 0.6645962732919255], 'avgRecall':
0.6600797484855456, 'params': [{'C': 1.0, 'break_ties': False, 'cache_size':
4000, 'class_weight': None, 'coef0': 0.0, 'decision_function_shape': 'ovr',
'degree': 3, 'gamma': 'scale', 'kernel': 'linear', 'max_iter': -1,
'probability': False, 'random_state': None, 'shrinking': True, 'tol': 0.001,
'verbose': False}]}
****

Processing Model: MLPClassifier
****
* MLPClassifier
* Best Params Result:
* {'classifier': 'MLPClassifier', 'features': 'Active inflammation?, Severity of
Crypt Arch, Increased lamina propria cellularity?, Marked & transmucosal
increase in lamina propria cellularity, Lamina propria polymorphs, Crypt
architecture, Patchy lamina propria cellularity?, Epithelial changes, Mucosal
surface, Cryptitis extent', 'accuracy': [0.6604938271604939, 0.6172839506172839,
0.6851851851851852, 0.6975308641975309, 0.6894409937888198], 'avgAccuracy':
0.6699869641898627, 'f1': [0.6418471253812619, 0.5916420442674649,
0.65354622203565, 0.6614359237305492, 0.6760578894226357], 'avgF1':
0.6449058409675124, 'precision': [0.6604938271604939, 0.6172839506172839,
0.6851851851851852, 0.6975308641975309, 0.6894409937888198], 'avgPrecision':
0.6699869641898627, 'recall': [0.6604938271604939, 0.6172839506172839,
0.6851851851851852, 0.6975308641975309, 0.6894409937888198], 'avgRecall':
0.6699869641898627, 'params': [{'activation': 'logistic', 'alpha': 0.0001,
'batch_size': 'auto', 'beta_1': 0.9, 'beta_2': 0.999, 'early_stopping': False,
'epsilon': 1e-08, 'hidden_layer_sizes': (100,), 'learning_rate': 'constant',

```
'learning_rate_init': 0.001, 'max_fun': 15000, 'max_iter': 5000, 'momentum':
0.9, 'n_iter_no_change': 10, 'nesterovs_momentum': True, 'power_t': 0.5,
'random_state': None, 'shuffle': True, 'solver': 'adam', 'tol': 0.0001,
'validation_fraction': 0.1, 'verbose': False, 'warm_start': False}]}
*****************************************************
*****************************************************
* Best Performing Model and Params is:
* {'classifier': 'MLPClassifier', 'features': 'Active inflammation?, Severity of
Crypt Arch, Increased lamina propria cellularity?, Marked & transmucosal
increase in lamina propria cellularity, Lamina propria polymorphs, Crypt
architecture, Patchy lamina propria cellularity?, Epithelial changes, Mucosal
surface, Cryptitis extent', 'accuracy': [0.6604938271604939, 0.6172839506172839,
0.6851851851851852, 0.6975308641975309, 0.6894409937888198], 'avgAccuracy':
0.6699869641898627, 'f1': [0.641847125381619, 0.5916420442674649,
0.65354622203565, 0.6614359237305492, 0.6760578894226357], 'avgF1':
0.6449058409675124, 'precision': [0.6604938271604939, 0.6172839506172839,
0.6851851851851852, 0.6975308641975309, 0.6894409937888198], 'avgPrecision':
0.6699869641898627, 'recall': [0.6604938271604939, 0.6172839506172839,
0.6851851851851852, 0.6975308641975309, 0.6894409937888198], 'avgRecall':
0.6699869641898627, 'params': [{'activation': 'logistic', 'alpha': 0.0001,
'batch_size': 'auto', 'beta_1': 0.9, 'beta_2': 0.999, 'early_stopping': False,
'epsilon': 1e-08, 'hidden_layer_sizes': (100,), 'learning_rate': 'constant',
'learning_rate_init': 0.001, 'max_fun': 15000, 'max_iter': 5000, 'momentum':
0.9, 'n_iter_no_change': 10, 'nesterovs_momentum': True, 'power_t': 0.5,
'random_state': None, 'shuffle': True, 'solver': 'adam', 'tol': 0.0001,
'validation_fraction': 0.1, 'verbose': False, 'warm_start': False}]}
*****************************************************

                     model                                    features  \
0  RandomForestClassifier  Active inflammation?, Severity of Crypt Arch, …
1    KNeighborsClassifier  Active inflammation?, Severity of Crypt Arch, …
2      LogisticRegression  Active inflammation?, Severity of Crypt Arch, …
3              GaussianNB  Active inflammation?, Severity of Crypt Arch, …
4      AdaBoostClassifier  Active inflammation?, Severity of Crypt Arch, …
5  DecisionTreeClassifier  Active inflammation?, Severity of Crypt Arch, …
6                     SVC  Active inflammation?, Severity of Crypt Arch, …
7           MLPClassifier  Active inflammation?, Severity of Crypt Arch, …

   accuracy        f1  precision    recall  \
0  0.658861  0.638322   0.658861  0.658861
1  0.662557  0.632584   0.662557  0.662557
2  0.665049  0.637944   0.665049  0.665049
3  0.611863  0.611269   0.611863  0.611863
4  0.658884  0.636310   0.658884  0.658884
5  0.636608  0.628695   0.636608  0.636608
6  0.660080  0.589520   0.660080  0.660080
7  0.669987  0.644906   0.669987  0.669987
```

```
                                                         params
0  {'bootstrap': True, 'ccp_alpha': 0.0, 'class_w…
1  {'algorithm': 'auto', 'leaf_size': 30, 'metric…
2  {'C': 1, 'class_weight': None, 'dual': False, …
3              {'priors': None, 'var_smoothing': 1e-09}
4  {'algorithm': 'SAMME.R', 'base_estimator': Non…
5  {'ccp_alpha': 0.0, 'class_weight': None, 'crit…
6  {'C': 1.0, 'break_ties': False, 'cache_size': …
7  {'activation': 'logistic', 'alpha': 0.0001, 'b…
```

Processing Model: RandomForestClassifier
****
* RandomForestClassifier
* Best Params Result:
* {'classifier': 'RandomForestClassifier', 'features': 'Active inflammation?,
Severity of Crypt Arch, Increased lamina propria cellularity?, Marked &
transmucosal increase in lamina propria cellularity, Lamina propria polymorphs,
Crypt architecture, Patchy lamina propria cellularity?, Epithelial changes,
Mucosal surface', 'accuracy': [0.6481481481481481, 0.6111111111111112,
0.6851851851851852, 0.691358024691358, 0.6583850931677019], 'avgAccuracy':
0.6588375124607009, 'f1': [0.6267558436233135, 0.5914528337008957,
0.6584647919524463, 0.6679011635381619, 0.6501927607624759], 'avgF1':
0.6389534787154587, 'precision': [0.6481481481481481, 0.6111111111111112,
0.6851851851851852, 0.691358024691358, 0.6583850931677019], 'avgPrecision':
0.6588375124607009, 'recall': [0.6481481481481481, 0.6111111111111112,
0.6851851851851852, 0.691358024691358, 0.6583850931677019], 'avgRecall':
0.6588375124607009, 'params': [{'bootstrap': True, 'ccp_alpha': 0.0,
'class_weight': None, 'criterion': 'gini', 'max_depth': None, 'max_features':
'auto', 'max_leaf_nodes': None, 'max_samples': None, 'min_impurity_decrease':
0.0, 'min_impurity_split': None, 'min_samples_leaf': 1, 'min_samples_split': 2,
'min_weight_fraction_leaf': 0.0, 'n_estimators': 700, 'n_jobs': -1, 'oob_score':
False, 'random_state': None, 'verbose': 0, 'warm_start': False}]}
****

Processing Model: KNeighborsClassifier
****
* KNeighborsClassifier
* Best Params Result:
* {'classifier': 'KNeighborsClassifier', 'features': 'Active inflammation?,
Severity of Crypt Arch, Increased lamina propria cellularity?, Marked &
transmucosal increase in lamina propria cellularity, Lamina propria polymorphs,
Crypt architecture, Patchy lamina propria cellularity?, Epithelial changes,
Mucosal surface', 'accuracy': [0.6358024691358025, 0.6111111111111112,
0.691358024691358, 0.6975308641975309, 0.6645962732919255], 'avgAccuracy':
0.6600797484855456, 'f1': [0.5808836402631875, 0.5813482097969886,
0.658384112492769, 0.6461066731219236, 0.6639030982847446], 'avgF1':
0.6261251467919227, 'precision': [0.6358024691358025, 0.6111111111111112,
0.691358024691358, 0.6975308641975309, 0.6645962732919255], 'avgPrecision':

0.6600797484855456, 'recall': [0.6358024691358025, 0.6111111111111112, 0.691358024691358, 0.6975308641975309, 0.6645962732919255], 'avgRecall': 0.6600797484855456, 'params': [{'algorithm': 'auto', 'leaf_size': 30, 'metric': 'minkowski', 'metric_params': None, 'n_jobs': -1, 'n_neighbors': 16, 'p': 2, 'weights': 'uniform'}]}
****

Processing Model: LogisticRegression
****
* LogisticRegression
* Best Params Result:
* {'classifier': 'LogisticRegression', 'features': 'Active inflammation?, Severity of Crypt Arch, Increased lamina propria cellularity?, Marked & transmucosal increase in lamina propria cellularity, Lamina propria polymorphs, Crypt architecture, Patchy lamina propria cellularity?, Epithelial changes, Mucosal surface', 'accuracy': [0.654320987654321, 0.6172839506172839, 0.6851851851851852, 0.691358024691358, 0.6894409937888198], 'avgAccuracy': 0.6675178283873936, 'f1': [0.6364135526199495, 0.5916420442674649, 0.65354622203565, 0.6567057085575605, 0.6786878001270805], 'avgF1': 0.6433990655215411, 'precision': [0.654320987654321, 0.6172839506172839, 0.6851851851851852, 0.691358024691358, 0.6894409937888198], 'avgPrecision': 0.6675178283873936, 'recall': [0.654320987654321, 0.6172839506172839, 0.6851851851851852, 0.691358024691358, 0.6894409937888198], 'avgRecall': 0.6675178283873936, 'params': [{'C': 1, 'class_weight': None, 'dual': False, 'fit_intercept': True, 'intercept_scaling': 1, 'l1_ratio': None, 'max_iter': 100, 'multi_class': 'multinomial', 'n_jobs': -1, 'penalty': 'l2', 'random_state': None, 'solver': 'newton-cg', 'tol': 0.0001, 'verbose': 0, 'warm_start': False}]}
****

Processing Model: GaussianNB
****
* GaussianNB
* Best Params Result:
* {'classifier': 'GaussianNB', 'features': 'Active inflammation?, Severity of Crypt Arch, Increased lamina propria cellularity?, Marked & transmucosal increase in lamina propria cellularity, Lamina propria polymorphs, Crypt architecture, Patchy lamina propria cellularity?, Epithelial changes, Mucosal surface', 'accuracy': [0.6172839506172839, 0.5802469135802469, 0.6419753086419753, 0.6604938271604939, 0.6211180124223602], 'avgAccuracy': 0.6242236024844721, 'f1': [0.6149403155980189, 0.5675423632954071, 0.6346691781793865, 0.6579802123636537, 0.6328312300949723], 'avgF1': 0.6215926599062876, 'precision': [0.6172839506172839, 0.5802469135802469, 0.6419753086419753, 0.6604938271604939, 0.6211180124223602], 'avgPrecision': 0.6242236024844721, 'recall': [0.6172839506172839, 0.5802469135802469, 0.6419753086419753, 0.6604938271604939, 0.6211180124223602], 'avgRecall': 0.6242236024844721, 'params': [{'priors': None, 'var_smoothing': 1e-09}]}
****

```
Processing Model: AdaBoostClassifier
********************************************************
* AdaBoostClassifier
* Best Params Result:
* {'classifier': 'AdaBoostClassifier', 'features': 'Active inflammation?,
Severity of Crypt Arch, Increased lamina propria cellularity?, Marked &
transmucosal increase in lamina propria cellularity, Lamina propria polymorphs,
Crypt architecture, Patchy lamina propria cellularity?, Epithelial changes,
Mucosal surface', 'accuracy': [0.6604938271604939, 0.6172839506172839,
0.6790123456790124, 0.691358024691358, 0.6770186335403726], 'avgAccuracy':
0.6650333563377041, 'f1': [0.6429785548143035, 0.5742884561203285,
0.642926116994092, 0.6417539673199425, 0.6626671891240248], 'avgF1':
0.6329228568745383, 'precision': [0.6604938271604939, 0.6172839506172839,
0.6790123456790124, 0.691358024691358, 0.6770186335403726], 'avgPrecision':
0.6650333563377041, 'recall': [0.6604938271604939, 0.6172839506172839,
0.6790123456790124, 0.691358024691358, 0.6770186335403726], 'avgRecall':
0.6650333563377041, 'params': [{'algorithm': 'SAMME.R', 'base_estimator': None,
'learning_rate': 1, 'n_estimators': 20, 'random_state': None}]}
********************************************************

Processing Model: DecisionTreeClassifier
********************************************************
* DecisionTreeClassifier
* Best Params Result:
* {'classifier': 'DecisionTreeClassifier', 'features': 'Active inflammation?,
Severity of Crypt Arch, Increased lamina propria cellularity?, Marked &
transmucosal increase in lamina propria cellularity, Lamina propria polymorphs,
Crypt architecture, Patchy lamina propria cellularity?, Epithelial changes,
Mucosal surface', 'accuracy': [0.6358024691358025, 0.6049382716049383,
0.6604938271604939, 0.6728395061728395, 0.639751552795031], 'avgAccuracy':
0.642765125373821, 'f1': [0.6212620027434842, 0.5941128933336219,
0.6384112669869971, 0.6571150688820176, 0.6404476949142506], 'avgF1':
0.6302697853720743, 'precision': [0.6358024691358025, 0.6049382716049383,
0.6604938271604939, 0.6728395061728395, 0.639751552795031], 'avgPrecision':
0.642765125373821, 'recall': [0.6358024691358025, 0.6049382716049383,
0.6604938271604939, 0.6728395061728395, 0.639751552795031], 'avgRecall':
0.642765125373821, 'params': [{'ccp_alpha': 0.0, 'class_weight': None,
'criterion': 'entropy', 'max_depth': None, 'max_features': 'sqrt',
'max_leaf_nodes': None, 'min_impurity_decrease': 0.0, 'min_impurity_split':
None, 'min_samples_leaf': 1, 'min_samples_split': 2, 'min_weight_fraction_leaf':
0.0, 'random_state': None, 'splitter': 'best'}]}
********************************************************

Processing Model: SVC
********************************************************
* SVC
* Best Params Result:
```

* {'classifier': 'SVC', 'features': 'Active inflammation?, Severity of Crypt
Arch, Increased lamina propria cellularity?, Marked & transmucosal increase in
lamina propria cellularity, Lamina propria polymorphs, Crypt architecture,
Patchy lamina propria cellularity?, Epithelial changes, Mucosal surface',
'accuracy': [0.6358024691358025, 0.6358024691358025, 0.6790123456790124,
0.6851851851851852, 0.6645962732919255], 'avgAccuracy': 0.6600797484855456,
'f1': [0.5537860082304527, 0.5587625610106229, 0.6001226483969817,
0.6180677396698739, 0.616860233879694], 'avgF1': 0.5895198382375251,
'precision': [0.6358024691358025, 0.6358024691358025, 0.6790123456790124,
0.6851851851851852, 0.6645962732919255], 'avgPrecision': 0.6600797484855456,
'recall': [0.6358024691358025, 0.6358024691358025, 0.6790123456790124,
0.6851851851851852, 0.6645962732919255], 'avgRecall': 0.6600797484855456,
'params': [{'C': 1.0, 'break_ties': False, 'cache_size': 4000, 'class_weight':
None, 'coef0': 0.0, 'decision_function_shape': 'ovr', 'degree': 3, 'gamma':
'scale', 'kernel': 'linear', 'max_iter': -1, 'probability': False,
'random_state': None, 'shrinking': True, 'tol': 0.001, 'verbose': False}]}
****

Processing Model: MLPClassifier
****
* MLPClassifier
* Best Params Result:
* {'classifier': 'MLPClassifier', 'features': 'Active inflammation?, Severity of
Crypt Arch, Increased lamina propria cellularity?, Marked & transmucosal
increase in lamina propria cellularity, Lamina propria polymorphs, Crypt
architecture, Patchy lamina propria cellularity?, Epithelial changes, Mucosal
surface', 'accuracy': [0.654320987654321, 0.6172839506172839,
0.6851851851851852, 0.6975308641975309, 0.6894409937888198], 'avgAccuracy':
0.6687523962886281, 'f1': [0.6364135526199495, 0.5916420442674649,
0.65354622203565, 0.6614359237305492, 0.6786878001270805], 'avgF1':
0.6443451085561388, 'precision': [0.654320987654321, 0.6172839506172839,
0.6851851851851852, 0.6975308641975309, 0.6894409937888198], 'avgPrecision':
0.6687523962886281, 'recall': [0.654320987654321, 0.6172839506172839,
0.6851851851851852, 0.6975308641975309, 0.6894409937888198], 'avgRecall':
0.6687523962886281, 'params': [{'activation': 'identity', 'alpha': 0.0001,
'batch_size': 'auto', 'beta_1': 0.9, 'beta_2': 0.999, 'early_stopping': False,
'epsilon': 1e-08, 'hidden_layer_sizes': (100,), 'learning_rate': 'constant',
'learning_rate_init': 0.001, 'max_fun': 15000, 'max_iter': 5000, 'momentum':
0.9, 'n_iter_no_change': 10, 'nesterovs_momentum': True, 'power_t': 0.5,
'random_state': None, 'shuffle': True, 'solver': 'adam', 'tol': 0.0001,
'validation_fraction': 0.1, 'verbose': False, 'warm_start': False}]}
****
****
* Best Performing Model and Params is:
* {'classifier': 'MLPClassifier', 'features': 'Active inflammation?, Severity of
Crypt Arch, Increased lamina propria cellularity?, Marked & transmucosal
increase in lamina propria cellularity, Lamina propria polymorphs, Crypt
architecture, Patchy lamina propria cellularity?, Epithelial changes, Mucosal

surface', 'accuracy': [0.654320987654321, 0.6172839506172839,
0.6851851851851852, 0.6975308641975309, 0.6894409937888198], 'avgAccuracy':
0.6687523962886281, 'f1': [0.6364135526199495, 0.5916420442674649,
0.65354622203565, 0.6614359237305492, 0.6786878001270805], 'avgF1':
0.6443451085561388, 'precision': [0.654320987654321, 0.6172839506172839,
0.6851851851851852, 0.6975308641975309, 0.6894409937888198], 'avgPrecision':
0.6687523962886281, 'recall': [0.654320987654321, 0.6172839506172839,
0.6851851851851852, 0.6975308641975309, 0.6894409937888198], 'avgRecall':
0.6687523962886281, 'params': [{'activation': 'identity', 'alpha': 0.0001,
'batch_size': 'auto', 'beta_1': 0.9, 'beta_2': 0.999, 'early_stopping': False,
'epsilon': 1e-08, 'hidden_layer_sizes': (100,), 'learning_rate': 'constant',
'learning_rate_init': 0.001, 'max_fun': 15000, 'max_iter': 5000, 'momentum':
0.9, 'n_iter_no_change': 10, 'nesterovs_momentum': True, 'power_t': 0.5,
'random_state': None, 'shuffle': True, 'solver': 'adam', 'tol': 0.0001,
'validation_fraction': 0.1, 'verbose': False, 'warm_start': False}]}
****

```
                    model                                  features  \
0  RandomForestClassifier  Active inflammation?, Severity of Crypt Arch, …
1    KNeighborsClassifier  Active inflammation?, Severity of Crypt Arch, …
2      LogisticRegression  Active inflammation?, Severity of Crypt Arch, …
3              GaussianNB  Active inflammation?, Severity of Crypt Arch, …
4      AdaBoostClassifier  Active inflammation?, Severity of Crypt Arch, …
5  DecisionTreeClassifier  Active inflammation?, Severity of Crypt Arch, …
6                     SVC  Active inflammation?, Severity of Crypt Arch, …
7           MLPClassifier  Active inflammation?, Severity of Crypt Arch, …


   accuracy        f1  precision    recall  \
0  0.658838  0.638953   0.658838  0.658838
1  0.660080  0.626125   0.660080  0.660080
2  0.667518  0.643399   0.667518  0.667518
3  0.624224  0.621593   0.624224  0.624224
4  0.665033  0.632923   0.665033  0.665033
5  0.642765  0.630270   0.642765  0.642765
6  0.660080  0.589520   0.660080  0.660080
7  0.668752  0.644345   0.668752  0.668752


                                             params
0  {'bootstrap': True, 'ccp_alpha': 0.0, 'class_w…
1  {'algorithm': 'auto', 'leaf_size': 30, 'metric…
2  {'C': 1, 'class_weight': None, 'dual': False, …
3          {'priors': None, 'var_smoothing': 1e-09}
4  {'algorithm': 'SAMME.R', 'base_estimator': Non…
5  {'ccp_alpha': 0.0, 'class_weight': None, 'crit…
6  {'C': 1.0, 'break_ties': False, 'cache_size': …
7  {'activation': 'identity', 'alpha': 0.0001, 'b…


Processing Model: RandomForestClassifier
```

```
**************************************************
* RandomForestClassifier
* Best Params Result:
* {'classifier': 'RandomForestClassifier', 'features': 'Active inflammation?,
Severity of Crypt Arch, Increased lamina propria cellularity?, Marked &
transmucosal increase in lamina propria cellularity, Lamina propria polymorphs,
Crypt architecture, Patchy lamina propria cellularity?, Epithelial changes',
'accuracy': [0.6481481481481481, 0.6296296296296297, 0.691358024691358,
0.691358024691358, 0.6583850931677019], 'avgAccuracy': 0.6637757840656391, 'f1':
[0.6290069316534547, 0.6015743389204401, 0.6579368517315236, 0.6630064893953782,
0.6498966027672993], 'avgF1': 0.6402842428936192, 'precision':
[0.6481481481481481, 0.6296296296296297, 0.691358024691358, 0.691358024691358,
0.6583850931677019], 'avgPrecision': 0.6637757840656391, 'recall':
[0.6481481481481481, 0.6296296296296297, 0.691358024691358, 0.691358024691358,
0.6583850931677019], 'avgRecall': 0.6637757840656391, 'params': [{'bootstrap':
True, 'ccp_alpha': 0.0, 'class_weight': None, 'criterion': 'entropy',
'max_depth': None, 'max_features': 'log2', 'max_leaf_nodes': None,
'max_samples': None, 'min_impurity_decrease': 0.0, 'min_impurity_split': None,
'min_samples_leaf': 1, 'min_samples_split': 2, 'min_weight_fraction_leaf': 0.0,
'n_estimators': 200, 'n_jobs': -1, 'oob_score': True, 'random_state': None,
'verbose': 0, 'warm_start': False}]}
**************************************************

Processing Model: KNeighborsClassifier
**************************************************
* KNeighborsClassifier
* Best Params Result:
* {'classifier': 'KNeighborsClassifier', 'features': 'Active inflammation?,
Severity of Crypt Arch, Increased lamina propria cellularity?, Marked &
transmucosal increase in lamina propria cellularity, Lamina propria polymorphs,
Crypt architecture, Patchy lamina propria cellularity?, Epithelial changes',
'accuracy': [0.6481481481481481, 0.5987654320987654, 0.691358024691358,
0.6975308641975309, 0.6645962732919255], 'avgAccuracy': 0.6600797484855456,
'f1': [0.6057098765432098, 0.5766990689471309, 0.658384112492769,
0.6618255937096517, 0.6688502859903516], 'avgF1': 0.6342937875366226,
'precision': [0.6481481481481481, 0.5987654320987654, 0.691358024691358,
0.6975308641975309, 0.6645962732919255], 'avgPrecision': 0.6600797484855456,
'recall': [0.6481481481481481, 0.5987654320987654, 0.691358024691358,
0.6975308641975309, 0.6645962732919255], 'avgRecall': 0.6600797484855456,
'params': [{'algorithm': 'auto', 'leaf_size': 30, 'metric': 'minkowski',
'metric_params': None, 'n_jobs': -1, 'n_neighbors': 16, 'p': 2, 'weights':
'uniform'}]}
**************************************************

Processing Model: LogisticRegression
**************************************************
* LogisticRegression
* Best Params Result:
```

```
* {'classifier': 'LogisticRegression', 'features': 'Active inflammation?,
Severity of Crypt Arch, Increased lamina propria cellularity?, Marked &
transmucosal increase in lamina propria cellularity, Lamina propria polymorphs,
Crypt architecture, Patchy lamina propria cellularity?, Epithelial changes',
'accuracy': [0.654320987654321, 0.6172839506172839, 0.6851851851851852,
0.6851851851851852, 0.6770186335403726], 'avgAccuracy': 0.6637987884364696,
'f1': [0.637536971349645, 0.5916420442674649, 0.65354622203565,
0.6522580260534254, 0.6683285552113006], 'avgF1': 0.6406623637834972,
'precision': [0.654320987654321, 0.6172839506172839, 0.6851851851851852,
0.6851851851851852, 0.6770186335403726], 'avgPrecision': 0.6637987884364696,
'recall': [0.654320987654321, 0.6172839506172839, 0.6851851851851852,
0.6851851851851852, 0.6770186335403726], 'avgRecall': 0.6637987884364696,
'params': [{'C': 1, 'class_weight': None, 'dual': False, 'fit_intercept': True,
'intercept_scaling': 1, 'l1_ratio': None, 'max_iter': 100, 'multi_class': 'ovr',
'n_jobs': -1, 'penalty': 'l2', 'random_state': None, 'solver': 'newton-cg',
'tol': 0.0001, 'verbose': 0, 'warm_start': False}]}
*****************************************************

Processing Model: GaussianNB
*****************************************************
* GaussianNB
* Best Params Result:
* {'classifier': 'GaussianNB', 'features': 'Active inflammation?, Severity of
Crypt Arch, Increased lamina propria cellularity?, Marked & transmucosal
increase in lamina propria cellularity, Lamina propria polymorphs, Crypt
architecture, Patchy lamina propria cellularity?, Epithelial changes',
'accuracy': [0.6296296296296297, 0.5802469135802469, 0.6604938271604939,
0.6728395061728395, 0.6086956521739131], 'avgAccuracy': 0.6303811057434247,
'f1': [0.6185336509260259, 0.5660689271575461, 0.6429435971919633,
0.6552397310531134, 0.6144905128302768], 'avgF1': 0.619455283831785,
'precision': [0.6296296296296297, 0.5802469135802469, 0.6604938271604939,
0.6728395061728395, 0.6086956521739131], 'avgPrecision': 0.6303811057434247,
'recall': [0.6296296296296297, 0.5802469135802469, 0.6604938271604939,
0.6728395061728395, 0.6086956521739131], 'avgRecall': 0.6303811057434247,
'params': [{'priors': None, 'var_smoothing': 1e-09}]}
*****************************************************

Processing Model: AdaBoostClassifier
*****************************************************
* AdaBoostClassifier
* Best Params Result:
* {'classifier': 'AdaBoostClassifier', 'features': 'Active inflammation?,
Severity of Crypt Arch, Increased lamina propria cellularity?, Marked &
transmucosal increase in lamina propria cellularity, Lamina propria polymorphs,
Crypt architecture, Patchy lamina propria cellularity?, Epithelial changes',
'accuracy': [0.654320987654321, 0.6172839506172839, 0.6851851851851852,
0.6728395061728395, 0.6770186335403726], 'avgAccuracy': 0.6613296526340005,
'f1': [0.6331826776271221, 0.5753251554407319, 0.6476015084691138,
```

0.6354938552163047, 0.6626671891240248], 'avgF1': 0.6308540771754595,
'precision': [0.654320987654321, 0.6172839506172839, 0.6851851851851852,
0.6728395061728395, 0.6770186335403726], 'avgPrecision': 0.6613296526340005,
'recall': [0.654320987654321, 0.6172839506172839, 0.6851851851851852,
0.6728395061728395, 0.6770186335403726], 'avgRecall': 0.6613296526340005,
'params': [{'algorithm': 'SAMME.R', 'base_estimator': None, 'learning_rate': 1,
'n_estimators': 20, 'random_state': None}]}
****

Processing Model: DecisionTreeClassifier
****
* DecisionTreeClassifier
* Best Params Result:
* {'classifier': 'DecisionTreeClassifier', 'features': 'Active inflammation?,
Severity of Crypt Arch, Increased lamina propria cellularity?, Marked &
transmucosal increase in lamina propria cellularity, Lamina propria polymorphs,
Crypt architecture, Patchy lamina propria cellularity?, Epithelial changes',
'accuracy': [0.6604938271604939, 0.6049382716049383, 0.6851851851851852,
0.6790123456790124, 0.6583850931677019], 'avgAccuracy': 0.6576029445594663,
'f1': [0.6482037523348847, 0.5863375331589531, 0.6538316572170498,
0.6529971420571906, 0.6498966027672993], 'avgF1': 0.6382533375070755,
'precision': [0.6604938271604939, 0.6049382716049383, 0.6851851851851852,
0.6790123456790124, 0.6583850931677019], 'avgPrecision': 0.6576029445594663,
'recall': [0.6604938271604939, 0.6049382716049383, 0.6851851851851852,
0.6790123456790124, 0.6583850931677019], 'avgRecall': 0.6576029445594663,
'params': [{'ccp_alpha': 0.0, 'class_weight': None, 'criterion': 'gini',
'max_depth': None, 'max_features': 'auto', 'max_leaf_nodes': None,
'min_impurity_decrease': 0.0, 'min_impurity_split': None, 'min_samples_leaf': 1,
'min_samples_split': 2, 'min_weight_fraction_leaf': 0.0, 'random_state': None,
'splitter': 'best'}]}
****

Processing Model: SVC
****
* SVC
* Best Params Result:
* {'classifier': 'SVC', 'features': 'Active inflammation?, Severity of Crypt
Arch, Increased lamina propria cellularity?, Marked & transmucosal increase in
lamina propria cellularity, Lamina propria polymorphs, Crypt architecture,
Patchy lamina propria cellularity?, Epithelial changes', 'accuracy':
[0.6358024691358025, 0.6358024691358025, 0.6790123456790124, 0.6851851851851852,
0.6645962732919255], 'avgAccuracy': 0.6600797484855456, 'f1':
[0.5537860082304527, 0.5587625610106229, 0.6001226483969817, 0.6180677396698739,
0.616860233879694], 'avgF1': 0.5895198382375251, 'precision':
[0.6358024691358025, 0.6358024691358025, 0.6790123456790124, 0.6851851851851852,
0.6645962732919255], 'avgPrecision': 0.6600797484855456, 'recall':
[0.6358024691358025, 0.6358024691358025, 0.6790123456790124, 0.6851851851851852,
0.6645962732919255], 'avgRecall': 0.6600797484855456, 'params': [{'C': 1.0,

'break_ties': False, 'cache_size': 4000, 'class_weight': None, 'coef0': 0.0,
'decision_function_shape': 'ovr', 'degree': 3, 'gamma': 'scale', 'kernel':
'linear', 'max_iter': -1, 'probability': False, 'random_state': None,
'shrinking': True, 'tol': 0.001, 'verbose': False}]}
****

Processing Model: MLPClassifier
****
* MLPClassifier
* Best Params Result:
* {'classifier': 'MLPClassifier', 'features': 'Active inflammation?, Severity of
Crypt Arch, Increased lamina propria cellularity?, Marked & transmucosal
increase in lamina propria cellularity, Lamina propria polymorphs, Crypt
architecture, Patchy lamina propria cellularity?, Epithelial changes',
'accuracy': [0.654320987654321, 0.6172839506172839, 0.6851851851851852,
0.691358024691358, 0.6770186335403726], 'avgAccuracy': 0.6650333563377041, 'f1':
[0.637536971349645, 0.5916420442674649, 0.65354622203565, 0.6570330818995961,
0.66832855521113006], 'avgF1': 0.6416173749527313, 'precision':
[0.654320987654321, 0.6172839506172839, 0.6851851851851852, 0.691358024691358,
0.6770186335403726], 'avgPrecision': 0.6650333563377041, 'recall':
[0.654320987654321, 0.6172839506172839, 0.6851851851851852, 0.691358024691358,
0.6770186335403726], 'avgRecall': 0.6650333563377041, 'params': [{'activation':
'identity', 'alpha': 0.0001, 'batch_size': 'auto', 'beta_1': 0.9, 'beta_2':
0.999, 'early_stopping': False, 'epsilon': 1e-08, 'hidden_layer_sizes': (100,),
'learning_rate': 'adaptive', 'learning_rate_init': 0.001, 'max_fun': 15000,
'max_iter': 5000, 'momentum': 0.9, 'n_iter_no_change': 10, 'nesterovs_momentum':
True, 'power_t': 0.5, 'random_state': None, 'shuffle': True, 'solver': 'adam',
'tol': 0.0001, 'validation_fraction': 0.1, 'verbose': False, 'warm_start':
False}]}
****
****
* Best Performing Model and Params is:
* {'classifier': 'MLPClassifier', 'features': 'Active inflammation?, Severity of
Crypt Arch, Increased lamina propria cellularity?, Marked & transmucosal
increase in lamina propria cellularity, Lamina propria polymorphs, Crypt
architecture, Patchy lamina propria cellularity?, Epithelial changes',
'accuracy': [0.654320987654321, 0.6172839506172839, 0.6851851851851852,
0.691358024691358, 0.6770186335403726], 'avgAccuracy': 0.6650333563377041, 'f1':
[0.637536971349645, 0.5916420442674649, 0.65354622203565, 0.6570330818995961,
0.66832855521113006], 'avgF1': 0.6416173749527313, 'precision':
[0.654320987654321, 0.6172839506172839, 0.6851851851851852, 0.691358024691358,
0.6770186335403726], 'avgPrecision': 0.6650333563377041, 'recall':
[0.654320987654321, 0.6172839506172839, 0.6851851851851852, 0.691358024691358,
0.6770186335403726], 'avgRecall': 0.6650333563377041, 'params': [{'activation':
'identity', 'alpha': 0.0001, 'batch_size': 'auto', 'beta_1': 0.9, 'beta_2':
0.999, 'early_stopping': False, 'epsilon': 1e-08, 'hidden_layer_sizes': (100,),
'learning_rate': 'adaptive', 'learning_rate_init': 0.001, 'max_fun': 15000,
'max_iter': 5000, 'momentum': 0.9, 'n_iter_no_change': 10, 'nesterovs_momentum':

```
True, 'power_t': 0.5, 'random_state': None, 'shuffle': True, 'solver': 'adam',
'tol': 0.0001, 'validation_fraction': 0.1, 'verbose': False, 'warm_start':
False}]}
********************************************************
```

```
                   model                                      features  \
0  RandomForestClassifier  Active inflammation?, Severity of Crypt Arch, …
1    KNeighborsClassifier  Active inflammation?, Severity of Crypt Arch, …
2      LogisticRegression  Active inflammation?, Severity of Crypt Arch, …
3              GaussianNB  Active inflammation?, Severity of Crypt Arch, …
4      AdaBoostClassifier  Active inflammation?, Severity of Crypt Arch, …
5  DecisionTreeClassifier  Active inflammation?, Severity of Crypt Arch, …
6                     SVC  Active inflammation?, Severity of Crypt Arch, …
7           MLPClassifier  Active inflammation?, Severity of Crypt Arch, …

   accuracy        f1  precision    recall  \
0  0.663776  0.640284   0.663776  0.663776
1  0.660080  0.634294   0.660080  0.660080
2  0.663799  0.640662   0.663799  0.663799
3  0.630381  0.619455   0.630381  0.630381
4  0.661330  0.630854   0.661330  0.661330
5  0.657603  0.638253   0.657603  0.657603
6  0.660080  0.589520   0.660080  0.660080
7  0.665033  0.641617   0.665033  0.665033

                                               params
0  {'bootstrap': True, 'ccp_alpha': 0.0, 'class_w…
1  {'algorithm': 'auto', 'leaf_size': 30, 'metric…
2  {'C': 1, 'class_weight': None, 'dual': False, …
3          {'priors': None, 'var_smoothing': 1e-09}
4  {'algorithm': 'SAMME.R', 'base_estimator': Non…
5  {'ccp_alpha': 0.0, 'class_weight': None, 'crit…
6  {'C': 1.0, 'break_ties': False, 'cache_size': …
7  {'activation': 'identity', 'alpha': 0.0001, 'b…

Processing Model: RandomForestClassifier
********************************************************
* RandomForestClassifier
* Best Params Result:
* {'classifier': 'RandomForestClassifier', 'features': 'Active inflammation?,
Severity of Crypt Arch, Increased lamina propria cellularity?, Marked &
transmucosal increase in lamina propria cellularity, Lamina propria polymorphs,
Crypt architecture, Patchy lamina propria cellularity?', 'accuracy':
[0.6481481481481481, 0.6172839506172839, 0.6851851851851852, 0.6851851851851852,
0.6770186335403726], 'avgAccuracy': 0.662564220535235, 'f1':
[0.6290069316534547, 0.591642044267465, 0.6530456650961214, 0.6517701533306176,
0.6657252766541621], 'avgF1': 0.6382380142003642, 'precision':
[0.6481481481481481, 0.6172839506172839, 0.6851851851851852, 0.6851851851851852,
```

0.6770186335403726], 'avgPrecision': 0.662564220535235, 'recall':
[0.6481481481481481, 0.6172839506172839, 0.6851851851851852, 0.6851851851851852,
0.6770186335403726], 'avgRecall': 0.662564220535235, 'params': [{'bootstrap':
True, 'ccp_alpha': 0.0, 'class_weight': None, 'criterion': 'entropy',
'max_depth': None, 'max_features': 'auto', 'max_leaf_nodes': None,
'max_samples': None, 'min_impurity_decrease': 0.0, 'min_impurity_split': None,
'min_samples_leaf': 1, 'min_samples_split': 2, 'min_weight_fraction_leaf': 0.0,
'n_estimators': 200, 'n_jobs': -1, 'oob_score': False, 'random_state': None,
'verbose': 0, 'warm_start': False}]}
****

Processing Model: KNeighborsClassifier
****
* KNeighborsClassifier
* Best Params Result:
* {'classifier': 'KNeighborsClassifier', 'features': 'Active inflammation?,
Severity of Crypt Arch, Increased lamina propria cellularity?, Marked &
transmucosal increase in lamina propria cellularity, Lamina propria polymorphs,
Crypt architecture, Patchy lamina propria cellularity?', 'accuracy':
[0.6419753086419753, 0.6172839506172839, 0.691358024691358, 0.6851851851851852,
0.6770186335403726], 'avgAccuracy': 0.662564220535235, 'f1':
[0.5680757496203289, 0.5916420442674649, 0.658384112492769, 0.6522580260534254,
0.6657252766541621], 'avgF1': 0.62721704181763, 'precision':
[0.6419753086419753, 0.6172839506172839, 0.691358024691358, 0.6851851851851852,
0.6770186335403726], 'avgPrecision': 0.662564220535235, 'recall':
[0.6419753086419753, 0.6172839506172839, 0.691358024691358, 0.6851851851851852,
0.6770186335403726], 'avgRecall': 0.662564220535235, 'params': [{'algorithm':
'auto', 'leaf_size': 30, 'metric': 'minkowski', 'metric_params': None, 'n_jobs':
-1, 'n_neighbors': 16, 'p': 2, 'weights': 'uniform'}]}
****

Processing Model: LogisticRegression
****
* LogisticRegression
* Best Params Result:
* {'classifier': 'LogisticRegression', 'features': 'Active inflammation?,
Severity of Crypt Arch, Increased lamina propria cellularity?, Marked &
transmucosal increase in lamina propria cellularity, Lamina propria polymorphs,
Crypt architecture, Patchy lamina propria cellularity?', 'accuracy':
[0.654320987654321, 0.6172839506172839, 0.6851851851851852, 0.6851851851851852,
0.6770186335403726], 'avgAccuracy': 0.6637987884364696, 'f1':
[0.637536971349645, 0.5916420442674649, 0.65354622203565, 0.6522580260534254,
0.66832855552113006], 'avgF1': 0.6406623637834972, 'precision':
[0.654320987654321, 0.6172839506172839, 0.6851851851851852, 0.6851851851851852,
0.6770186335403726], 'avgPrecision': 0.6637987884364696, 'recall':
[0.654320987654321, 0.6172839506172839, 0.6851851851851852, 0.6851851851851852,
0.6770186335403726], 'avgRecall': 0.6637987884364696, 'params': [{'C': 1,
'class_weight': None, 'dual': False, 'fit_intercept': True, 'intercept_scaling':

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1, 'l1_ratio': None, 'max_iter': 100, 'multi_class': 'ovr', 'n_jobs': -1,
'penalty': 'l2', 'random_state': None, 'solver': 'newton-cg', 'tol': 0.0001,
'verbose': 0, 'warm_start': False}]}
****

Processing Model: GaussianNB
****
* GaussianNB
* Best Params Result:
* {'classifier': 'GaussianNB', 'features': 'Active inflammation?, Severity of
Crypt Arch, Increased lamina propria cellularity?, Marked & transmucosal
increase in lamina propria cellularity, Lamina propria polymorphs, Crypt
architecture, Patchy lamina propria cellularity?', 'accuracy':
[0.6358024691358025, 0.5987654320987654, 0.654320987654321, 0.6666666666666666,
0.639751552795031], 'avgAccuracy': 0.6390614216701174, 'f1':
[0.6279565287848432, 0.5777481747637021, 0.6376559870711918, 0.6450083556026708,
0.6414490613790377], 'avgF1': 0.6259636215202891, 'precision':
[0.6358024691358025, 0.5987654320987654, 0.654320987654321, 0.6666666666666666,
0.639751552795031], 'avgPrecision': 0.6390614216701174, 'recall':
[0.6358024691358025, 0.5987654320987654, 0.654320987654321, 0.6666666666666666,
0.639751552795031], 'avgRecall': 0.6390614216701174, 'params': [{'priors': None,
'var_smoothing': 1e-09}]}
****

Processing Model: AdaBoostClassifier
****
* AdaBoostClassifier
* Best Params Result:
* {'classifier': 'AdaBoostClassifier', 'features': 'Active inflammation?,
Severity of Crypt Arch, Increased lamina propria cellularity?, Marked &
transmucosal increase in lamina propria cellularity, Lamina propria polymorphs,
Crypt architecture, Patchy lamina propria cellularity?', 'accuracy':
[0.654320987654321, 0.6111111111111112, 0.6975308641975309, 0.6790123456790124,
0.5031055900621118], 'avgAccuracy': 0.6290161797408175, 'f1':
[0.637536971349645, 0.5866697596746655, 0.6688400306544482, 0.6469561174422286,
0.5210211151409533], 'avgF1': 0.6122047988523881, 'precision':
[0.654320987654321, 0.6111111111111112, 0.6975308641975309, 0.6790123456790124,
0.5031055900621118], 'avgPrecision': 0.6290161797408175, 'recall':
[0.654320987654321, 0.6111111111111112, 0.6975308641975309, 0.6790123456790124,
0.5031055900621118], 'avgRecall': 0.6290161797408175, 'params': [{'algorithm':
'SAMME.R', 'base_estimator': None, 'learning_rate': 1, 'n_estimators': 20,
'random_state': None}]}
****

Processing Model: DecisionTreeClassifier
****
* DecisionTreeClassifier
* Best Params Result:

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* {'classifier': 'DecisionTreeClassifier', 'features': 'Active inflammation?,
Severity of Crypt Arch, Increased lamina propria cellularity?, Marked &
transmucosal increase in lamina propria cellularity, Lamina propria polymorphs,
Crypt architecture, Patchy lamina propria cellularity?', 'accuracy':
[0.6419753086419753, 0.6172839506172839, 0.6790123456790124, 0.6790123456790124,
0.6770186335403726], 'avgAccuracy': 0.6588605168315314, 'f1':
[0.6236772591777753, 0.5916420442674649, 0.6481647127875735, 0.6469561174422286,
0.6657252766541621], 'avgF1': 0.6352330820658408, 'precision':
[0.6419753086419753, 0.6172839506172839, 0.6790123456790124, 0.6790123456790124,
0.6770186335403726], 'avgPrecision': 0.6588605168315314, 'recall':
[0.6419753086419753, 0.6172839506172839, 0.6790123456790124, 0.6790123456790124,
0.6770186335403726], 'avgRecall': 0.6588605168315314, 'params': [{'ccp_alpha':
0.0, 'class_weight': None, 'criterion': 'gini', 'max_depth': None,
'max_features': 'sqrt', 'max_leaf_nodes': None, 'min_impurity_decrease': 0.0,
'min_impurity_split': None, 'min_samples_leaf': 1, 'min_samples_split': 2,
'min_weight_fraction_leaf': 0.0, 'random_state': None, 'splitter': 'best'}]}
****

Processing Model: SVC
****
* SVC
* Best Params Result:
* {'classifier': 'SVC', 'features': 'Active inflammation?, Severity of Crypt
Arch, Increased lamina propria cellularity?, Marked & transmucosal increase in
lamina propria cellularity, Lamina propria polymorphs, Crypt architecture,
Patchy lamina propria cellularity?', 'accuracy': [0.6358024691358025,
0.6358024691358025, 0.6790123456790124, 0.6851851851851852, 0.6645962732919255],
'avgAccuracy': 0.6600797484855456, 'f1': [0.5537860082304527,
0.5587625610106229, 0.6001226483969817, 0.6180677396698739, 0.616860233879694],
'avgF1': 0.5895198382375251, 'precision': [0.6358024691358025,
0.6358024691358025, 0.6790123456790124, 0.6851851851851852, 0.6645962732919255],
'avgPrecision': 0.6600797484855456, 'recall': [0.6358024691358025,
0.6358024691358025, 0.6790123456790124, 0.6851851851851852, 0.6645962732919255],
'avgRecall': 0.6600797484855456, 'params': [{'C': 1.0, 'break_ties': False,
'cache_size': 4000, 'class_weight': None, 'coef0': 0.0,
'decision_function_shape': 'ovr', 'degree': 3, 'gamma': 'scale', 'kernel':
'linear', 'max_iter': -1, 'probability': False, 'random_state': None,
'shrinking': True, 'tol': 0.001, 'verbose': False}]}
****

Processing Model: MLPClassifier
****
* MLPClassifier
* Best Params Result:
* {'classifier': 'MLPClassifier', 'features': 'Active inflammation?, Severity of
Crypt Arch, Increased lamina propria cellularity?, Marked & transmucosal
increase in lamina propria cellularity, Lamina propria polymorphs, Crypt
architecture, Patchy lamina propria cellularity?', 'accuracy':

```
[0.654320987654321, 0.6172839506172839, 0.6851851851851852, 0.6851851851851852,
0.6770186335403726], 'avgAccuracy': 0.6637987884364696, 'f1':
[0.637536971349645, 0.5916420442674649, 0.65354622203565, 0.6522580260534254,
0.6683285552113006], 'avgF1': 0.6406623637834972, 'precision':
[0.654320987654321, 0.6172839506172839, 0.6851851851851852, 0.6851851851851852,
0.6770186335403726], 'avgPrecision': 0.6637987884364696, 'recall':
[0.654320987654321, 0.6172839506172839, 0.6851851851851852, 0.6851851851851852,
0.6770186335403726], 'avgRecall': 0.6637987884364696, 'params': [{'activation':
'identity', 'alpha': 0.0001, 'batch_size': 'auto', 'beta_1': 0.9, 'beta_2':
0.999, 'early_stopping': False, 'epsilon': 1e-08, 'hidden_layer_sizes': (100,),
'learning_rate': 'constant', 'learning_rate_init': 0.001, 'max_fun': 15000,
'max_iter': 5000, 'momentum': 0.9, 'n_iter_no_change': 10, 'nesterovs_momentum':
True, 'power_t': 0.5, 'random_state': None, 'shuffle': True, 'solver': 'adam',
'tol': 0.0001, 'validation_fraction': 0.1, 'verbose': False, 'warm_start':
False}]}
********************************************************
********************************************************
* Best Performing Model and Params is:
* {'classifier': 'LogisticRegression', 'features': 'Active inflammation?,
Severity of Crypt Arch, Increased lamina propria cellularity?, Marked &
transmucosal increase in lamina propria cellularity, Lamina propria polymorphs,
Crypt architecture, Patchy lamina propria cellularity?', 'accuracy':
[0.654320987654321, 0.6172839506172839, 0.6851851851851852, 0.6851851851851852,
0.6770186335403726], 'avgAccuracy': 0.6637987884364696, 'f1':
[0.637536971349645, 0.5916420442674649, 0.65354622203565, 0.6522580260534254,
0.6683285552113006], 'avgF1': 0.6406623637834972, 'precision':
[0.654320987654321, 0.6172839506172839, 0.6851851851851852, 0.6851851851851852,
0.6770186335403726], 'avgPrecision': 0.6637987884364696, 'recall':
[0.654320987654321, 0.6172839506172839, 0.6851851851851852, 0.6851851851851852,
0.6770186335403726], 'avgRecall': 0.6637987884364696, 'params': [{'C': 1,
'class_weight': None, 'dual': False, 'fit_intercept': True, 'intercept_scaling':
1, 'l1_ratio': None, 'max_iter': 100, 'multi_class': 'ovr', 'n_jobs': -1,
'penalty': 'l2', 'random_state': None, 'solver': 'newton-cg', 'tol': 0.0001,
'verbose': 0, 'warm_start': False}]}
********************************************************

                  model                                   features  \
0  RandomForestClassifier   Active inflammation?, Severity of Crypt Arch, …
1    KNeighborsClassifier   Active inflammation?, Severity of Crypt Arch, …
2      LogisticRegression   Active inflammation?, Severity of Crypt Arch, …
3              GaussianNB   Active inflammation?, Severity of Crypt Arch, …
4       AdaBoostClassifier   Active inflammation?, Severity of Crypt Arch, …
5  DecisionTreeClassifier   Active inflammation?, Severity of Crypt Arch, …
6                     SVC   Active inflammation?, Severity of Crypt Arch, …
7           MLPClassifier   Active inflammation?, Severity of Crypt Arch, …

   accuracy        f1  precision    recall  \
0  0.662564  0.638238   0.662564  0.662564
```

```
1  0.662564  0.627217   0.662564  0.662564
2  0.663799  0.640662   0.663799  0.663799
3  0.639061  0.625964   0.639061  0.639061
4  0.629016  0.612205   0.629016  0.629016
5  0.658861  0.635233   0.658861  0.658861
6  0.660080  0.589520   0.660080  0.660080
7  0.663799  0.640662   0.663799  0.663799


                                        params
0  {'bootstrap': True, 'ccp_alpha': 0.0, 'class_w…
1  {'algorithm': 'auto', 'leaf_size': 30, 'metric…
2  {'C': 1, 'class_weight': None, 'dual': False, …
3           {'priors': None, 'var_smoothing': 1e-09}
4  {'algorithm': 'SAMME.R', 'base_estimator': Non…
5  {'ccp_alpha': 0.0, 'class_weight': None, 'crit…
6  {'C': 1.0, 'break_ties': False, 'cache_size': …
7  {'activation': 'identity', 'alpha': 0.0001, 'b…
```

[103]:
```python
now = datetime.datetime.now()
print ("Current date and time : ")
print (now.strftime("%Y-%m-%d %H:%M:%S"))
```

```
Current date and time :
2021-06-04 20:09:33
```

[104]:
```python
# MSMOTE Dataset
X3 = pd.concat([X_msm, X_test_ord]) #.to_numpy()
y3 = pd.concat([y_msm, y_test_ord]).to_numpy()
#data = (X, y, n_folds)

print('******************************************')
print('Starting MSMOTE data set....')
print('******************************************')

for i in range(1 ,6 , -1):
    col = []
    col = df[:i]
    nX3 = X3.loc[:, col]
    nX3 = nX3.to_numpy()
    data3 = (nX3, y3, n_folds)
    hyper_search(modelDictionary, modelParamsDictionary, data3, col)
```

```
******************************************
Starting MSMOTE data set…
******************************************

Processing Model: RandomForestClassifier
*****************************************************
* RandomForestClassifier
```

* Best Params Result:
* {'classifier': 'RandomForestClassifier', 'features': 'Active inflammation?,
Severity of Crypt Arch, Increased lamina propria cellularity?, Marked &
transmucosal increase in lamina propria cellularity, Lamina propria polymorphs,
Crypt architecture, Patchy lamina propria cellularity?, Epithelial changes,
Mucosal surface, Cryptitis extent, Mucin depletion, Cryptitis polymorphs, Lamina
propria granulomas, Crypt abscesses polymorphs, Crypt abscesses extent, Basal
histiocytic cells, Submucosal granulomas, Sex, Increased lymphoid aggregates in
lamina propria?, Mild & superficial increase in lamina propria cellularity?,
Intraepithelial lymphocytes, Age, Crypt profiles', 'accuracy': [0.68, 0.76,
0.772, 0.804, 0.6305220883534136], 'avgAccuracy': 0.7293044176706828, 'f1':
[0.6864281835205993, 0.7652111718288137, 0.7995323325880974, 0.8465789473684212,
0.6385909513235934], 'avgF1': 0.747268317325905, 'precision': [0.68, 0.76,
0.772, 0.804, 0.6305220883534136], 'avgPrecision': 0.7293044176706828, 'recall':
[0.68, 0.76, 0.772, 0.804, 0.6305220883534136], 'avgRecall': 0.7293044176706828,
'params': [{'bootstrap': True, 'ccp_alpha': 0.0, 'class_weight': None,
'criterion': 'gini', 'max_depth': None, 'max_features': 'auto',
'max_leaf_nodes': None, 'max_samples': None, 'min_impurity_decrease': 0.0,
'min_impurity_split': None, 'min_samples_leaf': 1, 'min_samples_split': 2,
'min_weight_fraction_leaf': 0.0, 'n_estimators': 200, 'n_jobs': -1, 'oob_score':
True, 'random_state': None, 'verbose': 0, 'warm_start': False}]}
****

Processing Model: KNeighborsClassifier
****
* KNeighborsClassifier
* Best Params Result:
* {'classifier': 'KNeighborsClassifier', 'features': 'Active inflammation?,
Severity of Crypt Arch, Increased lamina propria cellularity?, Marked &
transmucosal increase in lamina propria cellularity, Lamina propria polymorphs,
Crypt architecture, Patchy lamina propria cellularity?, Epithelial changes,
Mucosal surface, Cryptitis extent, Mucin depletion, Cryptitis polymorphs, Lamina
propria granulomas, Crypt abscesses polymorphs, Crypt abscesses extent, Basal
histiocytic cells, Submucosal granulomas, Sex, Increased lymphoid aggregates in
lamina propria?, Mild & superficial increase in lamina propria cellularity?,
Intraepithelial lymphocytes, Age, Crypt profiles', 'accuracy': [0.648, 0.728,
0.776, 0.796, 0.6305220883534136], 'avgAccuracy': 0.7157044176706827, 'f1':
[0.6600880084299263, 0.7347048388182248, 0.8120857906567037, 0.8432942667089007,
0.64220620036019671], 'avgF1': 0.7384758216431445, 'precision': [0.648, 0.728,
0.776, 0.796, 0.6305220883534136], 'avgPrecision': 0.7157044176706827, 'recall':
[0.648, 0.728, 0.776, 0.796, 0.6305220883534136], 'avgRecall':
0.7157044176706827, 'params': [{'algorithm': 'ball_tree', 'leaf_size': 30,
'metric': 'minkowski', 'metric_params': None, 'n_jobs': -1, 'n_neighbors': 12,
'p': 2, 'weights': 'distance'}]}
****

Processing Model: LogisticRegression
****

* LogisticRegression
* Best Params Result:
* {'classifier': 'LogisticRegression', 'features': 'Active inflammation?,
Severity of Crypt Arch, Increased lamina propria cellularity?, Marked &
transmucosal increase in lamina propria cellularity, Lamina propria polymorphs,
Crypt architecture, Patchy lamina propria cellularity?, Epithelial changes,
Mucosal surface, Cryptitis extent, Mucin depletion, Cryptitis polymorphs, Lamina
propria granulomas, Crypt abscesses polymorphs, Crypt abscesses extent, Basal
histiocytic cells, Submucosal granulomas, Sex, Increased lymphoid aggregates in
lamina propria?, Mild & superficial increase in lamina propria cellularity?,
Intraepithelial lymphocytes, Age, Crypt profiles', 'accuracy': [0.608, 0.672,
0.836, 0.516, 0.5943775100401606], 'avgAccuracy': 0.6452755020080321, 'f1':
[0.6163291428571429, 0.6768113348247576, 0.8399604349599986, 0.5298769352917825,
0.5912702740787712], 'avgF1': 0.6508496244024906, 'precision': [0.608, 0.672,
0.836, 0.516, 0.5943775100401606], 'avgPrecision': 0.6452755020080321, 'recall':
[0.608, 0.672, 0.836, 0.516, 0.5943775100401606], 'avgRecall':
0.6452755020080321, 'params': [{'C': 1, 'class_weight': None, 'dual': False,
'fit_intercept': True, 'intercept_scaling': 1, 'l1_ratio': None, 'max_iter':
100, 'multi_class': 'multinomial', 'n_jobs': -1, 'penalty': 'l2',
'random_state': None, 'solver': 'newton-cg', 'tol': 0.0001, 'verbose': 0,
'warm_start': False}]}
****

Processing Model: GaussianNB
****
* GaussianNB
* Best Params Result:
* {'classifier': 'GaussianNB', 'features': 'Active inflammation?, Severity of
Crypt Arch, Increased lamina propria cellularity?, Marked & transmucosal
increase in lamina propria cellularity, Lamina propria polymorphs, Crypt
architecture, Patchy lamina propria cellularity?, Epithelial changes, Mucosal
surface, Cryptitis extent, Mucin depletion, Cryptitis polymorphs, Lamina propria
granulomas, Crypt abscesses polymorphs, Crypt abscesses extent, Basal
histiocytic cells, Submucosal granulomas, Sex, Increased lymphoid aggregates in
lamina propria?, Mild & superficial increase in lamina propria cellularity?,
Intraepithelial lymphocytes, Age, Crypt profiles', 'accuracy': [0.616, 0.692,
0.88, 0.42, 0.570281124497992], 'avgAccuracy': 0.6356562248995984, 'f1':
[0.5780532081377153, 0.6466278870829768, 0.8669923145165056,
0.38858491578156856, 0.5341527446056398], 'avgF1': 0.6028822140248812,
'precision': [0.616, 0.692, 0.88, 0.42, 0.570281124497992], 'avgPrecision':
0.6356562248995984, 'recall': [0.616, 0.692, 0.88, 0.42, 0.570281124497992],
'avgRecall': 0.6356562248995984, 'params': [{'priors': None, 'var_smoothing':
1e-09}]}
****

Processing Model: AdaBoostClassifier
****
* AdaBoostClassifier

* Best Params Result:
* {'classifier': 'AdaBoostClassifier', 'features': 'Active inflammation?,
Severity of Crypt Arch, Increased lamina propria cellularity?, Marked &
transmucosal increase in lamina propria cellularity, Lamina propria polymorphs,
Crypt architecture, Patchy lamina propria cellularity?, Epithelial changes,
Mucosal surface, Cryptitis extent, Mucin depletion, Cryptitis polymorphs, Lamina
propria granulomas, Crypt abscesses polymorphs, Crypt abscesses extent, Basal
histiocytic cells, Submucosal granulomas, Sex, Increased lymphoid aggregates in
lamina propria?, Mild & superficial increase in lamina propria cellularity?,
Intraepithelial lymphocytes, Age, Crypt profiles', 'accuracy': [0.648, 0.656,
0.736, 0.648, 0.5461847389558233], 'avgAccuracy': 0.6468369477911646, 'f1':
[0.652473423834959, 0.6690947315541601, 0.7701602167176749, 0.6949019607843137,
0.5529110804007593], 'avgF1': 0.6679082826583734, 'precision': [0.648, 0.656,
0.736, 0.648, 0.5461847389558233], 'avgPrecision': 0.6468369477911646, 'recall':
[0.648, 0.656, 0.736, 0.648, 0.5461847389558233], 'avgRecall':
0.6468369477911646, 'params': [{'algorithm': 'SAMME.R', 'base_estimator': None,
'learning_rate': 1, 'n_estimators': 300, 'random_state': None}]}
****

Processing Model: DecisionTreeClassifier
****
* DecisionTreeClassifier
* Best Params Result:
* {'classifier': 'DecisionTreeClassifier', 'features': 'Active inflammation?,
Severity of Crypt Arch, Increased lamina propria cellularity?, Marked &
transmucosal increase in lamina propria cellularity, Lamina propria polymorphs,
Crypt architecture, Patchy lamina propria cellularity?, Epithelial changes,
Mucosal surface, Cryptitis extent, Mucin depletion, Cryptitis polymorphs, Lamina
propria granulomas, Crypt abscesses polymorphs, Crypt abscesses extent, Basal
histiocytic cells, Submucosal granulomas, Sex, Increased lymphoid aggregates in
lamina propria?, Mild & superficial increase in lamina propria cellularity?,
Intraepithelial lymphocytes, Age, Crypt profiles', 'accuracy': [0.632, 0.74,
0.736, 0.796, 0.6345381526104418], 'avgAccuracy': 0.7077076305220884, 'f1':
[0.6423983333333333, 0.7465577969018934, 0.774885183807468, 0.8415968063872256,
0.6459058501376495], 'avgF1': 0.730268794113514, 'precision': [0.632, 0.74,
0.736, 0.796, 0.6345381526104418], 'avgPrecision': 0.7077076305220884, 'recall':
[0.632, 0.74, 0.736, 0.796, 0.6345381526104418], 'avgRecall':
0.7077076305220884, 'params': [{'ccp_alpha': 0.0, 'class_weight': None,
'criterion': 'gini', 'max_depth': None, 'max_features': 'auto',
'max_leaf_nodes': None, 'min_impurity_decrease': 0.0, 'min_impurity_split':
None, 'min_samples_leaf': 1, 'min_samples_split': 2, 'min_weight_fraction_leaf':
0.0, 'random_state': None, 'splitter': 'best'}]}
****

Processing Model: SVC
****
* SVC
* Best Params Result:

* {'classifier': 'SVC', 'features': 'Active inflammation?, Severity of Crypt
Arch, Increased lamina propria cellularity?, Marked & transmucosal increase in
lamina propria cellularity, Lamina propria polymorphs, Crypt architecture,
Patchy lamina propria cellularity?, Epithelial changes, Mucosal surface,
Cryptitis extent, Mucin depletion, Cryptitis polymorphs, Lamina propria
granulomas, Crypt abscesses polymorphs, Crypt abscesses extent, Basal
histiocytic cells, Submucosal granulomas, Sex, Increased lymphoid aggregates in
lamina propria?, Mild & superficial increase in lamina propria cellularity?,
Intraepithelial lymphocytes, Age, Crypt profiles', 'accuracy': [0.636, 0.656,
0.832, 0.416, 0.5983935742971888], 'avgAccuracy': 0.6276787148594377, 'f1':
[0.6461992090499402, 0.6627632867767095, 0.8367556813248117,
0.40108543175807754, 0.6039295224412464], 'avgF1': 0.630146626270157,
'precision': [0.636, 0.656, 0.832, 0.416, 0.5983935742971888], 'avgPrecision':
0.6276787148594377, 'recall': [0.636, 0.656, 0.832, 0.416, 0.5983935742971888],
'avgRecall': 0.6276787148594377, 'params': [{'C': 1.0, 'break_ties': False,
'cache_size': 4000, 'class_weight': None, 'coef0': 0.0,
'decision_function_shape': 'ovr', 'degree': 3, 'gamma': 'scale', 'kernel':
'linear', 'max_iter': -1, 'probability': False, 'random_state': None,
'shrinking': True, 'tol': 0.001, 'verbose': False}]}
****

Processing Model: MLPClassifier
****
* MLPClassifier
* Best Params Result:
* {'classifier': 'MLPClassifier', 'features': 'Active inflammation?, Severity of
Crypt Arch, Increased lamina propria cellularity?, Marked & transmucosal
increase in lamina propria cellularity, Lamina propria polymorphs, Crypt
architecture, Patchy lamina propria cellularity?, Epithelial changes, Mucosal
surface, Cryptitis extent, Mucin depletion, Cryptitis polymorphs, Lamina propria
granulomas, Crypt abscesses polymorphs, Crypt abscesses extent, Basal
histiocytic cells, Submucosal granulomas, Sex, Increased lymphoid aggregates in
lamina propria?, Mild & superficial increase in lamina propria cellularity?,
Intraepithelial lymphocytes, Age, Crypt profiles', 'accuracy': [0.64, 0.668,
0.84, 0.508, 0.6506024096385542], 'avgAccuracy': 0.6613204819277109, 'f1':
[0.6485107989096247, 0.6726514587982478, 0.8443062200956938, 0.5183240001588625,
0.6623438294510445], 'avgF1': 0.6692272614826946, 'precision': [0.64, 0.668,
0.84, 0.508, 0.6506024096385542], 'avgPrecision': 0.6613204819277109, 'recall':
[0.64, 0.668, 0.84, 0.508, 0.6506024096385542], 'avgRecall': 0.6613204819277109,
'params': [{'activation': 'logistic', 'alpha': 0.0001, 'batch_size': 'auto',
'beta_1': 0.9, 'beta_2': 0.999, 'early_stopping': False, 'epsilon': 1e-08,
'hidden_layer_sizes': (100,), 'learning_rate': 'constant', 'learning_rate_init':
0.001, 'max_fun': 15000, 'max_iter': 7000, 'momentum': 0.9, 'n_iter_no_change':
10, 'nesterovs_momentum': True, 'power_t': 0.5, 'random_state': None, 'shuffle':
True, 'solver': 'adam', 'tol': 0.0001, 'validation_fraction': 0.1, 'verbose':
False, 'warm_start': False}]}
****
****

```
* Best Performing Model and Params is:
* {'classifier': 'RandomForestClassifier', 'features': 'Active inflammation?,
Severity of Crypt Arch, Increased lamina propria cellularity?, Marked &
transmucosal increase in lamina propria cellularity, Lamina propria polymorphs,
Crypt architecture, Patchy lamina propria cellularity?, Epithelial changes,
Mucosal surface, Cryptitis extent, Mucin depletion, Cryptitis polymorphs, Lamina
propria granulomas, Crypt abscesses polymorphs, Crypt abscesses extent, Basal
histiocytic cells, Submucosal granulomas, Sex, Increased lymphoid aggregates in
lamina propria?, Mild & superficial increase in lamina propria cellularity?,
Intraepithelial lymphocytes, Age, Crypt profiles', 'accuracy': [0.68, 0.76,
0.772, 0.804, 0.6305220883534136], 'avgAccuracy': 0.7293044176706828, 'f1':
[0.6864281835205993, 0.7652111718288137, 0.7995323325880974, 0.8465789473684212,
0.6385909513235934], 'avgF1': 0.747268317325905, 'precision': [0.68, 0.76,
0.772, 0.804, 0.6305220883534136], 'avgPrecision': 0.7293044176706828, 'recall':
[0.68, 0.76, 0.772, 0.804, 0.6305220883534136], 'avgRecall': 0.7293044176706828,
'params': [{'bootstrap': True, 'ccp_alpha': 0.0, 'class_weight': None,
'criterion': 'gini', 'max_depth': None, 'max_features': 'auto',
'max_leaf_nodes': None, 'max_samples': None, 'min_impurity_decrease': 0.0,
'min_impurity_split': None, 'min_samples_leaf': 1, 'min_samples_split': 2,
'min_weight_fraction_leaf': 0.0, 'n_estimators': 200, 'n_jobs': -1, 'oob_score':
True, 'random_state': None, 'verbose': 0, 'warm_start': False}]}
*******************************************************

                    model                                       features  \
0  RandomForestClassifier  Active inflammation?, Severity of Crypt Arch, …
1    KNeighborsClassifier  Active inflammation?, Severity of Crypt Arch, …
2      LogisticRegression  Active inflammation?, Severity of Crypt Arch, …
3              GaussianNB  Active inflammation?, Severity of Crypt Arch, …
4       AdaBoostClassifier  Active inflammation?, Severity of Crypt Arch, …
5  DecisionTreeClassifier  Active inflammation?, Severity of Crypt Arch, …
6                     SVC  Active inflammation?, Severity of Crypt Arch, …
7           MLPClassifier  Active inflammation?, Severity of Crypt Arch, …

   accuracy        f1  precision    recall  \
0  0.729304  0.747268   0.729304  0.729304
1  0.715704  0.738476   0.715704  0.715704
2  0.645276  0.650850   0.645276  0.645276
3  0.635656  0.602882   0.635656  0.635656
4  0.646837  0.667908   0.646837  0.646837
5  0.707708  0.730269   0.707708  0.707708
6  0.627679  0.630147   0.627679  0.627679
7  0.661320  0.669227   0.661320  0.661320


                                              params
0  {'bootstrap': True, 'ccp_alpha': 0.0, 'class_w…
1  {'algorithm': 'ball_tree', 'leaf_size': 30, 'm…
2  {'C': 1, 'class_weight': None, 'dual': False, …
3            {'priors': None, 'var_smoothing': 1e-09}
```

```
4  {'algorithm': 'SAMME.R', 'base_estimator': Non…
5  {'ccp_alpha': 0.0, 'class_weight': None, 'crit…
6  {'C': 1.0, 'break_ties': False, 'cache_size': …
7  {'activation': 'logistic', 'alpha': 0.0001, 'b…
```

Processing Model: RandomForestClassifier
****
* RandomForestClassifier
* Best Params Result:
* {'classifier': 'RandomForestClassifier', 'features': 'Active inflammation?,
Severity of Crypt Arch, Increased lamina propria cellularity?, Marked &
transmucosal increase in lamina propria cellularity, Lamina propria polymorphs,
Crypt architecture, Patchy lamina propria cellularity?, Epithelial changes,
Mucosal surface, Cryptitis extent, Mucin depletion, Cryptitis polymorphs, Lamina
propria granulomas, Crypt abscesses polymorphs, Crypt abscesses extent, Basal
histiocytic cells, Submucosal granulomas, Sex, Increased lymphoid aggregates in
lamina propria?, Mild & superficial increase in lamina propria cellularity?,
Intraepithelial lymphocytes, Age', 'accuracy': [0.68, 0.752, 0.78, 0.8,
0.6265060240963856], 'avgAccuracy': 0.7277012048192771, 'f1':
[0.688992177724217, 0.7566559646447356, 0.8090515459040047, 0.8425072324011571,
0.6336345486340393], 'avgF1': 0.7461682938616307, 'precision': [0.68, 0.752,
0.78, 0.8, 0.6265060240963856], 'avgPrecision': 0.7277012048192771, 'recall':
[0.68, 0.752, 0.78, 0.8, 0.6265060240963856], 'avgRecall': 0.7277012048192771,
'params': [{'bootstrap': True, 'ccp_alpha': 0.0, 'class_weight': None,
'criterion': 'entropy', 'max_depth': None, 'max_features': 'sqrt',
'max_leaf_nodes': None, 'max_samples': None, 'min_impurity_decrease': 0.0,
'min_impurity_split': None, 'min_samples_leaf': 1, 'min_samples_split': 2,
'min_weight_fraction_leaf': 0.0, 'n_estimators': 700, 'n_jobs': -1, 'oob_score':
True, 'random_state': None, 'verbose': 0, 'warm_start': False}]}
****

Processing Model: KNeighborsClassifier
****
* KNeighborsClassifier
* Best Params Result:
* {'classifier': 'KNeighborsClassifier', 'features': 'Active inflammation?,
Severity of Crypt Arch, Increased lamina propria cellularity?, Marked &
transmucosal increase in lamina propria cellularity, Lamina propria polymorphs,
Crypt architecture, Patchy lamina propria cellularity?, Epithelial changes,
Mucosal surface, Cryptitis extent, Mucin depletion, Cryptitis polymorphs, Lamina
propria granulomas, Crypt abscesses polymorphs, Crypt abscesses extent, Basal
histiocytic cells, Submucosal granulomas, Sex, Increased lymphoid aggregates in
lamina propria?, Mild & superficial increase in lamina propria cellularity?,
Intraepithelial lymphocytes, Age', 'accuracy': [0.636, 0.74, 0.78, 0.796,
0.6305220883534136], 'avgAccuracy': 0.7165044176706827, 'f1':
[0.6488656351877115, 0.7462576481218537, 0.8122161144508132, 0.8416623376623376,
0.6416174217580755], 'avgF1': 0.7381238314361582, 'precision': [0.636, 0.74,
0.78, 0.796, 0.6305220883534136], 'avgPrecision': 0.7165044176706827, 'recall':

[0.636, 0.74, 0.78, 0.796, 0.6305220883534136], 'avgRecall': 0.7165044176706827,
'params': [{'algorithm': 'auto', 'leaf_size': 30, 'metric': 'minkowski',
'metric_params': None, 'n_jobs': -1, 'n_neighbors': 14, 'p': 2, 'weights':
'distance'}]}
****

Processing Model: LogisticRegression
****
* LogisticRegression
* Best Params Result:
* {'classifier': 'LogisticRegression', 'features': 'Active inflammation?,
Severity of Crypt Arch, Increased lamina propria cellularity?, Marked &
transmucosal increase in lamina propria cellularity, Lamina propria polymorphs,
Crypt architecture, Patchy lamina propria cellularity?, Epithelial changes,
Mucosal surface, Cryptitis extent, Mucin depletion, Cryptitis polymorphs, Lamina
propria granulomas, Crypt abscesses polymorphs, Crypt abscesses extent, Basal
histiocytic cells, Submucosal granulomas, Sex, Increased lymphoid aggregates in
lamina propria?, Mild & superficial increase in lamina propria cellularity?,
Intraepithelial lymphocytes, Age', 'accuracy': [0.608, 0.672, 0.836, 0.524,
0.5863453815261044], 'avgAccuracy': 0.6452690763052209, 'f1':
[0.6163291428571429, 0.6768113348247576, 0.8399604349599986, 0.5412898360915983,
0.5798182492219697], 'avgF1': 0.6508417995910935, 'precision': [0.608, 0.672,
0.836, 0.524, 0.5863453815261044], 'avgPrecision': 0.6452690763052209, 'recall':
[0.608, 0.672, 0.836, 0.524, 0.5863453815261044], 'avgRecall':
0.6452690763052209, 'params': [{'C': 1, 'class_weight': None, 'dual': False,
'fit_intercept': True, 'intercept_scaling': 1, 'l1_ratio': None, 'max_iter':
100, 'multi_class': 'multinomial', 'n_jobs': -1, 'penalty': 'l2',
'random_state': None, 'solver': 'newton-cg', 'tol': 0.0001, 'verbose': 0,
'warm_start': False}]}
****

Processing Model: GaussianNB
****
* GaussianNB
* Best Params Result:
* {'classifier': 'GaussianNB', 'features': 'Active inflammation?, Severity of
Crypt Arch, Increased lamina propria cellularity?, Marked & transmucosal
increase in lamina propria cellularity, Lamina propria polymorphs, Crypt
architecture, Patchy lamina propria cellularity?, Epithelial changes, Mucosal
surface, Cryptitis extent, Mucin depletion, Cryptitis polymorphs, Lamina propria
granulomas, Crypt abscesses polymorphs, Crypt abscesses extent, Basal
histiocytic cells, Submucosal granulomas, Sex, Increased lymphoid aggregates in
lamina propria?, Mild & superficial increase in lamina propria cellularity?,
Intraepithelial lymphocytes, Age', 'accuracy': [0.612, 0.692, 0.88, 0.42,
0.5742971887550201], 'avgAccuracy': 0.635659437751004, 'f1':
[0.5747760421320552, 0.6466278870829768, 0.8669923145165056,
0.38858491578156856, 0.5375209317788143], 'avgF1': 0.6029004182583841,
'precision': [0.612, 0.692, 0.88, 0.42, 0.5742971887550201], 'avgPrecision':

0.635659437751004, 'recall': [0.612, 0.692, 0.88, 0.42, 0.5742971887550201],
'avgRecall': 0.635659437751004, 'params': [{'priors': None, 'var_smoothing':
1e-09}]}
****

Processing Model: AdaBoostClassifier
****
* AdaBoostClassifier
* Best Params Result:
* {'classifier': 'AdaBoostClassifier', 'features': 'Active inflammation?,
Severity of Crypt Arch, Increased lamina propria cellularity?, Marked &
transmucosal increase in lamina propria cellularity, Lamina propria polymorphs,
Crypt architecture, Patchy lamina propria cellularity?, Epithelial changes,
Mucosal surface, Cryptitis extent, Mucin depletion, Cryptitis polymorphs, Lamina
propria granulomas, Crypt abscesses polymorphs, Crypt abscesses extent, Basal
histiocytic cells, Submucosal granulomas, Sex, Increased lymphoid aggregates in
lamina propria?, Mild & superficial increase in lamina propria cellularity?,
Intraepithelial lymphocytes, Age', 'accuracy': [0.628, 0.688, 0.744, 0.548,
0.41767068273092367], 'avgAccuracy': 0.6051341365461848, 'f1':
[0.6381772368717602, 0.6942565251364821, 0.7739661154156515, 0.5800389863547758,
0.3959610490809915], 'avgF1': 0.6164799825719323, 'precision': [0.628, 0.688,
0.744, 0.548, 0.41767068273092367], 'avgPrecision': 0.6051341365461848,
'recall': [0.628, 0.688, 0.744, 0.548, 0.41767068273092367], 'avgRecall':
0.6051341365461848, 'params': [{'algorithm': 'SAMME.R', 'base_estimator': None,
'learning_rate': 1, 'n_estimators': 20, 'random_state': None}]}
****

Processing Model: DecisionTreeClassifier
****
* DecisionTreeClassifier
* Best Params Result:
* {'classifier': 'DecisionTreeClassifier', 'features': 'Active inflammation?,
Severity of Crypt Arch, Increased lamina propria cellularity?, Marked &
transmucosal increase in lamina propria cellularity, Lamina propria polymorphs,
Crypt architecture, Patchy lamina propria cellularity?, Epithelial changes,
Mucosal surface, Cryptitis extent, Mucin depletion, Cryptitis polymorphs, Lamina
propria granulomas, Crypt abscesses polymorphs, Crypt abscesses extent, Basal
histiocytic cells, Submucosal granulomas, Sex, Increased lymphoid aggregates in
lamina propria?, Mild & superficial increase in lamina propria cellularity?,
Intraepithelial lymphocytes, Age', 'accuracy': [0.648, 0.692, 0.764, 0.8,
0.6506024096385542], 'avgAccuracy': 0.7109204819277108, 'f1':
[0.6592157397095754, 0.7013835920177385, 0.795411897479814, 0.8441592385262049,
0.6606358505702215], 'avgF1': 0.7321612636607109, 'precision': [0.648, 0.692,
0.764, 0.8, 0.6506024096385542], 'avgPrecision': 0.7109204819277108, 'recall':
[0.648, 0.692, 0.764, 0.8, 0.6506024096385542], 'avgRecall': 0.7109204819277108,
'params': [{'ccp_alpha': 0.0, 'class_weight': None, 'criterion': 'entropy',
'max_depth': None, 'max_features': 'auto', 'max_leaf_nodes': None,
'min_impurity_decrease': 0.0, 'min_impurity_split': None, 'min_samples_leaf': 1,

```
'min_samples_split': 2, 'min_weight_fraction_leaf': 0.0, 'random_state': None,
'splitter': 'random'}]}
****************************************************

Processing Model: SVC
****************************************************
* SVC
* Best Params Result:
* {'classifier': 'SVC', 'features': 'Active inflammation?, Severity of Crypt
Arch, Increased lamina propria cellularity?, Marked & transmucosal increase in
lamina propria cellularity, Lamina propria polymorphs, Crypt architecture,
Patchy lamina propria cellularity?, Epithelial changes, Mucosal surface,
Cryptitis extent, Mucin depletion, Cryptitis polymorphs, Lamina propria
granulomas, Crypt abscesses polymorphs, Crypt abscesses extent, Basal
histiocytic cells, Submucosal granulomas, Sex, Increased lymphoid aggregates in
lamina propria?, Mild & superficial increase in lamina propria cellularity?,
Intraepithelial lymphocytes, Age', 'accuracy': [0.64, 0.656, 0.832, 0.404,
0.5943775100401606], 'avgAccuracy': 0.6252755020080322, 'f1':
[0.6502245511578677, 0.6627632867767095, 0.8367556813248117,
0.38255979073243646, 0.5998367843446151], 'avgF1': 0.626428018867288,
'precision': [0.64, 0.656, 0.832, 0.404, 0.5943775100401606], 'avgPrecision':
0.6252755020080322, 'recall': [0.64, 0.656, 0.832, 0.404, 0.5943775100401606],
'avgRecall': 0.6252755020080322, 'params': [{'C': 1.0, 'break_ties': False,
'cache_size': 4000, 'class_weight': None, 'coef0': 0.0,
'decision_function_shape': 'ovr', 'degree': 3, 'gamma': 'scale', 'kernel':
'linear', 'max_iter': -1, 'probability': False, 'random_state': None,
'shrinking': True, 'tol': 0.001, 'verbose': False}]}
****************************************************

Processing Model: MLPClassifier
****************************************************
* MLPClassifier
* Best Params Result:
* {'classifier': 'MLPClassifier', 'features': 'Active inflammation?, Severity of
Crypt Arch, Increased lamina propria cellularity?, Marked & transmucosal
increase in lamina propria cellularity, Lamina propria polymorphs, Crypt
architecture, Patchy lamina propria cellularity?, Epithelial changes, Mucosal
surface, Cryptitis extent, Mucin depletion, Cryptitis polymorphs, Lamina propria
granulomas, Crypt abscesses polymorphs, Crypt abscesses extent, Basal
histiocytic cells, Submucosal granulomas, Sex, Increased lymphoid aggregates in
lamina propria?, Mild & superficial increase in lamina propria cellularity?,
Intraepithelial lymphocytes, Age', 'accuracy': [0.652, 0.676, 0.848, 0.528,
0.5863453815261044], 'avgAccuracy': 0.6580690763052209, 'f1': [0.660224,
0.6810592059949858, 0.8501526613143027, 0.5421031584260284, 0.5801313730501261],
'avgF1': 0.6627340797570886, 'precision': [0.652, 0.676, 0.848, 0.528,
0.5863453815261044], 'avgPrecision': 0.6580690763052209, 'recall': [0.652,
0.676, 0.848, 0.528, 0.5863453815261044], 'avgRecall': 0.6580690763052209,
'params': [{'activation': 'logistic', 'alpha': 0.0001, 'batch_size': 'auto',
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'beta_1': 0.9, 'beta_2': 0.999, 'early_stopping': False, 'epsilon': 1e-08,
'hidden_layer_sizes': (100,), 'learning_rate': 'invscaling',
'learning_rate_init': 0.001, 'max_fun': 15000, 'max_iter': 9000, 'momentum':
0.9, 'n_iter_no_change': 10, 'nesterovs_momentum': True, 'power_t': 0.5,
'random_state': None, 'shuffle': True, 'solver': 'adam', 'tol': 0.0001,
'validation_fraction': 0.1, 'verbose': False, 'warm_start': False}]}
****
****
* Best Performing Model and Params is:
* {'classifier': 'RandomForestClassifier', 'features': 'Active inflammation?,
Severity of Crypt Arch, Increased lamina propria cellularity?, Marked &
transmucosal increase in lamina propria cellularity, Lamina propria polymorphs,
Crypt architecture, Patchy lamina propria cellularity?, Epithelial changes,
Mucosal surface, Cryptitis extent, Mucin depletion, Cryptitis polymorphs, Lamina
propria granulomas, Crypt abscesses polymorphs, Crypt abscesses extent, Basal
histiocytic cells, Submucosal granulomas, Sex, Increased lymphoid aggregates in
lamina propria?, Mild & superficial increase in lamina propria cellularity?,
Intraepithelial lymphocytes, Age', 'accuracy': [0.68, 0.752, 0.78, 0.8,
0.6265060240963856], 'avgAccuracy': 0.7277012048192771, 'f1':
[0.688992177724217, 0.7566559646447356, 0.8090515459040047, 0.8425072324011571,
0.6336345486340393], 'avgF1': 0.7461682938616307, 'precision': [0.68, 0.752,
0.78, 0.8, 0.6265060240963856], 'avgPrecision': 0.7277012048192771, 'recall':
[0.68, 0.752, 0.78, 0.8, 0.6265060240963856], 'avgRecall': 0.7277012048192771,
'params': [{'bootstrap': True, 'ccp_alpha': 0.0, 'class_weight': None,
'criterion': 'entropy', 'max_depth': None, 'max_features': 'sqrt',
'max_leaf_nodes': None, 'max_samples': None, 'min_impurity_decrease': 0.0,
'min_impurity_split': None, 'min_samples_leaf': 1, 'min_samples_split': 2,
'min_weight_fraction_leaf': 0.0, 'n_estimators': 700, 'n_jobs': -1, 'oob_score':
True, 'random_state': None, 'verbose': 0, 'warm_start': False}]}
****

	model	features \
0	RandomForestClassifier	Active inflammation?, Severity of Crypt Arch, …
1	KNeighborsClassifier	Active inflammation?, Severity of Crypt Arch, …
2	LogisticRegression	Active inflammation?, Severity of Crypt Arch, …
3	GaussianNB	Active inflammation?, Severity of Crypt Arch, …
4	AdaBoostClassifier	Active inflammation?, Severity of Crypt Arch, …
5	DecisionTreeClassifier	Active inflammation?, Severity of Crypt Arch, …
6	SVC	Active inflammation?, Severity of Crypt Arch, …
7	MLPClassifier	Active inflammation?, Severity of Crypt Arch, …

	accuracy	f1	precision	recall \
0	0.727701	0.746168	0.727701	0.727701
1	0.716504	0.738124	0.716504	0.716504
2	0.645269	0.650842	0.645269	0.645269
3	0.635659	0.602900	0.635659	0.635659
4	0.605134	0.616480	0.605134	0.605134
5	0.710920	0.732161	0.710920	0.710920

```
6  0.625276  0.626428   0.625276  0.625276
7  0.658069  0.662734   0.658069  0.658069


                                                      params
0  {'bootstrap': True, 'ccp_alpha': 0.0, 'class_w…
1  {'algorithm': 'auto', 'leaf_size': 30, 'metric…
2  {'C': 1, 'class_weight': None, 'dual': False, …
3            {'priors': None, 'var_smoothing': 1e-09}
4  {'algorithm': 'SAMME.R', 'base_estimator': Non…
5  {'ccp_alpha': 0.0, 'class_weight': None, 'crit…
6  {'C': 1.0, 'break_ties': False, 'cache_size': …
7  {'activation': 'logistic', 'alpha': 0.0001, 'b…
```

Processing Model: RandomForestClassifier
****
* RandomForestClassifier
* Best Params Result:
* {'classifier': 'RandomForestClassifier', 'features': 'Active inflammation?,
Severity of Crypt Arch, Increased lamina propria cellularity?, Marked &
transmucosal increase in lamina propria cellularity, Lamina propria polymorphs,
Crypt architecture, Patchy lamina propria cellularity?, Epithelial changes,
Mucosal surface, Cryptitis extent, Mucin depletion, Cryptitis polymorphs, Lamina
propria granulomas, Crypt abscesses polymorphs, Crypt abscesses extent, Basal
histiocytic cells, Submucosal granulomas, Sex, Increased lymphoid aggregates in
lamina propria?, Mild & superficial increase in lamina propria cellularity?,
Intraepithelial lymphocytes', 'accuracy': [0.608, 0.716, 0.876, 0.664,
0.6224899598393574], 'avgAccuracy': 0.6972979919678715, 'f1':
[0.6143682823365072, 0.7103250695331881, 0.8688429539951574, 0.6864714125560538,
0.63020566711695266], 'avgF1': 0.7020426779180866, 'precision': [0.608, 0.716,
0.876, 0.664, 0.6224899598393574], 'avgPrecision': 0.6972979919678715, 'recall':
[0.608, 0.716, 0.876, 0.664, 0.6224899598393574], 'avgRecall':
0.6972979919678715, 'params': [{'bootstrap': True, 'ccp_alpha': 0.0,
'class_weight': None, 'criterion': 'entropy', 'max_depth': None, 'max_features':
'sqrt', 'max_leaf_nodes': None, 'max_samples': None, 'min_impurity_decrease':
0.0, 'min_impurity_split': None, 'min_samples_leaf': 1, 'min_samples_split': 2,
'min_weight_fraction_leaf': 0.0, 'n_estimators': 500, 'n_jobs': -1, 'oob_score':
False, 'random_state': None, 'verbose': 0, 'warm_start': False}]}
****

Processing Model: KNeighborsClassifier
****
* KNeighborsClassifier
* Best Params Result:
* {'classifier': 'KNeighborsClassifier', 'features': 'Active inflammation?,
Severity of Crypt Arch, Increased lamina propria cellularity?, Marked &
transmucosal increase in lamina propria cellularity, Lamina propria polymorphs,
Crypt architecture, Patchy lamina propria cellularity?, Epithelial changes,
Mucosal surface, Cryptitis extent, Mucin depletion, Cryptitis polymorphs, Lamina

propria granulomas, Crypt abscesses polymorphs, Crypt abscesses extent, Basal histiocytic cells, Submucosal granulomas, Sex, Increased lymphoid aggregates in lamina propria?, Mild & superficial increase in lamina propria cellularity?, Intraepithelial lymphocytes', 'accuracy': [0.584, 0.668, 0.864, 0.484, 0.5983935742971888], 'avgAccuracy': 0.6396787148594377, 'f1': [0.5911158139305932, 0.6640446715639307, 0.8592720215564252, 0.5993440577977599, 0.6113493522111043], 'avgF1': 0.6650251834119627, 'precision': [0.584, 0.668, 0.864, 0.484, 0.5983935742971888], 'avgPrecision': 0.6396787148594377, 'recall': [0.584, 0.668, 0.864, 0.484, 0.5983935742971888], 'avgRecall': 0.6396787148594377, 'params': [{'algorithm': 'ball_tree', 'leaf_size': 30, 'metric': 'minkowski', 'metric_params': None, 'n_jobs': -1, 'n_neighbors': 17, 'p': 2, 'weights': 'distance'}]}
****

Processing Model: LogisticRegression
****
* LogisticRegression
* Best Params Result:
* {'classifier': 'LogisticRegression', 'features': 'Active inflammation?, Severity of Crypt Arch, Increased lamina propria cellularity?, Marked & transmucosal increase in lamina propria cellularity, Lamina propria polymorphs, Crypt architecture, Patchy lamina propria cellularity?, Epithelial changes, Mucosal surface, Cryptitis extent, Mucin depletion, Cryptitis polymorphs, Lamina propria granulomas, Crypt abscesses polymorphs, Crypt abscesses extent, Basal histiocytic cells, Submucosal granulomas, Sex, Increased lymphoid aggregates in lamina propria?, Mild & superficial increase in lamina propria cellularity?, Intraepithelial lymphocytes', 'accuracy': [0.628, 0.672, 0.832, 0.48, 0.6104417670682731], 'avgAccuracy': 0.6444883534136546, 'f1': [0.6379051644119679, 0.6808025761590495, 0.8398519936204146, 0.4794143390138147, 0.6105209028005728], 'avgF1': 0.6496989952011639, 'precision': [0.628, 0.672, 0.832, 0.48, 0.6104417670682731], 'avgPrecision': 0.6444883534136546, 'recall': [0.628, 0.672, 0.832, 0.48, 0.6104417670682731], 'avgRecall': 0.6444883534136546, 'params': [{'C': 1, 'class_weight': None, 'dual': False, 'fit_intercept': True, 'intercept_scaling': 1, 'l1_ratio': None, 'max_iter': 100, 'multi_class': 'multinomial', 'n_jobs': -1, 'penalty': 'l2', 'random_state': None, 'solver': 'newton-cg', 'tol': 0.0001, 'verbose': 0, 'warm_start': False}]}
****

Processing Model: GaussianNB
****
* GaussianNB
* Best Params Result:
* {'classifier': 'GaussianNB', 'features': 'Active inflammation?, Severity of Crypt Arch, Increased lamina propria cellularity?, Marked & transmucosal increase in lamina propria cellularity, Lamina propria polymorphs, Crypt architecture, Patchy lamina propria cellularity?, Epithelial changes, Mucosal surface, Cryptitis extent, Mucin depletion, Cryptitis polymorphs, Lamina propria

granulomas, Crypt abscesses polymorphs, Crypt abscesses extent, Basal
histiocytic cells, Submucosal granulomas, Sex, Increased lymphoid aggregates in
lamina propria?, Mild & superficial increase in lamina propria cellularity?,
Intraepithelial lymphocytes', 'accuracy': [0.612, 0.692, 0.88, 0.42,
0.5742971887550201], 'avgAccuracy': 0.635659437751004, 'f1':
[0.5747760421320552, 0.6466278870829768, 0.8669923145165056,
0.38858491578156856, 0.5375209317788143], 'avgF1': 0.6029004182583841,
'precision': [0.612, 0.692, 0.88, 0.42, 0.5742971887550201], 'avgPrecision':
0.635659437751004, 'recall': [0.612, 0.692, 0.88, 0.42, 0.5742971887550201],
'avgRecall': 0.635659437751004, 'params': [{'priors': None, 'var_smoothing':
1e-09}]}
****

Processing Model: AdaBoostClassifier
****
* AdaBoostClassifier
* Best Params Result:
* {'classifier': 'AdaBoostClassifier', 'features': 'Active inflammation?,
Severity of Crypt Arch, Increased lamina propria cellularity?, Marked &
transmucosal increase in lamina propria cellularity, Lamina propria polymorphs,
Crypt architecture, Patchy lamina propria cellularity?, Epithelial changes,
Mucosal surface, Cryptitis extent, Mucin depletion, Cryptitis polymorphs, Lamina
propria granulomas, Crypt abscesses polymorphs, Crypt abscesses extent, Basal
histiocytic cells, Submucosal granulomas, Sex, Increased lymphoid aggregates in
lamina propria?, Mild & superficial increase in lamina propria cellularity?,
Intraepithelial lymphocytes', 'accuracy': [0.592, 0.608, 0.772, 0.552,
0.4859437751004016], 'avgAccuracy': 0.6019887550200803, 'f1':
[0.5967484382598286, 0.6200531929991666, 0.7783447559042479, 0.5683240475831953,
0.4847737557944583], 'avgF1': 0.6096488381081794, 'precision': [0.592, 0.608,
0.772, 0.552, 0.4859437751004016], 'avgPrecision': 0.6019887550200803, 'recall':
[0.592, 0.608, 0.772, 0.552, 0.4859437751004016], 'avgRecall':
0.6019887550200803, 'params': [{'algorithm': 'SAMME.R', 'base_estimator': None,
'learning_rate': 1, 'n_estimators': 50, 'random_state': None}]}
****

Processing Model: DecisionTreeClassifier
****
* DecisionTreeClassifier
* Best Params Result:
* {'classifier': 'DecisionTreeClassifier', 'features': 'Active inflammation?,
Severity of Crypt Arch, Increased lamina propria cellularity?, Marked &
transmucosal increase in lamina propria cellularity, Lamina propria polymorphs,
Crypt architecture, Patchy lamina propria cellularity?, Epithelial changes,
Mucosal surface, Cryptitis extent, Mucin depletion, Cryptitis polymorphs, Lamina
propria granulomas, Crypt abscesses polymorphs, Crypt abscesses extent, Basal
histiocytic cells, Submucosal granulomas, Sex, Increased lymphoid aggregates in
lamina propria?, Mild & superficial increase in lamina propria cellularity?,
Intraepithelial lymphocytes', 'accuracy': [0.572, 0.672, 0.86, 0.652,

0.642570281124498], 'avgAccuracy': 0.6797140562248996, 'f1':
[0.5761874638379944, 0.6679580537631962, 0.8546861244019138, 0.6757624204611921,
0.655177219837597], 'avgF1': 0.6859542564603787, 'precision': [0.572, 0.672,
0.86, 0.652, 0.642570281124498], 'avgPrecision': 0.6797140562248996, 'recall':
[0.572, 0.672, 0.86, 0.652, 0.642570281124498], 'avgRecall': 0.6797140562248996,
'params': [{'ccp_alpha': 0.0, 'class_weight': None, 'criterion': 'entropy',
'max_depth': None, 'max_features': 'auto', 'max_leaf_nodes': None,
'min_impurity_decrease': 0.0, 'min_impurity_split': None, 'min_samples_leaf': 1,
'min_samples_split': 2, 'min_weight_fraction_leaf': 0.0, 'random_state': None,
'splitter': 'random'}]}
****

Processing Model: SVC
****
* SVC
* Best Params Result:
* {'classifier': 'SVC', 'features': 'Active inflammation?, Severity of Crypt
Arch, Increased lamina propria cellularity?, Marked & transmucosal increase in
lamina propria cellularity, Lamina propria polymorphs, Crypt architecture,
Patchy lamina propria cellularity?, Epithelial changes, Mucosal surface,
Cryptitis extent, Mucin depletion, Cryptitis polymorphs, Lamina propria
granulomas, Crypt abscesses polymorphs, Crypt abscesses extent, Basal
histiocytic cells, Submucosal granulomas, Sex, Increased lymphoid aggregates in
lamina propria?, Mild & superficial increase in lamina propria cellularity?,
Intraepithelial lymphocytes', 'accuracy': [0.636, 0.656, 0.832, 0.404,
0.5983935742971888], 'avgAccuracy': 0.6252787148594378, 'f1':
[0.6461992090499402, 0.6627632867767095, 0.8367556813248117,
0.38255979073243646, 0.6049488424255745], 'avgF1': 0.6266453620618945,
'precision': [0.636, 0.656, 0.832, 0.404, 0.5983935742971888], 'avgPrecision':
0.6252787148594378, 'recall': [0.636, 0.656, 0.832, 0.404, 0.5983935742971888],
'avgRecall': 0.6252787148594378, 'params': [{'C': 1.0, 'break_ties': False,
'cache_size': 4000, 'class_weight': None, 'coef0': 0.0,
'decision_function_shape': 'ovr', 'degree': 3, 'gamma': 'scale', 'kernel':
'linear', 'max_iter': -1, 'probability': False, 'random_state': None,
'shrinking': True, 'tol': 0.001, 'verbose': False}]}
****

Processing Model: MLPClassifier
****
* MLPClassifier
* Best Params Result:
* {'classifier': 'MLPClassifier', 'features': 'Active inflammation?, Severity of
Crypt Arch, Increased lamina propria cellularity?, Marked & transmucosal
increase in lamina propria cellularity, Lamina propria polymorphs, Crypt
architecture, Patchy lamina propria cellularity?, Epithelial changes, Mucosal
surface, Cryptitis extent, Mucin depletion, Cryptitis polymorphs, Lamina propria
granulomas, Crypt abscesses polymorphs, Crypt abscesses extent, Basal
histiocytic cells, Submucosal granulomas, Sex, Increased lymphoid aggregates in

lamina propria?, Mild & superficial increase in lamina propria cellularity?,
Intraepithelial lymphocytes', 'accuracy': [0.628, 0.672, 0.836, 0.504,
0.6104417670682731], 'avgAccuracy': 0.6500883534136547, 'f1':
[0.6376625660805445, 0.6779935671208398, 0.8433632557529535, 0.5097111481517796,
0.6119385049412153], 'avgF1': 0.6561338084094666, 'precision': [0.628, 0.672,
0.836, 0.504, 0.6104417670682731], 'avgPrecision': 0.6500883534136547, 'recall':
[0.628, 0.672, 0.836, 0.504, 0.6104417670682731], 'avgRecall':
0.6500883534136547, 'params': [{'activation': 'logistic', 'alpha': 0.0001,
'batch_size': 'auto', 'beta_1': 0.9, 'beta_2': 0.999, 'early_stopping': False,
'epsilon': 1e-08, 'hidden_layer_sizes': (100,), 'learning_rate': 'constant',
'learning_rate_init': 0.001, 'max_fun': 15000, 'max_iter': 5000, 'momentum':
0.9, 'n_iter_no_change': 10, 'nesterovs_momentum': True, 'power_t': 0.5,
'random_state': None, 'shuffle': True, 'solver': 'adam', 'tol': 0.0001,
'validation_fraction': 0.1, 'verbose': False, 'warm_start': False}]}
****
****
* Best Performing Model and Params is:
* {'classifier': 'RandomForestClassifier', 'features': 'Active inflammation?,
Severity of Crypt Arch, Increased lamina propria cellularity?, Marked &
transmucosal increase in lamina propria cellularity, Lamina propria polymorphs,
Crypt architecture, Patchy lamina propria cellularity?, Epithelial changes,
Mucosal surface, Cryptitis extent, Mucin depletion, Cryptitis polymorphs, Lamina
propria granulomas, Crypt abscesses polymorphs, Crypt abscesses extent, Basal
histiocytic cells, Submucosal granulomas, Sex, Increased lymphoid aggregates in
lamina propria?, Mild & superficial increase in lamina propria cellularity?,
Intraepithelial lymphocytes', 'accuracy': [0.608, 0.716, 0.876, 0.664,
0.6224899598393574], 'avgAccuracy': 0.6972979919678715, 'f1':
[0.6143682823365072, 0.7103250695331881, 0.8688429539951574, 0.6864714125560538,
0.6302056711695266], 'avgF1': 0.7020426779180866, 'precision': [0.608, 0.716,
0.876, 0.664, 0.6224899598393574], 'avgPrecision': 0.6972979919678715, 'recall':
[0.608, 0.716, 0.876, 0.664, 0.6224899598393574], 'avgRecall':
0.6972979919678715, 'params': [{'bootstrap': True, 'ccp_alpha': 0.0,
'class_weight': None, 'criterion': 'entropy', 'max_depth': None, 'max_features':
'sqrt', 'max_leaf_nodes': None, 'max_samples': None, 'min_impurity_decrease':
0.0, 'min_impurity_split': None, 'min_samples_leaf': 1, 'min_samples_split': 2,
'min_weight_fraction_leaf': 0.0, 'n_estimators': 500, 'n_jobs': -1, 'oob_score':
False, 'random_state': None, 'verbose': 0, 'warm_start': False}]}
****

```
                  model                                              features  \
0  RandomForestClassifier  Active inflammation?, Severity of Crypt Arch, …
1    KNeighborsClassifier  Active inflammation?, Severity of Crypt Arch, …
2      LogisticRegression  Active inflammation?, Severity of Crypt Arch, …
3              GaussianNB  Active inflammation?, Severity of Crypt Arch, …
4       AdaBoostClassifier  Active inflammation?, Severity of Crypt Arch, …
5  DecisionTreeClassifier  Active inflammation?, Severity of Crypt Arch, …
6                     SVC  Active inflammation?, Severity of Crypt Arch, …
7           MLPClassifier  Active inflammation?, Severity of Crypt Arch, …
```

```
     accuracy         f1  precision    recall  \
0   0.697298   0.702043   0.697298  0.697298
1   0.639679   0.665025   0.639679  0.639679
2   0.644488   0.649699   0.644488  0.644488
3   0.635659   0.602900   0.635659  0.635659
4   0.601989   0.609649   0.601989  0.601989
5   0.679714   0.685954   0.679714  0.679714
6   0.625279   0.626645   0.625279  0.625279
7   0.650088   0.656134   0.650088  0.650088


                                               params
0   {'bootstrap': True, 'ccp_alpha': 0.0, 'class_w…
1   {'algorithm': 'ball_tree', 'leaf_size': 30, 'm…
2   {'C': 1, 'class_weight': None, 'dual': False, …
3            {'priors': None, 'var_smoothing': 1e-09}
4   {'algorithm': 'SAMME.R', 'base_estimator': Non…
5   {'ccp_alpha': 0.0, 'class_weight': None, 'crit…
6   {'C': 1.0, 'break_ties': False, 'cache_size': …
7   {'activation': 'logistic', 'alpha': 0.0001, 'b…
```

Processing Model: RandomForestClassifier
****
* RandomForestClassifier
* Best Params Result:
* {'classifier': 'RandomForestClassifier', 'features': 'Active inflammation?,
Severity of Crypt Arch, Increased lamina propria cellularity?, Marked &
transmucosal increase in lamina propria cellularity, Lamina propria polymorphs,
Crypt architecture, Patchy lamina propria cellularity?, Epithelial changes,
Mucosal surface, Cryptitis extent, Mucin depletion, Cryptitis polymorphs, Lamina
propria granulomas, Crypt abscesses polymorphs, Crypt abscesses extent, Basal
histiocytic cells, Submucosal granulomas, Sex, Increased lymphoid aggregates in
lamina propria?, Mild & superficial increase in lamina propria cellularity?',
'accuracy': [0.604, 0.708, 0.876, 0.664, 0.6224899598393574], 'avgAccuracy':
0.6948979919678715, 'f1': [0.6120508580618935, 0.7029496822400348,
0.869457189043396, 0.6844305555555555, 0.6290135111088678], 'avgF1':
0.6995803592019495, 'precision': [0.604, 0.708, 0.876, 0.664,
0.6224899598393574], 'avgPrecision': 0.6948979919678715, 'recall': [0.604,
0.708, 0.876, 0.664, 0.6224899598393574], 'avgRecall': 0.6948979919678715,
'params': [{'bootstrap': True, 'ccp_alpha': 0.0, 'class_weight': None,
'criterion': 'gini', 'max_depth': None, 'max_features': 'log2',
'max_leaf_nodes': None, 'max_samples': None, 'min_impurity_decrease': 0.0,
'min_impurity_split': None, 'min_samples_leaf': 1, 'min_samples_split': 2,
'min_weight_fraction_leaf': 0.0, 'n_estimators': 200, 'n_jobs': -1, 'oob_score':
True, 'random_state': None, 'verbose': 0, 'warm_start': False}]}
****

Processing Model: KNeighborsClassifier

```
****************************************************
* KNeighborsClassifier
* Best Params Result:
* {'classifier': 'KNeighborsClassifier', 'features': 'Active inflammation?,
Severity of Crypt Arch, Increased lamina propria cellularity?, Marked &
transmucosal increase in lamina propria cellularity, Lamina propria polymorphs,
Crypt architecture, Patchy lamina propria cellularity?, Epithelial changes,
Mucosal surface, Cryptitis extent, Mucin depletion, Cryptitis polymorphs, Lamina
propria granulomas, Crypt abscesses polymorphs, Crypt abscesses extent, Basal
histiocytic cells, Submucosal granulomas, Sex, Increased lymphoid aggregates in
lamina propria?, Mild & superficial increase in lamina propria cellularity?',
'accuracy': [0.588, 0.68, 0.704, 0.624, 0.5983935742971888], 'avgAccuracy':
0.6388787148594377, 'f1': [0.595419420515904, 0.6748349491105675,
0.7664158071114593, 0.6750524453950886, 0.6079733955585187], 'avgF1':
0.6639392035383076, 'precision': [0.588, 0.68, 0.704, 0.624,
0.5983935742971888], 'avgPrecision': 0.6388787148594377, 'recall': [0.588, 0.68,
0.704, 0.624, 0.5983935742971888], 'avgRecall': 0.6388787148594377, 'params':
[{'algorithm': 'kd_tree', 'leaf_size': 30, 'metric': 'minkowski',
'metric_params': None, 'n_jobs': -1, 'n_neighbors': 13, 'p': 2, 'weights':
'distance'}]}
****************************************************

Processing Model: LogisticRegression
****************************************************
* LogisticRegression
* Best Params Result:
* {'classifier': 'LogisticRegression', 'features': 'Active inflammation?,
Severity of Crypt Arch, Increased lamina propria cellularity?, Marked &
transmucosal increase in lamina propria cellularity, Lamina propria polymorphs,
Crypt architecture, Patchy lamina propria cellularity?, Epithelial changes,
Mucosal surface, Cryptitis extent, Mucin depletion, Cryptitis polymorphs, Lamina
propria granulomas, Crypt abscesses polymorphs, Crypt abscesses extent, Basal
histiocytic cells, Submucosal granulomas, Sex, Increased lymphoid aggregates in
lamina propria?, Mild & superficial increase in lamina propria cellularity?',
'accuracy': [0.628, 0.672, 0.832, 0.48, 0.6104417670682731], 'avgAccuracy':
0.6444883534136546, 'f1': [0.6388272823186247, 0.6808025761590495,
0.8385342528943049, 0.48997968855788765, 0.6105209028005728], 'avgF1':
0.6517329405460879, 'precision': [0.628, 0.672, 0.832, 0.48,
0.6104417670682731], 'avgPrecision': 0.6444883534136546, 'recall': [0.628,
0.672, 0.832, 0.48, 0.6104417670682731], 'avgRecall': 0.6444883534136546,
'params': [{'C': 1, 'class_weight': None, 'dual': False, 'fit_intercept': True,
'intercept_scaling': 1, 'l1_ratio': None, 'max_iter': 100, 'multi_class':
'multinomial', 'n_jobs': -1, 'penalty': 'l2', 'random_state': None, 'solver':
'newton-cg', 'tol': 0.0001, 'verbose': 0, 'warm_start': False}]}
****************************************************

Processing Model: GaussianNB
****************************************************
```

* GaussianNB
* Best Params Result:
* {'classifier': 'GaussianNB', 'features': 'Active inflammation?, Severity of Crypt Arch, Increased lamina propria cellularity?, Marked & transmucosal increase in lamina propria cellularity, Lamina propria polymorphs, Crypt architecture, Patchy lamina propria cellularity?, Epithelial changes, Mucosal surface, Cryptitis extent, Mucin depletion, Cryptitis polymorphs, Lamina propria granulomas, Crypt abscesses polymorphs, Crypt abscesses extent, Basal histiocytic cells, Submucosal granulomas, Sex, Increased lymphoid aggregates in lamina propria?, Mild & superficial increase in lamina propria cellularity?', 'accuracy': [0.62, 0.696, 0.884, 0.42, 0.5742971887550201], 'avgAccuracy': 0.638859437751004, 'f1': [0.581380795874828, 0.6506278870829769, 0.8702176302289862, 0.38858491578156856, 0.5383866976335772], 'avgF1': 0.6058395853203874, 'precision': [0.62, 0.696, 0.884, 0.42, 0.5742971887550201], 'avgPrecision': 0.638859437751004, 'recall': [0.62, 0.696, 0.884, 0.42, 0.5742971887550201], 'avgRecall': 0.638859437751004, 'params': [{'priors': None, 'var_smoothing': 1e-09}]}
****

Processing Model: AdaBoostClassifier
****
* AdaBoostClassifier
* Best Params Result:
* {'classifier': 'AdaBoostClassifier', 'features': 'Active inflammation?, Severity of Crypt Arch, Increased lamina propria cellularity?, Marked & transmucosal increase in lamina propria cellularity, Lamina propria polymorphs, Crypt architecture, Patchy lamina propria cellularity?, Epithelial changes, Mucosal surface, Cryptitis extent, Mucin depletion, Cryptitis polymorphs, Lamina propria granulomas, Crypt abscesses polymorphs, Crypt abscesses extent, Basal histiocytic cells, Submucosal granulomas, Sex, Increased lymphoid aggregates in lamina propria?, Mild & superficial increase in lamina propria cellularity?', 'accuracy': [0.552, 0.632, 0.788, 0.596, 0.4939759036144578], 'avgAccuracy': 0.6123951807228916, 'f1': [0.5594200924746852, 0.6409346662538152, 0.7953259152108602, 0.6118156028368794, 0.4916557131048901], 'avgF1': 0.619830397976226, 'precision': [0.552, 0.632, 0.788, 0.596, 0.4939759036144578], 'avgPrecision': 0.6123951807228916, 'recall': [0.552, 0.632, 0.788, 0.596, 0.4939759036144578], 'avgRecall': 0.6123951807228916, 'params': [{'algorithm': 'SAMME.R', 'base_estimator': None, 'learning_rate': 1, 'n_estimators': 50, 'random_state': None}]}
****

Processing Model: DecisionTreeClassifier
****
* DecisionTreeClassifier
* Best Params Result:
* {'classifier': 'DecisionTreeClassifier', 'features': 'Active inflammation?, Severity of Crypt Arch, Increased lamina propria cellularity?, Marked & transmucosal increase in lamina propria cellularity, Lamina propria polymorphs,

Crypt architecture, Patchy lamina propria cellularity?, Epithelial changes,
Mucosal surface, Cryptitis extent, Mucin depletion, Cryptitis polymorphs, Lamina
propria granulomas, Crypt abscesses polymorphs, Crypt abscesses extent, Basal
histiocytic cells, Submucosal granulomas, Sex, Increased lymphoid aggregates in
lamina propria?, Mild & superficial increase in lamina propria cellularity?',
'accuracy': [0.564, 0.72, 0.856, 0.676, 0.6305220883534136], 'avgAccuracy':
0.6893044176706827, 'f1': [0.5706358679263149, 0.7231038687836389,
0.8477198225074581, 0.694891462891463, 0.6381265114878049], 'avgF1':
0.694895506719336, 'precision': [0.564, 0.72, 0.856, 0.676, 0.6305220883534136],
'avgPrecision': 0.6893044176706827, 'recall': [0.564, 0.72, 0.856, 0.676,
0.6305220883534136], 'avgRecall': 0.6893044176706827, 'params': [{'ccp_alpha':
0.0, 'class_weight': None, 'criterion': 'entropy', 'max_depth': None,
'max_features': 'auto', 'max_leaf_nodes': None, 'min_impurity_decrease': 0.0,
'min_impurity_split': None, 'min_samples_leaf': 1, 'min_samples_split': 2,
'min_weight_fraction_leaf': 0.0, 'random_state': None, 'splitter': 'random'}]}
****

Processing Model: SVC
****
* SVC
* Best Params Result:
* {'classifier': 'SVC', 'features': 'Active inflammation?, Severity of Crypt
Arch, Increased lamina propria cellularity?, Marked & transmucosal increase in
lamina propria cellularity, Lamina propria polymorphs, Crypt architecture,
Patchy lamina propria cellularity?, Epithelial changes, Mucosal surface,
Cryptitis extent, Mucin depletion, Cryptitis polymorphs, Lamina propria
granulomas, Crypt abscesses polymorphs, Crypt abscesses extent, Basal
histiocytic cells, Submucosal granulomas, Sex, Increased lymphoid aggregates in
lamina propria?, Mild & superficial increase in lamina propria cellularity?',
'accuracy': [0.632, 0.656, 0.832, 0.396, 0.5983935742971888], 'avgAccuracy':
0.6228787148594378, 'f1': [0.6423153515513544, 0.6627632867767095,
0.8354179635134348, 0.36887218045112785, 0.6049488424255745], 'avgF1':
0.6228635249436402, 'precision': [0.632, 0.656, 0.832, 0.396,
0.5983935742971888], 'avgPrecision': 0.6228787148594378, 'recall': [0.632,
0.656, 0.832, 0.396, 0.5983935742971888], 'avgRecall': 0.6228787148594378,
'params': [{'C': 1.0, 'break_ties': False, 'cache_size': 4000, 'class_weight':
None, 'coef0': 0.0, 'decision_function_shape': 'ovr', 'degree': 3, 'gamma':
'scale', 'kernel': 'linear', 'max_iter': -1, 'probability': False,
'random_state': None, 'shrinking': True, 'tol': 0.001, 'verbose': False}]}
****

Processing Model: MLPClassifier
****
* MLPClassifier
* Best Params Result:
* {'classifier': 'MLPClassifier', 'features': 'Active inflammation?, Severity of
Crypt Arch, Increased lamina propria cellularity?, Marked & transmucosal
increase in lamina propria cellularity, Lamina propria polymorphs, Crypt

architecture, Patchy lamina propria cellularity?, Epithelial changes, Mucosal
surface, Cryptitis extent, Mucin depletion, Cryptitis polymorphs, Lamina propria
granulomas, Crypt abscesses polymorphs, Crypt abscesses extent, Basal
histiocytic cells, Submucosal granulomas, Sex, Increased lymphoid aggregates in
lamina propria?, Mild & superficial increase in lamina propria cellularity?',
'accuracy': [0.628, 0.668, 0.844, 0.544, 0.6024096385542169], 'avgAccuracy':
0.6572819277108434, 'f1': [0.6379051644119679, 0.6731326004903987,
0.8415422372810129, 0.5672120830711139, 0.60261127763121584], 'avgF1':
0.6644806723133303, 'precision': [0.628, 0.668, 0.844, 0.544,
0.6024096385542169], 'avgPrecision': 0.6572819277108434, 'recall': [0.628,
0.668, 0.844, 0.544, 0.6024096385542169], 'avgRecall': 0.6572819277108434,
'params': [{'activation': 'logistic', 'alpha': 0.0001, 'batch_size': 'auto',
'beta_1': 0.9, 'beta_2': 0.999, 'early_stopping': False, 'epsilon': 1e-08,
'hidden_layer_sizes': (100,), 'learning_rate': 'adaptive', 'learning_rate_init':
0.001, 'max_fun': 15000, 'max_iter': 5000, 'momentum': 0.9, 'n_iter_no_change':
10, 'nesterovs_momentum': True, 'power_t': 0.5, 'random_state': None, 'shuffle':
True, 'solver': 'adam', 'tol': 0.0001, 'validation_fraction': 0.1, 'verbose':
False, 'warm_start': False}]}
****
****
* Best Performing Model and Params is:
* {'classifier': 'DecisionTreeClassifier', 'features': 'Active inflammation?,
Severity of Crypt Arch, Increased lamina propria cellularity?, Marked &
transmucosal increase in lamina propria cellularity, Lamina propria polymorphs,
Crypt architecture, Patchy lamina propria cellularity?, Epithelial changes,
Mucosal surface, Cryptitis extent, Mucin depletion, Cryptitis polymorphs, Lamina
propria granulomas, Crypt abscesses polymorphs, Crypt abscesses extent, Basal
histiocytic cells, Submucosal granulomas, Sex, Increased lymphoid aggregates in
lamina propria?, Mild & superficial increase in lamina propria cellularity?',
'accuracy': [0.564, 0.72, 0.856, 0.676, 0.6305220883534136], 'avgAccuracy':
0.6893044176706827, 'f1': [0.5706358679263149, 0.7231038687836389,
0.8477198225074581, 0.694891462891463, 0.6381265114878049], 'avgF1':
0.694895506719336, 'precision': [0.564, 0.72, 0.856, 0.676, 0.6305220883534136],
'avgPrecision': 0.6893044176706827, 'recall': [0.564, 0.72, 0.856, 0.676,
0.6305220883534136], 'avgRecall': 0.6893044176706827, 'params': [{'ccp_alpha':
0.0, 'class_weight': None, 'criterion': 'entropy', 'max_depth': None,
'max_features': 'auto', 'max_leaf_nodes': None, 'min_impurity_decrease': 0.0,
'min_impurity_split': None, 'min_samples_leaf': 1, 'min_samples_split': 2,
'min_weight_fraction_leaf': 0.0, 'random_state': None, 'splitter': 'random'}]}
****

```
                model                                          features  \
0  RandomForestClassifier  Active inflammation?, Severity of Crypt Arch, …
1    KNeighborsClassifier  Active inflammation?, Severity of Crypt Arch, …
2      LogisticRegression  Active inflammation?, Severity of Crypt Arch, …
3              GaussianNB  Active inflammation?, Severity of Crypt Arch, …
4      AdaBoostClassifier  Active inflammation?, Severity of Crypt Arch, …
5  DecisionTreeClassifier  Active inflammation?, Severity of Crypt Arch, …
```

```
6                    SVC  Active inflammation?, Severity of Crypt Arch, …
7          MLPClassifier  Active inflammation?, Severity of Crypt Arch, …


   accuracy        f1  precision    recall  \
0  0.694898  0.699580   0.694898  0.694898
1  0.638879  0.663939   0.638879  0.638879
2  0.644488  0.651733   0.644488  0.644488
3  0.638859  0.605840   0.638859  0.638859
4  0.612395  0.619830   0.612395  0.612395
5  0.689304  0.694896   0.689304  0.689304
6  0.622879  0.622864   0.622879  0.622879
7  0.657282  0.664481   0.657282  0.657282


                                                params
0  {'bootstrap': True, 'ccp_alpha': 0.0, 'class_w…
1  {'algorithm': 'kd_tree', 'leaf_size': 30, 'met…
2  {'C': 1, 'class_weight': None, 'dual': False, …
3           {'priors': None, 'var_smoothing': 1e-09}
4  {'algorithm': 'SAMME.R', 'base_estimator': Non…
5  {'ccp_alpha': 0.0, 'class_weight': None, 'crit…
6  {'C': 1.0, 'break_ties': False, 'cache_size': …
7  {'activation': 'logistic', 'alpha': 0.0001, 'b…


Processing Model: RandomForestClassifier
*******************************************************
* RandomForestClassifier
* Best Params Result:
* {'classifier': 'RandomForestClassifier', 'features': 'Active inflammation?,
Severity of Crypt Arch, Increased lamina propria cellularity?, Marked &
transmucosal increase in lamina propria cellularity, Lamina propria polymorphs,
Crypt architecture, Patchy lamina propria cellularity?, Epithelial changes,
Mucosal surface, Cryptitis extent, Mucin depletion, Cryptitis polymorphs, Lamina
propria granulomas, Crypt abscesses polymorphs, Crypt abscesses extent, Basal
histiocytic cells, Submucosal granulomas, Sex, Increased lymphoid aggregates in
lamina propria?', 'accuracy': [0.6, 0.708, 0.88, 0.66, 0.6224899598393574],
'avgAccuracy': 0.6940979919678715, 'f1': [0.6062508573827049,
0.7029496822400348, 0.8731232193732192, 0.6808888888888889, 0.6290135111088678],
'avgF1': 0.6984452317987432, 'precision': [0.6, 0.708, 0.88, 0.66,
0.6224899598393574], 'avgPrecision': 0.6940979919678715, 'recall': [0.6, 0.708,
0.88, 0.66, 0.6224899598393574], 'avgRecall': 0.6940979919678715, 'params':
[{'bootstrap': True, 'ccp_alpha': 0.0, 'class_weight': None, 'criterion':
'gini', 'max_depth': None, 'max_features': 'auto', 'max_leaf_nodes': None,
'max_samples': None, 'min_impurity_decrease': 0.0, 'min_impurity_split': None,
'min_samples_leaf': 1, 'min_samples_split': 2, 'min_weight_fraction_leaf': 0.0,
'n_estimators': 500, 'n_jobs': -1, 'oob_score': False, 'random_state': None,
'verbose': 0, 'warm_start': False}]}
*******************************************************
```

```
Processing Model: KNeighborsClassifier
******************************************************
* KNeighborsClassifier
* Best Params Result:
* {'classifier': 'KNeighborsClassifier', 'features': 'Active inflammation?,
Severity of Crypt Arch, Increased lamina propria cellularity?, Marked &
transmucosal increase in lamina propria cellularity, Lamina propria polymorphs,
Crypt architecture, Patchy lamina propria cellularity?, Epithelial changes,
Mucosal surface, Cryptitis extent, Mucin depletion, Cryptitis polymorphs, Lamina
propria granulomas, Crypt abscesses polymorphs, Crypt abscesses extent, Basal
histiocytic cells, Submucosal granulomas, Sex, Increased lymphoid aggregates in
lamina propria?', 'accuracy': [0.588, 0.684, 0.704, 0.62, 0.5983935742971888],
'avgAccuracy': 0.6388787148594377, 'f1': [0.595419420515904, 0.6794908813303588,
0.7664158071114593, 0.672090134334826, 0.6079733955585187], 'avgF1':
0.6642779277702133, 'precision': [0.588, 0.684, 0.704, 0.62,
0.5983935742971888], 'avgPrecision': 0.6388787148594377, 'recall': [0.588,
0.684, 0.704, 0.62, 0.5983935742971888], 'avgRecall': 0.6388787148594377,
'params': [{'algorithm': 'kd_tree', 'leaf_size': 30, 'metric': 'minkowski',
'metric_params': None, 'n_jobs': -1, 'n_neighbors': 13, 'p': 2, 'weights':
'distance'}]}
******************************************************

Processing Model: LogisticRegression
******************************************************
* LogisticRegression
* Best Params Result:
* {'classifier': 'LogisticRegression', 'features': 'Active inflammation?,
Severity of Crypt Arch, Increased lamina propria cellularity?, Marked &
transmucosal increase in lamina propria cellularity, Lamina propria polymorphs,
Crypt architecture, Patchy lamina propria cellularity?, Epithelial changes,
Mucosal surface, Cryptitis extent, Mucin depletion, Cryptitis polymorphs, Lamina
propria granulomas, Crypt abscesses polymorphs, Crypt abscesses extent, Basal
histiocytic cells, Submucosal granulomas, Sex, Increased lymphoid aggregates in
lamina propria?', 'accuracy': [0.628, 0.672, 0.832, 0.476, 0.6104417670682731],
'avgAccuracy': 0.6436883534136546, 'f1': [0.6388272823186247,
0.6808025761590495, 0.8385342528943049, 0.4847619047619048, 0.6105209028005728],
'avgF1': 0.6506893837868913, 'precision': [0.628, 0.672, 0.832, 0.476,
0.6104417670682731], 'avgPrecision': 0.6436883534136546, 'recall': [0.628,
0.672, 0.832, 0.476, 0.6104417670682731], 'avgRecall': 0.6436883534136546,
'params': [{'C': 1, 'class_weight': None, 'dual': False, 'fit_intercept': True,
'intercept_scaling': 1, 'l1_ratio': None, 'max_iter': 100, 'multi_class':
'multinomial', 'n_jobs': -1, 'penalty': 'l2', 'random_state': None, 'solver':
'newton-cg', 'tol': 0.0001, 'verbose': 0, 'warm_start': False}]}
******************************************************

Processing Model: GaussianNB
******************************************************
* GaussianNB
```

* Best Params Result:
* {'classifier': 'GaussianNB', 'features': 'Active inflammation?, Severity of Crypt Arch, Increased lamina propria cellularity?, Marked & transmucosal increase in lamina propria cellularity, Lamina propria polymorphs, Crypt architecture, Patchy lamina propria cellularity?, Epithelial changes, Mucosal surface, Cryptitis extent, Mucin depletion, Cryptitis polymorphs, Lamina propria granulomas, Crypt abscesses polymorphs, Crypt abscesses extent, Basal histiocytic cells, Submucosal granulomas, Sex, Increased lymphoid aggregates in lamina propria?', 'accuracy': [0.616, 0.704, 0.888, 0.4, 0.5742971887550201], 'avgAccuracy': 0.636459437751004, 'f1': [0.5735620650617654, 0.6566827155717494, 0.8722018562966778, 0.35738383615943625, 0.5342409725576194], 'avgF1': 0.5988142891294497, 'precision': [0.616, 0.704, 0.888, 0.4, 0.5742971887550201], 'avgPrecision': 0.636459437751004, 'recall': [0.616, 0.704, 0.888, 0.4, 0.5742971887550201], 'avgRecall': 0.636459437751004, 'params': [{'priors': None, 'var_smoothing': 1e-09}]}
****

Processing Model: AdaBoostClassifier
****
* AdaBoostClassifier
* Best Params Result:
* {'classifier': 'AdaBoostClassifier', 'features': 'Active inflammation?, Severity of Crypt Arch, Increased lamina propria cellularity?, Marked & transmucosal increase in lamina propria cellularity, Lamina propria polymorphs, Crypt architecture, Patchy lamina propria cellularity?, Epithelial changes, Mucosal surface, Cryptitis extent, Mucin depletion, Cryptitis polymorphs, Lamina propria granulomas, Crypt abscesses polymorphs, Crypt abscesses extent, Basal histiocytic cells, Submucosal granulomas, Sex, Increased lymphoid aggregates in lamina propria?', 'accuracy': [0.536, 0.632, 0.788, 0.6, 0.4859437751004016], 'avgAccuracy': 0.6083887550200804, 'f1': [0.5388402251039882, 0.6409346662538152, 0.7953259152108602, 0.6158128365851505, 0.4862730913187482], 'avgF1': 0.6154373468945125, 'precision': [0.536, 0.632, 0.788, 0.6, 0.4859437751004016], 'avgPrecision': 0.6083887550200804, 'recall': [0.536, 0.632, 0.788, 0.6, 0.4859437751004016], 'avgRecall': 0.6083887550200804, 'params': [{'algorithm': 'SAMME.R', 'base_estimator': None, 'learning_rate': 1, 'n_estimators': 50, 'random_state': None}]}
****

Processing Model: DecisionTreeClassifier
****
* DecisionTreeClassifier
* Best Params Result:
* {'classifier': 'DecisionTreeClassifier', 'features': 'Active inflammation?, Severity of Crypt Arch, Increased lamina propria cellularity?, Marked & transmucosal increase in lamina propria cellularity, Lamina propria polymorphs, Crypt architecture, Patchy lamina propria cellularity?, Epithelial changes, Mucosal surface, Cryptitis extent, Mucin depletion, Cryptitis polymorphs, Lamina propria granulomas, Crypt abscesses polymorphs, Crypt abscesses extent, Basal

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histiocytic cells, Submucosal granulomas, Sex, Increased lymphoid aggregates in lamina propria?', 'accuracy': [0.544, 0.712, 0.856, 0.672, 0.6184738955823293], 'avgAccuracy': 0.6804947791164658, 'f1': [0.5489587309760732, 0.7124640573834399, 0.8498274102231954, 0.6914315245478038, 0.6281682374442796], 'avgF1': 0.6861699921149583, 'precision': [0.544, 0.712, 0.856, 0.672, 0.6184738955823293], 'avgPrecision': 0.6804947791164658, 'recall': [0.544, 0.712, 0.856, 0.672, 0.6184738955823293], 'avgRecall': 0.6804947791164658, 'params': [{'ccp_alpha': 0.0, 'class_weight': None, 'criterion': 'gini', 'max_depth': None, 'max_features': 'sqrt', 'max_leaf_nodes': None, 'min_impurity_decrease': 0.0, 'min_impurity_split': None, 'min_samples_leaf': 1, 'min_samples_split': 2, 'min_weight_fraction_leaf': 0.0, 'random_state': None, 'splitter': 'random'}]}
****

Processing Model: SVC
****
* SVC
* Best Params Result:
* {'classifier': 'SVC', 'features': 'Active inflammation?, Severity of Crypt Arch, Increased lamina propria cellularity?, Marked & transmucosal increase in lamina propria cellularity, Lamina propria polymorphs, Crypt architecture, Patchy lamina propria cellularity?, Epithelial changes, Mucosal surface, Cryptitis extent, Mucin depletion, Cryptitis polymorphs, Lamina propria granulomas, Crypt abscesses polymorphs, Crypt abscesses extent, Basal histiocytic cells, Submucosal granulomas, Sex, Increased lymphoid aggregates in lamina propria?', 'accuracy': [0.632, 0.656, 0.832, 0.396, 0.5983935742971888], 'avgAccuracy': 0.6228787148594378, 'f1': [0.6423153515513544, 0.6627632867767095, 0.8354179635134348, 0.36887218045112785, 0.6049488424255745], 'avgF1': 0.6228635249436402, 'precision': [0.632, 0.656, 0.832, 0.396, 0.5983935742971888], 'avgPrecision': 0.6228787148594378, 'recall': [0.632, 0.656, 0.832, 0.396, 0.5983935742971888], 'avgRecall': 0.6228787148594378, 'params': [{'C': 1.0, 'break_ties': False, 'cache_size': 4000, 'class_weight': None, 'coef0': 0.0, 'decision_function_shape': 'ovr', 'degree': 3, 'gamma': 'scale', 'kernel': 'linear', 'max_iter': -1, 'probability': False, 'random_state': None, 'shrinking': True, 'tol': 0.001, 'verbose': False}]}
****

Processing Model: MLPClassifier
****
* MLPClassifier
* Best Params Result:
* {'classifier': 'MLPClassifier', 'features': 'Active inflammation?, Severity of Crypt Arch, Increased lamina propria cellularity?, Marked & transmucosal increase in lamina propria cellularity, Lamina propria polymorphs, Crypt architecture, Patchy lamina propria cellularity?, Epithelial changes, Mucosal surface, Cryptitis extent, Mucin depletion, Cryptitis polymorphs, Lamina propria granulomas, Crypt abscesses polymorphs, Crypt abscesses extent, Basal

histiocytic cells, Submucosal granulomas, Sex, Increased lymphoid aggregates in lamina propria?', 'accuracy': [0.632, 0.668, 0.836, 0.544, 0.6104417670682731], 'avgAccuracy': 0.6580883534136547, 'f1': [0.6419285034373348, 0.6765885221798534, 0.8420664832661283, 0.5672120830711139, 0.610559472213794], 'avgF1': 0.6676710128336449, 'precision': [0.632, 0.668, 0.836, 0.544, 0.6104417670682731], 'avgPrecision': 0.6580883534136547, 'recall': [0.632, 0.668, 0.836, 0.544, 0.6104417670682731], 'avgRecall': 0.6580883534136547, 'params': [{'activation': 'logistic', 'alpha': 0.0001, 'batch_size': 'auto', 'beta_1': 0.9, 'beta_2': 0.999, 'early_stopping': False, 'epsilon': 1e-08, 'hidden_layer_sizes': (100,), 'learning_rate': 'invscaling', 'learning_rate_init': 0.001, 'max_fun': 15000, 'max_iter': 9000, 'momentum': 0.9, 'n_iter_no_change': 10, 'nesterovs_momentum': True, 'power_t': 0.5, 'random_state': None, 'shuffle': True, 'solver': 'adam', 'tol': 0.0001, 'validation_fraction': 0.1, 'verbose': False, 'warm_start': False}]}
****
****
* Best Performing Model and Params is:
* {'classifier': 'RandomForestClassifier', 'features': 'Active inflammation?, Severity of Crypt Arch, Increased lamina propria cellularity?, Marked & transmucosal increase in lamina propria cellularity, Lamina propria polymorphs, Crypt architecture, Patchy lamina propria cellularity?, Epithelial changes, Mucosal surface, Cryptitis extent, Mucin depletion, Cryptitis polymorphs, Lamina propria granulomas, Crypt abscesses polymorphs, Crypt abscesses extent, Basal histiocytic cells, Submucosal granulomas, Sex, Increased lymphoid aggregates in lamina propria?', 'accuracy': [0.6, 0.708, 0.88, 0.66, 0.6224899598393574], 'avgAccuracy': 0.6940979919678715, 'f1': [0.6062508573827049, 0.7029496822400348, 0.8731232193732192, 0.6808888888888889, 0.6290135111088678], 'avgF1': 0.6984452317987432, 'precision': [0.6, 0.708, 0.88, 0.66, 0.6224899598393574], 'avgPrecision': 0.6940979919678715, 'recall': [0.6, 0.708, 0.88, 0.66, 0.6224899598393574], 'avgRecall': 0.6940979919678715, 'params': [{'bootstrap': True, 'ccp_alpha': 0.0, 'class_weight': None, 'criterion': 'gini', 'max_depth': None, 'max_features': 'auto', 'max_leaf_nodes': None, 'max_samples': None, 'min_impurity_decrease': 0.0, 'min_impurity_split': None, 'min_samples_leaf': 1, 'min_samples_split': 2, 'min_weight_fraction_leaf': 0.0, 'n_estimators': 500, 'n_jobs': -1, 'oob_score': False, 'random_state': None, 'verbose': 0, 'warm_start': False}]}
****

```
                    model                                            features  \
0   RandomForestClassifier  Active inflammation?, Severity of Crypt Arch, …
1      KNeighborsClassifier  Active inflammation?, Severity of Crypt Arch, …
2        LogisticRegression  Active inflammation?, Severity of Crypt Arch, …
3                GaussianNB  Active inflammation?, Severity of Crypt Arch, …
4        AdaBoostClassifier  Active inflammation?, Severity of Crypt Arch, …
5    DecisionTreeClassifier  Active inflammation?, Severity of Crypt Arch, …
6                       SVC  Active inflammation?, Severity of Crypt Arch, …
7             MLPClassifier  Active inflammation?, Severity of Crypt Arch, …
```

```
   accuracy         f1  precision    recall  \
0  0.694098   0.698445   0.694098  0.694098
1  0.638879   0.664278   0.638879  0.638879
2  0.643688   0.650689   0.643688  0.643688
3  0.636459   0.598814   0.636459  0.636459
4  0.608389   0.615437   0.608389  0.608389
5  0.680495   0.686170   0.680495  0.680495
6  0.622879   0.622864   0.622879  0.622879
7  0.658088   0.667671   0.658088  0.658088


                                             params
0  {'bootstrap': True, 'ccp_alpha': 0.0, 'class_w…
1  {'algorithm': 'kd_tree', 'leaf_size': 30, 'met…
2  {'C': 1, 'class_weight': None, 'dual': False, …
3           {'priors': None, 'var_smoothing': 1e-09}
4  {'algorithm': 'SAMME.R', 'base_estimator': Non…
5  {'ccp_alpha': 0.0, 'class_weight': None, 'crit…
6  {'C': 1.0, 'break_ties': False, 'cache_size': …
7  {'activation': 'logistic', 'alpha': 0.0001, 'b…
```

Processing Model: RandomForestClassifier
****
* RandomForestClassifier
* Best Params Result:
* {'classifier': 'RandomForestClassifier', 'features': 'Active inflammation?,
Severity of Crypt Arch, Increased lamina propria cellularity?, Marked &
transmucosal increase in lamina propria cellularity, Lamina propria polymorphs,
Crypt architecture, Patchy lamina propria cellularity?, Epithelial changes,
Mucosal surface, Cryptitis extent, Mucin depletion, Cryptitis polymorphs, Lamina
propria granulomas, Crypt abscesses polymorphs, Crypt abscesses extent, Basal
histiocytic cells, Submucosal granulomas, Sex', 'accuracy': [0.592, 0.712,
0.872, 0.656, 0.6265060240963856], 'avgAccuracy': 0.6917012048192771, 'f1':
[0.5972281364850892, 0.7066357039187228, 0.8642920227920228, 0.6773193350831147,
0.6330840065779825], 'avgF1': 0.6957118409713864, 'precision': [0.592, 0.712,
0.872, 0.656, 0.6265060240963856], 'avgPrecision': 0.6917012048192771, 'recall':
[0.592, 0.712, 0.872, 0.656, 0.6265060240963856], 'avgRecall':
0.6917012048192771, 'params': [{'bootstrap': True, 'ccp_alpha': 0.0,
'class_weight': None, 'criterion': 'entropy', 'max_depth': None, 'max_features':
'auto', 'max_leaf_nodes': None, 'max_samples': None, 'min_impurity_decrease':
0.0, 'min_impurity_split': None, 'min_samples_leaf': 1, 'min_samples_split': 2,
'min_weight_fraction_leaf': 0.0, 'n_estimators': 200, 'n_jobs': -1, 'oob_score':
True, 'random_state': None, 'verbose': 0, 'warm_start': False}]}
****

Processing Model: KNeighborsClassifier
****
* KNeighborsClassifier
* Best Params Result:

* {'classifier': 'KNeighborsClassifier', 'features': 'Active inflammation?,
Severity of Crypt Arch, Increased lamina propria cellularity?, Marked &
transmucosal increase in lamina propria cellularity, Lamina propria polymorphs,
Crypt architecture, Patchy lamina propria cellularity?, Epithelial changes,
Mucosal surface, Cryptitis extent, Mucin depletion, Cryptitis polymorphs, Lamina
propria granulomas, Crypt abscesses polymorphs, Crypt abscesses extent, Basal
histiocytic cells, Submucosal granulomas, Sex', 'accuracy': [0.588, 0.716,
0.836, 0.652, 0.6224899598393574], 'avgAccuracy': 0.6828979919678715, 'f1':
[0.6051075837742504, 0.7186145236050094, 0.8332251934526897, 0.6737215634606939,
0.6315838208948407], 'avgF1': 0.6924505370374968, 'precision': [0.588, 0.716,
0.836, 0.652, 0.6224899598393574], 'avgPrecision': 0.6828979919678715, 'recall':
[0.588, 0.716, 0.836, 0.652, 0.6224899598393574], 'avgRecall':
0.6828979919678715, 'params': [{'algorithm': 'auto', 'leaf_size': 30, 'metric':
'minkowski', 'metric_params': None, 'n_jobs': -1, 'n_neighbors': 14, 'p': 2,
'weights': 'distance'}]}
****

Processing Model: LogisticRegression
****
* LogisticRegression
* Best Params Result:
* {'classifier': 'LogisticRegression', 'features': 'Active inflammation?,
Severity of Crypt Arch, Increased lamina propria cellularity?, Marked &
transmucosal increase in lamina propria cellularity, Lamina propria polymorphs,
Crypt architecture, Patchy lamina propria cellularity?, Epithelial changes,
Mucosal surface, Cryptitis extent, Mucin depletion, Cryptitis polymorphs, Lamina
propria granulomas, Crypt abscesses polymorphs, Crypt abscesses extent, Basal
histiocytic cells, Submucosal granulomas, Sex', 'accuracy': [0.628, 0.672,
0.832, 0.476, 0.6104417670682731], 'avgAccuracy': 0.6436883534136546, 'f1':
[0.6388272823186247, 0.6808025761590495, 0.8385342528943049, 0.4847619047619048,
0.6105209028005728], 'avgF1': 0.6506893837868913, 'precision': [0.628, 0.672,
0.832, 0.476, 0.6104417670682731], 'avgPrecision': 0.6436883534136546, 'recall':
[0.628, 0.672, 0.832, 0.476, 0.6104417670682731], 'avgRecall':
0.6436883534136546, 'params': [{'C': 1, 'class_weight': None, 'dual': False,
'fit_intercept': True, 'intercept_scaling': 1, 'l1_ratio': None, 'max_iter':
100, 'multi_class': 'multinomial', 'n_jobs': -1, 'penalty': 'l2',
'random_state': None, 'solver': 'newton-cg', 'tol': 0.0001, 'verbose': 0,
'warm_start': False}]}
****

Processing Model: GaussianNB
****
* GaussianNB
* Best Params Result:
* {'classifier': 'GaussianNB', 'features': 'Active inflammation?, Severity of
Crypt Arch, Increased lamina propria cellularity?, Marked & transmucosal
increase in lamina propria cellularity, Lamina propria polymorphs, Crypt
architecture, Patchy lamina propria cellularity?, Epithelial changes, Mucosal

surface, Cryptitis extent, Mucin depletion, Cryptitis polymorphs, Lamina propria granulomas, Crypt abscesses polymorphs, Crypt abscesses extent, Basal histiocytic cells, Submucosal granulomas, Sex', 'accuracy': [0.616, 0.704, 0.88, 0.4, 0.5742971887550201], 'avgAccuracy': 0.6348594377510041, 'f1': [0.5735620650617654, 0.6566827155717494, 0.8635937332792022, 0.35738383615943625, 0.5342409725576194], 'avgF1': 0.5970926645259546, 'precision': [0.616, 0.704, 0.88, 0.4, 0.5742971887550201], 'avgPrecision': 0.6348594377510041, 'recall': [0.616, 0.704, 0.88, 0.4, 0.5742971887550201], 'avgRecall': 0.6348594377510041, 'params': [{'priors': None, 'var_smoothing': 1e-09}]}
****

Processing Model: AdaBoostClassifier
****
* AdaBoostClassifier
* Best Params Result:
* {'classifier': 'AdaBoostClassifier', 'features': 'Active inflammation?, Severity of Crypt Arch, Increased lamina propria cellularity?, Marked & transmucosal increase in lamina propria cellularity, Lamina propria polymorphs, Crypt architecture, Patchy lamina propria cellularity?, Epithelial changes, Mucosal surface, Cryptitis extent, Mucin depletion, Cryptitis polymorphs, Lamina propria granulomas, Crypt abscesses polymorphs, Crypt abscesses extent, Basal histiocytic cells, Submucosal granulomas, Sex', 'accuracy': [0.592, 0.672, 0.796, 0.532, 0.3855421686746988], 'avgAccuracy': 0.5955084337349398, 'f1': [0.59580395256917, 0.671128356789593, 0.8034175538484082, 0.5566354234001293, 0.35290320856246526], 'avgF1': 0.5959776990339531, 'precision': [0.592, 0.672, 0.796, 0.532, 0.3855421686746988], 'avgPrecision': 0.5955084337349398, 'recall': [0.592, 0.672, 0.796, 0.532, 0.3855421686746988], 'avgRecall': 0.5955084337349398, 'params': [{'algorithm': 'SAMME.R', 'base_estimator': None, 'learning_rate': 1, 'n_estimators': 20, 'random_state': None}]}
****

Processing Model: DecisionTreeClassifier
****
* DecisionTreeClassifier
* Best Params Result:
* {'classifier': 'DecisionTreeClassifier', 'features': 'Active inflammation?, Severity of Crypt Arch, Increased lamina propria cellularity?, Marked & transmucosal increase in lamina propria cellularity, Lamina propria polymorphs, Crypt architecture, Patchy lamina propria cellularity?, Epithelial changes, Mucosal surface, Cryptitis extent, Mucin depletion, Cryptitis polymorphs, Lamina propria granulomas, Crypt abscesses polymorphs, Crypt abscesses extent, Basal histiocytic cells, Submucosal granulomas, Sex', 'accuracy': [0.572, 0.692, 0.86, 0.66, 0.6224899598393574], 'avgAccuracy': 0.6812979919678714, 'f1': [0.5751168267576936, 0.6937423112789206, 0.8504099018733274, 0.6808888888888889, 0.632323489197313], 'avgF1': 0.6864962835992287, 'precision': [0.572, 0.692, 0.86, 0.66, 0.6224899598393574], 'avgPrecision': 0.6812979919678714, 'recall': [0.572, 0.692, 0.86, 0.66, 0.6224899598393574], 'avgRecall': 0.6812979919678714,

```
'params': [{'ccp_alpha': 0.0, 'class_weight': None, 'criterion': 'entropy',
'max_depth': None, 'max_features': 'auto', 'max_leaf_nodes': None,
'min_impurity_decrease': 0.0, 'min_impurity_split': None, 'min_samples_leaf': 1,
'min_samples_split': 2, 'min_weight_fraction_leaf': 0.0, 'random_state': None,
'splitter': 'random'}]}
*******************************************************

Processing Model: SVC
*******************************************************
* SVC
* Best Params Result:
* {'classifier': 'SVC', 'features': 'Active inflammation?, Severity of Crypt
Arch, Increased lamina propria cellularity?, Marked & transmucosal increase in
lamina propria cellularity, Lamina propria polymorphs, Crypt architecture,
Patchy lamina propria cellularity?, Epithelial changes, Mucosal surface,
Cryptitis extent, Mucin depletion, Cryptitis polymorphs, Lamina propria
granulomas, Crypt abscesses polymorphs, Crypt abscesses extent, Basal
histiocytic cells, Submucosal granulomas, Sex', 'accuracy': [0.632, 0.656,
0.832, 0.396, 0.5983935742971888], 'avgAccuracy': 0.6228787148594378, 'f1':
[0.6423153515513544, 0.6627632867767095, 0.8354179635134348,
0.36887218045112785, 0.6049488424255745], 'avgF1': 0.6228635249436402,
'precision': [0.632, 0.656, 0.832, 0.396, 0.5983935742971888], 'avgPrecision':
0.6228787148594378, 'recall': [0.632, 0.656, 0.832, 0.396, 0.5983935742971888],
'avgRecall': 0.6228787148594378, 'params': [{'C': 1.0, 'break_ties': False,
'cache_size': 4000, 'class_weight': None, 'coef0': 0.0,
'decision_function_shape': 'ovr', 'degree': 3, 'gamma': 'scale', 'kernel':
'linear', 'max_iter': -1, 'probability': False, 'random_state': None,
'shrinking': True, 'tol': 0.001, 'verbose': False}]}
*******************************************************

Processing Model: MLPClassifier
*******************************************************
* MLPClassifier
* Best Params Result:
* {'classifier': 'MLPClassifier', 'features': 'Active inflammation?, Severity of
Crypt Arch, Increased lamina propria cellularity?, Marked & transmucosal
increase in lamina propria cellularity, Lamina propria polymorphs, Crypt
architecture, Patchy lamina propria cellularity?, Epithelial changes, Mucosal
surface, Cryptitis extent, Mucin depletion, Cryptitis polymorphs, Lamina propria
granulomas, Crypt abscesses polymorphs, Crypt abscesses extent, Basal
histiocytic cells, Submucosal granulomas, Sex', 'accuracy': [0.628, 0.676,
0.844, 0.484, 0.6104417670682731], 'avgAccuracy': 0.6484883534136546, 'f1':
[0.6385671836734693, 0.6824563770381954, 0.8415422372810129, 0.4818709370540669,
0.610559472213794], 'avgF1': 0.6509992414521077, 'precision': [0.628, 0.676,
0.844, 0.484, 0.6104417670682731], 'avgPrecision': 0.6484883534136546, 'recall':
[0.628, 0.676, 0.844, 0.484, 0.6104417670682731], 'avgRecall':
0.6484883534136546, 'params': [{'activation': 'logistic', 'alpha': 0.0001,
'batch_size': 'auto', 'beta_1': 0.9, 'beta_2': 0.999, 'early_stopping': False,
```

'epsilon': 1e-08, 'hidden_layer_sizes': (100,), 'learning_rate': 'constant',
'learning_rate_init': 0.001, 'max_fun': 15000, 'max_iter': 5000, 'momentum':
0.9, 'n_iter_no_change': 10, 'nesterovs_momentum': True, 'power_t': 0.5,
'random_state': None, 'shuffle': True, 'solver': 'adam', 'tol': 0.0001,
'validation_fraction': 0.1, 'verbose': False, 'warm_start': False}]}
****
****
* Best Performing Model and Params is:
* {'classifier': 'RandomForestClassifier', 'features': 'Active inflammation?,
Severity of Crypt Arch, Increased lamina propria cellularity?, Marked &
transmucosal increase in lamina propria cellularity, Lamina propria polymorphs,
Crypt architecture, Patchy lamina propria cellularity?, Epithelial changes,
Mucosal surface, Cryptitis extent, Mucin depletion, Cryptitis polymorphs, Lamina
propria granulomas, Crypt abscesses polymorphs, Crypt abscesses extent, Basal
histiocytic cells, Submucosal granulomas, Sex', 'accuracy': [0.592, 0.712,
0.872, 0.656, 0.6265060240963856], 'avgAccuracy': 0.6917012048192771, 'f1':
[0.5972281364850892, 0.7066357039187228, 0.8642920227920228, 0.6773193350831147,
0.6330840065779825], 'avgF1': 0.6957118409713864, 'precision': [0.592, 0.712,
0.872, 0.656, 0.6265060240963856], 'avgPrecision': 0.6917012048192771, 'recall':
[0.592, 0.712, 0.872, 0.656, 0.6265060240963856], 'avgRecall':
0.6917012048192771, 'params': [{'bootstrap': True, 'ccp_alpha': 0.0,
'class_weight': None, 'criterion': 'entropy', 'max_depth': None, 'max_features':
'auto', 'max_leaf_nodes': None, 'max_samples': None, 'min_impurity_decrease':
0.0, 'min_impurity_split': None, 'min_samples_leaf': 1, 'min_samples_split': 2,
'min_weight_fraction_leaf': 0.0, 'n_estimators': 200, 'n_jobs': -1, 'oob_score':
True, 'random_state': None, 'verbose': 0, 'warm_start': False}]}
****

	model	features \
0	RandomForestClassifier	Active inflammation?, Severity of Crypt Arch, …
1	KNeighborsClassifier	Active inflammation?, Severity of Crypt Arch, …
2	LogisticRegression	Active inflammation?, Severity of Crypt Arch, …
3	GaussianNB	Active inflammation?, Severity of Crypt Arch, …
4	AdaBoostClassifier	Active inflammation?, Severity of Crypt Arch, …
5	DecisionTreeClassifier	Active inflammation?, Severity of Crypt Arch, …
6	SVC	Active inflammation?, Severity of Crypt Arch, …
7	MLPClassifier	Active inflammation?, Severity of Crypt Arch, …

	accuracy	f1	precision	recall \
0	0.691701	0.695712	0.691701	0.691701
1	0.682898	0.692451	0.682898	0.682898
2	0.643688	0.650689	0.643688	0.643688
3	0.634859	0.597093	0.634859	0.634859
4	0.595508	0.595978	0.595508	0.595508
5	0.681298	0.686496	0.681298	0.681298
6	0.622879	0.622864	0.622879	0.622879
7	0.648488	0.650999	0.648488	0.648488

```
                                                  params
0  {'bootstrap': True, 'ccp_alpha': 0.0, 'class_w…
1  {'algorithm': 'auto', 'leaf_size': 30, 'metric…
2  {'C': 1, 'class_weight': None, 'dual': False, …
3           {'priors': None, 'var_smoothing': 1e-09}
4  {'algorithm': 'SAMME.R', 'base_estimator': Non…
5  {'ccp_alpha': 0.0, 'class_weight': None, 'crit…
6  {'C': 1.0, 'break_ties': False, 'cache_size': …
7  {'activation': 'logistic', 'alpha': 0.0001, 'b…
```

Processing Model: RandomForestClassifier
****
* RandomForestClassifier
* Best Params Result:
* {'classifier': 'RandomForestClassifier', 'features': 'Active inflammation?,
Severity of Crypt Arch, Increased lamina propria cellularity?, Marked &
transmucosal increase in lamina propria cellularity, Lamina propria polymorphs,
Crypt architecture, Patchy lamina propria cellularity?, Epithelial changes,
Mucosal surface, Cryptitis extent, Mucin depletion, Cryptitis polymorphs, Lamina
propria granulomas, Crypt abscesses polymorphs, Crypt abscesses extent, Basal
histiocytic cells, Submucosal granulomas', 'accuracy': [0.608, 0.668, 0.852,
0.592, 0.6345381526104418], 'avgAccuracy': 0.6709076305220883, 'f1':
[0.6116112865635344, 0.6725202076843197, 0.8515502386708323, 0.6193624406627015,
0.6422521347653531], 'avgF1': 0.6794592616693482, 'precision': [0.608, 0.668,
0.852, 0.592, 0.6345381526104418], 'avgPrecision': 0.6709076305220883, 'recall':
[0.608, 0.668, 0.852, 0.592, 0.6345381526104418], 'avgRecall':
0.6709076305220883, 'params': [{'bootstrap': True, 'ccp_alpha': 0.0,
'class_weight': None, 'criterion': 'gini', 'max_depth': None, 'max_features':
'auto', 'max_leaf_nodes': None, 'max_samples': None, 'min_impurity_decrease':
0.0, 'min_impurity_split': None, 'min_samples_leaf': 1, 'min_samples_split': 2,
'min_weight_fraction_leaf': 0.0, 'n_estimators': 200, 'n_jobs': -1, 'oob_score':
False, 'random_state': None, 'verbose': 0, 'warm_start': False}]}
****

Processing Model: KNeighborsClassifier
****
* KNeighborsClassifier
* Best Params Result:
* {'classifier': 'KNeighborsClassifier', 'features': 'Active inflammation?,
Severity of Crypt Arch, Increased lamina propria cellularity?, Marked &
transmucosal increase in lamina propria cellularity, Lamina propria polymorphs,
Crypt architecture, Patchy lamina propria cellularity?, Epithelial changes,
Mucosal surface, Cryptitis extent, Mucin depletion, Cryptitis polymorphs, Lamina
propria granulomas, Crypt abscesses polymorphs, Crypt abscesses extent, Basal
histiocytic cells, Submucosal granulomas', 'accuracy': [0.592, 0.664, 0.868,
0.6, 0.6104417670682731], 'avgAccuracy': 0.6668883534136546, 'f1':
[0.6013157996022837, 0.675522238326175, 0.8611499202551833, 0.6257347218619131,
0.6196997066004238], 'avgF1': 0.6766844773291958, 'precision': [0.592, 0.664,

                              255
```

0.868, 0.6, 0.6104417670682731], 'avgPrecision': 0.6668883534136546, 'recall':
[0.592, 0.664, 0.868, 0.6, 0.6104417670682731], 'avgRecall': 0.6668883534136546,
'params': [{'algorithm': 'auto', 'leaf_size': 30, 'metric': 'minkowski',
'metric_params': None, 'n_jobs': -1, 'n_neighbors': 14, 'p': 2, 'weights':
'distance'}]}
****************************************************

Processing Model: LogisticRegression
****************************************************
* LogisticRegression
* Best Params Result:
* {'classifier': 'LogisticRegression', 'features': 'Active inflammation?,
Severity of Crypt Arch, Increased lamina propria cellularity?, Marked &
transmucosal increase in lamina propria cellularity, Lamina propria polymorphs,
Crypt architecture, Patchy lamina propria cellularity?, Epithelial changes,
Mucosal surface, Cryptitis extent, Mucin depletion, Cryptitis polymorphs, Lamina
propria granulomas, Crypt abscesses polymorphs, Crypt abscesses extent, Basal
histiocytic cells, Submucosal granulomas', 'accuracy': [0.616, 0.66, 0.832,
0.484, 0.6104417670682731], 'avgAccuracy': 0.6404883534136546, 'f1':
[0.6252674096415148, 0.6676229174773445, 0.8364503171247357, 0.4951482479784367,
0.6122674161518632], 'avgF1': 0.647351261674779, 'precision': [0.616, 0.66,
0.832, 0.484, 0.6104417670682731], 'avgPrecision': 0.6404883534136546, 'recall':
[0.616, 0.66, 0.832, 0.484, 0.6104417670682731], 'avgRecall':
0.6404883534136546, 'params': [{'C': 1, 'class_weight': None, 'dual': False,
'fit_intercept': True, 'intercept_scaling': 1, 'l1_ratio': None, 'max_iter':
100, 'multi_class': 'ovr', 'n_jobs': -1, 'penalty': 'l2', 'random_state': None,
'solver': 'newton-cg', 'tol': 0.0001, 'verbose': 0, 'warm_start': False}]}
****************************************************

Processing Model: GaussianNB
****************************************************
* GaussianNB
* Best Params Result:
* {'classifier': 'GaussianNB', 'features': 'Active inflammation?, Severity of
Crypt Arch, Increased lamina propria cellularity?, Marked & transmucosal
increase in lamina propria cellularity, Lamina propria polymorphs, Crypt
architecture, Patchy lamina propria cellularity?, Epithelial changes, Mucosal
surface, Cryptitis extent, Mucin depletion, Cryptitis polymorphs, Lamina propria
granulomas, Crypt abscesses polymorphs, Crypt abscesses extent, Basal
histiocytic cells, Submucosal granulomas', 'accuracy': [0.616, 0.704, 0.88, 0.4,
0.5742971887550201], 'avgAccuracy': 0.6348594377510041, 'f1':
[0.5735620650617654, 0.6566827155717494, 0.8635937332792022,
0.35738383615943625, 0.5342409725576194], 'avgF1': 0.5970926645259546,
'precision': [0.616, 0.704, 0.88, 0.4, 0.5742971887550201], 'avgPrecision':
0.6348594377510041, 'recall': [0.616, 0.704, 0.88, 0.4, 0.5742971887550201],
'avgRecall': 0.6348594377510041, 'params': [{'priors': None, 'var_smoothing':
1e-09}]}
****************************************************

```
Processing Model: AdaBoostClassifier
*******************************************************
* AdaBoostClassifier
* Best Params Result:
* {'classifier': 'AdaBoostClassifier', 'features': 'Active inflammation?,
Severity of Crypt Arch, Increased lamina propria cellularity?, Marked &
transmucosal increase in lamina propria cellularity, Lamina propria polymorphs,
Crypt architecture, Patchy lamina propria cellularity?, Epithelial changes,
Mucosal surface, Cryptitis extent, Mucin depletion, Cryptitis polymorphs, Lamina
propria granulomas, Crypt abscesses polymorphs, Crypt abscesses extent, Basal
histiocytic cells, Submucosal granulomas', 'accuracy': [0.592, 0.672, 0.796,
0.54, 0.4497991967871486], 'avgAccuracy': 0.6099598393574297, 'f1':
[0.59580395256917, 0.671128356789593, 0.8035043729791213, 0.5657694309854643,
0.43375249248743232], 'avgF1': 0.6139917211621562, 'precision': [0.592, 0.672,
0.796, 0.54, 0.4497991967871486], 'avgPrecision': 0.6099598393574297, 'recall':
[0.592, 0.672, 0.796, 0.54, 0.4497991967871486], 'avgRecall':
0.6099598393574297, 'params': [{'algorithm': 'SAMME.R', 'base_estimator': None,
'learning_rate': 1, 'n_estimators': 20, 'random_state': None}]}
*******************************************************

Processing Model: DecisionTreeClassifier
*******************************************************
* DecisionTreeClassifier
* Best Params Result:
* {'classifier': 'DecisionTreeClassifier', 'features': 'Active inflammation?,
Severity of Crypt Arch, Increased lamina propria cellularity?, Marked &
transmucosal increase in lamina propria cellularity, Lamina propria polymorphs,
Crypt architecture, Patchy lamina propria cellularity?, Epithelial changes,
Mucosal surface, Cryptitis extent, Mucin depletion, Cryptitis polymorphs, Lamina
propria granulomas, Crypt abscesses polymorphs, Crypt abscesses extent, Basal
histiocytic cells, Submucosal granulomas', 'accuracy': [0.604, 0.664, 0.828,
0.6, 0.6305220883534136], 'avgAccuracy': 0.6653044176706827, 'f1':
[0.6131357665674885, 0.6708764478764478, 0.832211366037098, 0.62944218095792741,
0.6411637541155615], 'avgF1': 0.6773659031109039, 'precision': [0.604, 0.664,
0.828, 0.6, 0.6305220883534136], 'avgPrecision': 0.6653044176706827, 'recall':
[0.604, 0.664, 0.828, 0.6, 0.6305220883534136], 'avgRecall': 0.6653044176706827,
'params': [{'ccp_alpha': 0.0, 'class_weight': None, 'criterion': 'gini',
'max_depth': None, 'max_features': 'sqrt', 'max_leaf_nodes': None,
'min_impurity_decrease': 0.0, 'min_impurity_split': None, 'min_samples_leaf': 1,
'min_samples_split': 2, 'min_weight_fraction_leaf': 0.0, 'random_state': None,
'splitter': 'random'}]}
*******************************************************

Processing Model: SVC
*******************************************************
* SVC
* Best Params Result:
```

* {'classifier': 'SVC', 'features': 'Active inflammation?, Severity of Crypt
Arch, Increased lamina propria cellularity?, Marked & transmucosal increase in
lamina propria cellularity, Lamina propria polymorphs, Crypt architecture,
Patchy lamina propria cellularity?, Epithelial changes, Mucosal surface,
Cryptitis extent, Mucin depletion, Cryptitis polymorphs, Lamina propria
granulomas, Crypt abscesses polymorphs, Crypt abscesses extent, Basal
histiocytic cells, Submucosal granulomas', 'accuracy': [0.632, 0.656, 0.832,
0.396, 0.5983935742971888], 'avgAccuracy': 0.6228787148594378, 'f1':
[0.6423153515513544, 0.6627632867767095, 0.8354179635134348,
0.36887218045112785, 0.6049488424255745], 'avgF1': 0.6228635249436402,
'precision': [0.632, 0.656, 0.832, 0.396, 0.5983935742971888], 'avgPrecision':
0.6228787148594378, 'recall': [0.632, 0.656, 0.832, 0.396, 0.5983935742971888],
'avgRecall': 0.6228787148594378, 'params': [{'C': 1.0, 'break_ties': False,
'cache_size': 4000, 'class_weight': None, 'coef0': 0.0,
'decision_function_shape': 'ovr', 'degree': 3, 'gamma': 'scale', 'kernel':
'linear', 'max_iter': -1, 'probability': False, 'random_state': None,
'shrinking': True, 'tol': 0.001, 'verbose': False}]}
****

Processing Model: MLPClassifier
****
* MLPClassifier
* Best Params Result:
* {'classifier': 'MLPClassifier', 'features': 'Active inflammation?, Severity of
Crypt Arch, Increased lamina propria cellularity?, Marked & transmucosal
increase in lamina propria cellularity, Lamina propria polymorphs, Crypt
architecture, Patchy lamina propria cellularity?, Epithelial changes, Mucosal
surface, Cryptitis extent, Mucin depletion, Cryptitis polymorphs, Lamina propria
granulomas, Crypt abscesses polymorphs, Crypt abscesses extent, Basal
histiocytic cells, Submucosal granulomas', 'accuracy': [0.616, 0.664, 0.836,
0.484, 0.6184738955823293], 'avgAccuracy': 0.6436947791164659, 'f1':
[0.6244176829455226, 0.6711551786686015, 0.8420664832661283, 0.4951482479784367,
0.6203725944151881], 'avgF1': 0.6506320374547755, 'precision': [0.616, 0.664,
0.836, 0.484, 0.6184738955823293], 'avgPrecision': 0.6436947791164659, 'recall':
[0.616, 0.664, 0.836, 0.484, 0.6184738955823293], 'avgRecall':
0.6436947791164659, 'params': [{'activation': 'identity', 'alpha': 0.0001,
'batch_size': 'auto', 'beta_1': 0.9, 'beta_2': 0.999, 'early_stopping': False,
'epsilon': 1e-08, 'hidden_layer_sizes': (100,), 'learning_rate': 'adaptive',
'learning_rate_init': 0.001, 'max_fun': 15000, 'max_iter': 7000, 'momentum':
0.9, 'n_iter_no_change': 10, 'nesterovs_momentum': True, 'power_t': 0.5,
'random_state': None, 'shuffle': True, 'solver': 'adam', 'tol': 0.0001,
'validation_fraction': 0.1, 'verbose': False, 'warm_start': False}]}
****
****
* Best Performing Model and Params is:
* {'classifier': 'RandomForestClassifier', 'features': 'Active inflammation?,
Severity of Crypt Arch, Increased lamina propria cellularity?, Marked &
transmucosal increase in lamina propria cellularity, Lamina propria polymorphs,

Crypt architecture, Patchy lamina propria cellularity?, Epithelial changes,
Mucosal surface, Cryptitis extent, Mucin depletion, Cryptitis polymorphs, Lamina
propria granulomas, Crypt abscesses polymorphs, Crypt abscesses extent, Basal
histiocytic cells, Submucosal granulomas', 'accuracy': [0.608, 0.668, 0.852,
0.592, 0.6345381526104418], 'avgAccuracy': 0.6709076305220883, 'f1':
[0.6116112865635344, 0.6725202076843197, 0.8515502386708323, 0.6193624406627015,
0.6422521347653531], 'avgF1': 0.6794592616693482, 'precision': [0.608, 0.668,
0.852, 0.592, 0.6345381526104418], 'avgPrecision': 0.6709076305220883, 'recall':
[0.608, 0.668, 0.852, 0.592, 0.6345381526104418], 'avgRecall':
0.6709076305220883, 'params': [{'bootstrap': True, 'ccp_alpha': 0.0,
'class_weight': None, 'criterion': 'gini', 'max_depth': None, 'max_features':
'auto', 'max_leaf_nodes': None, 'max_samples': None, 'min_impurity_decrease':
0.0, 'min_impurity_split': None, 'min_samples_leaf': 1, 'min_samples_split': 2,
'min_weight_fraction_leaf': 0.0, 'n_estimators': 200, 'n_jobs': -1, 'oob_score':
False, 'random_state': None, 'verbose': 0, 'warm_start': False}]}
****

```
                    model                                         features  \
0  RandomForestClassifier  Active inflammation?, Severity of Crypt Arch, …
1    KNeighborsClassifier  Active inflammation?, Severity of Crypt Arch, …
2      LogisticRegression  Active inflammation?, Severity of Crypt Arch, …
3              GaussianNB  Active inflammation?, Severity of Crypt Arch, …
4      AdaBoostClassifier  Active inflammation?, Severity of Crypt Arch, …
5  DecisionTreeClassifier  Active inflammation?, Severity of Crypt Arch, …
6                     SVC  Active inflammation?, Severity of Crypt Arch, …
7           MLPClassifier  Active inflammation?, Severity of Crypt Arch, …

   accuracy        f1  precision    recall  \
0  0.670908  0.679459   0.670908  0.670908
1  0.666888  0.676684   0.666888  0.666888
2  0.640488  0.647351   0.640488  0.640488
3  0.634859  0.597093   0.634859  0.634859
4  0.609960  0.613992   0.609960  0.609960
5  0.665304  0.677366   0.665304  0.665304
6  0.622879  0.622864   0.622879  0.622879
7  0.643695  0.650632   0.643695  0.643695

                                             params
0  {'bootstrap': True, 'ccp_alpha': 0.0, 'class_w…
1  {'algorithm': 'auto', 'leaf_size': 30, 'metric…
2  {'C': 1, 'class_weight': None, 'dual': False, …
3           {'priors': None, 'var_smoothing': 1e-09}
4  {'algorithm': 'SAMME.R', 'base_estimator': Non…
5  {'ccp_alpha': 0.0, 'class_weight': None, 'crit…
6  {'C': 1.0, 'break_ties': False, 'cache_size': …
7  {'activation': 'identity', 'alpha': 0.0001, 'b…

Processing Model: RandomForestClassifier
```

```
****************************************************
* RandomForestClassifier
* Best Params Result:
* {'classifier': 'RandomForestClassifier', 'features': 'Active inflammation?,
Severity of Crypt Arch, Increased lamina propria cellularity?, Marked &
transmucosal increase in lamina propria cellularity, Lamina propria polymorphs,
Crypt architecture, Patchy lamina propria cellularity?, Epithelial changes,
Mucosal surface, Cryptitis extent, Mucin depletion, Cryptitis polymorphs, Lamina
propria granulomas, Crypt abscesses polymorphs, Crypt abscesses extent, Basal
histiocytic cells', 'accuracy': [0.612, 0.672, 0.84, 0.588, 0.6305220883534136],
'avgAccuracy': 0.6685044176706827, 'f1': [0.6178045564310142,
0.6774241322314049, 0.8419885485205443, 0.6152978859705317, 0.6390009010591413],
'avgF1': 0.6783032048425273, 'precision': [0.612, 0.672, 0.84, 0.588,
0.6305220883534136], 'avgPrecision': 0.6685044176706827, 'recall': [0.612,
0.672, 0.84, 0.588, 0.6305220883534136], 'avgRecall': 0.6685044176706827,
'params': [{'bootstrap': True, 'ccp_alpha': 0.0, 'class_weight': None,
'criterion': 'gini', 'max_depth': None, 'max_features': 'sqrt',
'max_leaf_nodes': None, 'max_samples': None, 'min_impurity_decrease': 0.0,
'min_impurity_split': None, 'min_samples_leaf': 1, 'min_samples_split': 2,
'min_weight_fraction_leaf': 0.0, 'n_estimators': 700, 'n_jobs': -1, 'oob_score':
True, 'random_state': None, 'verbose': 0, 'warm_start': False}]}
****************************************************

Processing Model: KNeighborsClassifier
****************************************************
* KNeighborsClassifier
* Best Params Result:
* {'classifier': 'KNeighborsClassifier', 'features': 'Active inflammation?,
Severity of Crypt Arch, Increased lamina propria cellularity?, Marked &
transmucosal increase in lamina propria cellularity, Lamina propria polymorphs,
Crypt architecture, Patchy lamina propria cellularity?, Epithelial changes,
Mucosal surface, Cryptitis extent, Mucin depletion, Cryptitis polymorphs, Lamina
propria granulomas, Crypt abscesses polymorphs, Crypt abscesses extent, Basal
histiocytic cells', 'accuracy': [0.584, 0.664, 0.868, 0.608, 0.606425702811245],
'avgAccuracy': 0.666085140562249, 'f1': [0.5929949793619771, 0.675522238326175,
0.8611499202551833, 0.6336117033007425, 0.6148888851240942], 'avgF1':
0.6756335452736344, 'precision': [0.584, 0.664, 0.868, 0.608,
0.606425702811245], 'avgPrecision': 0.666085140562249, 'recall': [0.584, 0.664,
0.868, 0.608, 0.606425702811245], 'avgRecall': 0.666085140562249, 'params':
[{'algorithm': 'auto', 'leaf_size': 30, 'metric': 'minkowski', 'metric_params':
None, 'n_jobs': -1, 'n_neighbors': 14, 'p': 2, 'weights': 'distance'}]}
****************************************************

Processing Model: LogisticRegression
****************************************************
* LogisticRegression
* Best Params Result:
* {'classifier': 'LogisticRegression', 'features': 'Active inflammation?,
```

Severity of Crypt Arch, Increased lamina propria cellularity?, Marked &
transmucosal increase in lamina propria cellularity, Lamina propria polymorphs,
Crypt architecture, Patchy lamina propria cellularity?, Epithelial changes,
Mucosal surface, Cryptitis extent, Mucin depletion, Cryptitis polymorphs, Lamina
propria granulomas, Crypt abscesses polymorphs, Crypt abscesses extent, Basal
histiocytic cells', 'accuracy': [0.612, 0.66, 0.832, 0.484, 0.6104417670682731],
'avgAccuracy': 0.6396883534136546, 'f1': [0.6204501557854292,
0.6676229174773445, 0.8364503171247357, 0.4951482479784367, 0.6136620324153906],
'avgF1': 0.6466667341562673, 'precision': [0.612, 0.66, 0.832, 0.484,
0.6104417670682731], 'avgPrecision': 0.6396883534136546, 'recall': [0.612, 0.66,
0.832, 0.484, 0.6104417670682731], 'avgRecall': 0.6396883534136546, 'params':
[{'C': 1, 'class_weight': None, 'dual': False, 'fit_intercept': True,
'intercept_scaling': 1, 'l1_ratio': None, 'max_iter': 100, 'multi_class':
'multinomial', 'n_jobs': -1, 'penalty': 'l2', 'random_state': None, 'solver':
'newton-cg', 'tol': 0.0001, 'verbose': 0, 'warm_start': False}]}
****

Processing Model: GaussianNB
****
* GaussianNB
* Best Params Result:
* {'classifier': 'GaussianNB', 'features': 'Active inflammation?, Severity of
Crypt Arch, Increased lamina propria cellularity?, Marked & transmucosal
increase in lamina propria cellularity, Lamina propria polymorphs, Crypt
architecture, Patchy lamina propria cellularity?, Epithelial changes, Mucosal
surface, Cryptitis extent, Mucin depletion, Cryptitis polymorphs, Lamina propria
granulomas, Crypt abscesses polymorphs, Crypt abscesses extent, Basal
histiocytic cells', 'accuracy': [0.572, 0.652, 0.852, 0.524,
0.5542168674698795], 'avgAccuracy': 0.6308433734939759, 'f1':
[0.5744644846636755, 0.6407739188290086, 0.8462344497607656, 0.528072095268748,
0.5535787826373445], 'avgF1': 0.6286247462319084, 'precision': [0.572, 0.652,
0.852, 0.524, 0.5542168674698795], 'avgPrecision': 0.6308433734939759, 'recall':
[0.572, 0.652, 0.852, 0.524, 0.5542168674698795], 'avgRecall':
0.6308433734939759, 'params': [{'priors': None, 'var_smoothing': 1e-09}]}
****

Processing Model: AdaBoostClassifier
****
* AdaBoostClassifier
* Best Params Result:
* {'classifier': 'AdaBoostClassifier', 'features': 'Active inflammation?,
Severity of Crypt Arch, Increased lamina propria cellularity?, Marked &
transmucosal increase in lamina propria cellularity, Lamina propria polymorphs,
Crypt architecture, Patchy lamina propria cellularity?, Epithelial changes,
Mucosal surface, Cryptitis extent, Mucin depletion, Cryptitis polymorphs, Lamina
propria granulomas, Crypt abscesses polymorphs, Crypt abscesses extent, Basal
histiocytic cells', 'accuracy': [0.592, 0.672, 0.796, 0.54, 0.4578313253012048],
'avgAccuracy': 0.6115662650602409, 'f1': [0.59580395256917, 0.671128356789593,

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0.8035043729791213, 0.5657694309854643, 0.44297118544106495], 'avgF1':
0.6158354597528827, 'precision': [0.592, 0.672, 0.796, 0.54,
0.4578313253012048], 'avgPrecision': 0.6115662650602409, 'recall': [0.592,
0.672, 0.796, 0.54, 0.4578313253012048], 'avgRecall': 0.6115662650602409,
'params': [{'algorithm': 'SAMME.R', 'base_estimator': None, 'learning_rate': 1,
'n_estimators': 20, 'random_state': None}]}
****

Processing Model: DecisionTreeClassifier
****
* DecisionTreeClassifier
* Best Params Result:
* {'classifier': 'DecisionTreeClassifier', 'features': 'Active inflammation?,
Severity of Crypt Arch, Increased lamina propria cellularity?, Marked &
transmucosal increase in lamina propria cellularity, Lamina propria polymorphs,
Crypt architecture, Patchy lamina propria cellularity?, Epithelial changes,
Mucosal surface, Cryptitis extent, Mucin depletion, Cryptitis polymorphs, Lamina
propria granulomas, Crypt abscesses polymorphs, Crypt abscesses extent, Basal
histiocytic cells', 'accuracy': [0.604, 0.656, 0.828, 0.6, 0.6224899598393574],
'avgAccuracy': 0.6620979919678714, 'f1': [0.6099599016278012,
0.6575260037523452, 0.832211366037098, 0.627390357814041, 0.6320823835884077],
'avgF1': 0.6718340025639387, 'precision': [0.604, 0.656, 0.828, 0.6,
0.6224899598393574], 'avgPrecision': 0.6620979919678714, 'recall': [0.604,
0.656, 0.828, 0.6, 0.6224899598393574], 'avgRecall': 0.6620979919678714,
'params': [{'ccp_alpha': 0.0, 'class_weight': None, 'criterion': 'gini',
'max_depth': None, 'max_features': 'auto', 'max_leaf_nodes': None,
'min_impurity_decrease': 0.0, 'min_impurity_split': None, 'min_samples_leaf': 1,
'min_samples_split': 2, 'min_weight_fraction_leaf': 0.0, 'random_state': None,
'splitter': 'best'}]}
****

Processing Model: SVC
****
* SVC
* Best Params Result:
* {'classifier': 'SVC', 'features': 'Active inflammation?, Severity of Crypt
Arch, Increased lamina propria cellularity?, Marked & transmucosal increase in
lamina propria cellularity, Lamina propria polymorphs, Crypt architecture,
Patchy lamina propria cellularity?, Epithelial changes, Mucosal surface,
Cryptitis extent, Mucin depletion, Cryptitis polymorphs, Lamina propria
granulomas, Crypt abscesses polymorphs, Crypt abscesses extent, Basal
histiocytic cells', 'accuracy': [0.632, 0.652, 0.832, 0.396,
0.5983935742971888], 'avgAccuracy': 0.6220787148594378, 'f1':
[0.6423153515513544, 0.6584654545454545, 0.8354179635134348,
0.36887218045112785, 0.6049488424255745], 'avgF1': 0.6220039584973892,
'precision': [0.632, 0.652, 0.832, 0.396, 0.5983935742971888], 'avgPrecision':
0.6220787148594378, 'recall': [0.632, 0.652, 0.832, 0.396, 0.5983935742971888],
'avgRecall': 0.6220787148594378, 'params': [{'C': 1.0, 'break_ties': False,

```
'cache_size': 4000, 'class_weight': None, 'coef0': 0.0,
'decision_function_shape': 'ovr', 'degree': 3, 'gamma': 'scale', 'kernel':
'linear', 'max_iter': -1, 'probability': False, 'random_state': None,
'shrinking': True, 'tol': 0.001, 'verbose': False}]}
*******************************************************

Processing Model: MLPClassifier
*******************************************************
* MLPClassifier
* Best Params Result:
* {'classifier': 'MLPClassifier', 'features': 'Active inflammation?, Severity of
Crypt Arch, Increased lamina propria cellularity?, Marked & transmucosal
increase in lamina propria cellularity, Lamina propria polymorphs, Crypt
architecture, Patchy lamina propria cellularity?, Epithelial changes, Mucosal
surface, Cryptitis extent, Mucin depletion, Cryptitis polymorphs, Lamina propria
granulomas, Crypt abscesses polymorphs, Crypt abscesses extent, Basal
histiocytic cells', 'accuracy': [0.612, 0.668, 0.848, 0.484,
0.6184738955823293], 'avgAccuracy': 0.6460947791164658, 'f1':
[0.620382633883019, 0.6753764478764479, 0.851374734875327, 0.4951482479784367,
0.6203725944151881], 'avgF1': 0.6525309318056838, 'precision': [0.612, 0.668,
0.848, 0.484, 0.6184738955823293], 'avgPrecision': 0.6460947791164658, 'recall':
[0.612, 0.668, 0.848, 0.484, 0.6184738955823293], 'avgRecall':
0.6460947791164658, 'params': [{'activation': 'identity', 'alpha': 0.0001,
'batch_size': 'auto', 'beta_1': 0.9, 'beta_2': 0.999, 'early_stopping': False,
'epsilon': 1e-08, 'hidden_layer_sizes': (100,), 'learning_rate': 'constant',
'learning_rate_init': 0.001, 'max_fun': 15000, 'max_iter': 9000, 'momentum':
0.9, 'n_iter_no_change': 10, 'nesterovs_momentum': True, 'power_t': 0.5,
'random_state': None, 'shuffle': True, 'solver': 'adam', 'tol': 0.0001,
'validation_fraction': 0.1, 'verbose': False, 'warm_start': False}]}
*******************************************************
*******************************************************
* Best Performing Model and Params is:
* {'classifier': 'RandomForestClassifier', 'features': 'Active inflammation?,
Severity of Crypt Arch, Increased lamina propria cellularity?, Marked &
transmucosal increase in lamina propria cellularity, Lamina propria polymorphs,
Crypt architecture, Patchy lamina propria cellularity?, Epithelial changes,
Mucosal surface, Cryptitis extent, Mucin depletion, Cryptitis polymorphs, Lamina
propria granulomas, Crypt abscesses polymorphs, Crypt abscesses extent, Basal
histiocytic cells', 'accuracy': [0.612, 0.672, 0.84, 0.588, 0.6305220883534136],
'avgAccuracy': 0.6685044176706827, 'f1': [0.6178045564310142,
0.6774241322314049, 0.8419885485205443, 0.6152978859705317, 0.6390009010591413],
'avgF1': 0.6783032048425273, 'precision': [0.612, 0.672, 0.84, 0.588,
0.6305220883534136], 'avgPrecision': 0.6685044176706827, 'recall': [0.612,
0.672, 0.84, 0.588, 0.6305220883534136], 'avgRecall': 0.6685044176706827,
'params': [{'bootstrap': True, 'ccp_alpha': 0.0, 'class_weight': None,
'criterion': 'gini', 'max_depth': None, 'max_features': 'sqrt',
'max_leaf_nodes': None, 'max_samples': None, 'min_impurity_decrease': 0.0,
'min_impurity_split': None, 'min_samples_leaf': 1, 'min_samples_split': 2,
```

```
'min_weight_fraction_leaf': 0.0, 'n_estimators': 700, 'n_jobs': -1, 'oob_score':
True, 'random_state': None, 'verbose': 0, 'warm_start': False}]}
*******************************************************
```

```
                       model                                               features  \
0   RandomForestClassifier   Active inflammation?, Severity of Crypt Arch, …
1     KNeighborsClassifier   Active inflammation?, Severity of Crypt Arch, …
2       LogisticRegression   Active inflammation?, Severity of Crypt Arch, …
3               GaussianNB   Active inflammation?, Severity of Crypt Arch, …
4        AdaBoostClassifier   Active inflammation?, Severity of Crypt Arch, …
5   DecisionTreeClassifier   Active inflammation?, Severity of Crypt Arch, …
6                      SVC   Active inflammation?, Severity of Crypt Arch, …
7             MLPClassifier   Active inflammation?, Severity of Crypt Arch, …

   accuracy        f1  precision    recall  \
0  0.668504  0.678303   0.668504  0.668504
1  0.666085  0.675634   0.666085  0.666085
2  0.639688  0.646667   0.639688  0.639688
3  0.630843  0.628625   0.630843  0.630843
4  0.611566  0.615835   0.611566  0.611566
5  0.662098  0.671834   0.662098  0.662098
6  0.622079  0.622004   0.622079  0.622079
7  0.646095  0.652531   0.646095  0.646095

                                                params
0  {'bootstrap': True, 'ccp_alpha': 0.0, 'class_w…
1  {'algorithm': 'auto', 'leaf_size': 30, 'metric…
2  {'C': 1, 'class_weight': None, 'dual': False, …
3           {'priors': None, 'var_smoothing': 1e-09}
4  {'algorithm': 'SAMME.R', 'base_estimator': Non…
5  {'ccp_alpha': 0.0, 'class_weight': None, 'crit…
6  {'C': 1.0, 'break_ties': False, 'cache_size': …
7  {'activation': 'identity', 'alpha': 0.0001, 'b…
```

```
Processing Model: RandomForestClassifier
*******************************************************
* RandomForestClassifier
* Best Params Result:
* {'classifier': 'RandomForestClassifier', 'features': 'Active inflammation?,
Severity of Crypt Arch, Increased lamina propria cellularity?, Marked &
transmucosal increase in lamina propria cellularity, Lamina propria polymorphs,
Crypt architecture, Patchy lamina propria cellularity?, Epithelial changes,
Mucosal surface, Cryptitis extent, Mucin depletion, Cryptitis polymorphs, Lamina
propria granulomas, Crypt abscesses polymorphs, Crypt abscesses extent',
'accuracy': [0.624, 0.664, 0.848, 0.58, 0.6345381526104418], 'avgAccuracy':
0.6701076305220883, 'f1': [0.6295150476254813, 0.6675704794308692,
0.8483818769206523, 0.6070654404499506, 0.6431563380717892], 'avgF1':
0.6791378364997485, 'precision': [0.624, 0.664, 0.848, 0.58,
```

0.6345381526104418], 'avgPrecision': 0.6701076305220883, 'recall': [0.624, 0.664, 0.848, 0.58, 0.6345381526104418], 'avgRecall': 0.6701076305220883, 'params': [{'bootstrap': True, 'ccp_alpha': 0.0, 'class_weight': None, 'criterion': 'entropy', 'max_depth': None, 'max_features': 'log2', 'max_leaf_nodes': None, 'max_samples': None, 'min_impurity_decrease': 0.0, 'min_impurity_split': None, 'min_samples_leaf': 1, 'min_samples_split': 2, 'min_weight_fraction_leaf': 0.0, 'n_estimators': 500, 'n_jobs': -1, 'oob_score': True, 'random_state': None, 'verbose': 0, 'warm_start': False}]}
****

Processing Model: KNeighborsClassifier
****
* KNeighborsClassifier
* Best Params Result:
* {'classifier': 'KNeighborsClassifier', 'features': 'Active inflammation?, Severity of Crypt Arch, Increased lamina propria cellularity?, Marked & transmucosal increase in lamina propria cellularity, Lamina propria polymorphs, Crypt architecture, Patchy lamina propria cellularity?, Epithelial changes, Mucosal surface, Cryptitis extent, Mucin depletion, Cryptitis polymorphs, Lamina propria granulomas, Crypt abscesses polymorphs, Crypt abscesses extent', 'accuracy': [0.612, 0.668, 0.844, 0.6, 0.6184738955823293], 'avgAccuracy': 0.6684947791164658, 'f1': [0.6224127957619334, 0.679557675739494, 0.8391694809469661, 0.6257347218619131, 0.6284545157849594], 'avgF1': 0.6790658380190532, 'precision': [0.612, 0.668, 0.844, 0.6, 0.6184738955823293], 'avgPrecision': 0.6684947791164658, 'recall': [0.612, 0.668, 0.844, 0.6, 0.6184738955823293], 'avgRecall': 0.6684947791164658, 'params': [{'algorithm': 'brute', 'leaf_size': 30, 'metric': 'minkowski', 'metric_params': None, 'n_jobs': -1, 'n_neighbors': 17, 'p': 2, 'weights': 'distance'}]}
****

Processing Model: LogisticRegression
****
* LogisticRegression
* Best Params Result:
* {'classifier': 'LogisticRegression', 'features': 'Active inflammation?, Severity of Crypt Arch, Increased lamina propria cellularity?, Marked & transmucosal increase in lamina propria cellularity, Lamina propria polymorphs, Crypt architecture, Patchy lamina propria cellularity?, Epithelial changes, Mucosal surface, Cryptitis extent, Mucin depletion, Cryptitis polymorphs, Lamina propria granulomas, Crypt abscesses polymorphs, Crypt abscesses extent', 'accuracy': [0.612, 0.66, 0.836, 0.484, 0.6104417670682731], 'avgAccuracy': 0.6404883534136546, 'f1': [0.6212663067088687, 0.6676229174773445, 0.8399180901420046, 0.4951482479784367, 0.6136620324153906], 'avgF1': 0.6475235189444091, 'precision': [0.612, 0.66, 0.836, 0.484, 0.6104417670682731], 'avgPrecision': 0.6404883534136546, 'recall': [0.612, 0.66, 0.836, 0.484, 0.6104417670682731], 'avgRecall': 0.6404883534136546, 'params': [{'C': 1, 'class_weight': None, 'dual': False, 'fit_intercept': True, 'intercept_scaling': 1, 'l1_ratio': None, 'max_iter': 100, 'multi_class':

'multinomial', 'n_jobs': -1, 'penalty': 'l2', 'random_state': None, 'solver': 'newton-cg', 'tol': 0.0001, 'verbose': 0, 'warm_start': False}]}
****

Processing Model: GaussianNB
****
* GaussianNB
* Best Params Result:
* {'classifier': 'GaussianNB', 'features': 'Active inflammation?, Severity of Crypt Arch, Increased lamina propria cellularity?, Marked & transmucosal increase in lamina propria cellularity, Lamina propria polymorphs, Crypt architecture, Patchy lamina propria cellularity?, Epithelial changes, Mucosal surface, Cryptitis extent, Mucin depletion, Cryptitis polymorphs, Lamina propria granulomas, Crypt abscesses polymorphs, Crypt abscesses extent', 'accuracy': [0.572, 0.648, 0.852, 0.524, 0.5542168674698795], 'avgAccuracy': 0.6300433734939759, 'f1': [0.5744644846636755, 0.6373150181337444, 0.8462344497607656, 0.528072095268748, 0.5540211168434797], 'avgF1': 0.6280214329340826, 'precision': [0.572, 0.648, 0.852, 0.524, 0.5542168674698795], 'avgPrecision': 0.6300433734939759, 'recall': [0.572, 0.648, 0.852, 0.524, 0.5542168674698795], 'avgRecall': 0.6300433734939759, 'params': [{'priors': None, 'var_smoothing': 1e-09}]}
****

Processing Model: AdaBoostClassifier
****
* AdaBoostClassifier
* Best Params Result:
* {'classifier': 'AdaBoostClassifier', 'features': 'Active inflammation?, Severity of Crypt Arch, Increased lamina propria cellularity?, Marked & transmucosal increase in lamina propria cellularity, Lamina propria polymorphs, Crypt architecture, Patchy lamina propria cellularity?, Epithelial changes, Mucosal surface, Cryptitis extent, Mucin depletion, Cryptitis polymorphs, Lamina propria granulomas, Crypt abscesses polymorphs, Crypt abscesses extent', 'accuracy': [0.572, 0.628, 0.808, 0.5, 0.5220883534136547], 'avgAccuracy': 0.6060176706827309, 'f1': [0.5782235469448584, 0.63620424281675, 0.8135010898863237, 0.5184079101726161, 0.5244249150820828], 'avgF1': 0.6141523409805262, 'precision': [0.572, 0.628, 0.808, 0.5, 0.5220883534136547], 'avgPrecision': 0.6060176706827309, 'recall': [0.572, 0.628, 0.808, 0.5, 0.5220883534136547], 'avgRecall': 0.6060176706827309, 'params': [{'algorithm': 'SAMME.R', 'base_estimator': None, 'learning_rate': 1, 'n_estimators': 50, 'random_state': None}]}
****

Processing Model: DecisionTreeClassifier
****
* DecisionTreeClassifier
* Best Params Result:
* {'classifier': 'DecisionTreeClassifier', 'features': 'Active inflammation?,

Severity of Crypt Arch, Increased lamina propria cellularity?, Marked &
transmucosal increase in lamina propria cellularity, Lamina propria polymorphs,
Crypt architecture, Patchy lamina propria cellularity?, Epithelial changes,
Mucosal surface, Cryptitis extent, Mucin depletion, Cryptitis polymorphs, Lamina
propria granulomas, Crypt abscesses polymorphs, Crypt abscesses extent',
'accuracy': [0.62, 0.648, 0.844, 0.6, 0.6144578313253012], 'avgAccuracy':
0.6652915662650603, 'f1': [0.6276734541971846, 0.6577902513150204,
0.8454720731464918, 0.6284116481626855, 0.6215436969115401], 'avgF1':
0.6761782247465845, 'precision': [0.62, 0.648, 0.844, 0.6, 0.6144578313253012],
'avgPrecision': 0.6652915662650603, 'recall': [0.62, 0.648, 0.844, 0.6,
0.6144578313253012], 'avgRecall': 0.6652915662650603, 'params': [{'ccp_alpha':
0.0, 'class_weight': None, 'criterion': 'entropy', 'max_depth': None,
'max_features': 'auto', 'max_leaf_nodes': None, 'min_impurity_decrease': 0.0,
'min_impurity_split': None, 'min_samples_leaf': 1, 'min_samples_split': 2,
'min_weight_fraction_leaf': 0.0, 'random_state': None, 'splitter': 'random'}]}
****

Processing Model: SVC
****
* SVC
* Best Params Result:
* {'classifier': 'SVC', 'features': 'Active inflammation?, Severity of Crypt
Arch, Increased lamina propria cellularity?, Marked & transmucosal increase in
lamina propria cellularity, Lamina propria polymorphs, Crypt architecture,
Patchy lamina propria cellularity?, Epithelial changes, Mucosal surface,
Cryptitis extent, Mucin depletion, Cryptitis polymorphs, Lamina propria
granulomas, Crypt abscesses polymorphs, Crypt abscesses extent', 'accuracy':
[0.632, 0.652, 0.832, 0.396, 0.5983935742971888], 'avgAccuracy':
0.6220787148594378, 'f1': [0.6423153515513544, 0.6584654545454545,
0.8354179635134348, 0.36887218045112785, 0.6049488424255745], 'avgF1':
0.6220039584973892, 'precision': [0.632, 0.652, 0.832, 0.396,
0.5983935742971888], 'avgPrecision': 0.6220787148594378, 'recall': [0.632,
0.652, 0.832, 0.396, 0.5983935742971888], 'avgRecall': 0.6220787148594378,
'params': [{'C': 1.0, 'break_ties': False, 'cache_size': 4000, 'class_weight':
None, 'coef0': 0.0, 'decision_function_shape': 'ovr', 'degree': 3, 'gamma':
'scale', 'kernel': 'linear', 'max_iter': -1, 'probability': False,
'random_state': None, 'shrinking': True, 'tol': 0.001, 'verbose': False}]}
****

Processing Model: MLPClassifier
****
* MLPClassifier
* Best Params Result:
* {'classifier': 'MLPClassifier', 'features': 'Active inflammation?, Severity of
Crypt Arch, Increased lamina propria cellularity?, Marked & transmucosal
increase in lamina propria cellularity, Lamina propria polymorphs, Crypt
architecture, Patchy lamina propria cellularity?, Epithelial changes, Mucosal
surface, Cryptitis extent, Mucin depletion, Cryptitis polymorphs, Lamina propria

granulomas, Crypt abscesses polymorphs, Crypt abscesses extent', 'accuracy':
[0.612, 0.656, 0.836, 0.484, 0.6104417670682731], 'avgAccuracy':
0.6396883534136546, 'f1': [0.620382633883019, 0.6627632867767095,
0.8412044639485491, 0.4951482479784367, 0.61294869336687], 'avgF1':
0.6464894651907168, 'precision': [0.612, 0.656, 0.836, 0.484,
0.6104417670682731], 'avgPrecision': 0.6396883534136546, 'recall': [0.612,
0.656, 0.836, 0.484, 0.6104417670682731], 'avgRecall': 0.6396883534136546,
'params': [{'activation': 'identity', 'alpha': 0.0001, 'batch_size': 'auto',
'beta_1': 0.9, 'beta_2': 0.999, 'early_stopping': False, 'epsilon': 1e-08,
'hidden_layer_sizes': (100,), 'learning_rate': 'constant', 'learning_rate_init':
0.001, 'max_fun': 15000, 'max_iter': 5000, 'momentum': 0.9, 'n_iter_no_change':
10, 'nesterovs_momentum': True, 'power_t': 0.5, 'random_state': None, 'shuffle':
True, 'solver': 'adam', 'tol': 0.0001, 'validation_fraction': 0.1, 'verbose':
False, 'warm_start': False}]]
****
****
* Best Performing Model and Params is:
* {'classifier': 'KNeighborsClassifier', 'features': 'Active inflammation?,
Severity of Crypt Arch, Increased lamina propria cellularity?, Marked &
transmucosal increase in lamina propria cellularity, Lamina propria polymorphs,
Crypt architecture, Patchy lamina propria cellularity?, Epithelial changes,
Mucosal surface, Cryptitis extent, Mucin depletion, Cryptitis polymorphs, Lamina
propria granulomas, Crypt abscesses polymorphs, Crypt abscesses extent',
'accuracy': [0.612, 0.668, 0.844, 0.6, 0.6184738955823293], 'avgAccuracy':
0.6684947791164658, 'f1': [0.6224127957619334, 0.679557675739494,
0.8391694809469661, 0.6257347218619131, 0.6284545157849594], 'avgF1':
0.6790658380190532, 'precision': [0.612, 0.668, 0.844, 0.6, 0.6184738955823293],
'avgPrecision': 0.6684947791164658, 'recall': [0.612, 0.668, 0.844, 0.6,
0.6184738955823293], 'avgRecall': 0.6684947791164658, 'params': [{'algorithm':
'brute', 'leaf_size': 30, 'metric': 'minkowski', 'metric_params': None,
'n_jobs': -1, 'n_neighbors': 17, 'p': 2, 'weights': 'distance'}]]
****

```
                 model                                        features  \
0  RandomForestClassifier  Active inflammation?, Severity of Crypt Arch, …
1    KNeighborsClassifier  Active inflammation?, Severity of Crypt Arch, …
2      LogisticRegression  Active inflammation?, Severity of Crypt Arch, …
3              GaussianNB  Active inflammation?, Severity of Crypt Arch, …
4       AdaBoostClassifier  Active inflammation?, Severity of Crypt Arch, …
5  DecisionTreeClassifier  Active inflammation?, Severity of Crypt Arch, …
6                     SVC  Active inflammation?, Severity of Crypt Arch, …
7           MLPClassifier  Active inflammation?, Severity of Crypt Arch, …


   accuracy        f1  precision    recall  \
0  0.670108  0.679138   0.670108  0.670108
1  0.668495  0.679066   0.668495  0.668495
2  0.640488  0.647524   0.640488  0.640488
3  0.630043  0.628021   0.630043  0.630043
```

```
4  0.606018  0.614152   0.606018  0.606018
5  0.665292  0.676178   0.665292  0.665292
6  0.622079  0.622004   0.622079  0.622079
7  0.639688  0.646489   0.639688  0.639688


                                                params
0  {'bootstrap': True, 'ccp_alpha': 0.0, 'class_w…
1  {'algorithm': 'brute', 'leaf_size': 30, 'metri…
2  {'C': 1, 'class_weight': None, 'dual': False, …
3          {'priors': None, 'var_smoothing': 1e-09}
4  {'algorithm': 'SAMME.R', 'base_estimator': Non…
5  {'ccp_alpha': 0.0, 'class_weight': None, 'crit…
6  {'C': 1.0, 'break_ties': False, 'cache_size': …
7  {'activation': 'identity', 'alpha': 0.0001, 'b…
```

Processing Model: RandomForestClassifier
****
* RandomForestClassifier
* Best Params Result:
* {'classifier': 'RandomForestClassifier', 'features': 'Active inflammation?,
Severity of Crypt Arch, Increased lamina propria cellularity?, Marked &
transmucosal increase in lamina propria cellularity, Lamina propria polymorphs,
Crypt architecture, Patchy lamina propria cellularity?, Epithelial changes,
Mucosal surface, Cryptitis extent, Mucin depletion, Cryptitis polymorphs, Lamina
propria granulomas, Crypt abscesses polymorphs', 'accuracy': [0.616, 0.68, 0.84,
0.592, 0.6385542168674698], 'avgAccuracy': 0.673310843373494, 'f1':
[0.6205631670945079, 0.6845738818434891, 0.8419885485205443, 0.6193624406627015,
0.64730661777544496], 'avgF1': 0.6827589311793385, 'precision': [0.616, 0.68,
0.84, 0.592, 0.6385542168674698], 'avgPrecision': 0.673310843373494, 'recall':
[0.616, 0.68, 0.84, 0.592, 0.6385542168674698], 'avgRecall': 0.673310843373494,
'params': [{'bootstrap': True, 'ccp_alpha': 0.0, 'class_weight': None,
'criterion': 'entropy', 'max_depth': None, 'max_features': 'log2',
'max_leaf_nodes': None, 'max_samples': None, 'min_impurity_decrease': 0.0,
'min_impurity_split': None, 'min_samples_leaf': 1, 'min_samples_split': 2,
'min_weight_fraction_leaf': 0.0, 'n_estimators': 700, 'n_jobs': -1, 'oob_score':
False, 'random_state': None, 'verbose': 0, 'warm_start': False}]}
****

Processing Model: KNeighborsClassifier
****
* KNeighborsClassifier
* Best Params Result:
* {'classifier': 'KNeighborsClassifier', 'features': 'Active inflammation?,
Severity of Crypt Arch, Increased lamina propria cellularity?, Marked &
transmucosal increase in lamina propria cellularity, Lamina propria polymorphs,
Crypt architecture, Patchy lamina propria cellularity?, Epithelial changes,
Mucosal surface, Cryptitis extent, Mucin depletion, Cryptitis polymorphs, Lamina
propria granulomas, Crypt abscesses polymorphs', 'accuracy': [0.612, 0.668,

0.844, 0.592, 0.6144578313253012], 'avgAccuracy': 0.6660915662650603, 'f1':
[0.6224127957619334, 0.679557675739494, 0.8391694809469661, 0.6177264573991031,
0.624195853085189], 'avgF1': 0.6766124525865371, 'precision': [0.612, 0.668,
0.844, 0.592, 0.6144578313253012], 'avgPrecision': 0.6660915662650603, 'recall':
[0.612, 0.668, 0.844, 0.592, 0.6144578313253012], 'avgRecall':
0.6660915662650603, 'params': [{'algorithm': 'brute', 'leaf_size': 30, 'metric':
'minkowski', 'metric_params': None, 'n_jobs': -1, 'n_neighbors': 17, 'p': 2,
'weights': 'distance'}]}
****

Processing Model: LogisticRegression
****
* LogisticRegression
* Best Params Result:
* {'classifier': 'LogisticRegression', 'features': 'Active inflammation?,
Severity of Crypt Arch, Increased lamina propria cellularity?, Marked &
transmucosal increase in lamina propria cellularity, Lamina propria polymorphs,
Crypt architecture, Patchy lamina propria cellularity?, Epithelial changes,
Mucosal surface, Cryptitis extent, Mucin depletion, Cryptitis polymorphs, Lamina
propria granulomas, Crypt abscesses polymorphs', 'accuracy': [0.616, 0.66, 0.84,
0.48, 0.6024096385542169], 'avgAccuracy': 0.6396819277108434, 'f1':
[0.6252674096415148, 0.6676229174773445, 0.8433578131374949,
0.48997968855788765, 0.6056336603763478], 'avgF1': 0.6463722978381179,
'precision': [0.616, 0.66, 0.84, 0.48, 0.6024096385542169], 'avgPrecision':
0.6396819277108434, 'recall': [0.616, 0.66, 0.84, 0.48, 0.6024096385542169],
'avgRecall': 0.6396819277108434, 'params': [{'C': 1, 'class_weight': None,
'dual': False, 'fit_intercept': True, 'intercept_scaling': 1, 'l1_ratio': None,
'max_iter': 100, 'multi_class': 'multinomial', 'n_jobs': -1, 'penalty': 'l2',
'random_state': None, 'solver': 'newton-cg', 'tol': 0.0001, 'verbose': 0,
'warm_start': False}]}
****

Processing Model: GaussianNB
****
* GaussianNB
* Best Params Result:
* {'classifier': 'GaussianNB', 'features': 'Active inflammation?, Severity of
Crypt Arch, Increased lamina propria cellularity?, Marked & transmucosal
increase in lamina propria cellularity, Lamina propria polymorphs, Crypt
architecture, Patchy lamina propria cellularity?, Epithelial changes, Mucosal
surface, Cryptitis extent, Mucin depletion, Cryptitis polymorphs, Lamina propria
granulomas, Crypt abscesses polymorphs', 'accuracy': [0.576, 0.652, 0.852,
0.524, 0.5582329317269076], 'avgAccuracy': 0.6324465863453815, 'f1':
[0.5795765279460049, 0.6407739188290086, 0.8462344497607656, 0.528072095268748,
0.5578982494855594], 'avgF1': 0.6305110482580173, 'precision': [0.576, 0.652,
0.852, 0.524, 0.5582329317269076], 'avgPrecision': 0.6324465863453815, 'recall':
[0.576, 0.652, 0.852, 0.524, 0.5582329317269076], 'avgRecall':
0.6324465863453815, 'params': [{'priors': None, 'var_smoothing': 1e-09}]}

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

Processing Model: AdaBoostClassifier
**************************************************
* AdaBoostClassifier
* Best Params Result:
* {'classifier': 'AdaBoostClassifier', 'features': 'Active inflammation?,
Severity of Crypt Arch, Increased lamina propria cellularity?, Marked &
transmucosal increase in lamina propria cellularity, Lamina propria polymorphs,
Crypt architecture, Patchy lamina propria cellularity?, Epithelial changes,
Mucosal surface, Cryptitis extent, Mucin depletion, Cryptitis polymorphs, Lamina
propria granulomas, Crypt abscesses polymorphs', 'accuracy': [0.524, 0.552,
0.776, 0.608, 0.5261044176706827], 'avgAccuracy': 0.5972208835341366, 'f1':
[0.5278327789857201, 0.5656558640168915, 0.7833706037346775, 0.6373379513248795,
0.5261679521816043], 'avgF1': 0.6080730300487546, 'precision': [0.524, 0.552,
0.776, 0.608, 0.5261044176706827], 'avgPrecision': 0.5972208835341366, 'recall':
[0.524, 0.552, 0.776, 0.608, 0.5261044176706827], 'avgRecall':
0.5972208835341366, 'params': [{'algorithm': 'SAMME.R', 'base_estimator': None,
'learning_rate': 1, 'n_estimators': 300, 'random_state': None}]}
**************************************************

Processing Model: DecisionTreeClassifier
**************************************************
* DecisionTreeClassifier
* Best Params Result:
* {'classifier': 'DecisionTreeClassifier', 'features': 'Active inflammation?,
Severity of Crypt Arch, Increased lamina propria cellularity?, Marked &
transmucosal increase in lamina propria cellularity, Lamina propria polymorphs,
Crypt architecture, Patchy lamina propria cellularity?, Epithelial changes,
Mucosal surface, Cryptitis extent, Mucin depletion, Cryptitis polymorphs, Lamina
propria granulomas, Crypt abscesses polymorphs', 'accuracy': [0.616, 0.644,
0.832, 0.58, 0.642570281124498], 'avgAccuracy': 0.6629140562248996, 'f1':
[0.6245493293391482, 0.6506909931379712, 0.8367556813248117, 0.6070654404499506,
0.6531218834241497], 'avgF1': 0.6744366655352063, 'precision': [0.616, 0.644,
0.832, 0.58, 0.642570281124498], 'avgPrecision': 0.6629140562248996, 'recall':
[0.616, 0.644, 0.832, 0.58, 0.642570281124498], 'avgRecall': 0.6629140562248996,
'params': [{'ccp_alpha': 0.0, 'class_weight': None, 'criterion': 'entropy',
'max_depth': None, 'max_features': 'log2', 'max_leaf_nodes': None,
'min_impurity_decrease': 0.0, 'min_impurity_split': None, 'min_samples_leaf': 1,
'min_samples_split': 2, 'min_weight_fraction_leaf': 0.0, 'random_state': None,
'splitter': 'random'}]}
**************************************************

Processing Model: SVC
**************************************************
* SVC
* Best Params Result:
* {'classifier': 'SVC', 'features': 'Active inflammation?, Severity of Crypt
```

Arch, Increased lamina propria cellularity?, Marked & transmucosal increase in lamina propria cellularity, Lamina propria polymorphs, Crypt architecture, Patchy lamina propria cellularity?, Epithelial changes, Mucosal surface, Cryptitis extent, Mucin depletion, Cryptitis polymorphs, Lamina propria granulomas, Crypt abscesses polymorphs', 'accuracy': [0.632, 0.652, 0.832, 0.396, 0.5983935742971888], 'avgAccuracy': 0.6220787148594378, 'f1': [0.6423153515513544, 0.6584654545454545, 0.8354179635134348, 0.36887218045112785, 0.6049488424255745], 'avgF1': 0.6220039584973892, 'precision': [0.632, 0.652, 0.832, 0.396, 0.5983935742971888], 'avgPrecision': 0.6220787148594378, 'recall': [0.632, 0.652, 0.832, 0.396, 0.5983935742971888], 'avgRecall': 0.6220787148594378, 'params': [{'C': 1.0, 'break_ties': False, 'cache_size': 4000, 'class_weight': None, 'coef0': 0.0, 'decision_function_shape': 'ovr', 'degree': 3, 'gamma': 'scale', 'kernel': 'linear', 'max_iter': -1, 'probability': False, 'random_state': None, 'shrinking': True, 'tol': 0.001, 'verbose': False}]}
****

Processing Model: MLPClassifier
****
* MLPClassifier
* Best Params Result:
* {'classifier': 'MLPClassifier', 'features': 'Active inflammation?, Severity of Crypt Arch, Increased lamina propria cellularity?, Marked & transmucosal increase in lamina propria cellularity, Lamina propria polymorphs, Crypt architecture, Patchy lamina propria cellularity?, Epithelial changes, Mucosal surface, Cryptitis extent, Mucin depletion, Cryptitis polymorphs, Lamina propria granulomas, Crypt abscesses polymorphs', 'accuracy': [0.62, 0.66, 0.836, 0.484, 0.606425702811245], 'avgAccuracy': 0.641285140562249, 'f1': [0.6291438991474936, 0.6676229174773445, 0.8401103308404106, 0.4951482479784367, 0.6089492904150334], 'avgF1': 0.6481949371717438, 'precision': [0.62, 0.66, 0.836, 0.484, 0.606425702811245], 'avgPrecision': 0.641285140562249, 'recall': [0.62, 0.66, 0.836, 0.484, 0.606425702811245], 'avgRecall': 0.641285140562249, 'params': [{'activation': 'identity', 'alpha': 0.0001, 'batch_size': 'auto', 'beta_1': 0.9, 'beta_2': 0.999, 'early_stopping': False, 'epsilon': 1e-08, 'hidden_layer_sizes': (100,), 'learning_rate': 'constant', 'learning_rate_init': 0.001, 'max_fun': 15000, 'max_iter': 7000, 'momentum': 0.9, 'n_iter_no_change': 10, 'nesterovs_momentum': True, 'power_t': 0.5, 'random_state': None, 'shuffle': True, 'solver': 'adam', 'tol': 0.0001, 'validation_fraction': 0.1, 'verbose': False, 'warm_start': False}]}
****
****
* Best Performing Model and Params is:
* {'classifier': 'RandomForestClassifier', 'features': 'Active inflammation?, Severity of Crypt Arch, Increased lamina propria cellularity?, Marked & transmucosal increase in lamina propria cellularity, Lamina propria polymorphs, Crypt architecture, Patchy lamina propria cellularity?, Epithelial changes, Mucosal surface, Cryptitis extent, Mucin depletion, Cryptitis polymorphs, Lamina propria granulomas, Crypt abscesses polymorphs', 'accuracy': [0.616, 0.68, 0.84,

```
0.592, 0.6385542168674698], 'avgAccuracy': 0.673310843373494, 'f1':
[0.6205631670945079, 0.6845738818434891, 0.8419885485205443, 0.6193624406627015,
0.6473066177754496], 'avgF1': 0.6827589311793385, 'precision': [0.616, 0.68,
0.84, 0.592, 0.6385542168674698], 'avgPrecision': 0.673310843373494, 'recall':
[0.616, 0.68, 0.84, 0.592, 0.6385542168674698], 'avgRecall': 0.673310843373494,
'params': [{'bootstrap': True, 'ccp_alpha': 0.0, 'class_weight': None,
'criterion': 'entropy', 'max_depth': None, 'max_features': 'log2',
'max_leaf_nodes': None, 'max_samples': None, 'min_impurity_decrease': 0.0,
'min_impurity_split': None, 'min_samples_leaf': 1, 'min_samples_split': 2,
'min_weight_fraction_leaf': 0.0, 'n_estimators': 700, 'n_jobs': -1, 'oob_score':
False, 'random_state': None, 'verbose': 0, 'warm_start': False}]}
*******************************************************

                   model                                     features  \
0  RandomForestClassifier  Active inflammation?, Severity of Crypt Arch, …
1    KNeighborsClassifier  Active inflammation?, Severity of Crypt Arch, …
2      LogisticRegression  Active inflammation?, Severity of Crypt Arch, …
3              GaussianNB  Active inflammation?, Severity of Crypt Arch, …
4       AdaBoostClassifier  Active inflammation?, Severity of Crypt Arch, …
5  DecisionTreeClassifier  Active inflammation?, Severity of Crypt Arch, …
6                     SVC  Active inflammation?, Severity of Crypt Arch, …
7           MLPClassifier  Active inflammation?, Severity of Crypt Arch, …

   accuracy        f1  precision    recall  \
0  0.673311  0.682759   0.673311  0.673311
1  0.666092  0.676612   0.666092  0.666092
2  0.639682  0.646372   0.639682  0.639682
3  0.632447  0.630511   0.632447  0.632447
4  0.597221  0.608073   0.597221  0.597221
5  0.662914  0.674437   0.662914  0.662914
6  0.622079  0.622004   0.622079  0.622079
7  0.641285  0.648195   0.641285  0.641285

                                             params
0  {'bootstrap': True, 'ccp_alpha': 0.0, 'class_w…
1  {'algorithm': 'brute', 'leaf_size': 30, 'metri…
2  {'C': 1, 'class_weight': None, 'dual': False, …
3          {'priors': None, 'var_smoothing': 1e-09}
4  {'algorithm': 'SAMME.R', 'base_estimator': Non…
5  {'ccp_alpha': 0.0, 'class_weight': None, 'crit…
6  {'C': 1.0, 'break_ties': False, 'cache_size': …
7  {'activation': 'identity', 'alpha': 0.0001, 'b…

Processing Model: RandomForestClassifier
*******************************************************
* RandomForestClassifier
* Best Params Result:
* {'classifier': 'RandomForestClassifier', 'features': 'Active inflammation?,
```

Severity of Crypt Arch, Increased lamina propria cellularity?, Marked & transmucosal increase in lamina propria cellularity, Lamina propria polymorphs, Crypt architecture, Patchy lamina propria cellularity?, Epithelial changes, Mucosal surface, Cryptitis extent, Mucin depletion, Cryptitis polymorphs, Lamina propria granulomas', 'accuracy': [0.608, 0.672, 0.856, 0.596, 0.6305220883534136], 'avgAccuracy': 0.6725044176706827, 'f1': [0.6138864562070668, 0.676703791633693, 0.8565242192629947, 0.6223809523809524, 0.6390009010591413], 'avgF1': 0.6816992641087697, 'precision': [0.608, 0.672, 0.856, 0.596, 0.6305220883534136], 'avgPrecision': 0.6725044176706827, 'recall': [0.608, 0.672, 0.856, 0.596, 0.6305220883534136], 'avgRecall': 0.6725044176706827, 'params': [{'bootstrap': True, 'ccp_alpha': 0.0, 'class_weight': None, 'criterion': 'entropy', 'max_depth': None, 'max_features': 'log2', 'max_leaf_nodes': None, 'max_samples': None, 'min_impurity_decrease': 0.0, 'min_impurity_split': None, 'min_samples_leaf': 1, 'min_samples_split': 2, 'min_weight_fraction_leaf': 0.0, 'n_estimators': 200, 'n_jobs': -1, 'oob_score': True, 'random_state': None, 'verbose': 0, 'warm_start': False}]}
****

Processing Model: KNeighborsClassifier
****
* KNeighborsClassifier
* Best Params Result:
* {'classifier': 'KNeighborsClassifier', 'features': 'Active inflammation?, Severity of Crypt Arch, Increased lamina propria cellularity?, Marked & transmucosal increase in lamina propria cellularity, Lamina propria polymorphs, Crypt architecture, Patchy lamina propria cellularity?, Epithelial changes, Mucosal surface, Cryptitis extent, Mucin depletion, Cryptitis polymorphs, Lamina propria granulomas', 'accuracy': [0.6, 0.664, 0.86, 0.616, 0.6104417670682731], 'avgAccuracy': 0.6700883534136546, 'f1': [0.6095793715604474, 0.6764867748864816, 0.8537171717171718, 0.6403484320557491, 0.6198559939586665], 'avgF1': 0.6799975488357033, 'precision': [0.6, 0.664, 0.86, 0.616, 0.6104417670682731], 'avgPrecision': 0.6700883534136546, 'recall': [0.6, 0.664, 0.86, 0.616, 0.6104417670682731], 'avgRecall': 0.6700883534136546, 'params': [{'algorithm': 'brute', 'leaf_size': 30, 'metric': 'minkowski', 'metric_params': None, 'n_jobs': -1, 'n_neighbors': 13, 'p': 2, 'weights': 'distance'}]}
****

Processing Model: LogisticRegression
****
* LogisticRegression
* Best Params Result:
* {'classifier': 'LogisticRegression', 'features': 'Active inflammation?, Severity of Crypt Arch, Increased lamina propria cellularity?, Marked & transmucosal increase in lamina propria cellularity, Lamina propria polymorphs, Crypt architecture, Patchy lamina propria cellularity?, Epithelial changes, Mucosal surface, Cryptitis extent, Mucin depletion, Cryptitis polymorphs, Lamina propria granulomas', 'accuracy': [0.612, 0.664, 0.844, 0.48, 0.6144578313253012], 'avgAccuracy': 0.6428915662650603, 'f1':

[0.6212663067088687, 0.66976704707655, 0.8454720731464918, 0.48997968855788765, 0.6189946459356441], 'avgF1': 0.6490959522850884, 'precision': [0.612, 0.664, 0.844, 0.48, 0.6144578313253012], 'avgPrecision': 0.6428915662650603, 'recall': [0.612, 0.664, 0.844, 0.48, 0.6144578313253012], 'avgRecall': 0.6428915662650603, 'params': [{'C': 1, 'class_weight': None, 'dual': False, 'fit_intercept': True, 'intercept_scaling': 1, 'l1_ratio': None, 'max_iter': 100, 'multi_class': 'ovr', 'n_jobs': -1, 'penalty': 'l2', 'random_state': None, 'solver': 'newton-cg', 'tol': 0.0001, 'verbose': 0, 'warm_start': False}]}
****

Processing Model: GaussianNB
****
* GaussianNB
* Best Params Result:
* {'classifier': 'GaussianNB', 'features': 'Active inflammation?, Severity of Crypt Arch, Increased lamina propria cellularity?, Marked & transmucosal increase in lamina propria cellularity, Lamina propria polymorphs, Crypt architecture, Patchy lamina propria cellularity?, Epithelial changes, Mucosal surface, Cryptitis extent, Mucin depletion, Cryptitis polymorphs, Lamina propria granulomas', 'accuracy': [0.572, 0.656, 0.844, 0.532, 0.570281124497992], 'avgAccuracy': 0.6348562248995984, 'f1': [0.5755399038534448, 0.6449106474050295, 0.8386653198653198, 0.5365620328849028, 0.571529535594491], 'avgF1': 0.6334414879206376, 'precision': [0.572, 0.656, 0.844, 0.532, 0.570281124497992], 'avgPrecision': 0.6348562248995984, 'recall': [0.572, 0.656, 0.844, 0.532, 0.570281124497992], 'avgRecall': 0.6348562248995984, 'params': [{'priors': None, 'var_smoothing': 1e-09}]}
****

Processing Model: AdaBoostClassifier
****
* AdaBoostClassifier
* Best Params Result:
* {'classifier': 'AdaBoostClassifier', 'features': 'Active inflammation?, Severity of Crypt Arch, Increased lamina propria cellularity?, Marked & transmucosal increase in lamina propria cellularity, Lamina propria polymorphs, Crypt architecture, Patchy lamina propria cellularity?, Epithelial changes, Mucosal surface, Cryptitis extent, Mucin depletion, Cryptitis polymorphs, Lamina propria granulomas', 'accuracy': [0.612, 0.656, 0.792, 0.476, 0.41767068273092367], 'avgAccuracy': 0.5907341365461848, 'f1': [0.6100859456065563, 0.6563990440497984, 0.7996004458630999, 0.4847619047619048, 0.37171548087010137], 'avgF1': 0.5845125642302922, 'precision': [0.612, 0.656, 0.792, 0.476, 0.41767068273092367], 'avgPrecision': 0.5907341365461848, 'recall': [0.612, 0.656, 0.792, 0.476, 0.41767068273092367], 'avgRecall': 0.5907341365461848, 'params': [{'algorithm': 'SAMME.R', 'base_estimator': None, 'learning_rate': 1, 'n_estimators': 20, 'random_state': None}]}
****

Processing Model: DecisionTreeClassifier

```
********************************************************
* DecisionTreeClassifier
* Best Params Result:
* {'classifier': 'DecisionTreeClassifier', 'features': 'Active inflammation?,
Severity of Crypt Arch, Increased lamina propria cellularity?, Marked &
transmucosal increase in lamina propria cellularity, Lamina propria polymorphs,
Crypt architecture, Patchy lamina propria cellularity?, Epithelial changes,
Mucosal surface, Cryptitis extent, Mucin depletion, Cryptitis polymorphs, Lamina
propria granulomas', 'accuracy': [0.592, 0.648, 0.832, 0.576,
0.6345381526104418], 'avgAccuracy': 0.6565076305220884, 'f1':
[0.5971841477965231, 0.657462304972915, 0.8354992092235188, 0.6018844984802431,
0.6447271846004708], 'avgF1': 0.6673514690147342, 'precision': [0.592, 0.648,
0.832, 0.576, 0.6345381526104418], 'avgPrecision': 0.6565076305220884, 'recall':
[0.592, 0.648, 0.832, 0.576, 0.6345381526104418], 'avgRecall':
0.6565076305220884, 'params': [{'ccp_alpha': 0.0, 'class_weight': None,
'criterion': 'entropy', 'max_depth': None, 'max_features': 'log2',
'max_leaf_nodes': None, 'min_impurity_decrease': 0.0, 'min_impurity_split':
None, 'min_samples_leaf': 1, 'min_samples_split': 2, 'min_weight_fraction_leaf':
0.0, 'random_state': None, 'splitter': 'best'}]}
********************************************************

Processing Model: SVC
********************************************************
* SVC
* Best Params Result:
* {'classifier': 'SVC', 'features': 'Active inflammation?, Severity of Crypt
Arch, Increased lamina propria cellularity?, Marked & transmucosal increase in
lamina propria cellularity, Lamina propria polymorphs, Crypt architecture,
Patchy lamina propria cellularity?, Epithelial changes, Mucosal surface,
Cryptitis extent, Mucin depletion, Cryptitis polymorphs, Lamina propria
granulomas', 'accuracy': [0.632, 0.652, 0.832, 0.396, 0.5983935742971888],
'avgAccuracy': 0.6220787148594378, 'f1': [0.6423153515513544,
0.6584654545454545, 0.8354179635134348, 0.36887218045112785,
0.6049488424255745], 'avgF1': 0.6220039584973892, 'precision': [0.632, 0.652,
0.832, 0.396, 0.5983935742971888], 'avgPrecision': 0.6220787148594378, 'recall':
[0.632, 0.652, 0.832, 0.396, 0.5983935742971888], 'avgRecall':
0.6220787148594378, 'params': [{'C': 1.0, 'break_ties': False, 'cache_size':
4000, 'class_weight': None, 'coef0': 0.0, 'decision_function_shape': 'ovr',
'degree': 3, 'gamma': 'scale', 'kernel': 'linear', 'max_iter': -1,
'probability': False, 'random_state': None, 'shrinking': True, 'tol': 0.001,
'verbose': False}]}
********************************************************

Processing Model: MLPClassifier
********************************************************
* MLPClassifier
* Best Params Result:
* {'classifier': 'MLPClassifier', 'features': 'Active inflammation?, Severity of
```

Crypt Arch, Increased lamina propria cellularity?, Marked & transmucosal
increase in lamina propria cellularity, Lamina propria polymorphs, Crypt
architecture, Patchy lamina propria cellularity?, Epithelial changes, Mucosal
surface, Cryptitis extent, Mucin depletion, Cryptitis polymorphs, Lamina propria
granulomas', 'accuracy': [0.62, 0.664, 0.84, 0.488, 0.6184738955823293],
'avgAccuracy': 0.6460947791164658, 'f1': [0.629831836734694, 0.66976704707655,
0.8434369720494228, 0.5002682763246143, 0.6254514960133911], 'avgF1':
0.6537511256397345, 'precision': [0.62, 0.664, 0.84, 0.488, 0.6184738955823293],
'avgPrecision': 0.6460947791164658, 'recall': [0.62, 0.664, 0.84, 0.488,
0.6184738955823293], 'avgRecall': 0.6460947791164658, 'params': [{'activation':
'logistic', 'alpha': 0.0001, 'batch_size': 'auto', 'beta_1': 0.9, 'beta_2':
0.999, 'early_stopping': False, 'epsilon': 1e-08, 'hidden_layer_sizes': (100,),
'learning_rate': 'adaptive', 'learning_rate_init': 0.001, 'max_fun': 15000,
'max_iter': 7000, 'momentum': 0.9, 'n_iter_no_change': 10, 'nesterovs_momentum':
True, 'power_t': 0.5, 'random_state': None, 'shuffle': True, 'solver': 'adam',
'tol': 0.0001, 'validation_fraction': 0.1, 'verbose': False, 'warm_start':
False}]}
****
****
* Best Performing Model and Params is:
* {'classifier': 'RandomForestClassifier', 'features': 'Active inflammation?,
Severity of Crypt Arch, Increased lamina propria cellularity?, Marked &
transmucosal increase in lamina propria cellularity, Lamina propria polymorphs,
Crypt architecture, Patchy lamina propria cellularity?, Epithelial changes,
Mucosal surface, Cryptitis extent, Mucin depletion, Cryptitis polymorphs, Lamina
propria granulomas', 'accuracy': [0.608, 0.672, 0.856, 0.596,
0.6305220883534136], 'avgAccuracy': 0.6725044176706827, 'f1':
[0.6138864562070668, 0.676703791633693, 0.8565242192629947, 0.6223809523809524,
0.6390009010591413], 'avgF1': 0.6816992641087697, 'precision': [0.608, 0.672,
0.856, 0.596, 0.6305220883534136], 'avgPrecision': 0.6725044176706827, 'recall':
[0.608, 0.672, 0.856, 0.596, 0.6305220883534136], 'avgRecall':
0.6725044176706827, 'params': [{'bootstrap': True, 'ccp_alpha': 0.0,
'class_weight': None, 'criterion': 'entropy', 'max_depth': None, 'max_features':
'log2', 'max_leaf_nodes': None, 'max_samples': None, 'min_impurity_decrease':
0.0, 'min_impurity_split': None, 'min_samples_leaf': 1, 'min_samples_split': 2,
'min_weight_fraction_leaf': 0.0, 'n_estimators': 200, 'n_jobs': -1, 'oob_score':
True, 'random_state': None, 'verbose': 0, 'warm_start': False}]}
****

```
                 model                                        features  \
0  RandomForestClassifier  Active inflammation?, Severity of Crypt Arch, …
1     KNeighborsClassifier  Active inflammation?, Severity of Crypt Arch, …
2       LogisticRegression  Active inflammation?, Severity of Crypt Arch, …
3               GaussianNB  Active inflammation?, Severity of Crypt Arch, …
4       AdaBoostClassifier  Active inflammation?, Severity of Crypt Arch, …
5   DecisionTreeClassifier  Active inflammation?, Severity of Crypt Arch, …
6                      SVC  Active inflammation?, Severity of Crypt Arch, …
7            MLPClassifier  Active inflammation?, Severity of Crypt Arch, …
```

```
     accuracy         f1  precision    recall  \
0    0.672504   0.681699   0.672504  0.672504
1    0.670088   0.679998   0.670088  0.670088
2    0.642892   0.649096   0.642892  0.642892
3    0.634856   0.633441   0.634856  0.634856
4    0.590734   0.584513   0.590734  0.590734
5    0.656508   0.667351   0.656508  0.656508
6    0.622079   0.622004   0.622079  0.622079
7    0.646095   0.653751   0.646095  0.646095


                                                 params
0  {'bootstrap': True, 'ccp_alpha': 0.0, 'class_w…
1  {'algorithm': 'brute', 'leaf_size': 30, 'metri…
2  {'C': 1, 'class_weight': None, 'dual': False, …
3           {'priors': None, 'var_smoothing': 1e-09}
4  {'algorithm': 'SAMME.R', 'base_estimator': Non…
5  {'ccp_alpha': 0.0, 'class_weight': None, 'crit…
6  {'C': 1.0, 'break_ties': False, 'cache_size': …
7  {'activation': 'logistic', 'alpha': 0.0001, 'b…
```

Processing Model: RandomForestClassifier
****
* RandomForestClassifier
* Best Params Result:
* {'classifier': 'RandomForestClassifier', 'features': 'Active inflammation?,
Severity of Crypt Arch, Increased lamina propria cellularity?, Marked &
transmucosal increase in lamina propria cellularity, Lamina propria polymorphs,
Crypt architecture, Patchy lamina propria cellularity?, Epithelial changes,
Mucosal surface, Cryptitis extent, Mucin depletion, Cryptitis polymorphs',
'accuracy': [0.62, 0.648, 0.844, 0.616, 0.6184738955823293], 'avgAccuracy':
0.6692947791164658, 'f1': [0.6266970192904935, 0.6539884799951635,
0.845195714375976, 0.6420408163265307, 0.6238514586547004], 'avgF1':
0.6783546977285728, 'precision': [0.62, 0.648, 0.844, 0.616,
0.6184738955823293], 'avgPrecision': 0.6692947791164658, 'recall': [0.62, 0.648,
0.844, 0.616, 0.6184738955823293], 'avgRecall': 0.6692947791164658, 'params':
[{'bootstrap': True, 'ccp_alpha': 0.0, 'class_weight': None, 'criterion':
'gini', 'max_depth': None, 'max_features': 'sqrt', 'max_leaf_nodes': None,
'max_samples': None, 'min_impurity_decrease': 0.0, 'min_impurity_split': None,
'min_samples_leaf': 1, 'min_samples_split': 2, 'min_weight_fraction_leaf': 0.0,
'n_estimators': 700, 'n_jobs': -1, 'oob_score': False, 'random_state': None,
'verbose': 0, 'warm_start': False}]}
****

Processing Model: KNeighborsClassifier
****
* KNeighborsClassifier
* Best Params Result:

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```
* {'classifier': 'KNeighborsClassifier', 'features': 'Active inflammation?,
Severity of Crypt Arch, Increased lamina propria cellularity?, Marked &
transmucosal increase in lamina propria cellularity, Lamina propria polymorphs,
Crypt architecture, Patchy lamina propria cellularity?, Epithelial changes,
Mucosal surface, Cryptitis extent, Mucin depletion, Cryptitis polymorphs',
'accuracy': [0.588, 0.644, 0.848, 0.628, 0.5943775100401606], 'avgAccuracy':
0.6604755020080321, 'f1': [0.5967520020048303, 0.6569827251885728,
0.8424628001967451, 0.6517383820998278, 0.6030160983637309], 'avgF1':
0.6701904015707414, 'precision': [0.588, 0.644, 0.848, 0.628,
0.5943775100401606], 'avgPrecision': 0.6604755020080321, 'recall': [0.588,
0.644, 0.848, 0.628, 0.5943775100401606], 'avgRecall': 0.6604755020080321,
'params': [{'algorithm': 'brute', 'leaf_size': 30, 'metric': 'minkowski',
'metric_params': None, 'n_jobs': -1, 'n_neighbors': 13, 'p': 2, 'weights':
'distance'}]}
******************************************************

Processing Model: LogisticRegression
******************************************************
* LogisticRegression
* Best Params Result:
* {'classifier': 'LogisticRegression', 'features': 'Active inflammation?,
Severity of Crypt Arch, Increased lamina propria cellularity?, Marked &
transmucosal increase in lamina propria cellularity, Lamina propria polymorphs,
Crypt architecture, Patchy lamina propria cellularity?, Epithelial changes,
Mucosal surface, Cryptitis extent, Mucin depletion, Cryptitis polymorphs',
'accuracy': [0.612, 0.632, 0.836, 0.44, 0.5983935742971888], 'avgAccuracy':
0.6236787148594377, 'f1': [0.6221579731743667, 0.6435840421350142,
0.8399180901420046, 0.4354655294953802, 0.6028176493607932], 'avgF1':
0.6287886568615118, 'precision': [0.612, 0.632, 0.836, 0.44,
0.5983935742971888], 'avgPrecision': 0.6236787148594377, 'recall': [0.612,
0.632, 0.836, 0.44, 0.5983935742971888], 'avgRecall': 0.6236787148594377,
'params': [{'C': 1, 'class_weight': None, 'dual': False, 'fit_intercept': True,
'intercept_scaling': 1, 'l1_ratio': None, 'max_iter': 100, 'multi_class':
'multinomial', 'n_jobs': -1, 'penalty': 'l2', 'random_state': None, 'solver':
'newton-cg', 'tol': 0.0001, 'verbose': 0, 'warm_start': False}]}
******************************************************

Processing Model: GaussianNB
******************************************************
* GaussianNB
* Best Params Result:
* {'classifier': 'GaussianNB', 'features': 'Active inflammation?, Severity of
Crypt Arch, Increased lamina propria cellularity?, Marked & transmucosal
increase in lamina propria cellularity, Lamina propria polymorphs, Crypt
architecture, Patchy lamina propria cellularity?, Epithelial changes, Mucosal
surface, Cryptitis extent, Mucin depletion, Cryptitis polymorphs', 'accuracy':
[0.58, 0.64, 0.836, 0.528, 0.5301204819277109], 'avgAccuracy':
0.6228240963855421, 'f1': [0.5857504766415534, 0.6331520065987755,
```

0.8313846153846154, 0.5318918918918919, 0.5287786686779605], 'avgF1':
0.6221915318389594, 'precision': [0.58, 0.64, 0.836, 0.528, 0.5301204819277109],
'avgPrecision': 0.6228240963855421, 'recall': [0.58, 0.64, 0.836, 0.528,
0.5301204819277109], 'avgRecall': 0.6228240963855421, 'params': [{'priors':
None, 'var_smoothing': 1e-09}]}
****

Processing Model: AdaBoostClassifier
****
* AdaBoostClassifier
* Best Params Result:
* {'classifier': 'AdaBoostClassifier', 'features': 'Active inflammation?,
Severity of Crypt Arch, Increased lamina propria cellularity?, Marked &
transmucosal increase in lamina propria cellularity, Lamina propria polymorphs,
Crypt architecture, Patchy lamina propria cellularity?, Epithelial changes,
Mucosal surface, Cryptitis extent, Mucin depletion, Cryptitis polymorphs',
'accuracy': [0.608, 0.572, 0.792, 0.572, 0.41767068273092367], 'avgAccuracy':
0.5923341365461847, 'f1': [0.6109085850901976, 0.5866970317391823,
0.7978368619309906, 0.5976800976800977, 0.3684754613957759], 'avgF1':
0.5923196075672488, 'precision': [0.608, 0.572, 0.792, 0.572,
0.41767068273092367], 'avgPrecision': 0.5923341365461847, 'recall': [0.608,
0.572, 0.792, 0.572, 0.41767068273092367], 'avgRecall': 0.5923341365461847,
'params': [{'algorithm': 'SAMME.R', 'base_estimator': None, 'learning_rate': 1,
'n_estimators': 100, 'random_state': None}]}
****

Processing Model: DecisionTreeClassifier
****
* DecisionTreeClassifier
* Best Params Result:
* {'classifier': 'DecisionTreeClassifier', 'features': 'Active inflammation?,
Severity of Crypt Arch, Increased lamina propria cellularity?, Marked &
transmucosal increase in lamina propria cellularity, Lamina propria polymorphs,
Crypt architecture, Patchy lamina propria cellularity?, Epithelial changes,
Mucosal surface, Cryptitis extent, Mucin depletion, Cryptitis polymorphs',
'accuracy': [0.568, 0.624, 0.824, 0.62, 0.6224899598393574], 'avgAccuracy':
0.6516979919678715, 'f1': [0.5734366616989569, 0.6330195593879804,
0.829951117589893, 0.645876887340302, 0.6320823835884077], 'avgF1':
0.662873321921108, 'precision': [0.568, 0.624, 0.824, 0.62, 0.6224899598393574],
'avgPrecision': 0.6516979919678715, 'recall': [0.568, 0.624, 0.824, 0.62,
0.6224899598393574], 'avgRecall': 0.6516979919678715, 'params': [{'ccp_alpha':
0.0, 'class_weight': None, 'criterion': 'gini', 'max_depth': None,
'max_features': 'log2', 'max_leaf_nodes': None, 'min_impurity_decrease': 0.0,
'min_impurity_split': None, 'min_samples_leaf': 1, 'min_samples_split': 2,
'min_weight_fraction_leaf': 0.0, 'random_state': None, 'splitter': 'best'}]}
****

Processing Model: SVC

```
*****************************************************
* SVC
* Best Params Result:
* {'classifier': 'SVC', 'features': 'Active inflammation?, Severity of Crypt
Arch, Increased lamina propria cellularity?, Marked & transmucosal increase in
lamina propria cellularity, Lamina propria polymorphs, Crypt architecture,
Patchy lamina propria cellularity?, Epithelial changes, Mucosal surface,
Cryptitis extent, Mucin depletion, Cryptitis polymorphs', 'accuracy': [0.604,
0.62, 0.82, 0.316, 0.5742971887550201], 'avgAccuracy': 0.586859437751004, 'f1':
[0.6140264987537717, 0.6331286782757636, 0.8251004399748585,
0.22571428571428573, 0.5783146735895534], 'avgF1': 0.5752569152616466,
'precision': [0.604, 0.62, 0.82, 0.316, 0.5742971887550201], 'avgPrecision':
0.586859437751004, 'recall': [0.604, 0.62, 0.82, 0.316, 0.5742971887550201],
'avgRecall': 0.586859437751004, 'params': [{'C': 1.0, 'break_ties': False,
'cache_size': 4000, 'class_weight': None, 'coef0': 0.0,
'decision_function_shape': 'ovr', 'degree': 3, 'gamma': 'scale', 'kernel':
'linear', 'max_iter': -1, 'probability': False, 'random_state': None,
'shrinking': True, 'tol': 0.001, 'verbose': False}]}
*****************************************************

Processing Model: MLPClassifier
*****************************************************
* MLPClassifier
* Best Params Result:
* {'classifier': 'MLPClassifier', 'features': 'Active inflammation?, Severity of
Crypt Arch, Increased lamina propria cellularity?, Marked & transmucosal
increase in lamina propria cellularity, Lamina propria polymorphs, Crypt
architecture, Patchy lamina propria cellularity?, Epithelial changes, Mucosal
surface, Cryptitis extent, Mucin depletion, Cryptitis polymorphs', 'accuracy':
[0.608, 0.644, 0.832, 0.452, 0.5983935742971888], 'avgAccuracy':
0.6268787148594377, 'f1': [0.6186953430142244, 0.6521821246685654,
0.8377590540978296, 0.4523809523809524, 0.6049488424255745], 'avgF1':
0.6331932633174292, 'precision': [0.608, 0.644, 0.832, 0.452,
0.5983935742971888], 'avgPrecision': 0.6268787148594377, 'recall': [0.608,
0.644, 0.832, 0.452, 0.5983935742971888], 'avgRecall': 0.6268787148594377,
'params': [{'activation': 'identity', 'alpha': 0.0001, 'batch_size': 'auto',
'beta_1': 0.9, 'beta_2': 0.999, 'early_stopping': False, 'epsilon': 1e-08,
'hidden_layer_sizes': (100,), 'learning_rate': 'adaptive', 'learning_rate_init':
0.001, 'max_fun': 15000, 'max_iter': 5000, 'momentum': 0.9, 'n_iter_no_change':
10, 'nesterovs_momentum': True, 'power_t': 0.5, 'random_state': None, 'shuffle':
True, 'solver': 'adam', 'tol': 0.0001, 'validation_fraction': 0.1, 'verbose':
False, 'warm_start': False}]}
*****************************************************
*****************************************************
* Best Performing Model and Params is:
* {'classifier': 'KNeighborsClassifier', 'features': 'Active inflammation?,
Severity of Crypt Arch, Increased lamina propria cellularity?, Marked &
transmucosal increase in lamina propria cellularity, Lamina propria polymorphs,
```

Crypt architecture, Patchy lamina propria cellularity?, Epithelial changes,
Mucosal surface, Cryptitis extent, Mucin depletion, Cryptitis polymorphs',
'accuracy': [0.588, 0.644, 0.848, 0.628, 0.5943775100401606], 'avgAccuracy':
0.6604755020080321, 'f1': [0.5967520020048303, 0.6569827251885728,
0.8424628001967451, 0.6517383820998278, 0.6030160983637309], 'avgF1':
0.6701904015707414, 'precision': [0.588, 0.644, 0.848, 0.628,
0.5943775100401606], 'avgPrecision': 0.6604755020080321, 'recall': [0.588,
0.644, 0.848, 0.628, 0.5943775100401606], 'avgRecall': 0.6604755020080321,
'params': [{'algorithm': 'brute', 'leaf_size': 30, 'metric': 'minkowski',
'metric_params': None, 'n_jobs': -1, 'n_neighbors': 13, 'p': 2, 'weights':
'distance'}]}
****

```
                    model                                features  \
0  RandomForestClassifier  Active inflammation?, Severity of Crypt Arch, …
1    KNeighborsClassifier  Active inflammation?, Severity of Crypt Arch, …
2      LogisticRegression  Active inflammation?, Severity of Crypt Arch, …
3              GaussianNB  Active inflammation?, Severity of Crypt Arch, …
4       AdaBoostClassifier  Active inflammation?, Severity of Crypt Arch, …
5  DecisionTreeClassifier  Active inflammation?, Severity of Crypt Arch, …
6                     SVC  Active inflammation?, Severity of Crypt Arch, …
7           MLPClassifier  Active inflammation?, Severity of Crypt Arch, …

   accuracy        f1  precision    recall  \
0  0.669295  0.678355   0.669295  0.669295
1  0.660476  0.670190   0.660476  0.660476
2  0.623679  0.628789   0.623679  0.623679
3  0.622824  0.622192   0.622824  0.622824
4  0.592334  0.592320   0.592334  0.592334
5  0.651698  0.662873   0.651698  0.651698
6  0.586859  0.575257   0.586859  0.586859
7  0.626879  0.633193   0.626879  0.626879

                                             params
0  {'bootstrap': True, 'ccp_alpha': 0.0, 'class_w…
1  {'algorithm': 'brute', 'leaf_size': 30, 'metri…
2  {'C': 1, 'class_weight': None, 'dual': False, …
3          {'priors': None, 'var_smoothing': 1e-09}
4  {'algorithm': 'SAMME.R', 'base_estimator': Non…
5  {'ccp_alpha': 0.0, 'class_weight': None, 'crit…
6  {'C': 1.0, 'break_ties': False, 'cache_size': …
7  {'activation': 'identity', 'alpha': 0.0001, 'b…
```

Processing Model: RandomForestClassifier
****
* RandomForestClassifier
* Best Params Result:
* {'classifier': 'RandomForestClassifier', 'features': 'Active inflammation?,

Severity of Crypt Arch, Increased lamina propria cellularity?, Marked &
transmucosal increase in lamina propria cellularity, Lamina propria polymorphs,
Crypt architecture, Patchy lamina propria cellularity?, Epithelial changes,
Mucosal surface, Cryptitis extent, Mucin depletion', 'accuracy': [0.62, 0.668,
0.852, 0.616, 0.6224899598393574], 'avgAccuracy': 0.6756979919678715, 'f1':
[0.6256181504502163, 0.6744771553557324, 0.8515502386708323, 0.6420408163265307,
0.6279443109770415], 'avgF1': 0.6843261343560706, 'precision': [0.62, 0.668,
0.852, 0.616, 0.6224899598393574], 'avgPrecision': 0.6756979919678715, 'recall':
[0.62, 0.668, 0.852, 0.616, 0.6224899598393574], 'avgRecall':
0.6756979919678715, 'params': [{'bootstrap': True, 'ccp_alpha': 0.0,
'class_weight': None, 'criterion': 'gini', 'max_depth': None, 'max_features':
'sqrt', 'max_leaf_nodes': None, 'max_samples': None, 'min_impurity_decrease':
0.0, 'min_impurity_split': None, 'min_samples_leaf': 1, 'min_samples_split': 2,
'min_weight_fraction_leaf': 0.0, 'n_estimators': 500, 'n_jobs': -1, 'oob_score':
False, 'random_state': None, 'verbose': 0, 'warm_start': False}]}
****

Processing Model: KNeighborsClassifier
****
* KNeighborsClassifier
* Best Params Result:
* {'classifier': 'KNeighborsClassifier', 'features': 'Active inflammation?,
Severity of Crypt Arch, Increased lamina propria cellularity?, Marked &
transmucosal increase in lamina propria cellularity, Lamina propria polymorphs,
Crypt architecture, Patchy lamina propria cellularity?, Epithelial changes,
Mucosal surface, Cryptitis extent, Mucin depletion', 'accuracy': [0.596, 0.644,
0.844, 0.624, 0.5903614457831325], 'avgAccuracy': 0.6596722891566265, 'f1':
[0.6049698497038422, 0.655420190176696, 0.8405084165750609, 0.6479723502304148,
0.5977698673481806], 'avgF1': 0.6693281348068388, 'precision': [0.596, 0.644,
0.844, 0.624, 0.5903614457831325], 'avgPrecision': 0.6596722891566265, 'recall':
[0.596, 0.644, 0.844, 0.624, 0.5903614457831325], 'avgRecall':
0.6596722891566265, 'params': [{'algorithm': 'brute', 'leaf_size': 30, 'metric':
'minkowski', 'metric_params': None, 'n_jobs': -1, 'n_neighbors': 16, 'p': 2,
'weights': 'distance'}]}
****

Processing Model: LogisticRegression
****
* LogisticRegression
* Best Params Result:
* {'classifier': 'LogisticRegression', 'features': 'Active inflammation?,
Severity of Crypt Arch, Increased lamina propria cellularity?, Marked &
transmucosal increase in lamina propria cellularity, Lamina propria polymorphs,
Crypt architecture, Patchy lamina propria cellularity?, Epithelial changes,
Mucosal surface, Cryptitis extent, Mucin depletion', 'accuracy': [0.628, 0.66,
0.832, 0.44, 0.5983935742971888], 'avgAccuracy': 0.6316787148594377, 'f1':
[0.6390610785988635, 0.6720621284755512, 0.8364503171247357, 0.4354655294953802,
0.6028176493607932], 'avgF1': 0.6371713406110647, 'precision': [0.628, 0.66,

0.832, 0.44, 0.5983935742971888], 'avgPrecision': 0.6316787148594377, 'recall':
[0.628, 0.66, 0.832, 0.44, 0.5983935742971888], 'avgRecall': 0.6316787148594377,
'params': [{'C': 1, 'class_weight': None, 'dual': False, 'fit_intercept': True,
'intercept_scaling': 1, 'l1_ratio': None, 'max_iter': 100, 'multi_class':
'multinomial', 'n_jobs': -1, 'penalty': 'l2', 'random_state': None, 'solver':
'newton-cg', 'tol': 0.0001, 'verbose': 0, 'warm_start': False}]}
****

Processing Model: GaussianNB
****
* GaussianNB
* Best Params Result:
* {'classifier': 'GaussianNB', 'features': 'Active inflammation?, Severity of
Crypt Arch, Increased lamina propria cellularity?, Marked & transmucosal
increase in lamina propria cellularity, Lamina propria polymorphs, Crypt
architecture, Patchy lamina propria cellularity?, Epithelial changes, Mucosal
surface, Cryptitis extent, Mucin depletion', 'accuracy': [0.58, 0.644, 0.836,
0.528, 0.5341365461847389], 'avgAccuracy': 0.6244273092369478, 'f1':
[0.5857504766415534, 0.63451966873706, 0.8313846153846154, 0.5318918918918919,
0.534479981451725], 'avgF1': 0.6236053268213692, 'precision': [0.58, 0.644,
0.836, 0.528, 0.5341365461847389], 'avgPrecision': 0.6244273092369478, 'recall':
[0.58, 0.644, 0.836, 0.528, 0.5341365461847389], 'avgRecall':
0.6244273092369478, 'params': [{'priors': None, 'var_smoothing': 1e-09}]}
****

Processing Model: AdaBoostClassifier
****
* AdaBoostClassifier
* Best Params Result:
* {'classifier': 'AdaBoostClassifier', 'features': 'Active inflammation?,
Severity of Crypt Arch, Increased lamina propria cellularity?, Marked &
transmucosal increase in lamina propria cellularity, Lamina propria polymorphs,
Crypt architecture, Patchy lamina propria cellularity?, Epithelial changes,
Mucosal surface, Cryptitis extent, Mucin depletion', 'accuracy': [0.608, 0.504,
0.788, 0.56, 0.4538152610441767], 'avgAccuracy': 0.5827630522088354, 'f1':
[0.6027129319673541, 0.5141738814280947, 0.7956044296788483, 0.5848484848484848,
0.432697296941119], 'avgF1': 0.5860074049727801, 'precision': [0.608, 0.504,
0.788, 0.56, 0.4538152610441767], 'avgPrecision': 0.5827630522088354, 'recall':
[0.608, 0.504, 0.788, 0.56, 0.4538152610441767], 'avgRecall':
0.5827630522088354, 'params': [{'algorithm': 'SAMME.R', 'base_estimator': None,
'learning_rate': 1, 'n_estimators': 20, 'random_state': None}]}
****

Processing Model: DecisionTreeClassifier
****
* DecisionTreeClassifier
* Best Params Result:
* {'classifier': 'DecisionTreeClassifier', 'features': 'Active inflammation?,

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Severity of Crypt Arch, Increased lamina propria cellularity?, Marked &
transmucosal increase in lamina propria cellularity, Lamina propria polymorphs,
Crypt architecture, Patchy lamina propria cellularity?, Epithelial changes,
Mucosal surface, Cryptitis extent, Mucin depletion', 'accuracy': [0.596, 0.64,
0.828, 0.612, 0.6224899598393574], 'avgAccuracy': 0.6596979919678715, 'f1':
[0.6000196307120554, 0.6455423788160078, 0.8333701920257817, 0.6381733021077284,
0.6314165664615409], 'avgF1': 0.6697044140246229, 'precision': [0.596, 0.64,
0.828, 0.612, 0.6224899598393574], 'avgPrecision': 0.6596979919678715, 'recall':
[0.596, 0.64, 0.828, 0.612, 0.6224899598393574], 'avgRecall':
0.6596979919678715, 'params': [{'ccp_alpha': 0.0, 'class_weight': None,
'criterion': 'entropy', 'max_depth': None, 'max_features': 'log2',
'max_leaf_nodes': None, 'min_impurity_decrease': 0.0, 'min_impurity_split':
None, 'min_samples_leaf': 1, 'min_samples_split': 2, 'min_weight_fraction_leaf':
0.0, 'random_state': None, 'splitter': 'random'}]}
****

Processing Model: SVC
****
* SVC
* Best Params Result:
* {'classifier': 'SVC', 'features': 'Active inflammation?, Severity of Crypt
Arch, Increased lamina propria cellularity?, Marked & transmucosal increase in
lamina propria cellularity, Lamina propria polymorphs, Crypt architecture,
Patchy lamina propria cellularity?, Epithelial changes, Mucosal surface,
Cryptitis extent, Mucin depletion', 'accuracy': [0.616, 0.62, 0.82, 0.316,
0.5742971887550201], 'avgAccuracy': 0.589259437751004, 'f1':
[0.6268723980546203, 0.6346193243243243, 0.8251004399748585,
0.22571428571428573, 0.5749972353714392], 'avgF1': 0.5774607366879057,
'precision': [0.616, 0.62, 0.82, 0.316, 0.5742971887550201], 'avgPrecision':
0.589259437751004, 'recall': [0.616, 0.62, 0.82, 0.316, 0.5742971887550201],
'avgRecall': 0.589259437751004, 'params': [{'C': 1.0, 'break_ties': False,
'cache_size': 4000, 'class_weight': None, 'coef0': 0.0,
'decision_function_shape': 'ovr', 'degree': 3, 'gamma': 'scale', 'kernel':
'linear', 'max_iter': -1, 'probability': False, 'random_state': None,
'shrinking': True, 'tol': 0.001, 'verbose': False}]}
****

Processing Model: MLPClassifier
****
* MLPClassifier
* Best Params Result:
* {'classifier': 'MLPClassifier', 'features': 'Active inflammation?, Severity of
Crypt Arch, Increased lamina propria cellularity?, Marked & transmucosal
increase in lamina propria cellularity, Lamina propria polymorphs, Crypt
architecture, Patchy lamina propria cellularity?, Epithelial changes, Mucosal
surface, Cryptitis extent, Mucin depletion', 'accuracy': [0.62, 0.66, 0.836,
0.456, 0.5943775100401606], 'avgAccuracy': 0.6332755020080321, 'f1':
[0.6309448584202683, 0.6720621284755512, 0.8412044639485491,

0.45790940766550525, 0.5987565381483], 'avgF1': 0.6401754793316348, 'precision':
[0.62, 0.66, 0.836, 0.456, 0.5943775100401606], 'avgPrecision':
0.6332755020080321, 'recall': [0.62, 0.66, 0.836, 0.456, 0.5943775100401606],
'avgRecall': 0.6332755020080321, 'params': [{'activation': 'identity', 'alpha':
0.0001, 'batch_size': 'auto', 'beta_1': 0.9, 'beta_2': 0.999, 'early_stopping':
False, 'epsilon': 1e-08, 'hidden_layer_sizes': (100,), 'learning_rate':
'invscaling', 'learning_rate_init': 0.001, 'max_fun': 15000, 'max_iter': 7000,
'momentum': 0.9, 'n_iter_no_change': 10, 'nesterovs_momentum': True, 'power_t':
0.5, 'random_state': None, 'shuffle': True, 'solver': 'adam', 'tol': 0.0001,
'validation_fraction': 0.1, 'verbose': False, 'warm_start': False}]}
****
****
* Best Performing Model and Params is:
* {'classifier': 'RandomForestClassifier', 'features': 'Active inflammation?,
Severity of Crypt Arch, Increased lamina propria cellularity?, Marked &
transmucosal increase in lamina propria cellularity, Lamina propria polymorphs,
Crypt architecture, Patchy lamina propria cellularity?, Epithelial changes,
Mucosal surface, Cryptitis extent, Mucin depletion', 'accuracy': [0.62, 0.668,
0.852, 0.616, 0.6224899598393574], 'avgAccuracy': 0.6756979919678715, 'f1':
[0.6256181504502163, 0.6744771553557324, 0.8515502386708323, 0.6420408163265307,
0.6279443109770415], 'avgF1': 0.6843261343560706, 'precision': [0.62, 0.668,
0.852, 0.616, 0.6224899598393574], 'avgPrecision': 0.6756979919678715, 'recall':
[0.62, 0.668, 0.852, 0.616, 0.6224899598393574], 'avgRecall':
0.6756979919678715, 'params': [{'bootstrap': True, 'ccp_alpha': 0.0,
'class_weight': None, 'criterion': 'gini', 'max_depth': None, 'max_features':
'sqrt', 'max_leaf_nodes': None, 'max_samples': None, 'min_impurity_decrease':
0.0, 'min_impurity_split': None, 'min_samples_leaf': 1, 'min_samples_split': 2,
'min_weight_fraction_leaf': 0.0, 'n_estimators': 500, 'n_jobs': -1, 'oob_score':
False, 'random_state': None, 'verbose': 0, 'warm_start': False}]}
****

	model	features \
0	RandomForestClassifier	Active inflammation?, Severity of Crypt Arch, …
1	KNeighborsClassifier	Active inflammation?, Severity of Crypt Arch, …
2	LogisticRegression	Active inflammation?, Severity of Crypt Arch, …
3	GaussianNB	Active inflammation?, Severity of Crypt Arch, …
4	AdaBoostClassifier	Active inflammation?, Severity of Crypt Arch, …
5	DecisionTreeClassifier	Active inflammation?, Severity of Crypt Arch, …
6	SVC	Active inflammation?, Severity of Crypt Arch, …
7	MLPClassifier	Active inflammation?, Severity of Crypt Arch, …

	accuracy	f1	precision	recall \
0	0.675698	0.684326	0.675698	0.675698
1	0.659672	0.669328	0.659672	0.659672
2	0.631679	0.637171	0.631679	0.631679
3	0.624427	0.623605	0.624427	0.624427
4	0.582763	0.586007	0.582763	0.582763
5	0.659698	0.669704	0.659698	0.659698

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```
6  0.589259   0.577461    0.589259   0.589259
7  0.633276   0.640175    0.633276   0.633276


                                                           params
0  {'bootstrap': True, 'ccp_alpha': 0.0, 'class_w…
1  {'algorithm': 'brute', 'leaf_size': 30, 'metri…
2  {'C': 1, 'class_weight': None, 'dual': False, …
3            {'priors': None, 'var_smoothing': 1e-09}
4  {'algorithm': 'SAMME.R', 'base_estimator': Non…
5  {'ccp_alpha': 0.0, 'class_weight': None, 'crit…
6  {'C': 1.0, 'break_ties': False, 'cache_size': …
7  {'activation': 'identity', 'alpha': 0.0001, 'b…
```

Processing Model: RandomForestClassifier

****

* RandomForestClassifier

* Best Params Result:

* {'classifier': 'RandomForestClassifier', 'features': 'Active inflammation?, Severity of Crypt Arch, Increased lamina propria cellularity?, Marked & transmucosal increase in lamina propria cellularity, Lamina propria polymorphs, Crypt architecture, Patchy lamina propria cellularity?, Epithelial changes, Mucosal surface, Cryptitis extent', 'accuracy': [0.608, 0.672, 0.836, 0.556, 0.6265060240963856], 'avgAccuracy': 0.6597012048192771, 'f1': [0.6116112865635344, 0.6793267835326301, 0.8387573446961202, 0.5804968944099379, 0.6348395801251278], 'avgF1': 0.66900637786547, 'precision': [0.608, 0.672, 0.836, 0.556, 0.6265060240963856], 'avgPrecision': 0.6597012048192771, 'recall': [0.608, 0.672, 0.836, 0.556, 0.6265060240963856], 'avgRecall': 0.6597012048192771, 'params': [{'bootstrap': True, 'ccp_alpha': 0.0, 'class_weight': None, 'criterion': 'gini', 'max_depth': None, 'max_features': 'auto', 'max_leaf_nodes': None, 'max_samples': None, 'min_impurity_decrease': 0.0, 'min_impurity_split': None, 'min_samples_leaf': 1, 'min_samples_split': 2, 'min_weight_fraction_leaf': 0.0, 'n_estimators': 200, 'n_jobs': -1, 'oob_score': False, 'random_state': None, 'verbose': 0, 'warm_start': False}]}

****

Processing Model: KNeighborsClassifier

****

* KNeighborsClassifier

* Best Params Result:

* {'classifier': 'KNeighborsClassifier', 'features': 'Active inflammation?, Severity of Crypt Arch, Increased lamina propria cellularity?, Marked & transmucosal increase in lamina propria cellularity, Lamina propria polymorphs, Crypt architecture, Patchy lamina propria cellularity?, Epithelial changes, Mucosal surface, Cryptitis extent', 'accuracy': [0.608, 0.66, 0.828, 0.616, 0.5983935742971888], 'avgAccuracy': 0.6620787148594377, 'f1': [0.6177909300041678, 0.6710752840826217, 0.825257552596328, 0.6403484320557491, 0.6085144614238105], 'avgF1': 0.6725973320325355, 'precision': [0.608, 0.66, 0.828, 0.616, 0.5983935742971888], 'avgPrecision': 0.6620787148594377, 'recall':

[0.608, 0.66, 0.828, 0.616, 0.59839357429718 88], 'avgRecall':
0.6620787148594377, 'params': [{'algorithm': 'brute', 'leaf_size': 30, 'metric':
'minkowski', 'metric_params': None, 'n_jobs': -1, 'n_neighbors': 17, 'p': 2,
'weights': 'distance'}]}
****

Processing Model: LogisticRegression
****
* LogisticRegression
* Best Params Result:
* {'classifier': 'LogisticRegression', 'features': 'Active inflammation?,
Severity of Crypt Arch, Increased lamina propria cellularity?, Marked &
transmucosal increase in lamina propria cellularity, Lamina propria polymorphs,
Crypt architecture, Patchy lamina propria cellularity?, Epithelial changes,
Mucosal surface, Cryptitis extent', 'accuracy': [0.624, 0.66, 0.832, 0.444,
0.5983935742971888], 'avgAccuracy': 0.6316787148594377, 'f1':
[0.6350075207022942, 0.6720621284755512, 0.8364503171247357,
0.44115983026874117, 0.6028176493607932], 'avgF1': 0.6374994891864231,
'precision': [0.624, 0.66, 0.832, 0.444, 0.5983935742971888], 'avgPrecision':
0.6316787148594377, 'recall': [0.624, 0.66, 0.832, 0.444, 0.5983935742971888],
'avgRecall': 0.6316787148594377, 'params': [{'C': 1, 'class_weight': None,
'dual': False, 'fit_intercept': True, 'intercept_scaling': 1, 'l1_ratio': None,
'max_iter': 100, 'multi_class': 'multinomial', 'n_jobs': -1, 'penalty': 'l2',
'random_state': None, 'solver': 'newton-cg', 'tol': 0.0001, 'verbose': 0,
'warm_start': False}]}
****

Processing Model: GaussianNB
****
* GaussianNB
* Best Params Result:
* {'classifier': 'GaussianNB', 'features': 'Active inflammation?, Severity of
Crypt Arch, Increased lamina propria cellularity?, Marked & transmucosal
increase in lamina propria cellularity, Lamina propria polymorphs, Crypt
architecture, Patchy lamina propria cellularity?, Epithelial changes, Mucosal
surface, Cryptitis extent', 'accuracy': [0.58, 0.632, 0.832, 0.532,
0.5421686746987951], 'avgAccuracy': 0.623633734939759, 'f1':
[0.5848219648636716, 0.6240476761524063, 0.8265116148952483, 0.5365620328849028,
0.54274981061119568], 'avgF1': 0.6229386198816371, 'precision': [0.58, 0.632,
0.832, 0.532, 0.5421686746987951], 'avgPrecision': 0.623633734939759, 'recall':
[0.58, 0.632, 0.832, 0.532, 0.5421686746987951], 'avgRecall': 0.623633734939759,
'params': [{'priors': None, 'var_smoothing': 1e-09}]}
****

Processing Model: AdaBoostClassifier
****
* AdaBoostClassifier
* Best Params Result:

* {'classifier': 'AdaBoostClassifier', 'features': 'Active inflammation?,
Severity of Crypt Arch, Increased lamina propria cellularity?, Marked &
transmucosal increase in lamina propria cellularity, Lamina propria polymorphs,
Crypt architecture, Patchy lamina propria cellularity?, Epithelial changes,
Mucosal surface, Cryptitis extent', 'accuracy': [0.6, 0.508, 0.792, 0.56,
0.4738955823293173], 'avgAccuracy': 0.5867791164658634, 'f1':
[0.5942434303580734, 0.5200401690543853, 0.7993384817902589, 0.5848484848484848,
0.46561993544834585], 'avgF1': 0.5928181002999097, 'precision': [0.6, 0.508,
0.792, 0.56, 0.4738955823293173], 'avgPrecision': 0.5867791164658634, 'recall':
[0.6, 0.508, 0.792, 0.56, 0.4738955823293173], 'avgRecall': 0.5867791164658634,
'params': [{'algorithm': 'SAMME.R', 'base_estimator': None, 'learning_rate': 1,
'n_estimators': 20, 'random_state': None}]}
****

Processing Model: DecisionTreeClassifier
****
* DecisionTreeClassifier
* Best Params Result:
* {'classifier': 'DecisionTreeClassifier', 'features': 'Active inflammation?,
Severity of Crypt Arch, Increased lamina propria cellularity?, Marked &
transmucosal increase in lamina propria cellularity, Lamina propria polymorphs,
Crypt architecture, Patchy lamina propria cellularity?, Epithelial changes,
Mucosal surface, Cryptitis extent', 'accuracy': [0.596, 0.664, 0.82, 0.58,
0.6184738955823293], 'avgAccuracy': 0.6556947791164659, 'f1':
[0.6030658145682068, 0.673175055434839, 0.8255359201030141, 0.6060532687651332,
0.6293000207883297], 'avgF1': 0.6674260159319045, 'precision': [0.596, 0.664,
0.82, 0.58, 0.6184738955823293], 'avgPrecision': 0.6556947791164659, 'recall':
[0.596, 0.664, 0.82, 0.58, 0.6184738955823293], 'avgRecall': 0.6556947791164659,
'params': [{'ccp_alpha': 0.0, 'class_weight': None, 'criterion': 'entropy',
'max_depth': None, 'max_features': 'log2', 'max_leaf_nodes': None,
'min_impurity_decrease': 0.0, 'min_impurity_split': None, 'min_samples_leaf': 1,
'min_samples_split': 2, 'min_weight_fraction_leaf': 0.0, 'random_state': None,
'splitter': 'random'}]}
****

Processing Model: SVC
****
* SVC
* Best Params Result:
* {'classifier': 'SVC', 'features': 'Active inflammation?, Severity of Crypt
Arch, Increased lamina propria cellularity?, Marked & transmucosal increase in
lamina propria cellularity, Lamina propria polymorphs, Crypt architecture,
Patchy lamina propria cellularity?, Epithelial changes, Mucosal surface,
Cryptitis extent', 'accuracy': [0.616, 0.62, 0.82, 0.316, 0.5742971887550201],
'avgAccuracy': 0.589259437751004, 'f1': [0.6268723980546203, 0.6346193243243243,
0.8251004399748585, 0.22571428571428573, 0.5749972353714392], 'avgF1':
0.5774607366879057, 'precision': [0.616, 0.62, 0.82, 0.316, 0.5742971887550201],
'avgPrecision': 0.589259437751004, 'recall': [0.616, 0.62, 0.82, 0.316,

0.5742971887550201], 'avgRecall': 0.589259437751004, 'params': [{'C': 1.0,
'break_ties': False, 'cache_size': 4000, 'class_weight': None, 'coef0': 0.0,
'decision_function_shape': 'ovr', 'degree': 3, 'gamma': 'scale', 'kernel':
'linear', 'max_iter': -1, 'probability': False, 'random_state': None,
'shrinking': True, 'tol': 0.001, 'verbose': False}]}
****

Processing Model: MLPClassifier
****
* MLPClassifier
* Best Params Result:
* {'classifier': 'MLPClassifier', 'features': 'Active inflammation?, Severity of
Crypt Arch, Increased lamina propria cellularity?, Marked & transmucosal
increase in lamina propria cellularity, Lamina propria polymorphs, Crypt
architecture, Patchy lamina propria cellularity?, Epithelial changes, Mucosal
surface, Cryptitis extent', 'accuracy': [0.62, 0.66, 0.836, 0.444,
0.5983935742971888], 'avgAccuracy': 0.6316787148594377, 'f1':
[0.6302475373486969, 0.6720621284755512, 0.8412044639485491,
0.44115983026874117, 0.6028176493607932], 'avgF1': 0.6374983218804663,
'precision': [0.62, 0.66, 0.836, 0.444, 0.5983935742971888], 'avgPrecision':
0.6316787148594377, 'recall': [0.62, 0.66, 0.836, 0.444, 0.5983935742971888],
'avgRecall': 0.6316787148594377, 'params': [{'activation': 'identity', 'alpha':
0.0001, 'batch_size': 'auto', 'beta_1': 0.9, 'beta_2': 0.999, 'early_stopping':
False, 'epsilon': 1e-08, 'hidden_layer_sizes': (100,), 'learning_rate':
'adaptive', 'learning_rate_init': 0.001, 'max_fun': 15000, 'max_iter': 7000,
'momentum': 0.9, 'n_iter_no_change': 10, 'nesterovs_momentum': True, 'power_t':
0.5, 'random_state': None, 'shuffle': True, 'solver': 'adam', 'tol': 0.0001,
'validation_fraction': 0.1, 'verbose': False, 'warm_start': False}]}
****
****
* Best Performing Model and Params is:
* {'classifier': 'KNeighborsClassifier', 'features': 'Active inflammation?,
Severity of Crypt Arch, Increased lamina propria cellularity?, Marked &
transmucosal increase in lamina propria cellularity, Lamina propria polymorphs,
Crypt architecture, Patchy lamina propria cellularity?, Epithelial changes,
Mucosal surface, Cryptitis extent', 'accuracy': [0.608, 0.66, 0.828, 0.616,
0.5983935742971888], 'avgAccuracy': 0.6620787148594377, 'f1':
[0.6177909300041678, 0.6710752840826217, 0.825257552596328, 0.6403484320557491,
0.6085144614238105], 'avgF1': 0.6725973320325355, 'precision': [0.608, 0.66,
0.828, 0.616, 0.5983935742971888], 'avgPrecision': 0.6620787148594377, 'recall':
[0.608, 0.66, 0.828, 0.616, 0.5983935742971888], 'avgRecall':
0.6620787148594377, 'params': [{'algorithm': 'brute', 'leaf_size': 30, 'metric':
'minkowski', 'metric_params': None, 'n_jobs': -1, 'n_neighbors': 17, 'p': 2,
'weights': 'distance'}]}
****

                model   features \
0 RandomForestClassifier   Active inflammation?, Severity of Crypt Arch, …

```
1      KNeighborsClassifier  Active inflammation?, Severity of Crypt Arch, …
2       LogisticRegression  Active inflammation?, Severity of Crypt Arch, …
3               GaussianNB  Active inflammation?, Severity of Crypt Arch, …
4        AdaBoostClassifier  Active inflammation?, Severity of Crypt Arch, …
5   DecisionTreeClassifier  Active inflammation?, Severity of Crypt Arch, …
6                      SVC  Active inflammation?, Severity of Crypt Arch, …
7            MLPClassifier  Active inflammation?, Severity of Crypt Arch, …


    accuracy         f1  precision    recall  \
0   0.659701   0.669006   0.659701  0.659701
1   0.662079   0.672597   0.662079  0.662079
2   0.631679   0.637499   0.631679  0.631679
3   0.623634   0.622939   0.623634  0.623634
4   0.586779   0.592818   0.586779  0.586779
5   0.655695   0.667426   0.655695  0.655695
6   0.589259   0.577461   0.589259  0.589259
7   0.631679   0.637498   0.631679  0.631679


                                                 params
0  {'bootstrap': True, 'ccp_alpha': 0.0, 'class_w…
1  {'algorithm': 'brute', 'leaf_size': 30, 'metri…
2  {'C': 1, 'class_weight': None, 'dual': False, …
3           {'priors': None, 'var_smoothing': 1e-09}
4  {'algorithm': 'SAMME.R', 'base_estimator': Non…
5  {'ccp_alpha': 0.0, 'class_weight': None, 'crit…
6  {'C': 1.0, 'break_ties': False, 'cache_size': …
7  {'activation': 'identity', 'alpha': 0.0001, 'b…


Processing Model: RandomForestClassifier
********************************************************
* RandomForestClassifier
* Best Params Result:
* {'classifier': 'RandomForestClassifier', 'features': 'Active inflammation?,
Severity of Crypt Arch, Increased lamina propria cellularity?, Marked &
transmucosal increase in lamina propria cellularity, Lamina propria polymorphs,
Crypt architecture, Patchy lamina propria cellularity?, Epithelial changes,
Mucosal surface', 'accuracy': [0.616, 0.664, 0.836, 0.572, 0.6184738955823293],
'avgAccuracy': 0.6612947791164658, 'f1': [0.61878050241353, 0.6669812244897959,
0.8387946533823276, 0.5976800976800977, 0.6227983108147638], 'avgF1':
0.669006957756103, 'precision': [0.616, 0.664, 0.836, 0.572,
0.6184738955823293], 'avgPrecision': 0.6612947791164658, 'recall': [0.616,
0.664, 0.836, 0.572, 0.6184738955823293], 'avgRecall': 0.6612947791164658,
'params': [{'bootstrap': True, 'ccp_alpha': 0.0, 'class_weight': None,
'criterion': 'gini', 'max_depth': None, 'max_features': 'sqrt',
'max_leaf_nodes': None, 'max_samples': None, 'min_impurity_decrease': 0.0,
'min_impurity_split': None, 'min_samples_leaf': 1, 'min_samples_split': 2,
'min_weight_fraction_leaf': 0.0, 'n_estimators': 700, 'n_jobs': -1, 'oob_score':
True, 'random_state': None, 'verbose': 0, 'warm_start': False}]}
```

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

Processing Model: KNeighborsClassifier
**************************************************
* KNeighborsClassifier
* Best Params Result:
* {'classifier': 'KNeighborsClassifier', 'features': 'Active inflammation?,
Severity of Crypt Arch, Increased lamina propria cellularity?, Marked &
transmucosal increase in lamina propria cellularity, Lamina propria polymorphs,
Crypt architecture, Patchy lamina propria cellularity?, Epithelial changes,
Mucosal surface', 'accuracy': [0.616, 0.652, 0.836, 0.596, 0.5983935742971888],
'avgAccuracy': 0.6596787148594377, 'f1': [0.6201642335650117,
0.6578927272727274, 0.8311254288982082, 0.6207350326022525, 0.6058361329438835],
'avgF1': 0.6671507110564167, 'precision': [0.616, 0.652, 0.836, 0.596,
0.5983935742971888], 'avgPrecision': 0.6596787148594377, 'recall': [0.616,
0.652, 0.836, 0.596, 0.5983935742971888], 'avgRecall': 0.6596787148594377,
'params': [{'algorithm': 'brute', 'leaf_size': 30, 'metric': 'minkowski',
'metric_params': None, 'n_jobs': -1, 'n_neighbors': 14, 'p': 2, 'weights':
'distance'}]}
**************************************************

Processing Model: LogisticRegression
**************************************************
* LogisticRegression
* Best Params Result:
* {'classifier': 'LogisticRegression', 'features': 'Active inflammation?,
Severity of Crypt Arch, Increased lamina propria cellularity?, Marked &
transmucosal increase in lamina propria cellularity, Lamina propria polymorphs,
Crypt architecture, Patchy lamina propria cellularity?, Epithelial changes,
Mucosal surface', 'accuracy': [0.616, 0.636, 0.824, 0.428, 0.5943775100401606],
'avgAccuracy': 0.6196755020080321, 'f1': [0.6245976909931551,
0.6497764141898369, 0.8285736937481123, 0.418037518037518, 0.6008243056033455],
'avgF1': 0.6243619245143935, 'precision': [0.616, 0.636, 0.824, 0.428,
0.5943775100401606], 'avgPrecision': 0.6196755020080321, 'recall': [0.616,
0.636, 0.824, 0.428, 0.5943775100401606], 'avgRecall': 0.6196755020080321,
'params': [{'C': 1, 'class_weight': None, 'dual': False, 'fit_intercept': True,
'intercept_scaling': 1, 'l1_ratio': None, 'max_iter': 100, 'multi_class': 'ovr',
'n_jobs': -1, 'penalty': 'l2', 'random_state': None, 'solver': 'newton-cg',
'tol': 0.0001, 'verbose': 0, 'warm_start': False}]}
**************************************************

Processing Model: GaussianNB
**************************************************
* GaussianNB
* Best Params Result:
* {'classifier': 'GaussianNB', 'features': 'Active inflammation?, Severity of
Crypt Arch, Increased lamina propria cellularity?, Marked & transmucosal
increase in lamina propria cellularity, Lamina propria polymorphs, Crypt
```

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architecture, Patchy lamina propria cellularity?, Epithelial changes, Mucosal
surface', 'accuracy': [0.58, 0.62, 0.832, 0.532, 0.5421686746987951],
'avgAccuracy': 0.621233734939759, 'f1': [0.5848219648636716, 0.6126864253393665,
0.8265116148952483, 0.5365620328849028, 0.544523014600497], 'avgF1':
0.6210210105167372, 'precision': [0.58, 0.62, 0.832, 0.532, 0.5421686746987951],
'avgPrecision': 0.621233734939759, 'recall': [0.58, 0.62, 0.832, 0.532,
0.5421686746987951], 'avgRecall': 0.621233734939759, 'params': [{'priors': None,
'var_smoothing': 1e-09}]}
****

Processing Model: AdaBoostClassifier
****
* AdaBoostClassifier
* Best Params Result:
* {'classifier': 'AdaBoostClassifier', 'features': 'Active inflammation?,
Severity of Crypt Arch, Increased lamina propria cellularity?, Marked &
transmucosal increase in lamina propria cellularity, Lamina propria polymorphs,
Crypt architecture, Patchy lamina propria cellularity?, Epithelial changes,
Mucosal surface', 'accuracy': [0.6, 0.528, 0.788, 0.56, 0.4738955823293173],
'avgAccuracy': 0.5899791164658634, 'f1': [0.5942434303580734,
0.5391296894259936, 0.7956044296788483, 0.5848484848484848,
0.46561993544834585], 'avgF1': 0.5958891939519492, 'precision': [0.6, 0.528,
0.788, 0.56, 0.4738955823293173], 'avgPrecision': 0.5899791164658634, 'recall':
[0.6, 0.528, 0.788, 0.56, 0.4738955823293173], 'avgRecall': 0.5899791164658634,
'params': [{'algorithm': 'SAMME.R', 'base_estimator': None, 'learning_rate': 1,
'n_estimators': 20, 'random_state': None}]}
****

Processing Model: DecisionTreeClassifier
****
* DecisionTreeClassifier
* Best Params Result:
* {'classifier': 'DecisionTreeClassifier', 'features': 'Active inflammation?,
Severity of Crypt Arch, Increased lamina propria cellularity?, Marked &
transmucosal increase in lamina propria cellularity, Lamina propria polymorphs,
Crypt architecture, Patchy lamina propria cellularity?, Epithelial changes,
Mucosal surface', 'accuracy': [0.616, 0.644, 0.828, 0.6, 0.5943775100401606],
'avgAccuracy': 0.6564755020080321, 'f1': [0.61878050241353, 0.6504164680011972,
0.8320119366124717, 0.6263781861292235, 0.6009875867104784], 'avgF1':
0.6657149359733802, 'precision': [0.616, 0.644, 0.828, 0.6, 0.5943775100401606],
'avgPrecision': 0.6564755020080321, 'recall': [0.616, 0.644, 0.828, 0.6,
0.5943775100401606], 'avgRecall': 0.6564755020080321, 'params': [{'ccp_alpha':
0.0, 'class_weight': None, 'criterion': 'gini', 'max_depth': None,
'max_features': 'sqrt', 'max_leaf_nodes': None, 'min_impurity_decrease': 0.0,
'min_impurity_split': None, 'min_samples_leaf': 1, 'min_samples_split': 2,
'min_weight_fraction_leaf': 0.0, 'random_state': None, 'splitter': 'best'}]}
****

```
Processing Model: SVC
*******************************************************
* SVC
* Best Params Result:
* {'classifier': 'SVC', 'features': 'Active inflammation?, Severity of Crypt
Arch, Increased lamina propria cellularity?, Marked & transmucosal increase in
lamina propria cellularity, Lamina propria polymorphs, Crypt architecture,
Patchy lamina propria cellularity?, Epithelial changes, Mucosal surface',
'accuracy': [0.608, 0.62, 0.828, 0.316, 0.5742971887550201], 'avgAccuracy':
0.589259437751004, 'f1': [0.6196229060339602, 0.6346193243243243,
0.8293353210097396, 0.22571428571428573, 0.5736885692631442], 'avgF1':
0.5765960812690908, 'precision': [0.608, 0.62, 0.828, 0.316,
0.5742971887550201], 'avgPrecision': 0.589259437751004, 'recall': [0.608, 0.62,
0.828, 0.316, 0.5742971887550201], 'avgRecall': 0.589259437751004, 'params':
[{'C': 1.0, 'break_ties': False, 'cache_size': 4000, 'class_weight': None,
'coef0': 0.0, 'decision_function_shape': 'ovr', 'degree': 3, 'gamma': 'scale',
'kernel': 'linear', 'max_iter': -1, 'probability': False, 'random_state': None,
'shrinking': True, 'tol': 0.001, 'verbose': False}]}
*******************************************************

Processing Model: MLPClassifier
*******************************************************
* MLPClassifier
* Best Params Result:
* {'classifier': 'MLPClassifier', 'features': 'Active inflammation?, Severity of
Crypt Arch, Increased lamina propria cellularity?, Marked & transmucosal
increase in lamina propria cellularity, Lamina propria polymorphs, Crypt
architecture, Patchy lamina propria cellularity?, Epithelial changes, Mucosal
surface', 'accuracy': [0.62, 0.644, 0.828, 0.432, 0.5863453815261044],
'avgAccuracy': 0.6220690763052209, 'f1': [0.6302475373486969, 0.655511479124902,
0.8333701920257817, 0.4239052404881551, 0.5916239176378971], 'avgF1':
0.6269316733250866, 'precision': [0.62, 0.644, 0.828, 0.432,
0.5863453815261044], 'avgPrecision': 0.6220690763052209, 'recall': [0.62, 0.644,
0.828, 0.432, 0.5863453815261044], 'avgRecall': 0.6220690763052209, 'params':
[{'activation': 'logistic', 'alpha': 0.0001, 'batch_size': 'auto', 'beta_1':
0.9, 'beta_2': 0.999, 'early_stopping': False, 'epsilon': 1e-08,
'hidden_layer_sizes': (100,), 'learning_rate': 'constant', 'learning_rate_init':
0.001, 'max_fun': 15000, 'max_iter': 9000, 'momentum': 0.9, 'n_iter_no_change':
10, 'nesterovs_momentum': True, 'power_t': 0.5, 'random_state': None, 'shuffle':
True, 'solver': 'adam', 'tol': 0.0001, 'validation_fraction': 0.1, 'verbose':
False, 'warm_start': False}]}
*******************************************************
*******************************************************
* Best Performing Model and Params is:
* {'classifier': 'KNeighborsClassifier', 'features': 'Active inflammation?,
Severity of Crypt Arch, Increased lamina propria cellularity?, Marked &
transmucosal increase in lamina propria cellularity, Lamina propria polymorphs,
Crypt architecture, Patchy lamina propria cellularity?, Epithelial changes,
```

Mucosal surface', 'accuracy': [0.616, 0.652, 0.836, 0.596, 0.5983935742971888],
'avgAccuracy': 0.6596787148594377, 'f1': [0.6201642335650117,
0.6578927272727274, 0.8311254288982082, 0.6207350326022525, 0.6058361329438835],
'avgF1': 0.6671507110564167, 'precision': [0.616, 0.652, 0.836, 0.596,
0.5983935742971888], 'avgPrecision': 0.6596787148594377, 'recall': [0.616,
0.652, 0.836, 0.596, 0.5983935742971888], 'avgRecall': 0.6596787148594377,
'params': [{'algorithm': 'brute', 'leaf_size': 30, 'metric': 'minkowski',
'metric_params': None, 'n_jobs': -1, 'n_neighbors': 14, 'p': 2, 'weights':
'distance'}]}
****

```
                  model                                    features  \
0  RandomForestClassifier  Active inflammation?, Severity of Crypt Arch, …
1    KNeighborsClassifier  Active inflammation?, Severity of Crypt Arch, …
2      LogisticRegression  Active inflammation?, Severity of Crypt Arch, …
3              GaussianNB  Active inflammation?, Severity of Crypt Arch, …
4      AdaBoostClassifier  Active inflammation?, Severity of Crypt Arch, …
5  DecisionTreeClassifier  Active inflammation?, Severity of Crypt Arch, …
6                     SVC  Active inflammation?, Severity of Crypt Arch, …
7           MLPClassifier  Active inflammation?, Severity of Crypt Arch, …

   accuracy        f1  precision    recall  \
0  0.661295  0.669007   0.661295  0.661295
1  0.659679  0.667151   0.659679  0.659679
2  0.619676  0.624362   0.619676  0.619676
3  0.621234  0.621021   0.621234  0.621234
4  0.589979  0.595889   0.589979  0.589979
5  0.656476  0.665715   0.656476  0.656476
6  0.589259  0.576596   0.589259  0.589259
7  0.622069  0.626932   0.622069  0.622069


                                              params
0  {'bootstrap': True, 'ccp_alpha': 0.0, 'class_w…
1  {'algorithm': 'brute', 'leaf_size': 30, 'metri…
2  {'C': 1, 'class_weight': None, 'dual': False, …
3            {'priors': None, 'var_smoothing': 1e-09}
4  {'algorithm': 'SAMME.R', 'base_estimator': Non…
5  {'ccp_alpha': 0.0, 'class_weight': None, 'crit…
6  {'C': 1.0, 'break_ties': False, 'cache_size': …
7  {'activation': 'logistic', 'alpha': 0.0001, 'b…
```

Processing Model: RandomForestClassifier
****
* RandomForestClassifier
* Best Params Result:
* {'classifier': 'RandomForestClassifier', 'features': 'Active inflammation?,
Severity of Crypt Arch, Increased lamina propria cellularity?, Marked &
transmucosal increase in lamina propria cellularity, Lamina propria polymorphs,

Crypt architecture, Patchy lamina propria cellularity?, Epithelial changes',
'accuracy': [0.62, 0.676, 0.836, 0.576, 0.6104417670682731], 'avgAccuracy':
0.6636883534136546, 'f1': [0.6219245663497281, 0.6774000759013283,
0.8375130434782609, 0.6018844984802431, 0.6197509718468577], 'avgF1':
0.6716946312112836, 'precision': [0.62, 0.676, 0.836, 0.576,
0.6104417670682731], 'avgPrecision': 0.6636883534136546, 'recall': [0.62, 0.676,
0.836, 0.576, 0.6104417670682731], 'avgRecall': 0.6636883534136546, 'params':
[{'bootstrap': True, 'ccp_alpha': 0.0, 'class_weight': None, 'criterion':
'entropy', 'max_depth': None, 'max_features': 'sqrt', 'max_leaf_nodes': None,
'max_samples': None, 'min_impurity_decrease': 0.0, 'min_impurity_split': None,
'min_samples_leaf': 1, 'min_samples_split': 2, 'min_weight_fraction_leaf': 0.0,
'n_estimators': 700, 'n_jobs': -1, 'oob_score': False, 'random_state': None,
'verbose': 0, 'warm_start': False}]}
****

Processing Model: KNeighborsClassifier
****
* KNeighborsClassifier
* Best Params Result:
* {'classifier': 'KNeighborsClassifier', 'features': 'Active inflammation?,
Severity of Crypt Arch, Increased lamina propria cellularity?, Marked &
transmucosal increase in lamina propria cellularity, Lamina propria polymorphs,
Crypt architecture, Patchy lamina propria cellularity?, Epithelial changes',
'accuracy': [0.64, 0.684, 0.844, 0.484, 0.5863453815261044], 'avgAccuracy':
0.6476690763052209, 'f1': [0.6395593325239829, 0.6687113902802221,
0.8371960729312764, 0.4951482479784367, 0.5837303581277447], 'avgF1':
0.6448690803683326, 'precision': [0.64, 0.684, 0.844, 0.484,
0.5863453815261044], 'avgPrecision': 0.6476690763052209, 'recall': [0.64, 0.684,
0.844, 0.484, 0.5863453815261044], 'avgRecall': 0.6476690763052209, 'params':
[{'algorithm': 'ball_tree', 'leaf_size': 30, 'metric': 'minkowski',
'metric_params': None, 'n_jobs': -1, 'n_neighbors': 14, 'p': 2, 'weights':
'distance'}]}
****

Processing Model: LogisticRegression
****
* LogisticRegression
* Best Params Result:
* {'classifier': 'LogisticRegression', 'features': 'Active inflammation?,
Severity of Crypt Arch, Increased lamina propria cellularity?, Marked &
transmucosal increase in lamina propria cellularity, Lamina propria polymorphs,
Crypt architecture, Patchy lamina propria cellularity?, Epithelial changes',
'accuracy': [0.612, 0.628, 0.828, 0.432, 0.5983935742971888], 'avgAccuracy':
0.6196787148594377, 'f1': [0.6196968628659476, 0.6415478427612656,
0.8329514910259097, 0.4239052404881551, 0.6062438675922883], 'avgF1':
0.6248690609467132, 'precision': [0.612, 0.628, 0.828, 0.432,
0.5983935742971888], 'avgPrecision': 0.6196787148594377, 'recall': [0.612,
0.628, 0.828, 0.432, 0.5983935742971888], 'avgRecall': 0.6196787148594377,

```
'params': [{'C': 1, 'class_weight': None, 'dual': False, 'fit_intercept': True,
'intercept_scaling': 1, 'l1_ratio': None, 'max_iter': 100, 'multi_class':
'multinomial', 'n_jobs': -1, 'penalty': 'l2', 'random_state': None, 'solver':
'newton-cg', 'tol': 0.0001, 'verbose': 0, 'warm_start': False}]}
*********************************************************

Processing Model: GaussianNB
*********************************************************
* GaussianNB
* Best Params Result:
* {'classifier': 'GaussianNB', 'features': 'Active inflammation?, Severity of
Crypt Arch, Increased lamina propria cellularity?, Marked & transmucosal
increase in lamina propria cellularity, Lamina propria polymorphs, Crypt
architecture, Patchy lamina propria cellularity?, Epithelial changes',
'accuracy': [0.544, 0.632, 0.84, 0.5, 0.5381526104417671], 'avgAccuracy':
0.6108305220883534, 'f1': [0.5484682471999545, 0.627289657667412,
0.8336443779619283, 0.497984496124031, 0.5387900809587557], 'avgF1':
0.6092353719824163, 'precision': [0.544, 0.632, 0.84, 0.5, 0.5381526104417671],
'avgPrecision': 0.6108305220883534, 'recall': [0.544, 0.632, 0.84, 0.5,
0.5381526104417671], 'avgRecall': 0.6108305220883534, 'params': [{'priors':
None, 'var_smoothing': 1e-09}]}
*********************************************************

Processing Model: AdaBoostClassifier
*********************************************************
* AdaBoostClassifier
* Best Params Result:
* {'classifier': 'AdaBoostClassifier', 'features': 'Active inflammation?,
Severity of Crypt Arch, Increased lamina propria cellularity?, Marked &
transmucosal increase in lamina propria cellularity, Lamina propria polymorphs,
Crypt architecture, Patchy lamina propria cellularity?, Epithelial changes',
'accuracy': [0.584, 0.516, 0.772, 0.56, 0.41365461847389556], 'avgAccuracy':
0.5691309236947791, 'f1': [0.5844675834400753, 0.5232771986277808,
0.7785283653002982, 0.5848484848484848, 0.3818072642395157], 'avgF1':
0.570585779291231, 'precision': [0.584, 0.516, 0.772, 0.56,
0.41365461847389556], 'avgPrecision': 0.5691309236947791, 'recall': [0.584,
0.516, 0.772, 0.56, 0.41365461847389556], 'avgRecall': 0.5691309236947791,
'params': [{'algorithm': 'SAMME.R', 'base_estimator': None, 'learning_rate': 1,
'n_estimators': 20, 'random_state': None}]}
*********************************************************

Processing Model: DecisionTreeClassifier
*********************************************************
* DecisionTreeClassifier
* Best Params Result:
* {'classifier': 'DecisionTreeClassifier', 'features': 'Active inflammation?,
Severity of Crypt Arch, Increased lamina propria cellularity?, Marked &
transmucosal increase in lamina propria cellularity, Lamina propria polymorphs,
```

Crypt architecture, Patchy lamina propria cellularity?, Epithelial changes',
'accuracy': [0.616, 0.672, 0.832, 0.588, 0.6104417670682731], 'avgAccuracy':
0.6636883534136546, 'f1': [0.6196596633465465, 0.6739330498015015,
0.8341126602295771, 0.6142857142857143, 0.6211750088740849], 'avgF1':
0.6726332193074849, 'precision': [0.616, 0.672, 0.832, 0.588,
0.6104417670682731], 'avgPrecision': 0.6636883534136546, 'recall': [0.616,
0.672, 0.832, 0.588, 0.6104417670682731], 'avgRecall': 0.6636883534136546,
'params': [{'ccp_alpha': 0.0, 'class_weight': None, 'criterion': 'entropy',
'max_depth': None, 'max_features': 'sqrt', 'max_leaf_nodes': None,
'min_impurity_decrease': 0.0, 'min_impurity_split': None, 'min_samples_leaf': 1,
'min_samples_split': 2, 'min_weight_fraction_leaf': 0.0, 'random_state': None,
'splitter': 'random'}]}
****

Processing Model: SVC
****
* SVC
* Best Params Result:
* {'classifier': 'SVC', 'features': 'Active inflammation?, Severity of Crypt
Arch, Increased lamina propria cellularity?, Marked & transmucosal increase in
lamina propria cellularity, Lamina propria polymorphs, Crypt architecture,
Patchy lamina propria cellularity?, Epithelial changes', 'accuracy': [0.604,
0.62, 0.828, 0.316, 0.5742971887550201], 'avgAccuracy': 0.588459437751004, 'f1':
[0.615447354904982, 0.6346193243243243, 0.8293353210097396, 0.22571428571428573,
0.57368856 92631442], 'avgF1': 0.5757609710432952, 'precision': [0.604, 0.62,
0.828, 0.316, 0.5742971887550201], 'avgPrecision': 0.588459437751004, 'recall':
[0.604, 0.62, 0.828, 0.316, 0.5742971887550201], 'avgRecall': 0.588459437751004,
'params': [{'C': 1.0, 'break_ties': False, 'cache_size': 4000, 'class_weight':
None, 'coef0': 0.0, 'decision_function_shape': 'ovr', 'degree': 3, 'gamma':
'scale', 'kernel': 'linear', 'max_iter': -1, 'probability': False,
'random_state': None, 'shrinking': True, 'tol': 0.001, 'verbose': False}]}
****

Processing Model: MLPClassifier
****
* MLPClassifier
* Best Params Result:
* {'classifier': 'MLPClassifier', 'features': 'Active inflammation?, Severity of
Crypt Arch, Increased lamina propria cellularity?, Marked & transmucosal
increase in lamina propria cellularity, Lamina propria polymorphs, Crypt
architecture, Patchy lamina propria cellularity?, Epithelial changes',
'accuracy': [0.616, 0.628, 0.828, 0.432, 0.5983935742971888], 'avgAccuracy':
0.6204787148594377, 'f1': [0.6254503964934588, 0.6422275032353206,
0.8329514910259097, 0.4239052404881551, 0.6062438675922883], 'avgF1':
0.6261556997670266, 'precision': [0.616, 0.628, 0.828, 0.432,
0.5983935742971888], 'avgPrecision': 0.6204787148594377, 'recall': [0.616,
0.628, 0.828, 0.432, 0.5983935742971888], 'avgRecall': 0.6204787148594377,
'params': [{'activation': 'identity', 'alpha': 0.0001, 'batch_size': 'auto',

'beta_1': 0.9, 'beta_2': 0.999, 'early_stopping': False, 'epsilon': 1e-08, 'hidden_layer_sizes': (100,), 'learning_rate': 'constant', 'learning_rate_init': 0.001, 'max_fun': 15000, 'max_iter': 5000, 'momentum': 0.9, 'n_iter_no_change': 10, 'nesterovs_momentum': True, 'power_t': 0.5, 'random_state': None, 'shuffle': True, 'solver': 'adam', 'tol': 0.0001, 'validation_fraction': 0.1, 'verbose': False, 'warm_start': False}]}
****
****
* Best Performing Model and Params is:
* {'classifier': 'DecisionTreeClassifier', 'features': 'Active inflammation?, Severity of Crypt Arch, Increased lamina propria cellularity?, Marked & transmucosal increase in lamina propria cellularity, Lamina propria polymorphs, Crypt architecture, Patchy lamina propria cellularity?, Epithelial changes', 'accuracy': [0.616, 0.672, 0.832, 0.588, 0.6104417670682731], 'avgAccuracy': 0.6636883534136546, 'f1': [0.6196596633465465, 0.6739330498015015, 0.8341126602295771, 0.6142857142857143, 0.6211750088740849], 'avgF1': 0.6726332193074849, 'precision': [0.616, 0.672, 0.832, 0.588, 0.6104417670682731], 'avgPrecision': 0.6636883534136546, 'recall': [0.616, 0.672, 0.832, 0.588, 0.6104417670682731], 'avgRecall': 0.6636883534136546, 'params': [{'ccp_alpha': 0.0, 'class_weight': None, 'criterion': 'entropy', 'max_depth': None, 'max_features': 'sqrt', 'max_leaf_nodes': None, 'min_impurity_decrease': 0.0, 'min_impurity_split': None, 'min_samples_leaf': 1, 'min_samples_split': 2, 'min_weight_fraction_leaf': 0.0, 'random_state': None, 'splitter': 'random'}]}
****

	model	features \
0	RandomForestClassifier	Active inflammation?, Severity of Crypt Arch, …
1	KNeighborsClassifier	Active inflammation?, Severity of Crypt Arch, …
2	LogisticRegression	Active inflammation?, Severity of Crypt Arch, …
3	GaussianNB	Active inflammation?, Severity of Crypt Arch, …
4	AdaBoostClassifier	Active inflammation?, Severity of Crypt Arch, …
5	DecisionTreeClassifier	Active inflammation?, Severity of Crypt Arch, …
6	SVC	Active inflammation?, Severity of Crypt Arch, …
7	MLPClassifier	Active inflammation?, Severity of Crypt Arch, …

	accuracy	f1	precision	recall \
0	0.663688	0.671695	0.663688	0.663688
1	0.647669	0.644869	0.647669	0.647669
2	0.619679	0.624869	0.619679	0.619679
3	0.610831	0.609235	0.610831	0.610831
4	0.569131	0.570586	0.569131	0.569131
5	0.663688	0.672633	0.663688	0.663688
6	0.588459	0.575761	0.588459	0.588459
7	0.620479	0.626156	0.620479	0.620479

	params
0	{'bootstrap': True, 'ccp_alpha': 0.0, 'class_w…

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```
1  {'algorithm': 'ball_tree', 'leaf_size': 30, 'm…
2  {'C': 1, 'class_weight': None, 'dual': False, …
3          {'priors': None, 'var_smoothing': 1e-09}
4  {'algorithm': 'SAMME.R', 'base_estimator': Non…
5  {'ccp_alpha': 0.0, 'class_weight': None, 'crit…
6  {'C': 1.0, 'break_ties': False, 'cache_size': …
7  {'activation': 'identity', 'alpha': 0.0001, 'b…
```

Processing Model: RandomForestClassifier
****
* RandomForestClassifier
* Best Params Result:
* {'classifier': 'RandomForestClassifier', 'features': 'Active inflammation?,
Severity of Crypt Arch, Increased lamina propria cellularity?, Marked &
transmucosal increase in lamina propria cellularity, Lamina propria polymorphs,
Crypt architecture, Patchy lamina propria cellularity?', 'accuracy': [0.6,
0.652, 0.832, 0.492, 0.5983935742971888], 'avgAccuracy': 0.6348787148594377,
'f1': [0.6102253571117878, 0.6633460869565218, 0.8341126602295771,
0.5053404539385848, 0.6092647088705605], 'avgF1': 0.6444578534214064,
'precision': [0.6, 0.652, 0.832, 0.492, 0.5983935742971888], 'avgPrecision':
0.6348787148594377, 'recall': [0.6, 0.652, 0.832, 0.492, 0.5983935742971888],
'avgRecall': 0.6348787148594377, 'params': [{'bootstrap': True, 'ccp_alpha':
0.0, 'class_weight': None, 'criterion': 'entropy', 'max_depth': None,
'max_features': 'log2', 'max_leaf_nodes': None, 'max_samples': None,
'min_impurity_decrease': 0.0, 'min_impurity_split': None, 'min_samples_leaf': 1,
'min_samples_split': 2, 'min_weight_fraction_leaf': 0.0, 'n_estimators': 200,
'n_jobs': -1, 'oob_score': False, 'random_state': None, 'verbose': 0,
'warm_start': False}]}
****

Processing Model: KNeighborsClassifier
****
* KNeighborsClassifier
* Best Params Result:
* {'classifier': 'KNeighborsClassifier', 'features': 'Active inflammation?,
Severity of Crypt Arch, Increased lamina propria cellularity?, Marked &
transmucosal increase in lamina propria cellularity, Lamina propria polymorphs,
Crypt architecture, Patchy lamina propria cellularity?', 'accuracy': [0.62,
0.656, 0.836, 0.464, 0.5983935742971888], 'avgAccuracy': 0.6348787148594377,
'f1': [0.6271431939532626, 0.6540799999999999, 0.8300735307458044,
0.4688060731538992, 0.5751756933583476], 'avgF1': 0.6310556982422627,
'precision': [0.62, 0.656, 0.836, 0.464, 0.5983935742971888], 'avgPrecision':
0.6348787148594377, 'recall': [0.62, 0.656, 0.836, 0.464, 0.5983935742971888],
'avgRecall': 0.6348787148594377, 'params': [{'algorithm': 'auto', 'leaf_size':
30, 'metric': 'minkowski', 'metric_params': None, 'n_jobs': -1, 'n_neighbors':
15, 'p': 2, 'weights': 'distance'}]}
****

```
Processing Model: LogisticRegression
*********************************************************
* LogisticRegression
* Best Params Result:
* {'classifier': 'LogisticRegression', 'features': 'Active inflammation?,
Severity of Crypt Arch, Increased lamina propria cellularity?, Marked &
transmucosal increase in lamina propria cellularity, Lamina propria polymorphs,
Crypt architecture, Patchy lamina propria cellularity?', 'accuracy': [0.604,
0.632, 0.824, 0.432, 0.5863453815261044], 'avgAccuracy': 0.6156690763052208,
'f1': [0.6145893939393938, 0.6460102162145839, 0.829418696571376,
0.4239052404881551, 0.5869828117711994], 'avgF1': 0.6201812717969416,
'precision': [0.604, 0.632, 0.824, 0.432, 0.5863453815261044], 'avgPrecision':
0.6156690763052208, 'recall': [0.604, 0.632, 0.824, 0.432, 0.5863453815261044],
'avgRecall': 0.6156690763052208, 'params': [{'C': 1, 'class_weight': None,
'dual': False, 'fit_intercept': True, 'intercept_scaling': 1, 'l1_ratio': None,
'max_iter': 100, 'multi_class': 'multinomial', 'n_jobs': -1, 'penalty': 'l2',
'random_state': None, 'solver': 'newton-cg', 'tol': 0.0001, 'verbose': 0,
'warm_start': False}]}
*********************************************************

Processing Model: GaussianNB
*********************************************************
* GaussianNB
* Best Params Result:
* {'classifier': 'GaussianNB', 'features': 'Active inflammation?, Severity of
Crypt Arch, Increased lamina propria cellularity?, Marked & transmucosal
increase in lamina propria cellularity, Lamina propria polymorphs, Crypt
architecture, Patchy lamina propria cellularity?', 'accuracy': [0.588, 0.62,
0.864, 0.476, 0.5301204819277109], 'avgAccuracy': 0.6156240963855422, 'f1':
[0.5948966346627165, 0.6179430340557276, 0.8550768444389703, 0.4671132376395534,
0.5137319810463191], 'avgF1': 0.6097523463686574, 'precision': [0.588, 0.62,
0.864, 0.476, 0.5301204819277109], 'avgPrecision': 0.6156240963855422, 'recall':
[0.588, 0.62, 0.864, 0.476, 0.5301204819277109], 'avgRecall':
0.6156240963855422, 'params': [{'priors': None, 'var_smoothing': 1e-09}]}
*********************************************************

Processing Model: AdaBoostClassifier
*********************************************************
* AdaBoostClassifier
* Best Params Result:
* {'classifier': 'AdaBoostClassifier', 'features': 'Active inflammation?,
Severity of Crypt Arch, Increased lamina propria cellularity?, Marked &
transmucosal increase in lamina propria cellularity, Lamina propria polymorphs,
Crypt architecture, Patchy lamina propria cellularity?', 'accuracy': [0.604,
0.5, 0.764, 0.572, 0.42168674698795183], 'avgAccuracy': 0.5723373493975904,
'f1': [0.6009976689976689, 0.5104181724315953, 0.7703594579333709,
0.5976800976800977, 0.4065652717358779], 'avgF1': 0.5772041337557221,
'precision': [0.604, 0.5, 0.764, 0.572, 0.42168674698795183], 'avgPrecision':
```

0.5723373493975904, 'recall': [0.604, 0.5, 0.764, 0.572, 0.42168674698795183],
'avgRecall': 0.5723373493975904, 'params': [{'algorithm': 'SAMME.R',
'base_estimator': None, 'learning_rate': 1, 'n_estimators': 300, 'random_state':
None}]}
****

Processing Model: DecisionTreeClassifier
****
* DecisionTreeClassifier
* Best Params Result:
* {'classifier': 'DecisionTreeClassifier', 'features': 'Active inflammation?,
Severity of Crypt Arch, Increased lamina propria cellularity?, Marked &
transmucosal increase in lamina propria cellularity, Lamina propria polymorphs,
Crypt architecture, Patchy lamina propria cellularity?', 'accuracy': [0.6,
0.644, 0.824, 0.5, 0.5943775100401606], 'avgAccuracy': 0.6324755020080322, 'f1':
[0.6102253571117878, 0.655694554498395, 0.8272258125090278, 0.5153439153439153,
0.6049001073687206], 'avgF1': 0.6426779493663693, 'precision': [0.6, 0.644,
0.824, 0.5, 0.5943775100401606], 'avgPrecision': 0.6324755020080322, 'recall':
[0.6, 0.644, 0.824, 0.5, 0.5943775100401606], 'avgRecall': 0.6324755020080322,
'params': [{'ccp_alpha': 0.0, 'class_weight': None, 'criterion': 'entropy',
'max_depth': None, 'max_features': 'auto', 'max_leaf_nodes': None,
'min_impurity_decrease': 0.0, 'min_impurity_split': None, 'min_samples_leaf': 1,
'min_samples_split': 2, 'min_weight_fraction_leaf': 0.0, 'random_state': None,
'splitter': 'best'}]}
****

Processing Model: SVC
****
* SVC
* Best Params Result:
* {'classifier': 'SVC', 'features': 'Active inflammation?, Severity of Crypt
Arch, Increased lamina propria cellularity?, Marked & transmucosal increase in
lamina propria cellularity, Lamina propria polymorphs, Crypt architecture,
Patchy lamina propria cellularity?', 'accuracy': [0.604, 0.62, 0.828, 0.316,
0.5742971887550201], 'avgAccuracy': 0.588459437751004, 'f1': [0.615447354904982,
0.6346193243243243, 0.8293353210097396, 0.22571428571428573,
0.5736885692631442], 'avgF1': 0.5757609710432952, 'precision': [0.604, 0.62,
0.828, 0.316, 0.5742971887550201], 'avgPrecision': 0.588459437751004, 'recall':
[0.604, 0.62, 0.828, 0.316, 0.5742971887550201], 'avgRecall': 0.588459437751004,
'params': [{'C': 1.0, 'break_ties': False, 'cache_size': 4000, 'class_weight':
None, 'coef0': 0.0, 'decision_function_shape': 'ovr', 'degree': 3, 'gamma':
'scale', 'kernel': 'linear', 'max_iter': -1, 'probability': False,
'random_state': None, 'shrinking': True, 'tol': 0.001, 'verbose': False}]}
****

Processing Model: MLPClassifier
****
* MLPClassifier

* Best Params Result:
* {'classifier': 'MLPClassifier', 'features': 'Active inflammation?, Severity of
Crypt Arch, Increased lamina propria cellularity?, Marked & transmucosal
increase in lamina propria cellularity, Lamina propria polymorphs, Crypt
architecture, Patchy lamina propria cellularity?', 'accuracy': [0.608, 0.628,
0.836, 0.432, 0.5823293172690763], 'avgAccuracy': 0.6172658634538153, 'f1':
[0.6196229060339602, 0.6422275032353206, 0.8357099335019992, 0.4239052404881551,
0.5829959797045021], 'avgF1': 0.6208923125927874, 'precision': [0.608, 0.628,
0.836, 0.432, 0.5823293172690763], 'avgPrecision': 0.6172658634538153, 'recall':
[0.608, 0.628, 0.836, 0.432, 0.5823293172690763], 'avgRecall':
0.6172658634538153, 'params': [{'activation': 'logistic', 'alpha': 0.0001,
'batch_size': 'auto', 'beta_1': 0.9, 'beta_2': 0.999, 'early_stopping': False,
'epsilon': 1e-08, 'hidden_layer_sizes': (100,), 'learning_rate': 'invscaling',
'learning_rate_init': 0.001, 'max_fun': 15000, 'max_iter': 5000, 'momentum':
0.9, 'n_iter_no_change': 10, 'nesterovs_momentum': True, 'power_t': 0.5,
'random_state': None, 'shuffle': True, 'solver': 'adam', 'tol': 0.0001,
'validation_fraction': 0.1, 'verbose': False, 'warm_start': False}]}
****
****
* Best Performing Model and Params is:
* {'classifier': 'DecisionTreeClassifier', 'features': 'Active inflammation?,
Severity of Crypt Arch, Increased lamina propria cellularity?, Marked &
transmucosal increase in lamina propria cellularity, Lamina propria polymorphs,
Crypt architecture, Patchy lamina propria cellularity?', 'accuracy': [0.6,
0.644, 0.824, 0.5, 0.5943775100401606], 'avgAccuracy': 0.6324755020080322, 'f1':
[0.6102253571117878, 0.655694554498395, 0.8272258125090278, 0.5153439153439153,
0.6049001073687206], 'avgF1': 0.6426779493663693, 'precision': [0.6, 0.644,
0.824, 0.5, 0.5943775100401606], 'avgPrecision': 0.6324755020080322, 'recall':
[0.6, 0.644, 0.824, 0.5, 0.5943775100401606], 'avgRecall': 0.6324755020080322,
'params': [{'ccp_alpha': 0.0, 'class_weight': None, 'criterion': 'entropy',
'max_depth': None, 'max_features': 'auto', 'max_leaf_nodes': None,
'min_impurity_decrease': 0.0, 'min_impurity_split': None, 'min_samples_leaf': 1,
'min_samples_split': 2, 'min_weight_fraction_leaf': 0.0, 'random_state': None,
'splitter': 'best'}]}
****

	model	features \
0	RandomForestClassifier	Active inflammation?, Severity of Crypt Arch, …
1	KNeighborsClassifier	Active inflammation?, Severity of Crypt Arch, …
2	LogisticRegression	Active inflammation?, Severity of Crypt Arch, …
3	GaussianNB	Active inflammation?, Severity of Crypt Arch, …
4	AdaBoostClassifier	Active inflammation?, Severity of Crypt Arch, …
5	DecisionTreeClassifier	Active inflammation?, Severity of Crypt Arch, …
6	SVC	Active inflammation?, Severity of Crypt Arch, …
7	MLPClassifier	Active inflammation?, Severity of Crypt Arch, …

	accuracy	f1	precision	recall \
0	0.634879	0.644458	0.634879	0.634879

```
1  0.634879  0.631056    0.634879  0.634879
2  0.615669  0.620181    0.615669  0.615669
3  0.615624  0.609752    0.615624  0.615624
4  0.572337  0.577204    0.572337  0.572337
5  0.632476  0.642678    0.632476  0.632476
6  0.588459  0.575761    0.588459  0.588459
7  0.617266  0.620892    0.617266  0.617266


                                                 params
0  {'bootstrap': True, 'ccp_alpha': 0.0, 'class_w…
1  {'algorithm': 'auto', 'leaf_size': 30, 'metric…
2  {'C': 1, 'class_weight': None, 'dual': False, …
3           {'priors': None, 'var_smoothing': 1e-09}
4  {'algorithm': 'SAMME.R', 'base_estimator': Non…
5  {'ccp_alpha': 0.0, 'class_weight': None, 'crit…
6  {'C': 1.0, 'break_ties': False, 'cache_size': …
7  {'activation': 'logistic', 'alpha': 0.0001, 'b…
```

```python
[105]:  now = datetime.datetime.now()
        print ("Current date and time : ")
        print (now.strftime("%Y-%m-%d %H:%M:%S"))
```

```
Current date and time :
2021-06-04 21:43:43
```

0.7.2 Creation of novel ML Models

```python
[ ]:
```

0.7.3 Running Models

```python
[ ]:
```

0.7.4 Results

```python
[127]:  smotePrintoutBytes = open('smotePrintout.txt','r')
        smotePrintout      = smotePrintoutBytes.read()
        smotePrintout[:100]
```

```
[127]:  '********************************************\nStarting SMOTE data
        set…\n**************************'
```

```python
[128]:  originalPrintoutBytes = open('originalDatasetPrintout.txt','r')
        originalPrintout      = originalPrintoutBytes.read()
        originalPrintout[:100]
```

```
[128]:  '********************************************\nStarting Original data
        set…\n**********************'
```

```python
[129]: msmotePrintoutBytes = open('msmotePrintout.txt','r')
       msmotePrintout      = msmotePrintoutBytes.read()
       msmotePrintout[:100]
```

```
[129]: '**********************************************\nStarting MSMOTE data
       set…\n*************************'
```

```python
[130]: '''
       Using the printout from the SMOTE and original runs,
       grab the dictionaries that match this format
       {'classifier':'RandomForestClassifier','features':'Feature1, Feature2'}
       '''
       smoteModelDictionaries = re.findall('Best Params Result: \n\*␣
        ↪\{([^}]+)\}',smotePrintout)
       originalModelDictionaries = re.findall('Best Params Result: \n\*␣
        ↪\{([^}]+)\}',originalPrintout)
       msmoteModelDictionaries = re.findall('Best Params Result: \n\*␣
        ↪\{([^}]+)\}',msmotePrintout)
```

```python
[131]: '''
       each dictionary is in format of 'key':'value' or 'key':[values] or 'key': 0.
        ↪0002 or 'key': None

       get the classifier: (text is here) ..... avgRecall : (text is here) .... avgF1 :
        ↪ (text is here)
       '''
       def getMetricsForAllModels(modelDictionaries, smote='smote'):
           listOfDicts = []
           for dictionary in modelDictionaries:
               keys   = ['classifier','avgAccuracy','avgF1','avgPrecision','avgRecall']
               values = re.findall("'classifier': '([^']+)'.+'avgAccuracy': ([.\d]+).
        ↪+'avgF1': ([.\d]+).+'avgPrecision': ([.\d]+).+'avgRecall': ([.
        ↪\d]+)",dictionary)[0]
               dictionary = dict(zip(keys,values))
               dictionary['smote'] = smote
               listOfDicts.append(dictionary)
           return listOfDicts
```

```python
[132]: smoteDictList    = getMetricsForAllModels(smoteModelDictionaries,'smote')
       originalDictList = getMetricsForAllModels(originalModelDictionaries,'no smote')
       msmoteDictList   = getMetricsForAllModels(msmoteModelDictionaries,'msmote')
```

```python
[133]: def createModelCompareDf(dictList):
           modelCompare = pd.DataFrame(columns =␣
        ↪['classifier','avgAccuracy','avgF1','avgPrecision','avgRecall'])
           for dictionary in dictList:
               modelCompare = modelCompare.append(dictionary, ignore_index=True)
```

```
    return modelCompare
```

[134]:
```
smoteCompareDf = createModelCompareDf(smoteDictList)
originalCompareDf = createModelCompareDf(originalDictList)
msmoteCompareDf = createModelCompareDf(msmoteDictList)
modelCompare    = pd.concat([smoteCompareDf,
 ↪originalCompareDf,msmoteCompareDf], ignore_index=True)
modelCompare.head()
```

[134]:
```
              classifier          avgAccuracy                avgF1  \
0  RandomForestClassifier  0.6969028112449799   0.7155392078257132
1    KNeighborsClassifier  0.6535903614457832    0.675490753065065
2      LogisticRegression  0.6375293172690764   0.6510828707605834
3               GaussianNB  0.6086265060240964   0.5661950836953876
4       AdaBoostClassifier  0.6085879518072289   0.6140078165468233

         avgPrecision            avgRecall  smote
0  0.6969028112449799  0.6969028112449799  smote
1  0.6535903614457832  0.6535903614457832  smote
2  0.6375293172690764  0.6375293172690764  smote
3  0.6086265060240964  0.6086265060240964  smote
4  0.6085879518072289  0.6085879518072289  smote
```

[135]:
```
modelCompare[['avgAccuracy','avgF1','avgPrecision','avgRecall']] =
 ↪modelCompare[['avgAccuracy','avgF1','avgPrecision','avgRecall']].
 ↪astype(float)
```

[136]:
```
bestModels = pd.merge(modelCompare[modelCompare['smote']=='smote'],
 ↪modelCompare[modelCompare['smote']=='smote'].
 ↪groupby('classifier')['avgAccuracy'].max().reset_index(),
 ↪on=['classifier','avgAccuracy'])
bestModelsNo = pd.merge(modelCompare[modelCompare['smote']=='no smote'],
 ↪modelCompare[modelCompare['smote']=='no smote'].
 ↪groupby('classifier')['avgAccuracy'].max().reset_index(),
 ↪on=['classifier','avgAccuracy'])
bestModelsM = pd.merge(modelCompare[modelCompare['smote']=='msmote'],
 ↪modelCompare[modelCompare['smote']=='msmote'].
 ↪groupby('classifier')['avgAccuracy'].max().reset_index(),
 ↪on=['classifier','avgAccuracy'])
```

[137]:
```
rotation = 90

fig,ax=plt.subplots(nrows=2,ncols=2,figsize=(20,15))
plt.subplots_adjust(hspace=0.5)
ax[0][0].scatter(bestModels['classifier'].unique(),bestModels['avgAccuracy'].
 ↪unique(),label='smote')
```

```python
ax[0][0].scatter(bestModelsNo['classifier'].
 ↪unique(),bestModelsNo['avgAccuracy'].unique(),label='no smote')
ax[0][0].scatter(bestModelsM['classifier'].unique(),bestModelsM['avgAccuracy'].
 ↪unique(),label='msmote')
ax[0][0].tick_params(rotation=rotation)
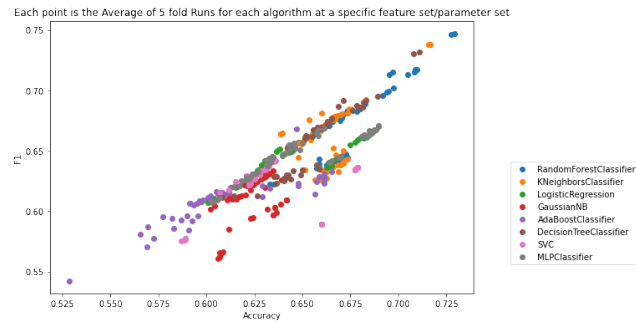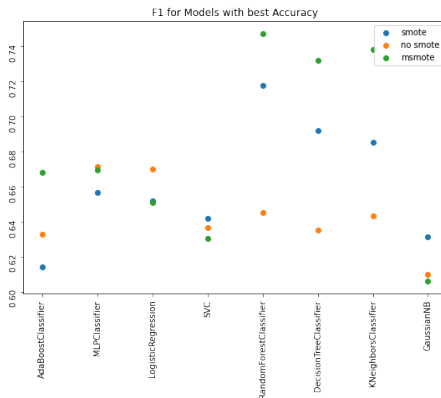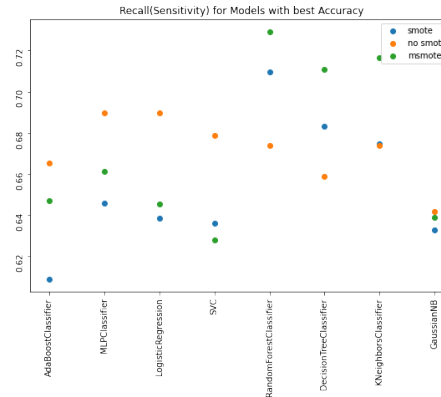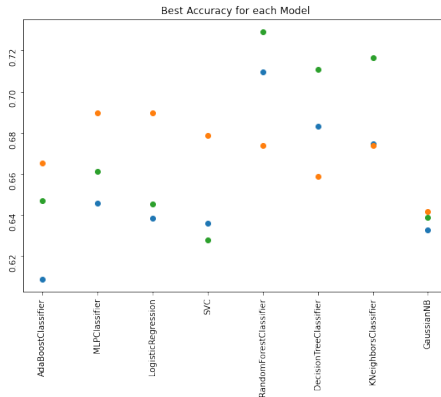ax[0][0].set(title='Best Accuracy for each Model')

ax[0][1].scatter(bestModels['classifier'].unique(),bestModels['avgRecall'].
 ↪unique(),label='smote')
ax[0][1].scatter(bestModelsNo['classifier'].unique(),bestModelsNo['avgRecall'].
 ↪unique(),label='no smote')
ax[0][1].scatter(bestModelsM['classifier'].unique(),bestModelsM['avgRecall'].
 ↪unique(),label='msmote')
ax[0][1].tick_params(rotation=rotation)
ax[0][1].set(title='Recall(Sensitivity) for Models with best Accuracy')
ax[0][1].legend()

ax[1][0].scatter(bestModels['classifier'].unique(),bestModels['avgF1'].unique(),
label='smote')
ax[1][0].scatter(bestModelsNo['classifier'].unique(),bestModelsNo['avgF1'].
 ↪unique(),label='no smote')
ax[1][0].scatter(bestModelsM['classifier'].unique(),bestModelsM['avgF1'].
 ↪unique(),label='msmote')
ax[1][0].tick_params(rotation=rotation)
ax[1][0].set(title='F1 for Models with best Accuracy')
ax[1][0].legend()

for classifier in modelCompare['classifier'].unique():
    subdf = modelCompare[modelCompare['classifier']==classifier]
    ax[1][1].scatter(subdf['avgAccuracy'],subdf['avgF1'],label=classifier)
ax[1][1].set(xlabel='Accuracy',ylabel='F1',title='Each point is the Average of␣
 ↪5 fold Runs for each algorithm at a specific feature set/parameter set')
ax[1][1].legend(bbox_to_anchor=(1.4,0.5))
```

[137]: <matplotlib.legend.Legend at 0x23cc6ef9460>

Best Accuracy for each Model

Recall(Sensitivity) for Models with best Accuracy

F1 for Models with best Accuracy

Each point is the Average of 5 fold Runs for each algorithm at a specific feature set/parameter set

[138]:
```python
fig,ax=plt.subplots()
ax.scatter(bestModels['classifier'].unique(),bestModels['avgRecall'].
 ↪unique(),label='smote')
ax.scatter(bestModelsNo['classifier'].unique(),bestModelsNo['avgRecall'].
 ↪unique(),label='no smote')
ax.scatter(bestModelsM['classifier'].unique(),bestModelsM['avgRecall'].
 ↪unique(),label='msmote')
ax.tick_params(rotation=90)
ax.set(title='Precision/Recall for Models with best Accuracy')
ax.legend()
```

[138]: <matplotlib.legend.Legend at 0x23cc6fa4070>

Precision/Recall for Models with best Accuracy
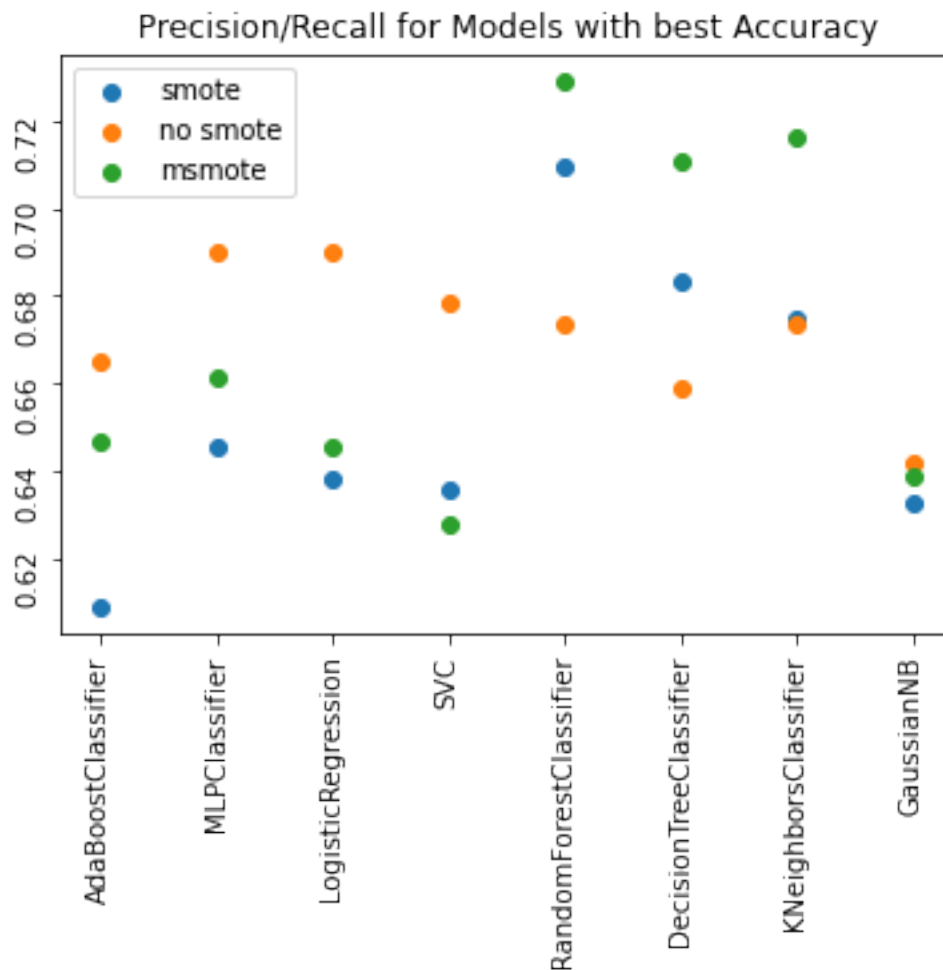
```
[139]: fig,ax=plt.subplots()
       ax.scatter(bestModels['classifier'].unique(),bestModels['avgF1'].
        ↪unique(),label='smote')
       ax.scatter(bestModelsNo['classifier'].unique(),bestModelsNo['avgF1'].
        ↪unique(),label='no smote')
       ax.scatter(bestModelsM['classifier'].unique(),bestModelsM['avgF1'].
        ↪unique(),label='msmote')
       ax.tick_params(rotation=90)
       ax.set(title='F1 for Models with best Accuracy')
       ax.legend()
```

[139]: <matplotlib.legend.Legend at 0x23cc6fc0310>

F1 for Models with best Accuracy
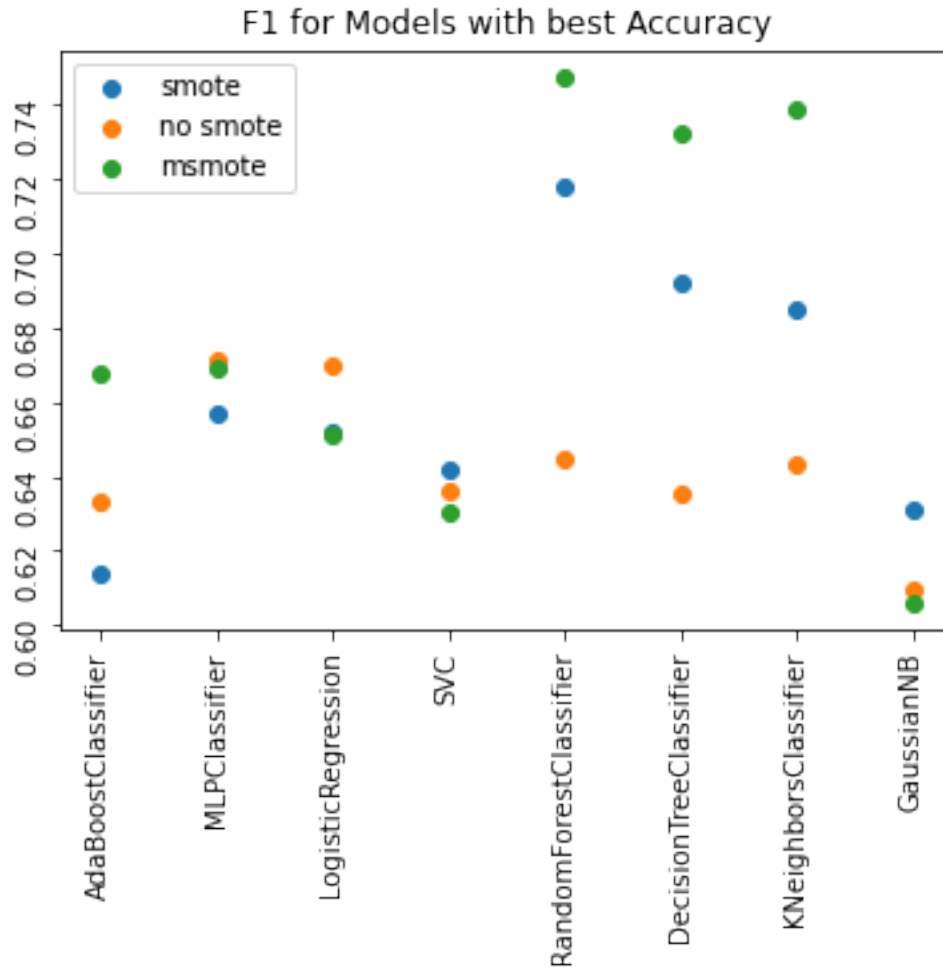

```
[140]: fig,ax=plt.subplots()
       for classifier in modelCompare['classifier'].unique():
           subdf = modelCompare[modelCompare['classifier']==classifier]
           ax.scatter(subdf['avgAccuracy'],subdf['avgF1'],label=classifier)
       ax.set(xlabel='Accuracy',ylabel='F1',title='Each point is the Average of 5 fold␣
        ↪Runs for each algorithm at a specific feature set/parameter set')
       ax.legend(bbox_to_anchor=(1.4,0.5))
```

```
[140]: <matplotlib.legend.Legend at 0x23cc6de8280>
```

Each point is the Average of 5 fold Runs for each algorithm at a specific feature set/parameter set
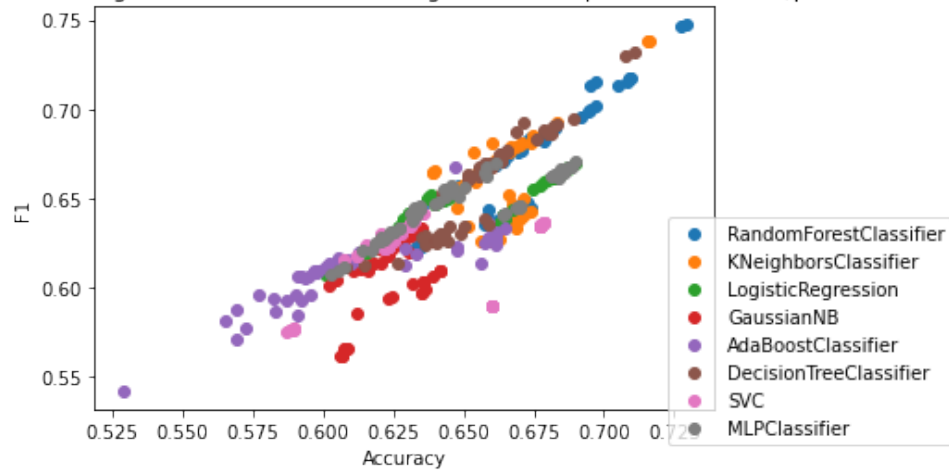

```
[141]: classifiers = list(bestModels['classifier'].unique())
       f1s        = list(bestModels['avgPrecision'].astype(float).unique())
       classifiers2 = list(bestModelsNo['classifier'].unique())
       f1s2         = list(bestModelsNo['avgPrecision'].astype(float).unique())
       classifiers3 = list(bestModelsM['classifier'].unique())
       f1s3         = list(bestModelsM['avgPrecision'].astype(float).unique())
       fig,ax=plt.subplots()
       ax.scatter(classifiers,f1s,label='smote')
       ax.scatter(classifiers2,f1s2,label='no smote')
       ax.scatter(classifiers3,f1s3,label='msmote')
       ax.tick_params(rotation=90)
       ax.set(title='Precision for Models with best Accuracy')
       ax.legend()
```

[141]: <matplotlib.legend.Legend at 0x23cc70c2c40>

Precision for Models with best Accuracy
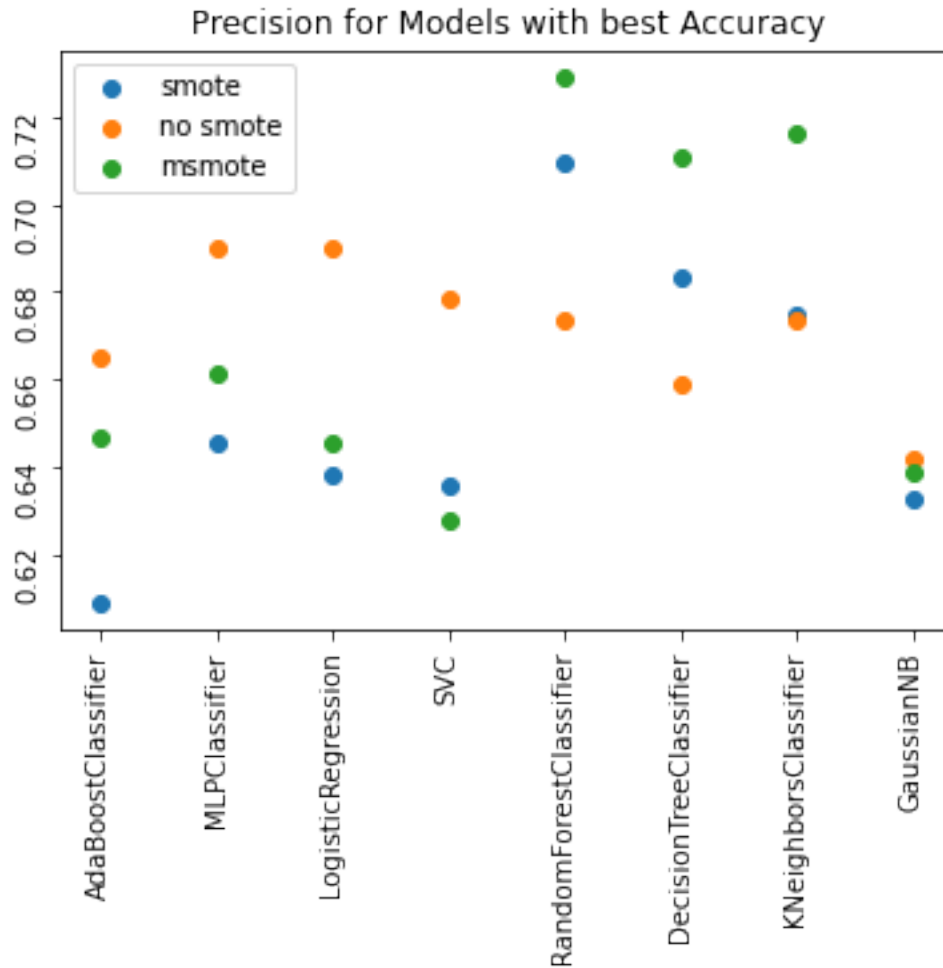

```
classifiers  = list(bestModels['classifier'].unique())
f1s          = list(bestModels['avgAccuracy'].astype(float).unique())
classifiers2 = list(bestModelsNo['classifier'].unique())
f1s2         = list(bestModelsNo['avgAccuracy'].astype(float).unique())
classifiers3 = list(bestModelsM['classifier'].unique())
f1s3         = list(bestModelsM['avgAccuracy'].astype(float).unique())
fig,ax=plt.subplots()
ax.scatter(classifiers,f1s,label='smote')
ax.scatter(classifiers2,f1s2,label='no smote')
ax.scatter(classifiers3,f1s3,label='msmote')
ax.tick_params(rotation=90)
ax.set(title='Best Accuracy for each Model')
ax.legend(bbox_to_anchor=(1.4,0.5))
```

[142]: <matplotlib.legend.Legend at 0x23cc712b160>

Best Accuracy for each Model
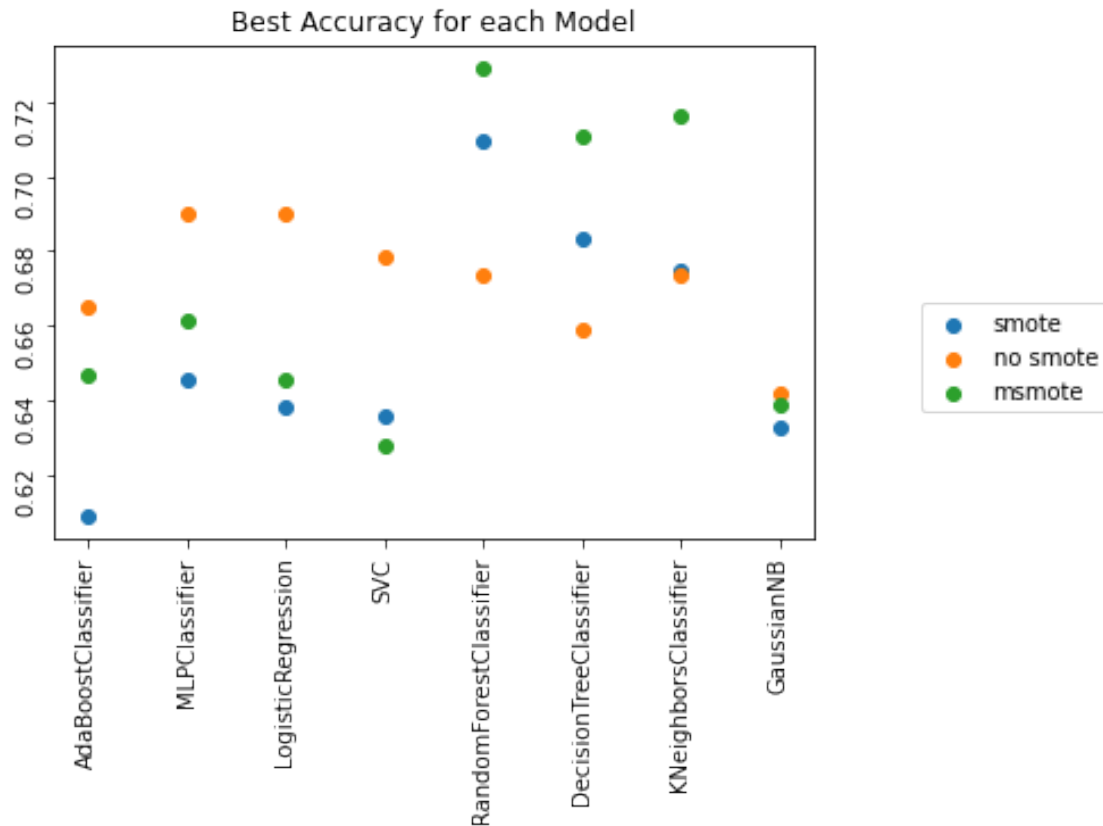

```
[150]: bestRf = pd.merge( modelCompare,
       modelCompare[modelCompare['classifier']=='RandomForestClassifier'].
       →groupby(['smote','classifier'])['avgAccuracy'].max().reset_index(),
       on = ['classifier','avgAccuracy'])

       fig,ax= plt.subplots()

       ax.scatter(bestRf['smote_x'],bestRf['avgF1'],label='f1')
       ax.scatter(bestRf['smote_x'],bestRf['avgRecall']+0.001,label='recall')
       ax.scatter(bestRf['smote_x'],bestRf['avgPrecision'],label='precision')
       ax.scatter(bestRf['smote_x'],bestRf['avgAccuracy'],label='accuracy')
       ax.set(ylabel='metric value')
       ax.legend(bbox_to_anchor=(1.4,0.5))
       ax.set(ylim=[0.6,0.9])
       ax.set(title='Best SMOTE vs Best No Smote Models for Random Forest (the best␣
       →out of all models)')
```

```
[150]: [Text(0.5, 1.0, 'Best SMOTE vs Best No Smote Models for Random Forest (the best
       out of all models)')]
```

Best SMOTE vs Best No Smote Models for Random Forest (the best out of all models)
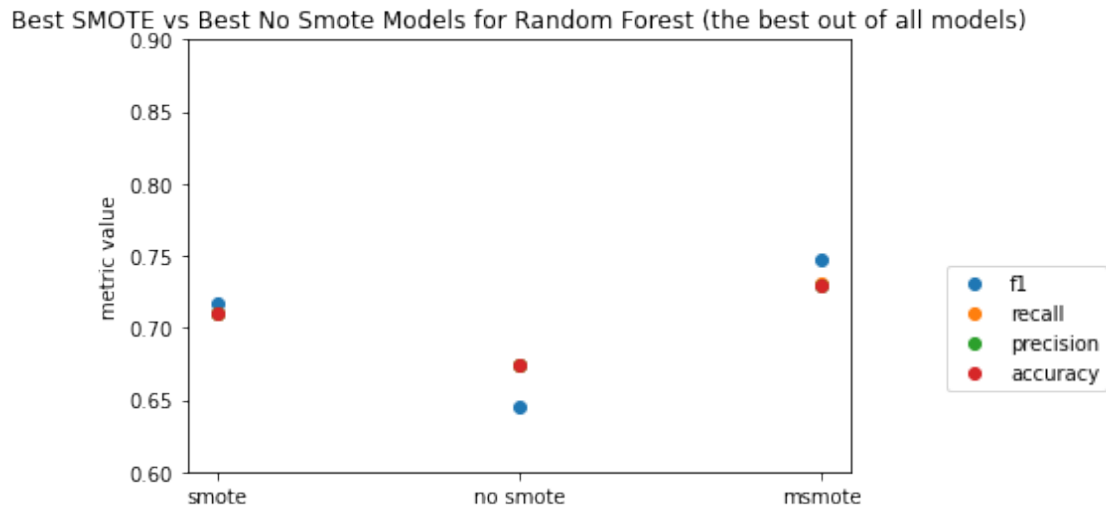

```
[144]: bestRf
```

```
[144]:           classifier  avgAccuracy      avgF1  avgPrecision  avgRecall  \
       0  RandomForestClassifier     0.709767   0.717516      0.709767   0.709767
       1  RandomForestClassifier     0.673683   0.644905      0.673683   0.673683
       2  RandomForestClassifier     0.729304   0.747268      0.729304   0.729304

           smote_x    smote_y
       0     smote      smote
       1  no smote   no smote
       2    msmote     msmote
```

```
[145]: '''

       acc
       recall
       f1
       precision

       '''
```

```
[145]: '\n\nacc          \nrecall\nf1\nprecision\n\n'
```

```
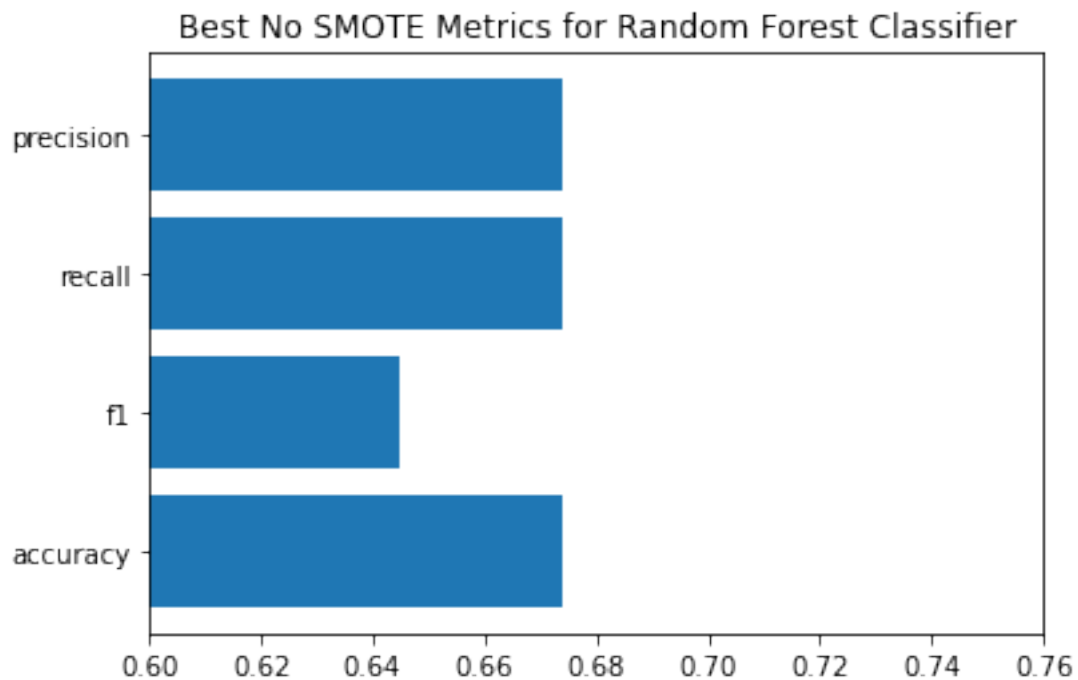[163]: fig,ax=plt.subplots()
       ax.barh(['accuracy','f1','recall','precision'],
               [0.709767,0.717516,0.709767,0.709767],label='smote')
       ax.set(xlim=[0.6,0.76])
       ax.set(title='Best SMOTE Metrics for Random Forest Classifier')
```

```
[163]: [Text(0.5, 1.0, 'Best SMOTE Metrics for Random Forest Classifier')]
```

Best SMOTE Metrics for Random Forest Classifier
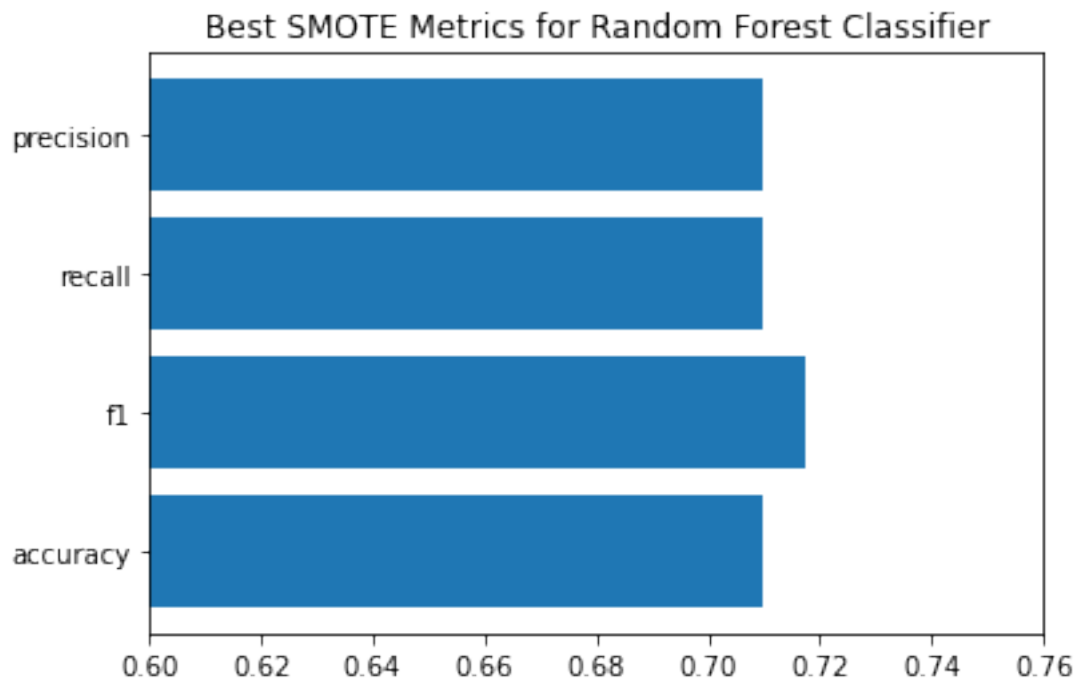

```
[162]: fig,ax=plt.subplots()
       ax.barh(['accuracy','f1','recall','precision'],
               [0.673683,0.644905,0.673683,0.673683],label='no smote')
       ax.set(xlim=[0.6,0.76])
       ax.set(title='Best No SMOTE Metrics for Random Forest Classifier')
```

```
[162]: [Text(0.5, 1.0, 'Best No SMOTE Metrics for Random Forest Classifier')]
```

Best No SMOTE Metrics for Random Forest Classifier

```
[161]: fig,ax=plt.subplots()
       ax.barh(['accuracy','f1','recall','precision'],
               [0.729304,0.747268,0.729304,0.729304],label='msmote')
       ax.set(xlim=[0.6,0.76])
       ax.set(title='Best MSMOTE Metrics for Random Forest Classifier')
```

[161]: [Text(0.5, 1.0, 'Best MSMOTE Metrics for Random Forest Classifier')]

Best MSMOTE Metrics for Random Forest Classifier

[ ]:

[ ]:

[ ]:

[ ]:
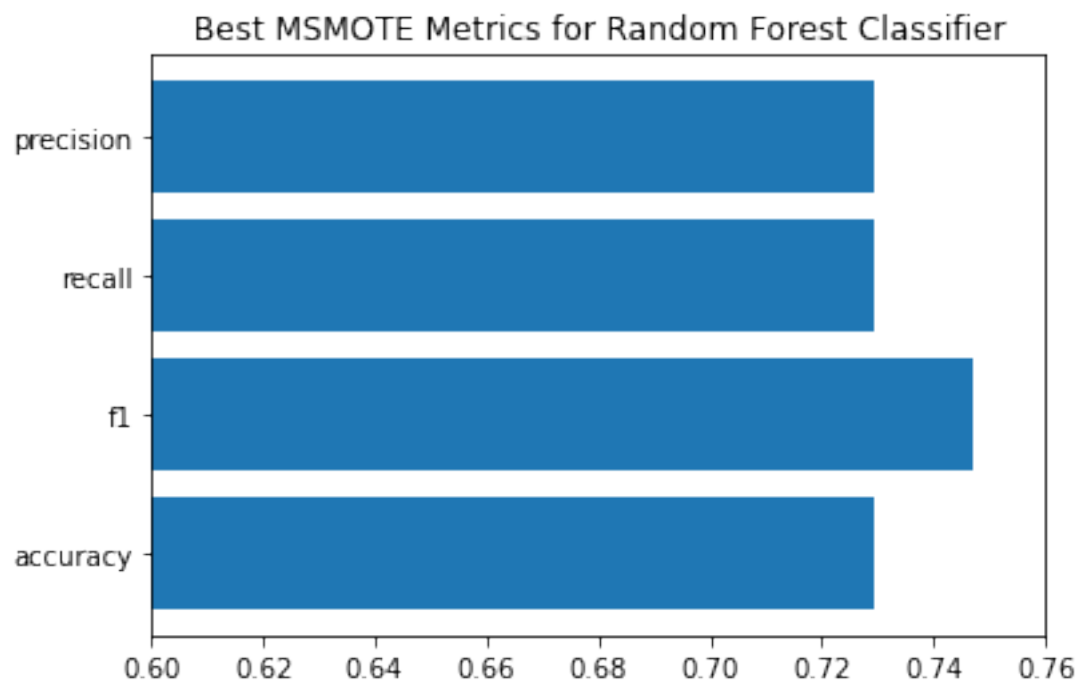
0.7.5 Statistics

[ ]:

0.7.6 Visualizations

[ ]:

0.7.7 Discussion

[ ]:

0.7.8 Conclusions

[ ]: