CapStone B Final WB - Only IBD - Thad

June 6, 2021

0.1 ## Table of Contents

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0.3 ### Libraries

```python
[1]: # 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
[2]: # 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
[3]: # 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
     from sklearn.svm import SVC
     from sklearn.tree import DecisionTreeClassifier
```

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

```
[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 17:26:25
```

0.4 ## Data

```
[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>
```

```
[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>
     """)
```

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

0.4.1 Pull in Data

ENDSC Data

```
[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")
     cleaned_cases_og = cleaned_cases
     cleaned_cases.head()
```

```
[8]:    Year  Lab No         Age  Sex  Active inflammation?  Mucosal surface  \
     0    90    8989  52.410959    1                     0                0
     1    92   10640  24.673973    1                     1                0
     2    92    7489  51.345205    0                     1                0
     3    91    8691  48.556164    1                     1                0
     4    90   14201  39.367123    0                     0                0

        Crypt architecture  Crypt profiles  Increased lamina propria cellularity?  \
     0                   2               5                                       1
     1                   0               7                                       1
     2                   1               7                                       1
     3                   2               6                                       1
     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                2                            0                       0
     2                2                            0                       0
     3                0                            0                       0
     4                0                            1                       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                Crohns                Resection
2                Crohns                Endoscopy
3                    UC                Resection
4                Crohns                Endoscopy


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


                   Observing pathologists diagnosis
0              Chronic idiopathic IBD - indeterminate
1   Chronic idiopathic IBD - highly suggestive of …
2   Chronic idiopathic IBD - highly suggestive of …
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"]]
```

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

```
[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 375 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': 285, 'CROHNS': 90})
```

```
[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:\ProgramData\Anaconda\lib\site-packages\seaborn\distributions.py:2557:
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).
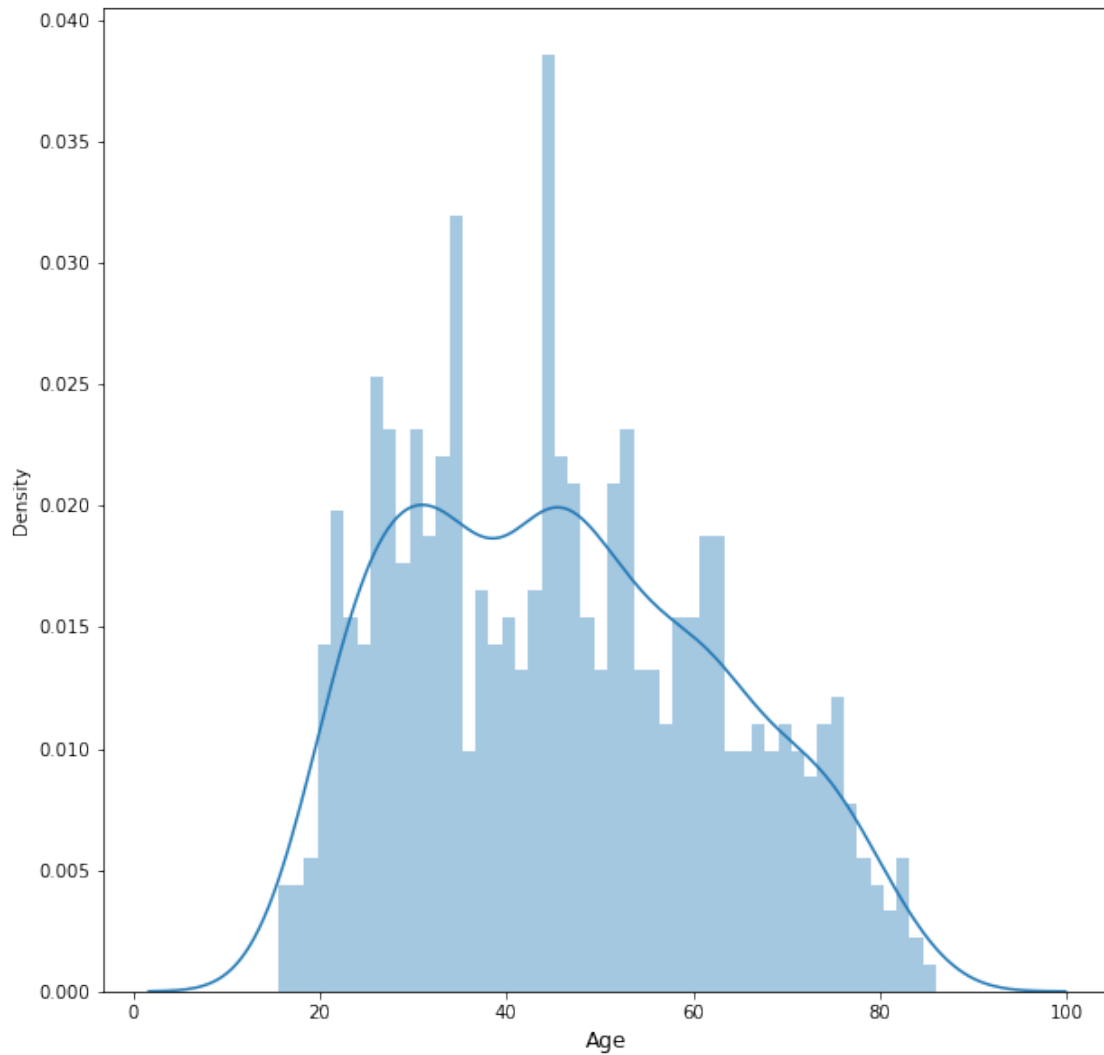
The data below shows that majority of the cases are from years 90-92 and 95-96. The other years have minimal contribution for years prior to year 90.

```
[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.

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

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

[30]: <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.

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

[31]:

	Age	Sex	Active inflammation? \
Age	1.000000	-0.024630	0.000645
Sex	-0.024630	1.000000	0.012179
Active inflammation?	0.000645	0.012179	1.000000
Mucosal surface	0.066984	0.105066	0.281825
Crypt architecture	0.024193	0.000677	0.066631

	Mucosal surface	Crypt architecture	Crypt profiles \
Age	0.066984	0.024193	-0.013297
Sex	0.105066	0.000677	0.035672
Active inflammation?	0.281825	0.066631	0.136076
Mucosal surface	1.000000	-0.060980	0.166125
Crypt architecture	-0.060980	1.000000	0.131529

	Increased lamina propria cellularity? \
Age	0.025116
Sex	-0.001894
Active inflammation?	-0.694303
Mucosal surface	-0.278963
Crypt architecture	-0.129055

	Mild & superficial increase in lamina propria cellularity? \
Age	-0.014794
Sex	0.011948
Active inflammation?	0.076122
```

```
Mucosal surface                                                     -0.059369
Crypt architecture                                                  -0.025416


                        Increased lymphoid aggregates in lamina propria?  \
Age                                                          0.030832
Sex                                                          0.010158
Active inflammation?                                         0.320400
Mucosal surface                                              0.025034
Crypt architecture                                          -0.104277


                        Patchy lamina propria cellularity?  …  \
Age                                          0.030682  …
Sex                                         -0.012239  …
Active inflammation?                         0.419807  …
Mucosal surface                             -0.067872  …
Crypt architecture                           0.071958  …


                        Lamina propria polymorphs  Epithelial changes  \
Age                                      0.009706           -0.005371
Sex                                     -0.007131           -0.005653
Active inflammation?                     0.900782            0.526095
Mucosal surface                          0.191447            0.228068
Crypt architecture                       0.088256            0.076395


                        Mucin depletion  Intraepithelial lymphocytes  \
Age                           -0.017000                    -0.014212
Sex                            0.059029                    -0.033380
Active inflammation?           0.575044                    -0.044335
Mucosal surface                0.310093                    -0.026130
Crypt architecture             0.107059                    -0.004681


                        Subepithelial collagen  Lamina propria granulomas  \
Age                                        NaN                  -0.015907
Sex                                        NaN                  -0.004193
Active inflammation?                       NaN                   0.097917
Mucosal surface                            NaN                  -0.051666
Crypt architecture                         NaN                   0.038857


                        Submucosal granulomas  Basal histiocytic cells  \
Age                                 -0.019861                 0.055083
Sex                                 -0.006338                 0.040239
Active inflammation?                 0.018071                 0.104854
Mucosal surface                     -0.040136                 0.023768
Crypt architecture                   0.032759                -0.007064


                        Confirmed diagnosis  Severity of Crypt Arch
Age                              -0.015878                0.024193
```

```
Sex                              -0.113294              0.000677
Active inflammation?             -0.079975              0.066631
Mucosal surface                  -0.229855             -0.060980
Crypt architecture               -0.010103              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.

```
[32]: 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.

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

```
[34]: %%time
      sns.pairplot(cleaned_cases)
```

Wall time: 1min 36s

```
[34]: <seaborn.axisgrid.PairGrid at 0x22ada860400>
```

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.

```
[36]:  # odds ratio calc
       uc_ch = cleaned_cases.loc[cleaned_cases["Confirmed diagnosis"].isin(['UC',␣
        ↪'CROHNS'])]
       table_uc = uc_ch[["Confirmed diagnosis", "Sex", "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)
```

```
                     Sex   Active inflammation?
Confirmed diagnosis
CROHNS                96                     87
UC                   205                    283
OddsR:  1.5233 p-Value: 0.01851111505184613
```

*** 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.

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

Supervised Learning

Get only the binary variables

```
[38]: 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

```
[39]: 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                  63
                                    UC                     231
1                                   CROHNS                  27
                                    UC                      54
dtype: int64
Patchy lamina propria cellularity?
0    294
1     81
dtype: int64
```

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

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

```
[40]: Patchy lamina propria cellularity?  Confirmed diagnosis
      0                                   CROHNS                 0.214286
                                          UC                     0.785714
      1                                   CROHNS                 0.333333
                                          UC                     0.666667
      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?

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

```
[41]: Confirmed diagnosis
      CROHNS    1.555556
      UC        0.848485
      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)

```
[42]: #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()
```

```
[42]: variable                            value  Confirmed diagnosis
      Basal histiocytic cells             0      CROHNS                   86
                                                 UC                      269
                                          1      CROHNS                    4
                                                 UC                       16
      Increased lamina propria cellularity?  0   CROHNS                   36
      dtype: int64
```

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

```
[43]: variable                                    value
      Basal histiocytic cells                     0          355
                                                  1           20
      Increased lamina propria cellularity?       0          103
                                                  1          272
      Increased lymphoid aggregates in lamina propria?  0    307
      dtype: int64
```

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

```
[44]: variable                                value  Confirmed diagnosis
      Basal histiocytic cells                 0      CROHNS                 0.242254
                                                     UC                     0.757746
                                              1      CROHNS                 0.200000
                                                     UC                     0.800000
      Increased lamina propria cellularity?   0      CROHNS                 0.349515
      dtype: float64
```

```
[45]: #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()
```

[45]:
```
                                                                    0
variable                                 Confirmed diagnosis
Basal histiocytic cells                  CROHNS                0.200000
                                         UC                    0.800000
Increased lamina propria cellularity?    CROHNS                0.198529
                                         UC                    0.801471
Increased lymphoid aggregates in lamina propria? CROHNS        0.205882
```

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?

[46]:
```
noSymptom = pd.merge(noSymptom, allCombos, left_index=True, right_index=True,␣
 ↪how='outer').fillna({0:0})
noSymptom.head()
```

[46]:
```
                                                                    0
variable                                 Confirmed diagnosis
Basal histiocytic cells                  CROHNS                0.242254
                                         UC                    0.757746
Increased lamina propria cellularity?    CROHNS                0.349515
                                         UC                    0.650485
Increased lymphoid aggregates in lamina propria? CROHNS        0.247557
```

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?

[47]:
```
relativeRiskIbd = (yesSymptom/noSymptom).reset_index()
relativeRiskIbd.head()
```

[47]:
```
                                           variable Confirmed diagnosis  \
0                           Basal histiocytic cells              CROHNS
1                           Basal histiocytic cells                  UC
2             Increased lamina propria cellularity?              CROHNS
3             Increased lamina propria cellularity?                  UC
4  Increased lymphoid aggregates in lamina propria?              CROHNS
```

```
        0
0  0.825581
1  1.055762
2  0.568015
3  1.232112
4  0.831656
```

[48]:
```python
fig,ax = plt.subplots(nrows=1,ncols=2, 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')
```

[48]: [Text(0.5, 1.0, 'UC'),
      Text(0.5, 0, 'Relative Risk of Diagnosis Given That Patient has this Symptom')]
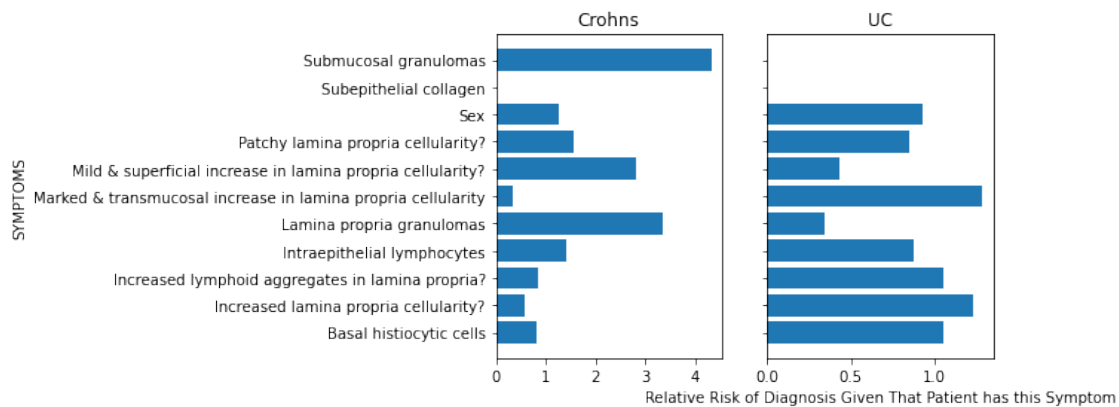
For unsupervised EDA, The objective is to find multiple symptoms that are all 1 for the same patients and are all 0 for other patients.

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.

```
[49]: 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
```

[49]: 1.2046332046332047

Get the cross tab of every symptom with every other symptom

```
[50]: 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
```

```
[51]: 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.

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

```
[52]:                                               Basal histiocytic
      cells_0  \
```

```
variable                                           value
Basal histiocytic cells                            0
1.000000
                                                   1
0.000000
Increased lamina propria cellularity?              0
0.980583
                                                   1
0.933824
Increased lymphoid aggregates in lamina propria? 0
0.941368
```

```
                                                   Basal histiocytic
cells_1  \
variable                                           value
Basal histiocytic cells                            0
0.000000
                                                   1
1.000000
Increased lamina propria cellularity?              0
0.019417
                                                   1
0.066176
Increased lymphoid aggregates in lamina propria? 0
0.058632
```

```
                                                   Increased lamina propria
cellularity?_0  \
variable                                           value
Basal histiocytic cells                            0
0.284507
                                                   1
0.100000
Increased lamina propria cellularity?              0
1.000000
                                                   1
0.000000
Increased lymphoid aggregates in lamina propria? 0
0.335505
```

```
                                                   Increased lamina propria
cellularity?_1  \
variable                                           value
Basal histiocytic cells                            0
0.715493
                                                   1
0.900000
```

```
Increased lamina propria cellularity?            0
0.000000
                                                 1
1.000000
Increased lymphoid aggregates in lamina propria? 0
0.664495

                                                                Increased lymphoid
aggregates in lamina propria?_0  \
variable                                         value
Basal histiocytic cells                          0
0.814085
                                                 1
0.900000
Increased lamina propria cellularity?            0
1.000000
                                                 1
0.750000
Increased lymphoid aggregates in lamina propria? 0
1.000000

                                                                Increased lymphoid
aggregates in lamina propria?_1  \
variable                                         value
Basal histiocytic cells                          0
0.185915
                                                 1
0.100000
Increased lamina propria cellularity?            0
0.000000
                                                 1
0.250000
Increased lymphoid aggregates in lamina propria? 0
0.000000

                                                                Intraepithelial
lymphocytes_0  \
variable                                         value
Basal histiocytic cells                          0
0.974648
                                                 1
1.000000
Increased lamina propria cellularity?            0
0.980583
                                                 1
0.974265
Increased lymphoid aggregates in lamina propria? 0
```

```
0.977199

                                                      Intraepithelial
lymphocytes_1  \
variable                                      value
Basal histiocytic cells                       0
0.025352
                                              1
0.000000
Increased lamina propria cellularity?         0
0.019417
                                              1
0.025735
Increased lymphoid aggregates in lamina propria? 0
0.022801


                                                      Lamina propria
granulomas_0  \
variable                                      value
Basal histiocytic cells                       0
0.963380
                                              1
0.900000
Increased lamina propria cellularity?         0
0.980583
                                              1
0.952206
Increased lymphoid aggregates in lamina propria? 0
0.951140


                                                      Lamina propria
granulomas_1  \
variable                                      value
Basal histiocytic cells                       0
0.036620
                                              1
0.100000
Increased lamina propria cellularity?         0
0.019417
                                              1
0.047794
Increased lymphoid aggregates in lamina propria? 0
0.048860


                                                      …  \
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
0.329577
                                                 1
0.300000
Increased lamina propria cellularity?            0
0.000000
                                                 1
0.452206
Increased lymphoid aggregates in lamina propria? 0
0.400651


                                                       Mild & superficial
increase in lamina propria cellularity?_0  \
variable                                         value
Basal histiocytic cells                          0
0.991549
                                                 1
1.000000
Increased lamina propria cellularity?            0
1.000000
                                                 1
0.988971
Increased lymphoid aggregates in lamina propria? 0
0.990228


                                                       Mild & superficial
increase in lamina propria cellularity?_1  \
variable                                         value
Basal histiocytic cells                          0
0.008451
                                                 1
0.000000
Increased lamina propria cellularity?            0
0.000000
                                                 1
0.011029
Increased lymphoid aggregates in lamina propria? 0
0.009772
```

```
                                                  Patchy lamina propria
cellularity?_0  \
variable                                          value
Basal histiocytic cells                           0
0.800000
                                                  1
0.500000
Increased lamina propria cellularity?             0
1.000000
                                                  1
0.702206
Increased lymphoid aggregates in lamina propria? 0
0.745928


                                                  Patchy lamina propria
cellularity?_1  \
variable                                          value
Basal histiocytic cells                           0
0.200000
                                                  1
0.500000
Increased lamina propria cellularity?             0
0.000000
                                                  1
0.297794
Increased lymphoid aggregates in lamina propria? 0
0.254072


                                                       Sex_0      Sex_1  \
variable                                          value
Basal histiocytic cells                           0    0.523944  0.476056
                                                  1    0.750000  0.250000
Increased lamina propria cellularity?             0    0.533981  0.466019
                                                  1    0.536765  0.463235
Increased lymphoid aggregates in lamina propria? 0    0.537459  0.462541


                                                  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              0.988732
                                                           1              1.000000
Increased lamina propria cellularity?                      0              1.000000
                                                           1              0.985294
Increased lymphoid aggregates in lamina propria? 0                        0.986971


                                                               Submucosal granulomas_1
variable                                                   value
Basal histiocytic cells                                    0              0.011268
                                                           1              0.000000
Increased lamina propria cellularity?                      0              0.000000
                                                           1              0.014706
Increased lymphoid aggregates in lamina propria? 0                        0.013029

[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.

```
[53]: 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

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

```
[54]:                                                      Basal histiocytic cells_0  \
      variable
      Basal histiocytic cells                                           0.000000
      Increased lamina propria cellularity?                             0.952315
      Increased lymphoid aggregates in lamina propria?                  1.031040
      Intraepithelial lymphocytes                                       1.057803
      Lamina propria granulomas                                         0.912281


                                                           Basal histiocytic cells_1  \
      variable
      Basal histiocytic cells                                                inf
      Increased lamina propria cellularity?                             3.408088
      Increased lymphoid aggregates in lamina propria?                  0.501634
```

```
Intraepithelial lymphocytes                                              0.000000
Lamina propria granulomas                                                2.666667

                                                   Increased lamina propria
cellularity?_0  \
variable
Basal histiocytic cells
0.351485
Increased lamina propria cellularity?
0.000000
Increased lymphoid aggregates in lamina propria?
0.000000
Intraepithelial lymphocytes
0.805281
Lamina propria granulomas
0.475248


                                                   Increased lamina propria
cellularity?_1  \
variable
Basal histiocytic cells
1.257874
Increased lamina propria cellularity?
inf
Increased lymphoid aggregates in lamina propria?
1.504902
Intraepithelial lymphocytes
1.074214
Lamina propria granulomas
1.204633


                                                   Increased lymphoid aggregates
in lamina propria?_0  \
variable
Basal histiocytic cells
1.105536
Increased lamina propria cellularity?
0.750000
Increased lymphoid aggregates in lamina propria?
0.000000
Intraepithelial lymphocytes
0.948889
Lamina propria granulomas
1.232877


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

```
variable
Basal histiocytic cells
0.537879
Increased lamina propria cellularity?
inf
Increased lymphoid aggregates in lamina propria?
inf
Intraepithelial lymphocytes
1.232323
Lamina propria granulomas
0.000000


                                        Intraepithelial lymphocytes_0
\
variable
Basal histiocytic cells                                     1.026012
Increased lamina propria cellularity?                       0.993557
Increased lymphoid aggregates in lamina propria?            0.993235
Intraepithelial lymphocytes                                 0.000000
Lamina propria granulomas                                   0.954545


                                        Intraepithelial lymphocytes_1
\
variable
Basal histiocytic cells                                     0.000000
Increased lamina propria cellularity?                       1.325368
Increased lymphoid aggregates in lamina propria?            1.289916
Intraepithelial lymphocytes                                      inf
Lamina propria granulomas                                   3.000000


                                        Lamina propria granulomas_0  \
variable
Basal histiocytic cells                                     0.934211
Increased lamina propria cellularity?                       0.971061
Increased lymphoid aggregates in lamina propria?            1.051370
Intraepithelial lymphocytes                                 0.924242
Lamina propria granulomas                                   0.000000


                                        Lamina propria granulomas_1  \
variable
Basal histiocytic cells                                     2.730769
Increased lamina propria cellularity?                       2.461397
Increased lymphoid aggregates in lamina propria?            0.000000
Intraepithelial lymphocytes                                 2.904762
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
0.910256
Increased lamina propria cellularity?
inf
Increased lymphoid aggregates in lamina propria?
0.000000
Intraepithelial lymphocytes
1.016667
Lamina propria granulomas
0.000000


                                       Mild & superficial increase in
lamina propria cellularity?_0  \
variable
Basal histiocytic cells
1.008523
Increased lamina propria cellularity?
0.988971
Increased lymphoid aggregates in lamina propria?
1.009868
Intraepithelial lymphocytes
1.008264
Lamina propria granulomas
1.008403


                                       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
0.625000
Increased lamina propria cellularity?
0.702206
Increased lymphoid aggregates in lamina propria?
1.281467
Intraepithelial lymphocytes
0.991870
Lamina propria granulomas
0.164384


                                          Patchy lamina propria
cellularity?_1  \
variable
Basal histiocytic cells
2.500000
Increased lamina propria cellularity?
inf
Increased lymphoid aggregates in lamina propria?
0.173643
Intraepithelial lymphocytes
1.029536
Lamina propria granulomas
4.588235


                                                    Sex_0      Sex_1  \
variable
Basal histiocytic cells                          1.431452  0.525148
Increased lamina propria cellularity?            1.005214  0.994026
Increased lymphoid aggregates in lamina propria? 0.985027  1.017399
Intraepithelial lymphocytes                      0.616162  1.452381
Lamina propria granulomas                        0.865979  1.156627


                                                  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                                      1.011396
Increased lamina propria cellularity?                        0.985294
Increased lymphoid aggregates in lamina propria?             1.013201
Intraepithelial lymphocytes                                  1.011050
Lamina propria granulomas                                    0.802228

                                                  Submucosal granulomas_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                                           72.0

[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

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

```
[55]: 1.2046332046332047
```

Replace infinity values or abnormally high Relative risks with 0

```
[56]: 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

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

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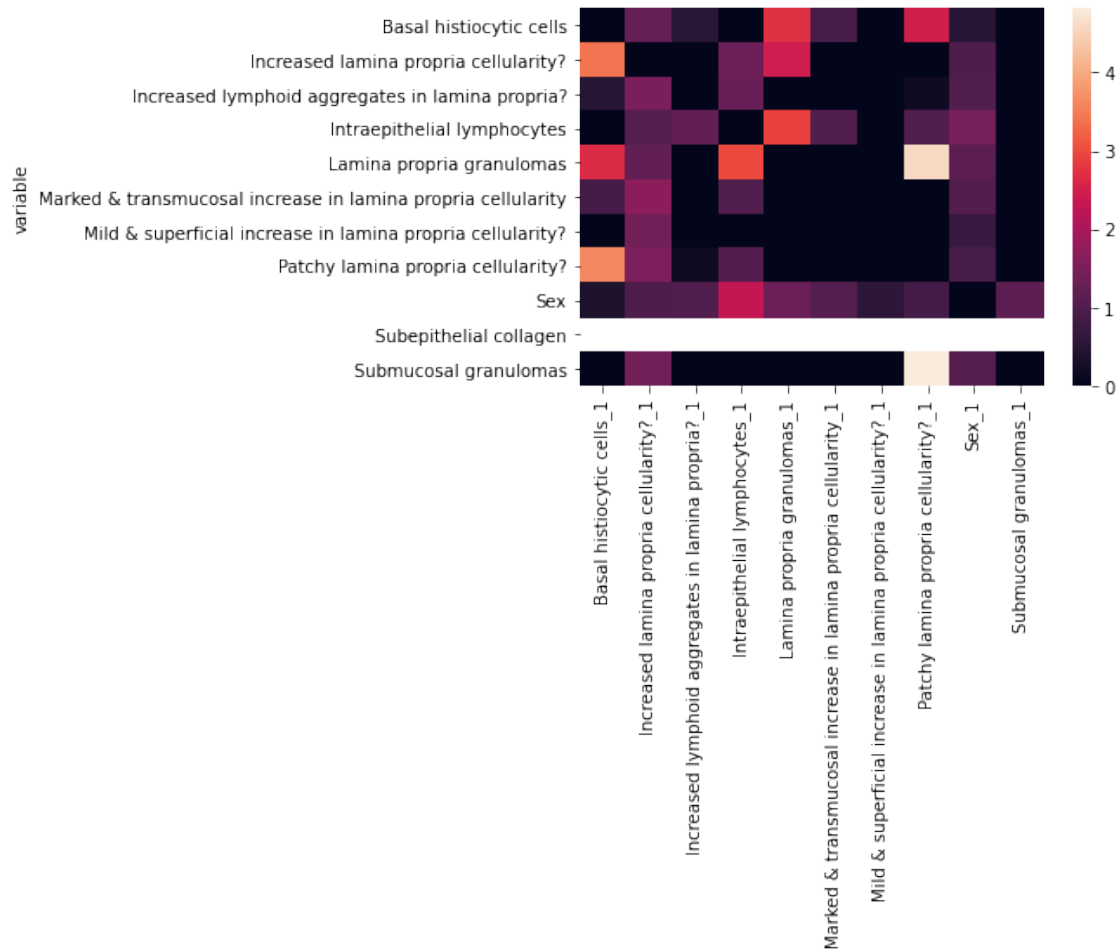
Out of the 453 patients that did not have patchy lamina propria cellularity none of those patients also had lamina propria granulomas. However, out of the 87 patients that had patchy laminap propria cellularity, 4 of those patients also had lamina propria granulomas. It looks like these 2 columns are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

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

```
[58]: Patchy lamina propria cellularity?  Submucosal granulomas
      0                                    0                        294
      1                                    0                         77
                                           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.

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

```
[59]: Patchy lamina propria cellularity?  Lamina propria granulomas
      0                                   0                             292
                                          1                               2
      1                                   0                              68
                                          1                              13
      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?

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

```
[60]: Submucosal granulomas  Confirmed diagnosis
      0                      CROHNS                  86
                             UC                     285
      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.

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

```
[61]:         Age  Sex  Active inflammation? Mucosal surface Crypt architecture  \
      0  52.410959    1                     0               0                  2
      1  24.673973    1                     1               0                  0
      2  51.345205    0                     1               0                  1
      3  48.556164    1                     1               0                  2
      4  39.367123    0                     0               0                  0
```

```
    Crypt profiles  Increased lamina propria cellularity?  \
0               5                                        1
1               7                                        1
2               7                                        1
3               6                                        1
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                                                1
1                                                0
2                                                0
3                                                0
4                                                0


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


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


  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                moderate
1                       0              CROHNS                  normal
2                       0              CROHNS                    mild
3                       0                  UC                moderate
```

```
    4                    0          CROHNS              normal

    [5 rows x 25 columns]
```

[62]: ```
transform_dict
```

[62]: ```
[{'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'}]}]
```

[63]: ```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'}]
```

[64]: ```python
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",
```

[65]:
```
df_dummy
```

[65]:
```
     Cryptitis extent_Little  Cryptitis extent_Marked  \
0                          0                        0
1                          0                        0
2                          0                        0
3                          0                        1
4                          0                        0
..                       ...                      ...
639                        0                        0
640                        0                        0
641                        1                        0
642                        1                        0
643                        1                        0

     Cryptitis extent_Moderate  Cryptitis extent_None  \
0                            0                      1
1                            1                      0
2                            1                      0
3                            0                      0
4                            0                      1
..                         ...                    ...
639                          1                      0
640                          1                      0
641                          0                      0
642                          0                      0
643                          0                      0

     Cryptitis polymorphs_Few  Cryptitis polymorphs_Many  \
```

```
0                             0                           0
1                             1                           0
2                             0                           0
3                             1                           0
4                             0                           0
..                           ...                         ...
639                           1                           0
640                           1                           0
641                           1                           0
642                           1                           0
643                           1                           0

     Cryptitis polymorphs_None  Cryptitis polymorphs_Several  \
0                             1                             0
1                             0                             0
2                             0                             1
3                             0                             0
4                             1                             0
..                          ...                           ...
639                           0                             0
640                           0                             0
641                           0                             0
642                           0                             0
643                           0                             0

     Crypt abscesses extent_Little  Crypt abscesses extent_Marked  …  \
0                                 0                              0  …
1                                 1                              0  …
2                                 0                              0  …
3                                 1                              0  …
4                                 0                              0  …
..                              ...                            …  …
639                               0                              0  …
640                               0                              0  …
641                               1                              0  …
642                               0                              0  …
643                               1                              0  …

     Mild & superficial increase in lamina propria cellularity?  \
0                                                    0
1                                                    0
2                                                    0
3                                                    0
4                                                    0
..                                                 ...
639                                                  0
640                                                  0
```

```
641                                                    0
642                                                    0
643                                                    0


      Increased lymphoid aggregates in lamina propria?  \
0                                                    1
1                                                    0
2                                                    0
3                                                    0
4                                                    0
..                                                   …
639                                                  0
640                                                  0
641                                                  0
642                                                  0
643                                                  0


      Patchy lamina propria cellularity?  \
0                                  0
1                                  0
2                                  0
3                                  1
4                                  0
..                                 …
639                                0
640                                0
641                                0
642                                1
643                                1


      Marked & transmucosal increase in lamina propria cellularity  \
0                                                    0
1                                                    1
2                                                    1
3                                                    0
4                                                    0
..                                                   …
639                                                  1
640                                                  1
641                                                  1
642                                                  0
643                                                  0


      Intraepithelial lymphocytes  Subepithelial collagen  \
0                               0                        0
1                               0                        0
2                               0                        0
```

```
3                                        0                     0
4                                        1                     0
..                                      ...                   ...
639                                      0                     0
640                                      0                     0
641                                      0                     0
642                                      0                     0
643                                      0                     0

     Lamina propria granulomas  Submucosal granulomas  \
0                            0                      0
1                            0                      0
2                            0                      0
3                            0                      0
4                            0                      0
..                         ...                    ...
639                          0                      0
640                          0                      0
641                          0                      0
642                          0                      0
643                          0                      0

     Basal histiocytic cells  Confirmed diagnosis
0                          0                   UC
1                          0               CROHNS
2                          0               CROHNS
3                          0                   UC
4                          0               CROHNS
..                       ...                  ...
639                        1                   UC
640                        0                   UC
641                        0                   UC
642                        0                   UC
643                        0                   UC

[644 rows x 48 columns]
```

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.

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

```
[67]: 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
```

[67]:
```
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.

```
[68]: ord_cols = ["Severity of Crypt Arch"]
      # "Method of confirmation","Initial pathologists diagnosis","Observing␣
      ↪pathologists diagnosis",
```

```
[69]: 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
```

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

```
[70]:          Age  Sex  Active inflammation? Mucosal surface Crypt architecture  \
      0  52.410959    1                     0               0                   2
      1  24.673973    1                     1               0                   0
      2  51.345205    0                     1               0                   1
      3  48.556164    1                     1               0                   2
      4  39.367123    0                     0               0                   0

         Crypt profiles  Increased lamina propria cellularity?  \
      0               5                                      1
      1               7                                      1
      2               7                                      1
      3               6                                      1
      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                                                  1
```

```
                                                               0
1                                                              0
2                                                              0
3                                                              0
4                                                              0

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

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

   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               CROHNS                       1
2                        0               CROHNS                       2
3                        0                   UC                       0
4                        0               CROHNS                       1

[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

```
[71]: #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)
```

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

[72]: 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

```
[73]: 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)
```

```
[74]: # 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)
```

```
[75]: # 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)]
```

[75]: 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]

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

[76]: 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

[77]:
```python
sm = SMOTE(random_state=123)
```

[78]:
```python
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: (644, 24)
Shape of X after SMOTE: (706, 24)

[79]:
```python
print('\nBalance of positive and negative classes (%):')
y_sm.value_counts(normalize=True) * 100
```

Balance of positive and negative classes (%):

[79]: CROHNS   50.0
      UC   50.0

```
Name: Confirmed diagnosis, dtype: float64
```

[80]:
```python
# Final Sets
data = [X_sm, X_test_ord, y_sm, y_test_ord]
```

[81]:
```python
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 17:31:35,375:INFO:MSMOTE: Running sampling via ('MSMOTE',
"{'proportion': 28, 'n_neighbors': 5, 'n_jobs': 1, 'random_state': 123}")
2021-06-04 17:31:35,643: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

[82]:
```python
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())
```

[83]:
```python
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)
```

[84]:
```python
# plot the scores
ax = sns.barplot(x="Scores", y="Features", data=df_features)
```
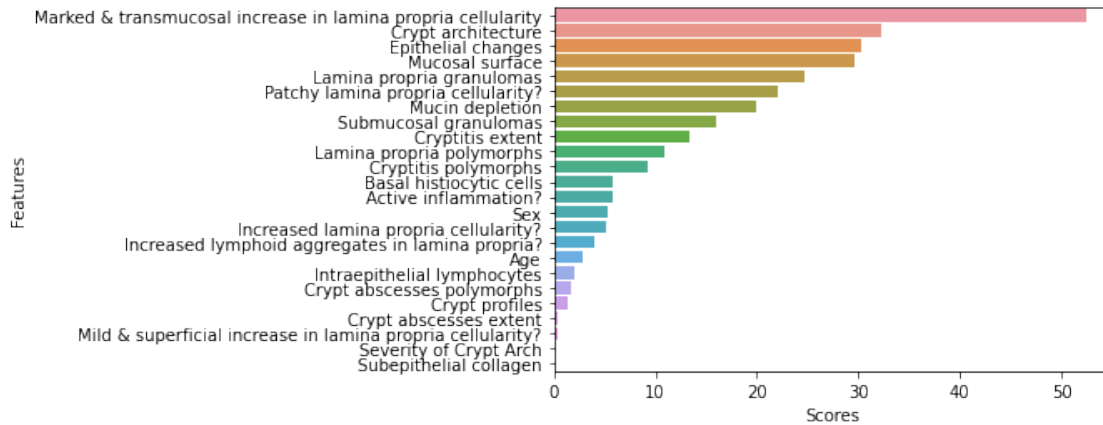
```
[85]: # fit the model
      # data = [X_sm, X_test_ord, y_sm, y_test_ord]
      model = LogisticRegression(solver='lbfgs')
      t = model.fit(X_sm, y_sm)
      # evaluate the model
      yhat = model.predict(X_test_ord)
      # evaluate predictions
      accuracy = accuracy_score(y_test_ord, yhat)
      print('Accuracy: %.2f' % (accuracy*100))
```

Accuracy: 65.22

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

[86]: array(['CROHNS', 'UC'], dtype=object)

```
[87]: df_logit = pd.DataFrame()
      df_logit['Attributes'] = X_sm.columns
      for l in range(0, len(model.coef_)):
          df_logit['data_'+str(assigned[1])] = 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)
```
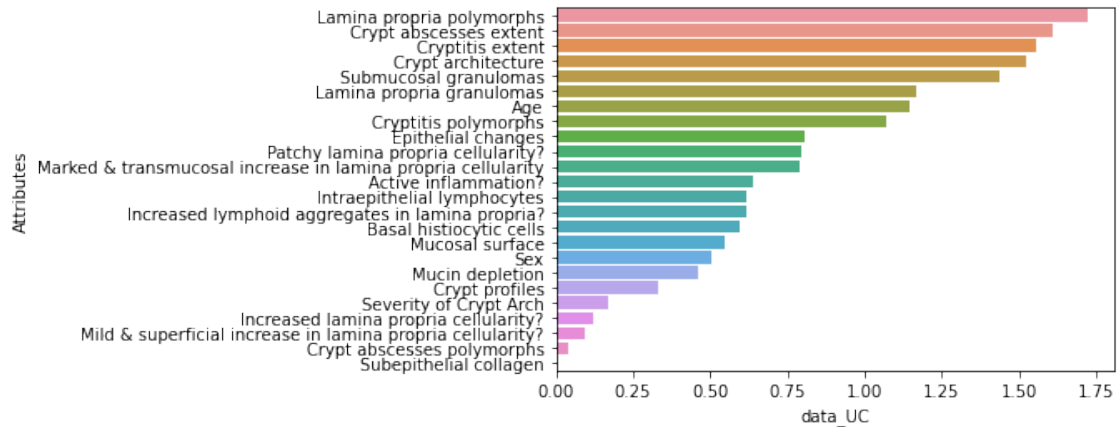
```
[88]: ax = sns.barplot(x="data_UC", y="Attributes", data=df_logit)
```
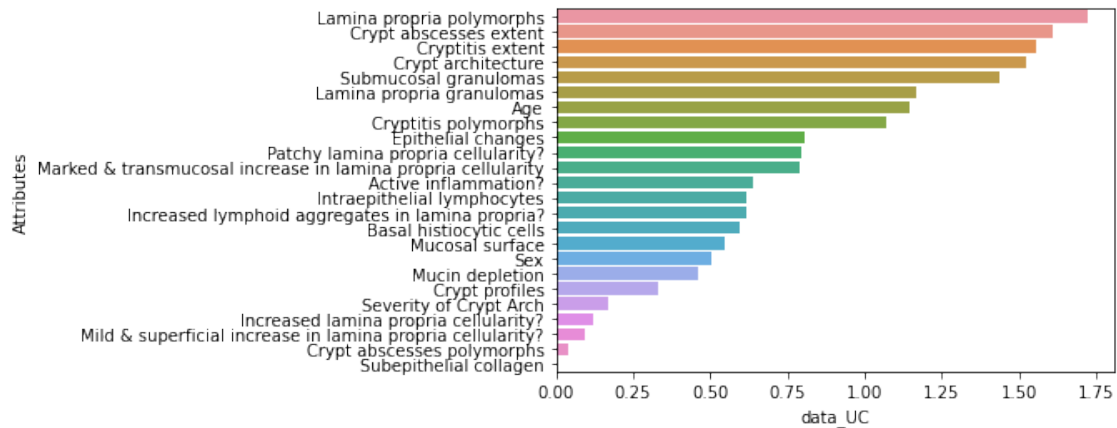


```
[89]: # ax = sns.barplot(x="data_NORMAL", y="Attributes", data=df_logit)
```

0.6.5 ETL PipeLine

confirmed to not be needed considering time constraint.

0.7 ## Machine Learning Models

0.7.1 Parameter Tuning

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

```
[91]: def hyper_search(modelDictionary, modelParamDictionary, data, features):
          # define empty dictionaries to start
```

47

```python
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:
        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'],
```

```python
                                    '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}')
```

```python
[92]: 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
```

[93]:
```python
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)
```

[94]:
```python
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()
```

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

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

[103]:
```
now = datetime.datetime.now()
print ("Current date and time : ")
print (now.strftime("%Y-%m-%d %H:%M:%S"))
```

```
Current date and time :
2021-06-05 09:02:04
```

[104]:
```
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': 'Marked & transmucosal
increase in lamina propria cellularity, Crypt architecture, Epithelial changes,
Mucosal surface, Lamina propria granulomas, Patchy lamina propria cellularity?,
Mucin depletion, Submucosal granulomas, Cryptitis extent, Lamina propria
polymorphs, Cryptitis polymorphs, Basal histiocytic cells, Active inflammation?,
Sex, Increased lamina propria cellularity?, Increased lymphoid aggregates in
lamina propria?, Age, Intraepithelial lymphocytes, Crypt abscesses polymorphs,
Crypt profiles, Crypt abscesses extent, Mild & superficial increase in lamina
propria cellularity?, Severity of Crypt Arch', 'accuracy': [0.7471264367816092,
0.8045977011494253, 0.791907514450867, 0.8323699421965318, 0.7167630057803468],
'avgAccuracy': 0.778552920071756, 'f1': [0.7513006208760027, 0.809542780416137,
0.7881332879972798, 0.9085173501577286, 0.7188681233776127], 'avgF1':
0.7952724325649522, 'precision': [0.7471264367816092, 0.8045977011494253,
0.791907514450867, 0.8323699421965318, 0.7167630057803468], 'avgPrecision':
0.778552920071756, 'recall': [0.7471264367816092, 0.8045977011494253,
0.791907514450867, 0.8323699421965318, 0.7167630057803468], 'avgRecall':
0.778552920071756, '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': 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': 'Marked & transmucosal
increase in lamina propria cellularity, Crypt architecture, Epithelial changes,
Mucosal surface, Lamina propria granulomas, Patchy lamina propria cellularity?,
Mucin depletion, Submucosal granulomas, Cryptitis extent, Lamina propria
polymorphs, Cryptitis polymorphs, Basal histiocytic cells, Active inflammation?,
Sex, Increased lamina propria cellularity?, Increased lymphoid aggregates in
lamina propria?, Age, Intraepithelial lymphocytes, Crypt abscesses polymorphs,
Crypt profiles, Crypt abscesses extent, Mild & superficial increase in lamina
propria cellularity?, Severity of Crypt Arch', 'accuracy': [0.7528735632183908,

0.7011494252873564, 0.8092485549132948, 0.7803468208092486, 0.6878612716763006],
'avgAccuracy': 0.7462959271809182, 'f1': [0.7614140312830404,
0.7269124058660326, 0.8098284444609322, 0.8766233766233766, 0.6945299026787184],
'avgF1': 0.77386163218242, 'precision': [0.7528735632183908, 0.7011494252873564,
0.8092485549132948, 0.7803468208092486, 0.6878612716763006], 'avgPrecision':
0.7462959271809182, 'recall': [0.7528735632183908, 0.7011494252873564,
0.8092485549132948, 0.7803468208092486, 0.6878612716763006], 'avgRecall':
0.7462959271809182, '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': 'Marked & transmucosal
increase in lamina propria cellularity, Crypt architecture, Epithelial changes,
Mucosal surface, Lamina propria granulomas, Patchy lamina propria cellularity?,
Mucin depletion, Submucosal granulomas, Cryptitis extent, Lamina propria
polymorphs, Cryptitis polymorphs, Basal histiocytic cells, Active inflammation?,
Sex, Increased lamina propria cellularity?, Increased lymphoid aggregates in
lamina propria?, Age, Intraepithelial lymphocytes, Crypt abscesses polymorphs,
Crypt profiles, Crypt abscesses extent, Mild & superficial increase in lamina
propria cellularity?, Severity of Crypt Arch', 'accuracy': [0.6609195402298851,
0.6724137931034483, 0.7572254335260116, 0.48554913294797686,
0.6647398843930635], 'avgAccuracy': 0.648169556840077, 'f1':
[0.6727523667809623, 0.7007398731536663, 0.7575712193301322, 0.6536964980544747,
0.6754816535722745], 'avgF1': 0.692048322178302, 'precision':
[0.6609195402298851, 0.6724137931034483, 0.7572254335260116,
0.48554913294797686, 0.6647398843930635], 'avgPrecision': 0.648169556840077,
'recall': [0.6609195402298851, 0.6724137931034483, 0.7572254335260116,
0.48554913294797686, 0.6647398843930635], 'avgRecall': 0.648169556840077,
'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': 'Marked & transmucosal increase in
lamina propria cellularity, Crypt architecture, Epithelial changes, Mucosal
surface, Lamina propria granulomas, Patchy lamina propria cellularity?, Mucin
depletion, Submucosal granulomas, Cryptitis extent, Lamina propria polymorphs,
Cryptitis polymorphs, Basal histiocytic cells, Active inflammation?, Sex,

Increased lamina propria cellularity?, Increased lymphoid aggregates in lamina propria?, Age, Intraepithelial lymphocytes, Crypt abscesses polymorphs, Crypt profiles, Crypt abscesses extent, Mild & superficial increase in lamina propria cellularity?, Severity of Crypt Arch', 'accuracy': [0.7011494252873564, 0.8045977011494253, 0.6242774566473989, 0.10404624277456648, 0.6994219653179191], 'avgAccuracy': 0.5866985582353332, 'f1': [0.6179526873886999, 0.7363619777412881, 0.533935969056559, 0.18848167539267016, 0.6083727447889298], 'avgF1': 0.5370210108736294, 'precision': [0.7011494252873564, 0.8045977011494253, 0.6242774566473989, 0.10404624277456648, 0.6994219653179191], 'avgPrecision': 0.5866985582353332, 'recall': [0.7011494252873564, 0.8045977011494253, 0.6242774566473989, 0.10404624277456648, 0.6994219653179191], 'avgRecall': 0.5866985582353332, 'params': [{'priors': None, 'var_smoothing': 1e-09}]}
****

Processing Model: AdaBoostClassifier
****
* AdaBoostClassifier
* Best Params Result:
* {'classifier': 'AdaBoostClassifier', 'features': 'Marked & transmucosal increase in lamina propria cellularity, Crypt architecture, Epithelial changes, Mucosal surface, Lamina propria granulomas, Patchy lamina propria cellularity?, Mucin depletion, Submucosal granulomas, Cryptitis extent, Lamina propria polymorphs, Cryptitis polymorphs, Basal histiocytic cells, Active inflammation?, Sex, Increased lamina propria cellularity?, Increased lymphoid aggregates in lamina propria?, Age, Intraepithelial lymphocytes, Crypt abscesses polymorphs, Crypt profiles, Crypt abscesses extent, Mild & superficial increase in lamina propria cellularity?, Severity of Crypt Arch', 'accuracy': [0.7413793103448276, 0.7758620689655172, 0.791907514450867, 0.630057803468208, 0.6647398843930635], 'avgAccuracy': 0.7207893163244967, 'f1': [0.7487416194991541, 0.7853084951776985, 0.7915524562923408, 0.7730496453900708, 0.6761087339122022], 'avgF1': 0.7549521900542933, 'precision': [0.7413793103448276, 0.7758620689655172, 0.791907514450867, 0.630057803468208, 0.6647398843930635], 'avgPrecision': 0.7207893163244967, 'recall': [0.7413793103448276, 0.7758620689655172, 0.791907514450867, 0.630057803468208, 0.6647398843930635], 'avgRecall': 0.7207893163244967, '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': 'Marked & transmucosal increase in lamina propria cellularity, Crypt architecture, Epithelial changes, Mucosal surface, Lamina propria granulomas, Patchy lamina propria cellularity?, Mucin depletion, Submucosal granulomas, Cryptitis extent, Lamina propria

polymorphs, Cryptitis polymorphs, Basal histiocytic cells, Active inflammation?, Sex, Increased lamina propria cellularity?, Increased lymphoid aggregates in lamina propria?, Age, Intraepithelial lymphocytes, Crypt abscesses polymorphs, Crypt profiles, Crypt abscesses extent, Mild & superficial increase in lamina propria cellularity?, Severity of Crypt Arch', 'accuracy': [0.7298850574712644, 0.764367816091954, 0.7456647398843931, 0.815028901734104, 0.7052023121387283], 'avgAccuracy': 0.7520297654640887, 'f1': [0.7370073707540847, 0.7780496848350018, 0.7441433449703351, 0.8980891719745221, 0.7109950617364541], 'avgF1': 0.7736569268540796, 'precision': [0.7298850574712644, 0.764367816091954, 0.7456647398843931, 0.815028901734104, 0.7052023121387283], 'avgPrecision': 0.7520297654640887, 'recall': [0.7298850574712644, 0.764367816091954, 0.7456647398843931, 0.815028901734104, 0.7052023121387283], 'avgRecall': 0.7520297654640887, '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': 'Marked & transmucosal increase in lamina propria cellularity, Crypt architecture, Epithelial changes, Mucosal surface, Lamina propria granulomas, Patchy lamina propria cellularity?, Mucin depletion, Submucosal granulomas, Cryptitis extent, Lamina propria polymorphs, Cryptitis polymorphs, Basal histiocytic cells, Active inflammation?, Sex, Increased lamina propria cellularity?, Increased lymphoid aggregates in lamina propria?, Age, Intraepithelial lymphocytes, Crypt abscesses polymorphs, Crypt profiles, Crypt abscesses extent, Mild & superficial increase in lamina propria cellularity?, Severity of Crypt Arch', 'accuracy': [0.632183908045977, 0.6954022988505747, 0.7052023121387283, 0.1791907514450867, 0.6647398843930635], 'avgAccuracy': 0.575343830974686, 'f1': [0.6435917379656038, 0.7209330675066161, 0.706315018674652, 0.30392156862745096, 0.6777699519114003], 'avgF1': 0.6105062689371447, 'precision': [0.632183908045977, 0.6954022988505747, 0.7052023121387283, 0.1791907514450867, 0.6647398843930635], 'avgPrecision': 0.575343830974686, 'recall': [0.632183908045977, 0.6954022988505747, 0.7052023121387283, 0.1791907514450867, 0.6647398843930635], 'avgRecall': 0.575343830974686, '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': 'Marked & transmucosal increase in lamina propria cellularity, Crypt architecture, Epithelial changes, Mucosal surface, Lamina propria granulomas, Patchy lamina propria cellularity?, Mucin depletion, Submucosal granulomas, Cryptitis extent, Lamina propria polymorphs, Cryptitis polymorphs, Basal histiocytic cells, Active inflammation?, Sex, Increased lamina propria cellularity?, Increased lymphoid aggregates in lamina propria?, Age, Intraepithelial lymphocytes, Crypt abscesses polymorphs, Crypt profiles, Crypt abscesses extent, Mild & superficial increase in lamina propria cellularity?, Severity of Crypt Arch', 'accuracy': [0.6839080459770115, 0.6896551724137931, 0.7572254335260116, 0.49710982658959535, 0.6820809248554913], 'avgAccuracy': 0.6619958806723806, 'f1': [0.69462582219584, 0.7154500671742051, 0.7572254335260116, 0.664092664092664, 0.6925765699788141], 'avgF1': 0.704794111393507, 'precision': [0.6839080459770115, 0.6896551724137931, 0.7572254335260116, 0.49710982658959535, 0.6820809248554913], 'avgPrecision': 0.6619958806723806, 'recall': [0.6839080459770115, 0.6896551724137931, 0.7572254335260116, 0.49710982658959535, 0.6820809248554913], 'avgRecall': 0.6619958806723806, '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': 'Marked & transmucosal increase in lamina propria cellularity, Crypt architecture, Epithelial changes, Mucosal surface, Lamina propria granulomas, Patchy lamina propria cellularity?, Mucin depletion, Submucosal granulomas, Cryptitis extent, Lamina propria polymorphs, Cryptitis polymorphs, Basal histiocytic cells, Active inflammation?, Sex, Increased lamina propria cellularity?, Increased lymphoid aggregates in lamina propria?, Age, Intraepithelial lymphocytes, Crypt abscesses polymorphs, Crypt profiles, Crypt abscesses extent, Mild & superficial increase in lamina propria cellularity?, Severity of Crypt Arch', 'accuracy': [0.7471264367816092, 0.8045977011494253, 0.791907514450867, 0.8323699421965318, 0.7167630057803468], 'avgAccuracy': 0.778552920071756, 'f1': [0.7513006208760027, 0.809542780416137, 0.7881332879972798, 0.9085173501577286, 0.7188681233776127], 'avgF1': 0.7952724325649522, 'precision': [0.7471264367816092, 0.8045977011494253, 0.791907514450867, 0.8323699421965318, 0.7167630057803468], 'avgPrecision': 0.778552920071756, 'recall': [0.7471264367816092, 0.8045977011494253, 0.791907514450867, 0.8323699421965318, 0.7167630057803468], 'avgRecall': 0.778552920071756, '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': 700, 'n_jobs': -1, 'oob_score':
True, 'random_state': None, 'verbose': 0, 'warm_start': False}]}
*********************************************************
```

```
                    model                                    features  \
0  RandomForestClassifier  Marked & transmucosal increase in lamina propr…
1    KNeighborsClassifier  Marked & transmucosal increase in lamina propr…
2      LogisticRegression  Marked & transmucosal increase in lamina propr…
3              GaussianNB  Marked & transmucosal increase in lamina propr…
4      AdaBoostClassifier  Marked & transmucosal increase in lamina propr…
5  DecisionTreeClassifier  Marked & transmucosal increase in lamina propr…
6                     SVC  Marked & transmucosal increase in lamina propr…
7           MLPClassifier  Marked & transmucosal increase in lamina propr…

   accuracy        f1  precision    recall  \
0  0.778553  0.795272   0.778553  0.778553
1  0.746296  0.773862   0.746296  0.746296
2  0.648170  0.692048   0.648170  0.648170
3  0.586699  0.537021   0.586699  0.586699
4  0.720789  0.754952   0.720789  0.720789
5  0.752030  0.773657   0.752030  0.752030
6  0.575344  0.610506   0.575344  0.575344
7  0.661996  0.704794   0.661996  0.661996

                                                  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': 'Marked & transmucosal
increase in lamina propria cellularity, Crypt architecture, Epithelial changes,
Mucosal surface, Lamina propria granulomas, Patchy lamina propria cellularity?,
Mucin depletion, Submucosal granulomas, Cryptitis extent, Lamina propria
polymorphs, Cryptitis polymorphs, Basal histiocytic cells, Active inflammation?,
Sex, Increased lamina propria cellularity?, Increased lymphoid aggregates in
lamina propria?, Age, Intraepithelial lymphocytes, Crypt abscesses polymorphs,
Crypt profiles, Crypt abscesses extent, Mild & superficial increase in lamina
propria cellularity?', 'accuracy': [0.7413793103448276, 0.8045977011494253,
```

0.8034682080924855, 0.815028901734104, 0.7052023121387283], 'avgAccuracy':
0.7739352866919141, 'f1': [0.7460770183694619, 0.809542780416137,
0.7999036608863198, 0.8980891719745221, 0.7059631398632363], 'avgF1':
0.7919151543019355, 'precision': [0.7413793103448276, 0.8045977011494253,
0.8034682080924855, 0.815028901734104, 0.7052023121387283], 'avgPrecision':
0.7739352866919141, 'recall': [0.7413793103448276, 0.8045977011494253,
0.8034682080924855, 0.815028901734104, 0.7052023121387283], 'avgRecall':
0.7739352866919141, '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': 'Marked & transmucosal
increase in lamina propria cellularity, Crypt architecture, Epithelial changes,
Mucosal surface, Lamina propria granulomas, Patchy lamina propria cellularity?,
Mucin depletion, Submucosal granulomas, Cryptitis extent, Lamina propria
polymorphs, Cryptitis polymorphs, Basal histiocytic cells, Active inflammation?,
Sex, Increased lamina propria cellularity?, Increased lymphoid aggregates in
lamina propria?, Age, Intraepithelial lymphocytes, Crypt abscesses polymorphs,
Crypt profiles, Crypt abscesses extent, Mild & superficial increase in lamina
propria cellularity?', 'accuracy': [0.7298850574712644, 0.7126436781609196,
0.8092485549132948, 0.7861271676300579, 0.6936416184971098], 'avgAccuracy':
0.7463092153345293, 'f1': [0.7392199876814629, 0.7372040475488753,
0.8099685414953629, 0.8802588996763754, 0.6985286449786023], 'avgF1':
0.7730360242761357, 'precision': [0.7298850574712644, 0.7126436781609196,
0.8092485549132948, 0.7861271676300579, 0.6936416184971098], 'avgPrecision':
0.7463092153345293, 'recall': [0.7298850574712644, 0.7126436781609196,
0.8092485549132948, 0.7861271676300579, 0.6936416184971098], 'avgRecall':
0.7463092153345293, 'params': [{'algorithm': 'kd_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': 'Marked & transmucosal
increase in lamina propria cellularity, Crypt architecture, Epithelial changes,
Mucosal surface, Lamina propria granulomas, Patchy lamina propria cellularity?,
Mucin depletion, Submucosal granulomas, Cryptitis extent, Lamina propria

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polymorphs, Cryptitis polymorphs, Basal histiocytic cells, Active inflammation?, Sex, Increased lamina propria cellularity?, Increased lymphoid aggregates in lamina propria?, Age, Intraepithelial lymphocytes, Crypt abscesses polymorphs, Crypt profiles, Crypt abscesses extent, Mild & superficial increase in lamina propria cellularity?', 'accuracy': [0.6551724137931034, 0.6839080459770115, 0.7630057803468208, 0.4797687861271676, 0.6647398843930635], 'avgAccuracy': 0.6493189821274333, 'f1': [0.6671455938697318, 0.7110521992222772, 0.7631828519322299, 0.6484375, 0.6754816535722745], 'avgF1': 0.6930599597193027, 'precision': [0.6551724137931034, 0.6839080459770115, 0.7630057803468208, 0.4797687861271676, 0.6647398843930635], 'avgPrecision': 0.6493189821274333, 'recall': [0.6551724137931034, 0.6839080459770115, 0.7630057803468208, 0.4797687861271676, 0.6647398843930635], 'avgRecall': 0.6493189821274333, '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': 'Marked & transmucosal increase in lamina propria cellularity, Crypt architecture, Epithelial changes, Mucosal surface, Lamina propria granulomas, Patchy lamina propria cellularity?, Mucin depletion, Submucosal granulomas, Cryptitis extent, Lamina propria polymorphs, Cryptitis polymorphs, Basal histiocytic cells, Active inflammation?, Sex, Increased lamina propria cellularity?, Increased lymphoid aggregates in lamina propria?, Age, Intraepithelial lymphocytes, Crypt abscesses polymorphs, Crypt profiles, Crypt abscesses extent, Mild & superficial increase in lamina propria cellularity?', 'accuracy': [0.7011494252873564, 0.8045977011494253, 0.6242774566473989, 0.10404624277456648, 0.6994219653179191], 'avgAccuracy': 0.5866985582353332, 'f1': [0.6179526873886999, 0.7363619777412881, 0.533935969056559, 0.18848167539267016, 0.6083727447889298], 'avgF1': 0.5370210108736294, 'precision': [0.7011494252873564, 0.8045977011494253, 0.6242774566473989, 0.10404624277456648, 0.6994219653179191], 'avgPrecision': 0.5866985582353332, 'recall': [0.7011494252873564, 0.8045977011494253, 0.6242774566473989, 0.10404624277456648, 0.6994219653179191], 'avgRecall': 0.5866985582353332, 'params': [{'priors': None, 'var_smoothing': 1e-09}]}
****

Processing Model: AdaBoostClassifier
****
* AdaBoostClassifier
* Best Params Result:
* {'classifier': 'AdaBoostClassifier', 'features': 'Marked & transmucosal increase in lamina propria cellularity, Crypt architecture, Epithelial changes, Mucosal surface, Lamina propria granulomas, Patchy lamina propria cellularity?,

Mucin depletion, Submucosal granulomas, Cryptitis extent, Lamina propria polymorphs, Cryptitis polymorphs, Basal histiocytic cells, Active inflammation?, Sex, Increased lamina propria cellularity?, Increased lymphoid aggregates in lamina propria?, Age, Intraepithelial lymphocytes, Crypt abscesses polymorphs, Crypt profiles, Crypt abscesses extent, Mild & superficial increase in lamina propria cellularity?', 'accuracy': [0.7068965517241379, 0.764367816091954, 0.8208092485549133, 0.630057803468208, 0.6589595375722543], 'avgAccuracy': 0.7162181914822935, 'f1': [0.7162071512876903, 0.7769116254290009, 0.8209431319487592, 0.7730496453900708, 0.6702185023409096], 'avgF1': 0.7514660112792861, 'precision': [0.7068965517241379, 0.764367816091954, 0.8208092485549133, 0.630057803468208, 0.6589595375722543], 'avgPrecision': 0.7162181914822935, 'recall': [0.7068965517241379, 0.764367816091954, 0.8208092485549133, 0.630057803468208, 0.6589595375722543], 'avgRecall': 0.7162181914822935, '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': 'Marked & transmucosal increase in lamina propria cellularity, Crypt architecture, Epithelial changes, Mucosal surface, Lamina propria granulomas, Patchy lamina propria cellularity?, Mucin depletion, Submucosal granulomas, Cryptitis extent, Lamina propria polymorphs, Cryptitis polymorphs, Basal histiocytic cells, Active inflammation?, Sex, Increased lamina propria cellularity?, Increased lymphoid aggregates in lamina propria?, Age, Intraepithelial lymphocytes, Crypt abscesses polymorphs, Crypt profiles, Crypt abscesses extent, Mild & superficial increase in lamina propria cellularity?', 'accuracy': [0.7528735632183908, 0.7528735632183908, 0.7456647398843931, 0.7861271676300579, 0.653179190751445], 'avgAccuracy': 0.7381436449405355, 'f1': [0.7555943058513662, 0.7692864045654093, 0.7441433449703351, 0.8802588996763754, 0.6626681671696762], 'avgF1': 0.7623902244466324, 'precision': [0.7528735632183908, 0.7528735632183908, 0.7456647398843931, 0.7861271676300579, 0.653179190751445], 'avgPrecision': 0.7381436449405355, 'recall': [0.7528735632183908, 0.7528735632183908, 0.7456647398843931, 0.7861271676300579, 0.653179190751445], 'avgRecall': 0.7381436449405355, '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': 'Marked & transmucosal increase in lamina
propria cellularity, Crypt architecture, Epithelial changes, Mucosal surface,
Lamina propria granulomas, Patchy lamina propria cellularity?, Mucin depletion,
Submucosal granulomas, Cryptitis extent, Lamina propria polymorphs, Cryptitis
polymorphs, Basal histiocytic cells, Active inflammation?, Sex, Increased lamina
propria cellularity?, Increased lymphoid aggregates in lamina propria?, Age,
Intraepithelial lymphocytes, Crypt abscesses polymorphs, Crypt profiles, Crypt
abscesses extent, Mild & superficial increase in lamina propria cellularity?',
'accuracy': [0.6264367816091954, 0.6551724137931034, 0.7341040462427746,
0.12716763005780346, 0.653179190751445], 'avgAccuracy': 0.5592120124908644,
'f1': [0.6363903285293359, 0.6850557771961477, 0.7352264963289916,
0.22564102564102562, 0.6665109396848238], 'avgF1': 0.589764913476065,
'precision': [0.6264367816091954, 0.6551724137931034, 0.7341040462427746,
0.12716763005780346, 0.653179190751445], 'avgPrecision': 0.5592120124908644,
'recall': [0.6264367816091954, 0.6551724137931034, 0.7341040462427746,
0.12716763005780346, 0.653179190751445], 'avgRecall': 0.5592120124908644,
'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': 'Marked & transmucosal increase in
lamina propria cellularity, Crypt architecture, Epithelial changes, Mucosal
surface, Lamina propria granulomas, Patchy lamina propria cellularity?, Mucin
depletion, Submucosal granulomas, Cryptitis extent, Lamina propria polymorphs,
Cryptitis polymorphs, Basal histiocytic cells, Active inflammation?, Sex,
Increased lamina propria cellularity?, Increased lymphoid aggregates in lamina
propria?, Age, Intraepithelial lymphocytes, Crypt abscesses polymorphs, Crypt
profiles, Crypt abscesses extent, Mild & superficial increase in lamina propria
cellularity?', 'accuracy': [0.6781609195402298, 0.6666666666666666,
0.7630057803468208, 0.47398843930635837, 0.6763005780346821], 'avgAccuracy':
0.6516244767789515, 'f1': [0.6894341290893015, 0.6954022988505747,
0.763487329101577, 0.6431372549019608, 0.6866719413801271], 'avgF1':
0.6956265906647082, 'precision': [0.6781609195402298, 0.6666666666666666,
0.7630057803468208, 0.47398843930635837, 0.6763005780346821], 'avgPrecision':
0.6516244767789515, 'recall': [0.6781609195402298, 0.6666666666666666,
0.7630057803468208, 0.47398843930635837, 0.6763005780346821], 'avgRecall':
0.6516244767789515, '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': 'Marked & transmucosal
increase in lamina propria cellularity, Crypt architecture, Epithelial changes,
Mucosal surface, Lamina propria granulomas, Patchy lamina propria cellularity?,
Mucin depletion, Submucosal granulomas, Cryptitis extent, Lamina propria
polymorphs, Cryptitis polymorphs, Basal histiocytic cells, Active inflammation?,
Sex, Increased lamina propria cellularity?, Increased lymphoid aggregates in
lamina propria?, Age, Intraepithelial lymphocytes, Crypt abscesses polymorphs,
Crypt profiles, Crypt abscesses extent, Mild & superficial increase in lamina
propria cellularity?', 'accuracy': [0.7413793103448276, 0.8045977011494253,
0.8034682080924855, 0.815028901734104, 0.7052023121387283], 'avgAccuracy':
0.7739352866919141, 'f1': [0.7460770183694619, 0.809542780416137,
0.7999036608863198, 0.8980891719745221, 0.7059631398632363], 'avgF1':
0.7919151543019355, 'precision': [0.7413793103448276, 0.8045977011494253,
0.8034682080924855, 0.815028901734104, 0.7052023121387283], 'avgPrecision':
0.7739352866919141, 'recall': [0.7413793103448276, 0.8045977011494253,
0.8034682080924855, 0.815028901734104, 0.7052023121387283], 'avgRecall':
0.7739352866919141, '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}]]}
****

```
                    model                                         features  \
0  RandomForestClassifier  Marked & transmucosal increase in lamina propr…
1     KNeighborsClassifier  Marked & transmucosal increase in lamina propr…
2       LogisticRegression  Marked & transmucosal increase in lamina propr…
3               GaussianNB  Marked & transmucosal increase in lamina propr…
4        AdaBoostClassifier  Marked & transmucosal increase in lamina propr…
5    DecisionTreeClassifier  Marked & transmucosal increase in lamina propr…
6                      SVC  Marked & transmucosal increase in lamina propr…
7            MLPClassifier  Marked & transmucosal increase in lamina propr…

   accuracy        f1  precision    recall  \
0  0.773935  0.791915   0.773935  0.773935
1  0.746309  0.773036   0.746309  0.746309
2  0.649319  0.693060   0.649319  0.649319
3  0.586699  0.537021   0.586699  0.586699
4  0.716218  0.751466   0.716218  0.716218
5  0.738144  0.762390   0.738144  0.738144
6  0.559212  0.589765   0.559212  0.559212
7  0.651624  0.695627   0.651624  0.651624
```

```
                                        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': 'Marked & transmucosal
increase in lamina propria cellularity, Crypt architecture, Epithelial changes,
Mucosal surface, Lamina propria granulomas, Patchy lamina propria cellularity?,
Mucin depletion, Submucosal granulomas, Cryptitis extent, Lamina propria
polymorphs, Cryptitis polymorphs, Basal histiocytic cells, Active inflammation?,
Sex, Increased lamina propria cellularity?, Increased lymphoid aggregates in
lamina propria?, Age, Intraepithelial lymphocytes, Crypt abscesses polymorphs,
Crypt profiles, Crypt abscesses extent', 'accuracy': [0.7413793103448276,
0.8103448275862069, 0.7976878612716763, 0.815028901734104, 0.7109826589595376],
'avgAccuracy': 0.7750847119792705, 'f1': [0.7460770183694619,
0.8158374552210141, 0.7943811144786455, 0.8980891719745221, 0.7124443868748527],
'avgF1': 0.7933658293836993, 'precision': [0.7413793103448276,
0.8103448275862069, 0.7976878612716763, 0.815028901734104, 0.7109826589595376],
'avgPrecision': 0.7750847119792705, 'recall': [0.7413793103448276,
0.8103448275862069, 0.7976878612716763, 0.815028901734104, 0.7109826589595376],
'avgRecall': 0.7750847119792705, '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': 'Marked & transmucosal
increase in lamina propria cellularity, Crypt architecture, Epithelial changes,
Mucosal surface, Lamina propria granulomas, Patchy lamina propria cellularity?,
Mucin depletion, Submucosal granulomas, Cryptitis extent, Lamina propria
polymorphs, Cryptitis polymorphs, Basal histiocytic cells, Active inflammation?,
Sex, Increased lamina propria cellularity?, Increased lymphoid aggregates in
```

lamina propria?, Age, Intraepithelial lymphocytes, Crypt abscesses polymorphs, Crypt profiles, Crypt abscesses extent', 'accuracy': [0.7298850574712644, 0.7068965517241379, 0.8092485549132948, 0.7861271676300579, 0.6936416184971098], 'avgAccuracy': 0.7451597900471729, 'f1': [0.7392199876814629, 0.7318084132477162, 0.8099685414953629, 0.8802588996763754, 0.6985286449786023], 'avgF1': 0.7719568974159039, 'precision': [0.7298850574712644, 0.7068965517241379, 0.8092485549132948, 0.7861271676300579, 0.6936416184971098], 'avgPrecision': 0.7451597900471729, 'recall': [0.7298850574712644, 0.7068965517241379, 0.8092485549132948, 0.7861271676300579, 0.6936416184971098], 'avgRecall': 0.7451597900471729, 'params': [{'algorithm': 'kd_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': 'Marked & transmucosal increase in lamina propria cellularity, Crypt architecture, Epithelial changes, Mucosal surface, Lamina propria granulomas, Patchy lamina propria cellularity?, Mucin depletion, Submucosal granulomas, Cryptitis extent, Lamina propria polymorphs, Cryptitis polymorphs, Basal histiocytic cells, Active inflammation?, Sex, Increased lamina propria cellularity?, Increased lymphoid aggregates in lamina propria?, Age, Intraepithelial lymphocytes, Crypt abscesses polymorphs, Crypt profiles, Crypt abscesses extent', 'accuracy': [0.6494252873563219, 0.6839080459770115, 0.7630057803468208, 0.4797687861271676, 0.6647398843930635], 'avgAccuracy': 0.648169556840077, 'f1': [0.6612784074000162, 0.7110521992222772, 0.7631828519322299, 0.6484375, 0.6754816535722745], 'avgF1': 0.6918865224253595, 'precision': [0.6494252873563219, 0.6839080459770115, 0.7630057803468208, 0.4797687861271676, 0.6647398843930635], 'avgPrecision': 0.648169556840077, 'recall': [0.6494252873563219, 0.6839080459770115, 0.7630057803468208, 0.4797687861271676, 0.6647398843930635], 'avgRecall': 0.648169556840077, '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': 'Marked & transmucosal increase in lamina propria cellularity, Crypt architecture, Epithelial changes, Mucosal surface, Lamina propria granulomas, Patchy lamina propria cellularity?, Mucin depletion, Submucosal granulomas, Cryptitis extent, Lamina propria polymorphs, Cryptitis polymorphs, Basal histiocytic cells, Active inflammation?, Sex,

Increased lamina propria cellularity?, Increased lymphoid aggregates in lamina
propria?, Age, Intraepithelial lymphocytes, Crypt abscesses polymorphs, Crypt
profiles, Crypt abscesses extent', 'accuracy': [0.7011494252873564,
0.8045977011494253, 0.6242774566473989, 0.10404624277456648,
0.7109826589595376], 'avgAccuracy': 0.5890106969636569, 'f1':
[0.6179526873886999, 0.7363619777412881, 0.533935969056559, 0.18848167539267016,
0.6154740548800743], 'avgF1': 0.5384412728918583, 'precision':
[0.7011494252873564, 0.8045977011494253, 0.6242774566473989,
0.10404624277456648, 0.7109826589595376], 'avgPrecision': 0.5890106969636569,
'recall': [0.7011494252873564, 0.8045977011494253, 0.6242774566473989,
0.10404624277456648, 0.7109826589595376], 'avgRecall': 0.5890106969636569,
'params': [{'priors': None, 'var_smoothing': 1e-09}]}
****

Processing Model: AdaBoostClassifier
****
* AdaBoostClassifier
* Best Params Result:
* {'classifier': 'AdaBoostClassifier', 'features': 'Marked & transmucosal
increase in lamina propria cellularity, Crypt architecture, Epithelial changes,
Mucosal surface, Lamina propria granulomas, Patchy lamina propria cellularity?,
Mucin depletion, Submucosal granulomas, Cryptitis extent, Lamina propria
polymorphs, Cryptitis polymorphs, Basal histiocytic cells, Active inflammation?,
Sex, Increased lamina propria cellularity?, Increased lymphoid aggregates in
lamina propria?, Age, Intraepithelial lymphocytes, Crypt abscesses polymorphs,
Crypt profiles, Crypt abscesses extent', 'accuracy': [0.7413793103448276,
0.7816091954022989, 0.7976878612716763, 0.6127167630057804, 0.6416184971098265],
'avgAccuracy': 0.7150023254268819, 'f1': [0.7481985464666768,
0.7914596897355518, 0.7971484175626274, 0.7598566308243728, 0.6547897831134825],
'avgF1': 0.7502906135405423, 'precision': [0.7413793103448276,
0.7816091954022989, 0.7976878612716763, 0.6127167630057804, 0.6416184971098265],
'avgPrecision': 0.7150023254268819, 'recall': [0.7413793103448276,
0.7816091954022989, 0.7976878612716763, 0.6127167630057804, 0.6416184971098265],
'avgRecall': 0.7150023254268819, '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': 'Marked & transmucosal
increase in lamina propria cellularity, Crypt architecture, Epithelial changes,
Mucosal surface, Lamina propria granulomas, Patchy lamina propria cellularity?,
Mucin depletion, Submucosal granulomas, Cryptitis extent, Lamina propria
polymorphs, Cryptitis polymorphs, Basal histiocytic cells, Active inflammation?,
Sex, Increased lamina propria cellularity?, Increased lymphoid aggregates in

lamina propria?, Age, Intraepithelial lymphocytes, Crypt abscesses polymorphs, Crypt profiles, Crypt abscesses extent', 'accuracy': [0.6896551724137931, 0.7471264367816092, 0.7745664739884393, 0.861271676300578, 0.6647398843930635], 'avgAccuracy': 0.7474719287754966, 'f1': [0.697476362625139, 0.7612131434282859, 0.7739653795697847, 0.9254658385093167, 0.6719024880623272], 'avgF1': 0.7660046424389707, 'precision': [0.6896551724137931, 0.7471264367816092, 0.7745664739884393, 0.861271676300578, 0.6647398843930635], 'avgPrecision': 0.7474719287754966, 'recall': [0.6896551724137931, 0.7471264367816092, 0.7745664739884393, 0.861271676300578, 0.6647398843930635], 'avgRecall': 0.7474719287754966, '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': 'Marked & transmucosal increase in lamina propria cellularity, Crypt architecture, Epithelial changes, Mucosal surface, Lamina propria granulomas, Patchy lamina propria cellularity?, Mucin depletion, Submucosal granulomas, Cryptitis extent, Lamina propria polymorphs, Cryptitis polymorphs, Basal histiocytic cells, Active inflammation?, Sex, Increased lamina propria cellularity?, Increased lymphoid aggregates in lamina propria?, Age, Intraepithelial lymphocytes, Crypt abscesses polymorphs, Crypt profiles, Crypt abscesses extent', 'accuracy': [0.6264367816091954, 0.6551724137931034, 0.7283236994219653, 0.12716763005780346, 0.653179190751445], 'avgAccuracy': 0.5580559431267025, 'f1': [0.6355735479569788, 0.6850557771961477, 0.72950771222643383, 0.22564102564102562, 0.6665109396848238], 'avgF1': 0.5884578005486628, 'precision': [0.6264367816091954, 0.6551724137931034, 0.7283236994219653, 0.12716763005780346, 0.653179190751445], 'avgPrecision': 0.5580559431267025, 'recall': [0.6264367816091954, 0.6551724137931034, 0.7283236994219653, 0.12716763005780346, 0.653179190751445], 'avgRecall': 0.5580559431267025, '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': 'Marked & transmucosal increase in lamina propria cellularity, Crypt architecture, Epithelial changes, Mucosal

surface, Lamina propria granulomas, Patchy lamina propria cellularity?, Mucin depletion, Submucosal granulomas, Cryptitis extent, Lamina propria polymorphs, Cryptitis polymorphs, Basal histiocytic cells, Active inflammation?, Sex, Increased lamina propria cellularity?, Increased lymphoid aggregates in lamina propria?, Age, Intraepithelial lymphocytes, Crypt abscesses polymorphs, Crypt profiles, Crypt abscesses extent', 'accuracy': [0.6781609195402298, 0.6781609195402298, 0.7745664739884393, 0.4797687861271676, 0.6705202312138728], 'avgAccuracy': 0.6562354660819879, 'f1': [0.6894341290893015, 0.7059056678557273, 0.7752517979992833, 0.6484375, 0.680730512429674], 'avgF1': 0.6999519214747972, 'precision': [0.6781609195402298, 0.6781609195402298, 0.7745664739884393, 0.4797687861271676, 0.6705202312138728], 'avgPrecision': 0.6562354660819879, 'recall': [0.6781609195402298, 0.6781609195402298, 0.7745664739884393, 0.4797687861271676, 0.6705202312138728], 'avgRecall': 0.6562354660819879, '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': 'Marked & transmucosal increase in lamina propria cellularity, Crypt architecture, Epithelial changes, Mucosal surface, Lamina propria granulomas, Patchy lamina propria cellularity?, Mucin depletion, Submucosal granulomas, Cryptitis extent, Lamina propria polymorphs, Cryptitis polymorphs, Basal histiocytic cells, Active inflammation?, Sex, Increased lamina propria cellularity?, Increased lymphoid aggregates in lamina propria?, Age, Intraepithelial lymphocytes, Crypt abscesses polymorphs, Crypt profiles, Crypt abscesses extent', 'accuracy': [0.7413793103448276, 0.8103448275862069, 0.7976878612716763, 0.815028901734104, 0.7109826589595376], 'avgAccuracy': 0.7750847119792705, 'f1': [0.7460770183694619, 0.8158374552210141, 0.7943811144786455, 0.8980891719745221, 0.7124443868748527], 'avgF1': 0.7933658293836993, 'precision': [0.7413793103448276, 0.8103448275862069, 0.7976878612716763, 0.815028901734104, 0.7109826589595376], 'avgPrecision': 0.7750847119792705, 'recall': [0.7413793103448276, 0.8103448275862069, 0.7976878612716763, 0.815028901734104, 0.7109826589595376], 'avgRecall': 0.7750847119792705, '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  Marked & transmucosal increase in lamina propr…
1      KNeighborsClassifier  Marked & transmucosal increase in lamina propr…
2        LogisticRegression  Marked & transmucosal increase in lamina propr…
3                GaussianNB  Marked & transmucosal increase in lamina propr…
4          AdaBoostClassifier  Marked & transmucosal increase in lamina propr…
5      DecisionTreeClassifier  Marked & transmucosal increase in lamina propr…
6                        SVC  Marked & transmucosal increase in lamina propr…
7             MLPClassifier  Marked & transmucosal increase in lamina propr…

   accuracy        f1  precision    recall  \
0  0.775085  0.793366   0.775085  0.775085
1  0.745160  0.771957   0.745160  0.745160
2  0.648170  0.691887   0.648170  0.648170
3  0.589011  0.538441   0.589011  0.589011
4  0.715002  0.750291   0.715002  0.715002
5  0.747472  0.766005   0.747472  0.747472
6  0.558056  0.588458   0.558056  0.558056
7  0.656235  0.699952   0.656235  0.656235


                                              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': 'Marked & transmucosal
increase in lamina propria cellularity, Crypt architecture, Epithelial changes,
Mucosal surface, Lamina propria granulomas, Patchy lamina propria cellularity?,
Mucin depletion, Submucosal granulomas, Cryptitis extent, Lamina propria
polymorphs, Cryptitis polymorphs, Basal histiocytic cells, Active inflammation?,
Sex, Increased lamina propria cellularity?, Increased lymphoid aggregates in
lamina propria?, Age, Intraepithelial lymphocytes, Crypt abscesses polymorphs,
Crypt profiles', 'accuracy': [0.7528735632183908, 0.8160919540229885,
0.791907514450867, 0.8265895953757225, 0.7109826589595376], 'avgAccuracy':
0.7796890572055013, 'f1': [0.756521894452929, 0.8207461462740112,
0.7888626829315445, 0.9050632911392403, 0.7093979325981428], 'avgF1':
0.7961183894791736, 'precision': [0.7528735632183908, 0.8160919540229885,
0.791907514450867, 0.8265895953757225, 0.7109826589595376], 'avgPrecision':
0.7796890572055013, 'recall': [0.7528735632183908, 0.8160919540229885,
0.791907514450867, 0.8265895953757225, 0.7109826589595376], 'avgRecall':
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0.7796890572055013, 'params': [{'bootstrap': True, 'ccp_alpha': 0.0,
'class_weight': None, 'criterion': 'entropy', 'max_depth': None, 'max_features':
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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': 'Marked & transmucosal
increase in lamina propria cellularity, Crypt architecture, Epithelial changes,
Mucosal surface, Lamina propria granulomas, Patchy lamina propria cellularity?,
Mucin depletion, Submucosal granulomas, Cryptitis extent, Lamina propria
polymorphs, Cryptitis polymorphs, Basal histiocytic cells, Active inflammation?,
Sex, Increased lamina propria cellularity?, Increased lymphoid aggregates in
lamina propria?, Age, Intraepithelial lymphocytes, Crypt abscesses polymorphs,
Crypt profiles', 'accuracy': [0.7241379310344828, 0.7068965517241379,
0.8034682080924855, 0.7861271676300579, 0.6878612716763006], 'avgAccuracy':
0.7416982260314929, 'f1': [0.7335910291247274, 0.7318084132477162,
0.8039733628606461, 0.8802588996763754, 0.6922203519024327], 'avgF1':
0.7683704113623796, 'precision': [0.7241379310344828, 0.7068965517241379,
0.8034682080924855, 0.7861271676300579, 0.6878612716763006], 'avgPrecision':
0.7416982260314929, 'recall': [0.7241379310344828, 0.7068965517241379,
0.8034682080924855, 0.7861271676300579, 0.6878612716763006], 'avgRecall':
0.7416982260314929, 'params': [{'algorithm': 'kd_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': 'Marked & transmucosal
increase in lamina propria cellularity, Crypt architecture, Epithelial changes,
Mucosal surface, Lamina propria granulomas, Patchy lamina propria cellularity?,
Mucin depletion, Submucosal granulomas, Cryptitis extent, Lamina propria
polymorphs, Cryptitis polymorphs, Basal histiocytic cells, Active inflammation?,
Sex, Increased lamina propria cellularity?, Increased lymphoid aggregates in
lamina propria?, Age, Intraepithelial lymphocytes, Crypt abscesses polymorphs,
Crypt profiles', 'accuracy': [0.6436781609195402, 0.6724137931034483,
0.7572254335260116, 0.48554913294797686, 0.6878612716763006], 'avgAccuracy':
0.6493455584346555, 'f1': [0.6555716060888476, 0.7005450064667237,
0.7575712193301322, 0.6536964980544747, 0.6964013504527086], 'avgF1':
0.6927571360785774, 'precision': [0.6436781609195402, 0.6724137931034483,

0.7572254335260116, 0.48554913294797686, 0.6878612716763006], 'avgPrecision':
0.6493455584346555, 'recall': [0.6436781609195402, 0.6724137931034483,
0.7572254335260116, 0.48554913294797686, 0.6878612716763006], 'avgRecall':
0.6493455584346555, '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': 'Marked & transmucosal increase in
lamina propria cellularity, Crypt architecture, Epithelial changes, Mucosal
surface, Lamina propria granulomas, Patchy lamina propria cellularity?, Mucin
depletion, Submucosal granulomas, Cryptitis extent, Lamina propria polymorphs,
Cryptitis polymorphs, Basal histiocytic cells, Active inflammation?, Sex,
Increased lamina propria cellularity?, Increased lymphoid aggregates in lamina
propria?, Age, Intraepithelial lymphocytes, Crypt abscesses polymorphs, Crypt
profiles', 'accuracy': [0.7011494252873564, 0.8045977011494253,
0.6242774566473989, 0.10404624277456648, 0.7109826589595376], 'avgAccuracy':
0.5890106969636569, 'f1': [0.6179526873886999, 0.7363619777412881,
0.533935969056559, 0.18848167539267016, 0.6154740548800743], 'avgF1':
0.5384412728918583, 'precision': [0.7011494252873564, 0.8045977011494253,
0.6242774566473989, 0.10404624277456648, 0.7109826589595376], 'avgPrecision':
0.5890106969636569, 'recall': [0.7011494252873564, 0.8045977011494253,
0.6242774566473989, 0.10404624277456648, 0.7109826589595376], 'avgRecall':
0.5890106969636569, 'params': [{'priors': None, 'var_smoothing': 1e-09}]}
****

Processing Model: AdaBoostClassifier
****
* AdaBoostClassifier
* Best Params Result:
* {'classifier': 'AdaBoostClassifier', 'features': 'Marked & transmucosal
increase in lamina propria cellularity, Crypt architecture, Epithelial changes,
Mucosal surface, Lamina propria granulomas, Patchy lamina propria cellularity?,
Mucin depletion, Submucosal granulomas, Cryptitis extent, Lamina propria
polymorphs, Cryptitis polymorphs, Basal histiocytic cells, Active inflammation?,
Sex, Increased lamina propria cellularity?, Increased lymphoid aggregates in
lamina propria?, Age, Intraepithelial lymphocytes, Crypt abscesses polymorphs,
Crypt profiles', 'accuracy': [0.7528735632183908, 0.7988505747126436,
0.7976878612716763, 0.618497109826589 6, 0.6242774566473989], 'avgAccuracy':
0.7184373131353399, 'f1': [0.759908658632525, 0.8060579417292026,
0.7971484175626274, 0.7642857142857142, 0.6386013066534284], 'avgF1':
0.7532004077726996, 'precision': [0.7528735632183908, 0.7988505747126436,

71

0.7976878612716763, 0.6184971098265896, 0.6242774566473989], 'avgPrecision':
0.7184373131353399, 'recall': [0.7528735632183908, 0.7988505747126436,
0.7976878612716763, 0.6184971098265896, 0.6242774566473989], 'avgRecall':
0.7184373131353399, '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': 'Marked & transmucosal
increase in lamina propria cellularity, Crypt architecture, Epithelial changes,
Mucosal surface, Lamina propria granulomas, Patchy lamina propria cellularity?,
Mucin depletion, Submucosal granulomas, Cryptitis extent, Lamina propria
polymorphs, Cryptitis polymorphs, Basal histiocytic cells, Active inflammation?,
Sex, Increased lamina propria cellularity?, Increased lymphoid aggregates in
lamina propria?, Age, Intraepithelial lymphocytes, Crypt abscesses polymorphs,
Crypt profiles', 'accuracy': [0.7471264367816092, 0.7241379310344828,
0.7687861271676301, 0.7861271676300579, 0.6820809248554913], 'avgAccuracy':
0.7416517174938543, 'f1': [0.7534992584352984, 0.7429641097818438,
0.7654029810350493, 0.8802588996763754, 0.6844438119544635], 'avgF1':
0.7653138121766061, 'precision': [0.7471264367816092, 0.7241379310344828,
0.7687861271676301, 0.7861271676300579, 0.6820809248554913], 'avgPrecision':
0.7416517174938543, 'recall': [0.7471264367816092, 0.7241379310344828,
0.7687861271676301, 0.7861271676300579, 0.6820809248554913], 'avgRecall':
0.7416517174938543, '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': 'Marked & transmucosal increase in lamina
propria cellularity, Crypt architecture, Epithelial changes, Mucosal surface,
Lamina propria granulomas, Patchy lamina propria cellularity?, Mucin depletion,
Submucosal granulomas, Cryptitis extent, Lamina propria polymorphs, Cryptitis
polymorphs, Basal histiocytic cells, Active inflammation?, Sex, Increased lamina
propria cellularity?, Increased lymphoid aggregates in lamina propria?, Age,
Intraepithelial lymphocytes, Crypt abscesses polymorphs, Crypt profiles',
'accuracy': [0.6264367816091954, 0.6494252873563219, 0.7283236994219653,
0.10404624277456648, 0.6647398843930635], 'avgAccuracy': 0.5545943791110225,
'f1': [0.6355735479569788, 0.6798662051724348, 0.7295077122643383,
0.18848167539267016, 0.6773916573765312], 'avgF1': 0.5821641596325906,

'precision': [0.6264367816091954, 0.6494252873563219, 0.7283236994219653, 0.10404624277456648, 0.6647398843930635], 'avgPrecision': 0.5545943791110225, 'recall': [0.6264367816091954, 0.6494252873563219, 0.7283236994219653, 0.10404624277456648, 0.6647398843930635], 'avgRecall': 0.5545943791110225, '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': 'Marked & transmucosal increase in lamina propria cellularity, Crypt architecture, Epithelial changes, Mucosal surface, Lamina propria granulomas, Patchy lamina propria cellularity?, Mucin depletion, Submucosal granulomas, Cryptitis extent, Lamina propria polymorphs, Cryptitis polymorphs, Basal histiocytic cells, Active inflammation?, Sex, Increased lamina propria cellularity?, Increased lymphoid aggregates in lamina propria?, Age, Intraepithelial lymphocytes, Crypt abscesses polymorphs, Crypt profiles', 'accuracy': [0.6781609195402298, 0.6666666666666666, 0.7687861271676301, 0.48554913294797686, 0.6994219653179191], 'avgAccuracy': 0.6597169623280845, 'f1': [0.6893358876117496, 0.6951566951566953, 0.7693804268948776, 0.6536964980544747, 0.7083970705689648], 'avgF1': 0.7031933156573524, 'precision': [0.6781609195402298, 0.6666666666666666, 0.7687861271676301, 0.48554913294797686, 0.6994219653179191], 'avgPrecision': 0.6597169623280845, 'recall': [0.6781609195402298, 0.6666666666666666, 0.7687861271676301, 0.48554913294797686, 0.6994219653179191], 'avgRecall': 0.6597169623280845, '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': 'Marked & transmucosal increase in lamina propria cellularity, Crypt architecture, Epithelial changes, Mucosal surface, Lamina propria granulomas, Patchy lamina propria cellularity?, Mucin depletion, Submucosal granulomas, Cryptitis extent, Lamina propria polymorphs, Cryptitis polymorphs, Basal histiocytic cells, Active inflammation?, Sex, Increased lamina propria cellularity?, Increased lymphoid aggregates in lamina propria?, Age, Intraepithelial lymphocytes, Crypt abscesses polymorphs, Crypt profiles', 'accuracy': [0.7528735632183908, 0.8160919540229885, 0.791907514450867, 0.8265895953757225, 0.7109826589595376], 'avgAccuracy':

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0.7796890572055013, 'f1': [0.756521894452929, 0.8207461462740112,
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0.791907514450867, 0.8265895953757225, 0.7109826589595376], 'avgPrecision':
0.7796890572055013, 'recall': [0.7528735632183908, 0.8160919540229885,
0.791907514450867, 0.8265895953757225, 0.7109826589595376], 'avgRecall':
0.7796890572055013, '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  Marked & transmucosal increase in lamina propr…
1    KNeighborsClassifier  Marked & transmucosal increase in lamina propr…
2      LogisticRegression  Marked & transmucosal increase in lamina propr…
3              GaussianNB  Marked & transmucosal increase in lamina propr…
4      AdaBoostClassifier  Marked & transmucosal increase in lamina propr…
5  DecisionTreeClassifier  Marked & transmucosal increase in lamina propr…
6                     SVC  Marked & transmucosal increase in lamina propr…
7           MLPClassifier  Marked & transmucosal increase in lamina propr…

   accuracy        f1  precision    recall  \
0  0.779689  0.796118   0.779689  0.779689
1  0.741698  0.768370   0.741698  0.741698
2  0.649346  0.692757   0.649346  0.649346
3  0.589011  0.538441   0.589011  0.589011
4  0.718437  0.753200   0.718437  0.718437
5  0.741652  0.765314   0.741652  0.741652
6  0.554594  0.582164   0.554594  0.554594
7  0.659717  0.703193   0.659717  0.659717


                                            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': 'Marked & transmucosal
increase in lamina propria cellularity, Crypt architecture, Epithelial changes,
Mucosal surface, Lamina propria granulomas, Patchy lamina propria cellularity?,
Mucin depletion, Submucosal granulomas, Cryptitis extent, Lamina propria
polymorphs, Cryptitis polymorphs, Basal histiocytic cells, Active inflammation?,
Sex, Increased lamina propria cellularity?, Increased lymphoid aggregates in
lamina propria?, Age, Intraepithelial lymphocytes, Crypt abscesses polymorphs',
'accuracy': [0.7586206896551724, 0.8160919540229885, 0.7861271676300579,
0.815028901734104, 0.7052023121387283], 'avgAccuracy': 0.7762142050362102, 'f1':
[0.7626051381089116, 0.8193172070681077, 0.782631463877425, 0.8980891719745221,
0.7044101270853962], 'avgF1': 0.7934106216228726, 'precision':
[0.7586206896551724, 0.8160919540229885, 0.7861271676300579, 0.815028901734104,
0.7052023121387283], 'avgPrecision': 0.7762142050362102, 'recall':
[0.7586206896551724, 0.8160919540229885, 0.7861271676300579, 0.815028901734104,
0.7052023121387283], 'avgRecall': 0.7762142050362102, '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': 'Marked & transmucosal
increase in lamina propria cellularity, Crypt architecture, Epithelial changes,
Mucosal surface, Lamina propria granulomas, Patchy lamina propria cellularity?,
Mucin depletion, Submucosal granulomas, Cryptitis extent, Lamina propria
polymorphs, Cryptitis polymorphs, Basal histiocytic cells, Active inflammation?,
Sex, Increased lamina propria cellularity?, Increased lymphoid aggregates in
lamina propria?, Age, Intraepithelial lymphocytes, Crypt abscesses polymorphs',
'accuracy': [0.7413793103448276, 0.7126436781609196, 0.7976878612716763,
0.7861271676300579, 0.6878612716763006], 'avgAccuracy': 0.7451398578167564,
'f1': [0.7499080499966836, 0.7369089365728758, 0.7980989394769558,
0.8802588996763754, 0.6922203519024327], 'avgF1': 0.7714790355250647,
'precision': [0.7413793103448276, 0.7126436781609196, 0.7976878612716763,
0.7861271676300579, 0.6878612716763006], 'avgPrecision': 0.7451398578167564,
'recall': [0.7413793103448276, 0.7126436781609196, 0.7976878612716763,
0.7861271676300579, 0.6878612716763006], 'avgRecall': 0.7451398578167564,
'params': [{'algorithm': 'kd_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': 'Marked & transmucosal
increase in lamina propria cellularity, Crypt architecture, Epithelial changes,
Mucosal surface, Lamina propria granulomas, Patchy lamina propria cellularity?,
Mucin depletion, Submucosal granulomas, Cryptitis extent, Lamina propria
polymorphs, Cryptitis polymorphs, Basal histiocytic cells, Active inflammation?,
Sex, Increased lamina propria cellularity?, Increased lymphoid aggregates in
lamina propria?, Age, Intraepithelial lymphocytes, Crypt abscesses polymorphs',
'accuracy': [0.6551724137931034, 0.6724137931034483, 0.7572254335260116,
0.48554913294797686, 0.6936416184971098], 'avgAccuracy': 0.65280047837353, 'f1':
[0.666958193221306, 0.7005450064667237, 0.7575712193301322, 0.6536964980544747,
0.7031353887503986], 'avgF1': 0.6963812611646071, 'precision':
[0.6551724137931034, 0.6724137931034483, 0.7572254335260116,
0.48554913294797686, 0.6936416184971098], 'avgPrecision': 0.65280047837353,
'recall': [0.6551724137931034, 0.6724137931034483, 0.7572254335260116,
0.48554913294797686, 0.6936416184971098], 'avgRecall': 0.65280047837353,
'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': 'Marked & transmucosal increase in
lamina propria cellularity, Crypt architecture, Epithelial changes, Mucosal
surface, Lamina propria granulomas, Patchy lamina propria cellularity?, Mucin
depletion, Submucosal granulomas, Cryptitis extent, Lamina propria polymorphs,
Cryptitis polymorphs, Basal histiocytic cells, Active inflammation?, Sex,
Increased lamina propria cellularity?, Increased lymphoid aggregates in lamina
propria?, Age, Intraepithelial lymphocytes, Crypt abscesses polymorphs',
'accuracy': [0.7011494252873564, 0.8045977011494253, 0.6242774566473989,
0.10404624277456648, 0.7109826589595376], 'avgAccuracy': 0.5890106969636569,
'f1': [0.6179526873886999, 0.7363619777412881, 0.533935969056559,
0.18848167539267016, 0.6154740548800743], 'avgF1': 0.5384412728918583,
'precision': [0.7011494252873564, 0.8045977011494253, 0.6242774566473989,
0.10404624277456648, 0.7109826589595376], 'avgPrecision': 0.5890106969636569,
'recall': [0.7011494252873564, 0.8045977011494253, 0.6242774566473989,
0.10404624277456648, 0.7109826589595376], 'avgRecall': 0.5890106969636569,
'params': [{'priors': None, 'var_smoothing': 1e-09}]}
***************************************************

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

* AdaBoostClassifier
* Best Params Result:
* {'classifier': 'AdaBoostClassifier', 'features': 'Marked & transmucosal
increase in lamina propria cellularity, Crypt architecture, Epithelial changes,
Mucosal surface, Lamina propria granulomas, Patchy lamina propria cellularity?,
Mucin depletion, Submucosal granulomas, Cryptitis extent, Lamina propria
polymorphs, Cryptitis polymorphs, Basal histiocytic cells, Active inflammation?,
Sex, Increased lamina propria cellularity?, Increased lymphoid aggregates in
lamina propria?, Age, Intraepithelial lymphocytes, Crypt abscesses polymorphs',
'accuracy': [0.7183908045977011, 0.7931034482758621, 0.791907514450867,
0.6473988439306358, 0.630057803468208], 'avgAccuracy': 0.7161716829446548, 'f1':
[0.7258161950414926, 0.7983394145582627, 0.7911378573125346, 0.7859649122807019,
0.6440183805534138], 'avgF1': 0.7490553519492811, 'precision':
[0.7183908045977011, 0.7931034482758621, 0.791907514450867, 0.6473988439306358,
0.630057803468208], 'avgPrecision': 0.7161716829446548, 'recall':
[0.7183908045977011, 0.7931034482758621, 0.791907514450867, 0.6473988439306358,
0.630057803468208], 'avgRecall': 0.7161716829446548, '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': 'Marked & transmucosal
increase in lamina propria cellularity, Crypt architecture, Epithelial changes,
Mucosal surface, Lamina propria granulomas, Patchy lamina propria cellularity?,
Mucin depletion, Submucosal granulomas, Cryptitis extent, Lamina propria
polymorphs, Cryptitis polymorphs, Basal histiocytic cells, Active inflammation?,
Sex, Increased lamina propria cellularity?, Increased lymphoid aggregates in
lamina propria?, Age, Intraepithelial lymphocytes, Crypt abscesses polymorphs',
'accuracy': [0.7298850574712644, 0.7816091954022989, 0.7456647398843931,
0.8208092485549133, 0.6589595375722543], 'avgAccuracy': 0.7473855557770248,
'f1': [0.7356183742329876, 0.7886998059411853, 0.7441433449703351,
0.9015873015873017, 0.6643998123346705], 'avgF1': 0.766889727813296,
'precision': [0.7298850574712644, 0.7816091954022989, 0.7456647398843931,
0.8208092485549133, 0.6589595375722543], 'avgPrecision': 0.7473855557770248,
'recall': [0.7298850574712644, 0.7816091954022989, 0.7456647398843931,
0.8208092485549133, 0.6589595375722543], 'avgRecall': 0.7473855557770248,
'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': 'Marked & transmucosal increase in lamina
propria cellularity, Crypt architecture, Epithelial changes, Mucosal surface,
Lamina propria granulomas, Patchy lamina propria cellularity?, Mucin depletion,
Submucosal granulomas, Cryptitis extent, Lamina propria polymorphs, Cryptitis
polymorphs, Basal histiocytic cells, Active inflammation?, Sex, Increased lamina
propria cellularity?, Increased lymphoid aggregates in lamina propria?, Age,
Intraepithelial lymphocytes, Crypt abscesses polymorphs', 'accuracy':
[0.6264367816091954, 0.6494252873563219, 0.7341040462427746,
0.10404624277456648, 0.6647398843930635], 'avgAccuracy': 0.5557504484751844,
'f1': [0.6355735479569788, 0.6798662051724348, 0.7352264963289916,
0.18848167539267016, 0.6773916573765312], 'avgF1': 0.5833079164455213,
'precision': [0.6264367816091954, 0.6494252873563219, 0.7341040462427746,
0.10404624277456648, 0.6647398843930635], 'avgPrecision': 0.5557504484751844,
'recall': [0.6264367816091954, 0.6494252873563219, 0.7341040462427746,
0.10404624277456648, 0.6647398843930635], 'avgRecall': 0.5557504484751844,
'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': 'Marked & transmucosal increase in
lamina propria cellularity, Crypt architecture, Epithelial changes, Mucosal
surface, Lamina propria granulomas, Patchy lamina propria cellularity?, Mucin
depletion, Submucosal granulomas, Cryptitis extent, Lamina propria polymorphs,
Cryptitis polymorphs, Basal histiocytic cells, Active inflammation?, Sex,
Increased lamina propria cellularity?, Increased lymphoid aggregates in lamina
propria?, Age, Intraepithelial lymphocytes, Crypt abscesses polymorphs',
'accuracy': [0.6724137931034483, 0.6781609195402298, 0.7687861271676301,
0.48554913294797686, 0.6936416184971098], 'avgAccuracy': 0.659710318251279,
'f1': [0.6837098692033294, 0.7053380089616209, 0.7693804268948776,
0.6536964980544747, 0.7016031031087794], 'avgF1': 0.7027455812446164,
'precision': [0.6724137931034483, 0.6781609195402298, 0.7687861271676301,
0.48554913294797686, 0.6936416184971098], 'avgPrecision': 0.659710318251279,
'recall': [0.6724137931034483, 0.6781609195402298, 0.7687861271676301,
0.48554913294797686, 0.6936416184971098], 'avgRecall': 0.659710318251279,
'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': 'Marked & transmucosal
increase in lamina propria cellularity, Crypt architecture, Epithelial changes,
Mucosal surface, Lamina propria granulomas, Patchy lamina propria cellularity?,
Mucin depletion, Submucosal granulomas, Cryptitis extent, Lamina propria
polymorphs, Cryptitis polymorphs, Basal histiocytic cells, Active inflammation?,
Sex, Increased lamina propria cellularity?, Increased lymphoid aggregates in
lamina propria?, Age, Intraepithelial lymphocytes, Crypt abscesses polymorphs',
'accuracy': [0.7586206896551724, 0.8160919540229885, 0.7861271676300579,
0.815028901734104, 0.7052023121387283], 'avgAccuracy': 0.7762142050362102, 'f1':
[0.7626051381089116, 0.8193172070681077, 0.782631463877425, 0.8980891719745221,
0.7044101270853962], 'avgF1': 0.7934106216228726, 'precision':
[0.7586206896551724, 0.8160919540229885, 0.7861271676300579, 0.815028901734104,
0.7052023121387283], 'avgPrecision': 0.7762142050362102, 'recall':
[0.7586206896551724, 0.8160919540229885, 0.7861271676300579, 0.815028901734104,
0.7052023121387283], 'avgRecall': 0.7762142050362102, '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}]}
****

```
                     model                                   features  \
0  RandomForestClassifier  Marked & transmucosal increase in lamina propr…
1    KNeighborsClassifier  Marked & transmucosal increase in lamina propr…
2      LogisticRegression  Marked & transmucosal increase in lamina propr…
3              GaussianNB  Marked & transmucosal increase in lamina propr…
4       AdaBoostClassifier  Marked & transmucosal increase in lamina propr…
5  DecisionTreeClassifier  Marked & transmucosal increase in lamina propr…
6                     SVC  Marked & transmucosal increase in lamina propr…
7           MLPClassifier  Marked & transmucosal increase in lamina propr…


   accuracy        f1  precision    recall  \
0  0.776214  0.793411   0.776214  0.776214
1  0.745140  0.771479   0.745140  0.745140
2  0.652800  0.696381   0.652800  0.652800
3  0.589011  0.538441   0.589011  0.589011
4  0.716172  0.749055   0.716172  0.716172
5  0.747386  0.766890   0.747386  0.747386
6  0.555750  0.583308   0.555750  0.555750
7  0.659710  0.702746   0.659710  0.659710
```

```
                                                          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': 'Marked & transmucosal
increase in lamina propria cellularity, Crypt architecture, Epithelial changes,
Mucosal surface, Lamina propria granulomas, Patchy lamina propria cellularity?,
Mucin depletion, Submucosal granulomas, Cryptitis extent, Lamina propria
polymorphs, Cryptitis polymorphs, Basal histiocytic cells, Active inflammation?,
Sex, Increased lamina propria cellularity?, Increased lymphoid aggregates in
lamina propria?, Age, Intraepithelial lymphocytes', 'accuracy':
[0.7528735632183908, 0.8333333333333334, 0.7803468208092486, 0.8265895953757225,
0.7109826589595376], 'avgAccuracy': 0.7808251943392466, 'f1':
[0.7573624842197081, 0.8381601879214974, 0.7763629151082398, 0.9050632911392403,
0.707684646871162], 'avgF1': 0.7969267050519695, 'precision':
[0.7528735632183908, 0.8333333333333334, 0.7803468208092486, 0.8265895953757225,
0.7109826589595376], 'avgPrecision': 0.7808251943392466, 'recall':
[0.7528735632183908, 0.8333333333333334, 0.7803468208092486, 0.8265895953757225,
0.7109826589595376], 'avgRecall': 0.7808251943392466, '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': 'Marked & transmucosal
increase in lamina propria cellularity, Crypt architecture, Epithelial changes,
Mucosal surface, Lamina propria granulomas, Patchy lamina propria cellularity?,
Mucin depletion, Submucosal granulomas, Cryptitis extent, Lamina propria
polymorphs, Cryptitis polymorphs, Basal histiocytic cells, Active inflammation?,
Sex, Increased lamina propria cellularity?, Increased lymphoid aggregates in
lamina propria?, Age, Intraepithelial lymphocytes', 'accuracy':

```

[0.735632183908046, 0.7241379310344828, 0.7745664739884393, 0.7630057803468208, 0.6820809248554913], 'avgAccuracy': 0.735884658826656, 'f1': [0.7441996594295445, 0.7470667263770712, 0.7747349079355358, 0.8655737704918033, 0.687152367430625], 'avgF1': 0.763745486332916, 'precision': [0.735632183908046, 0.7241379310344828, 0.7745664739884393, 0.7630057803468208, 0.6820809248554913], 'avgPrecision': 0.735884658826656, 'recall': [0.735632183908046, 0.7241379310344828, 0.7745664739884393, 0.7630057803468208, 0.6820809248554913], 'avgRecall': 0.735884658826656, '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': 'Marked & transmucosal increase in lamina propria cellularity, Crypt architecture, Epithelial changes, Mucosal surface, Lamina propria granulomas, Patchy lamina propria cellularity?, Mucin depletion, Submucosal granulomas, Cryptitis extent, Lamina propria polymorphs, Cryptitis polymorphs, Basal histiocytic cells, Active inflammation?, Sex, Increased lamina propria cellularity?, Increased lymphoid aggregates in lamina propria?, Age, Intraepithelial lymphocytes', 'accuracy': [0.6609195402298851, 0.6954022988505747, 0.7341040462427746, 0.4508670520231214, 0.7109826589595376], 'avgAccuracy': 0.6504551192611787, 'f1': [0.6726119698771305, 0.7212910961201756, 0.73448276402824, 0.6215139442231076, 0.7188901393080636], 'avgF1': 0.6937579827113435, 'precision': [0.6609195402298851, 0.6954022988505747, 0.7341040462427746, 0.4508670520231214, 0.7109826589595376], 'avgPrecision': 0.6504551192611787, 'recall': [0.6609195402298851, 0.6954022988505747, 0.7341040462427746, 0.4508670520231214, 0.7109826589595376], 'avgRecall': 0.6504551192611787, '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': 'Marked & transmucosal increase in lamina propria cellularity, Crypt architecture, Epithelial changes, Mucosal surface, Lamina propria granulomas, Patchy lamina propria cellularity?, Mucin depletion, Submucosal granulomas, Cryptitis extent, Lamina propria polymorphs, Cryptitis polymorphs, Basal histiocytic cells, Active inflammation?, Sex, Increased lamina propria cellularity?, Increased lymphoid aggregates in lamina propria?, Age, Intraepithelial lymphocytes', 'accuracy': [0.7011494252873564,

0.8045977011494253, 0.6242774566473989, 0.10404624277456648,
0.7109826589595376], 'avgAccuracy': 0.5890106969636569, 'f1':
[0.6179526873886999, 0.7363619777412881, 0.533935969056559, 0.18848167539267016,
0.6154740548800743], 'avgF1': 0.5384412728918583, 'precision':
[0.7011494252873564, 0.8045977011494253, 0.6242774566473989,
0.10404624277456648, 0.7109826589595376], 'avgPrecision': 0.5890106969636569,
'recall': [0.7011494252873564, 0.8045977011494253, 0.6242774566473989,
0.10404624277456648, 0.7109826589595376], 'avgRecall': 0.5890106969636569,
'params': [{'priors': None, 'var_smoothing': 1e-09}]}
*********************************************************

Processing Model: AdaBoostClassifier
*********************************************************
* AdaBoostClassifier
* Best Params Result:
* {'classifier': 'AdaBoostClassifier', 'features': 'Marked & transmucosal
increase in lamina propria cellularity, Crypt architecture, Epithelial changes,
Mucosal surface, Lamina propria granulomas, Patchy lamina propria cellularity?,
Mucin depletion, Submucosal granulomas, Cryptitis extent, Lamina propria
polymorphs, Cryptitis polymorphs, Basal histiocytic cells, Active inflammation?,
Sex, Increased lamina propria cellularity?, Increased lymphoid aggregates in
lamina propria?, Age, Intraepithelial lymphocytes', 'accuracy':
[0.7471264367816092, 0.7758620689655172, 0.7630057803468208, 0.6416184971098265,
0.5780346820809249], 'avgAccuracy': 0.7011294930569397, 'f1':
[0.7540693402762367, 0.7877939851641717, 0.7612913297585413, 0.7816901408450704,
0.5944891736773938], 'avgF1': 0.7358667939442828, 'precision':
[0.7471264367816092, 0.7758620689655172, 0.7630057803468208, 0.6416184971098265,
0.5780346820809249], 'avgPrecision': 0.7011294930569397, 'recall':
[0.7471264367816092, 0.7758620689655172, 0.7630057803468208, 0.6416184971098265,
0.5780346820809249], 'avgRecall': 0.7011294930569397, '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': 'Marked & transmucosal
increase in lamina propria cellularity, Crypt architecture, Epithelial changes,
Mucosal surface, Lamina propria granulomas, Patchy lamina propria cellularity?,
Mucin depletion, Submucosal granulomas, Cryptitis extent, Lamina propria
polymorphs, Cryptitis polymorphs, Basal histiocytic cells, Active inflammation?,
Sex, Increased lamina propria cellularity?, Increased lymphoid aggregates in
lamina propria?, Age, Intraepithelial lymphocytes', 'accuracy':
[0.7471264367816092, 0.735632183908046, 0.7456647398843931, 0.8323699421965318,
0.6589595375722543], 'avgAccuracy': 0.7439505680685669, 'f1':
[0.7545617816091953, 0.7526797117314359, 0.7434873322446296, 0.9085173501577286,

0.6678223223286411], 'avgF1': 0.7654136996143261, 'precision':
[0.7471264367816092, 0.735632183908046, 0.7456647398843931, 0.8323699421965318,
0.6589595375722543], 'avgPrecision': 0.7439505680685669, 'recall':
[0.7471264367816092, 0.735632183908046, 0.7456647398843931, 0.8323699421965318,
0.6589595375722543], 'avgRecall': 0.7439505680685669, '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': 'Marked & transmucosal increase in lamina
propria cellularity, Crypt architecture, Epithelial changes, Mucosal surface,
Lamina propria granulomas, Patchy lamina propria cellularity?, Mucin depletion,
Submucosal granulomas, Cryptitis extent, Lamina propria polymorphs, Cryptitis
polymorphs, Basal histiocytic cells, Active inflammation?, Sex, Increased lamina
propria cellularity?, Increased lymphoid aggregates in lamina propria?, Age,
Intraepithelial lymphocytes', 'accuracy': [0.6666666666666666,
0.6666666666666666, 0.7225433526011561, 0.10404624277456648, 0.653179190751445],
'avgAccuracy': 0.5626204238921002, 'f1': [0.6774410774410775,
0.6956140350877194, 0.7237720253553377, 0.18848167539267016,
0.6665109396848238], 'avgF1': 0.5903639505923257, 'precision':
[0.6666666666666666, 0.6666666666666666, 0.7225433526011561,
0.10404624277456648, 0.653179190751445], 'avgPrecision': 0.5626204238921002,
'recall': [0.6666666666666666, 0.6666666666666666, 0.7225433526011561,
0.10404624277456648, 0.653179190751445], 'avgRecall': 0.5626204238921002,
'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': 'Marked & transmucosal increase in
lamina propria cellularity, Crypt architecture, Epithelial changes, Mucosal
surface, Lamina propria granulomas, Patchy lamina propria cellularity?, Mucin
depletion, Submucosal granulomas, Cryptitis extent, Lamina propria polymorphs,
Cryptitis polymorphs, Basal histiocytic cells, Active inflammation?, Sex,
Increased lamina propria cellularity?, Increased lymphoid aggregates in lamina
propria?, Age, Intraepithelial lymphocytes', 'accuracy': [0.6666666666666666,
0.6954022988505747, 0.7572254335260116, 0.47398843930635837,

0.6994219653179191], 'avgAccuracy': 0.6585409607335061, 'f1':
[0.6782407407407407, 0.7209330675066161, 0.7578494482396217, 0.6431372549019608,
0.707645744880386], 'avgF1': 0.701561251253865, 'precision':
[0.6666666666666666, 0.6954022988505747, 0.7572254335260116,
0.47398843930635837, 0.6994219653179191], 'avgPrecision': 0.6585409607335061,
'recall': [0.6666666666666666, 0.6954022988505747, 0.7572254335260116,
0.47398843930635837, 0.6994219653179191], 'avgRecall': 0.6585409607335061,
'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': 'Marked & transmucosal
increase in lamina propria cellularity, Crypt architecture, Epithelial changes,
Mucosal surface, Lamina propria granulomas, Patchy lamina propria cellularity?,
Mucin depletion, Submucosal granulomas, Cryptitis extent, Lamina propria
polymorphs, Cryptitis polymorphs, Basal histiocytic cells, Active inflammation?,
Sex, Increased lamina propria cellularity?, Increased lymphoid aggregates in
lamina propria?, Age, Intraepithelial lymphocytes', 'accuracy':
[0.7528735632183908, 0.8333333333333334, 0.7803468208092486, 0.8265895953757225,
0.7109826589595376], 'avgAccuracy': 0.7808251943392466, 'f1':
[0.7573624842197081, 0.8381601879214974, 0.7763629151082398, 0.9050632911392403,
0.707684646871162], 'avgF1': 0.7969267050519695, 'precision':
[0.7528735632183908, 0.8333333333333334, 0.7803468208092486, 0.8265895953757225,
0.7109826589595376], 'avgPrecision': 0.7808251943392466, 'recall':
[0.7528735632183908, 0.8333333333333334, 0.7803468208092486, 0.8265895953757225,
0.7109826589595376], 'avgRecall': 0.7808251943392466, '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 Marked & transmucosal increase in lamina propr…
1   KNeighborsClassifier Marked & transmucosal increase in lamina propr…
2   LogisticRegression Marked & transmucosal increase in lamina propr…
3   GaussianNB Marked & transmucosal increase in lamina propr…
4   AdaBoostClassifier Marked & transmucosal increase in lamina propr…
5 DecisionTreeClassifier Marked & transmucosal increase in lamina propr…
6   SVC Marked & transmucosal increase in lamina propr…
```

```
7            MLPClassifier  Marked & transmucosal increase in lamina propr…

   accuracy        f1  precision    recall  \
0  0.780825  0.796927   0.780825  0.780825
1  0.735885  0.763745   0.735885  0.735885
2  0.650455  0.693758   0.650455  0.650455
3  0.589011  0.538441   0.589011  0.589011
4  0.701129  0.735867   0.701129  0.701129
5  0.743951  0.765414   0.743951  0.743951
6  0.562620  0.590364   0.562620  0.562620
7  0.658541  0.701561   0.658541  0.658541


                                                 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': 'Marked & transmucosal
increase in lamina propria cellularity, Crypt architecture, Epithelial changes,
Mucosal surface, Lamina propria granulomas, Patchy lamina propria cellularity?,
Mucin depletion, Submucosal granulomas, Cryptitis extent, Lamina propria
polymorphs, Cryptitis polymorphs, Basal histiocytic cells, Active inflammation?,
Sex, Increased lamina propria cellularity?, Increased lymphoid aggregates in
lamina propria?, Age', 'accuracy': [0.7586206896551724, 0.8275862068965517,
0.7745664739884393, 0.8323699421965318, 0.7167630057803468], 'avgAccuracy':
0.7819812637034084, 'f1': [0.7626051381089116, 0.8319495121318856,
0.7708818132762049, 0.9085173501577286, 0.7160018868075376], 'avgF1':
0.7979911400964537, 'precision': [0.7586206896551724, 0.8275862068965517,
0.7745664739884393, 0.8323699421965318, 0.7167630057803468], 'avgPrecision':
0.7819812637034084, 'recall': [0.7586206896551724, 0.8275862068965517,
0.7745664739884393, 0.8323699421965318, 0.7167630057803468], 'avgRecall':
0.7819812637034084, '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': 'Marked & transmucosal
increase in lamina propria cellularity, Crypt architecture, Epithelial changes,
Mucosal surface, Lamina propria granulomas, Patchy lamina propria cellularity?,
Mucin depletion, Submucosal granulomas, Cryptitis extent, Lamina propria
polymorphs, Cryptitis polymorphs, Basal histiocytic cells, Active inflammation?,
Sex, Increased lamina propria cellularity?, Increased lymphoid aggregates in
lamina propria?, Age', 'accuracy': [0.7298850574712644, 0.7241379310344828,
0.7745664739884393, 0.7687861271676301, 0.6878612716763006], 'avgAccuracy':
0.7370473722676234, 'f1': [0.7387928522187587, 0.7470667263770712,
0.7747349079355358, 0.8692810457516339, 0.6922203519024327], 'avgF1':
0.7644191768370865, 'precision': [0.7298850574712644, 0.7241379310344828,
0.7745664739884393, 0.7687861271676301, 0.6878612716763006], 'avgPrecision':
0.7370473722676234, 'recall': [0.7298850574712644, 0.7241379310344828,
0.7745664739884393, 0.7687861271676301, 0.6878612716763006], 'avgRecall':
0.7370473722676234, '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': 'Marked & transmucosal
increase in lamina propria cellularity, Crypt architecture, Epithelial changes,
Mucosal surface, Lamina propria granulomas, Patchy lamina propria cellularity?,
Mucin depletion, Submucosal granulomas, Cryptitis extent, Lamina propria
polymorphs, Cryptitis polymorphs, Basal histiocytic cells, Active inflammation?,
Sex, Increased lamina propria cellularity?, Increased lymphoid aggregates in
lamina propria?, Age', 'accuracy': [0.6551724137931034, 0.6839080459770115,
0.7456647398843931, 0.4508670520231214, 0.7167630057803468], 'avgAccuracy':
0.6504750514915952, 'f1': [0.666958193221306, 0.710773778992635,
0.7460269916791861, 0.6215139442231076, 0.7248777846781], 'avgF1':
0.694030138558867, 'precision': [0.6551724137931034, 0.6839080459770115,
0.7456647398843931, 0.4508670520231214, 0.7167630057803468], 'avgPrecision':
0.6504750514915952, 'recall': [0.6551724137931034, 0.6839080459770115,
0.7456647398843931, 0.4508670520231214, 0.7167630057803468], 'avgRecall':
0.6504750514915952, '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': 'Marked & transmucosal increase in
lamina propria cellularity, Crypt architecture, Epithelial changes, Mucosal
surface, Lamina propria granulomas, Patchy lamina propria cellularity?, Mucin
depletion, Submucosal granulomas, Cryptitis extent, Lamina propria polymorphs,
Cryptitis polymorphs, Basal histiocytic cells, Active inflammation?, Sex,
Increased lamina propria cellularity?, Increased lymphoid aggregates in lamina
propria?, Age', 'accuracy': [0.7011494252873564, 0.8045977011494253,
0.6242774566473989, 0.10404624277456648, 0.7109826589595376], 'avgAccuracy':
0.5890106969636569, 'f1': [0.6179526873886999, 0.7363619777412881,
0.533935969056559, 0.18848167539267016, 0.6154740548800743], 'avgF1':
0.5384412728918583, 'precision': [0.7011494252873564, 0.8045977011494253,
0.6242774566473989, 0.10404624277456648, 0.7109826589595376], 'avgPrecision':
0.5890106969636569, 'recall': [0.7011494252873564, 0.8045977011494253,
0.6242774566473989, 0.10404624277456648, 0.7109826589595376], 'avgRecall':
0.5890106969636569, 'params': [{'priors': None, 'var_smoothing': 1e-09}]}
****

Processing Model: AdaBoostClassifier
****
* AdaBoostClassifier
* Best Params Result:
* {'classifier': 'AdaBoostClassifier', 'features': 'Marked & transmucosal
increase in lamina propria cellularity, Crypt architecture, Epithelial changes,
Mucosal surface, Lamina propria granulomas, Patchy lamina propria cellularity?,
Mucin depletion, Submucosal granulomas, Cryptitis extent, Lamina propria
polymorphs, Cryptitis polymorphs, Basal histiocytic cells, Active inflammation?,
Sex, Increased lamina propria cellularity?, Increased lymphoid aggregates in
lamina propria?, Age', 'accuracy': [0.7471264367816092, 0.7873563218390804,
0.7687861271676301, 0.6242774566473989, 0.5664739884393064], 'avgAccuracy':
0.698804066175005, 'f1': [0.7545617816091953, 0.7975498607036771,
0.767403040882123, 0.7686832740213524, 0.5827172687489401], 'avgF1':
0.7341830451930575, 'precision': [0.7471264367816092, 0.7873563218390804,
0.7687861271676301, 0.6242774566473989, 0.5664739884393064], 'avgPrecision':
0.698804066175005, 'recall': [0.7471264367816092, 0.7873563218390804,
0.7687861271676301, 0.6242774566473989, 0.5664739884393064], 'avgRecall':
0.698804066175005, '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': 'Marked & transmucosal

increase in lamina propria cellularity, Crypt architecture, Epithelial changes, Mucosal surface, Lamina propria granulomas, Patchy lamina propria cellularity?, Mucin depletion, Submucosal granulomas, Cryptitis extent, Lamina propria polymorphs, Cryptitis polymorphs, Basal histiocytic cells, Active inflammation?, Sex, Increased lamina propria cellularity?, Increased lymphoid aggregates in lamina propria?, Age', 'accuracy': [0.7126436781609196, 0.7528735632183908, 0.7341040462427746, 0.8323699421965318, 0.6589595375722543], 'avgAccuracy': 0.7381901534781742, 'f1': [0.7205333412229964, 0.7701666995393626, 0.7331205954549055, 0.9085173501577286, 0.6656609537735448], 'avgF1': 0.7595997880297076, 'precision': [0.7126436781609196, 0.7528735632183908, 0.7341040462427746, 0.8323699421965318, 0.6589595375722543], 'avgPrecision': 0.7381901534781742, 'recall': [0.7126436781609196, 0.7528735632183908, 0.7341040462427746, 0.8323699421965318, 0.6589595375722543], 'avgRecall': 0.7381901534781742, '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': 'Marked & transmucosal increase in lamina propria cellularity, Crypt architecture, Epithelial changes, Mucosal surface, Lamina propria granulomas, Patchy lamina propria cellularity?, Mucin depletion, Submucosal granulomas, Cryptitis extent, Lamina propria polymorphs, Cryptitis polymorphs, Basal histiocytic cells, Active inflammation?, Sex, Increased lamina propria cellularity?, Increased lymphoid aggregates in lamina propria?, Age', 'accuracy': [0.6666666666666666, 0.6666666666666666, 0.7283236994219653, 0.10404624277456648, 0.6647398843930635], 'avgAccuracy': 0.5660886319845857, 'f1': [0.6774410774410775, 0.6956140350877194, 0.7295077122643383, 0.18848167539267016, 0.6776272416953296], 'avgF1': 0.593734348376227, 'precision': [0.6666666666666666, 0.6666666666666666, 0.7283236994219653, 0.10404624277456648, 0.6647398843930635], 'avgPrecision': 0.5660886319845857, 'recall': [0.6666666666666666, 0.6666666666666666, 0.7283236994219653, 0.10404624277456648, 0.6647398843930635], 'avgRecall': 0.5660886319845857, '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': 'Marked & transmucosal increase in lamina propria cellularity, Crypt architecture, Epithelial changes, Mucosal surface, Lamina propria granulomas, Patchy lamina propria cellularity?, Mucin depletion, Submucosal granulomas, Cryptitis extent, Lamina propria polymorphs, Cryptitis polymorphs, Basal histiocytic cells, Active inflammation?, Sex, Increased lamina propria cellularity?, Increased lymphoid aggregates in lamina propria?, Age', 'accuracy': [0.6666666666666666, 0.6839080459770115, 0.7630057803468208, 0.45664739884393063, 0.7109826589595376], 'avgAccuracy': 0.6562421101587934, 'f1': [0.6782407407407407, 0.7104022398653563, 0.763487329101577, 0.626984126984127, 0.7188901393080636], 'avgF1': 0.6996009151999729, 'precision': [0.6666666666666666, 0.6839080459770115, 0.7630057803468208, 0.45664739884393063, 0.7109826589595376], 'avgPrecision': 0.6562421101587934, 'recall': [0.6666666666666666, 0.6839080459770115, 0.7630057803468208, 0.45664739884393063, 0.7109826589595376], 'avgRecall': 0.6562421101587934, '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': 'Marked & transmucosal increase in lamina propria cellularity, Crypt architecture, Epithelial changes, Mucosal surface, Lamina propria granulomas, Patchy lamina propria cellularity?, Mucin depletion, Submucosal granulomas, Cryptitis extent, Lamina propria polymorphs, Cryptitis polymorphs, Basal histiocytic cells, Active inflammation?, Sex, Increased lamina propria cellularity?, Increased lymphoid aggregates in lamina propria?, Age', 'accuracy': [0.7586206896551724, 0.8275862068965517, 0.7745664739884393, 0.8323699421965318, 0.7167630057803468], 'avgAccuracy': 0.7819812637034084, 'f1': [0.7626051381089116, 0.8319495121318856, 0.7708818132762049, 0.9085173501577286, 0.7160018868075376], 'avgF1': 0.7979911400964537, 'precision': [0.7586206896551724, 0.8275862068965517, 0.7745664739884393, 0.8323699421965318, 0.7167630057803468], 'avgPrecision': 0.7819812637034084, 'recall': [0.7586206896551724, 0.8275862068965517, 0.7745664739884393, 0.8323699421965318, 0.7167630057803468], 'avgRecall': 0.7819812637034084, '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 Marked & transmucosal increase in lamina propr…

```
1       KNeighborsClassifier  Marked & transmucosal increase in lamina propr…
2         LogisticRegression  Marked & transmucosal increase in lamina propr…
3                 GaussianNB  Marked & transmucosal increase in lamina propr…
4         AdaBoostClassifier  Marked & transmucosal increase in lamina propr…
5     DecisionTreeClassifier  Marked & transmucosal increase in lamina propr…
6                        SVC  Marked & transmucosal increase in lamina propr…
7              MLPClassifier  Marked & transmucosal increase in lamina propr…


   accuracy        f1  precision    recall  \
0  0.781981  0.797991   0.781981  0.781981
1  0.737047  0.764419   0.737047  0.737047
2  0.650475  0.694030   0.650475  0.650475
3  0.589011  0.538441   0.589011  0.589011
4  0.698804  0.734183   0.698804  0.698804
5  0.738190  0.759600   0.738190  0.738190
6  0.566089  0.593734   0.566089  0.566089
7  0.656242  0.699601   0.656242  0.656242


                                                 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': 'Marked & transmucosal
increase in lamina propria cellularity, Crypt architecture, Epithelial changes,
Mucosal surface, Lamina propria granulomas, Patchy lamina propria cellularity?,
Mucin depletion, Submucosal granulomas, Cryptitis extent, Lamina propria
polymorphs, Cryptitis polymorphs, Basal histiocytic cells, Active inflammation?,
Sex, Increased lamina propria cellularity?, Increased lymphoid aggregates in
lamina propria?', 'accuracy': [0.7068965517241379, 0.7471264367816092,
0.7630057803468208, 0.7456647398843931, 0.6994219653179191], 'avgAccuracy':
0.732423094810976, 'f1': [0.7157671562434775, 0.767236450385442,
0.764010094465016, 0.8543046357615894, 0.7100861086068835], 'avgF1':
0.7622808890924817, 'precision': [0.7068965517241379, 0.7471264367816092,
0.7630057803468208, 0.7456647398843931, 0.6994219653179191], 'avgPrecision':
0.732423094810976, 'recall': [0.7068965517241379, 0.7471264367816092,
0.7630057803468208, 0.7456647398843931, 0.6994219653179191], 'avgRecall':
0.732423094810976, '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': 'Marked & transmucosal
increase in lamina propria cellularity, Crypt architecture, Epithelial changes,
Mucosal surface, Lamina propria granulomas, Patchy lamina propria cellularity?,
Mucin depletion, Submucosal granulomas, Cryptitis extent, Lamina propria
polymorphs, Cryptitis polymorphs, Basal histiocytic cells, Active inflammation?,
Sex, Increased lamina propria cellularity?, Increased lymphoid aggregates in
lamina propria?', 'accuracy': [0.6494252873563219, 0.6609195402298851,
0.7398843930635838, 0.7341040462427746, 0.6763005780346821], 'avgAccuracy':
0.6921267689854494, 'f1': [0.6612784074000162, 0.690126075975465,
0.7410180223807494, 0.8466666666666667, 0.688516082984237], 'avgF1':
0.7255210510814268, 'precision': [0.6494252873563219, 0.6609195402298851,
0.7398843930635838, 0.7341040462427746, 0.6763005780346821], 'avgPrecision':
0.6921267689854494, 'recall': [0.6494252873563219, 0.6609195402298851,
0.7398843930635838, 0.7341040462427746, 0.6763005780346821], 'avgRecall':
0.6921267689854494, 'params': [{'algorithm': 'ball_tree', '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': 'Marked & transmucosal
increase in lamina propria cellularity, Crypt architecture, Epithelial changes,
Mucosal surface, Lamina propria granulomas, Patchy lamina propria cellularity?,
Mucin depletion, Submucosal granulomas, Cryptitis extent, Lamina propria
polymorphs, Cryptitis polymorphs, Basal histiocytic cells, Active inflammation?,
Sex, Increased lamina propria cellularity?, Increased lymphoid aggregates in
lamina propria?', 'accuracy': [0.632183908045977, 0.6609195402298851,
0.7167630057803468, 0.4913294797687861, 0.6820809248554913], 'avgAccuracy':
0.6366553717360972, 'f1': [0.6440729130384304, 0.6903623951667812,
0.7176240538965356, 0.6589147286821705, 0.6925765699788141], 'avgF1':
0.6807101321525464, 'precision': [0.632183908045977, 0.6609195402298851,
0.7167630057803468, 0.4913294797687861, 0.6820809248554913], 'avgPrecision':
0.6366553717360972, 'recall': [0.632183908045977, 0.6609195402298851,
0.7167630057803468, 0.4913294797687861, 0.6820809248554913], 'avgRecall':
0.6366553717360972, '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': 'Marked & transmucosal increase in
lamina propria cellularity, Crypt architecture, Epithelial changes, Mucosal
surface, Lamina propria granulomas, Patchy lamina propria cellularity?, Mucin
depletion, Submucosal granulomas, Cryptitis extent, Lamina propria polymorphs,
Cryptitis polymorphs, Basal histiocytic cells, Active inflammation?, Sex,
Increased lamina propria cellularity?, Increased lymphoid aggregates in lamina
propria?', 'accuracy': [0.7011494252873564, 0.8045977011494253,
0.6242774566473989, 0.10404624277456648, 0.7109826589595376], 'avgAccuracy':
0.5890106969636569, 'f1': [0.6179526873886999, 0.7363619777412881,
0.533935969056559, 0.18848167539267016, 0.6154740548800743], 'avgF1':
0.5384412728918583, 'precision': [0.7011494252873564, 0.8045977011494253,
0.6242774566473989, 0.10404624277456648, 0.7109826589595376], 'avgPrecision':
0.5890106969636569, 'recall': [0.7011494252873564, 0.8045977011494253,
0.6242774566473989, 0.10404624277456648, 0.7109826589595376], 'avgRecall':
0.5890106969636569, 'params': [{'priors': None, 'var_smoothing': 1e-09}]}
********************************************************

Processing Model: AdaBoostClassifier
********************************************************
* AdaBoostClassifier
* Best Params Result:
* {'classifier': 'AdaBoostClassifier', 'features': 'Marked & transmucosal
increase in lamina propria cellularity, Crypt architecture, Epithelial changes,
Mucosal surface, Lamina propria granulomas, Patchy lamina propria cellularity?,
Mucin depletion, Submucosal granulomas, Cryptitis extent, Lamina propria
polymorphs, Cryptitis polymorphs, Basal histiocytic cells, Active inflammation?,
Sex, Increased lamina propria cellularity?, Increased lymphoid aggregates in
lamina propria?', 'accuracy': [0.6954022988505747, 0.7183908045977011,
0.7687861271676301, 0.6705202312138728, 0.6127167630057804], 'avgAccuracy':
0.6931632449671118, 'f1': [0.7060784028789387, 0.7397835063050998,
0.7698100211294482, 0.8027681660899654, 0.6275255539756237], 'avgF1':
0.7291931300758152, 'precision': [0.6954022988505747, 0.7183908045977011,
0.7687861271676301, 0.6705202312138728, 0.6127167630057804], 'avgPrecision':
0.6931632449671118, 'recall': [0.6954022988505747, 0.7183908045977011,
0.7687861271676301, 0.6705202312138728, 0.6127167630057804], 'avgRecall':
0.6931632449671118, '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': 'Marked & transmucosal
increase in lamina propria cellularity, Crypt architecture, Epithelial changes,
Mucosal surface, Lamina propria granulomas, Patchy lamina propria cellularity?,
Mucin depletion, Submucosal granulomas, Cryptitis extent, Lamina propria
polymorphs, Cryptitis polymorphs, Basal histiocytic cells, Active inflammation?,
Sex, Increased lamina propria cellularity?, Increased lymphoid aggregates in
lamina propria?', 'accuracy': [0.6781609195402298, 0.6494252873563219,
0.7052023121387283, 0.7514450867052023, 0.6589595375722543], 'avgAccuracy':
0.6886386286625473, 'f1': [0.6894272677690964, 0.6796218751610743,
0.7059513050273538, 0.858085808580858, 0.6719611860392657], 'avgF1':
0.7210094885155296, 'precision': [0.6781609195402298, 0.6494252873563219,
0.7052023121387283, 0.7514450867052023, 0.6589595375722543], 'avgPrecision':
0.6886386286625473, 'recall': [0.6781609195402298, 0.6494252873563219,
0.7052023121387283, 0.7514450867052023, 0.6589595375722543], 'avgRecall':
0.6886386286625473, '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': 'Marked & transmucosal increase in lamina
propria cellularity, Crypt architecture, Epithelial changes, Mucosal surface,
Lamina propria granulomas, Patchy lamina propria cellularity?, Mucin depletion,
Submucosal granulomas, Cryptitis extent, Lamina propria polymorphs, Cryptitis
polymorphs, Basal histiocytic cells, Active inflammation?, Sex, Increased lamina
propria cellularity?, Increased lymphoid aggregates in lamina propria?',
'accuracy': [0.6494252873563219, 0.6724137931034483, 0.7109826589595376,
0.10404624277456648, 0.6647398843930635], 'avgAccuracy': 0.5603215733173875,
'f1': [0.6605387426298953, 0.7008436261117909, 0.7119772530481384,
0.18848167539267016, 0.6766345057538314], 'avgF1': 0.5876951605872652,
'precision': [0.6494252873563219, 0.6724137931034483, 0.7109826589595376,
0.10404624277456648, 0.6647398843930635], 'avgPrecision': 0.5603215733173875,
'recall': [0.6494252873563219, 0.6724137931034483, 0.7109826589595376,
0.10404624277456648, 0.6647398843930635], 'avgRecall': 0.5603215733173875,
'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': 'Marked & transmucosal increase in
lamina propria cellularity, Crypt architecture, Epithelial changes, Mucosal
surface, Lamina propria granulomas, Patchy lamina propria cellularity?, Mucin
depletion, Submucosal granulomas, Cryptitis extent, Lamina propria polymorphs,
Cryptitis polymorphs, Basal histiocytic cells, Active inflammation?, Sex,
Increased lamina propria cellularity?, Increased lymphoid aggregates in lamina
propria?', 'accuracy': [0.6264367816091954, 0.6724137931034483,
0.7225433526011561, 0.49710982658959535, 0.6878612716763006], 'avgAccuracy':
0.6412730051159391, 'f1': [0.6387204866421128, 0.7008436261117909,
0.7234981629262128, 0.664092664092664, 0.6971815732831559], 'avgF1':
0.6848673026111872, 'precision': [0.6264367816091954, 0.6724137931034483,
0.7225433526011561, 0.49710982658959535, 0.6878612716763006], 'avgPrecision':
0.6412730051159391, 'recall': [0.6264367816091954, 0.6724137931034483,
0.7225433526011561, 0.49710982658959535, 0.6878612716763006], 'avgRecall':
0.6412730051159391, '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': 'RandomForestClassifier', 'features': 'Marked & transmucosal
increase in lamina propria cellularity, Crypt architecture, Epithelial changes,
Mucosal surface, Lamina propria granulomas, Patchy lamina propria cellularity?,
Mucin depletion, Submucosal granulomas, Cryptitis extent, Lamina propria
polymorphs, Cryptitis polymorphs, Basal histiocytic cells, Active inflammation?,
Sex, Increased lamina propria cellularity?, Increased lymphoid aggregates in
lamina propria?', 'accuracy': [0.7068965517241379, 0.7471264367816092,
0.7630057803468208, 0.7456647398843931, 0.6994219653179191], 'avgAccuracy':
0.732423094810976, 'f1': [0.7157671562434775, 0.767236450385442,
0.764010094465016, 0.8543046357615894, 0.7100861086068835], 'avgF1':
0.7622808890924817, 'precision': [0.7068965517241379, 0.7471264367816092,
0.7630057803468208, 0.7456647398843931, 0.6994219653179191], 'avgPrecision':
0.732423094810976, 'recall': [0.7068965517241379, 0.7471264367816092,
0.7630057803468208, 0.7456647398843931, 0.6994219653179191], 'avgRecall':
0.732423094810976, '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  Marked & transmucosal increase in lamina propr…
1      KNeighborsClassifier  Marked & transmucosal increase in lamina propr…
2        LogisticRegression  Marked & transmucosal increase in lamina propr…
3                GaussianNB  Marked & transmucosal increase in lamina propr…
4           AdaBoostClassifier  Marked & transmucosal increase in lamina propr…
5   DecisionTreeClassifier  Marked & transmucosal increase in lamina propr…
6                       SVC  Marked & transmucosal increase in lamina propr…
7             MLPClassifier  Marked & transmucosal increase in lamina propr…

    accuracy        f1  precision    recall  \
0   0.732423  0.762281   0.732423  0.732423
1   0.692127  0.725521   0.692127  0.692127
2   0.636655  0.680710   0.636655  0.636655
3   0.589011  0.538441   0.589011  0.589011
4   0.693163  0.729193   0.693163  0.693163
5   0.688639  0.721009   0.688639  0.688639
6   0.560322  0.587695   0.560322  0.560322
7   0.641273  0.684867   0.641273  0.641273


                                                    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': 'Marked & transmucosal
increase in lamina propria cellularity, Crypt architecture, Epithelial changes,
Mucosal surface, Lamina propria granulomas, Patchy lamina propria cellularity?,
Mucin depletion, Submucosal granulomas, Cryptitis extent, Lamina propria
polymorphs, Cryptitis polymorphs, Basal histiocytic cells, Active inflammation?,
Sex, Increased lamina propria cellularity?', 'accuracy': [0.7011494252873564,
0.735632183908046, 0.7572254335260116, 0.7456647398843931, 0.6936416184971098],
'avgAccuracy': 0.7266626802205833, 'f1': [0.7099366509926854,
0.7571732652192422, 0.758206208774358, 0.8543046357615894, 0.7047170545733049],
'avgF1': 0.756867563064236, 'precision': [0.7011494252873564, 0.735632183908046,
```

0.7572254335260116, 0.7456647398843931, 0.6936416184971098], 'avgPrecision':
0.7266626802205833, 'recall': [0.7011494252873564, 0.735632183908046,
0.7572254335260116, 0.7456647398843931, 0.6936416184971098], 'avgRecall':
0.7266626802205833, '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': 'Marked & transmucosal
increase in lamina propria cellularity, Crypt architecture, Epithelial changes,
Mucosal surface, Lamina propria granulomas, Patchy lamina propria cellularity?,
Mucin depletion, Submucosal granulomas, Cryptitis extent, Lamina propria
polymorphs, Cryptitis polymorphs, Basal histiocytic cells, Active inflammation?,
Sex, Increased lamina propria cellularity?', 'accuracy': [0.6494252873563219,
0.6724137931034483, 0.7456647398843931, 0.7109826589595376, 0.6878612716763006],
'avgAccuracy': 0.6932695501960003, 'f1': [0.6615140705509314,
0.7007868423511822, 0.7467383877929485, 0.8310810810810811, 0.6955185553773727],
'avgF1': 0.7271277874307032, 'precision': [0.6494252873563219,
0.6724137931034483, 0.7456647398843931, 0.7109826589595376, 0.6878612716763006],
'avgPrecision': 0.6932695501960003, 'recall': [0.6494252873563219,
0.6724137931034483, 0.7456647398843931, 0.7109826589595376, 0.6878612716763006],
'avgRecall': 0.6932695501960003, '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': 'Marked & transmucosal
increase in lamina propria cellularity, Crypt architecture, Epithelial changes,
Mucosal surface, Lamina propria granulomas, Patchy lamina propria cellularity?,
Mucin depletion, Submucosal granulomas, Cryptitis extent, Lamina propria
polymorphs, Cryptitis polymorphs, Basal histiocytic cells, Active inflammation?,
Sex, Increased lamina propria cellularity?', 'accuracy': [0.632183908045977,
0.6609195402298851, 0.7167630057803468, 0.4913294797687861, 0.6820809248554913],
'avgAccuracy': 0.6366553717360972, 'f1': [0.6440729130384304,
0.6903623951667812, 0.7176240538965356, 0.6589147286821705, 0.693122877416869],
'avgF1': 0.6808193936401573, 'precision': [0.632183908045977,
0.6609195402298851, 0.7167630057803468, 0.4913294797687861, 0.6820809248554913],

'avgPrecision': 0.6366553717360972, 'recall': [0.632183908045977,
0.6609195402298851, 0.7167630057803468, 0.4913294797687861, 0.6820809248554913],
'avgRecall': 0.6366553717360972, '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': 'Marked & transmucosal increase in
lamina propria cellularity, Crypt architecture, Epithelial changes, Mucosal
surface, Lamina propria granulomas, Patchy lamina propria cellularity?, Mucin
depletion, Submucosal granulomas, Cryptitis extent, Lamina propria polymorphs,
Cryptitis polymorphs, Basal histiocytic cells, Active inflammation?, Sex,
Increased lamina propria cellularity?', 'accuracy': [0.7011494252873564,
0.8045977011494253, 0.6242774566473989, 0.10404624277456648,
0.7109826589595376], 'avgAccuracy': 0.5890106969636569, 'f1':
[0.6179526873886999, 0.7363619777412881, 0.533935969056559, 0.18848167539267016,
0.6154740548800743], 'avgF1': 0.5384412728918583, 'precision':
[0.7011494252873564, 0.8045977011494253, 0.6242774566473989,
0.10404624277456648, 0.7109826589595376], 'avgPrecision': 0.5890106969636569,
'recall': [0.7011494252873564, 0.8045977011494253, 0.6242774566473989,
0.10404624277456648, 0.7109826589595376], 'avgRecall': 0.5890106969636569,
'params': [{'priors': None, 'var_smoothing': 1e-09}]}
****

Processing Model: AdaBoostClassifier
****
* AdaBoostClassifier
* Best Params Result:
* {'classifier': 'AdaBoostClassifier', 'features': 'Marked & transmucosal
increase in lamina propria cellularity, Crypt architecture, Epithelial changes,
Mucosal surface, Lamina propria granulomas, Patchy lamina propria cellularity?,
Mucin depletion, Submucosal granulomas, Cryptitis extent, Lamina propria
polymorphs, Cryptitis polymorphs, Basal histiocytic cells, Active inflammation?,
Sex, Increased lamina propria cellularity?', 'accuracy': [0.6954022988505747,
0.7183908045977011, 0.7687861271676301, 0.6705202312138728, 0.6184971098265896],
'avgAccuracy': 0.6943193143312737, 'f1': [0.7060784028789387,
0.7397835063050998, 0.7698100211294482, 0.8027681660899654, 0.6321668489298549],
'avgF1': 0.7301213890666614, 'precision': [0.6954022988505747,
0.7183908045977011, 0.7687861271676301, 0.6705202312138728, 0.6184971098265896],
'avgPrecision': 0.6943193143312737, 'recall': [0.6954022988505747,
0.7183908045977011, 0.7687861271676301, 0.6705202312138728, 0.6184971098265896],
'avgRecall': 0.6943193143312737, 'params': [{'algorithm': 'SAMME.R',

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'base_estimator': None, 'learning_rate': 1, 'n_estimators': 100, 'random_state':
None}]}
******************************************************

Processing Model: DecisionTreeClassifier
******************************************************
* DecisionTreeClassifier
* Best Params Result:
* {'classifier': 'DecisionTreeClassifier', 'features': 'Marked & transmucosal
increase in lamina propria cellularity, Crypt architecture, Epithelial changes,
Mucosal surface, Lamina propria granulomas, Patchy lamina propria cellularity?,
Mucin depletion, Submucosal granulomas, Cryptitis extent, Lamina propria
polymorphs, Cryptitis polymorphs, Basal histiocytic cells, Active inflammation?,
Sex, Increased lamina propria cellularity?', 'accuracy': [0.6609195402298851,
0.6839080459770115, 0.7572254335260116, 0.6878612716763006, 0.6878612716763006],
'avgAccuracy': 0.6955551126171019, 'f1': [0.67280425980863, 0.7112402284816078,
0.7574038965192762, 0.815068493150685, 0.6996405085919428], 'avgF1':
0.7312314773104284, 'precision': [0.6609195402298851, 0.6839080459770115,
0.7572254335260116, 0.6878612716763006, 0.6878612716763006], 'avgPrecision':
0.6955551126171019, 'recall': [0.6609195402298851, 0.6839080459770115,
0.7572254335260116, 0.6878612716763006, 0.6878612716763006], 'avgRecall':
0.6955551126171019, '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': 'Marked & transmucosal increase in lamina
propria cellularity, Crypt architecture, Epithelial changes, Mucosal surface,
Lamina propria granulomas, Patchy lamina propria cellularity?, Mucin depletion,
Submucosal granulomas, Cryptitis extent, Lamina propria polymorphs, Cryptitis
polymorphs, Basal histiocytic cells, Active inflammation?, Sex, Increased lamina
propria cellularity?', 'accuracy': [0.6436781609195402, 0.6724137931034483,
0.7167630057803468, 0.10404624277456648, 0.6647398843930635], 'avgAccuracy':
0.560328217394193, 'f1': [0.6547294961541786, 0.7008585851611275,
0.7178320767658422, 0.18848167539267016, 0.6776272416953296], 'avgF1':
0.5879058150338297, 'precision': [0.6436781609195402, 0.6724137931034483,
0.7167630057803468, 0.10404624277456648, 0.6647398843930635], 'avgPrecision':
0.560328217394193, 'recall': [0.6436781609195402, 0.6724137931034483,
0.7167630057803468, 0.10404624277456648, 0.6647398843930635], 'avgRecall':
0.560328217394193, '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,
```

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'probability': False, 'random_state': None, 'shrinking': True, 'tol': 0.001,
'verbose': False}]}
*******************************************************

Processing Model: MLPClassifier
*******************************************************
* MLPClassifier
* Best Params Result:
* {'classifier': 'MLPClassifier', 'features': 'Marked & transmucosal increase in
lamina propria cellularity, Crypt architecture, Epithelial changes, Mucosal
surface, Lamina propria granulomas, Patchy lamina propria cellularity?, Mucin
depletion, Submucosal granulomas, Cryptitis extent, Lamina propria polymorphs,
Cryptitis polymorphs, Basal histiocytic cells, Active inflammation?, Sex,
Increased lamina propria cellularity?', 'accuracy': [0.6264367816091954,
0.6781609195402298, 0.7167630057803468, 0.48554913294797686,
0.6820809248554913], 'avgAccuracy': 0.637798152946648, 'f1':
[0.6387204866421128, 0.7060520587164044, 0.7176240538965356, 0.6536964980544747,
0.693122877416869], 'avgF1': 0.6818431949452793, 'precision':
[0.6264367816091954, 0.6781609195402298, 0.7167630057803468,
0.48554913294797686, 0.6820809248554913], 'avgPrecision': 0.637798152946648,
'recall': [0.6264367816091954, 0.6781609195402298, 0.7167630057803468,
0.48554913294797686, 0.6820809248554913], 'avgRecall': 0.637798152946648,
'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': 'Marked & transmucosal
increase in lamina propria cellularity, Crypt architecture, Epithelial changes,
Mucosal surface, Lamina propria granulomas, Patchy lamina propria cellularity?,
Mucin depletion, Submucosal granulomas, Cryptitis extent, Lamina propria
polymorphs, Cryptitis polymorphs, Basal histiocytic cells, Active inflammation?,
Sex, Increased lamina propria cellularity?', 'accuracy': [0.7011494252873564,
0.735632183908046, 0.7572254335260116, 0.7456647398843931, 0.6936416184971098],
'avgAccuracy': 0.7266626802205833, 'f1': [0.7099366509926854,
0.7571732652192422, 0.758206208774358, 0.8543046357615894, 0.7047170545733049],
'avgF1': 0.756867563064236, 'precision': [0.7011494252873564, 0.735632183908046,
0.7572254335260116, 0.7456647398843931, 0.6936416184971098], 'avgPrecision':
0.7266626802205833, 'recall': [0.7011494252873564, 0.735632183908046,
0.7572254335260116, 0.7456647398843931, 0.6936416184971098], 'avgRecall':
0.7266626802205833, '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':
```

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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  Marked & transmucosal increase in lamina propr…
1    KNeighborsClassifier  Marked & transmucosal increase in lamina propr…
2      LogisticRegression  Marked & transmucosal increase in lamina propr…
3              GaussianNB  Marked & transmucosal increase in lamina propr…
4       AdaBoostClassifier  Marked & transmucosal increase in lamina propr…
5  DecisionTreeClassifier  Marked & transmucosal increase in lamina propr…
6                     SVC  Marked & transmucosal increase in lamina propr…
7           MLPClassifier  Marked & transmucosal increase in lamina propr…

   accuracy        f1  precision    recall  \
0  0.726663  0.756868   0.726663  0.726663
1  0.693270  0.727128   0.693270  0.693270
2  0.636655  0.680819   0.636655  0.636655
3  0.589011  0.538441   0.589011  0.589011
4  0.694319  0.730121   0.694319  0.694319
5  0.695555  0.731231   0.695555  0.695555
6  0.560328  0.587906   0.560328  0.560328
7  0.637798  0.681843   0.637798  0.637798

                                                 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': 'Marked & transmucosal
increase in lamina propria cellularity, Crypt architecture, Epithelial changes,
Mucosal surface, Lamina propria granulomas, Patchy lamina propria cellularity?,
Mucin depletion, Submucosal granulomas, Cryptitis extent, Lamina propria
polymorphs, Cryptitis polymorphs, Basal histiocytic cells, Active inflammation?,
Sex', 'accuracy': [0.6839080459770115, 0.7413793103448276, 0.7572254335260116,
0.7456647398843931, 0.6820809248554913], 'avgAccuracy': 0.7220516909175471,
'f1': [0.6939488886435876, 0.7622097742380217, 0.758206208774358,
0.8543046357615894, 0.6939330473089527], 'avgF1': 0.7525205109453019,
```

```
'precision': [0.6839080459770115, 0.7413793103448276, 0.7572254335260116,
0.7456647398843931, 0.6820809248554913], 'avgPrecision': 0.7220516909175471,
'recall': [0.6839080459770115, 0.7413793103448276, 0.7572254335260116,
0.7456647398843931, 0.6820809248554913], 'avgRecall': 0.7220516909175471,
'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': 'Marked & transmucosal
increase in lamina propria cellularity, Crypt architecture, Epithelial changes,
Mucosal surface, Lamina propria granulomas, Patchy lamina propria cellularity?,
Mucin depletion, Submucosal granulomas, Cryptitis extent, Lamina propria
polymorphs, Cryptitis polymorphs, Basal histiocytic cells, Active inflammation?,
Sex', 'accuracy': [0.6724137931034483, 0.6781609195402298, 0.7514450867052023,
0.8208092485549133, 0.6647398843930635], 'avgAccuracy': 0.7175137864593715,
'f1': [0.6802616577889917, 0.7059695958472377, 0.7525283324971606,
0.9015873015873017, 0.6776272416953296], 'avgF1': 0.7435948258832042,
'precision': [0.6724137931034483, 0.6781609195402298, 0.7514450867052023,
0.8208092485549133, 0.6647398843930635], 'avgPrecision': 0.7175137864593715,
'recall': [0.6724137931034483, 0.6781609195402298, 0.7514450867052023,
0.8208092485549133, 0.6647398843930635], 'avgRecall': 0.7175137864593715,
'params': [{'algorithm': 'brute', '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': 'Marked & transmucosal
increase in lamina propria cellularity, Crypt architecture, Epithelial changes,
Mucosal surface, Lamina propria granulomas, Patchy lamina propria cellularity?,
Mucin depletion, Submucosal granulomas, Cryptitis extent, Lamina propria
polymorphs, Cryptitis polymorphs, Basal histiocytic cells, Active inflammation?,
Sex', 'accuracy': [0.632183908045977, 0.6839080459770115, 0.7225433526011561,
0.2658959537572254, 0.6820809248554913], 'avgAccuracy': 0.5973224370473723,
'f1': [0.6440729130384304, 0.7112402284816078, 0.7237553608055194,
0.4200913242009132, 0.6939330473089527], 'avgF1': 0.6386185747670847,
'precision': [0.632183908045977, 0.6839080459770115, 0.7225433526011561,
```

0.2658959537572254, 0.6820809248554913], 'avgPrecision': 0.5973224370473723,
'recall': [0.632183908045977, 0.6839080459770115, 0.7225433526011561,
0.2658959537572254, 0.6820809248554913], 'avgRecall': 0.5973224370473723,
'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': 'Marked & transmucosal increase in
lamina propria cellularity, Crypt architecture, Epithelial changes, Mucosal
surface, Lamina propria granulomas, Patchy lamina propria cellularity?, Mucin
depletion, Submucosal granulomas, Cryptitis extent, Lamina propria polymorphs,
Cryptitis polymorphs, Basal histiocytic cells, Active inflammation?, Sex',
'accuracy': [0.7011494252873564, 0.8045977011494253, 0.6242774566473989,
0.10404624277456648, 0.7109826589595376], 'avgAccuracy': 0.5890106969636569,
'f1': [0.6179526873886999, 0.7363619777412881, 0.533935969056559,
0.18848167539267016, 0.6154740548800743], 'avgF1': 0.5384412728918583,
'precision': [0.7011494252873564, 0.8045977011494253, 0.6242774566473989,
0.10404624277456648, 0.7109826589595376], 'avgPrecision': 0.5890106969636569,
'recall': [0.7011494252873564, 0.8045977011494253, 0.6242774566473989,
0.10404624277456648, 0.7109826589595376], 'avgRecall': 0.5890106969636569,
'params': [{'priors': None, 'var_smoothing': 1e-09}]}
****

Processing Model: AdaBoostClassifier
****
* AdaBoostClassifier
* Best Params Result:
* {'classifier': 'AdaBoostClassifier', 'features': 'Marked & transmucosal
increase in lamina propria cellularity, Crypt architecture, Epithelial changes,
Mucosal surface, Lamina propria granulomas, Patchy lamina propria cellularity?,
Mucin depletion, Submucosal granulomas, Cryptitis extent, Lamina propria
polymorphs, Cryptitis polymorphs, Basal histiocytic cells, Active inflammation?,
Sex', 'accuracy': [0.6954022988505747, 0.7126436781609196, 0.7687861271676301,
0.6936416184971098, 0.6184971098265896], 'avgAccuracy': 0.6977941665005647,
'f1': [0.7060784028789387, 0.7340820264186416, 0.7698100211294482,
0.8191126279863481, 0.6321668489298549], 'avgF1': 0.7322499854686463,
'precision': [0.6954022988505747, 0.7126436781609196, 0.7687861271676301,
0.6936416184971098, 0.6184971098265896], 'avgPrecision': 0.6977941665005647,
'recall': [0.6954022988505747, 0.7126436781609196, 0.7687861271676301,
0.6936416184971098, 0.6184971098265896], 'avgRecall': 0.6977941665005647,
'params': [{'algorithm': 'SAMME.R', 'base_estimator': None, 'learning_rate': 1,
'n_estimators': 100, 'random_state': None}]}

```
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Processing Model: DecisionTreeClassifier
*****************************************************
* DecisionTreeClassifier
* Best Params Result:
* {'classifier': 'DecisionTreeClassifier', 'features': 'Marked & transmucosal
increase in lamina propria cellularity, Crypt architecture, Epithelial changes,
Mucosal surface, Lamina propria granulomas, Patchy lamina propria cellularity?,
Mucin depletion, Submucosal granulomas, Cryptitis extent, Lamina propria
polymorphs, Cryptitis polymorphs, Basal histiocytic cells, Active inflammation?,
Sex', 'accuracy': [0.6264367816091954, 0.7126436781609196, 0.7398843930635838,
0.7167630057803468, 0.6647398843930635], 'avgAccuracy': 0.6920935486014218,
'f1': [0.639530116738321, 0.7372040475488753, 0.7402494675996348,
0.8350168350168351, 0.6773916573765312], 'avgF1': 0.7258784248560395,
'precision': [0.6264367816091954, 0.7126436781609196, 0.7398843930635838,
0.7167630057803468, 0.6647398843930635], 'avgPrecision': 0.6920935486014218,
'recall': [0.6264367816091954, 0.7126436781609196, 0.7398843930635838,
0.7167630057803468, 0.6647398843930635], 'avgRecall': 0.6920935486014218,
'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': 'Marked & transmucosal increase in lamina
propria cellularity, Crypt architecture, Epithelial changes, Mucosal surface,
Lamina propria granulomas, Patchy lamina propria cellularity?, Mucin depletion,
Submucosal granulomas, Cryptitis extent, Lamina propria polymorphs, Cryptitis
polymorphs, Basal histiocytic cells, Active inflammation?, Sex', 'accuracy':
[0.632183908045977, 0.6551724137931034, 0.7283236994219653, 0.10404624277456648,
0.653179190751445], 'avgAccuracy': 0.5545810909574115, 'f1':
[0.6423519009725907, 0.6850878202274172, 0.7294153169029419,
0.18848167539267016, 0.6665109396848238], 'avgF1': 0.5823695306360888,
'precision': [0.632183908045977, 0.6551724137931034, 0.7283236994219653,
0.10404624277456648, 0.653179190751445], 'avgPrecision': 0.5545810909574115,
'recall': [0.632183908045977, 0.6551724137931034, 0.7283236994219653,
0.10404624277456648, 0.653179190751445], 'avgRecall': 0.5545810909574115,
'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': 'Marked & transmucosal increase in
lamina propria cellularity, Crypt architecture, Epithelial changes, Mucosal
surface, Lamina propria granulomas, Patchy lamina propria cellularity?, Mucin
depletion, Submucosal granulomas, Cryptitis extent, Lamina propria polymorphs,
Cryptitis polymorphs, Basal histiocytic cells, Active inflammation?, Sex',
'accuracy': [0.6206896551724138, 0.6839080459770115, 0.7283236994219653,
0.5086705202312138, 0.6936416184971098], 'avgAccuracy': 0.6470467078599429,
'f1': [0.6329501915708813, 0.7112402284816078, 0.7295277038428584,
0.6743295019157087, 0.704282045510801], 'avgF1': 0.6904659342643714,
'precision': [0.6206896551724138, 0.6839080459770115, 0.7283236994219653,
0.5086705202312138, 0.6936416184971098], 'avgPrecision': 0.6470467078599429,
'recall': [0.6206896551724138, 0.6839080459770115, 0.7283236994219653,
0.5086705202312138, 0.6936416184971098], 'avgRecall': 0.6470467078599429,
'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': 'Marked & transmucosal
increase in lamina propria cellularity, Crypt architecture, Epithelial changes,
Mucosal surface, Lamina propria granulomas, Patchy lamina propria cellularity?,
Mucin depletion, Submucosal granulomas, Cryptitis extent, Lamina propria
polymorphs, Cryptitis polymorphs, Basal histiocytic cells, Active inflammation?,
Sex', 'accuracy': [0.6724137931034483, 0.6781609195402298, 0.7514450867052023,
0.8208092485549133, 0.6647398843930635], 'avgAccuracy': 0.7175137864593715,
'f1': [0.6802616577889917, 0.7059695958472377, 0.7525283324971606,
0.9015873015873017, 0.6776272416953296], 'avgF1': 0.7435948258832042,
'precision': [0.6724137931034483, 0.6781609195402298, 0.7514450867052023,
0.8208092485549133, 0.6647398843930635], 'avgPrecision': 0.7175137864593715,
'recall': [0.6724137931034483, 0.6781609195402298, 0.7514450867052023,
0.8208092485549133, 0.6647398843930635], 'avgRecall': 0.7175137864593715,
'params': [{'algorithm': 'brute', 'leaf_size': 30, 'metric': 'minkowski',
'metric_params': None, 'n_jobs': -1, 'n_neighbors': 12, 'p': 2, 'weights':
'distance'}]}
****************************************************

                 model                                            features  \
0  RandomForestClassifier  Marked & transmucosal increase in lamina propr…
```

```
1    KNeighborsClassifier  Marked & transmucosal increase in lamina propr…
2      LogisticRegression  Marked & transmucosal increase in lamina propr…
3              GaussianNB  Marked & transmucosal increase in lamina propr…
4       AdaBoostClassifier  Marked & transmucosal increase in lamina propr…
5  DecisionTreeClassifier  Marked & transmucosal increase in lamina propr…
6                     SVC  Marked & transmucosal increase in lamina propr…
7           MLPClassifier  Marked & transmucosal increase in lamina propr…


   accuracy        f1  precision    recall  \
0  0.722052  0.752521   0.722052  0.722052
1  0.717514  0.743595   0.717514  0.717514
2  0.597322  0.638619   0.597322  0.597322
3  0.589011  0.538441   0.589011  0.589011
4  0.697794  0.732250   0.697794  0.697794
5  0.692094  0.725878   0.692094  0.692094
6  0.554581  0.582370   0.554581  0.554581
7  0.647047  0.690466   0.647047  0.647047


                                                 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': 'Marked & transmucosal
increase in lamina propria cellularity, Crypt architecture, Epithelial changes,
Mucosal surface, Lamina propria granulomas, Patchy lamina propria cellularity?,
Mucin depletion, Submucosal granulomas, Cryptitis extent, Lamina propria
polymorphs, Cryptitis polymorphs, Basal histiocytic cells, Active
inflammation?', 'accuracy': [0.6781609195402298, 0.7241379310344828,
0.7456647398843931, 0.5375722543352601, 0.6763005780346821], 'avgAccuracy':
0.6723672845658096, 'f1': [0.6885908897403151, 0.7466155810983398,
0.7465399826823617, 0.6992481203007519, 0.6887435437058355], 'avgF1':
0.7139476235055208, 'precision': [0.6781609195402298, 0.7241379310344828,
0.7456647398843931, 0.5375722543352601, 0.6763005780346821], 'avgPrecision':
0.6723672845658096, 'recall': [0.6781609195402298, 0.7241379310344828,
0.7456647398843931, 0.5375722543352601, 0.6763005780346821], 'avgRecall':
0.6723672845658096, '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': 'Marked & transmucosal
increase in lamina propria cellularity, Crypt architecture, Epithelial changes,
Mucosal surface, Lamina propria granulomas, Patchy lamina propria cellularity?,
Mucin depletion, Submucosal granulomas, Cryptitis extent, Lamina propria
polymorphs, Cryptitis polymorphs, Basal histiocytic cells, Active
inflammation?', 'accuracy': [0.6954022988505747, 0.6781609195402298,
0.7398843930635838, 0.8208092485549133, 0.7167630057803468], 'avgAccuracy':
0.7302039731579297, 'f1': [0.7060445027907718, 0.7060819655455894,
0.7408661929482224, 0.9015873015873017, 0.6864138286685275], 'avgF1':
0.7481987583080826, 'precision': [0.6954022988505747, 0.6781609195402298,
0.7398843930635838, 0.8208092485549133, 0.7167630057803468], 'avgPrecision':
0.7302039731579297, 'recall': [0.6954022988505747, 0.6781609195402298,
0.7398843930635838, 0.8208092485549133, 0.7167630057803468], 'avgRecall':
0.7302039731579297, 'params': [{'algorithm': 'brute', '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': 'Marked & transmucosal
increase in lamina propria cellularity, Crypt architecture, Epithelial changes,
Mucosal surface, Lamina propria granulomas, Patchy lamina propria cellularity?,
Mucin depletion, Submucosal granulomas, Cryptitis extent, Lamina propria
polymorphs, Cryptitis polymorphs, Basal histiocytic cells, Active
inflammation?', 'accuracy': [0.6264367816091954, 0.6666666666666666,
0.7167630057803468, 0.26011560693641617, 0.6936416184971098], 'avgAccuracy':
0.5927247358979469, 'f1': [0.6377432198933213, 0.6955848928865033,
0.7178320767658422, 0.4128440366972477, 0.7047170545733049], 'avgF1':
0.6337442561632438, 'precision': [0.6264367816091954, 0.6666666666666666,
0.7167630057803468, 0.26011560693641617, 0.6936416184971098], 'avgPrecision':
0.5927247358979469, 'recall': [0.6264367816091954, 0.6666666666666666,
0.7167630057803468, 0.26011560693641617, 0.6936416184971098], 'avgRecall':
0.5927247358979469, '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,

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'warm_start': False}]]}
****************************************************

Processing Model: GaussianNB
****************************************************
* GaussianNB
* Best Params Result:
* {'classifier': 'GaussianNB', 'features': 'Marked & transmucosal increase in
lamina propria cellularity, Crypt architecture, Epithelial changes, Mucosal
surface, Lamina propria granulomas, Patchy lamina propria cellularity?, Mucin
depletion, Submucosal granulomas, Cryptitis extent, Lamina propria polymorphs,
Cryptitis polymorphs, Basal histiocytic cells, Active inflammation?',
'accuracy': [0.7011494252873564, 0.8045977011494253, 0.6242774566473989,
0.10404624277456648, 0.7109826589595376], 'avgAccuracy': 0.5890106969636569,
'f1': [0.6179526873886999, 0.7363619777412881, 0.533935969056559,
0.18848167539267016, 0.6154740548800743], 'avgF1': 0.5384412728918583,
'precision': [0.7011494252873564, 0.8045977011494253, 0.6242774566473989,
0.10404624277456648, 0.7109826589595376], 'avgPrecision': 0.5890106969636569,
'recall': [0.7011494252873564, 0.8045977011494253, 0.6242774566473989,
0.10404624277456648, 0.7109826589595376], 'avgRecall': 0.5890106969636569,
'params': [{'priors': None, 'var_smoothing': 1e-09}]]}
****************************************************

Processing Model: AdaBoostClassifier
****************************************************
* AdaBoostClassifier
* Best Params Result:
* {'classifier': 'AdaBoostClassifier', 'features': 'Marked & transmucosal
increase in lamina propria cellularity, Crypt architecture, Epithelial changes,
Mucosal surface, Lamina propria granulomas, Patchy lamina propria cellularity?,
Mucin depletion, Submucosal granulomas, Cryptitis extent, Lamina propria
polymorphs, Cryptitis polymorphs, Basal histiocytic cells, Active
inflammation?', 'accuracy': [0.6954022988505747, 0.7068965517241379,
0.7803468208092486, 0.48554913294797686, 0.5664739884393064], 'avgAccuracy':
0.6469337585542488, 'f1': [0.7060784028789387, 0.729883030266172,
0.7813195200729757, 0.6536964980544747, 0.5772928193873451], 'avgF1':
0.6896540541319812, 'precision': [0.6954022988505747, 0.7068965517241379,
0.7803468208092486, 0.48554913294797686, 0.5664739884393064], 'avgPrecision':
0.6469337585542488, 'recall': [0.6954022988505747, 0.7068965517241379,
0.7803468208092486, 0.48554913294797686, 0.5664739884393064], 'avgRecall':
0.6469337585542488, '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': 'Marked & transmucosal
increase in lamina propria cellularity, Crypt architecture, Epithelial changes,
Mucosal surface, Lamina propria granulomas, Patchy lamina propria cellularity?,
Mucin depletion, Submucosal granulomas, Cryptitis extent, Lamina propria
polymorphs, Cryptitis polymorphs, Basal histiocytic cells, Active
inflammation?', 'accuracy': [0.6666666666666666, 0.6896551724137931,
0.7398843930635838, 0.4913294797687861, 0.6820809248554913], 'avgAccuracy':
0.6539233273536642, 'f1': [0.6783424908424908, 0.7165501994765329,
0.7409295587368592, 0.6589147286821705, 0.694201105629824], 'avgF1':
0.6977876166735755, 'precision': [0.6666666666666666, 0.6896551724137931,
0.7398843930635838, 0.4913294797687861, 0.6820809248554913], 'avgPrecision':
0.6539233273536642, 'recall': [0.6666666666666666, 0.6896551724137931,
0.7398843930635838, 0.4913294797687861, 0.6820809248554913], 'avgRecall':
0.6539233273536642, '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': 'Marked & transmucosal increase in lamina
propria cellularity, Crypt architecture, Epithelial changes, Mucosal surface,
Lamina propria granulomas, Patchy lamina propria cellularity?, Mucin depletion,
Submucosal granulomas, Cryptitis extent, Lamina propria polymorphs, Cryptitis
polymorphs, Basal histiocytic cells, Active inflammation?', 'accuracy':
[0.6091954022988506, 0.632183908045977, 0.7052023121387283, 0.10404624277456648,
0.630057803468208], 'avgAccuracy': 0.5361371337452661, 'f1':
[0.6199988947833777, 0.6634273772204807, 0.7064515809198981,
0.18848167539267016, 0.644309926201206], 'avgF1': 0.5645338909035266,
'precision': [0.6091954022988506, 0.632183908045977, 0.7052023121387283,
0.10404624277456648, 0.630057803468208], 'avgPrecision': 0.5361371337452661,
'recall': [0.6091954022988506, 0.632183908045977, 0.7052023121387283,
0.10404624277456648, 0.630057803468208], 'avgRecall': 0.5361371337452661,
'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': 'Marked & transmucosal increase in

lamina propria cellularity, Crypt architecture, Epithelial changes, Mucosal
surface, Lamina propria granulomas, Patchy lamina propria cellularity?, Mucin
depletion, Submucosal granulomas, Cryptitis extent, Lamina propria polymorphs,
Cryptitis polymorphs, Basal histiocytic cells, Active inflammation?',
'accuracy': [0.632183908045977, 0.6896551724137931, 0.7109826589595376,
0.2543352601156069, 0.6936416184971098], 'avgAccuracy': 0.5961597236064049,
'f1': [0.643017960828128, 0.7158616514987058, 0.7119772530481384,
0.40552995391705066, 0.7047170545733049], 'avgF1': 0.6362207747730656,
'precision': [0.632183908045977, 0.6896551724137931, 0.7109826589595376,
0.2543352601156069, 0.6936416184971098], 'avgPrecision': 0.5961597236064049,
'recall': [0.632183908045977, 0.6896551724137931, 0.7109826589595376,
0.2543352601156069, 0.6936416184971098], 'avgRecall': 0.5961597236064049,
'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': 'KNeighborsClassifier', 'features': 'Marked & transmucosal
increase in lamina propria cellularity, Crypt architecture, Epithelial changes,
Mucosal surface, Lamina propria granulomas, Patchy lamina propria cellularity?,
Mucin depletion, Submucosal granulomas, Cryptitis extent, Lamina propria
polymorphs, Cryptitis polymorphs, Basal histiocytic cells, Active
inflammation?', 'accuracy': [0.6954022988505747, 0.6781609195402298,
0.7398843930635838, 0.8208092485549133, 0.7167630057803468], 'avgAccuracy':
0.7302039731579297, 'f1': [0.7060445027907718, 0.7060819655455894,
0.7408661929482224, 0.9015873015873017, 0.6864138286685275], 'avgF1':
0.7481987583080826, 'precision': [0.6954022988505747, 0.6781609195402298,
0.7398843930635838, 0.8208092485549133, 0.7167630057803468], 'avgPrecision':
0.7302039731579297, 'recall': [0.6954022988505747, 0.6781609195402298,
0.7398843930635838, 0.8208092485549133, 0.7167630057803468], 'avgRecall':
0.7302039731579297, 'params': [{'algorithm': 'brute', 'leaf_size': 30, 'metric':
'minkowski', 'metric_params': None, 'n_jobs': -1, 'n_neighbors': 12, 'p': 2,
'weights': 'distance'}]}
****

```
                model                                        features  \
0  RandomForestClassifier  Marked & transmucosal increase in lamina propr…
1    KNeighborsClassifier  Marked & transmucosal increase in lamina propr…
2      LogisticRegression  Marked & transmucosal increase in lamina propr…
3              GaussianNB  Marked & transmucosal increase in lamina propr…
4      AdaBoostClassifier  Marked & transmucosal increase in lamina propr…
5  DecisionTreeClassifier  Marked & transmucosal increase in lamina propr…
6                     SVC  Marked & transmucosal increase in lamina propr…
```

```
7              MLPClassifier  Marked & transmucosal increase in lamina propr…


   accuracy          f1  precision    recall  \
0  0.672367   0.713948   0.672367  0.672367
1  0.730204   0.748199   0.730204  0.730204
2  0.592725   0.633744   0.592725  0.592725
3  0.589011   0.538441   0.589011  0.589011
4  0.646934   0.689654   0.646934  0.646934
5  0.653923   0.697788   0.653923  0.653923
6  0.536137   0.564534   0.536137  0.536137
7  0.596160   0.636221   0.596160  0.596160


                                                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': 'Marked & transmucosal
increase in lamina propria cellularity, Crypt architecture, Epithelial changes,
Mucosal surface, Lamina propria granulomas, Patchy lamina propria cellularity?,
Mucin depletion, Submucosal granulomas, Cryptitis extent, Lamina propria
polymorphs, Cryptitis polymorphs, Basal histiocytic cells', 'accuracy':
[0.6839080459770115, 0.7241379310344828, 0.7398843930635838, 0.5375722543352601,
0.6763005780346821], 'avgAccuracy': 0.672360640489004, 'f1':
[0.6943320611070581, 0.7466155810983398, 0.7408661929482224, 0.6992481203007519,
0.6887435437058355], 'avgF1': 0.7139610998320416, 'precision':
[0.6839080459770115, 0.7241379310344828, 0.7398843930635838, 0.5375722543352601,
0.6763005780346821], 'avgPrecision': 0.672360640489004, 'recall':
[0.6839080459770115, 0.7241379310344828, 0.7398843930635838, 0.5375722543352601,
0.6763005780346821], 'avgRecall': 0.672360640489004, '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': 'Marked & transmucosal
increase in lamina propria cellularity, Crypt architecture, Epithelial changes,
Mucosal surface, Lamina propria granulomas, Patchy lamina propria cellularity?,
Mucin depletion, Submucosal granulomas, Cryptitis extent, Lamina propria
polymorphs, Cryptitis polymorphs, Basal histiocytic cells', 'accuracy':
[0.6954022988505747, 0.6781609195402298, 0.7456647398843931, 0.8265895953757225,
0.6763005780346821], 'avgAccuracy': 0.7244236263371204, 'f1':
[0.7059289222790964, 0.7060819655455894, 0.746692218715994, 0.9050632911392403,
0.688516082984237], 'avgF1': 0.7504564961328315, 'precision':
[0.6954022988505747, 0.6781609195402298, 0.7456647398843931, 0.8265895953757225,
0.6763005780346821], 'avgPrecision': 0.7244236263371204, 'recall':
[0.6954022988505747, 0.6781609195402298, 0.7456647398843931, 0.8265895953757225,
0.6763005780346821], 'avgRecall': 0.7244236263371204, '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': 'Marked & transmucosal
increase in lamina propria cellularity, Crypt architecture, Epithelial changes,
Mucosal surface, Lamina propria granulomas, Patchy lamina propria cellularity?,
Mucin depletion, Submucosal granulomas, Cryptitis extent, Lamina propria
polymorphs, Cryptitis polymorphs, Basal histiocytic cells', 'accuracy':
[0.6149425287356322, 0.6781609195402298, 0.7167630057803468, 0.2543352601156069,
0.6820809248554913], 'avgAccuracy': 0.5892565278054614, 'f1':
[0.625947848405732, 0.7061101028433151, 0.7178320767658422, 0.40552995391705066,
0.6939330473089527], 'avgF1': 0.6298706058481786, 'precision':
[0.6149425287356322, 0.6781609195402298, 0.7167630057803468, 0.2543352601156069,
0.6820809248554913], 'avgPrecision': 0.5892565278054614, 'recall':
[0.6149425287356322, 0.6781609195402298, 0.7167630057803468, 0.2543352601156069,
0.6820809248554913], 'avgRecall': 0.5892565278054614, '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': 'Marked & transmucosal increase in
```

lamina propria cellularity, Crypt architecture, Epithelial changes, Mucosal surface, Lamina propria granulomas, Patchy lamina propria cellularity?, Mucin depletion, Submucosal granulomas, Cryptitis extent, Lamina propria polymorphs, Cryptitis polymorphs, Basal histiocytic cells', 'accuracy': [0.7011494252873564, 0.8045977011494253, 0.6242774566473989, 0.10404624277456648, 0.7109826589595376], 'avgAccuracy': 0.5890106969636569, 'f1': [0.6179526873886999, 0.7363619777412881, 0.533935969056559, 0.18848167539267016, 0.6154740548800743], 'avgF1': 0.5384412728918583, 'precision': [0.7011494252873564, 0.8045977011494253, 0.6242774566473989, 0.10404624277456648, 0.7109826589595376], 'avgPrecision': 0.5890106969636569, 'recall': [0.7011494252873564, 0.8045977011494253, 0.6242774566473989, 0.10404624277456648, 0.7109826589595376], 'avgRecall': 0.5890106969636569, 'params': [{'priors': None, 'var_smoothing': 1e-09}]}
****

Processing Model: AdaBoostClassifier
****
* AdaBoostClassifier
* Best Params Result:
* {'classifier': 'AdaBoostClassifier', 'features': 'Marked & transmucosal increase in lamina propria cellularity, Crypt architecture, Epithelial changes, Mucosal surface, Lamina propria granulomas, Patchy lamina propria cellularity?, Mucin depletion, Submucosal granulomas, Cryptitis extent, Lamina propria polymorphs, Cryptitis polymorphs, Basal histiocytic cells', 'accuracy': [0.6954022988505747, 0.7068965517241379, 0.7803468208092486, 0.48554913294797686, 0.5664739884393064], 'avgAccuracy': 0.6469337585542488, 'f1': [0.7060784028789387, 0.729883030266172, 0.7813195200729757, 0.6536964980544747, 0.5772928193873451], 'avgF1': 0.6896540541319812, 'precision': [0.6954022988505747, 0.7068965517241379, 0.7803468208092486, 0.48554913294797686, 0.5664739884393064], 'avgPrecision': 0.6469337585542488, 'recall': [0.6954022988505747, 0.7068965517241379, 0.7803468208092486, 0.48554913294797686, 0.5664739884393064], 'avgRecall': 0.6469337585542488, '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': 'Marked & transmucosal increase in lamina propria cellularity, Crypt architecture, Epithelial changes, Mucosal surface, Lamina propria granulomas, Patchy lamina propria cellularity?, Mucin depletion, Submucosal granulomas, Cryptitis extent, Lamina propria polymorphs, Cryptitis polymorphs, Basal histiocytic cells', 'accuracy': [0.6724137931034483, 0.6781609195402298, 0.7514450867052023, 0.45664739884393063, 0.6936416184971098], 'avgAccuracy': 0.6504617633379841, 'f1': [0.683748786775187, 0.7053380089616209, 0.7523832510394124,

0.626984126984127, 0.7050627546795359], 'avgF1': 0.694700604068443, 'precision':
[0.6724137931034483, 0.6781609195402298, 0.7514450867052023,
0.45664739884393063, 0.6936416184971098], 'avgPrecision': 0.6504617633379841,
'recall': [0.6724137931034483, 0.6781609195402298, 0.7514450867052023,
0.45664739884393063, 0.6936416184971098], 'avgRecall': 0.6504617633379841,
'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': 'Marked & transmucosal increase in lamina
propria cellularity, Crypt architecture, Epithelial changes, Mucosal surface,
Lamina propria granulomas, Patchy lamina propria cellularity?, Mucin depletion,
Submucosal granulomas, Cryptitis extent, Lamina propria polymorphs, Cryptitis
polymorphs, Basal histiocytic cells', 'accuracy': [0.603448275862069,
0.6781609195402298, 0.6936416184971098, 0.10404624277456648,
0.6184971098265896], 'avgAccuracy': 0.5395588333001129, 'f1':
[0.6140143487465257, 0.7061101028433151, 0.6946869653981668,
0.18848167539267016, 0.6329503615101394], 'avgF1': 0.5672486907781634,
'precision': [0.603448275862069, 0.6781609195402298, 0.6936416184971098,
0.10404624277456648, 0.6184971098265896], 'avgPrecision': 0.5395588333001129,
'recall': [0.603448275862069, 0.6781609195402298, 0.6936416184971098,
0.10404624277456648, 0.6184971098265896], 'avgRecall': 0.5395588333001129,
'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': 'Marked & transmucosal increase in
lamina propria cellularity, Crypt architecture, Epithelial changes, Mucosal
surface, Lamina propria granulomas, Patchy lamina propria cellularity?, Mucin
depletion, Submucosal granulomas, Cryptitis extent, Lamina propria polymorphs,
Cryptitis polymorphs, Basal histiocytic cells', 'accuracy': [0.6206896551724138,
0.6954022988505747, 0.7225433526011561, 0.24277456647398843,
0.6994219653179191], 'avgAccuracy': 0.5961663676832104, 'f1':
[0.6318622721040069, 0.7215593919778308, 0.7232565122738532,
0.39069767441860465, 0.7100861086068835], 'avgF1': 0.6354923918762359,

'precision': [0.6206896551724138, 0.6954022988505747, 0.7225433526011561,
0.24277456647398843, 0.6994219653179191], 'avgPrecision': 0.5961663676832104,
'recall': [0.6206896551724138, 0.6954022988505747, 0.7225433526011561,
0.24277456647398843, 0.6994219653179191], 'avgRecall': 0.5961663676832104,
'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': 'DecisionTreeClassifier', 'features': 'Marked & transmucosal
increase in lamina propria cellularity, Crypt architecture, Epithelial changes,
Mucosal surface, Lamina propria granulomas, Patchy lamina propria cellularity?,
Mucin depletion, Submucosal granulomas, Cryptitis extent, Lamina propria
polymorphs, Cryptitis polymorphs, Basal histiocytic cells', 'accuracy':
[0.6724137931034483, 0.6781609195402298, 0.7514450867052023,
0.45664739884393063, 0.6936416184971098], 'avgAccuracy': 0.6504617633379841,
'f1': [0.6837348786775187, 0.7053380089616209, 0.7523832510394124,
0.626984126984127, 0.7050627546795359], 'avgF1': 0.694700604068443, 'precision':
[0.6724137931034483, 0.6781609195402298, 0.7514450867052023,
0.45664739884393063, 0.6936416184971098], 'avgPrecision': 0.6504617633379841,
'recall': [0.6724137931034483, 0.6781609195402298, 0.7514450867052023,
0.45664739884393063, 0.6936416184971098], 'avgRecall': 0.6504617633379841,
'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'}]}
****

```
                 model                                          features  \
0  RandomForestClassifier  Marked & transmucosal increase in lamina propr…
1    KNeighborsClassifier  Marked & transmucosal increase in lamina propr…
2      LogisticRegression  Marked & transmucosal increase in lamina propr…
3              GaussianNB  Marked & transmucosal increase in lamina propr…
4      AdaBoostClassifier  Marked & transmucosal increase in lamina propr…
5  DecisionTreeClassifier  Marked & transmucosal increase in lamina propr…
6                     SVC  Marked & transmucosal increase in lamina propr…
7           MLPClassifier  Marked & transmucosal increase in lamina propr…

   accuracy        f1  precision    recall  \
0  0.672361  0.713961   0.672361  0.672361
1  0.724424  0.750456   0.724424  0.724424
2  0.589257  0.629871   0.589257  0.589257
```

```
3  0.589011  0.538441    0.589011    0.589011
4  0.646934  0.689654    0.646934    0.646934
5  0.650462  0.694701    0.650462    0.650462
6  0.539559  0.567249    0.539559    0.539559
7  0.596166  0.635492    0.596166    0.596166


                                                          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': 'Marked & transmucosal increase in lamina propria cellularity, Crypt architecture, Epithelial changes, Mucosal surface, Lamina propria granulomas, Patchy lamina propria cellularity?, Mucin depletion, Submucosal granulomas, Cryptitis extent, Lamina propria polymorphs, Cryptitis polymorphs', 'accuracy': [0.6781609195402298, 0.7241379310344828, 0.7456647398843931, 0.5375722543352601, 0.6705202312138728], 'avgAccuracy': 0.6712112152016477, 'f1': [0.6889352784899223, 0.7466155810983398, 0.746692218715994, 0.6992481203007519, 0.6832668243401608], 'avgF1': 0.7129516045890337, 'precision': [0.6781609195402298, 0.7241379310344828, 0.7456647398843931, 0.5375722543352601, 0.6705202312138728], 'avgPrecision': 0.6712112152016477, 'recall': [0.6781609195402298, 0.7241379310344828, 0.7456647398843931, 0.5375722543352601, 0.6705202312138728], 'avgRecall': 0.6712112152016477, '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': 'Marked & transmucosal increase in lamina propria cellularity, Crypt architecture, Epithelial changes, Mucosal surface, Lamina propria granulomas, Patchy lamina propria cellularity?,

Mucin depletion, Submucosal granulomas, Cryptitis extent, Lamina propria
polymorphs, Cryptitis polymorphs', 'accuracy': [0.6954022988505747,
0.6896551724137931, 0.7398843930635838, 0.8265895953757225, 0.6820809248554913],
'avgAccuracy': 0.7267224769118331, 'f1': [0.7059289222790964,
0.7165501994765329, 0.7410371632538006, 0.9050632911392403, 0.694201105629824],
'avgF1': 0.7525561363556988, 'precision': [0.6954022988505747,
0.6896551724137931, 0.7398843930635838, 0.8265895953757225, 0.6820809248554913],
'avgPrecision': 0.7267224769118331, 'recall': [0.6954022988505747,
0.6896551724137931, 0.7398843930635838, 0.8265895953757225, 0.6820809248554913],
'avgRecall': 0.7267224769118331, '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': 'Marked & transmucosal
increase in lamina propria cellularity, Crypt architecture, Epithelial changes,
Mucosal surface, Lamina propria granulomas, Patchy lamina propria cellularity?,
Mucin depletion, Submucosal granulomas, Cryptitis extent, Lamina propria
polymorphs, Cryptitis polymorphs', 'accuracy': [0.6091954022988506,
0.6666666666666666, 0.7167630057803468, 0.2543352601156069, 0.6820809248554913],
'avgAccuracy': 0.5858082519433925, 'f1': [0.6191933347117247,
0.6956140350877194, 0.7178320767658422, 0.40552995391705066, 0.694201105629824],
'avgF1': 0.6264741012224322, 'precision': [0.6091954022988506,
0.6666666666666666, 0.7167630057803468, 0.2543352601156069, 0.6820809248554913],
'avgPrecision': 0.5858082519433925, 'recall': [0.6091954022988506,
0.6666666666666666, 0.7167630057803468, 0.2543352601156069, 0.6820809248554913],
'avgRecall': 0.5858082519433925, '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': 'Marked & transmucosal increase in
lamina propria cellularity, Crypt architecture, Epithelial changes, Mucosal
surface, Lamina propria granulomas, Patchy lamina propria cellularity?, Mucin
depletion, Submucosal granulomas, Cryptitis extent, Lamina propria polymorphs,
Cryptitis polymorphs', 'accuracy': [0.7011494252873564, 0.8045977011494253,
0.6242774566473989, 0.10404624277456648, 0.7109826589595376], 'avgAccuracy':
0.5890106969636569, 'f1': [0.6179526873886999, 0.7363619777412881,

0.533935969056559, 0.18848167539267016, 0.6154740548800743], 'avgF1':
0.5384412728918583, 'precision': [0.7011494252873564, 0.8045977011494253,
0.6242774566473989, 0.10404624277456648, 0.7109826589595376], 'avgPrecision':
0.5890106969636569, 'recall': [0.7011494252873564, 0.8045977011494253,
0.6242774566473989, 0.10404624277456648, 0.7109826589595376], 'avgRecall':
0.5890106969636569, 'params': [{'priors': None, 'var_smoothing': 1e-09}]}
****

Processing Model: AdaBoostClassifier
****
* AdaBoostClassifier
* Best Params Result:
* {'classifier': 'AdaBoostClassifier', 'features': 'Marked & transmucosal
increase in lamina propria cellularity, Crypt architecture, Epithelial changes,
Mucosal surface, Lamina propria granulomas, Patchy lamina propria cellularity?,
Mucin depletion, Submucosal granulomas, Cryptitis extent, Lamina propria
polymorphs, Cryptitis polymorphs', 'accuracy': [0.6954022988505747,
0.7068965517241379, 0.7803468208092486, 0.5086705202312138, 0.5664739884393064],
'avgAccuracy': 0.6515580360108962, 'f1': [0.7060784028789387, 0.729883030266172,
0.7813195200729757, 0.6743295019157087, 0.5772928193873451], 'avgF1':
0.693780654904228, 'precision': [0.6954022988505747, 0.7068965517241379,
0.7803468208092486, 0.5086705202312138, 0.5664739884393064], 'avgPrecision':
0.6515580360108962, 'recall': [0.6954022988505747, 0.7068965517241379,
0.7803468208092486, 0.5086705202312138, 0.5664739884393064], 'avgRecall':
0.6515580360108962, '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': 'Marked & transmucosal
increase in lamina propria cellularity, Crypt architecture, Epithelial changes,
Mucosal surface, Lamina propria granulomas, Patchy lamina propria cellularity?,
Mucin depletion, Submucosal granulomas, Cryptitis extent, Lamina propria
polymorphs, Cryptitis polymorphs', 'accuracy': [0.6551724137931034,
0.6954022988505747, 0.7109826589595376, 0.5433526011560693, 0.6589595375722543],
'avgAccuracy': 0.6527739020663079, 'f1': [0.6672508525956802,
0.7209330675066161, 0.7122625264118102, 0.7041198501872659, 0.6721740443329903],
'avgF1': 0.6953480682068726, 'precision': [0.6551724137931034,
0.6954022988505747, 0.7109826589595376, 0.5433526011560693, 0.6589595375722543],
'avgPrecision': 0.6527739020663079, 'recall': [0.6551724137931034,
0.6954022988505747, 0.7109826589595376, 0.5433526011560693, 0.6589595375722543],
'avgRecall': 0.6527739020663079, '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': 'Marked & transmucosal increase in lamina
propria cellularity, Crypt architecture, Epithelial changes, Mucosal surface,
Lamina propria granulomas, Patchy lamina propria cellularity?, Mucin depletion,
Submucosal granulomas, Cryptitis extent, Lamina propria polymorphs, Cryptitis
polymorphs', 'accuracy': [0.6091954022988506, 0.6724137931034483,
0.6936416184971098, 0.10404624277456648, 0.6358381502890174], 'avgAccuracy':
0.5430270413925985, 'f1': [0.6199988947833777, 0.7008585851611275,
0.6949398782108746, 0.18848167539267016, 0.6497628343352881], 'avgF1':
0.5708083735766676, 'precision': [0.6091954022988506, 0.6724137931034483,
0.6936416184971098, 0.10404624277456648, 0.6358381502890174], 'avgPrecision':
0.5430270413925985, 'recall': [0.6091954022988506, 0.6724137931034483,
0.6936416184971098, 0.10404624277456648, 0.6358381502890174], 'avgRecall':
0.5430270413925985, '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': 'Marked & transmucosal increase in
lamina propria cellularity, Crypt architecture, Epithelial changes, Mucosal
surface, Lamina propria granulomas, Patchy lamina propria cellularity?, Mucin
depletion, Submucosal granulomas, Cryptitis extent, Lamina propria polymorphs,
Cryptitis polymorphs', 'accuracy': [0.6149425287356322, 0.6781609195402298,
0.7109826589595376, 0.2658959537572254, 0.6878612716763006], 'avgAccuracy':
0.5915686665337851, 'f1': [0.6252023386379308, 0.7059056678557273,
0.7119772530481384, 0.4200913242009132, 0.6996405085919428], 'avgF1':
0.6325634184669305, 'precision': [0.6149425287356322, 0.6781609195402298,
0.7109826589595376, 0.2658959537572254, 0.6878612716763006], 'avgPrecision':
0.5915686665337851, 'recall': [0.6149425287356322, 0.6781609195402298,
0.7109826589595376, 0.2658959537572254, 0.6878612716763006], 'avgRecall':
0.5915686665337851, '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': 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,
```

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'validation_fraction': 0.1, 'verbose': False, 'warm_start': False}]}
*********************************************************
*********************************************************
* Best Performing Model and Params is:
* {'classifier': 'DecisionTreeClassifier', 'features': 'Marked & transmucosal
increase in lamina propria cellularity, Crypt architecture, Epithelial changes,
Mucosal surface, Lamina propria granulomas, Patchy lamina propria cellularity?,
Mucin depletion, Submucosal granulomas, Cryptitis extent, Lamina propria
polymorphs, Cryptitis polymorphs', 'accuracy': [0.6551724137931034,
0.6954022988505747, 0.7109826589595376, 0.5433526011560693, 0.6589595375722543],
'avgAccuracy': 0.6527739020663079, 'f1': [0.6672508525956802,
0.7209330675066161, 0.7122625264118102, 0.7041198501872659, 0.6721740443329903],
'avgF1': 0.6953480682068726, 'precision': [0.6551724137931034,
0.6954022988505747, 0.7109826589595376, 0.5433526011560693, 0.6589595375722543],
'avgPrecision': 0.6527739020663079, 'recall': [0.6551724137931034,
0.6954022988505747, 0.7109826589595376, 0.5433526011560693, 0.6589595375722543],
'avgRecall': 0.6527739020663079, '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'}]}
*********************************************************
```

```
                   model                                    features  \
0  RandomForestClassifier  Marked & transmucosal increase in lamina propr…
1    KNeighborsClassifier  Marked & transmucosal increase in lamina propr…
2      LogisticRegression  Marked & transmucosal increase in lamina propr…
3              GaussianNB  Marked & transmucosal increase in lamina propr…
4      AdaBoostClassifier  Marked & transmucosal increase in lamina propr…
5  DecisionTreeClassifier  Marked & transmucosal increase in lamina propr…
6                     SVC  Marked & transmucosal increase in lamina propr…
7           MLPClassifier  Marked & transmucosal increase in lamina propr…

   accuracy        f1  precision    recall  \
0  0.671211  0.712952   0.671211  0.671211
1  0.726722  0.752556   0.726722  0.726722
2  0.585808  0.626474   0.585808  0.585808
3  0.589011  0.538441   0.589011  0.589011
4  0.651558  0.693781   0.651558  0.651558
5  0.652774  0.695348   0.652774  0.652774
6  0.543027  0.570808   0.543027  0.543027
7  0.591569  0.632563   0.591569  0.591569

                                             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': 'Marked & transmucosal increase in lamina propria cellularity, Crypt architecture, Epithelial changes, Mucosal surface, Lamina propria granulomas, Patchy lamina propria cellularity?, Mucin depletion, Submucosal granulomas, Cryptitis extent, Lamina propria polymorphs', 'accuracy': [0.6839080459770115, 0.7183908045977011, 0.7572254335260116, 0.5260115606936416, 0.6763005780346821], 'avgAccuracy': 0.6723672845658096, 'f1': [0.6934743841841423, 0.7404758526086751, 0.758206208774358, 0.6893939393939393, 0.6887435437058355], 'avgF1': 0.71405878573339, 'precision': [0.6839080459770115, 0.7183908045977011, 0.7572254335260116, 0.5260115606936416, 0.6763005780346821], 'avgPrecision': 0.6723672845658096, 'recall': [0.6839080459770115, 0.7183908045977011, 0.7572254335260116, 0.5260115606936416, 0.6763005780346821], 'avgRecall': 0.6723672845658096, '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': 'Marked & transmucosal increase in lamina propria cellularity, Crypt architecture, Epithelial changes, Mucosal surface, Lamina propria granulomas, Patchy lamina propria cellularity?, Mucin depletion, Submucosal granulomas, Cryptitis extent, Lamina propria polymorphs', 'accuracy': [0.6666666666666666, 0.6896551724137931, 0.7572254335260116, 0.8092485549132948, 0.6763005780346821], 'avgAccuracy': 0.7198192811108897, 'f1': [0.6782608695652173, 0.7158616514987058, 0.7583005221859206, 0.8945686900958467, 0.6888813328799728], 'avgF1': 0.7471746132451327, 'precision': [0.6666666666666666, 0.6896551724137931, 0.7572254335260116, 0.8092485549132948, 0.6763005780346821], 'avgPrecision': 0.7198192811108897, 'recall': [0.6666666666666666, 0.6896551724137931, 0.7572254335260116, 0.8092485549132948, 0.6763005780346821], 'avgRecall': 0.7198192811108897, 'params': [{'algorithm': 'ball_tree', 'leaf_size': 30, 'metric': 'minkowski', 'metric_params': None, 'n_jobs': -1, 'n_neighbors': 12, 'p': 2, 'weights': 'distance'}]}

```

```
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Processing Model: LogisticRegression
****
* LogisticRegression
* Best Params Result:
* {'classifier': 'LogisticRegression', 'features': 'Marked & transmucosal
increase in lamina propria cellularity, Crypt architecture, Epithelial changes,
Mucosal surface, Lamina propria granulomas, Patchy lamina propria cellularity?,
Mucin depletion, Submucosal granulomas, Cryptitis extent, Lamina propria
polymorphs', 'accuracy': [0.6149425287356322, 0.6781609195402298,
0.7052023121387283, 0.23699421965317918, 0.6647398843930635], 'avgAccuracy':
0.5800079728921665, 'f1': [0.6252023386379308, 0.7060520587164044,
0.7058013118092785, 0.38317757009345793, 0.6777699519114003], 'avgF1':
0.6196006462336944, 'precision': [0.6149425287356322, 0.6781609195402298,
0.7052023121387283, 0.23699421965317918, 0.6647398843930635], 'avgPrecision':
0.5800079728921665, 'recall': [0.6149425287356322, 0.6781609195402298,
0.7052023121387283, 0.23699421965317918, 0.6647398843930635], 'avgRecall':
0.5800079728921665, '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': 'Marked & transmucosal increase in
lamina propria cellularity, Crypt architecture, Epithelial changes, Mucosal
surface, Lamina propria granulomas, Patchy lamina propria cellularity?, Mucin
depletion, Submucosal granulomas, Cryptitis extent, Lamina propria polymorphs',
'accuracy': [0.7011494252873564, 0.8045977011494253, 0.6242774566473989,
0.10404624277456648, 0.7109826589595376], 'avgAccuracy': 0.5890106969636569,
'f1': [0.6179526873886999, 0.7363619777412881, 0.533935969056559,
0.18848167539267016, 0.6154740548800743], 'avgF1': 0.5384412728918583,
'precision': [0.7011494252873564, 0.8045977011494253, 0.6242774566473989,
0.10404624277456648, 0.7109826589595376], 'avgPrecision': 0.5890106969636569,
'recall': [0.7011494252873564, 0.8045977011494253, 0.6242774566473989,
0.10404624277456648, 0.7109826589595376], 'avgRecall': 0.5890106969636569,
'params': [{'priors': None, 'var_smoothing': 1e-09}]}
****

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

* {'classifier': 'AdaBoostClassifier', 'features': 'Marked & transmucosal
increase in lamina propria cellularity, Crypt architecture, Epithelial changes,
Mucosal surface, Lamina propria granulomas, Patchy lamina propria cellularity?,
Mucin depletion, Submucosal granulomas, Cryptitis extent, Lamina propria
polymorphs', 'accuracy': [0.7011494252873564, 0.7068965517241379,
0.7745664739884393, 0.5144508670520231, 0.7109826589595376], 'avgAccuracy':
0.6816091954022988, 'f1': [0.711544227886057, 0.729883030266172,
0.7755655414866272, 0.6793893129770993, 0.7216046638011956], 'avgF1':
0.7235973552834302, 'precision': [0.7011494252873564, 0.7068965517241379,
0.7745664739884393, 0.5144508670520231, 0.7109826589595376], 'avgPrecision':
0.6816091954022988, 'recall': [0.7011494252873564, 0.7068965517241379,
0.7745664739884393, 0.5144508670520231, 0.7109826589595376], 'avgRecall':
0.6816091954022988, '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': 'Marked & transmucosal
increase in lamina propria cellularity, Crypt architecture, Epithelial changes,
Mucosal surface, Lamina propria granulomas, Patchy lamina propria cellularity?,
Mucin depletion, Submucosal granulomas, Cryptitis extent, Lamina propria
polymorphs', 'accuracy': [0.6724137931034483, 0.7068965517241379,
0.7456647398843931, 0.49710982658959535, 0.6994219653179191], 'avgAccuracy':
0.6643013753238988, 'f1': [0.6828197573215363, 0.729883030266172,
0.746791023242393, 0.664092664092664, 0.7111040948171177], 'avgF1':
0.7069381139479766, 'precision': [0.6724137931034483, 0.7068965517241379,
0.7456647398843931, 0.49710982658959535, 0.6994219653179191], 'avgPrecision':
0.6643013753238988, 'recall': [0.6724137931034483, 0.7068965517241379,
0.7456647398843931, 0.49710982658959535, 0.6994219653179191], 'avgRecall':
0.6643013753238988, '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': 'Marked & transmucosal increase in lamina
propria cellularity, Crypt architecture, Epithelial changes, Mucosal surface,
Lamina propria granulomas, Patchy lamina propria cellularity?, Mucin depletion,
Submucosal granulomas, Cryptitis extent, Lamina propria polymorphs', 'accuracy':
[0.6091954022988506, 0.6666666666666666, 0.6994219653179191,

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0.10404624277456648, 0.6416184971098265], 'avgAccuracy': 0.5441897548335659,
'f1': [0.6172885281771698, 0.6956140350877194, 0.7006362584825384,
0.18848167539267016, 0.6551957941458886], 'avgF1': 0.5714432582571972,
'precision': [0.6091954022988506, 0.6666666666666666, 0.6994219653179191,
0.10404624277456648, 0.6416184971098265], 'avgPrecision': 0.5441897548335659,
'recall': [0.6091954022988506, 0.6666666666666666, 0.6994219653179191,
0.10404624277456648, 0.6416184971098265], 'avgRecall': 0.5441897548335659,
'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': 'Marked & transmucosal increase in
lamina propria cellularity, Crypt architecture, Epithelial changes, Mucosal
surface, Lamina propria granulomas, Patchy lamina propria cellularity?, Mucin
depletion, Submucosal granulomas, Cryptitis extent, Lamina propria polymorphs',
'accuracy': [0.6264367816091954, 0.6954022988505747, 0.7167630057803468,
0.24277456647398843, 0.6705202312138728], 'avgAccuracy': 0.5903793767855956,
'f1': [0.6363903285293359, 0.7215593919778308, 0.7169746279190063,
0.39069767441860465, 0.6832668243401608], 'avgF1': 0.6297777694369877,
'precision': [0.6264367816091954, 0.6954022988505747, 0.7167630057803468,
0.24277456647398843, 0.6705202312138728], 'avgPrecision': 0.5903793767855956,
'recall': [0.6264367816091954, 0.6954022988505747, 0.7167630057803468,
0.24277456647398843, 0.6705202312138728], 'avgRecall': 0.5903793767855956,
'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': 'AdaBoostClassifier', 'features': 'Marked & transmucosal
increase in lamina propria cellularity, Crypt architecture, Epithelial changes,
Mucosal surface, Lamina propria granulomas, Patchy lamina propria cellularity?,
Mucin depletion, Submucosal granulomas, Cryptitis extent, Lamina propria
polymorphs', 'accuracy': [0.7011494252873564, 0.7068965517241379,
0.7745664739884393, 0.5144508670520231, 0.7109826589595376], 'avgAccuracy':
0.6816091954022988, 'f1': [0.711544227886057, 0.729883030266172,
0.7755655414866272, 0.6793893129770993, 0.7216046638011956], 'avgF1':
0.7235973552834302, 'precision': [0.7011494252873564, 0.7068965517241379,

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```
0.7745664739884393, 0.5144508670520231, 0.7109826589595376], 'avgPrecision':
0.6816091954022988, 'recall': [0.7011494252873564, 0.7068965517241379,
0.7745664739884393, 0.5144508670520231, 0.7109826589595376], 'avgRecall':
0.6816091954022988, 'params': [{'algorithm': 'SAMME.R', 'base_estimator': None,
'learning_rate': 1, 'n_estimators': 300, 'random_state': None}]}
********************************************************
```

```
                     model                                      features  \
0  RandomForestClassifier  Marked & transmucosal increase in lamina propr…
1     KNeighborsClassifier  Marked & transmucosal increase in lamina propr…
2       LogisticRegression  Marked & transmucosal increase in lamina propr…
3               GaussianNB  Marked & transmucosal increase in lamina propr…
4       AdaBoostClassifier  Marked & transmucosal increase in lamina propr…
5   DecisionTreeClassifier  Marked & transmucosal increase in lamina propr…
6                      SVC  Marked & transmucosal increase in lamina propr…
7            MLPClassifier  Marked & transmucosal increase in lamina propr…

   accuracy        f1  precision    recall  \
0  0.672367  0.714059   0.672367  0.672367
1  0.719819  0.747175   0.719819  0.719819
2  0.580008  0.619601   0.580008  0.580008
3  0.589011  0.538441   0.589011  0.589011
4  0.681609  0.723597   0.681609  0.681609
5  0.664301  0.706938   0.664301  0.664301
6  0.544190  0.571443   0.544190  0.544190
7  0.590379  0.629778   0.590379  0.590379

                                             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': 'Marked & transmucosal
increase in lamina propria cellularity, Crypt architecture, Epithelial changes,
Mucosal surface, Lamina propria granulomas, Patchy lamina propria cellularity?,
Mucin depletion, Submucosal granulomas, Cryptitis extent', 'accuracy':
[0.6839080459770115, 0.7126436781609196, 0.7630057803468208,
0.49710982658959535, 0.6878612716763006], 'avgAccuracy': 0.6689057205501295,
'f1': [0.6934743841841423, 0.734082026418641, 0.764010094465016,
```

0.664092664092664, 0.69964050859194281, 'avgF1': 0.7110599355504813,
'precision': [0.6839080459770115, 0.7126436781609196, 0.7630057803468208,
0.49710982658959535, 0.6878612716763006], 'avgPrecision': 0.6689057205501295,
'recall': [0.6839080459770115, 0.7126436781609196, 0.7630057803468208,
0.49710982658959535, 0.6878612716763006], 'avgRecall': 0.6689057205501295,
'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': 'Marked & transmucosal
increase in lamina propria cellularity, Crypt architecture, Epithelial changes,
Mucosal surface, Lamina propria granulomas, Patchy lamina propria cellularity?,
Mucin depletion, Submucosal granulomas, Cryptitis extent', 'accuracy':
[0.6666666666666666, 0.6666666666666666, 0.7572254335260116, 0.7861271676300579,
0.6589595375722543], 'avgAccuracy': 0.7071290944123314, 'f1':
[0.6783424908424908, 0.6951566951566953, 0.7583005221859206, 0.8802588996763754,
0.6722583732461128], 'avgF1': 0.736863396221519, 'precision':
[0.6666666666666666, 0.6666666666666666, 0.7572254335260116, 0.7861271676300579,
0.6589595375722543], 'avgPrecision': 0.7071290944123314, 'recall':
[0.6666666666666666, 0.6666666666666666, 0.7572254335260116, 0.7861271676300579,
0.6589595375722543], 'avgRecall': 0.7071290944123314, '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': 'Marked & transmucosal
increase in lamina propria cellularity, Crypt architecture, Epithelial changes,
Mucosal surface, Lamina propria granulomas, Patchy lamina propria cellularity?,
Mucin depletion, Submucosal granulomas, Cryptitis extent', 'accuracy':
[0.6494252873563219, 0.6839080459770115, 0.6994219653179191,
0.23121387283236994, 0.6878612716763006], 'avgAccuracy': 0.5903660886319846,
'f1': [0.6605387426298953, 0.7110521992222772, 0.700194554963341,
0.37558685446009393, 0.6996405085919428], 'avgF1': 0.6294025719735101,
'precision': [0.6494252873563219, 0.6839080459770115, 0.6994219653179191,
0.23121387283236994, 0.6878612716763006], 'avgPrecision': 0.5903660886319846,
'recall': [0.6494252873563219, 0.6839080459770115, 0.6994219653179191,

0.23121387283236994, 0.6878612716763006], 'avgRecall': 0.5903660886319846,
'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': 'Marked & transmucosal increase in
lamina propria cellularity, Crypt architecture, Epithelial changes, Mucosal
surface, Lamina propria granulomas, Patchy lamina propria cellularity?, Mucin
depletion, Submucosal granulomas, Cryptitis extent', 'accuracy':
[0.7011494252873564, 0.8045977011494253, 0.6242774566473989,
0.10404624277456648, 0.7109826589595376], 'avgAccuracy': 0.5890106969636569,
'f1': [0.6179526873886999, 0.7363619777412881, 0.533935969056559,
0.18848167539267016, 0.6154740548800743], 'avgF1': 0.5384412728918583,
'precision': [0.7011494252873564, 0.8045977011494253, 0.6242774566473989,
0.10404624277456648, 0.7109826589595376], 'avgPrecision': 0.5890106969636569,
'recall': [0.7011494252873564, 0.8045977011494253, 0.6242774566473989,
0.10404624277456648, 0.7109826589595376], 'avgRecall': 0.5890106969636569,
'params': [{'priors': None, 'var_smoothing': 1e-09}]}
****

Processing Model: AdaBoostClassifier
****
* AdaBoostClassifier
* Best Params Result:
* {'classifier': 'AdaBoostClassifier', 'features': 'Marked & transmucosal
increase in lamina propria cellularity, Crypt architecture, Epithelial changes,
Mucosal surface, Lamina propria granulomas, Patchy lamina propria cellularity?,
Mucin depletion, Submucosal granulomas, Cryptitis extent', 'accuracy':
[0.6954022988505747, 0.7068965517241379, 0.7745664739884393, 0.5028901734104047,
0.7109826589595376], 'avgAccuracy': 0.6781476313866188, 'f1':
[0.7060445027907718, 0.729883030266172, 0.7755655414866272, 0.6692307692307693,
0.7216046638011956], 'avgF1': 0.7204657015151071, 'precision':
[0.6954022988505747, 0.7068965517241379, 0.7745664739884393, 0.5028901734104047,
0.7109826589595376], 'avgPrecision': 0.6781476313866188, 'recall':
[0.6954022988505747, 0.7068965517241379, 0.7745664739884393, 0.5028901734104047,
0.7109826589595376], 'avgRecall': 0.6781476313866188, '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': 'Marked & transmucosal
increase in lamina propria cellularity, Crypt architecture, Epithelial changes,
Mucosal surface, Lamina propria granulomas, Patchy lamina propria cellularity?,
Mucin depletion, Submucosal granulomas, Cryptitis extent', 'accuracy':
[0.6666666666666666, 0.7183908045977011, 0.7341040462427746, 0.4682080924855491,
0.6647398843930635], 'avgAccuracy': 0.650421898877151, 'f1':
[0.6780891601923789, 0.7410728652814014, 0.7352815242988655, 0.6377952755905512,
0.67776995919114003], 'avgF1': 0.6940017554549195, 'precision':
[0.6666666666666666, 0.7183908045977011, 0.7341040462427746, 0.4682080924855491,
0.6647398843930635], 'avgPrecision': 0.650421898877151, 'recall':
[0.6666666666666666, 0.7183908045977011, 0.7341040462427746, 0.4682080924855491,
0.6647398843930635], 'avgRecall': 0.650421898877151, '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': 'Marked & transmucosal increase in lamina
propria cellularity, Crypt architecture, Epithelial changes, Mucosal surface,
Lamina propria granulomas, Patchy lamina propria cellularity?, Mucin depletion,
Submucosal granulomas, Cryptitis extent', 'accuracy': [0.6149425287356322,
0.6666666666666666, 0.6994219653179191, 0.10404624277456648,
0.6127167630057804], 'avgAccuracy': 0.5395588333001129, 'f1':
[0.6243604263556551, 0.6955848928865033, 0.7006362584825384,
0.18848167539267016, 0.6272274267490533], 'avgF1': 0.567258135973284,
'precision': [0.6149425287356322, 0.6666666666666666, 0.6994219653179191,
0.10404624277456648, 0.6127167630057804], 'avgPrecision': 0.5395588333001129,
'recall': [0.6149425287356322, 0.6666666666666666, 0.6994219653179191,
0.10404624277456648, 0.6127167630057804], 'avgRecall': 0.5395588333001129,
'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': 'Marked & transmucosal increase in
lamina propria cellularity, Crypt architecture, Epithelial changes, Mucosal

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surface, Lamina propria granulomas, Patchy lamina propria cellularity?, Mucin
depletion, Submucosal granulomas, Cryptitis extent', 'accuracy':
[0.6494252873563219, 0.6839080459770115, 0.7225433526011561,
0.23121387283236994, 0.6763005780346821], 'avgAccuracy': 0.5926782273603083,
'f1': [0.660035944822963, 0.7113403409850614, 0.7229385363772938,
0.37558685446009393, 0.6887435437058355], 'avgF1': 0.6317290440702495,
'precision': [0.6494252873563219, 0.6839080459770115, 0.7225433526011561,
0.23121387283236994, 0.6763005780346821], 'avgPrecision': 0.5926782273603083,
'recall': [0.6494252873563219, 0.6839080459770115, 0.7225433526011561,
0.23121387283236994, 0.6763005780346821], 'avgRecall': 0.5926782273603083,
'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': 'AdaBoostClassifier', 'features': 'Marked & transmucosal
increase in lamina propria cellularity, Crypt architecture, Epithelial changes,
Mucosal surface, Lamina propria granulomas, Patchy lamina propria cellularity?,
Mucin depletion, Submucosal granulomas, Cryptitis extent', 'accuracy':
[0.6954022988505747, 0.7068965517241379, 0.7745664739884393, 0.5028901734104047,
0.7109826589595376], 'avgAccuracy': 0.6781476313866188, 'f1':
[0.7060445027907718, 0.729883030266172, 0.7755655414866272, 0.6692307692307693,
0.7216046638011956], 'avgF1': 0.7204657015151071, 'precision':
[0.6954022988505747, 0.7068965517241379, 0.7745664739884393, 0.5028901734104047,
0.7109826589595376], 'avgPrecision': 0.6781476313866188, 'recall':
[0.6954022988505747, 0.7068965517241379, 0.7745664739884393, 0.5028901734104047,
0.7109826589595376], 'avgRecall': 0.6781476313866188, 'params': [{'algorithm':
'SAMME.R', 'base_estimator': None, 'learning_rate': 1, 'n_estimators': 300,
'random_state': None}]}
****

                   model   features \
0 RandomForestClassifier Marked & transmucosal increase in lamina propr…
1   KNeighborsClassifier Marked & transmucosal increase in lamina propr…
2   LogisticRegression Marked & transmucosal increase in lamina propr…
3   GaussianNB Marked & transmucosal increase in lamina propr…
4   AdaBoostClassifier Marked & transmucosal increase in lamina propr…
5 DecisionTreeClassifier Marked & transmucosal increase in lamina propr…
6   SVC Marked & transmucosal increase in lamina propr…
7   MLPClassifier Marked & transmucosal increase in lamina propr…

   accuracy   f1 precision   recall \
0 0.668906 0.711060   0.668906 0.668906

```
1   0.707129   0.736863    0.707129   0.707129
2   0.590366   0.629403    0.590366   0.590366
3   0.589011   0.538441    0.589011   0.589011
4   0.678148   0.720466    0.678148   0.678148
5   0.650422   0.694002    0.650422   0.650422
6   0.539559   0.567258    0.539559   0.539559
7   0.592678   0.631729    0.592678   0.592678


                                               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': 'Marked & transmucosal
increase in lamina propria cellularity, Crypt architecture, Epithelial changes,
Mucosal surface, Lamina propria granulomas, Patchy lamina propria cellularity?,
Mucin depletion, Submucosal granulomas', 'accuracy': [0.6609195402298851,
0.7068965517241379, 0.7341040462427746, 0.49710982658959535,
0.6820809248554913], 'avgAccuracy': 0.6562221779283769, 'f1':
[0.6726378568767298, 0.7314638951478758, 0.7352815242988655, 0.664092664092664,
0.69438026910001552], 'avgF1': 0.699571241903258, 'precision':
[0.6609195402298851, 0.7068965517241379, 0.7341040462427746,
0.49710982658959535, 0.6820809248554913], 'avgPrecision': 0.6562221779283769,
'recall': [0.6609195402298851, 0.7068965517241379, 0.7341040462427746,
0.49710982658959535, 0.6820809248554913], 'avgRecall': 0.6562221779283769,
'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':
True, 'random_state': None, 'verbose': 0, 'warm_start': False}]}
****

Processing Model: KNeighborsClassifier
****
* KNeighborsClassifier
* Best Params Result:
* {'classifier': 'KNeighborsClassifier', 'features': 'Marked & transmucosal
increase in lamina propria cellularity, Crypt architecture, Epithelial changes,

Mucosal surface, Lamina propria granulomas, Patchy lamina propria cellularity?, Mucin depletion, Submucosal granulomas', 'accuracy': [0.632183908045977, 0.6724137931034483, 0.7456647398843931, 0.791907514450867, 0.6589595375722543], 'avgAccuracy': 0.700225898611388, 'f1': [0.6435917379656038, 0.7003905678898892, 0.746791023242393, 0.8838709677419355, 0.6722583732461128], 'avgF1': 0.7293805340171868, 'precision': [0.632183908045977, 0.6724137931034483, 0.7456647398843931, 0.791907514450867, 0.6589595375722543], 'avgPrecision': 0.700225898611388, 'recall': [0.632183908045977, 0.6724137931034483, 0.7456647398843931, 0.791907514450867, 0.6589595375722543], 'avgRecall': 0.700225898611388, 'params': [{'algorithm': 'ball_tree', 'leaf_size': 30, 'metric': 'minkowski', 'metric_params': None, 'n_jobs': -1, 'n_neighbors': 12, 'p': 2, 'weights': 'uniform'}]}
****

Processing Model: LogisticRegression
****
* LogisticRegression
* Best Params Result:
* {'classifier': 'LogisticRegression', 'features': 'Marked & transmucosal increase in lamina propria cellularity, Crypt architecture, Epithelial changes, Mucosal surface, Lamina propria granulomas, Patchy lamina propria cellularity?, Mucin depletion, Submucosal granulomas', 'accuracy': [0.632183908045977, 0.6666666666666666, 0.7109826589595376, 0.24277456647398843, 0.6820809248554913], 'avgAccuracy': 0.5869377450003322, 'f1': [0.6423519009725907, 0.6954685099846389, 0.7104895226282509, 0.39069767441860465, 0.6943802691001552], 'avgF1': 0.626677575420848, 'precision': [0.632183908045977, 0.6666666666666666, 0.7109826589595376, 0.24277456647398843, 0.6820809248554913], 'avgPrecision': 0.5869377450003322, 'recall': [0.632183908045977, 0.6666666666666666, 0.7109826589595376, 0.24277456647398843, 0.6820809248554913], 'avgRecall': 0.5869377450003322, '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': 'Marked & transmucosal increase in lamina propria cellularity, Crypt architecture, Epithelial changes, Mucosal surface, Lamina propria granulomas, Patchy lamina propria cellularity?, Mucin depletion, Submucosal granulomas', 'accuracy': [0.7011494252873564, 0.8045977011494253, 0.6242774566473989, 0.10404624277456648, 0.7109826589595376], 'avgAccuracy': 0.5890106969636569, 'f1': [0.6179526873886999, 0.7363619777412881, 0.533935969056559, 0.18848167539267016, 0.6154740548800743], 'avgF1': 0.5384412728918583, 'precision':

[0.7011494252873564, 0.8045977011494253, 0.6242774566473989,
0.10404624277456648, 0.7109826589595376], 'avgPrecision': 0.5890106969636569,
'recall': [0.7011494252873564, 0.8045977011494253, 0.6242774566473989,
0.10404624277456648, 0.7109826589595376], 'avgRecall': 0.5890106969636569,
'params': [{'priors': None, 'var_smoothing': 1e-09}]}
****

Processing Model: AdaBoostClassifier
****
* AdaBoostClassifier
* Best Params Result:
* {'classifier': 'AdaBoostClassifier', 'features': 'Marked & transmucosal
increase in lamina propria cellularity, Crypt architecture, Epithelial changes,
Mucosal surface, Lamina propria granulomas, Patchy lamina propria cellularity?,
Mucin depletion, Submucosal granulomas', 'accuracy': [0.6666666666666666,
0.7126436781609196, 0.7572254335260116, 0.47398843930635837,
0.7109826589595376], 'avgAccuracy': 0.6643013753238988, 'f1':
[0.6782407407407407, 0.7354959663470932, 0.758206208774358, 0.6431372549019608,
0.7218893598073546], 'avgF1': 0.7073939061143014, 'precision':
[0.6666666666666666, 0.7126436781609196, 0.7572254335260116,
0.47398843930635837, 0.7109826589595376], 'avgPrecision': 0.6643013753238988,
'recall': [0.6666666666666666, 0.7126436781609196, 0.7572254335260116,
0.47398843930635837, 0.7109826589595376], 'avgRecall': 0.6643013753238988,
'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': 'Marked & transmucosal
increase in lamina propria cellularity, Crypt architecture, Epithelial changes,
Mucosal surface, Lamina propria granulomas, Patchy lamina propria cellularity?,
Mucin depletion, Submucosal granulomas', 'accuracy': [0.6494252873563219,
0.6954022988505747, 0.7052023121387283, 0.45664739884393063,
0.6647398843930635], 'avgAccuracy': 0.6342834363165238, 'f1':
[0.6616738617025865, 0.7217405838095492, 0.7059513050273538, 0.626984126984127,
0.67776995519114003], 'avgF1': 0.6788239658870033, 'precision':
[0.6494252873563219, 0.6954022988505747, 0.7052023121387283,
0.45664739884393063, 0.6647398843930635], 'avgPrecision': 0.6342834363165238,
'recall': [0.6494252873563219, 0.6954022988505747, 0.7052023121387283,
0.45664739884393063, 0.6647398843930635], 'avgRecall': 0.6342834363165238,
'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': 'Marked & transmucosal increase in lamina
propria cellularity, Crypt architecture, Epithelial changes, Mucosal surface,
Lamina propria granulomas, Patchy lamina propria cellularity?, Mucin depletion,
Submucosal granulomas', 'accuracy': [0.603448275862069, 0.632183908045977,
0.7109826589595376, 0.10404624277456648, 0.6416184971098265], 'avgAccuracy':
0.5384559165503953, 'f1': [0.6111149863635583, 0.6630212769409226,
0.7121502485409023, 0.18848167539267016, 0.6555610784635982], 'avgF1':
0.5660658531403303, 'precision': [0.603448275862069, 0.632183908045977,
0.7109826589595376, 0.10404624277456648, 0.6416184971098265], 'avgPrecision':
0.5384559165503953, 'recall': [0.603448275862069, 0.632183908045977,
0.7109826589595376, 0.10404624277456648, 0.6416184971098265], 'avgRecall':
0.5384559165503953, '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': 'Marked & transmucosal increase in
lamina propria cellularity, Crypt architecture, Epithelial changes, Mucosal
surface, Lamina propria granulomas, Patchy lamina propria cellularity?, Mucin
depletion, Submucosal granulomas', 'accuracy': [0.632183908045977,
0.6781609195402298, 0.6994219653179191, 0.24277456647398843,
0.6820809248554913], 'avgAccuracy': 0.5869244568467211, 'f1':
[0.6423519009725907, 0.7061101028433151, 0.700194554963341, 0.39069767441860465,
0.6943802691001552], 'avgF1': 0.6267469004596014, 'precision':
[0.632183908045977, 0.6781609195402298, 0.6994219653179191, 0.24277456647398843,
0.6820809248554913], 'avgPrecision': 0.5869244568467211, 'recall':
[0.632183908045977, 0.6781609195402298, 0.6994219653179191, 0.24277456647398843,
0.6820809248554913], 'avgRecall': 0.5869244568467211, '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': 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': 'AdaBoostClassifier', 'features': 'Marked & transmucosal
increase in lamina propria cellularity, Crypt architecture, Epithelial changes,
Mucosal surface, Lamina propria granulomas, Patchy lamina propria cellularity?,
Mucin depletion, Submucosal granulomas', 'accuracy': [0.6666666666666666,
0.7126436781609196, 0.7572254335260116, 0.47398843930635837,
0.7109826589595376], 'avgAccuracy': 0.6643013753238988, 'f1':
[0.6782407407407407, 0.7354959663470932, 0.758206208774358, 0.6431372549019608,
0.7218893598073546], 'avgF1': 0.7073939061143014, 'precision':
[0.6666666666666666, 0.7126436781609196, 0.7572254335260116,
0.47398843930635837, 0.7109826589595376], 'avgPrecision': 0.6643013753238988,
'recall': [0.6666666666666666, 0.7126436781609196, 0.7572254335260116,
0.47398843930635837, 0.7109826589595376], 'avgRecall': 0.6643013753238988,
'params': [{'algorithm': 'SAMME.R', 'base_estimator': None, 'learning_rate': 1,
'n_estimators': 300, 'random_state': None}]}
*****************************************************

                    model                                        features  \
0  RandomForestClassifier  Marked & transmucosal increase in lamina propr…
1     KNeighborsClassifier  Marked & transmucosal increase in lamina propr…
2       LogisticRegression  Marked & transmucosal increase in lamina propr…
3               GaussianNB  Marked & transmucosal increase in lamina propr…
4        AdaBoostClassifier  Marked & transmucosal increase in lamina propr…
5  DecisionTreeClassifier  Marked & transmucosal increase in lamina propr…
6                      SVC  Marked & transmucosal increase in lamina propr…
7            MLPClassifier  Marked & transmucosal increase in lamina propr…

   accuracy        f1  precision    recall  \
0  0.656222  0.699571   0.656222  0.656222
1  0.700226  0.729381   0.700226  0.700226
2  0.586938  0.626678   0.586938  0.586938
3  0.589011  0.538441   0.589011  0.589011
4  0.664301  0.707394   0.664301  0.664301
5  0.634283  0.678824   0.634283  0.634283
6  0.538456  0.566066   0.538456  0.538456
7  0.586924  0.626747   0.586924  0.586924

                                              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': 'Marked & transmucosal
increase in lamina propria cellularity, Crypt architecture, Epithelial changes,
Mucosal surface, Lamina propria granulomas, Patchy lamina propria cellularity?,
Mucin depletion', 'accuracy': [0.6609195402298851, 0.7126436781609196,
0.7398843930635838, 0.47398843930635837, 0.6936416184971098], 'avgAccuracy':
0.6562155338515713, 'f1': [0.6726378568767298, 0.7365278399761159,
0.7410371632538006, 0.6431372549019608, 0.70532106542510311], 'avgF1':
0.6997322360867421, 'precision': [0.6609195402298851, 0.7126436781609196,
0.7398843930635838, 0.47398843930635837, 0.6936416184971098], 'avgPrecision':
0.6562155338515713, 'recall': [0.6609195402298851, 0.7126436781609196,
0.7398843930635838, 0.47398843930635837, 0.6936416184971098], 'avgRecall':
0.6562155338515713, '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': 'Marked & transmucosal
increase in lamina propria cellularity, Crypt architecture, Epithelial changes,
Mucosal surface, Lamina propria granulomas, Patchy lamina propria cellularity?,
Mucin depletion', 'accuracy': [0.6436781609195402, 0.6896551724137931,
0.7109826589595376, 0.7803468208092486, 0.6763005780346821], 'avgAccuracy':
0.7001926782273603, 'f1': [0.656151617887214, 0.7165501994765329,
0.7120659903583504, 0.8766233766233766, 0.6889309902629832], 'avgF1':
0.7300644349216914, 'precision': [0.6436781609195402, 0.6896551724137931,
0.7109826589595376, 0.7803468208092486, 0.6763005780346821], 'avgPrecision':
0.7001926782273603, 'recall': [0.6436781609195402, 0.6896551724137931,
0.7109826589595376, 0.7803468208092486, 0.6763005780346821], 'avgRecall':
0.7001926782273603, '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': 'Marked & transmucosal
```

increase in lamina propria cellularity, Crypt architecture, Epithelial changes, Mucosal surface, Lamina propria granulomas, Patchy lamina propria cellularity?, Mucin depletion', 'accuracy': [0.6264367816091954, 0.6666666666666666, 0.7052023121387283, 0.23699421965317918, 0.6763005780346821], 'avgAccuracy': 0.5823201116204904, 'f1': [0.6363903285293359, 0.6954685099846389, 0.7049612756344981, 0.38317757009345793, 0.6888813328799728], 'avgF1': 0.6217758034243808, 'precision': [0.6264367816091954, 0.6666666666666666, 0.7052023121387283, 0.23699421965317918, 0.6763005780346821], 'avgPrecision': 0.5823201116204904, 'recall': [0.6264367816091954, 0.6666666666666666, 0.7052023121387283, 0.23699421965317918, 0.6763005780346821], 'avgRecall': 0.5823201116204904, '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': 'Marked & transmucosal increase in lamina propria cellularity, Crypt architecture, Epithelial changes, Mucosal surface, Lamina propria granulomas, Patchy lamina propria cellularity?, Mucin depletion', 'accuracy': [0.5977011494252874, 0.6666666666666666, 0.6878612716763006, 0.7745664739884393, 0.6184971098265896], 'avgAccuracy': 0.6690585343166567, 'f1': [0.609550894655765, 0.6955539179562761, 0.6892435285247549, 0.8729641693811074, 0.633339212558024], 'avgF1': 0.7001303446151854, 'precision': [0.5977011494252874, 0.6666666666666666, 0.6878612716763006, 0.7745664739884393, 0.6184971098265896], 'avgPrecision': 0.6690585343166567, 'recall': [0.5977011494252874, 0.6666666666666666, 0.6878612716763006, 0.7745664739884393, 0.6184971098265896], 'avgRecall': 0.6690585343166567, 'params': [{'priors': None, 'var_smoothing': 1e-09}]}
****

Processing Model: AdaBoostClassifier
****
* AdaBoostClassifier
* Best Params Result:
* {'classifier': 'AdaBoostClassifier', 'features': 'Marked & transmucosal increase in lamina propria cellularity, Crypt architecture, Epithelial changes, Mucosal surface, Lamina propria granulomas, Patchy lamina propria cellularity?, Mucin depletion', 'accuracy': [0.6666666666666666, 0.7126436781609196, 0.7572254335260116, 0.4797687861271676, 0.7109826589595376], 'avgAccuracy': 0.6654574446880606, 'f1': [0.6782407407407407, 0.7354959663470932, 0.758206208774358, 0.6484375, 0.7218893598073546], 'avgF1': 0.7084539551339093, 'precision': [0.6666666666666666, 0.7126436781609196, 0.7572254335260116, 0.4797687861271676, 0.7109826589595376], 'avgPrecision': 0.6654574446880606, 'recall': [0.6666666666666666, 0.7126436781609196, 0.7572254335260116,

135

0.4797687861271676, 0.7109826589595376], 'avgRecall': 0.6654574446880606, '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': 'Marked & transmucosal increase in lamina propria cellularity, Crypt architecture, Epithelial changes, Mucosal surface, Lamina propria granulomas, Patchy lamina propria cellularity?, Mucin depletion', 'accuracy': [0.6494252873563219, 0.6781609195402298, 0.7225433526011561, 0.47398843930635837, 0.6705202312138728], 'avgAccuracy': 0.6389276460035878, 'f1': [0.6617128787851937, 0.7060520587164044, 0.7233783946779984, 0.6431372549019608, 0.6828651242491945], 'avgF1': 0.6834291422661504, 'precision': [0.6494252873563219, 0.6781609195402298, 0.7225433526011561, 0.47398843930635837, 0.6705202312138728], 'avgPrecision': 0.6389276460035878, 'recall': [0.6494252873563219, 0.6781609195402298, 0.7225433526011561, 0.47398843930635837, 0.6705202312138728], 'avgRecall': 0.6389276460035878, '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': 'Marked & transmucosal increase in lamina propria cellularity, Crypt architecture, Epithelial changes, Mucosal surface, Lamina propria granulomas, Patchy lamina propria cellularity?, Mucin depletion', 'accuracy': [0.6149425287356322, 0.6724137931034483, 0.7109826589595376, 0.09248554913294797, 0.6127167630057804], 'avgAccuracy': 0.5407082585874693, 'f1': [0.6252023386379308, 0.7007868423511822, 0.7121502485409023, 0.1693121693121693, 0.626829637946328], 'avgF1': 0.5668562473577025, 'precision': [0.6149425287356322, 0.6724137931034483, 0.7109826589595376, 0.09248554913294797, 0.6127167630057804], 'avgPrecision': 0.5407082585874693, 'recall': [0.6149425287356322, 0.6724137931034483, 0.7109826589595376, 0.09248554913294797, 0.6127167630057804], 'avgRecall': 0.5407082585874693, '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': 'Marked & transmucosal increase in
lamina propria cellularity, Crypt architecture, Epithelial changes, Mucosal
surface, Lamina propria granulomas, Patchy lamina propria cellularity?, Mucin
depletion', 'accuracy': [0.6206896551724138, 0.6781609195402298,
0.7052023121387283, 0.23699421965317918, 0.6820809248554913], 'avgAccuracy':
0.5846256062720085, 'f1': [0.6303935307496151, 0.7061101028433151,
0.7049612756344981, 0.38317757009345793, 0.6943802691001552], 'avgF1':
0.6238045496842083, 'precision': [0.6206896551724138, 0.6781609195402298,
0.7052023121387283, 0.23699421965317918, 0.6820809248554913], 'avgPrecision':
0.5846256062720085, 'recall': [0.6206896551724138, 0.6781609195402298,
0.7052023121387283, 0.23699421965317918, 0.6820809248554913], 'avgRecall':
0.5846256062720085, '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': 'GaussianNB', 'features': 'Marked & transmucosal increase in
lamina propria cellularity, Crypt architecture, Epithelial changes, Mucosal
surface, Lamina propria granulomas, Patchy lamina propria cellularity?, Mucin
depletion', 'accuracy': [0.5977011494252874, 0.6666666666666666,
0.6878612716763006, 0.7745664739884393, 0.6184971098265896], 'avgAccuracy':
0.6690585343166567, 'f1': [0.609550894655765, 0.6955539179562761,
0.6892435285247549, 0.8729641693811074, 0.633339212558024], 'avgF1':
0.7001303446151854, 'precision': [0.5977011494252874, 0.6666666666666666,
0.6878612716763006, 0.7745664739884393, 0.6184971098265896], 'avgPrecision':
0.6690585343166567, 'recall': [0.5977011494252874, 0.6666666666666666,
0.6878612716763006, 0.7745664739884393, 0.6184971098265896], 'avgRecall':
0.6690585343166567, 'params': [{'priors': None, 'var_smoothing': 1e-09}]}
*******************************************************


                  model                                        features  \
0  RandomForestClassifier  Marked & transmucosal increase in lamina propr…
1    KNeighborsClassifier  Marked & transmucosal increase in lamina propr…
2      LogisticRegression  Marked & transmucosal increase in lamina propr…
3              GaussianNB  Marked & transmucosal increase in lamina propr…
4      AdaBoostClassifier  Marked & transmucosal increase in lamina propr…
5  DecisionTreeClassifier  Marked & transmucosal increase in lamina propr…
6                     SVC  Marked & transmucosal increase in lamina propr…
7           MLPClassifier  Marked & transmucosal increase in lamina propr…
```

```
   accuracy        f1  precision    recall  \
0  0.656216  0.699732   0.656216  0.656216
1  0.700193  0.730064   0.700193  0.700193
2  0.582320  0.621776   0.582320  0.582320
3  0.669059  0.700130   0.669059  0.669059
4  0.665457  0.708454   0.665457  0.665457
5  0.638928  0.683429   0.638928  0.638928
6  0.540708  0.566856   0.540708  0.540708
7  0.584626  0.623805   0.584626  0.584626


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

```
Current date and time :
2021-06-05 10:17:02
```

```python
# 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)

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': 'Marked & transmucosal
increase in lamina propria cellularity, Crypt architecture, Epithelial changes,
Mucosal surface, Lamina propria granulomas, Patchy lamina propria cellularity?,
Mucin depletion, Submucosal granulomas, Cryptitis extent, Lamina propria
polymorphs, Cryptitis polymorphs, Basal histiocytic cells, Active inflammation?,
Sex, Increased lamina propria cellularity?, Increased lymphoid aggregates in
lamina propria?, Age, Intraepithelial lymphocytes, Crypt abscesses polymorphs,
Crypt profiles, Crypt abscesses extent, Mild & superficial increase in lamina
propria cellularity?, Severity of Crypt Arch', 'accuracy': [0.7286821705426356,
0.7906976744186046, 0.7674418604651163, 0.7829457364341085, 0.6796875],
'avgAccuracy': 0.749890988372093, 'f1': [0.7163066220090751, 0.7804492770684618,
0.745016611295681, 0.7577327500191879, 0.6551259410725903], 'avgF1':
0.7309262402929992, 'precision': [0.7286821705426356, 0.7906976744186046,
0.7674418604651163, 0.7829457364341085, 0.6796875], 'avgPrecision':
0.749890988372093, 'recall': [0.7286821705426356, 0.7906976744186046,
0.7674418604651163, 0.7829457364341085, 0.6796875], 'avgRecall':
0.749890988372093, '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': 'Marked & transmucosal
increase in lamina propria cellularity, Crypt architecture, Epithelial changes,
Mucosal surface, Lamina propria granulomas, Patchy lamina propria cellularity?,
Mucin depletion, Submucosal granulomas, Cryptitis extent, Lamina propria
polymorphs, Cryptitis polymorphs, Basal histiocytic cells, Active inflammation?,
Sex, Increased lamina propria cellularity?, Increased lymphoid aggregates in
lamina propria?, Age, Intraepithelial lymphocytes, Crypt abscesses polymorphs,
Crypt profiles, Crypt abscesses extent, Mild & superficial increase in lamina
propria cellularity?, Severity of Crypt Arch', 'accuracy': [0.7131782945736435,
0.751937984496124, 0.7984496124031008, 0.7906976744186046, 0.75], 'avgAccuracy':
0.7608527131782946, 'f1': [0.6808189226793878, 0.7418047322288088,
0.7744338668752504, 0.7599524823681759, 0.7285067873303167], 'avgF1':
0.737103358296388, 'precision': [0.7131782945736435, 0.751937984496124,
0.7984496124031008, 0.7906976744186046, 0.75], 'avgPrecision':
0.7608527131782946, 'recall': [0.7131782945736435, 0.751937984496124,
0.7984496124031008, 0.7906976744186046, 0.75], 'avgRecall': 0.7608527131782946,

```
'params': [{'algorithm': 'kd_tree', 'leaf_size': 30, 'metric': 'minkowski',
'metric_params': None, 'n_jobs': -1, 'n_neighbors': 13, 'p': 2, 'weights':
'uniform'}]}
****************************************************

Processing Model: LogisticRegression
****************************************************
* LogisticRegression
* Best Params Result:
* {'classifier': 'LogisticRegression', 'features': 'Marked & transmucosal
increase in lamina propria cellularity, Crypt architecture, Epithelial changes,
Mucosal surface, Lamina propria granulomas, Patchy lamina propria cellularity?,
Mucin depletion, Submucosal granulomas, Cryptitis extent, Lamina propria
polymorphs, Cryptitis polymorphs, Basal histiocytic cells, Active inflammation?,
Sex, Increased lamina propria cellularity?, Increased lymphoid aggregates in
lamina propria?, Age, Intraepithelial lymphocytes, Crypt abscesses polymorphs,
Crypt profiles, Crypt abscesses extent, Mild & superficial increase in lamina
propria cellularity?, Severity of Crypt Arch', 'accuracy': [0.7131782945736435,
0.8217054263565892, 0.8062015503875969, 0.751937984496124, 0.71875],
'avgAccuracy': 0.7623546511627907, 'f1': [0.6808189226793878,
0.7982676420278779, 0.7697812954980905, 0.6928223031968, 0.65], 'avgF1':
0.7183380326804313, 'precision': [0.7131782945736435, 0.8217054263565892,
0.8062015503875969, 0.751937984496124, 0.71875], 'avgPrecision':
0.7623546511627907, 'recall': [0.7131782945736435, 0.8217054263565892,
0.8062015503875969, 0.751937984496124, 0.71875], 'avgRecall':
0.7623546511627907, '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': 'Marked & transmucosal increase in
lamina propria cellularity, Crypt architecture, Epithelial changes, Mucosal
surface, Lamina propria granulomas, Patchy lamina propria cellularity?, Mucin
depletion, Submucosal granulomas, Cryptitis extent, Lamina propria polymorphs,
Cryptitis polymorphs, Basal histiocytic cells, Active inflammation?, Sex,
Increased lamina propria cellularity?, Increased lymphoid aggregates in lamina
propria?, Age, Intraepithelial lymphocytes, Crypt abscesses polymorphs, Crypt
profiles, Crypt abscesses extent, Mild & superficial increase in lamina propria
cellularity?, Severity of Crypt Arch', 'accuracy': [0.689922480620155,
0.7829457364341085, 0.7829457364341085, 0.7441860465116279, 0.7421875],
'avgAccuracy': 0.7484375, 'f1': [0.6098389982110913, 0.7223269781409317,
0.7223269781409317, 0.6606878200386334, 0.6744062389223681], 'avgF1':
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0.6779174026907913, 'precision': [0.689922480620155, 0.7829457364341085, 0.7829457364341085, 0.7441860465116279, 0.7421875], 'avgPrecision': 0.7484375, 'recall': [0.689922480620155, 0.7829457364341085, 0.7829457364341085, 0.7441860465116279, 0.7421875], 'avgRecall': 0.7484375, 'params': [{'priors': None, 'var_smoothing': 1e-09}]}
****

Processing Model: AdaBoostClassifier
****
* AdaBoostClassifier
* Best Params Result:
* {'classifier': 'AdaBoostClassifier', 'features': 'Marked & transmucosal increase in lamina propria cellularity, Crypt architecture, Epithelial changes, Mucosal surface, Lamina propria granulomas, Patchy lamina propria cellularity?, Mucin depletion, Submucosal granulomas, Cryptitis extent, Lamina propria polymorphs, Cryptitis polymorphs, Basal histiocytic cells, Active inflammation?, Sex, Increased lamina propria cellularity?, Increased lymphoid aggregates in lamina propria?, Age, Intraepithelial lymphocytes, Crypt abscesses polymorphs, Crypt profiles, Crypt abscesses extent, Mild & superficial increase in lamina propria cellularity?, Severity of Crypt Arch', 'accuracy': [0.7131782945736435, 0.7751937984496124, 0.7829457364341085, 0.7906976744186046, 0.734375], 'avgAccuracy': 0.7592781007751938, 'f1': [0.6808189226793878, 0.7558764019683761, 0.7664579606440072, 0.7599524823681759, 0.7163549688302163], 'avgF1': 0.7358921472980327, 'precision': [0.7131782945736435, 0.7751937984496124, 0.7829457364341085, 0.7906976744186046, 0.734375], 'avgPrecision': 0.7592781007751938, 'recall': [0.7131782945736435, 0.7751937984496124, 0.7829457364341085, 0.7906976744186046, 0.734375], 'avgRecall': 0.7592781007751938, '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': 'Marked & transmucosal increase in lamina propria cellularity, Crypt architecture, Epithelial changes, Mucosal surface, Lamina propria granulomas, Patchy lamina propria cellularity?, Mucin depletion, Submucosal granulomas, Cryptitis extent, Lamina propria polymorphs, Cryptitis polymorphs, Basal histiocytic cells, Active inflammation?, Sex, Increased lamina propria cellularity?, Increased lymphoid aggregates in lamina propria?, Age, Intraepithelial lymphocytes, Crypt abscesses polymorphs, Crypt profiles, Crypt abscesses extent, Mild & superficial increase in lamina propria cellularity?, Severity of Crypt Arch', 'accuracy': [0.7364341085271318, 0.7286821705426356, 0.7286821705426356, 0.7209302325581395, 0.65625], 'avgAccuracy': 0.7141957364341085, 'f1': [0.7379664683612764, 0.7356029920194277, 0.7196908945104614, 0.7130246958024337, 0.6627033792240301],

'avgF1': 0.7137976859835259, 'precision': [0.7364341085271318,
0.7286821705426356, 0.7286821705426356, 0.7209302325581395, 0.65625],
'avgPrecision': 0.7141957364341085, 'recall': [0.7364341085271318,
0.7286821705426356, 0.7286821705426356, 0.7209302325581395, 0.65625],
'avgRecall': 0.7141957364341085, 'params': [{'ccp_alpha': 0.0, 'class_weight':
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'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': 'Marked & transmucosal increase in lamina
propria cellularity, Crypt architecture, Epithelial changes, Mucosal surface,
Lamina propria granulomas, Patchy lamina propria cellularity?, Mucin depletion,
Submucosal granulomas, Cryptitis extent, Lamina propria polymorphs, Cryptitis
polymorphs, Basal histiocytic cells, Active inflammation?, Sex, Increased lamina
propria cellularity?, Increased lymphoid aggregates in lamina propria?, Age,
Intraepithelial lymphocytes, Crypt abscesses polymorphs, Crypt profiles, Crypt
abscesses extent, Mild & superficial increase in lamina propria cellularity?,
Severity of Crypt Arch', 'accuracy': [0.6976744186046512, 0.7829457364341085,
0.7829457364341085, 0.7441860465116279, 0.7578125], 'avgAccuracy':
0.7531128875968992, 'f1': [0.6150153396175428, 0.7125512995896034,
0.7125512995896034, 0.6606878200386334, 0.6843761569788968], 'avgF1':
0.677036383162856, 'precision': [0.6976744186046512, 0.7829457364341085,
0.7829457364341085, 0.7441860465116279, 0.7578125], 'avgPrecision':
0.7531128875968992, 'recall': [0.6976744186046512, 0.7829457364341085,
0.7829457364341085, 0.7441860465116279, 0.7578125], 'avgRecall':
0.7531128875968992, 'params': [{'C': 1.0, 'break_ties': False, 'cache_size':
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'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': 'Marked & transmucosal increase in
lamina propria cellularity, Crypt architecture, Epithelial changes, Mucosal
surface, Lamina propria granulomas, Patchy lamina propria cellularity?, Mucin
depletion, Submucosal granulomas, Cryptitis extent, Lamina propria polymorphs,
Cryptitis polymorphs, Basal histiocytic cells, Active inflammation?, Sex,
Increased lamina propria cellularity?, Increased lymphoid aggregates in lamina

propria?, Age, Intraepithelial lymphocytes, Crypt abscesses polymorphs, Crypt profiles, Crypt abscesses extent, Mild & superficial increase in lamina propria cellularity?, Severity of Crypt Arch', 'accuracy': [0.7131782945736435, 0.8062015503875969, 0.8062015503875969, 0.7674418604651163, 0.734375], 'avgAccuracy': 0.7654796511627907, 'f1': [0.6808189226793878, 0.780725697856389, 0.7697812954980905, 0.712020909247, 0.7003205128205128], 'avgF1': 0.728733467620276, 'precision': [0.7131782945736435, 0.8062015503875969, 0.8062015503875969, 0.7674418604651163, 0.734375], 'avgPrecision': 0.7654796511627907, 'recall': [0.7131782945736435, 0.8062015503875969, 0.8062015503875969, 0.7674418604651163, 0.734375], 'avgRecall': 0.7654796511627907, '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': 'Marked & transmucosal increase in lamina propria cellularity, Crypt architecture, Epithelial changes, Mucosal surface, Lamina propria granulomas, Patchy lamina propria cellularity?, Mucin depletion, Submucosal granulomas, Cryptitis extent, Lamina propria polymorphs, Cryptitis polymorphs, Basal histiocytic cells, Active inflammation?, Sex, Increased lamina propria cellularity?, Increased lymphoid aggregates in lamina propria?, Age, Intraepithelial lymphocytes, Crypt abscesses polymorphs, Crypt profiles, Crypt abscesses extent, Mild & superficial increase in lamina propria cellularity?, Severity of Crypt Arch', 'accuracy': [0.7131782945736435, 0.8062015503875969, 0.8062015503875969, 0.7674418604651163, 0.734375], 'avgAccuracy': 0.7654796511627907, 'f1': [0.6808189226793878, 0.780725697856389, 0.7697812954980905, 0.712020909247, 0.7003205128205128], 'avgF1': 0.728733467620276, 'precision': [0.7131782945736435, 0.8062015503875969, 0.8062015503875969, 0.7674418604651163, 0.734375], 'avgPrecision': 0.7654796511627907, 'recall': [0.7131782945736435, 0.8062015503875969, 0.8062015503875969, 0.7674418604651163, 0.734375], 'avgRecall': 0.7654796511627907, '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  Marked & transmucosal increase in lamina propr…
1     KNeighborsClassifier  Marked & transmucosal increase in lamina propr…
```

```
2        LogisticRegression  Marked & transmucosal increase in lamina propr…
3                 GaussianNB  Marked & transmucosal increase in lamina propr…
4          AdaBoostClassifier  Marked & transmucosal increase in lamina propr…
5      DecisionTreeClassifier  Marked & transmucosal increase in lamina propr…
6                        SVC  Marked & transmucosal increase in lamina propr…
7              MLPClassifier  Marked & transmucosal increase in lamina propr…

   accuracy        f1  precision    recall  \
0  0.749891  0.730926   0.749891  0.749891
1  0.760853  0.737103   0.760853  0.760853
2  0.762355  0.718338   0.762355  0.762355
3  0.748437  0.677917   0.748437  0.748437
4  0.759278  0.735892   0.759278  0.759278
5  0.714196  0.713798   0.714196  0.714196
6  0.753113  0.677036   0.753113  0.753113
7  0.765480  0.728733   0.765480  0.765480

                                              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': 'Marked & transmucosal
increase in lamina propria cellularity, Crypt architecture, Epithelial changes,
Mucosal surface, Lamina propria granulomas, Patchy lamina propria cellularity?,
Mucin depletion, Submucosal granulomas, Cryptitis extent, Lamina propria
polymorphs, Cryptitis polymorphs, Basal histiocytic cells, Active inflammation?,
Sex, Increased lamina propria cellularity?, Increased lymphoid aggregates in
lamina propria?, Age, Intraepithelial lymphocytes, Crypt abscesses polymorphs,
Crypt profiles, Crypt abscesses extent, Mild & superficial increase in lamina
propria cellularity?', 'accuracy': [0.7364341085271318, 0.7984496124031008,
0.7751937984496124, 0.7674418604651163, 0.6796875], 'avgAccuracy':
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0.7602450484743948, 0.7446672012830794, 0.6551259410725903], 'avgF1':
0.733973987358489, 'precision': [0.7364341085271318, 0.7984496124031008,
0.7751937984496124, 0.7674418604651163, 0.6796875], 'avgPrecision':
0.7514413759689923, 'recall': [0.7364341085271318, 0.7984496124031008,
0.7751937984496124, 0.7674418604651163, 0.6796875], 'avgRecall':
0.7514413759689923, 'params': [{'bootstrap': True, 'ccp_alpha': 0.0,
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'class_weight': None, 'criterion': 'gini', 'max_depth': None, 'max_features':
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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': 'Marked & transmucosal
increase in lamina propria cellularity, Crypt architecture, Epithelial changes,
Mucosal surface, Lamina propria granulomas, Patchy lamina propria cellularity?,
Mucin depletion, Submucosal granulomas, Cryptitis extent, Lamina propria
polymorphs, Cryptitis polymorphs, Basal histiocytic cells, Active inflammation?,
Sex, Increased lamina propria cellularity?, Increased lymphoid aggregates in
lamina propria?, Age, Intraepithelial lymphocytes, Crypt abscesses polymorphs,
Crypt profiles, Crypt abscesses extent, Mild & superficial increase in lamina
propria cellularity?', 'accuracy': [0.7131782945736435, 0.7596899224806202,
0.8062015503875969, 0.7984496124031008, 0.75], 'avgAccuracy':
0.7655038759689923, 'f1': [0.6808189226793878, 0.7479232440415672,
0.7853697315626679, 0.7710053875124555, 0.7285067873303167], 'avgF1':
0.7427248146252791, 'precision': [0.7131782945736435, 0.7596899224806202,
0.8062015503875969, 0.7984496124031008, 0.75], 'avgPrecision':
0.7655038759689923, 'recall': [0.7131782945736435, 0.7596899224806202,
0.8062015503875969, 0.7984496124031008, 0.75], 'avgRecall': 0.7655038759689923,
'params': [{'algorithm': 'kd_tree', 'leaf_size': 30, 'metric': 'minkowski',
'metric_params': None, 'n_jobs': -1, 'n_neighbors': 13, 'p': 2, 'weights':
'uniform'}]}
*******************************************************

Processing Model: LogisticRegression
*******************************************************
* LogisticRegression
* Best Params Result:
* {'classifier': 'LogisticRegression', 'features': 'Marked & transmucosal
increase in lamina propria cellularity, Crypt architecture, Epithelial changes,
Mucosal surface, Lamina propria granulomas, Patchy lamina propria cellularity?,
Mucin depletion, Submucosal granulomas, Cryptitis extent, Lamina propria
polymorphs, Cryptitis polymorphs, Basal histiocytic cells, Active inflammation?,
Sex, Increased lamina propria cellularity?, Increased lymphoid aggregates in
lamina propria?, Age, Intraepithelial lymphocytes, Crypt abscesses polymorphs,
Crypt profiles, Crypt abscesses extent, Mild & superficial increase in lamina
propria cellularity?', 'accuracy': [0.7054263565891473, 0.8062015503875969,
0.7984496124031008, 0.7596899224806202, 0.7265625], 'avgAccuracy':
0.759265988372093, 'f1': [0.664364575992483, 0.7697812954980905,
0.7501835985312117, 0.6986158120124709, 0.6546732837055418], 'avgF1':
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0.7075237131479596, 'precision': [0.7054263565891473, 0.8062015503875969,
0.7984496124031008, 0.7596899224806202, 0.7265625], 'avgPrecision':
0.759265988372093, 'recall': [0.7054263565891473, 0.8062015503875969,
0.7984496124031008, 0.7596899224806202, 0.7265625], 'avgRecall':
0.759265988372093, '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': 'Marked & transmucosal increase in
lamina propria cellularity, Crypt architecture, Epithelial changes, Mucosal
surface, Lamina propria granulomas, Patchy lamina propria cellularity?, Mucin
depletion, Submucosal granulomas, Cryptitis extent, Lamina propria polymorphs,
Cryptitis polymorphs, Basal histiocytic cells, Active inflammation?, Sex,
Increased lamina propria cellularity?, Increased lymphoid aggregates in lamina
propria?, Age, Intraepithelial lymphocytes, Crypt abscesses polymorphs, Crypt
profiles, Crypt abscesses extent, Mild & superficial increase in lamina propria
cellularity?', 'accuracy': [0.689922480620155, 0.7829457364341085,
0.7829457364341085, 0.7441860465116279, 0.7421875], 'avgAccuracy': 0.7484375,
'f1': [0.6098389982110913, 0.7223269781409317, 0.7223269781409317,
0.6606878200386334, 0.6744062389223681], 'avgF1': 0.6779174026907913,
'precision': [0.689922480620155, 0.7829457364341085, 0.7829457364341085,
0.7441860465116279, 0.7421875], 'avgPrecision': 0.7484375, 'recall':
[0.689922480620155, 0.7829457364341085, 0.7829457364341085, 0.7441860465116279,
0.7421875], 'avgRecall': 0.7484375, 'params': [{'priors': None, 'var_smoothing':
1e-09}]}
****

Processing Model: AdaBoostClassifier
****
* AdaBoostClassifier
* Best Params Result:
* {'classifier': 'AdaBoostClassifier', 'features': 'Marked & transmucosal
increase in lamina propria cellularity, Crypt architecture, Epithelial changes,
Mucosal surface, Lamina propria granulomas, Patchy lamina propria cellularity?,
Mucin depletion, Submucosal granulomas, Cryptitis extent, Lamina propria
polymorphs, Cryptitis polymorphs, Basal histiocytic cells, Active inflammation?,
Sex, Increased lamina propria cellularity?, Increased lymphoid aggregates in
lamina propria?, Age, Intraepithelial lymphocytes, Crypt abscesses polymorphs,
Crypt profiles, Crypt abscesses extent, Mild & superficial increase in lamina
propria cellularity?', 'accuracy': [0.7364341085271318, 0.7751937984496124,
0.7906976744186046, 0.7906976744186046, 0.734375], 'avgAccuracy':
0.7654796511627907, 'f1': [0.7088378086789738, 0.7558764019683761,

0.77677987271754, 0.7599524823681759, 0.7163549688302163], 'avgF1':
0.7435603069126564, 'precision': [0.7364341085271318, 0.7751937984496124,
0.7906976744186046, 0.7906976744186046, 0.734375], 'avgPrecision':
0.7654796511627907, 'recall': [0.7364341085271318, 0.7751937984496124,
0.7906976744186046, 0.7906976744186046, 0.734375], 'avgRecall':
0.7654796511627907, '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': 'Marked & transmucosal
increase in lamina propria cellularity, Crypt architecture, Epithelial changes,
Mucosal surface, Lamina propria granulomas, Patchy lamina propria cellularity?,
Mucin depletion, Submucosal granulomas, Cryptitis extent, Lamina propria
polymorphs, Cryptitis polymorphs, Basal histiocytic cells, Active inflammation?,
Sex, Increased lamina propria cellularity?, Increased lymphoid aggregates in
lamina propria?, Age, Intraepithelial lymphocytes, Crypt abscesses polymorphs,
Crypt profiles, Crypt abscesses extent, Mild & superficial increase in lamina
propria cellularity?', 'accuracy': [0.6976744186046512, 0.7131782945736435,
0.7364341085271318, 0.7131782945736435, 0.6640625], 'avgAccuracy':
0.704905523255814, 'f1': [0.683884521667255, 0.7148013182874647,
0.7332076984763432, 0.7034509662814625, 0.6657672170761176], 'avgF1':
0.7002223443577286, 'precision': [0.6976744186046512, 0.7131782945736435,
0.7364341085271318, 0.7131782945736435, 0.6640625], 'avgPrecision':
0.704905523255814, 'recall': [0.6976744186046512, 0.7131782945736435,
0.7364341085271318, 0.7131782945736435, 0.6640625], 'avgRecall':
0.704905523255814, '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': 'Marked & transmucosal increase in lamina
propria cellularity, Crypt architecture, Epithelial changes, Mucosal surface,
Lamina propria granulomas, Patchy lamina propria cellularity?, Mucin depletion,
Submucosal granulomas, Cryptitis extent, Lamina propria polymorphs, Cryptitis
polymorphs, Basal histiocytic cells, Active inflammation?, Sex, Increased lamina
propria cellularity?, Increased lymphoid aggregates in lamina propria?, Age,
Intraepithelial lymphocytes, Crypt abscesses polymorphs, Crypt profiles, Crypt
abscesses extent, Mild & superficial increase in lamina propria cellularity?',

'accuracy': [0.6976744186046512, 0.7829457364341085, 0.7829457364341085,
0.7441860465116279, 0.7578125], 'avgAccuracy': 0.7531128875968992, 'f1':
[0.6150153396175428, 0.7125512995896034, 0.7125512995896034, 0.6606878200386334,
0.6843761569788968], 'avgF1': 0.677036383162856, 'precision':
[0.6976744186046512, 0.7829457364341085, 0.7829457364341085, 0.7441860465116279,
0.7578125], 'avgPrecision': 0.7531128875968992, 'recall': [0.6976744186046512,
0.7829457364341085, 0.7829457364341085, 0.7441860465116279, 0.7578125],
'avgRecall': 0.7531128875968992, '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': 'Marked & transmucosal increase in
lamina propria cellularity, Crypt architecture, Epithelial changes, Mucosal
surface, Lamina propria granulomas, Patchy lamina propria cellularity?, Mucin
depletion, Submucosal granulomas, Cryptitis extent, Lamina propria polymorphs,
Cryptitis polymorphs, Basal histiocytic cells, Active inflammation?, Sex,
Increased lamina propria cellularity?, Increased lymphoid aggregates in lamina
propria?, Age, Intraepithelial lymphocytes, Crypt abscesses polymorphs, Crypt
profiles, Crypt abscesses extent, Mild & superficial increase in lamina propria
cellularity?', 'accuracy': [0.7054263565891473, 0.7906976744186046,
0.813953488372093, 0.7674418604651163, 0.734375], 'avgAccuracy':
0.7623788759689922, 'f1': [0.6745834332294414, 0.7681993100876813,
0.7818383167220376, 0.712020909247, 0.7003205128205128], 'avgF1':
0.7273924964213346, 'precision': [0.7054263565891473, 0.7906976744186046,
0.813953488372093, 0.7674418604651163, 0.734375], 'avgPrecision':
0.7623788759689922, 'recall': [0.7054263565891473, 0.7906976744186046,
0.813953488372093, 0.7674418604651163, 0.734375], 'avgRecall':
0.7623788759689922, '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': 'Marked & transmucosal increase in
lamina propria cellularity, Crypt architecture, Epithelial changes, Mucosal
surface, Lamina propria granulomas, Patchy lamina propria cellularity?, Mucin
depletion, Submucosal granulomas, Cryptitis extent, Lamina propria polymorphs,

Cryptitis polymorphs, Basal histiocytic cells, Active inflammation?, Sex,
Increased lamina propria cellularity?, Increased lymphoid aggregates in lamina
propria?, Age, Intraepithelial lymphocytes, Crypt abscesses polymorphs, Crypt
profiles, Crypt abscesses extent, Mild & superficial increase in lamina propria
cellularity?', 'accuracy': [0.7054263565891473, 0.7906976744186046,
0.813953488372093, 0.7674418604651163, 0.734375], 'avgAccuracy':
0.7623788759689922, 'f1': [0.6745834332294414, 0.7681993100876813,
0.7818383167220376, 0.712020909247, 0.7003205128205128], 'avgF1':
0.7273924964213346, 'precision': [0.7054263565891473, 0.7906976744186046,
0.813953488372093, 0.7674418604651163, 0.734375], 'avgPrecision':
0.7623788759689922, 'recall': [0.7054263565891473, 0.7906976744186046,
0.813953488372093, 0.7674418604651163, 0.734375], 'avgRecall':
0.7623788759689922, '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  Marked & transmucosal increase in lamina propr…
1    KNeighborsClassifier  Marked & transmucosal increase in lamina propr…
2      LogisticRegression  Marked & transmucosal increase in lamina propr…
3              GaussianNB  Marked & transmucosal increase in lamina propr…
4      AdaBoostClassifier  Marked & transmucosal increase in lamina propr…
5  DecisionTreeClassifier  Marked & transmucosal increase in lamina propr…
6                     SVC  Marked & transmucosal increase in lamina propr…
7           MLPClassifier  Marked & transmucosal increase in lamina propr…

   accuracy        f1  precision    recall  \
0  0.751441  0.733974   0.751441  0.751441
1  0.765504  0.742725   0.765504  0.765504
2  0.759266  0.707524   0.759266  0.759266
3  0.748437  0.677917   0.748437  0.748437
4  0.765480  0.743560   0.765480  0.765480
5  0.704906  0.700222   0.704906  0.704906
6  0.753113  0.677036   0.753113  0.753113
7  0.762379  0.727392   0.762379  0.762379

                                              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': 'Marked & transmucosal
increase in lamina propria cellularity, Crypt architecture, Epithelial changes,
Mucosal surface, Lamina propria granulomas, Patchy lamina propria cellularity?,
Mucin depletion, Submucosal granulomas, Cryptitis extent, Lamina propria
polymorphs, Cryptitis polymorphs, Basal histiocytic cells, Active inflammation?,
Sex, Increased lamina propria cellularity?, Increased lymphoid aggregates in
lamina propria?, Age, Intraepithelial lymphocytes, Crypt abscesses polymorphs,
Crypt profiles, Crypt abscesses extent', 'accuracy': [0.7364341085271318,
0.8062015503875969, 0.7829457364341085, 0.7751937984496124, 0.6875],
'avgAccuracy': 0.7576550387596899, 'f1': [0.7198911429985156,
0.7933146969606852, 0.762015503875969, 0.7511767965557768, 0.6662999633296663],
'avgF1': 0.7385396207441226, 'precision': [0.7364341085271318,
0.8062015503875969, 0.7829457364341085, 0.7751937984496124, 0.6875],
'avgPrecision': 0.7576550387596899, 'recall': [0.7364341085271318,
0.8062015503875969, 0.7829457364341085, 0.7751937984496124, 0.6875],
'avgRecall': 0.7576550387596899, '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': 'Marked & transmucosal
increase in lamina propria cellularity, Crypt architecture, Epithelial changes,
Mucosal surface, Lamina propria granulomas, Patchy lamina propria cellularity?,
Mucin depletion, Submucosal granulomas, Cryptitis extent, Lamina propria
polymorphs, Cryptitis polymorphs, Basal histiocytic cells, Active inflammation?,
Sex, Increased lamina propria cellularity?, Increased lymphoid aggregates in
lamina propria?, Age, Intraepithelial lymphocytes, Crypt abscesses polymorphs,
Crypt profiles, Crypt abscesses extent', 'accuracy': [0.7131782945736435,
0.7596899224806202, 0.8062015503875969, 0.7984496124031008, 0.75],
'avgAccuracy': 0.7655038759689923, 'f1': [0.6808189226793878,
0.7479232440415672, 0.7853697315626679, 0.7710053875124555, 0.7285067873303167],
'avgF1': 0.7427248146252791, 'precision': [0.7131782945736435,
0.7596899224806202, 0.8062015503875969, 0.7984496124031008, 0.75],

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'avgPrecision': 0.7655038759689923, 'recall': [0.7131782945736435, 0.7596899224806202, 0.8062015503875969, 0.7984496124031008, 0.75], 'avgRecall': 0.7655038759689923, 'params': [{'algorithm': 'kd_tree', 'leaf_size': 30, 'metric': 'minkowski', 'metric_params': None, 'n_jobs': -1, 'n_neighbors': 13, 'p': 2, 'weights': 'uniform'}]}
****

Processing Model: LogisticRegression
****
* LogisticRegression
* Best Params Result:
* {'classifier': 'LogisticRegression', 'features': 'Marked & transmucosal increase in lamina propria cellularity, Crypt architecture, Epithelial changes, Mucosal surface, Lamina propria granulomas, Patchy lamina propria cellularity?, Mucin depletion, Submucosal granulomas, Cryptitis extent, Lamina propria polymorphs, Cryptitis polymorphs, Basal histiocytic cells, Active inflammation?, Sex, Increased lamina propria cellularity?, Increased lymphoid aggregates in lamina propria?, Age, Intraepithelial lymphocytes, Crypt abscesses polymorphs, Crypt profiles, Crypt abscesses extent', 'accuracy': [0.7054263565891473, 0.8062015503875969, 0.7984496124031008, 0.7596899224806202, 0.7265625], 'avgAccuracy': 0.759265988372093, 'f1': [0.664364575992483, 0.7697812954980905, 0.7501835985312117, 0.6986158120124709, 0.6546732837055418], 'avgF1': 0.7075237131479596, 'precision': [0.7054263565891473, 0.8062015503875969, 0.7984496124031008, 0.7596899224806202, 0.7265625], 'avgPrecision': 0.759265988372093, 'recall': [0.7054263565891473, 0.8062015503875969, 0.7984496124031008, 0.7596899224806202, 0.7265625], 'avgRecall': 0.759265988372093, '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': 'Marked & transmucosal increase in lamina propria cellularity, Crypt architecture, Epithelial changes, Mucosal surface, Lamina propria granulomas, Patchy lamina propria cellularity?, Mucin depletion, Submucosal granulomas, Cryptitis extent, Lamina propria polymorphs, Cryptitis polymorphs, Basal histiocytic cells, Active inflammation?, Sex, Increased lamina propria cellularity?, Increased lymphoid aggregates in lamina propria?, Age, Intraepithelial lymphocytes, Crypt abscesses polymorphs, Crypt profiles, Crypt abscesses extent', 'accuracy': [0.6976744186046512, 0.7829457364341085, 0.7829457364341085, 0.7441860465116279, 0.7578125], 'avgAccuracy': 0.7531128875968992, 'f1': [0.6150153396175428, 0.7223269781409317, 0.7223269781409317, 0.6606878200386334, 0.6843761569788968], 'avgF1': 0.6809466545833873, 'precision': [0.6976744186046512,

0.7829457364341085, 0.7829457364341085, 0.7441860465116279, 0.7578125],
'avgPrecision': 0.7531128875968992, 'recall': [0.6976744186046512,
0.7829457364341085, 0.7829457364341085, 0.7441860465116279, 0.7578125],
'avgRecall': 0.7531128875968992, 'params': [{'priors': None, 'var_smoothing':
1e-09}]}
****

Processing Model: AdaBoostClassifier
****
* AdaBoostClassifier
* Best Params Result:
* {'classifier': 'AdaBoostClassifier', 'features': 'Marked & transmucosal
increase in lamina propria cellularity, Crypt architecture, Epithelial changes,
Mucosal surface, Lamina propria granulomas, Patchy lamina propria cellularity?,
Mucin depletion, Submucosal granulomas, Cryptitis extent, Lamina propria
polymorphs, Cryptitis polymorphs, Basal histiocytic cells, Active inflammation?,
Sex, Increased lamina propria cellularity?, Increased lymphoid aggregates in
lamina propria?, Age, Intraepithelial lymphocytes, Crypt abscesses polymorphs,
Crypt profiles, Crypt abscesses extent', 'accuracy': [0.7364341085271318,
0.7751937984496124, 0.7906976744186046, 0.7906976744186046, 0.734375],
'avgAccuracy': 0.7654796511627907, 'f1': [0.7088378086789738,
0.7558764019683761, 0.77677987271754, 0.7599524823681759, 0.7163549688302163],
'avgF1': 0.7435603069126564, 'precision': [0.7364341085271318,
0.7751937984496124, 0.7906976744186046, 0.7906976744186046, 0.734375],
'avgPrecision': 0.7654796511627907, 'recall': [0.7364341085271318,
0.7751937984496124, 0.7906976744186046, 0.7906976744186046, 0.734375],
'avgRecall': 0.7654796511627907, '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': 'Marked & transmucosal
increase in lamina propria cellularity, Crypt architecture, Epithelial changes,
Mucosal surface, Lamina propria granulomas, Patchy lamina propria cellularity?,
Mucin depletion, Submucosal granulomas, Cryptitis extent, Lamina propria
polymorphs, Cryptitis polymorphs, Basal histiocytic cells, Active inflammation?,
Sex, Increased lamina propria cellularity?, Increased lymphoid aggregates in
lamina propria?, Age, Intraepithelial lymphocytes, Crypt abscesses polymorphs,
Crypt profiles, Crypt abscesses extent', 'accuracy': [0.7209302325581395,
0.7054263565891473, 0.689922480620155, 0.7829457364341085, 0.640625],
'avgAccuracy': 0.7079699612403101, 'f1': [0.7170891037366083,
0.7115949412610886, 0.6899224806201549, 0.7715825541436906, 0.640625], 'avgF1':
0.7061628159523085, 'precision': [0.7209302325581395, 0.7054263565891473,
0.689922480620155, 0.7829457364341085, 0.640625], 'avgPrecision':

0.7079699612403101, 'recall': [0.7209302325581395, 0.7054263565891473, 0.689922480620155, 0.7829457364341085, 0.640625], 'avgRecall': 0.7079699612403101, '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': 'Marked & transmucosal increase in lamina propria cellularity, Crypt architecture, Epithelial changes, Mucosal surface, Lamina propria granulomas, Patchy lamina propria cellularity?, Mucin depletion, Submucosal granulomas, Cryptitis extent, Lamina propria polymorphs, Cryptitis polymorphs, Basal histiocytic cells, Active inflammation?, Sex, Increased lamina propria cellularity?, Increased lymphoid aggregates in lamina propria?, Age, Intraepithelial lymphocytes, Crypt abscesses polymorphs, Crypt profiles, Crypt abscesses extent', 'accuracy': [0.6976744186046512, 0.7829457364341085, 0.7829457364341085, 0.7441860465116279, 0.765625], 'avgAccuracy': 0.7546753875968992, 'f1': [0.6150153396175428, 0.7125512995896034, 0.7125512995896034, 0.6606878200386334, 0.6893939393939393], 'avgF1': 0.6780399396458645, 'precision': [0.6976744186046512, 0.7829457364341085, 0.7829457364341085, 0.7441860465116279, 0.765625], 'avgPrecision': 0.7546753875968992, 'recall': [0.6976744186046512, 0.7829457364341085, 0.7829457364341085, 0.7441860465116279, 0.765625], 'avgRecall': 0.7546753875968992, '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': 'Marked & transmucosal increase in lamina propria cellularity, Crypt architecture, Epithelial changes, Mucosal surface, Lamina propria granulomas, Patchy lamina propria cellularity?, Mucin depletion, Submucosal granulomas, Cryptitis extent, Lamina propria polymorphs, Cryptitis polymorphs, Basal histiocytic cells, Active inflammation?, Sex, Increased lamina propria cellularity?, Increased lymphoid aggregates in lamina propria?, Age, Intraepithelial lymphocytes, Crypt abscesses polymorphs, Crypt profiles, Crypt abscesses extent', 'accuracy': [0.7131782945736435, 0.813953488372093, 0.813953488372093, 0.7674418604651163, 0.734375],

'avgAccuracy': 0.7685804263565892, 'f1': [0.6808189226793878,
0.7870818596747744, 0.7818383167220376, 0.712020909247, 0.6865351629502573],
'avgF1': 0.7296590342546915, 'precision': [0.7131782945736435,
0.813953488372093, 0.813953488372093, 0.7674418604651163, 0.734375],
'avgPrecision': 0.7685804263565892, 'recall': [0.7131782945736435,
0.813953488372093, 0.813953488372093, 0.7674418604651163, 0.734375],
'avgRecall': 0.7685804263565892, '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': 'MLPClassifier', 'features': 'Marked & transmucosal increase in
lamina propria cellularity, Crypt architecture, Epithelial changes, Mucosal
surface, Lamina propria granulomas, Patchy lamina propria cellularity?, Mucin
depletion, Submucosal granulomas, Cryptitis extent, Lamina propria polymorphs,
Cryptitis polymorphs, Basal histiocytic cells, Active inflammation?, Sex,
Increased lamina propria cellularity?, Increased lymphoid aggregates in lamina
propria?, Age, Intraepithelial lymphocytes, Crypt abscesses polymorphs, Crypt
profiles, Crypt abscesses extent', 'accuracy': [0.7131782945736435,
0.813953488372093, 0.813953488372093, 0.7674418604651163, 0.734375],
'avgAccuracy': 0.7685804263565892, 'f1': [0.6808189226793878,
0.7870818596747744, 0.7818383167220376, 0.712020909247, 0.6865351629502573],
'avgF1': 0.7296590342546915, 'precision': [0.7131782945736435,
0.813953488372093, 0.813953488372093, 0.7674418604651163, 0.734375],
'avgPrecision': 0.7685804263565892, 'recall': [0.7131782945736435,
0.813953488372093, 0.813953488372093, 0.7674418604651163, 0.734375],
'avgRecall': 0.7685804263565892, '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}]}
****

                  model   features \
0 RandomForestClassifier Marked & transmucosal increase in lamina propr…
1   KNeighborsClassifier Marked & transmucosal increase in lamina propr…
2   LogisticRegression Marked & transmucosal increase in lamina propr…
3   GaussianNB Marked & transmucosal increase in lamina propr…
4   AdaBoostClassifier Marked & transmucosal increase in lamina propr…
5 DecisionTreeClassifier Marked & transmucosal increase in lamina propr…
6   SVC Marked & transmucosal increase in lamina propr…

```
7              MLPClassifier  Marked & transmucosal increase in lamina propr…


   accuracy        f1  precision    recall  \
0  0.757655  0.738540   0.757655  0.757655
1  0.765504  0.742725   0.765504  0.765504
2  0.759266  0.707524   0.759266  0.759266
3  0.753113  0.680947   0.753113  0.753113
4  0.765480  0.743560   0.765480  0.765480
5  0.707970  0.706163   0.707970  0.707970
6  0.754675  0.678040   0.754675  0.754675
7  0.768580  0.729659   0.768580  0.768580


                                                 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': 'Marked & transmucosal
increase in lamina propria cellularity, Crypt architecture, Epithelial changes,
Mucosal surface, Lamina propria granulomas, Patchy lamina propria cellularity?,
Mucin depletion, Submucosal granulomas, Cryptitis extent, Lamina propria
polymorphs, Cryptitis polymorphs, Basal histiocytic cells, Active inflammation?,
Sex, Increased lamina propria cellularity?, Increased lymphoid aggregates in
lamina propria?, Age, Intraepithelial lymphocytes, Crypt abscesses polymorphs,
Crypt profiles', 'accuracy': [0.7596899224806202, 0.7906976744186046,
0.7829457364341085, 0.7751937984496124, 0.6796875], 'avgAccuracy':
0.7576429263565891, 'f1': [0.748728722350895, 0.77677987271754,
0.762015503875969, 0.7550893344663139, 0.6606512890094979], 'avgF1':
0.7406529444840432, 'precision': [0.7596899224806202, 0.7906976744186046,
0.7829457364341085, 0.7751937984496124, 0.6796875], 'avgPrecision':
0.7576429263565891, 'recall': [0.7596899224806202, 0.7906976744186046,
0.7829457364341085, 0.7751937984496124, 0.6796875], 'avgRecall':
0.7576429263565891, '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': 'Marked & transmucosal
increase in lamina propria cellularity, Crypt architecture, Epithelial changes,
Mucosal surface, Lamina propria granulomas, Patchy lamina propria cellularity?,
Mucin depletion, Submucosal granulomas, Cryptitis extent, Lamina propria
polymorphs, Cryptitis polymorphs, Basal histiocytic cells, Active inflammation?,
Sex, Increased lamina propria cellularity?, Increased lymphoid aggregates in
lamina propria?, Age, Intraepithelial lymphocytes, Crypt abscesses polymorphs,
Crypt profiles', 'accuracy': [0.7209302325581395, 0.7596899224806202,
0.8062015503875969, 0.7906976744186046, 0.7421875], 'avgAccuracy':
0.7639413759689923, 'f1': [0.6870799332486183, 0.751726220852123,
0.7853697315626679, 0.7599524823681759, 0.7268656716417911], 'avgF1':
0.7421988079346752, 'precision': [0.7209302325581395, 0.7596899224806202,
0.8062015503875969, 0.7906976744186046, 0.7421875], 'avgPrecision':
0.7639413759689923, 'recall': [0.7209302325581395, 0.7596899224806202,
0.8062015503875969, 0.7906976744186046, 0.7421875], 'avgRecall':
0.7639413759689923, 'params': [{'algorithm': 'kd_tree', 'leaf_size': 30,
'metric': 'minkowski', 'metric_params': None, 'n_jobs': -1, 'n_neighbors': 13,
'p': 2, 'weights': 'uniform'}]}
****

Processing Model: LogisticRegression
****
* LogisticRegression
* Best Params Result:
* {'classifier': 'LogisticRegression', 'features': 'Marked & transmucosal
increase in lamina propria cellularity, Crypt architecture, Epithelial changes,
Mucosal surface, Lamina propria granulomas, Patchy lamina propria cellularity?,
Mucin depletion, Submucosal granulomas, Cryptitis extent, Lamina propria
polymorphs, Cryptitis polymorphs, Basal histiocytic cells, Active inflammation?,
Sex, Increased lamina propria cellularity?, Increased lymphoid aggregates in
lamina propria?, Age, Intraepithelial lymphocytes, Crypt abscesses polymorphs,
Crypt profiles', 'accuracy': [0.7054263565891473, 0.8062015503875969,
0.813953488372093, 0.7596899224806202, 0.7421875], 'avgAccuracy':
0.7654917635658914, 'f1': [0.664364575992483, 0.7697812954980905,
0.7694002447980417, 0.6986158120124709, 0.6836642087351106], 'avgF1':
0.7171652274072393, 'precision': [0.7054263565891473, 0.8062015503875969,
0.813953488372093, 0.7596899224806202, 0.7421875], 'avgPrecision':
0.7654917635658914, 'recall': [0.7054263565891473, 0.8062015503875969,
0.813953488372093, 0.7596899224806202, 0.7421875], 'avgRecall':
0.7654917635658914, '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': 'Marked & transmucosal increase in
lamina propria cellularity, Crypt architecture, Epithelial changes, Mucosal
surface, Lamina propria granulomas, Patchy lamina propria cellularity?, Mucin
depletion, Submucosal granulomas, Cryptitis extent, Lamina propria polymorphs,
Cryptitis polymorphs, Basal histiocytic cells, Active inflammation?, Sex,
Increased lamina propria cellularity?, Increased lymphoid aggregates in lamina
propria?, Age, Intraepithelial lymphocytes, Crypt abscesses polymorphs, Crypt
profiles', 'accuracy': [0.6976744186046512, 0.7829457364341085,
0.7829457364341085, 0.7441860465116279, 0.7578125], 'avgAccuracy':
0.7531128875968992, 'f1': [0.6150153396175428, 0.7223269781409317,
0.7223269781409317, 0.6606878200386334, 0.6843761569788968], 'avgF1':
0.6809466545833873, 'precision': [0.6976744186046512, 0.7829457364341085,
0.7829457364341085, 0.7441860465116279, 0.7578125], 'avgPrecision':
0.7531128875968992, 'recall': [0.6976744186046512, 0.7829457364341085,
0.7829457364341085, 0.7441860465116279, 0.7578125], 'avgRecall':
0.7531128875968992, 'params': [{'priors': None, 'var_smoothing': 1e-09}]}
**************************************************

Processing Model: AdaBoostClassifier
**************************************************
* AdaBoostClassifier
* Best Params Result:
* {'classifier': 'AdaBoostClassifier', 'features': 'Marked & transmucosal
increase in lamina propria cellularity, Crypt architecture, Epithelial changes,
Mucosal surface, Lamina propria granulomas, Patchy lamina propria cellularity?,
Mucin depletion, Submucosal granulomas, Cryptitis extent, Lamina propria
polymorphs, Cryptitis polymorphs, Basal histiocytic cells, Active inflammation?,
Sex, Increased lamina propria cellularity?, Increased lymphoid aggregates in
lamina propria?, Age, Intraepithelial lymphocytes, Crypt abscesses polymorphs,
Crypt profiles', 'accuracy': [0.7596899224806202, 0.8449612403100775,
0.7829457364341085, 0.7596899224806202, 0.7109375], 'avgAccuracy':
0.7716448643410853, 'f1': [0.7431053760679646, 0.8331842576028622,
0.762015503875969, 0.7340165756285891, 0.6982720620647096], 'avgF1':
0.7541187550480188, 'precision': [0.7596899224806202, 0.8449612403100775,
0.7829457364341085, 0.7596899224806202, 0.7109375], 'avgPrecision':
0.7716448643410853, 'recall': [0.7596899224806202, 0.8449612403100775,
0.7829457364341085, 0.7596899224806202, 0.7109375], 'avgRecall':
0.7716448643410853, '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': 'Marked & transmucosal
increase in lamina propria cellularity, Crypt architecture, Epithelial changes,
Mucosal surface, Lamina propria granulomas, Patchy lamina propria cellularity?,
Mucin depletion, Submucosal granulomas, Cryptitis extent, Lamina propria
polymorphs, Cryptitis polymorphs, Basal histiocytic cells, Active inflammation?,
Sex, Increased lamina propria cellularity?, Increased lymphoid aggregates in
lamina propria?, Age, Intraepithelial lymphocytes, Crypt abscesses polymorphs,
Crypt profiles', 'accuracy': [0.7674418604651163, 0.7286821705426356,
0.7054263565891473, 0.7286821705426356, 0.671875], 'avgAccuracy':
0.720421511627907, 'f1': [0.764240919780507, 0.733055058636454,
0.7142133544749825, 0.7224406745808836, 0.6598746081504703], 'avgF1':
0.7187649231246594, 'precision': [0.7674418604651163, 0.7286821705426356,
0.7054263565891473, 0.7286821705426356, 0.671875], 'avgPrecision':
0.720421511627907, 'recall': [0.7674418604651163, 0.7286821705426356,
0.7054263565891473, 0.7286821705426356, 0.671875], 'avgRecall':
0.720421511627907, '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': 'Marked & transmucosal increase in lamina
propria cellularity, Crypt architecture, Epithelial changes, Mucosal surface,
Lamina propria granulomas, Patchy lamina propria cellularity?, Mucin depletion,
Submucosal granulomas, Cryptitis extent, Lamina propria polymorphs, Cryptitis
polymorphs, Basal histiocytic cells, Active inflammation?, Sex, Increased lamina
propria cellularity?, Increased lymphoid aggregates in lamina propria?, Age,
Intraepithelial lymphocytes, Crypt abscesses polymorphs, Crypt profiles',
'accuracy': [0.6976744186046512, 0.7829457364341085, 0.7829457364341085,
0.7441860465116279, 0.765625], 'avgAccuracy': 0.7546753875968992, 'f1':
[0.6150153396175428, 0.7125512995896034, 0.7125512995896034, 0.6606878200386334,
0.6893939393939393], 'avgF1': 0.6780399396458645, 'precision':
[0.6976744186046512, 0.7829457364341085, 0.7829457364341085, 0.7441860465116279,
0.765625], 'avgPrecision': 0.7546753875968992, 'recall': [0.6976744186046512,
0.7829457364341085, 0.7829457364341085, 0.7441860465116279, 0.765625],
'avgRecall': 0.7546753875968992, '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}]}
```

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

Processing Model: MLPClassifier
****************************************************
* MLPClassifier
* Best Params Result:
* {'classifier': 'MLPClassifier', 'features': 'Marked & transmucosal increase in
lamina propria cellularity, Crypt architecture, Epithelial changes, Mucosal
surface, Lamina propria granulomas, Patchy lamina propria cellularity?, Mucin
depletion, Submucosal granulomas, Cryptitis extent, Lamina propria polymorphs,
Cryptitis polymorphs, Basal histiocytic cells, Active inflammation?, Sex,
Increased lamina propria cellularity?, Increased lymphoid aggregates in lamina
propria?, Age, Intraepithelial lymphocytes, Crypt abscesses polymorphs, Crypt
profiles', 'accuracy': [0.7131782945736435, 0.813953488372093,
0.813953488372093, 0.7674418604651163, 0.7421875], 'avgAccuracy':
0.7701429263565892, 'f1': [0.6808189226793878, 0.7870818596747744,
0.7818383167220376, 0.7188538205980066, 0.6919423517851294], 'avgF1':
0.7321070542918672, 'precision': [0.7131782945736435, 0.813953488372093,
0.813953488372093, 0.7674418604651163, 0.7421875], 'avgPrecision':
0.7701429263565892, 'recall': [0.7131782945736435, 0.813953488372093,
0.813953488372093, 0.7674418604651163, 0.7421875], 'avgRecall':
0.7701429263565892, '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': 'MLPClassifier', 'features': 'Marked & transmucosal increase in
lamina propria cellularity, Crypt architecture, Epithelial changes, Mucosal
surface, Lamina propria granulomas, Patchy lamina propria cellularity?, Mucin
depletion, Submucosal granulomas, Cryptitis extent, Lamina propria polymorphs,
Cryptitis polymorphs, Basal histiocytic cells, Active inflammation?, Sex,
Increased lamina propria cellularity?, Increased lymphoid aggregates in lamina
propria?, Age, Intraepithelial lymphocytes, Crypt abscesses polymorphs, Crypt
profiles', 'accuracy': [0.7131782945736435, 0.813953488372093,
0.813953488372093, 0.7674418604651163, 0.7421875], 'avgAccuracy':
0.7701429263565892, 'f1': [0.6808189226793878, 0.7870818596747744,
0.7818383167220376, 0.7188538205980066, 0.6919423517851294], 'avgF1':
0.7321070542918672, 'precision': [0.7131782945736435, 0.813953488372093,
0.813953488372093, 0.7674418604651163, 0.7421875], 'avgPrecision':
0.7701429263565892, 'recall': [0.7131782945736435, 0.813953488372093,
0.813953488372093, 0.7674418604651163, 0.7421875], 'avgRecall':
0.7701429263565892, '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}]}
*******************************************************
```

	model	features \
0	RandomForestClassifier	Marked & transmucosal increase in lamina propr…
1	KNeighborsClassifier	Marked & transmucosal increase in lamina propr…
2	LogisticRegression	Marked & transmucosal increase in lamina propr…
3	GaussianNB	Marked & transmucosal increase in lamina propr…
4	AdaBoostClassifier	Marked & transmucosal increase in lamina propr…
5	DecisionTreeClassifier	Marked & transmucosal increase in lamina propr…
6	SVC	Marked & transmucosal increase in lamina propr…
7	MLPClassifier	Marked & transmucosal increase in lamina propr…

	accuracy	f1	precision	recall \
0	0.757643	0.740653	0.757643	0.757643
1	0.763941	0.742199	0.763941	0.763941
2	0.765492	0.717165	0.765492	0.765492
3	0.753113	0.680947	0.753113	0.753113
4	0.771645	0.754119	0.771645	0.771645
5	0.720422	0.718765	0.720422	0.720422
6	0.754675	0.678040	0.754675	0.754675
7	0.770143	0.732107	0.770143	0.770143

	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': 'identity', 'alpha': 0.0001, 'b…

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

'accuracy': [0.751937984496124, 0.7829457364341085, 0.7829457364341085,
0.7674418604651163, 0.6796875], 'avgAccuracy': 0.7529917635658915, 'f1':
[0.7392681503709261, 0.7704639005158309, 0.762015503875969, 0.7446672012830794,
0.6606512890094979], 'avgF1': 0.7354132090110607, 'precision':
[0.751937984496124, 0.7829457364341085, 0.7829457364341085, 0.7674418604651163,
0.6796875], 'avgPrecision': 0.7529917635658915, 'recall': [0.751937984496124,
0.7829457364341085, 0.7829457364341085, 0.7674418604651163, 0.6796875],
'avgRecall': 0.7529917635658915, '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': 'Marked & transmucosal
increase in lamina propria cellularity, Crypt architecture, Epithelial changes,
Mucosal surface, Lamina propria granulomas, Patchy lamina propria cellularity?,
Mucin depletion, Submucosal granulomas, Cryptitis extent, Lamina propria
polymorphs, Cryptitis polymorphs, Basal histiocytic cells, Active inflammation?,
Sex, Increased lamina propria cellularity?, Increased lymphoid aggregates in
lamina propria?, Age, Intraepithelial lymphocytes, Crypt abscesses polymorphs',
'accuracy': [0.7209302325581395, 0.751937984496124, 0.8062015503875969,
0.7984496124031008, 0.75], 'avgAccuracy': 0.7655038759689923, 'f1':
[0.6870799332486183, 0.7455346863590013, 0.7853697315626679, 0.7710053875124555,
0.733039970663733], 'avgF1': 0.7444059418692952, 'precision':
[0.7209302325581395, 0.751937984496124, 0.8062015503875969, 0.7984496124031008,
0.75], 'avgPrecision': 0.7655038759689923, 'recall': [0.7209302325581395,
0.751937984496124, 0.8062015503875969, 0.7984496124031008, 0.75], 'avgRecall':
0.7655038759689923, 'params': [{'algorithm': 'ball_tree', 'leaf_size': 30,
'metric': 'minkowski', 'metric_params': None, 'n_jobs': -1, 'n_neighbors': 13,
'p': 2, 'weights': 'uniform'}]}
****

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

Sex, Increased lamina propria cellularity?, Increased lymphoid aggregates in
lamina propria?, Age, Intraepithelial lymphocytes, Crypt abscesses polymorphs',
'accuracy': [0.7054263565891473, 0.813953488372093, 0.813953488372093,
0.7596899224806202, 0.7421875], 'avgAccuracy': 0.7670421511627907, 'f1':
[0.664364575992483, 0.7818383167220376, 0.7694002447980417, 0.6986158120124709,
0.6836642087351106], 'avgF1': 0.7195766316520288, 'precision':
[0.7054263565891473, 0.813953488372093, 0.813953488372093, 0.7596899224806202,
0.7421875], 'avgPrecision': 0.7670421511627907, 'recall': [0.7054263565891473,
0.813953488372093, 0.813953488372093, 0.7596899224806202, 0.7421875],
'avgRecall': 0.7670421511627907, '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': 'Marked & transmucosal increase in
lamina propria cellularity, Crypt architecture, Epithelial changes, Mucosal
surface, Lamina propria granulomas, Patchy lamina propria cellularity?, Mucin
depletion, Submucosal granulomas, Cryptitis extent, Lamina propria polymorphs,
Cryptitis polymorphs, Basal histiocytic cells, Active inflammation?, Sex,
Increased lamina propria cellularity?, Increased lymphoid aggregates in lamina
propria?, Age, Intraepithelial lymphocytes, Crypt abscesses polymorphs',
'accuracy': [0.6976744186046512, 0.7829457364341085, 0.7906976744186046,
0.7441860465116279, 0.7578125], 'avgAccuracy': 0.7546632751937984, 'f1':
[0.6150153396175428, 0.7223269781409317, 0.7276790369917914, 0.6606878200386334,
0.6843761569788968], 'avgF1': 0.6820170663535592, 'precision':
[0.6976744186046512, 0.7829457364341085, 0.7906976744186046, 0.7441860465116279,
0.7578125], 'avgPrecision': 0.7546632751937984, 'recall': [0.6976744186046512,
0.7829457364341085, 0.7906976744186046, 0.7441860465116279, 0.7578125],
'avgRecall': 0.7546632751937984, 'params': [{'priors': None, 'var_smoothing':
1e-09}]}
****

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

lamina propria?, Age, Intraepithelial lymphocytes, Crypt abscesses polymorphs',
'accuracy': [0.7596899224806202, 0.8062015503875969, 0.7906976744186046,
0.7829457364341085, 0.734375], 'avgAccuracy': 0.774781976744186, 'f1':
[0.7363964147673029, 0.7895486223865311, 0.7727125121774536, 0.7486206876588453,
0.7163549688302163], 'avgF1': 0.7527266411640698, 'precision':
[0.7596899224806202, 0.8062015503875969, 0.7906976744186046, 0.7829457364341085,
0.734375], 'avgPrecision': 0.774781976744186, 'recall': [0.7596899224806202,
0.8062015503875969, 0.7906976744186046, 0.7829457364341085, 0.734375],
'avgRecall': 0.774781976744186, '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': 'Marked & transmucosal
increase in lamina propria cellularity, Crypt architecture, Epithelial changes,
Mucosal surface, Lamina propria granulomas, Patchy lamina propria cellularity?,
Mucin depletion, Submucosal granulomas, Cryptitis extent, Lamina propria
polymorphs, Cryptitis polymorphs, Basal histiocytic cells, Active inflammation?,
Sex, Increased lamina propria cellularity?, Increased lymphoid aggregates in
lamina propria?, Age, Intraepithelial lymphocytes, Crypt abscesses polymorphs',
'accuracy': [0.7054263565891473, 0.7286821705426356, 0.7441860465116279,
0.7364341085271318, 0.6171875], 'avgAccuracy': 0.7063832364341085, 'f1':
[0.7013718317219756, 0.733055058636454, 0.7426608802784123, 0.7259513742071881,
0.622719734660033], 'avgF1': 0.7051517759008126, 'precision':
[0.7054263565891473, 0.7286821705426356, 0.7441860465116279, 0.7364341085271318,
0.6171875], 'avgPrecision': 0.7063832364341085, 'recall': [0.7054263565891473,
0.7286821705426356, 0.7441860465116279, 0.7364341085271318, 0.6171875],
'avgRecall': 0.7063832364341085, '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': 'Marked & transmucosal increase in lamina
propria cellularity, Crypt architecture, Epithelial changes, Mucosal surface,
Lamina propria granulomas, Patchy lamina propria cellularity?, Mucin depletion,
Submucosal granulomas, Cryptitis extent, Lamina propria polymorphs, Cryptitis
polymorphs, Basal histiocytic cells, Active inflammation?, Sex, Increased lamina
propria cellularity?, Increased lymphoid aggregates in lamina propria?, Age,

Intraepithelial lymphocytes, Crypt abscesses polymorphs', 'accuracy':
[0.6976744186046512, 0.7829457364341085, 0.7829457364341085, 0.7441860465116279,
0.765625], 'avgAccuracy': 0.7546753875968992, 'f1': [0.6150153396175428,
0.7125512995896034, 0.7125512995896034, 0.6606878200386334, 0.6893939393939393],
'avgF1': 0.6780399396458645, 'precision': [0.6976744186046512,
0.7829457364341085, 0.7829457364341085, 0.7441860465116279, 0.765625],
'avgPrecision': 0.7546753875968992, 'recall': [0.6976744186046512,
0.7829457364341085, 0.7829457364341085, 0.7441860465116279, 0.765625],
'avgRecall': 0.7546753875968992, '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': 'Marked & transmucosal increase in
lamina propria cellularity, Crypt architecture, Epithelial changes, Mucosal
surface, Lamina propria granulomas, Patchy lamina propria cellularity?, Mucin
depletion, Submucosal granulomas, Cryptitis extent, Lamina propria polymorphs,
Cryptitis polymorphs, Basal histiocytic cells, Active inflammation?, Sex,
Increased lamina propria cellularity?, Increased lymphoid aggregates in lamina
propria?, Age, Intraepithelial lymphocytes, Crypt abscesses polymorphs',
'accuracy': [0.7131782945736435, 0.7906976744186046, 0.8217054263565892,
0.7674418604651163, 0.7421875], 'avgAccuracy': 0.7670421511627907, 'f1':
[0.6808189226793878, 0.7681993100876813, 0.7881987918582434, 0.7188538205980066,
0.6919423517851294], 'avgF1': 0.7296026394016897, 'precision':
[0.7131782945736435, 0.7906976744186046, 0.8217054263565892, 0.7674418604651163,
0.7421875], 'avgPrecision': 0.7670421511627907, 'recall': [0.7131782945736435,
0.7906976744186046, 0.8217054263565892, 0.7674418604651163, 0.7421875],
'avgRecall': 0.7670421511627907, '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': 'MLPClassifier', 'features': 'Marked & transmucosal increase in
lamina propria cellularity, Crypt architecture, Epithelial changes, Mucosal
surface, Lamina propria granulomas, Patchy lamina propria cellularity?, Mucin
depletion, Submucosal granulomas, Cryptitis extent, Lamina propria polymorphs,
Cryptitis polymorphs, Basal histiocytic cells, Active inflammation?, Sex,

Increased lamina propria cellularity?, Increased lymphoid aggregates in lamina
propria?, Age, Intraepithelial lymphocytes, Crypt abscesses polymorphs',
'accuracy': [0.7131782945736435, 0.7906976744186046, 0.8217054263565892,
0.7674418604651163, 0.7421875], 'avgAccuracy': 0.7670421511627907, 'f1':
[0.6808189226793878, 0.7681993100876813, 0.7881987918582434, 0.7188538205980066,
0.6919423517851294], 'avgF1': 0.7296026394016897, 'precision':
[0.7131782945736435, 0.7906976744186046, 0.8217054263565892, 0.7674418604651163,
0.7421875], 'avgPrecision': 0.7670421511627907, 'recall': [0.7131782945736435,
0.7906976744186046, 0.8217054263565892, 0.7674418604651163, 0.7421875],
'avgRecall': 0.7670421511627907, '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}]}
****

	model	features \
0	RandomForestClassifier	Marked & transmucosal increase in lamina propr…
1	KNeighborsClassifier	Marked & transmucosal increase in lamina propr…
2	LogisticRegression	Marked & transmucosal increase in lamina propr…
3	GaussianNB	Marked & transmucosal increase in lamina propr…
4	AdaBoostClassifier	Marked & transmucosal increase in lamina propr…
5	DecisionTreeClassifier	Marked & transmucosal increase in lamina propr…
6	SVC	Marked & transmucosal increase in lamina propr…
7	MLPClassifier	Marked & transmucosal increase in lamina propr…

	accuracy	f1	precision	recall \
0	0.752992	0.735413	0.752992	0.752992
1	0.765504	0.744406	0.765504	0.765504
2	0.767042	0.719577	0.767042	0.767042
3	0.754663	0.682017	0.754663	0.754663
4	0.774782	0.752727	0.774782	0.774782
5	0.706383	0.705152	0.706383	0.706383
6	0.754675	0.678040	0.754675	0.754675
7	0.767042	0.729603	0.767042	0.767042

	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': 'Marked & transmucosal
increase in lamina propria cellularity, Crypt architecture, Epithelial changes,
Mucosal surface, Lamina propria granulomas, Patchy lamina propria cellularity?,
Mucin depletion, Submucosal granulomas, Cryptitis extent, Lamina propria
polymorphs, Cryptitis polymorphs, Basal histiocytic cells, Active inflammation?,
Sex, Increased lamina propria cellularity?, Increased lymphoid aggregates in
lamina propria?, Age, Intraepithelial lymphocytes', 'accuracy':
[0.7596899224806202, 0.7984496124031008, 0.7596899224806202, 0.751937984496124,
0.6953125], 'avgAccuracy': 0.753015988372093, 'f1': [0.748728722350895,
0.7902163449359072, 0.7437102242312496, 0.7276450147019514, 0.6772048846675713],
'avgF1': 0.7375010381775149, 'precision': [0.7596899224806202,
0.7984496124031008, 0.7596899224806202, 0.751937984496124, 0.6953125],
'avgPrecision': 0.753015988372093, 'recall': [0.7596899224806202,
0.7984496124031008, 0.7596899224806202, 0.751937984496124, 0.6953125],
'avgRecall': 0.753015988372093, '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': 'Marked & transmucosal
increase in lamina propria cellularity, Crypt architecture, Epithelial changes,
Mucosal surface, Lamina propria granulomas, Patchy lamina propria cellularity?,
Mucin depletion, Submucosal granulomas, Cryptitis extent, Lamina propria
polymorphs, Cryptitis polymorphs, Basal histiocytic cells, Active inflammation?,
Sex, Increased lamina propria cellularity?, Increased lymphoid aggregates in
lamina propria?, Age, Intraepithelial lymphocytes', 'accuracy':
[0.7441860465116279, 0.7596899224806202, 0.8062015503875969, 0.7984496124031008,
0.7421875], 'avgAccuracy': 0.7701429263565891, 'f1': [0.7108921276253989,
0.751726220852123, 0.780725697856389, 0.7710053875124555, 0.7224184403754995],
'avgF1': 0.7473535748443731, 'precision': [0.7441860465116279,
0.7596899224806202, 0.8062015503875969, 0.7984496124031008, 0.7421875],
'avgPrecision': 0.7701429263565891, 'recall': [0.7441860465116279,
0.7596899224806202, 0.8062015503875969, 0.7984496124031008, 0.7421875],
'avgRecall': 0.7701429263565891, 'params': [{'algorithm': 'ball_tree',
'leaf_size': 30, 'metric': 'minkowski', 'metric_params': None, 'n_jobs': -1,
'n_neighbors': 13, 'p': 2, 'weights': 'uniform'}]}
********************************************************
```

```
Processing Model: LogisticRegression
*****************************************************
* LogisticRegression
* Best Params Result:
* {'classifier': 'LogisticRegression', 'features': 'Marked & transmucosal
increase in lamina propria cellularity, Crypt architecture, Epithelial changes,
Mucosal surface, Lamina propria granulomas, Patchy lamina propria cellularity?,
Mucin depletion, Submucosal granulomas, Cryptitis extent, Lamina propria
polymorphs, Cryptitis polymorphs, Basal histiocytic cells, Active inflammation?,
Sex, Increased lamina propria cellularity?, Increased lymphoid aggregates in
lamina propria?, Age, Intraepithelial lymphocytes', 'accuracy':
[0.7209302325581395, 0.8217054263565892, 0.813953488372093, 0.751937984496124,
0.7421875], 'avgAccuracy': 0.7701429263565891, 'f1': [0.6765196471531675,
0.7982676420278779, 0.7694002447980417, 0.6928223031968, 0.6993680884676144],
'avgF1': 0.7272755851287003, 'precision': [0.7209302325581395,
0.8217054263565892, 0.813953488372093, 0.751937984496124, 0.7421875],
'avgPrecision': 0.7701429263565891, 'recall': [0.7209302325581395,
0.8217054263565892, 0.813953488372093, 0.751937984496124, 0.7421875],
'avgRecall': 0.7701429263565891, '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': 'Marked & transmucosal increase in
lamina propria cellularity, Crypt architecture, Epithelial changes, Mucosal
surface, Lamina propria granulomas, Patchy lamina propria cellularity?, Mucin
depletion, Submucosal granulomas, Cryptitis extent, Lamina propria polymorphs,
Cryptitis polymorphs, Basal histiocytic cells, Active inflammation?, Sex,
Increased lamina propria cellularity?, Increased lymphoid aggregates in lamina
propria?, Age, Intraepithelial lymphocytes', 'accuracy': [0.6976744186046512,
0.7829457364341085, 0.7906976744186046, 0.7441860465116279, 0.7578125],
'avgAccuracy': 0.7546632751937984, 'f1': [0.6150153396175428,
0.7223269781409317, 0.7276790369917914, 0.6606878200386334, 0.6843761569788968],
'avgF1': 0.6820170663535592, 'precision': [0.6976744186046512,
0.7829457364341085, 0.7906976744186046, 0.7441860465116279, 0.7578125],
'avgPrecision': 0.7546632751937984, 'recall': [0.6976744186046512,
0.7829457364341085, 0.7906976744186046, 0.7441860465116279, 0.7578125],
'avgRecall': 0.7546632751937984, 'params': [{'priors': None, 'var_smoothing':
1e-09}]}
*****************************************************
```

Processing Model: AdaBoostClassifier
****
* AdaBoostClassifier
* Best Params Result:
* {'classifier': 'AdaBoostClassifier', 'features': 'Marked & transmucosal
increase in lamina propria cellularity, Crypt architecture, Epithelial changes,
Mucosal surface, Lamina propria granulomas, Patchy lamina propria cellularity?,
Mucin depletion, Submucosal granulomas, Cryptitis extent, Lamina propria
polymorphs, Cryptitis polymorphs, Basal histiocytic cells, Active inflammation?,
Sex, Increased lamina propria cellularity?, Increased lymphoid aggregates in
lamina propria?, Age, Intraepithelial lymphocytes', 'accuracy':
[0.7596899224806202, 0.8449612403100775, 0.7674418604651163, 0.751937984496124,
0.7265625], 'avgAccuracy': 0.7701187015503876, 'f1': [0.7534136170908624,
0.8331842576028622, 0.7579419364645084, 0.7276450147019514, 0.7003825920612148],
'avgF1': 0.7545134835842798, 'precision': [0.7596899224806202,
0.8449612403100775, 0.7674418604651163, 0.751937984496124, 0.7265625],
'avgPrecision': 0.7701187015503876, 'recall': [0.7596899224806202,
0.8449612403100775, 0.7674418604651163, 0.751937984496124, 0.7265625],
'avgRecall': 0.7701187015503876, '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': 'Marked & transmucosal
increase in lamina propria cellularity, Crypt architecture, Epithelial changes,
Mucosal surface, Lamina propria granulomas, Patchy lamina propria cellularity?,
Mucin depletion, Submucosal granulomas, Cryptitis extent, Lamina propria
polymorphs, Cryptitis polymorphs, Basal histiocytic cells, Active inflammation?,
Sex, Increased lamina propria cellularity?, Increased lymphoid aggregates in
lamina propria?, Age, Intraepithelial lymphocytes', 'accuracy':
[0.7054263565891473, 0.7441860465116279, 0.7441860465116279, 0.7751937984496124,
0.640625], 'avgAccuracy': 0.7219234496124031, 'f1': [0.7035077089671531,
0.7483090552857994, 0.7357085576812923, 0.7586565027709453, 0.6366810774858664],
'avgF1': 0.7165725804382113, 'precision': [0.7054263565891473,
0.7441860465116279, 0.7441860465116279, 0.7751937984496124, 0.640625],
'avgPrecision': 0.7219234496124031, 'recall': [0.7054263565891473,
0.7441860465116279, 0.7441860465116279, 0.7751937984496124, 0.640625],
'avgRecall': 0.7219234496124031, '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': 'Marked & transmucosal increase in lamina
propria cellularity, Crypt architecture, Epithelial changes, Mucosal surface,
Lamina propria granulomas, Patchy lamina propria cellularity?, Mucin depletion,
Submucosal granulomas, Cryptitis extent, Lamina propria polymorphs, Cryptitis
polymorphs, Basal histiocytic cells, Active inflammation?, Sex, Increased lamina
propria cellularity?, Increased lymphoid aggregates in lamina propria?, Age,
Intraepithelial lymphocytes', 'accuracy': [0.6976744186046512,
0.7829457364341085, 0.7829457364341085, 0.7441860465116279, 0.765625],
'avgAccuracy': 0.7546753875968992, 'f1': [0.6150153396175428,
0.7125512995896034, 0.7125512995896034, 0.6606878200386334, 0.6893939393939393],
'avgF1': 0.6780399396458645, 'precision': [0.6976744186046512,
0.7829457364341085, 0.7829457364341085, 0.7441860465116279, 0.765625],
'avgPrecision': 0.7546753875968992, 'recall': [0.6976744186046512,
0.7829457364341085, 0.7829457364341085, 0.7441860465116279, 0.765625],
'avgRecall': 0.7546753875968992, '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': 'Marked & transmucosal increase in
lamina propria cellularity, Crypt architecture, Epithelial changes, Mucosal
surface, Lamina propria granulomas, Patchy lamina propria cellularity?, Mucin
depletion, Submucosal granulomas, Cryptitis extent, Lamina propria polymorphs,
Cryptitis polymorphs, Basal histiocytic cells, Active inflammation?, Sex,
Increased lamina propria cellularity?, Increased lymphoid aggregates in lamina
propria?, Age, Intraepithelial lymphocytes', 'accuracy': [0.7364341085271318,
0.813953488372093, 0.8217054263565892, 0.7674418604651163, 0.7421875],
'avgAccuracy': 0.776344476744186, 'f1': [0.7044643814014727, 0.7998211091234347,
0.7822514111141063, 0.712020909247, 0.6993680884676144], 'avgF1':
0.7395851798707257, 'precision': [0.7364341085271318, 0.813953488372093,
0.8217054263565892, 0.7674418604651163, 0.7421875], 'avgPrecision':
0.776344476744186, 'recall': [0.7364341085271318, 0.813953488372093,
0.8217054263565892, 0.7674418604651163, 0.7421875], 'avgRecall':
0.776344476744186, '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,

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'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': 'Marked & transmucosal increase in
lamina propria cellularity, Crypt architecture, Epithelial changes, Mucosal
surface, Lamina propria granulomas, Patchy lamina propria cellularity?, Mucin
depletion, Submucosal granulomas, Cryptitis extent, Lamina propria polymorphs,
Cryptitis polymorphs, Basal histiocytic cells, Active inflammation?, Sex,
Increased lamina propria cellularity?, Increased lymphoid aggregates in lamina
propria?, Age, Intraepithelial lymphocytes', 'accuracy': [0.7364341085271318,
0.813953488372093, 0.8217054263565892, 0.7674418604651163, 0.7421875],
'avgAccuracy': 0.776344476744186, 'f1': [0.7044643814014727, 0.7998211091234347,
0.7822514111141063, 0.712020909247, 0.6993680884676144], 'avgF1':
0.7395851798707257, 'precision': [0.7364341085271318, 0.813953488372093,
0.8217054263565892, 0.7674418604651163, 0.7421875], 'avgPrecision':
0.776344476744186, 'recall': [0.7364341085271318, 0.813953488372093,
0.8217054263565892, 0.7674418604651163, 0.7421875], 'avgRecall':
0.776344476744186, '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}]}
****************************************************
```

	model	features \
0	RandomForestClassifier	Marked & transmucosal increase in lamina propr…
1	KNeighborsClassifier	Marked & transmucosal increase in lamina propr…
2	LogisticRegression	Marked & transmucosal increase in lamina propr…
3	GaussianNB	Marked & transmucosal increase in lamina propr…
4	AdaBoostClassifier	Marked & transmucosal increase in lamina propr…
5	DecisionTreeClassifier	Marked & transmucosal increase in lamina propr…
6	SVC	Marked & transmucosal increase in lamina propr…
7	MLPClassifier	Marked & transmucosal increase in lamina propr…

	accuracy	f1	precision	recall \
0	0.753016	0.737501	0.753016	0.753016
1	0.770143	0.747354	0.770143	0.770143
2	0.770143	0.727276	0.770143	0.770143
3	0.754663	0.682017	0.754663	0.754663
4	0.770119	0.754513	0.770119	0.770119
5	0.721923	0.716573	0.721923	0.721923
6	0.754675	0.678040	0.754675	0.754675
7	0.776344	0.739585	0.776344	0.776344

```
                                                            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': 'Marked & transmucosal increase in lamina propria cellularity, Crypt architecture, Epithelial changes, Mucosal surface, Lamina propria granulomas, Patchy lamina propria cellularity?, Mucin depletion, Submucosal granulomas, Cryptitis extent, Lamina propria polymorphs, Cryptitis polymorphs, Basal histiocytic cells, Active inflammation?, Sex, Increased lamina propria cellularity?, Increased lymphoid aggregates in lamina propria?, Age', 'accuracy': [0.7364341085271318, 0.7984496124031008, 0.7751937984496124, 0.7596899224806202, 0.6953125], 'avgAccuracy': 0.753015988372093, 'f1': [0.7257877189626429, 0.7902163449359072, 0.7641862605550145, 0.738198943739853, 0.6719490658983177], 'avgF1': 0.738067666818347, 'precision': [0.7364341085271318, 0.7984496124031008, 0.7751937984496124, 0.7596899224806202, 0.6953125], 'avgPrecision': 0.753015988372093, 'recall': [0.7364341085271318, 0.7984496124031008, 0.7751937984496124, 0.7596899224806202, 0.6953125], 'avgRecall': 0.753015988372093, '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': 'Marked & transmucosal increase in lamina propria cellularity, Crypt architecture, Epithelial changes, Mucosal surface, Lamina propria granulomas, Patchy lamina propria cellularity?, Mucin depletion, Submucosal granulomas, Cryptitis extent, Lamina propria polymorphs, Cryptitis polymorphs, Basal histiocytic cells, Active inflammation?, Sex, Increased lamina propria cellularity?, Increased lymphoid aggregates in lamina propria?, Age', 'accuracy': [0.7441860465116279, 0.7596899224806202, 0.7984496124031008, 0.7984496124031008, 0.75], 'avgAccuracy':

0.7701550387596899, 'f1': [0.7108921276253989, 0.751726220852123,
0.7790143964562569, 0.7665763528260706, 0.733039970663733], 'avgF1':
0.7482498136847165, 'precision': [0.7441860465116279, 0.7596899224806202,
0.7984496124031008, 0.7984496124031008, 0.75], 'avgPrecision':
0.7701550387596899, 'recall': [0.7441860465116279, 0.7596899224806202,
0.7984496124031008, 0.7984496124031008, 0.75], 'avgRecall': 0.7701550387596899,
'params': [{'algorithm': 'auto', 'leaf_size': 30, 'metric': 'minkowski',
'metric_params': None, 'n_jobs': -1, 'n_neighbors': 13, 'p': 2, 'weights':
'uniform'}]}
****

Processing Model: LogisticRegression
****
* LogisticRegression
* Best Params Result:
* {'classifier': 'LogisticRegression', 'features': 'Marked & transmucosal
increase in lamina propria cellularity, Crypt architecture, Epithelial changes,
Mucosal surface, Lamina propria granulomas, Patchy lamina propria cellularity?,
Mucin depletion, Submucosal granulomas, Cryptitis extent, Lamina propria
polymorphs, Cryptitis polymorphs, Basal histiocytic cells, Active inflammation?,
Sex, Increased lamina propria cellularity?, Increased lymphoid aggregates in
lamina propria?, Age', 'accuracy': [0.7131782945736435, 0.8217054263565892,
0.813953488372093, 0.751937984496124, 0.7421875], 'avgAccuracy':
0.7685925387596899, 'f1': [0.6704274228850202, 0.7982676420278779,
0.7694002447980417, 0.6928223031968, 0.6993680884676144], 'avgF1':
0.7260571402750708, 'precision': [0.7131782945736435, 0.8217054263565892,
0.813953488372093, 0.751937984496124, 0.7421875], 'avgPrecision':
0.7685925387596899, 'recall': [0.7131782945736435, 0.8217054263565892,
0.813953488372093, 0.751937984496124, 0.7421875], 'avgRecall':
0.7685925387596899, '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': 'Marked & transmucosal increase in
lamina propria cellularity, Crypt architecture, Epithelial changes, Mucosal
surface, Lamina propria granulomas, Patchy lamina propria cellularity?, Mucin
depletion, Submucosal granulomas, Cryptitis extent, Lamina propria polymorphs,
Cryptitis polymorphs, Basal histiocytic cells, Active inflammation?, Sex,
Increased lamina propria cellularity?, Increased lymphoid aggregates in lamina
propria?, Age', 'accuracy': [0.6976744186046512, 0.7906976744186046,
0.7829457364341085, 0.7441860465116279, 0.765625], 'avgAccuracy':

0.7562257751937984, 'f1': [0.6150153396175428, 0.7276790369917914,
0.7125512995896034, 0.6606878200386334, 0.6893939393939393], 'avgF1':
0.6810654871263021, 'precision': [0.6976744186046512, 0.7906976744186046,
0.7829457364341085, 0.7441860465116279, 0.765625], 'avgPrecision':
0.7562257751937984, 'recall': [0.6976744186046512, 0.7906976744186046,
0.7829457364341085, 0.7441860465116279, 0.765625], 'avgRecall':
0.7562257751937984, 'params': [{'priors': None, 'var_smoothing': 1e-09}]}
****

Processing Model: AdaBoostClassifier
****
* AdaBoostClassifier
* Best Params Result:
* {'classifier': 'AdaBoostClassifier', 'features': 'Marked & transmucosal
increase in lamina propria cellularity, Crypt architecture, Epithelial changes,
Mucosal surface, Lamina propria granulomas, Patchy lamina propria cellularity?,
Mucin depletion, Submucosal granulomas, Cryptitis extent, Lamina propria
polymorphs, Cryptitis polymorphs, Basal histiocytic cells, Active inflammation?,
Sex, Increased lamina propria cellularity?, Increased lymphoid aggregates in
lamina propria?, Age', 'accuracy': [0.751937984496124, 0.8449612403100775,
0.7751937984496124, 0.7286821705426356, 0.734375], 'avgAccuracy':
0.7670300387596899, 'f1': [0.7465315046710396, 0.8331842576028622,
0.7677438840229539, 0.7044181622869307, 0.7062135922330097], 'avgF1':
0.7516182801633592, 'precision': [0.751937984496124, 0.8449612403100775,
0.7751937984496124, 0.7286821705426356, 0.734375], 'avgPrecision':
0.7670300387596899, 'recall': [0.751937984496124, 0.8449612403100775,
0.7751937984496124, 0.7286821705426356, 0.734375], 'avgRecall':
0.7670300387596899, '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': 'Marked & transmucosal
increase in lamina propria cellularity, Crypt architecture, Epithelial changes,
Mucosal surface, Lamina propria granulomas, Patchy lamina propria cellularity?,
Mucin depletion, Submucosal granulomas, Cryptitis extent, Lamina propria
polymorphs, Cryptitis polymorphs, Basal histiocytic cells, Active inflammation?,
Sex, Increased lamina propria cellularity?, Increased lymphoid aggregates in
lamina propria?, Age', 'accuracy': [0.7286821705426356, 0.7751937984496124,
0.7286821705426356, 0.6744186046511628, 0.671875], 'avgAccuracy':
0.7157703488372092, 'f1': [0.7215960192961348, 0.7788170485844904,
0.7302174632448992, 0.6685799109351804, 0.6682740272697041], 'avgF1':
0.7134968938660818, 'precision': [0.7286821705426356, 0.7751937984496124,
0.7286821705426356, 0.6744186046511628, 0.671875], 'avgPrecision':
0.7157703488372092, 'recall': [0.7286821705426356, 0.7751937984496124,

0.7286821705426356, 0.6744186046511628, 0.671875], 'avgRecall':
0.7157703488372092, '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': 'Marked & transmucosal increase in lamina
propria cellularity, Crypt architecture, Epithelial changes, Mucosal surface,
Lamina propria granulomas, Patchy lamina propria cellularity?, Mucin depletion,
Submucosal granulomas, Cryptitis extent, Lamina propria polymorphs, Cryptitis
polymorphs, Basal histiocytic cells, Active inflammation?, Sex, Increased lamina
propria cellularity?, Increased lymphoid aggregates in lamina propria?, Age',
'accuracy': [0.6976744186046512, 0.7829457364341085, 0.7829457364341085,
0.7441860465116279, 0.765625], 'avgAccuracy': 0.7546753875968992, 'f1':
[0.6150153396175428, 0.7125512995896034, 0.7125512995896034, 0.6606878200386334,
0.6893939393939393], 'avgF1': 0.6780399396458645, 'precision':
[0.6976744186046512, 0.7829457364341085, 0.7829457364341085, 0.7441860465116279,
0.765625], 'avgPrecision': 0.7546753875968992, 'recall': [0.6976744186046512,
0.7829457364341085, 0.7829457364341085, 0.7441860465116279, 0.765625],
'avgRecall': 0.7546753875968992, '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': 'Marked & transmucosal increase in
lamina propria cellularity, Crypt architecture, Epithelial changes, Mucosal
surface, Lamina propria granulomas, Patchy lamina propria cellularity?, Mucin
depletion, Submucosal granulomas, Cryptitis extent, Lamina propria polymorphs,
Cryptitis polymorphs, Basal histiocytic cells, Active inflammation?, Sex,
Increased lamina propria cellularity?, Increased lymphoid aggregates in lamina
propria?, Age', 'accuracy': [0.7364341085271318, 0.7984496124031008,
0.8294573643410853, 0.7596899224806202, 0.7421875], 'avgAccuracy':
0.7732437015503876, 'f1': [0.7044643814014727, 0.7790143964562569,
0.7946447621079583, 0.6986158120124709, 0.6993680884676144], 'avgF1':
0.7352214880891547, 'precision': [0.7364341085271318, 0.7984496124031008,
0.8294573643410853, 0.7596899224806202, 0.7421875], 'avgPrecision':

0.7732437015503876, 'recall': [0.7364341085271318, 0.7984496124031008,
0.8294573643410853, 0.7596899224806202, 0.7421875], 'avgRecall':
0.7732437015503876, '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': 'Marked & transmucosal increase in
lamina propria cellularity, Crypt architecture, Epithelial changes, Mucosal
surface, Lamina propria granulomas, Patchy lamina propria cellularity?, Mucin
depletion, Submucosal granulomas, Cryptitis extent, Lamina propria polymorphs,
Cryptitis polymorphs, Basal histiocytic cells, Active inflammation?, Sex,
Increased lamina propria cellularity?, Increased lymphoid aggregates in lamina
propria?, Age', 'accuracy': [0.7364341085271318, 0.7984496124031008,
0.8294573643410853, 0.7596899224806202, 0.7421875], 'avgAccuracy':
0.7732437015503876, 'f1': [0.7044643814014727, 0.7790143964562569,
0.7946447621079583, 0.6986158120124709, 0.6993680884676144], 'avgF1':
0.7352214880891547, 'precision': [0.7364341085271318, 0.7984496124031008,
0.8294573643410853, 0.7596899224806202, 0.7421875], 'avgPrecision':
0.7732437015503876, 'recall': [0.7364341085271318, 0.7984496124031008,
0.8294573643410853, 0.7596899224806202, 0.7421875], 'avgRecall':
0.7732437015503876, '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  Marked & transmucosal increase in lamina propr…
1     KNeighborsClassifier  Marked & transmucosal increase in lamina propr…
2       LogisticRegression  Marked & transmucosal increase in lamina propr…
3               GaussianNB  Marked & transmucosal increase in lamina propr…
4        AdaBoostClassifier  Marked & transmucosal increase in lamina propr…
5  DecisionTreeClassifier  Marked & transmucosal increase in lamina propr…
6                      SVC  Marked & transmucosal increase in lamina propr…
7            MLPClassifier  Marked & transmucosal increase in lamina propr…

   accuracy       f1  precision    recall  \
0  0.753016  0.738068   0.753016  0.753016
1  0.770155  0.748250   0.770155  0.770155
```

```
2   0.768593   0.726057    0.768593   0.768593
3   0.756226   0.681065    0.756226   0.756226
4   0.767030   0.751618    0.767030   0.767030
5   0.715770   0.713497    0.715770   0.715770
6   0.754675   0.678040    0.754675   0.754675
7   0.773244   0.735221    0.773244   0.773244


                                                    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': 'Marked & transmucosal
increase in lamina propria cellularity, Crypt architecture, Epithelial changes,
Mucosal surface, Lamina propria granulomas, Patchy lamina propria cellularity?,
Mucin depletion, Submucosal granulomas, Cryptitis extent, Lamina propria
polymorphs, Cryptitis polymorphs, Basal histiocytic cells, Active inflammation?,
Sex, Increased lamina propria cellularity?, Increased lymphoid aggregates in
lamina propria?', 'accuracy': [0.7054263565891473, 0.751937984496124,
0.7596899224806202, 0.7286821705426356, 0.703125], 'avgAccuracy':
0.7297722868217055, 'f1': [0.664364575992483, 0.751937984496124,
0.7145288064176323, 0.6888272919587466, 0.687857142857143], 'avgF1':
0.7015031603444257, 'precision': [0.7054263565891473, 0.751937984496124,
0.7596899224806202, 0.7286821705426356, 0.703125], 'avgPrecision':
0.7297722868217055, 'recall': [0.7054263565891473, 0.751937984496124,
0.7596899224806202, 0.7286821705426356, 0.703125], 'avgRecall':
0.7297722868217055, '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': 'Marked & transmucosal

increase in lamina propria cellularity, Crypt architecture, Epithelial changes,
Mucosal surface, Lamina propria granulomas, Patchy lamina propria cellularity?,
Mucin depletion, Submucosal granulomas, Cryptitis extent, Lamina propria
polymorphs, Cryptitis polymorphs, Basal histiocytic cells, Active inflammation?,
Sex, Increased lamina propria cellularity?, Increased lymphoid aggregates in
lamina propria?', 'accuracy': [0.6976744186046512, 0.7286821705426356,
0.7674418604651163, 0.8372093023255814, 0.6953125], 'avgAccuracy':
0.7452640503875969, 'f1': [0.658327059920926, 0.733055058636454,
0.7579419364645084, 0.825234019247926, 0.6661406025824965], 'avgF1':
0.7281397353704622, 'precision': [0.6976744186046512, 0.7286821705426356,
0.7674418604651163, 0.8372093023255814, 0.6953125], 'avgPrecision':
0.7452640503875969, 'recall': [0.6976744186046512, 0.7286821705426356,
0.7674418604651163, 0.8372093023255814, 0.6953125], 'avgRecall':
0.7452640503875969, 'params': [{'algorithm': 'ball_tree', 'leaf_size': 30,
'metric': 'minkowski', 'metric_params': None, 'n_jobs': -1, 'n_neighbors': 12,
'p': 2, 'weights': 'uniform'}]}
****

Processing Model: LogisticRegression
****
* LogisticRegression
* Best Params Result:
* {'classifier': 'LogisticRegression', 'features': 'Marked & transmucosal
increase in lamina propria cellularity, Crypt architecture, Epithelial changes,
Mucosal surface, Lamina propria granulomas, Patchy lamina propria cellularity?,
Mucin depletion, Submucosal granulomas, Cryptitis extent, Lamina propria
polymorphs, Cryptitis polymorphs, Basal histiocytic cells, Active inflammation?,
Sex, Increased lamina propria cellularity?, Increased lymphoid aggregates in
lamina propria?', 'accuracy': [0.7209302325581395, 0.7906976744186046,
0.7984496124031008, 0.751937984496124, 0.7578125], 'avgAccuracy':
0.7639656007751938, 'f1': [0.6705042597282984, 0.7443820913078638,
0.7421607654165794, 0.6928223031968, 0.6941391941391942], 'avgF1':
0.7088017227577472, 'precision': [0.7209302325581395, 0.7906976744186046,
0.7984496124031008, 0.751937984496124, 0.7578125], 'avgPrecision':
0.7639656007751938, 'recall': [0.7209302325581395, 0.7906976744186046,
0.7984496124031008, 0.751937984496124, 0.7578125], 'avgRecall':
0.7639656007751938, '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': 'Marked & transmucosal increase in

lamina propria cellularity, Crypt architecture, Epithelial changes, Mucosal
surface, Lamina propria granulomas, Patchy lamina propria cellularity?, Mucin
depletion, Submucosal granulomas, Cryptitis extent, Lamina propria polymorphs,
Cryptitis polymorphs, Basal histiocytic cells, Active inflammation?, Sex,
Increased lamina propria cellularity?, Increased lymphoid aggregates in lamina
propria?', 'accuracy': [0.6976744186046512, 0.7906976744186046,
0.7829457364341085, 0.7441860465116279, 0.765625], 'avgAccuracy':
0.7562257751937984, 'f1': [0.6150153396175428, 0.7276790369917914,
0.7125512995896034, 0.6606878200386334, 0.6893939393939393], 'avgF1':
0.6810654871263021, 'precision': [0.6976744186046512, 0.7906976744186046,
0.7829457364341085, 0.7441860465116279, 0.765625], 'avgPrecision':
0.7562257751937984, 'recall': [0.6976744186046512, 0.7906976744186046,
0.7829457364341085, 0.7441860465116279, 0.765625], 'avgRecall':
0.7562257751937984, 'params': [{'priors': None, 'var_smoothing': 1e-09}]}
****

Processing Model: AdaBoostClassifier
****
* AdaBoostClassifier
* Best Params Result:
* {'classifier': 'AdaBoostClassifier', 'features': 'Marked & transmucosal
increase in lamina propria cellularity, Crypt architecture, Epithelial changes,
Mucosal surface, Lamina propria granulomas, Patchy lamina propria cellularity?,
Mucin depletion, Submucosal granulomas, Cryptitis extent, Lamina propria
polymorphs, Cryptitis polymorphs, Basal histiocytic cells, Active inflammation?,
Sex, Increased lamina propria cellularity?, Increased lymphoid aggregates in
lamina propria?', 'accuracy': [0.6976744186046512, 0.7906976744186046,
0.7906976744186046, 0.7209302325581395, 0.703125], 'avgAccuracy': 0.740625,
'f1': [0.6683696830943487, 0.7443820913078638, 0.7276790369917914,
0.6700536672629696, 0.6776018099547512], 'avgF1': 0.697617257722345,
'precision': [0.6976744186046512, 0.7906976744186046, 0.7906976744186046,
0.7209302325581395, 0.703125], 'avgPrecision': 0.740625, 'recall':
[0.6976744186046512, 0.7906976744186046, 0.7906976744186046, 0.7209302325581395,
0.703125], 'avgRecall': 0.740625, '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': 'Marked & transmucosal
increase in lamina propria cellularity, Crypt architecture, Epithelial changes,
Mucosal surface, Lamina propria granulomas, Patchy lamina propria cellularity?,
Mucin depletion, Submucosal granulomas, Cryptitis extent, Lamina propria
polymorphs, Cryptitis polymorphs, Basal histiocytic cells, Active inflammation?,
Sex, Increased lamina propria cellularity?, Increased lymphoid aggregates in

lamina propria?', 'accuracy': [0.7131782945736435, 0.751937984496124,
0.7131782945736435, 0.6589147286821705, 0.640625], 'avgAccuracy':
0.6955668604651163, 'f1': [0.6853763660125872, 0.7593375616631429,
0.7036732313396307, 0.6311800172265288, 0.640625], 'avgF1': 0.6840384352483779,
'precision': [0.7131782945736435, 0.751937984496124, 0.7131782945736435,
0.6589147286821705, 0.640625], 'avgPrecision': 0.6955668604651163, 'recall':
[0.7131782945736435, 0.751937984496124, 0.7131782945736435, 0.6589147286821705,
0.640625], 'avgRecall': 0.6955668604651163, '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': 'Marked & transmucosal increase in lamina
propria cellularity, Crypt architecture, Epithelial changes, Mucosal surface,
Lamina propria granulomas, Patchy lamina propria cellularity?, Mucin depletion,
Submucosal granulomas, Cryptitis extent, Lamina propria polymorphs, Cryptitis
polymorphs, Basal histiocytic cells, Active inflammation?, Sex, Increased lamina
propria cellularity?, Increased lymphoid aggregates in lamina propria?',
'accuracy': [0.6976744186046512, 0.7829457364341085, 0.7829457364341085,
0.7441860465116279, 0.765625], 'avgAccuracy': 0.7546753875968992, 'f1':
[0.6150153396175428, 0.7125512995896034, 0.7125512995896034, 0.6606878200386334,
0.6893939393939393], 'avgF1': 0.6780399396458645, 'precision':
[0.6976744186046512, 0.7829457364341085, 0.7829457364341085, 0.7441860465116279,
0.765625], 'avgPrecision': 0.7546753875968992, 'recall': [0.6976744186046512,
0.7829457364341085, 0.7829457364341085, 0.7441860465116279, 0.765625],
'avgRecall': 0.7546753875968992, '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': 'Marked & transmucosal increase in
lamina propria cellularity, Crypt architecture, Epithelial changes, Mucosal
surface, Lamina propria granulomas, Patchy lamina propria cellularity?, Mucin
depletion, Submucosal granulomas, Cryptitis extent, Lamina propria polymorphs,
Cryptitis polymorphs, Basal histiocytic cells, Active inflammation?, Sex,
Increased lamina propria cellularity?, Increased lymphoid aggregates in lamina

propria?', 'accuracy': [0.7131782945736435, 0.7906976744186046, 0.7984496124031008, 0.751937984496124, 0.7578125], 'avgAccuracy': 0.7624152131782945, 'f1': [0.6758487491557502, 0.7443820913078638, 0.7421607654165794, 0.6928223031968, 0.6941391941391942], 'avgF1': 0.7098706206432376, 'precision': [0.7131782945736435, 0.7906976744186046, 0.7984496124031008, 0.751937984496124, 0.7578125], 'avgPrecision': 0.7624152131782945, 'recall': [0.7131782945736435, 0.7906976744186046, 0.7984496124031008, 0.751937984496124, 0.7578125], 'avgRecall': 0.7624152131782945, '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': 'Marked & transmucosal increase in lamina propria cellularity, Crypt architecture, Epithelial changes, Mucosal surface, Lamina propria granulomas, Patchy lamina propria cellularity?, Mucin depletion, Submucosal granulomas, Cryptitis extent, Lamina propria polymorphs, Cryptitis polymorphs, Basal histiocytic cells, Active inflammation?, Sex, Increased lamina propria cellularity?, Increased lymphoid aggregates in lamina propria?', 'accuracy': [0.7209302325581395, 0.7906976744186046, 0.7984496124031008, 0.751937984496124, 0.7578125], 'avgAccuracy': 0.7639656007751938, 'f1': [0.6705042597282984, 0.7443820913078638, 0.7421607654165794, 0.6928223031968, 0.6941391941391942], 'avgF1': 0.7088017227577472, 'precision': [0.7209302325581395, 0.7906976744186046, 0.7984496124031008, 0.751937984496124, 0.7578125], 'avgPrecision': 0.7639656007751938, 'recall': [0.7209302325581395, 0.7906976744186046, 0.7984496124031008, 0.751937984496124, 0.7578125], 'avgRecall': 0.7639656007751938, '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  Marked & transmucosal increase in lamina propr…
1     KNeighborsClassifier  Marked & transmucosal increase in lamina propr…
2       LogisticRegression  Marked & transmucosal increase in lamina propr…
3              GaussianNB  Marked & transmucosal increase in lamina propr…
4        AdaBoostClassifier  Marked & transmucosal increase in lamina propr…
5   DecisionTreeClassifier  Marked & transmucosal increase in lamina propr…
6                     SVC  Marked & transmucosal increase in lamina propr…
7           MLPClassifier  Marked & transmucosal increase in lamina propr…
```

```
     accuracy        f1  precision    recall  \
0    0.729772  0.701503   0.729772  0.729772
1    0.745264  0.728140   0.745264  0.745264
2    0.763966  0.708802   0.763966  0.763966
3    0.756226  0.681065   0.756226  0.756226
4    0.740625  0.697617   0.740625  0.740625
5    0.695567  0.684038   0.695567  0.695567
6    0.754675  0.678040   0.754675  0.754675
7    0.762415  0.709871   0.762415  0.762415


                                                 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': 'Marked & transmucosal
increase in lamina propria cellularity, Crypt architecture, Epithelial changes,
Mucosal surface, Lamina propria granulomas, Patchy lamina propria cellularity?,
Mucin depletion, Submucosal granulomas, Cryptitis extent, Lamina propria
polymorphs, Cryptitis polymorphs, Basal histiocytic cells, Active inflammation?,
Sex, Increased lamina propria cellularity?', 'accuracy': [0.6976744186046512,
0.7441860465116279, 0.7751937984496124, 0.7364341085271318, 0.6953125],
'avgAccuracy': 0.7297601744186046, 'f1': [0.658327059920926, 0.7456336082023335,
0.7254474314047425, 0.6947536921571692, 0.6719490658983177], 'avgF1':
0.6992221715166977, 'precision': [0.6976744186046512, 0.7441860465116279,
0.7751937984496124, 0.7364341085271318, 0.6953125], 'avgPrecision':
0.7297601744186046, 'recall': [0.6976744186046512, 0.7441860465116279,
0.7751937984496124, 0.7364341085271318, 0.6953125], 'avgRecall':
0.7297601744186046, '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': 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': 'Marked & transmucosal
increase in lamina propria cellularity, Crypt architecture, Epithelial changes,
Mucosal surface, Lamina propria granulomas, Patchy lamina propria cellularity?,
Mucin depletion, Submucosal granulomas, Cryptitis extent, Lamina propria
polymorphs, Cryptitis polymorphs, Basal histiocytic cells, Active inflammation?,
Sex, Increased lamina propria cellularity?', 'accuracy': [0.7054263565891473,
0.7751937984496124, 0.7751937984496124, 0.7674418604651163, 0.71875],
'avgAccuracy': 0.7484011627906977, 'f1': [0.6452601712519633,
0.7329463027777849, 0.739643050297458, 0.7044614807057755, 0.6889320388349514],
'avgF1': 0.7022486087735866, 'precision': [0.7054263565891473,
0.7751937984496124, 0.7751937984496124, 0.7674418604651163, 0.71875],
'avgPrecision': 0.7484011627906977, 'recall': [0.7054263565891473,
0.7751937984496124, 0.7751937984496124, 0.7674418604651163, 0.71875],
'avgRecall': 0.7484011627906977, 'params': [{'algorithm': 'brute', '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': 'Marked & transmucosal
increase in lamina propria cellularity, Crypt architecture, Epithelial changes,
Mucosal surface, Lamina propria granulomas, Patchy lamina propria cellularity?,
Mucin depletion, Submucosal granulomas, Cryptitis extent, Lamina propria
polymorphs, Cryptitis polymorphs, Basal histiocytic cells, Active inflammation?,
Sex, Increased lamina propria cellularity?', 'accuracy': [0.7209302325581395,
0.7906976744186046, 0.7984496124031008, 0.751937984496124, 0.7578125],
'avgAccuracy': 0.7639656007751938, 'f1': [0.6705042597282984,
0.7443820913078638, 0.7421607654165794, 0.6928223031968, 0.6941391941391942],
'avgF1': 0.7088017227577472, 'precision': [0.7209302325581395,
0.7906976744186046, 0.7984496124031008, 0.751937984496124, 0.7578125],
'avgPrecision': 0.7639656007751938, 'recall': [0.7209302325581395,
0.7906976744186046, 0.7984496124031008, 0.751937984496124, 0.7578125],
'avgRecall': 0.7639656007751938, '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': 'Marked & transmucosal increase in lamina propria cellularity, Crypt architecture, Epithelial changes, Mucosal surface, Lamina propria granulomas, Patchy lamina propria cellularity?, Mucin depletion, Submucosal granulomas, Cryptitis extent, Lamina propria polymorphs, Cryptitis polymorphs, Basal histiocytic cells, Active inflammation?, Sex, Increased lamina propria cellularity?', 'accuracy': [0.6976744186046512, 0.7906976744186046, 0.7829457364341085, 0.7441860465116279, 0.765625], 'avgAccuracy': 0.7562257751937984, 'f1': [0.6150153396175428, 0.7276790369917914, 0.7125512995896034, 0.6606878200386334, 0.6893939393939393], 'avgF1': 0.6810654871263021, 'precision': [0.6976744186046512, 0.7906976744186046, 0.7829457364341085, 0.7441860465116279, 0.765625], 'avgPrecision': 0.7562257751937984, 'recall': [0.6976744186046512, 0.7906976744186046, 0.7829457364341085, 0.7441860465116279, 0.765625], 'avgRecall': 0.7562257751937984, 'params': [{'priors': None, 'var_smoothing': 1e-09}]}
****

Processing Model: AdaBoostClassifier
****
* AdaBoostClassifier
* Best Params Result:
* {'classifier': 'AdaBoostClassifier', 'features': 'Marked & transmucosal increase in lamina propria cellularity, Crypt architecture, Epithelial changes, Mucosal surface, Lamina propria granulomas, Patchy lamina propria cellularity?, Mucin depletion, Submucosal granulomas, Cryptitis extent, Lamina propria polymorphs, Cryptitis polymorphs, Basal histiocytic cells, Active inflammation?, Sex, Increased lamina propria cellularity?', 'accuracy': [0.6976744186046512, 0.7906976744186046, 0.8062015503875969, 0.7209302325581395, 0.765625], 'avgAccuracy': 0.7562257751937984, 'f1': [0.6683696830943487, 0.7443820913078638, 0.7478509601775845, 0.6700536672629696, 0.7083333333333335], 'avgF1': 0.70779794703522, 'precision': [0.6976744186046512, 0.7906976744186046, 0.8062015503875969, 0.7209302325581395, 0.765625], 'avgPrecision': 0.7562257751937984, 'recall': [0.6976744186046512, 0.7906976744186046, 0.8062015503875969, 0.7209302325581395, 0.765625], 'avgRecall': 0.7562257751937984, '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': 'Marked & transmucosal increase in lamina propria cellularity, Crypt architecture, Epithelial changes, Mucosal surface, Lamina propria granulomas, Patchy lamina propria cellularity?, Mucin depletion, Submucosal granulomas, Cryptitis extent, Lamina propria polymorphs, Cryptitis polymorphs, Basal histiocytic cells, Active inflammation?, Sex, Increased lamina propria cellularity?', 'accuracy': [0.6589147286821705,

0.7441860465116279, 0.7286821705426356, 0.7131782945736435, 0.6640625],
'avgAccuracy': 0.7018047480620155, 'f1': [0.6283914728682171,
0.7528617717451948, 0.7270645699922553, 0.6825359128470256, 0.6657672170761176],
'avgF1': 0.6913241889057621, 'precision': [0.6589147286821705,
0.7441860465116279, 0.7286821705426356, 0.7131782945736435, 0.6640625],
'avgPrecision': 0.7018047480620155, 'recall': [0.6589147286821705,
0.7441860465116279, 0.7286821705426356, 0.7131782945736435, 0.6640625],
'avgRecall': 0.7018047480620155, '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': 'Marked & transmucosal increase in lamina
propria cellularity, Crypt architecture, Epithelial changes, Mucosal surface,
Lamina propria granulomas, Patchy lamina propria cellularity?, Mucin depletion,
Submucosal granulomas, Cryptitis extent, Lamina propria polymorphs, Cryptitis
polymorphs, Basal histiocytic cells, Active inflammation?, Sex, Increased lamina
propria cellularity?', 'accuracy': [0.6976744186046512, 0.7829457364341085,
0.7829457364341085, 0.7441860465116279, 0.765625], 'avgAccuracy':
0.7546753875968992, 'f1': [0.6150153396175428, 0.7125512995896034,
0.7125512995896034, 0.6606878200386334, 0.6893939393939393], 'avgF1':
0.6780399396458645, 'precision': [0.6976744186046512, 0.7829457364341085,
0.7829457364341085, 0.7441860465116279, 0.765625], 'avgPrecision':
0.7546753875968992, 'recall': [0.6976744186046512, 0.7829457364341085,
0.7829457364341085, 0.7441860465116279, 0.765625], 'avgRecall':
0.7546753875968992, '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': 'Marked & transmucosal increase in
lamina propria cellularity, Crypt architecture, Epithelial changes, Mucosal
surface, Lamina propria granulomas, Patchy lamina propria cellularity?, Mucin
depletion, Submucosal granulomas, Cryptitis extent, Lamina propria polymorphs,
Cryptitis polymorphs, Basal histiocytic cells, Active inflammation?, Sex,
Increased lamina propria cellularity?', 'accuracy': [0.7131782945736435,

0.7906976744186046, 0.7906976744186046, 0.751937984496124, 0.7734375],
'avgAccuracy': 0.7639898255813954, 'f1': [0.6580489278163697,
0.7443820913078638, 0.7276790369917914, 0.6847589127528272, 0.7220079410096427],
'avgF1': 0.7073753819756989, 'precision': [0.7131782945736435,
0.7906976744186046, 0.7906976744186046, 0.751937984496124, 0.7734375],
'avgPrecision': 0.7639898255813954, 'recall': [0.7131782945736435,
0.7906976744186046, 0.7906976744186046, 0.751937984496124, 0.7734375],
'avgRecall': 0.7639898255813954, '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': 'Marked & transmucosal increase in
lamina propria cellularity, Crypt architecture, Epithelial changes, Mucosal
surface, Lamina propria granulomas, Patchy lamina propria cellularity?, Mucin
depletion, Submucosal granulomas, Cryptitis extent, Lamina propria polymorphs,
Cryptitis polymorphs, Basal histiocytic cells, Active inflammation?, Sex,
Increased lamina propria cellularity?', 'accuracy': [0.7131782945736435,
0.7906976744186046, 0.7906976744186046, 0.751937984496124, 0.7734375],
'avgAccuracy': 0.7639898255813954, 'f1': [0.6580489278163697,
0.7443820913078638, 0.7276790369917914, 0.6847589127528272, 0.7220079410096427],
'avgF1': 0.7073753819756989, 'precision': [0.7131782945736435,
0.7906976744186046, 0.7906976744186046, 0.751937984496124, 0.7734375],
'avgPrecision': 0.7639898255813954, 'recall': [0.7131782945736435,
0.7906976744186046, 0.7906976744186046, 0.751937984496124, 0.7734375],
'avgRecall': 0.7639898255813954, '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  Marked & transmucosal increase in lamina propr…
1    KNeighborsClassifier  Marked & transmucosal increase in lamina propr…
2      LogisticRegression  Marked & transmucosal increase in lamina propr…
3              GaussianNB  Marked & transmucosal increase in lamina propr…
4       AdaBoostClassifier  Marked & transmucosal increase in lamina propr…
5  DecisionTreeClassifier  Marked & transmucosal increase in lamina propr…
6                     SVC  Marked & transmucosal increase in lamina propr…
7           MLPClassifier  Marked & transmucosal increase in lamina propr…
```

```
     accuracy        f1  precision    recall  \
0    0.729760  0.699222   0.729760  0.729760
1    0.748401  0.702249   0.748401  0.748401
2    0.763966  0.708802   0.763966  0.763966
3    0.756226  0.681065   0.756226  0.756226
4    0.756226  0.707798   0.756226  0.756226
5    0.701805  0.691324   0.701805  0.701805
6    0.754675  0.678040   0.754675  0.754675
7    0.763990  0.707375   0.763990  0.763990


                                                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': 'Marked & transmucosal
increase in lamina propria cellularity, Crypt architecture, Epithelial changes,
Mucosal surface, Lamina propria granulomas, Patchy lamina propria cellularity?,
Mucin depletion, Submucosal granulomas, Cryptitis extent, Lamina propria
polymorphs, Cryptitis polymorphs, Basal histiocytic cells, Active inflammation?,
Sex', 'accuracy': [0.7131782945736435, 0.7441860465116279, 0.7674418604651163,
0.7286821705426356, 0.6796875], 'avgAccuracy': 0.7266351744186047, 'f1':
[0.6758487491557502, 0.7456336082023335, 0.7199701301472157, 0.6888272919587466,
0.6656528255311646], 'avgF1': 0.6991865209990421, 'precision':
[0.7131782945736435, 0.7441860465116279, 0.7674418604651163, 0.7286821705426356,
0.6796875], 'avgPrecision': 0.7266351744186047, 'recall': [0.7131782945736435,
0.7441860465116279, 0.7674418604651163, 0.7286821705426356, 0.6796875],
'avgRecall': 0.7266351744186047, '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': 'Marked & transmucosal
increase in lamina propria cellularity, Crypt architecture, Epithelial changes,
Mucosal surface, Lamina propria granulomas, Patchy lamina propria cellularity?,
Mucin depletion, Submucosal granulomas, Cryptitis extent, Lamina propria
polymorphs, Cryptitis polymorphs, Basal histiocytic cells, Active inflammation?,
Sex', 'accuracy': [0.7364341085271318, 0.7906976744186046, 0.7596899224806202,
0.7596899224806202, 0.734375], 'avgAccuracy': 0.7561773255813954, 'f1':
[0.7405131044665928, 0.7513637991379379, 0.6975037754791518, 0.6903912024517757,
0.7246603970741902], 'avgF1': 0.7208864557219297, 'precision':
[0.7364341085271318, 0.7906976744186046, 0.7596899224806202, 0.7596899224806202,
0.734375], 'avgPrecision': 0.7561773255813954, 'recall': [0.7364341085271318,
0.7906976744186046, 0.7596899224806202, 0.7596899224806202, 0.734375],
'avgRecall': 0.7561773255813954, 'params': [{'algorithm': 'brute', 'leaf_size':
30, 'metric': 'minkowski', 'metric_params': None, 'n_jobs': -1, 'n_neighbors':
13, 'p': 2, 'weights': 'uniform'}]}
*****************************************************

Processing Model: LogisticRegression
*****************************************************
* LogisticRegression
* Best Params Result:
* {'classifier': 'LogisticRegression', 'features': 'Marked & transmucosal
increase in lamina propria cellularity, Crypt architecture, Epithelial changes,
Mucosal surface, Lamina propria granulomas, Patchy lamina propria cellularity?,
Mucin depletion, Submucosal granulomas, Cryptitis extent, Lamina propria
polymorphs, Cryptitis polymorphs, Basal histiocytic cells, Active inflammation?,
Sex', 'accuracy': [0.7209302325581395, 0.7906976744186046, 0.8062015503875969,
0.751937984496124, 0.7578125], 'avgAccuracy': 0.765515988372093, 'f1':
[0.6705042597282984, 0.7443820913078638, 0.7560514318380255, 0.6928223031968,
0.6941391941391942], 'avgF1': 0.7115798560420364, 'precision':
[0.7209302325581395, 0.7906976744186046, 0.8062015503875969, 0.751937984496124,
0.7578125], 'avgPrecision': 0.765515988372093, 'recall': [0.7209302325581395,
0.7906976744186046, 0.8062015503875969, 0.751937984496124, 0.7578125],
'avgRecall': 0.765515988372093, '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': 'Marked & transmucosal increase in
lamina propria cellularity, Crypt architecture, Epithelial changes, Mucosal
```

surface, Lamina propria granulomas, Patchy lamina propria cellularity?, Mucin depletion, Submucosal granulomas, Cryptitis extent, Lamina propria polymorphs, Cryptitis polymorphs, Basal histiocytic cells, Active inflammation?, Sex', 'accuracy': [0.6976744186046512, 0.7906976744186046, 0.7829457364341085, 0.7441860465116279, 0.765625], 'avgAccuracy': 0.7562257751937984, 'f1': [0.6150153396175428, 0.7276790369917914, 0.7125512995896034, 0.6606878200386334, 0.6893939393939393], 'avgF1': 0.6810654871263021, 'precision': [0.6976744186046512, 0.7906976744186046, 0.7829457364341085, 0.7441860465116279, 0.765625], 'avgPrecision': 0.7562257751937984, 'recall': [0.6976744186046512, 0.7906976744186046, 0.7829457364341085, 0.7441860465116279, 0.765625], 'avgRecall': 0.7562257751937984, 'params': [{'priors': None, 'var_smoothing': 1e-09}]}
****

Processing Model: AdaBoostClassifier
****
* AdaBoostClassifier
* Best Params Result:
* {'classifier': 'AdaBoostClassifier', 'features': 'Marked & transmucosal increase in lamina propria cellularity, Crypt architecture, Epithelial changes, Mucosal surface, Lamina propria granulomas, Patchy lamina propria cellularity?, Mucin depletion, Submucosal granulomas, Cryptitis extent, Lamina propria polymorphs, Cryptitis polymorphs, Basal histiocytic cells, Active inflammation?, Sex', 'accuracy': [0.6976744186046512, 0.7906976744186046, 0.8062015503875969, 0.7209302325581395, 0.765625], 'avgAccuracy': 0.7562257751937984, 'f1': [0.6683696830943487, 0.7443820913078638, 0.7478509601775845, 0.6700536672629696, 0.7083333333333335], 'avgF1': 0.70779794703522, 'precision': [0.6976744186046512, 0.7906976744186046, 0.8062015503875969, 0.7209302325581395, 0.765625], 'avgPrecision': 0.7562257751937984, 'recall': [0.6976744186046512, 0.7906976744186046, 0.8062015503875969, 0.7209302325581395, 0.765625], 'avgRecall': 0.7562257751937984, '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': 'Marked & transmucosal increase in lamina propria cellularity, Crypt architecture, Epithelial changes, Mucosal surface, Lamina propria granulomas, Patchy lamina propria cellularity?, Mucin depletion, Submucosal granulomas, Cryptitis extent, Lamina propria polymorphs, Cryptitis polymorphs, Basal histiocytic cells, Active inflammation?, Sex', 'accuracy': [0.6821705426356589, 0.7054263565891473, 0.7286821705426356, 0.6666666666666666, 0.703125], 'avgAccuracy': 0.6972141472868217, 'f1': [0.6559931379265853, 0.7142133544749825, 0.7053680713411435, 0.6310552500654623, 0.6962585034013606], 'avgF1': 0.6805776634419068, 'precision':

[0.6821705426356589, 0.7054263565891473, 0.7286821705426356, 0.6666666666666666, 0.703125], 'avgPrecision': 0.6972141472868217, 'recall': [0.6821705426356589, 0.7054263565891473, 0.7286821705426356, 0.6666666666666666, 0.703125], 'avgRecall': 0.6972141472868217, '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': 'Marked & transmucosal increase in lamina propria cellularity, Crypt architecture, Epithelial changes, Mucosal surface, Lamina propria granulomas, Patchy lamina propria cellularity?, Mucin depletion, Submucosal granulomas, Cryptitis extent, Lamina propria polymorphs, Cryptitis polymorphs, Basal histiocytic cells, Active inflammation?, Sex', 'accuracy': [0.6976744186046512, 0.7829457364341085, 0.7829457364341085, 0.7441860465116279, 0.765625], 'avgAccuracy': 0.7546753875968992, 'f1': [0.6150153396175428, 0.7125512995896034, 0.7125512995896034, 0.6606878200386334, 0.6893939393939393], 'avgF1': 0.6780399396458645, 'precision': [0.6976744186046512, 0.7829457364341085, 0.7829457364341085, 0.7441860465116279, 0.765625], 'avgPrecision': 0.7546753875968992, 'recall': [0.6976744186046512, 0.7829457364341085, 0.7829457364341085, 0.7441860465116279, 0.765625], 'avgRecall': 0.7546753875968992, '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': 'Marked & transmucosal increase in lamina propria cellularity, Crypt architecture, Epithelial changes, Mucosal surface, Lamina propria granulomas, Patchy lamina propria cellularity?, Mucin depletion, Submucosal granulomas, Cryptitis extent, Lamina propria polymorphs, Cryptitis polymorphs, Basal histiocytic cells, Active inflammation?, Sex', 'accuracy': [0.7286821705426356, 0.7829457364341085, 0.8062015503875969, 0.751937984496124, 0.765625], 'avgAccuracy': 0.767078488372093, 'f1': [0.6826455239104355, 0.7386387881374012, 0.7560514318380255, 0.6847589127528272, 0.7083333333333335], 'avgF1': 0.7140855979944046, 'precision': [0.7286821705426356, 0.7829457364341085, 0.8062015503875969, 0.751937984496124, 0.765625], 'avgPrecision': 0.767078488372093, 'recall': [0.7286821705426356,

0.7829457364341085, 0.8062015503875969, 0.751937984496124, 0.765625],
'avgRecall': 0.767078488372093, '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': 'MLPClassifier', 'features': 'Marked & transmucosal increase in
lamina propria cellularity, Crypt architecture, Epithelial changes, Mucosal
surface, Lamina propria granulomas, Patchy lamina propria cellularity?, Mucin
depletion, Submucosal granulomas, Cryptitis extent, Lamina propria polymorphs,
Cryptitis polymorphs, Basal histiocytic cells, Active inflammation?, Sex',
'accuracy': [0.7286821705426356, 0.7829457364341085, 0.8062015503875969,
0.751937984496124, 0.765625], 'avgAccuracy': 0.767078488372093, 'f1':
[0.6826455239104355, 0.7386387881374012, 0.7560514318380255, 0.6847589127528272,
0.7083333333333335], 'avgF1': 0.7140855979944046, 'precision':
[0.7286821705426356, 0.7829457364341085, 0.8062015503875969, 0.751937984496124,
0.765625], 'avgPrecision': 0.767078488372093, 'recall': [0.7286821705426356,
0.7829457364341085, 0.8062015503875969, 0.751937984496124, 0.765625],
'avgRecall': 0.767078488372093, '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  Marked & transmucosal increase in lamina propr…
1     KNeighborsClassifier  Marked & transmucosal increase in lamina propr…
2       LogisticRegression  Marked & transmucosal increase in lamina propr…
3               GaussianNB  Marked & transmucosal increase in lamina propr…
4        AdaBoostClassifier  Marked & transmucosal increase in lamina propr…
5  DecisionTreeClassifier  Marked & transmucosal increase in lamina propr…
6                     SVC  Marked & transmucosal increase in lamina propr…
7            MLPClassifier  Marked & transmucosal increase in lamina propr…

   accuracy        f1  precision    recall  \
0  0.726635  0.699187   0.726635  0.726635
1  0.756177  0.720886   0.756177  0.756177
2  0.765516  0.711580   0.765516  0.765516
3  0.756226  0.681065   0.756226  0.756226
4  0.756226  0.707798   0.756226  0.756226
```

```
5  0.697214   0.680578    0.697214   0.697214
6  0.754675   0.678040    0.754675   0.754675
7  0.767078   0.714086    0.767078   0.767078


                                               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': 'Marked & transmucosal
increase in lamina propria cellularity, Crypt architecture, Epithelial changes,
Mucosal surface, Lamina propria granulomas, Patchy lamina propria cellularity?,
Mucin depletion, Submucosal granulomas, Cryptitis extent, Lamina propria
polymorphs, Cryptitis polymorphs, Basal histiocytic cells, Active
inflammation?', 'accuracy': [0.689922480620155, 0.8062015503875969,
0.7829457364341085, 0.7054263565891473, 0.7578125], 'avgAccuracy':
0.7484617248062015, 'f1': [0.6405773857257417, 0.7633167512109851,
0.7309669522643819, 0.6517233154442457, 0.7028360748723765], 'avgF1':
0.6978840959035462, 'precision': [0.689922480620155, 0.8062015503875969,
0.7829457364341085, 0.7054263565891473, 0.7578125], 'avgPrecision':
0.7484617248062015, 'recall': [0.689922480620155, 0.8062015503875969,
0.7829457364341085, 0.7054263565891473, 0.7578125], 'avgRecall':
0.7484617248062015, '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': 'Marked & transmucosal
increase in lamina propria cellularity, Crypt architecture, Epithelial changes,
Mucosal surface, Lamina propria granulomas, Patchy lamina propria cellularity?,
Mucin depletion, Submucosal granulomas, Cryptitis extent, Lamina propria
polymorphs, Cryptitis polymorphs, Basal histiocytic cells, Active

inflammation?', 'accuracy': [0.689922480620155, 0.7751937984496124,
0.7906976744186046, 0.7364341085271318, 0.7734375], 'avgAccuracy':
0.7531371124031008, 'f1': [0.6002214839424141, 0.707507113805998,
0.7176321353065539, 0.6555514540010664, 0.6944408532643827], 'avgF1':
0.675070608064083, 'precision': [0.689922480620155, 0.7751937984496124,
0.7906976744186046, 0.7364341085271318, 0.7734375], 'avgPrecision':
0.7531371124031008, 'recall': [0.689922480620155, 0.7751937984496124,
0.7906976744186046, 0.7364341085271318, 0.7734375], 'avgRecall':
0.7531371124031008, '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': 'Marked & transmucosal
increase in lamina propria cellularity, Crypt architecture, Epithelial changes,
Mucosal surface, Lamina propria granulomas, Patchy lamina propria cellularity?,
Mucin depletion, Submucosal granulomas, Cryptitis extent, Lamina propria
polymorphs, Cryptitis polymorphs, Basal histiocytic cells, Active
inflammation?', 'accuracy': [0.7054263565891473, 0.7829457364341085,
0.7984496124031008, 0.7441860465116279, 0.7578125], 'avgAccuracy':
0.7577640503875969, 'f1': [0.664364575992483, 0.7309669522643819,
0.7330833496189173, 0.6606878200386334, 0.6941391941391942], 'avgF1':
0.6966483784107219, 'precision': [0.7054263565891473, 0.7829457364341085,
0.7984496124031008, 0.7441860465116279, 0.7578125], 'avgPrecision':
0.7577640503875969, 'recall': [0.7054263565891473, 0.7829457364341085,
0.7984496124031008, 0.7441860465116279, 0.7578125], 'avgRecall':
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'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': 'Marked & transmucosal increase in
lamina propria cellularity, Crypt architecture, Epithelial changes, Mucosal
surface, Lamina propria granulomas, Patchy lamina propria cellularity?, Mucin
depletion, Submucosal granulomas, Cryptitis extent, Lamina propria polymorphs,
Cryptitis polymorphs, Basal histiocytic cells, Active inflammation?',
'accuracy': [0.6976744186046512, 0.7906976744186046, 0.7829457364341085,
0.7441860465116279, 0.765625], 'avgAccuracy': 0.7562257751937984, 'f1':
[0.6150153396175428, 0.7276790369917914, 0.7125512995896034, 0.6606878200386334,

0.6893939393939393], 'avgF1': 0.6810654871263021, 'precision':
[0.6976744186046512, 0.7906976744186046, 0.7829457364341085, 0.7441860465116279,
0.765625], 'avgPrecision': 0.7562257751937984, 'recall': [0.6976744186046512,
0.7906976744186046, 0.7829457364341085, 0.7441860465116279, 0.765625],
'avgRecall': 0.7562257751937984, 'params': [{'priors': None, 'var_smoothing':
1e-09}]}
****

Processing Model: AdaBoostClassifier
****
* AdaBoostClassifier
* Best Params Result:
* {'classifier': 'AdaBoostClassifier', 'features': 'Marked & transmucosal
increase in lamina propria cellularity, Crypt architecture, Epithelial changes,
Mucosal surface, Lamina propria granulomas, Patchy lamina propria cellularity?,
Mucin depletion, Submucosal granulomas, Cryptitis extent, Lamina propria
polymorphs, Cryptitis polymorphs, Basal histiocytic cells, Active
inflammation?', 'accuracy': [0.7131782945736435, 0.8062015503875969,
0.8062015503875969, 0.7441860465116279, 0.75], 'avgAccuracy': 0.763953488372093,
'f1': [0.6853763660125872, 0.7697812954980905, 0.7633167512109851,
0.6870748139792838, 0.6686868686868686], 'avgF1': 0.714847219077563,
'precision': [0.7131782945736435, 0.8062015503875969, 0.8062015503875969,
0.7441860465116279, 0.75], 'avgPrecision': 0.763953488372093, 'recall':
[0.7131782945736435, 0.8062015503875969, 0.8062015503875969, 0.7441860465116279,
0.75], 'avgRecall': 0.763953488372093, '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': 'Marked & transmucosal
increase in lamina propria cellularity, Crypt architecture, Epithelial changes,
Mucosal surface, Lamina propria granulomas, Patchy lamina propria cellularity?,
Mucin depletion, Submucosal granulomas, Cryptitis extent, Lamina propria
polymorphs, Cryptitis polymorphs, Basal histiocytic cells, Active
inflammation?', 'accuracy': [0.6666666666666666, 0.751937984496124,
0.7286821705426356, 0.6434108527131783, 0.765625], 'avgAccuracy':
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0.7286821705426356, 0.6434108527131783, 0.765625], 'avgPrecision':
0.7112645348837209, 'recall': [0.6666666666666666, 0.751937984496124,
0.7286821705426356, 0.6434108527131783, 0.765625], 'avgRecall':
0.7112645348837209, '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': 'Marked & transmucosal increase in lamina
propria cellularity, Crypt architecture, Epithelial changes, Mucosal surface,
Lamina propria granulomas, Patchy lamina propria cellularity?, Mucin depletion,
Submucosal granulomas, Cryptitis extent, Lamina propria polymorphs, Cryptitis
polymorphs, Basal histiocytic cells, Active inflammation?', 'accuracy':
[0.6976744186046512, 0.7829457364341085, 0.7829457364341085, 0.7441860465116279,
0.765625], 'avgAccuracy': 0.7546753875968992, 'f1': [0.6150153396175428,
0.7125512995896034, 0.7125512995896034, 0.6606878200386334, 0.6893939393939393],
'avgF1': 0.6780399396458645, 'precision': [0.6976744186046512,
0.7829457364341085, 0.7829457364341085, 0.7441860465116279, 0.765625],
'avgPrecision': 0.7546753875968992, 'recall': [0.6976744186046512,
0.7829457364341085, 0.7829457364341085, 0.7441860465116279, 0.765625],
'avgRecall': 0.7546753875968992, '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': 'Marked & transmucosal increase in
lamina propria cellularity, Crypt architecture, Epithelial changes, Mucosal
surface, Lamina propria granulomas, Patchy lamina propria cellularity?, Mucin
depletion, Submucosal granulomas, Cryptitis extent, Lamina propria polymorphs,
Cryptitis polymorphs, Basal histiocytic cells, Active inflammation?',
'accuracy': [0.7054263565891473, 0.7829457364341085, 0.7984496124031008,
0.7441860465116279, 0.765625], 'avgAccuracy': 0.7593265503875969, 'f1':
[0.664364575992483, 0.7309669522643819, 0.7330833496189173, 0.6606878200386334,
0.7162883845126836], 'avgF1': 0.7010782164854198, 'precision':
[0.7054263565891473, 0.7829457364341085, 0.7984496124031008, 0.7441860465116279,
0.765625], 'avgPrecision': 0.7593265503875969, 'recall': [0.7054263565891473,
0.7829457364341085, 0.7984496124031008, 0.7441860465116279, 0.765625],
'avgRecall': 0.7593265503875969, '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,

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'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': 'AdaBoostClassifier', 'features': 'Marked & transmucosal
increase in lamina propria cellularity, Crypt architecture, Epithelial changes,
Mucosal surface, Lamina propria granulomas, Patchy lamina propria cellularity?,
Mucin depletion, Submucosal granulomas, Cryptitis extent, Lamina propria
polymorphs, Cryptitis polymorphs, Basal histiocytic cells, Active
inflammation?', 'accuracy': [0.7131782945736435, 0.8062015503875969,
0.8062015503875969, 0.7441860465116279, 0.75], 'avgAccuracy': 0.763953488372093,
'f1': [0.6853763660125872, 0.7697812954980905, 0.7633167512109851,
0.6870748139792838, 0.6686868686868686], 'avgF1': 0.714847219077563,
'precision': [0.7131782945736435, 0.8062015503875969, 0.8062015503875969,
0.7441860465116279, 0.75], 'avgPrecision': 0.763953488372093, 'recall':
[0.7131782945736435, 0.8062015503875969, 0.8062015503875969, 0.7441860465116279,
0.75], 'avgRecall': 0.763953488372093, 'params': [{'algorithm': 'SAMME.R',
'base_estimator': None, 'learning_rate': 1, 'n_estimators': 300, 'random_state':
None}]}
*********************************************************

                    model                                      features  \
0  RandomForestClassifier  Marked & transmucosal increase in lamina propr…
1    KNeighborsClassifier  Marked & transmucosal increase in lamina propr…
2      LogisticRegression  Marked & transmucosal increase in lamina propr…
3              GaussianNB  Marked & transmucosal increase in lamina propr…
4      AdaBoostClassifier  Marked & transmucosal increase in lamina propr…
5  DecisionTreeClassifier  Marked & transmucosal increase in lamina propr…
6                     SVC  Marked & transmucosal increase in lamina propr…
7           MLPClassifier  Marked & transmucosal increase in lamina propr…

   accuracy        f1  precision    recall  \
0  0.748462  0.697884   0.748462  0.748462
1  0.753137  0.675071   0.753137  0.753137
2  0.757764  0.696648   0.757764  0.757764
3  0.756226  0.681065   0.756226  0.756226
4  0.763953  0.714847   0.763953  0.763953
5  0.711265  0.681546   0.711265  0.711265
6  0.754675  0.678040   0.754675  0.754675
7  0.759327  0.701078   0.759327  0.759327


                                            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': 'Marked & transmucosal
increase in lamina propria cellularity, Crypt architecture, Epithelial changes,
Mucosal surface, Lamina propria granulomas, Patchy lamina propria cellularity?,
Mucin depletion, Submucosal granulomas, Cryptitis extent, Lamina propria
polymorphs, Cryptitis polymorphs, Basal histiocytic cells', 'accuracy':
[0.689922480620155, 0.7906976744186046, 0.7829457364341085, 0.7054263565891473,
0.7421875], 'avgAccuracy': 0.7422359496124031, 'f1': [0.6405773857257417,
0.7513637991379379, 0.7223269781409317, 0.6438815060908084, 0.6744062389223681],
'avgF1': 0.6865111816035576, 'precision': [0.689922480620155,
0.7906976744186046, 0.7829457364341085, 0.7054263565891473, 0.7421875],
'avgPrecision': 0.7422359496124031, 'recall': [0.689922480620155,
0.7906976744186046, 0.7829457364341085, 0.7054263565891473, 0.7421875],
'avgRecall': 0.7422359496124031, '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': 'Marked & transmucosal
increase in lamina propria cellularity, Crypt architecture, Epithelial changes,
Mucosal surface, Lamina propria granulomas, Patchy lamina propria cellularity?,
Mucin depletion, Submucosal granulomas, Cryptitis extent, Lamina propria
polymorphs, Cryptitis polymorphs, Basal histiocytic cells', 'accuracy':
[0.689922480620155, 0.7829457364341085, 0.7906976744186046, 0.7364341085271318,
0.7734375], 'avgAccuracy': 0.7546875, 'f1': [0.6002214839424141,
0.7223269781409317, 0.7176321353065539, 0.6555514540010664, 0.6944408532643827],
'avgF1': 0.6780345809310697, 'precision': [0.689922480620155,
0.7829457364341085, 0.7906976744186046, 0.7364341085271318, 0.7734375],
'avgPrecision': 0.7546875, 'recall': [0.689922480620155, 0.7829457364341085,
0.7906976744186046, 0.7364341085271318, 0.7734375], 'avgRecall': 0.7546875,
'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': 'Marked & transmucosal
increase in lamina propria cellularity, Crypt architecture, Epithelial changes,
Mucosal surface, Lamina propria granulomas, Patchy lamina propria cellularity?,
Mucin depletion, Submucosal granulomas, Cryptitis extent, Lamina propria
polymorphs, Cryptitis polymorphs, Basal histiocytic cells', 'accuracy':
[0.7054263565891473, 0.7906976744186046, 0.7984496124031008, 0.7441860465116279,
0.7578125], 'avgAccuracy': 0.7593144379844962, 'f1': [0.664364575992483,
0.7365355463850676, 0.7330833496189173, 0.6606878200386334, 0.6941391941391942],
'avgF1': 0.697762097234859, 'precision': [0.7054263565891473,
0.7906976744186046, 0.7984496124031008, 0.7441860465116279, 0.7578125],
'avgPrecision': 0.7593144379844962, 'recall': [0.7054263565891473,
0.7906976744186046, 0.7984496124031008, 0.7441860465116279, 0.7578125],
'avgRecall': 0.7593144379844962, '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': 'Marked & transmucosal increase in
lamina propria cellularity, Crypt architecture, Epithelial changes, Mucosal
surface, Lamina propria granulomas, Patchy lamina propria cellularity?, Mucin
depletion, Submucosal granulomas, Cryptitis extent, Lamina propria polymorphs,
Cryptitis polymorphs, Basal histiocytic cells', 'accuracy': [0.6976744186046512,
0.7906976744186046, 0.7829457364341085, 0.7441860465116279, 0.765625],
'avgAccuracy': 0.7562257751937984, 'f1': [0.6150153396175428,
0.7276790369917914, 0.7125512995896034, 0.6606878200386334, 0.6893939393939393],
'avgF1': 0.6810654871263021, 'precision': [0.6976744186046512,
0.7906976744186046, 0.7829457364341085, 0.7441860465116279, 0.765625],
'avgPrecision': 0.7562257751937984, 'recall': [0.6976744186046512,
0.7906976744186046, 0.7829457364341085, 0.7441860465116279, 0.765625],
'avgRecall': 0.7562257751937984, 'params': [{'priors': None, 'var_smoothing':
1e-09}]}
****

Processing Model: AdaBoostClassifier
****

```
* AdaBoostClassifier
* Best Params Result:
* {'classifier': 'AdaBoostClassifier', 'features': 'Marked & transmucosal
increase in lamina propria cellularity, Crypt architecture, Epithelial changes,
Mucosal surface, Lamina propria granulomas, Patchy lamina propria cellularity?,
Mucin depletion, Submucosal granulomas, Cryptitis extent, Lamina propria
polymorphs, Cryptitis polymorphs, Basal histiocytic cells', 'accuracy':
[0.7131782945736435, 0.8062015503875969, 0.8062015503875969, 0.7441860465116279,
0.75], 'avgAccuracy': 0.763953488372093, 'f1': [0.6853763660125872,
0.7697812954980905, 0.7633167512109851, 0.6870748139792838, 0.6686868686868686],
'avgF1': 0.714847219077563, 'precision': [0.7131782945736435,
0.8062015503875969, 0.8062015503875969, 0.7441860465116279, 0.75],
'avgPrecision': 0.763953488372093, 'recall': [0.7131782945736435,
0.8062015503875969, 0.8062015503875969, 0.7441860465116279, 0.75], 'avgRecall':
0.763953488372093, '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': 'Marked & transmucosal
increase in lamina propria cellularity, Crypt architecture, Epithelial changes,
Mucosal surface, Lamina propria granulomas, Patchy lamina propria cellularity?,
Mucin depletion, Submucosal granulomas, Cryptitis extent, Lamina propria
polymorphs, Cryptitis polymorphs, Basal histiocytic cells', 'accuracy':
[0.6744186046511628, 0.751937984496124, 0.7441860465116279, 0.6511627906976745,
0.7265625], 'avgAccuracy': 0.7096535852713178, 'f1': [0.6498236014111888,
0.7280177187153931, 0.7222041815502211, 0.6199662086546249, 0.6644923425978446],
'avgF1': 0.6769008105858545, 'precision': [0.6744186046511628,
0.751937984496124, 0.7441860465116279, 0.6511627906976745, 0.7265625],
'avgPrecision': 0.7096535852713178, 'recall': [0.6744186046511628,
0.751937984496124, 0.7441860465116279, 0.6511627906976745, 0.7265625],
'avgRecall': 0.7096535852713178, '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': 'Marked & transmucosal increase in lamina
propria cellularity, Crypt architecture, Epithelial changes, Mucosal surface,
Lamina propria granulomas, Patchy lamina propria cellularity?, Mucin depletion,
```

Submucosal granulomas, Cryptitis extent, Lamina propria polymorphs, Cryptitis polymorphs, Basal histiocytic cells', 'accuracy': [0.6976744186046512, 0.7829457364341085, 0.7829457364341085, 0.7441860465116279, 0.765625], 'avgAccuracy': 0.7546753875968992, 'f1': [0.6150153396175428, 0.7125512995896034, 0.7125512995896034, 0.6606878200386334, 0.6893939393939393], 'avgF1': 0.6780399396458645, 'precision': [0.6976744186046512, 0.7829457364341085, 0.7829457364341085, 0.7441860465116279, 0.765625], 'avgPrecision': 0.7546753875968992, 'recall': [0.6976744186046512, 0.7829457364341085, 0.7829457364341085, 0.7441860465116279, 0.765625], 'avgRecall': 0.7546753875968992, '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': 'Marked & transmucosal increase in lamina propria cellularity, Crypt architecture, Epithelial changes, Mucosal surface, Lamina propria granulomas, Patchy lamina propria cellularity?, Mucin depletion, Submucosal granulomas, Cryptitis extent, Lamina propria polymorphs, Cryptitis polymorphs, Basal histiocytic cells', 'accuracy': [0.6976744186046512, 0.7906976744186046, 0.7984496124031008, 0.7441860465116279, 0.765625], 'avgAccuracy': 0.7593265503875969, 'f1': [0.658327059920926, 0.7365355463850676, 0.7330833496189173, 0.6606878200386334, 0.7162883845126836], 'avgF1': 0.7009844320952455, 'precision': [0.6976744186046512, 0.7906976744186046, 0.7984496124031008, 0.7441860465116279, 0.765625], 'avgPrecision': 0.7593265503875969, 'recall': [0.6976744186046512, 0.7906976744186046, 0.7984496124031008, 0.7441860465116279, 0.765625], 'avgRecall': 0.7593265503875969, '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': 'AdaBoostClassifier', 'features': 'Marked & transmucosal increase in lamina propria cellularity, Crypt architecture, Epithelial changes, Mucosal surface, Lamina propria granulomas, Patchy lamina propria cellularity?, Mucin depletion, Submucosal granulomas, Cryptitis extent, Lamina propria polymorphs, Cryptitis polymorphs, Basal histiocytic cells', 'accuracy': [0.7131782945736435, 0.8062015503875969, 0.8062015503875969, 0.7441860465116279,

0.75], 'avgAccuracy': 0.763953488372093, 'f1': [0.6853763660125872,
0.7697812954980905, 0.7633167512109851, 0.6870748139792838, 0.6686868686868686],
'avgF1': 0.714847219077563, 'precision': [0.7131782945736435,
0.8062015503875969, 0.8062015503875969, 0.7441860465116279, 0.75],
'avgPrecision': 0.763953488372093, 'recall': [0.7131782945736435,
0.8062015503875969, 0.8062015503875969, 0.7441860465116279, 0.75], 'avgRecall':
0.763953488372093, 'params': [{'algorithm': 'SAMME.R', 'base_estimator': None,
'learning_rate': 1, 'n_estimators': 300, 'random_state': None}]}
****

```
                     model                                    features  \
0  RandomForestClassifier  Marked & transmucosal increase in lamina propr…
1    KNeighborsClassifier  Marked & transmucosal increase in lamina propr…
2      LogisticRegression  Marked & transmucosal increase in lamina propr…
3              GaussianNB  Marked & transmucosal increase in lamina propr…
4      AdaBoostClassifier  Marked & transmucosal increase in lamina propr…
5  DecisionTreeClassifier  Marked & transmucosal increase in lamina propr…
6                     SVC  Marked & transmucosal increase in lamina propr…
7           MLPClassifier  Marked & transmucosal increase in lamina propr…

   accuracy        f1  precision    recall  \
0  0.742236  0.686511   0.742236  0.742236
1  0.754687  0.678035   0.754687  0.754687
2  0.759314  0.697762   0.759314  0.759314
3  0.756226  0.681065   0.756226  0.756226
4  0.763953  0.714847   0.763953  0.763953
5  0.709654  0.676901   0.709654  0.709654
6  0.754675  0.678040   0.754675  0.754675
7  0.759327  0.700984   0.759327  0.759327

                                              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': 'Marked & transmucosal
increase in lamina propria cellularity, Crypt architecture, Epithelial changes,
Mucosal surface, Lamina propria granulomas, Patchy lamina propria cellularity?,
Mucin depletion, Submucosal granulomas, Cryptitis extent, Lamina propria

polymorphs, Cryptitis polymorphs', 'accuracy': [0.689922480620155, 0.7906976744186046, 0.751937984496124, 0.6821705426356589, 0.7578125], 'avgAccuracy': 0.7345082364341086, 'f1': [0.6338936219203315, 0.7513637991379379, 0.7013014721570301, 0.6281603080508689, 0.7028360748723765], 'avgF1': 0.6835110552277089, 'precision': [0.689922480620155, 0.7906976744186046, 0.751937984496124, 0.6821705426356589, 0.7578125], 'avgPrecision': 0.7345082364341086, 'recall': [0.689922480620155, 0.7906976744186046, 0.751937984496124, 0.6821705426356589, 0.7578125], 'avgRecall': 0.7345082364341086, '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': 'Marked & transmucosal increase in lamina propria cellularity, Crypt architecture, Epithelial changes, Mucosal surface, Lamina propria granulomas, Patchy lamina propria cellularity?, Mucin depletion, Submucosal granulomas, Cryptitis extent, Lamina propria polymorphs, Cryptitis polymorphs', 'accuracy': [0.689922480620155, 0.7829457364341085, 0.7906976744186046, 0.7364341085271318, 0.7734375], 'avgAccuracy': 0.7546875, 'f1': [0.6002214839424141, 0.7309669522643819, 0.7176321353065539, 0.6736236971466001, 0.6944408532643827], 'avgF1': 0.6833770243848666, 'precision': [0.689922480620155, 0.7829457364341085, 0.7906976744186046, 0.7364341085271318, 0.7734375], 'avgPrecision': 0.7546875, 'recall': [0.689922480620155, 0.7829457364341085, 0.7906976744186046, 0.7364341085271318, 0.7734375], 'avgRecall': 0.7546875, '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': 'Marked & transmucosal increase in lamina propria cellularity, Crypt architecture, Epithelial changes, Mucosal surface, Lamina propria granulomas, Patchy lamina propria cellularity?, Mucin depletion, Submucosal granulomas, Cryptitis extent, Lamina propria polymorphs, Cryptitis polymorphs', 'accuracy': [0.7054263565891473, 0.7906976744186046, 0.7984496124031008, 0.7441860465116279, 0.7578125], 'avgAccuracy': 0.7593144379844962, 'f1': [0.664364575992483, 0.7365355463850676,

0.7330833496189173, 0.6606878200386334, 0.6941391941391942], 'avgF1':
0.697762097234859, 'precision': [0.7054263565891473, 0.7906976744186046,
0.7984496124031008, 0.7441860465116279, 0.7578125], 'avgPrecision':
0.7593144379844962, 'recall': [0.7054263565891473, 0.7906976744186046,
0.7984496124031008, 0.7441860465116279, 0.7578125], 'avgRecall':
0.7593144379844962, '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': 'Marked & transmucosal increase in
lamina propria cellularity, Crypt architecture, Epithelial changes, Mucosal
surface, Lamina propria granulomas, Patchy lamina propria cellularity?, Mucin
depletion, Submucosal granulomas, Cryptitis extent, Lamina propria polymorphs,
Cryptitis polymorphs', 'accuracy': [0.6976744186046512, 0.7906976744186046,
0.7829457364341085, 0.7441860465116279, 0.765625], 'avgAccuracy':
0.7562257751937984, 'f1': [0.6150153396175428, 0.7276790369917914,
0.7125512995896034, 0.6606878200386334, 0.6893939393939393], 'avgF1':
0.6810654871263021, 'precision': [0.6976744186046512, 0.7906976744186046,
0.7829457364341085, 0.7441860465116279, 0.765625], 'avgPrecision':
0.7562257751937984, 'recall': [0.6976744186046512, 0.7906976744186046,
0.7829457364341085, 0.7441860465116279, 0.765625], 'avgRecall':
0.7562257751937984, 'params': [{'priors': None, 'var_smoothing': 1e-09}]}
****

Processing Model: AdaBoostClassifier
****
* AdaBoostClassifier
* Best Params Result:
* {'classifier': 'AdaBoostClassifier', 'features': 'Marked & transmucosal
increase in lamina propria cellularity, Crypt architecture, Epithelial changes,
Mucosal surface, Lamina propria granulomas, Patchy lamina propria cellularity?,
Mucin depletion, Submucosal granulomas, Cryptitis extent, Lamina propria
polymorphs, Cryptitis polymorphs', 'accuracy': [0.7131782945736435,
0.8062015503875969, 0.8062015503875969, 0.7441860465116279, 0.75],
'avgAccuracy': 0.763953488372093, 'f1': [0.6808189226793878, 0.7697812954980905,
0.7633167512109851, 0.6870748139792838, 0.6686868686868686], 'avgF1':
0.7139357304109232, 'precision': [0.7131782945736435, 0.8062015503875969,
0.8062015503875969, 0.7441860465116279, 0.75], 'avgPrecision':
0.763953488372093, 'recall': [0.7131782945736435, 0.8062015503875969,
0.8062015503875969, 0.7441860465116279, 0.75], 'avgRecall': 0.763953488372093,
'params': [{'algorithm': 'SAMME.R', 'base_estimator': None, 'learning_rate': 1,
'n_estimators': 300, 'random_state': None}]}

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

Processing Model: DecisionTreeClassifier
*******************************************************
* DecisionTreeClassifier
* Best Params Result:
* {'classifier': 'DecisionTreeClassifier', 'features': 'Marked & transmucosal
increase in lamina propria cellularity, Crypt architecture, Epithelial changes,
Mucosal surface, Lamina propria granulomas, Patchy lamina propria cellularity?,
Mucin depletion, Submucosal granulomas, Cryptitis extent, Lamina propria
polymorphs, Cryptitis polymorphs', 'accuracy': [0.6976744186046512,
0.7674418604651163, 0.751937984496124, 0.6976744186046512, 0.71875],
'avgAccuracy': 0.7266957364341086, 'f1': [0.6727739604667519,
0.7397313848560582, 0.7161091462330323, 0.6532646967540319, 0.6826923076923077],
'avgF1': 0.6929142992004363, 'precision': [0.6976744186046512,
0.7674418604651163, 0.751937984496124, 0.6976744186046512, 0.71875],
'avgPrecision': 0.7266957364341086, 'recall': [0.6976744186046512,
0.7674418604651163, 0.751937984496124, 0.6976744186046512, 0.71875],
'avgRecall': 0.7266957364341086, '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': 'Marked & transmucosal increase in lamina
propria cellularity, Crypt architecture, Epithelial changes, Mucosal surface,
Lamina propria granulomas, Patchy lamina propria cellularity?, Mucin depletion,
Submucosal granulomas, Cryptitis extent, Lamina propria polymorphs, Cryptitis
polymorphs', 'accuracy': [0.6976744186046512, 0.7829457364341085,
0.7829457364341085, 0.7441860465116279, 0.765625], 'avgAccuracy':
0.7546753875968992, 'f1': [0.6150153396175428, 0.7125512995896034,
0.7125512995896034, 0.6606878200386334, 0.6893939393939393], 'avgF1':
0.6780399396458645, 'precision': [0.6976744186046512, 0.7829457364341085,
0.7829457364341085, 0.7441860465116279, 0.765625], 'avgPrecision':
0.7546753875968992, 'recall': [0.6976744186046512, 0.7829457364341085,
0.7829457364341085, 0.7441860465116279, 0.765625], 'avgRecall':
0.7546753875968992, '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}]}
*******************************************************
```

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Processing Model: MLPClassifier
****************************************************
* MLPClassifier
* Best Params Result:
* {'classifier': 'MLPClassifier', 'features': 'Marked & transmucosal increase in
lamina propria cellularity, Crypt architecture, Epithelial changes, Mucosal
surface, Lamina propria granulomas, Patchy lamina propria cellularity?, Mucin
depletion, Submucosal granulomas, Cryptitis extent, Lamina propria polymorphs,
Cryptitis polymorphs', 'accuracy': [0.6976744186046512, 0.7906976744186046,
0.7906976744186046, 0.7364341085271318, 0.765625], 'avgAccuracy':
0.7562257751937984, 'f1': [0.658327059920926, 0.7443820913078638,
0.7276790369917914, 0.6555514540010664, 0.7162883845126836], 'avgF1':
0.7004456053468663, 'precision': [0.6976744186046512, 0.7906976744186046,
0.7906976744186046, 0.7364341085271318, 0.765625], 'avgPrecision':
0.7562257751937984, 'recall': [0.6976744186046512, 0.7906976744186046,
0.7906976744186046, 0.7364341085271318, 0.765625], 'avgRecall':
0.7562257751937984, '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': 'AdaBoostClassifier', 'features': 'Marked & transmucosal
increase in lamina propria cellularity, Crypt architecture, Epithelial changes,
Mucosal surface, Lamina propria granulomas, Patchy lamina propria cellularity?,
Mucin depletion, Submucosal granulomas, Cryptitis extent, Lamina propria
polymorphs, Cryptitis polymorphs', 'accuracy': [0.7131782945736435,
0.8062015503875969, 0.8062015503875969, 0.7441860465116279, 0.75],
'avgAccuracy': 0.763953488372093, 'f1': [0.6808189226793878, 0.7697812954980905,
0.7633167512109851, 0.6870748139792838, 0.6686868686868686], 'avgF1':
0.7139357304109232, 'precision': [0.7131782945736435, 0.8062015503875969,
0.8062015503875969, 0.7441860465116279, 0.75], 'avgPrecision':
0.763953488372093, 'recall': [0.7131782945736435, 0.8062015503875969,
0.8062015503875969, 0.7441860465116279, 0.75], 'avgRecall': 0.763953488372093,
'params': [{'algorithm': 'SAMME.R', 'base_estimator': None, 'learning_rate': 1,
'n_estimators': 300, 'random_state': None}]}
****************************************************

                     model                                         features  \
0   RandomForestClassifier  Marked & transmucosal increase in lamina propr…
1      KNeighborsClassifier  Marked & transmucosal increase in lamina propr…
2        LogisticRegression  Marked & transmucosal increase in lamina propr…
3                GaussianNB  Marked & transmucosal increase in lamina propr…
4       AdaBoostClassifier  Marked & transmucosal increase in lamina propr…
```

```
5   DecisionTreeClassifier   Marked & transmucosal increase in lamina propr…
6                      SVC   Marked & transmucosal increase in lamina propr…
7            MLPClassifier   Marked & transmucosal increase in lamina propr…


    accuracy        f1  precision    recall  \
0   0.734508  0.683511   0.734508  0.734508
1   0.754687  0.683377   0.754687  0.754687
2   0.759314  0.697762   0.759314  0.759314
3   0.756226  0.681065   0.756226  0.756226
4   0.763953  0.713936   0.763953  0.763953
5   0.726696  0.692914   0.726696  0.726696
6   0.754675  0.678040   0.754675  0.754675
7   0.756226  0.700446   0.756226  0.756226


                                                  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': 'Marked & transmucosal
increase in lamina propria cellularity, Crypt architecture, Epithelial changes,
Mucosal surface, Lamina propria granulomas, Patchy lamina propria cellularity?,
Mucin depletion, Submucosal granulomas, Cryptitis extent, Lamina propria
polymorphs', 'accuracy': [0.6976744186046512, 0.7906976744186046,
0.7441860465116279, 0.7286821705426356, 0.7578125], 'avgAccuracy':
0.7438105620155039, 'f1': [0.658327059920926, 0.7575987020010818,
0.6961113100574797, 0.6597275296914996, 0.7175882043180621], 'avgF1':
0.6978705611978099, 'precision': [0.6976744186046512, 0.7906976744186046,
0.7441860465116279, 0.7286821705426356, 0.7578125], 'avgPrecision':
0.7438105620155039, 'recall': [0.6976744186046512, 0.7906976744186046,
0.7441860465116279, 0.7286821705426356, 0.7578125], 'avgRecall':
0.7438105620155039, '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':
True, 'random_state': None, 'verbose': 0, 'warm_start': False}]}
********************************************************
```

```
Processing Model: KNeighborsClassifier
*******************************************************
* KNeighborsClassifier
* Best Params Result:
* {'classifier': 'KNeighborsClassifier', 'features': 'Marked & transmucosal
increase in lamina propria cellularity, Crypt architecture, Epithelial changes,
Mucosal surface, Lamina propria granulomas, Patchy lamina propria cellularity?,
Mucin depletion, Submucosal granulomas, Cryptitis extent, Lamina propria
polymorphs', 'accuracy': [0.6821705426356589, 0.7829457364341085,
0.7829457364341085, 0.751937984496124, 0.78125], 'avgAccuracy': 0.75625, 'f1':
[0.6408053706861018, 0.7454780361757106, 0.7125512995896034, 0.6928223031968,
0.7194591984548527], 'avgF1': 0.7022232416206137, 'precision':
[0.6821705426356589, 0.7829457364341085, 0.7829457364341085, 0.751937984496124,
0.78125], 'avgPrecision': 0.75625, 'recall': [0.6821705426356589,
0.7829457364341085, 0.7829457364341085, 0.751937984496124, 0.78125],
'avgRecall': 0.75625, 'params': [{'algorithm': 'auto', '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': 'Marked & transmucosal
increase in lamina propria cellularity, Crypt architecture, Epithelial changes,
Mucosal surface, Lamina propria granulomas, Patchy lamina propria cellularity?,
Mucin depletion, Submucosal granulomas, Cryptitis extent, Lamina propria
polymorphs', 'accuracy': [0.7054263565891473, 0.7906976744186046,
0.7984496124031008, 0.7441860465116279, 0.765625], 'avgAccuracy':
0.7608769379844961, 'f1': [0.664364575992483, 0.7365355463850676,
0.7330833496189173, 0.6606878200386334, 0.7162883845126836], 'avgF1':
0.7021919353095569, 'precision': [0.7054263565891473, 0.7906976744186046,
0.7984496124031008, 0.7441860465116279, 0.765625], 'avgPrecision':
0.7608769379844961, 'recall': [0.7054263565891473, 0.7906976744186046,
0.7984496124031008, 0.7441860465116279, 0.765625], 'avgRecall':
0.7608769379844961, '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': 'Marked & transmucosal increase in
lamina propria cellularity, Crypt architecture, Epithelial changes, Mucosal
```

surface, Lamina propria granulomas, Patchy lamina propria cellularity?, Mucin depletion, Submucosal granulomas, Cryptitis extent, Lamina propria polymorphs', 'accuracy': [0.6976744186046512, 0.7906976744186046, 0.7829457364341085, 0.7441860465116279, 0.765625], 'avgAccuracy': 0.7562257751937984, 'f1': [0.6150153396175428, 0.7276790369917914, 0.7125512995896034, 0.6606878200386334, 0.6893939393939393], 'avgF1': 0.6810654871263021, 'precision': [0.6976744186046512, 0.7906976744186046, 0.7829457364341085, 0.7441860465116279, 0.765625], 'avgPrecision': 0.7562257751937984, 'recall': [0.6976744186046512, 0.7906976744186046, 0.7829457364341085, 0.7441860465116279, 0.765625], 'avgRecall': 0.7562257751937984, 'params': [{'priors': None, 'var_smoothing': 1e-09}]}
****

Processing Model: AdaBoostClassifier
****
* AdaBoostClassifier
* Best Params Result:
* {'classifier': 'AdaBoostClassifier', 'features': 'Marked & transmucosal increase in lamina propria cellularity, Crypt architecture, Epithelial changes, Mucosal surface, Lamina propria granulomas, Patchy lamina propria cellularity?, Mucin depletion, Submucosal granulomas, Cryptitis extent, Lamina propria polymorphs', 'accuracy': [0.7131782945736435, 0.8062015503875969, 0.7984496124031008, 0.7286821705426356, 0.7578125], 'avgAccuracy': 0.7608648255813953, 'f1': [0.6808189226793878, 0.7697812954980905, 0.7501835985312117, 0.6756955814483354, 0.7175882043180621], 'avgF1': 0.7188135204950176, 'precision': [0.7131782945736435, 0.8062015503875969, 0.7984496124031008, 0.7286821705426356, 0.7578125], 'avgPrecision': 0.7608648255813953, 'recall': [0.7131782945736435, 0.8062015503875969, 0.7984496124031008, 0.7286821705426356, 0.7578125], 'avgRecall': 0.7608648255813953, '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': 'Marked & transmucosal increase in lamina propria cellularity, Crypt architecture, Epithelial changes, Mucosal surface, Lamina propria granulomas, Patchy lamina propria cellularity?, Mucin depletion, Submucosal granulomas, Cryptitis extent, Lamina propria polymorphs', 'accuracy': [0.6976744186046512, 0.7441860465116279, 0.751937984496124, 0.6434108527131783, 0.7734375], 'avgAccuracy': 0.7221293604651163, 'f1': [0.6683696830943487, 0.7222041815502211, 0.7161091462330323, 0.6198182198610876, 0.7599728629579376], 'avgF1': 0.6972948187393255, 'precision': [0.6976744186046512, 0.7441860465116279, 0.751937984496124, 0.6434108527131783, 0.7734375], 'avgPrecision': 0.7221293604651163, 'recall': [0.6976744186046512, 0.7441860465116279,

0.751937984496124, 0.6434108527131783, 0.7734375], 'avgRecall':
0.7221293604651163, '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': 'Marked & transmucosal increase in lamina
propria cellularity, Crypt architecture, Epithelial changes, Mucosal surface,
Lamina propria granulomas, Patchy lamina propria cellularity?, Mucin depletion,
Submucosal granulomas, Cryptitis extent, Lamina propria polymorphs', 'accuracy':
[0.6976744186046512, 0.7829457364341085, 0.7829457364341085, 0.7441860465116279,
0.765625], 'avgAccuracy': 0.7546753875968992, 'f1': [0.6150153396175428,
0.7125512995896034, 0.7125512995896034, 0.6606878200386334, 0.6893939393939393],
'avgF1': 0.6780399396458645, 'precision': [0.6976744186046512,
0.7829457364341085, 0.7829457364341085, 0.7441860465116279, 0.765625],
'avgPrecision': 0.7546753875968992, 'recall': [0.6976744186046512,
0.7829457364341085, 0.7829457364341085, 0.7441860465116279, 0.765625],
'avgRecall': 0.7546753875968992, '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': 'Marked & transmucosal increase in
lamina propria cellularity, Crypt architecture, Epithelial changes, Mucosal
surface, Lamina propria granulomas, Patchy lamina propria cellularity?, Mucin
depletion, Submucosal granulomas, Cryptitis extent, Lamina propria polymorphs',
'accuracy': [0.7054263565891473, 0.7751937984496124, 0.8062015503875969,
0.7364341085271318, 0.765625], 'avgAccuracy': 0.7577761627906977, 'f1':
[0.664364575992483, 0.7329463027777849, 0.7560514318380255, 0.6555514540010664,
0.7162883845126836], 'avgF1': 0.7050404298244087, 'precision':
[0.7054263565891473, 0.7751937984496124, 0.8062015503875969, 0.7364341085271318,
0.765625], 'avgPrecision': 0.7577761627906977, 'recall': [0.7054263565891473,
0.7751937984496124, 0.8062015503875969, 0.7364341085271318, 0.765625],
'avgRecall': 0.7577761627906977, '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': 'AdaBoostClassifier', 'features': 'Marked & transmucosal
increase in lamina propria cellularity, Crypt architecture, Epithelial changes,
Mucosal surface, Lamina propria granulomas, Patchy lamina propria cellularity?,
Mucin depletion, Submucosal granulomas, Cryptitis extent, Lamina propria
polymorphs', 'accuracy': [0.7131782945736435, 0.8062015503875969,
0.7984496124031008, 0.7286821705426356, 0.7578125], 'avgAccuracy':
0.7608648255813953, 'f1': [0.6808189226793878, 0.7697812954980905,
0.7501835985312117, 0.6756955814483354, 0.7175882043180621], 'avgF1':
0.7188135204950176, 'precision': [0.7131782945736435, 0.8062015503875969,
0.7984496124031008, 0.7286821705426356, 0.7578125], 'avgPrecision':
0.7608648255813953, 'recall': [0.7131782945736435, 0.8062015503875969,
0.7984496124031008, 0.7286821705426356, 0.7578125], 'avgRecall':
0.7608648255813953, 'params': [{'algorithm': 'SAMME.R', 'base_estimator': None,
'learning_rate': 1, 'n_estimators': 100, 'random_state': None}]}
*****************************************************
```

```
                   model                                    features  \
0  RandomForestClassifier  Marked & transmucosal increase in lamina propr…
1    KNeighborsClassifier  Marked & transmucosal increase in lamina propr…
2      LogisticRegression  Marked & transmucosal increase in lamina propr…
3              GaussianNB  Marked & transmucosal increase in lamina propr…
4      AdaBoostClassifier  Marked & transmucosal increase in lamina propr…
5  DecisionTreeClassifier  Marked & transmucosal increase in lamina propr…
6                     SVC  Marked & transmucosal increase in lamina propr…
7           MLPClassifier  Marked & transmucosal increase in lamina propr…


   accuracy        f1  precision    recall  \
0  0.743811  0.697871   0.743811  0.743811
1  0.756250  0.702223   0.756250  0.756250
2  0.760877  0.702192   0.760877  0.760877
3  0.756226  0.681065   0.756226  0.756226
4  0.760865  0.718814   0.760865  0.760865
5  0.722129  0.697295   0.722129  0.722129
6  0.754675  0.678040   0.754675  0.754675
7  0.757776  0.705040   0.757776  0.757776


                                            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': 'Marked & transmucosal increase in lamina propria cellularity, Crypt architecture, Epithelial changes, Mucosal surface, Lamina propria granulomas, Patchy lamina propria cellularity?, Mucin depletion, Submucosal granulomas, Cryptitis extent', 'accuracy': [0.7054263565891473, 0.7906976744186046, 0.7674418604651163, 0.7209302325581395, 0.7578125], 'avgAccuracy': 0.7484617248062015, 'f1': [0.6585485164394547, 0.7443820913078638, 0.7199701301472157, 0.662624584717608, 0.7175882043180621], 'avgF1': 0.7006227053860409, 'precision': [0.7054263565891473, 0.7906976744186046, 0.7674418604651163, 0.7209302325581395, 0.7578125], 'avgPrecision': 0.7484617248062015, 'recall': [0.7054263565891473, 0.7906976744186046, 0.7674418604651163, 0.7209302325581395, 0.7578125], 'avgRecall': 0.7484617248062015, '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': True, 'random_state': None, 'verbose': 0, 'warm_start': False}]}
```
********************************************************
```

Processing Model: KNeighborsClassifier
```
********************************************************
```
* KNeighborsClassifier
* Best Params Result:
* {'classifier': 'KNeighborsClassifier', 'features': 'Marked & transmucosal increase in lamina propria cellularity, Crypt architecture, Epithelial changes, Mucosal surface, Lamina propria granulomas, Patchy lamina propria cellularity?, Mucin depletion, Submucosal granulomas, Cryptitis extent', 'accuracy': [0.6821705426356589, 0.7829457364341085, 0.7906976744186046, 0.751937984496124, 0.78125], 'avgAccuracy': 0.7578003875968992, 'f1': [0.6408053706861018, 0.7386387881374012, 0.7276790369917914, 0.6928223031968, 0.7194591984548527], 'avgF1': 0.7038809394933895, 'precision': [0.6821705426356589, 0.7829457364341085, 0.7906976744186046, 0.751937984496124, 0.78125], 'avgPrecision': 0.7578003875968992, 'recall': [0.6821705426356589, 0.7829457364341085, 0.7906976744186046, 0.751937984496124, 0.78125], 'avgRecall': 0.7578003875968992, 'params': [{'algorithm': 'ball_tree', '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': 'Marked & transmucosal
increase in lamina propria cellularity, Crypt architecture, Epithelial changes,
Mucosal surface, Lamina propria granulomas, Patchy lamina propria cellularity?,
Mucin depletion, Submucosal granulomas, Cryptitis extent', 'accuracy':
[0.7054263565891473, 0.7984496124031008, 0.7984496124031008, 0.7364341085271318,
0.765625], 'avgAccuracy': 0.7608769379844961, 'f1': [0.664364575992483,
0.7421607654165794, 0.7330833496189173, 0.6555514540010664, 0.7162883845126836],
'avgF1': 0.7022897059083459, 'precision': [0.7054263565891473,
0.7984496124031008, 0.7984496124031008, 0.7364341085271318, 0.765625],
'avgPrecision': 0.7608769379844961, 'recall': [0.7054263565891473,
0.7984496124031008, 0.7984496124031008, 0.7364341085271318, 0.765625],
'avgRecall': 0.7608769379844961, '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': 'Marked & transmucosal increase in
lamina propria cellularity, Crypt architecture, Epithelial changes, Mucosal
surface, Lamina propria granulomas, Patchy lamina propria cellularity?, Mucin
depletion, Submucosal granulomas, Cryptitis extent', 'accuracy':
[0.6976744186046512, 0.7906976744186046, 0.7829457364341085, 0.7441860465116279,
0.765625], 'avgAccuracy': 0.7562257751937984, 'f1': [0.6150153396175428,
0.7276790369917914, 0.7125512995896034, 0.6606878200386334, 0.6893939393939393],
'avgF1': 0.6810654871263021, 'precision': [0.6976744186046512,
0.7906976744186046, 0.7829457364341085, 0.7441860465116279, 0.765625],
'avgPrecision': 0.7562257751937984, 'recall': [0.6976744186046512,
0.7906976744186046, 0.7829457364341085, 0.7441860465116279, 0.765625],
'avgRecall': 0.7562257751937984, 'params': [{'priors': None, 'var_smoothing':
1e-09}]}
****

Processing Model: AdaBoostClassifier
****
* AdaBoostClassifier
* Best Params Result:
* {'classifier': 'AdaBoostClassifier', 'features': 'Marked & transmucosal
increase in lamina propria cellularity, Crypt architecture, Epithelial changes,

Mucosal surface, Lamina propria granulomas, Patchy lamina propria cellularity?, Mucin depletion, Submucosal granulomas, Cryptitis extent', 'accuracy': [0.6976744186046512, 0.7906976744186046, 0.7829457364341085, 0.7364341085271318, 0.75], 'avgAccuracy': 0.7515503875968992, 'f1': [0.6727739604667519, 0.7513637991379379, 0.7223269781409317, 0.6813676633444076, 0.7118012422360248], 'avgF1': 0.7079267286652108, 'precision': [0.6976744186046512, 0.7906976744186046, 0.7829457364341085, 0.7364341085271318, 0.75], 'avgPrecision': 0.7515503875968992, 'recall': [0.6976744186046512, 0.7906976744186046, 0.7829457364341085, 0.7364341085271318, 0.75], 'avgRecall': 0.7515503875968992, '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': 'Marked & transmucosal increase in lamina propria cellularity, Crypt architecture, Epithelial changes, Mucosal surface, Lamina propria granulomas, Patchy lamina propria cellularity?, Mucin depletion, Submucosal granulomas, Cryptitis extent', 'accuracy': [0.7054263565891473, 0.7596899224806202, 0.7364341085271318, 0.6666666666666666, 0.7578125], 'avgAccuracy': 0.7252059108527131, 'f1': [0.664364575992483, 0.7390402917592985, 0.7110188261351053, 0.6513617643151322, 0.734624581539933], 'avgF1': 0.7000820079483904, 'precision': [0.7054263565891473, 0.7596899224806202, 0.7364341085271318, 0.6666666666666666, 0.7578125], 'avgPrecision': 0.7252059108527131, 'recall': [0.7054263565891473, 0.7596899224806202, 0.7364341085271318, 0.6666666666666666, 0.7578125], 'avgRecall': 0.7252059108527131, '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': 'Marked & transmucosal increase in lamina propria cellularity, Crypt architecture, Epithelial changes, Mucosal surface, Lamina propria granulomas, Patchy lamina propria cellularity?, Mucin depletion, Submucosal granulomas, Cryptitis extent', 'accuracy': [0.6976744186046512, 0.7829457364341085, 0.7829457364341085, 0.7441860465116279, 0.765625], 'avgAccuracy': 0.7546753875968992, 'f1': [0.6150153396175428, 0.7125512995896034, 0.7125512995896034, 0.6606878200386334, 0.6893939393939393], 'avgF1': 0.6780399396458645, 'precision': [0.6976744186046512, 0.7829457364341085, 0.7829457364341085, 0.7441860465116279, 0.765625],

'avgPrecision': 0.7546753875968992, 'recall': [0.6976744186046512, 0.7829457364341085, 0.7829457364341085, 0.7441860465116279, 0.765625], 'avgRecall': 0.7546753875968992, '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': 'Marked & transmucosal increase in lamina propria cellularity, Crypt architecture, Epithelial changes, Mucosal surface, Lamina propria granulomas, Patchy lamina propria cellularity?, Mucin depletion, Submucosal granulomas, Cryptitis extent', 'accuracy': [0.6976744186046512, 0.7984496124031008, 0.7984496124031008, 0.7364341085271318, 0.765625], 'avgAccuracy': 0.7593265503875969, 'f1': [0.658327059920926, 0.7421607654165794, 0.7330833496189173, 0.6555514540010664, 0.7162883845126836], 'avgF1': 0.7010822026940345, 'precision': [0.6976744186046512, 0.7984496124031008, 0.7984496124031008, 0.7364341085271318, 0.765625], 'avgPrecision': 0.7593265503875969, 'recall': [0.6976744186046512, 0.7984496124031008, 0.7984496124031008, 0.7364341085271318, 0.765625], 'avgRecall': 0.7593265503875969, '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': 'LogisticRegression', 'features': 'Marked & transmucosal increase in lamina propria cellularity, Crypt architecture, Epithelial changes, Mucosal surface, Lamina propria granulomas, Patchy lamina propria cellularity?, Mucin depletion, Submucosal granulomas, Cryptitis extent', 'accuracy': [0.7054263565891473, 0.7984496124031008, 0.7984496124031008, 0.7364341085271318, 0.765625], 'avgAccuracy': 0.7608769379844961, 'f1': [0.664364575992483, 0.7421607654165794, 0.7330833496189173, 0.6555514540010664, 0.7162883845126836], 'avgF1': 0.7022897059083459, 'precision': [0.7054263565891473, 0.7984496124031008, 0.7984496124031008, 0.7364341085271318, 0.765625], 'avgPrecision': 0.7608769379844961, 'recall': [0.7054263565891473, 0.7984496124031008, 0.7984496124031008, 0.7364341085271318, 0.765625], 'avgRecall': 0.7608769379844961, '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  Marked & transmucosal increase in lamina propr…
1    KNeighborsClassifier  Marked & transmucosal increase in lamina propr…
2      LogisticRegression  Marked & transmucosal increase in lamina propr…
3              GaussianNB  Marked & transmucosal increase in lamina propr…
4      AdaBoostClassifier  Marked & transmucosal increase in lamina propr…
5  DecisionTreeClassifier  Marked & transmucosal increase in lamina propr…
6                     SVC  Marked & transmucosal increase in lamina propr…
7           MLPClassifier  Marked & transmucosal increase in lamina propr…


   accuracy        f1  precision    recall  \
0  0.748462  0.700623   0.748462  0.748462
1  0.757800  0.703881   0.757800  0.757800
2  0.760877  0.702290   0.760877  0.760877
3  0.756226  0.681065   0.756226  0.756226
4  0.751550  0.707927   0.751550  0.751550
5  0.725206  0.700082   0.725206  0.725206
6  0.754675  0.678040   0.754675  0.754675
7  0.759327  0.701082   0.759327  0.759327


                                               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': 'Marked & transmucosal
increase in lamina propria cellularity, Crypt architecture, Epithelial changes,
Mucosal surface, Lamina propria granulomas, Patchy lamina propria cellularity?,
Mucin depletion, Submucosal granulomas', 'accuracy': [0.6976744186046512,
0.8062015503875969, 0.7441860465116279, 0.689922480620155, 0.765625],
'avgAccuracy': 0.7407218992248062, 'f1': [0.6635658914728682,
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'avgF1': 0.7023643757540459, 'precision': [0.6976744186046512,
0.8062015503875969, 0.7441860465116279, 0.689922480620155, 0.765625],
'avgPrecision': 0.7407218992248062, 'recall': [0.6976744186046512,
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0.8062015503875969, 0.7441860465116279, 0.689922480620155, 0.765625],
'avgRecall': 0.7407218992248062, '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': 'Marked & transmucosal
increase in lamina propria cellularity, Crypt architecture, Epithelial changes,
Mucosal surface, Lamina propria granulomas, Patchy lamina propria cellularity?,
Mucin depletion, Submucosal granulomas', 'accuracy': [0.6976744186046512,
0.813953488372093, 0.7674418604651163, 0.7364341085271318, 0.765625],
'avgAccuracy': 0.7562257751937984, 'f1': [0.7063172311088063,
0.7694002447980417, 0.7024931908652838, 0.6813676633444076, 0.7234133790737565],
'avgF1': 0.7165983418380591, 'precision': [0.6976744186046512,
0.813953488372093, 0.7674418604651163, 0.7364341085271318, 0.765625],
'avgPrecision': 0.7562257751937984, 'recall': [0.6976744186046512,
0.813953488372093, 0.7674418604651163, 0.7364341085271318, 0.765625],
'avgRecall': 0.7562257751937984, 'params': [{'algorithm': 'auto', 'leaf_size':
30, 'metric': 'minkowski', 'metric_params': None, 'n_jobs': -1, 'n_neighbors':
13, 'p': 2, 'weights': 'uniform'}]}
****

Processing Model: LogisticRegression
****
* LogisticRegression
* Best Params Result:
* {'classifier': 'LogisticRegression', 'features': 'Marked & transmucosal
increase in lamina propria cellularity, Crypt architecture, Epithelial changes,
Mucosal surface, Lamina propria granulomas, Patchy lamina propria cellularity?,
Mucin depletion, Submucosal granulomas', 'accuracy': [0.6976744186046512,
0.7984496124031008, 0.7984496124031008, 0.7441860465116279, 0.7578125],
'avgAccuracy': 0.7593144379844962, 'f1': [0.658327059920926, 0.7501835985312117,
0.7330833496189173, 0.6606878200386334, 0.7175882043180621], 'avgF1':
0.7039740064855501, 'precision': [0.6976744186046512, 0.7984496124031008,
0.7984496124031008, 0.7441860465116279, 0.7578125], 'avgPrecision':
0.7593144379844962, 'recall': [0.6976744186046512, 0.7984496124031008,
0.7984496124031008, 0.7441860465116279, 0.7578125], 'avgRecall':
0.7593144379844962, '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': 'Marked & transmucosal increase in
lamina propria cellularity, Crypt architecture, Epithelial changes, Mucosal
surface, Lamina propria granulomas, Patchy lamina propria cellularity?, Mucin
depletion, Submucosal granulomas', 'accuracy': [0.6976744186046512,
0.7906976744186046, 0.7829457364341085, 0.7441860465116279, 0.765625],
'avgAccuracy': 0.7562257751937984, 'f1': [0.6150153396175428,
0.7276790369917914, 0.7125512995896034, 0.6606878200386334, 0.6893939393939393],
'avgF1': 0.6810654871263021, 'precision': [0.6976744186046512,
0.7906976744186046, 0.7829457364341085, 0.7441860465116279, 0.765625],
'avgPrecision': 0.7562257751937984, 'recall': [0.6976744186046512,
0.7906976744186046, 0.7829457364341085, 0.7441860465116279, 0.765625],
'avgRecall': 0.7562257751937984, 'params': [{'priors': None, 'var_smoothing':
1e-09}]}
*****************************************************

Processing Model: AdaBoostClassifier
*****************************************************
* AdaBoostClassifier
* Best Params Result:
* {'classifier': 'AdaBoostClassifier', 'features': 'Marked & transmucosal
increase in lamina propria cellularity, Crypt architecture, Epithelial changes,
Mucosal surface, Lamina propria granulomas, Patchy lamina propria cellularity?,
Mucin depletion, Submucosal granulomas', 'accuracy': [0.689922480620155,
0.8062015503875969, 0.7751937984496124, 0.7364341085271318, 0.765625],
'avgAccuracy': 0.7546753875968992, 'f1': [0.6664986680106559,
0.7633167512109851, 0.7170196609321097, 0.6813676633444076, 0.7234133790737565],
'avgF1': 0.7103232245143829, 'precision': [0.689922480620155,
0.8062015503875969, 0.7751937984496124, 0.7364341085271318, 0.765625],
'avgPrecision': 0.7546753875968992, 'recall': [0.689922480620155,
0.8062015503875969, 0.7751937984496124, 0.7364341085271318, 0.765625],
'avgRecall': 0.7546753875968992, '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': 'Marked & transmucosal
```

increase in lamina propria cellularity, Crypt architecture, Epithelial changes, Mucosal surface, Lamina propria granulomas, Patchy lamina propria cellularity?, Mucin depletion, Submucosal granulomas', 'accuracy': [0.6976744186046512, 0.7751937984496124, 0.7131782945736435, 0.6821705426356589, 0.765625], 'avgAccuracy': 0.7267684108527132, 'f1': [0.6683696830943487, 0.7558764019683761, 0.6823472027127483, 0.6587902280554744, 0.745475113122172], 'avgF1': 0.7021717257906239, 'precision': [0.6976744186046512, 0.7751937984496124, 0.7131782945736435, 0.6821705426356589, 0.765625], 'avgPrecision': 0.7267684108527132, 'recall': [0.6976744186046512, 0.7751937984496124, 0.7131782945736435, 0.6821705426356589, 0.765625], 'avgRecall': 0.7267684108527132, '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': 'Marked & transmucosal increase in lamina propria cellularity, Crypt architecture, Epithelial changes, Mucosal surface, Lamina propria granulomas, Patchy lamina propria cellularity?, Mucin depletion, Submucosal granulomas', 'accuracy': [0.6976744186046512, 0.7829457364341085, 0.7829457364341085, 0.7441860465116279, 0.765625], 'avgAccuracy': 0.7546753875968992, 'f1': [0.6150153396175428, 0.7125512995896034, 0.7125512995896034, 0.6606878200386334, 0.6893939393939393], 'avgF1': 0.6780399396458645, 'precision': [0.6976744186046512, 0.7829457364341085, 0.7829457364341085, 0.7441860465116279, 0.765625], 'avgPrecision': 0.7546753875968992, 'recall': [0.6976744186046512, 0.7829457364341085, 0.7829457364341085, 0.7441860465116279, 0.765625], 'avgRecall': 0.7546753875968992, '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': 'Marked & transmucosal increase in lamina propria cellularity, Crypt architecture, Epithelial changes, Mucosal surface, Lamina propria granulomas, Patchy lamina propria cellularity?, Mucin depletion, Submucosal granulomas', 'accuracy': [0.6976744186046512, 0.7984496124031008, 0.7984496124031008, 0.7441860465116279, 0.765625],

'avgAccuracy': 0.7608769379844961, 'f1': [0.658327059920926, 0.7501835985312117,
0.7330833496189173, 0.6606878200386334, 0.6893939393939393], 'avgF1':
0.6983351535007255, 'precision': [0.6976744186046512, 0.7984496124031008,
0.7984496124031008, 0.7441860465116279, 0.765625], 'avgPrecision':
0.7608769379844961, 'recall': [0.6976744186046512, 0.7984496124031008,
0.7984496124031008, 0.7441860465116279, 0.765625], 'avgRecall':
0.7608769379844961, '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': 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': 'Marked & transmucosal increase in
lamina propria cellularity, Crypt architecture, Epithelial changes, Mucosal
surface, Lamina propria granulomas, Patchy lamina propria cellularity?, Mucin
depletion, Submucosal granulomas', 'accuracy': [0.6976744186046512,
0.7984496124031008, 0.7984496124031008, 0.7441860465116279, 0.765625],
'avgAccuracy': 0.7608769379844961, 'f1': [0.658327059920926, 0.7501835985312117,
0.7330833496189173, 0.6606878200386334, 0.6893939393939393], 'avgF1':
0.6983351535007255, 'precision': [0.6976744186046512, 0.7984496124031008,
0.7984496124031008, 0.7441860465116279, 0.765625], 'avgPrecision':
0.7608769379844961, 'recall': [0.6976744186046512, 0.7984496124031008,
0.7984496124031008, 0.7441860465116279, 0.765625], 'avgRecall':
0.7608769379844961, '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': 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  Marked & transmucosal increase in lamina propr…
1    KNeighborsClassifier  Marked & transmucosal increase in lamina propr…
2      LogisticRegression  Marked & transmucosal increase in lamina propr…
3              GaussianNB  Marked & transmucosal increase in lamina propr…
4      AdaBoostClassifier  Marked & transmucosal increase in lamina propr…
5  DecisionTreeClassifier  Marked & transmucosal increase in lamina propr…
6                     SVC  Marked & transmucosal increase in lamina propr…
7           MLPClassifier  Marked & transmucosal increase in lamina propr…

   accuracy        f1  precision    recall  \
0  0.740722  0.702364   0.740722  0.740722
```

```
1  0.756226   0.716598    0.756226   0.756226
2  0.759314   0.703974    0.759314   0.759314
3  0.756226   0.681065    0.756226   0.756226
4  0.754675   0.710323    0.754675   0.754675
5  0.726768   0.702172    0.726768   0.726768
6  0.754675   0.678040    0.754675   0.754675
7  0.760877   0.698335    0.760877   0.760877


                                                  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': 'Marked & transmucosal
increase in lamina propria cellularity, Crypt architecture, Epithelial changes,
Mucosal surface, Lamina propria granulomas, Patchy lamina propria cellularity?,
Mucin depletion', 'accuracy': [0.6976744186046512, 0.813953488372093,
0.751937984496124, 0.6976744186046512, 0.765625], 'avgAccuracy':
0.7453730620155039, 'f1': [0.6635658914728682, 0.7818383167220376,
0.7091177556293835, 0.6596027869484165, 0.7355769230769231], 'avgF1':
0.7099403347699258, 'precision': [0.6976744186046512, 0.813953488372093,
0.751937984496124, 0.6976744186046512, 0.765625], 'avgPrecision':
0.7453730620155039, 'recall': [0.6976744186046512, 0.813953488372093,
0.751937984496124, 0.6976744186046512, 0.765625], 'avgRecall':
0.7453730620155039, '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': 'Marked & transmucosal
increase in lamina propria cellularity, Crypt architecture, Epithelial changes,
Mucosal surface, Lamina propria granulomas, Patchy lamina propria cellularity?,

Mucin depletion', 'accuracy': [0.6976744186046512, 0.813953488372093,
0.7596899224806202, 0.7364341085271318, 0.765625], 'avgAccuracy':
0.7546753875968992, 'f1': [0.7070291844805862, 0.7694002447980417,
0.6975037754791518, 0.6813676633444076, 0.7234133790737565], 'avgF1':
0.7157428494351887, 'precision': [0.6976744186046512, 0.813953488372093,
0.7596899224806202, 0.7364341085271318, 0.765625], 'avgPrecision':
0.7546753875968992, 'recall': [0.6976744186046512, 0.813953488372093,
0.7596899224806202, 0.7364341085271318, 0.765625], 'avgRecall':
0.7546753875968992, 'params': [{'algorithm': 'auto', 'leaf_size': 30, 'metric':
'minkowski', 'metric_params': None, 'n_jobs': -1, 'n_neighbors': 13, 'p': 2,
'weights': 'uniform'}]}
****

Processing Model: LogisticRegression
****
* LogisticRegression
* Best Params Result:
* {'classifier': 'LogisticRegression', 'features': 'Marked & transmucosal
increase in lamina propria cellularity, Crypt architecture, Epithelial changes,
Mucosal surface, Lamina propria granulomas, Patchy lamina propria cellularity?,
Mucin depletion', 'accuracy': [0.6976744186046512, 0.7829457364341085,
0.7984496124031008, 0.7441860465116279, 0.7578125], 'avgAccuracy':
0.7562136627906977, 'f1': [0.658327059920926, 0.7125512995896034,
0.7330833496189173, 0.6606878200386334, 0.7175882043180621], 'avgF1':
0.6964475466972284, 'precision': [0.6976744186046512, 0.7829457364341085,
0.7984496124031008, 0.7441860465116279, 0.7578125], 'avgPrecision':
0.7562136627906977, 'recall': [0.6976744186046512, 0.7829457364341085,
0.7984496124031008, 0.7441860465116279, 0.7578125], 'avgRecall':
0.7562136627906977, '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': 'Marked & transmucosal increase in
lamina propria cellularity, Crypt architecture, Epithelial changes, Mucosal
surface, Lamina propria granulomas, Patchy lamina propria cellularity?, Mucin
depletion', 'accuracy': [0.6666666666666666, 0.6589147286821705,
0.6821705426356589, 0.7596899224806202, 0.6171875], 'avgAccuracy':
0.6769258720930232, 'f1': [0.676594962309248, 0.6841180738534388,
0.7035224968465439, 0.7653217970740854, 0.6417397809970754], 'avgF1':
0.6942594222160783, 'precision': [0.6666666666666666, 0.6589147286821705,
0.6821705426356589, 0.7596899224806202, 0.6171875], 'avgPrecision':
0.6769258720930232, 'recall': [0.6666666666666666, 0.6589147286821705,

0.6821705426356589, 0.7596899224806202, 0.6171875], 'avgRecall':
0.6769258720930232, 'params': [{'priors': None, 'var_smoothing': 1e-09}]]}
****

Processing Model: AdaBoostClassifier
****
* AdaBoostClassifier
* Best Params Result:
* {'classifier': 'AdaBoostClassifier', 'features': 'Marked & transmucosal
increase in lamina propria cellularity, Crypt architecture, Epithelial changes,
Mucosal surface, Lamina propria granulomas, Patchy lamina propria cellularity?,
Mucin depletion', 'accuracy': [0.689922480620155, 0.813953488372093,
0.7751937984496124, 0.7364341085271318, 0.7578125], 'avgAccuracy':
0.7546632751937985, 'f1': [0.6664986680106559, 0.7759761041177725,
0.7170196609321097, 0.6813676633444076, 0.7175882043180621], 'avgF1':
0.7116900601446016, 'precision': [0.689922480620155, 0.813953488372093,
0.7751937984496124, 0.7364341085271318, 0.7578125], 'avgPrecision':
0.7546632751937985, 'recall': [0.689922480620155, 0.813953488372093,
0.7751937984496124, 0.7364341085271318, 0.7578125], 'avgRecall':
0.7546632751937985, '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': 'Marked & transmucosal
increase in lamina propria cellularity, Crypt architecture, Epithelial changes,
Mucosal surface, Lamina propria granulomas, Patchy lamina propria cellularity?,
Mucin depletion', 'accuracy': [0.6666666666666666, 0.7829457364341085,
0.7441860465116279, 0.6744186046511628, 0.7421875], 'avgAccuracy':
0.7220809108527132, 'f1': [0.6392123153864188, 0.762015503875969,
0.7166880456627216, 0.6528775050905584, 0.717503586800574], 'avgF1':
0.6976593913632484, 'precision': [0.6666666666666666, 0.7829457364341085,
0.7441860465116279, 0.6744186046511628, 0.7421875], 'avgPrecision':
0.7220809108527132, 'recall': [0.6666666666666666, 0.7829457364341085,
0.7441860465116279, 0.6744186046511628, 0.7421875], 'avgRecall':
0.7220809108527132, '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': 'Marked & transmucosal increase in lamina propria cellularity, Crypt architecture, Epithelial changes, Mucosal surface, Lamina propria granulomas, Patchy lamina propria cellularity?, Mucin depletion', 'accuracy': [0.6976744186046512, 0.7829457364341085, 0.7829457364341085, 0.7441860465116279, 0.765625], 'avgAccuracy': 0.7546753875968992, 'f1': [0.6150153396175428, 0.7125512995896034, 0.7125512995896034, 0.6606878200386334, 0.6893939393939393], 'avgF1': 0.6780399396458645, 'precision': [0.6976744186046512, 0.7829457364341085, 0.7829457364341085, 0.7441860465116279, 0.765625], 'avgPrecision': 0.7546753875968992, 'recall': [0.6976744186046512, 0.7829457364341085, 0.7829457364341085, 0.7441860465116279, 0.765625], 'avgRecall': 0.7546753875968992, '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': 'Marked & transmucosal increase in lamina propria cellularity, Crypt architecture, Epithelial changes, Mucosal surface, Lamina propria granulomas, Patchy lamina propria cellularity?, Mucin depletion', 'accuracy': [0.7054263565891473, 0.7984496124031008, 0.7984496124031008, 0.7441860465116279, 0.7578125], 'avgAccuracy': 0.7608648255813953, 'f1': [0.6696954850957637, 0.7501835985312117, 0.7330833496189173, 0.6606878200386334, 0.7175882043180621], 'avgF1': 0.7062476915205177, 'precision': [0.7054263565891473, 0.7984496124031008, 0.7984496124031008, 0.7441860465116279, 0.7578125], 'avgPrecision': 0.7608648255813953, 'recall': [0.7054263565891473, 0.7984496124031008, 0.7984496124031008, 0.7441860465116279, 0.7578125], 'avgRecall': 0.7608648255813953, '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': 'MLPClassifier', 'features': 'Marked & transmucosal increase in lamina propria cellularity, Crypt architecture, Epithelial changes, Mucosal surface, Lamina propria granulomas, Patchy lamina propria cellularity?, Mucin depletion', 'accuracy': [0.7054263565891473, 0.7984496124031008, 0.7984496124031008, 0.7441860465116279, 0.7578125], 'avgAccuracy':

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0.7608648255813953, 'f1': [0.6696954850957637, 0.7501835985312117,
0.7330833496189173, 0.6606878200386334, 0.7175882043180621], 'avgF1':
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0.7984496124031008, 0.7441860465116279, 0.7578125], 'avgPrecision':
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0.7984496124031008, 0.7441860465116279, 0.7578125], 'avgRecall':
0.7608648255813953, '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}]}
****************************************************

                        model                                features  \
0   RandomForestClassifier  Marked & transmucosal increase in lamina propr…
1      KNeighborsClassifier  Marked & transmucosal increase in lamina propr…
2        LogisticRegression  Marked & transmucosal increase in lamina propr…
3                GaussianNB  Marked & transmucosal increase in lamina propr…
4        AdaBoostClassifier  Marked & transmucosal increase in lamina propr…
5    DecisionTreeClassifier  Marked & transmucosal increase in lamina propr…
6                       SVC  Marked & transmucosal increase in lamina propr…
7             MLPClassifier  Marked & transmucosal increase in lamina propr…

    accuracy        f1  precision    recall  \
0   0.745373  0.709940   0.745373  0.745373
1   0.754675  0.715743   0.754675  0.754675
2   0.756214  0.696448   0.756214  0.756214
3   0.676926  0.694259   0.676926  0.676926
4   0.754663  0.711690   0.754663  0.754663
5   0.722081  0.697659   0.722081  0.722081
6   0.754675  0.678040   0.754675  0.754675
7   0.760865  0.706248   0.760865  0.760865


                                            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…
```

```python
now = datetime.datetime.now()
print ("Current date and time : ")
```

```
print (now.strftime("%Y-%m-%d %H:%M:%S"))
```

Current date and time :
2021-06-05 11:25:12

```
# 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)
```

[108]:

```
*******************************************
Starting MSMOTE data set…
*******************************************


Processing Model: RandomForestClassifier
********************************************************
* RandomForestClassifier
* Best Params Result:
* {'classifier': 'RandomForestClassifier', 'features': 'Marked & transmucosal
increase in lamina propria cellularity, Crypt architecture, Epithelial changes,
Mucosal surface, Lamina propria granulomas, Patchy lamina propria cellularity?,
Mucin depletion, Submucosal granulomas, Cryptitis extent, Lamina propria
polymorphs, Cryptitis polymorphs, Basal histiocytic cells, Active inflammation?,
Sex, Increased lamina propria cellularity?, Increased lymphoid aggregates in
lamina propria?, Age, Intraepithelial lymphocytes, Crypt abscesses polymorphs,
Crypt profiles, Crypt abscesses extent, Mild & superficial increase in lamina
propria cellularity?, Severity of Crypt Arch', 'accuracy': [0.9748257164988381,
0.9918667699457785, 0.9961270333075135, 1.0, 0.9790778767919411], 'avgAccuracy':
0.9883794793088142, 'f1': [0.9743678853272765, 0.995916780089442,
0.9961302741477175, 1.0, 0.9793228295369784], 'avgF1': 0.9891475538202829,
'precision': [0.9748257164988381, 0.9918667699457785, 0.9961270333075135, 1.0,
0.9790778767919411], 'avgPrecision': 0.9883794793088142, 'recall':
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0.9790778767919411], 'avgRecall': 0.9883794793088142, 'params': [{'bootstrap':
True, 'ccp_alpha': 0.0, 'class_weight': None, 'criterion': 'entropy',
'max_depth': None, 'max_features': 'auto', 'max_leaf_nodes': None,
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'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': 'Marked & transmucosal
increase in lamina propria cellularity, Crypt architecture, Epithelial changes,
Mucosal surface, Lamina propria granulomas, Patchy lamina propria cellularity?,
Mucin depletion, Submucosal granulomas, Cryptitis extent, Lamina propria
polymorphs, Cryptitis polymorphs, Basal histiocytic cells, Active inflammation?,
Sex, Increased lamina propria cellularity?, Increased lymphoid aggregates in
lamina propria?, Age, Intraepithelial lymphocytes, Crypt abscesses polymorphs,
Crypt profiles, Crypt abscesses extent, Mild & superficial increase in lamina
propria cellularity?, Severity of Crypt Arch', 'accuracy': [0.9686289697908598,
0.9941905499612703, 0.9969016266460109, 0.9965143299767621, 0.9728787291747385],
'avgAccuracy': 0.9858228411099283, 'f1': [0.9676739206610505,
0.9970868129733929, 0.9969026764273867, 0.9982541222114452, 0.9758846916161877],
'avgF1': 0.9871604447778926, 'precision': [0.9686289697908598,
0.9941905499612703, 0.9969016266460109, 0.9965143299767621, 0.9728787291747385],
'avgPrecision': 0.9858228411099283, 'recall': [0.9686289697908598,
0.9941905499612703, 0.9969016266460109, 0.9965143299767621, 0.9728787291747385],
'avgRecall': 0.9858228411099283, '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': 'Marked & transmucosal
increase in lamina propria cellularity, Crypt architecture, Epithelial changes,
Mucosal surface, Lamina propria granulomas, Patchy lamina propria cellularity?,
Mucin depletion, Submucosal granulomas, Cryptitis extent, Lamina propria
polymorphs, Cryptitis polymorphs, Basal histiocytic cells, Active inflammation?,
Sex, Increased lamina propria cellularity?, Increased lymphoid aggregates in
lamina propria?, Age, Intraepithelial lymphocytes, Crypt abscesses polymorphs,
Crypt profiles, Crypt abscesses extent, Mild & superficial increase in lamina
propria cellularity?, Severity of Crypt Arch', 'accuracy': [0.7405112316034083,
0.6994577846630519, 0.7854376452362509, 0.6646010844306739, 0.6594343277799303],
'avgAccuracy': 0.7098884147426631, 'f1': [0.777423060191904, 0.8231540565177757,
0.7867707062024818, 0.798510935318753, 0.7804853075974088], 'avgF1':
0.7932688131656647, 'precision': [0.7405112316034083, 0.6994577846630519,

0.7854376452362509, 0.6646010844306739, 0.6594343277799303], 'avgPrecision':
0.7098884147426631, 'recall': [0.7405112316034083, 0.6994577846630519,
0.7854376452362509, 0.6646010844306739, 0.6594343277799303], 'avgRecall':
0.7098884147426631, 'params': [{'C': 1, 'class_weight': None, 'dual': False,
'fit_intercept': True, 'intercept_scaling': 1, 'l1_ratio': None, 'max_iter':
1000, 'multi_class': 'multinomial', 'n_jobs': -1, 'penalty': 'l2',
'random_state': None, 'solver': 'lbfgs', 'tol': 0.0001, 'verbose': 0,
'warm_start': False}]}
****

Processing Model: GaussianNB
****
* GaussianNB
* Best Params Result:
* {'classifier': 'GaussianNB', 'features': 'Marked & transmucosal increase in
lamina propria cellularity, Crypt architecture, Epithelial changes, Mucosal
surface, Lamina propria granulomas, Patchy lamina propria cellularity?, Mucin
depletion, Submucosal granulomas, Cryptitis extent, Lamina propria polymorphs,
Cryptitis polymorphs, Basal histiocytic cells, Active inflammation?, Sex,
Increased lamina propria cellularity?, Increased lymphoid aggregates in lamina
propria?, Age, Intraepithelial lymphocytes, Crypt abscesses polymorphs, Crypt
profiles, Crypt abscesses extent, Mild & superficial increase in lamina propria
cellularity?, Severity of Crypt Arch', 'accuracy': [0.26103795507358635,
0.13168086754453912, 0.4763749031758327, 1.0, 0.9845021309569935],
'avgAccuracy': 0.5707191713501903, 'f1': [0.25640924396388326,
0.23271731690622857, 0.3812585496570828, 1.0, 0.9790648204787236], 'avgF1':
0.5698899862011836, 'precision': [0.26103795507358635, 0.13168086754453912,
0.4763749031758327, 1.0, 0.9845021309569935], 'avgPrecision':
0.5707191713501903, 'recall': [0.26103795507358635, 0.13168086754453912,
0.4763749031758327, 1.0, 0.9845021309569935], 'avgRecall': 0.5707191713501903,
'params': [{'priors': None, 'var_smoothing': 1e-09}]}
****

Processing Model: AdaBoostClassifier
****
* AdaBoostClassifier
* Best Params Result:
* {'classifier': 'AdaBoostClassifier', 'features': 'Marked & transmucosal
increase in lamina propria cellularity, Crypt architecture, Epithelial changes,
Mucosal surface, Lamina propria granulomas, Patchy lamina propria cellularity?,
Mucin depletion, Submucosal granulomas, Cryptitis extent, Lamina propria
polymorphs, Cryptitis polymorphs, Basal histiocytic cells, Active inflammation?,
Sex, Increased lamina propria cellularity?, Increased lymphoid aggregates in
lamina propria?, Age, Intraepithelial lymphocytes, Crypt abscesses polymorphs,
Crypt profiles, Crypt abscesses extent, Mild & superficial increase in lamina
propria cellularity?, Severity of Crypt Arch', 'accuracy': [0.84856700232378,
0.82571649883811, 0.8733539891556933, 0.7827265685515105, 0.7861294072065091],
'avgAccuracy': 0.8232986932151206, 'f1': [0.8633451762715798,

0.9045396690708528, 0.8738148077694966, 0.8781229632848142, 0.8663113674226026],
'avgF1': 0.8772267967638692, 'precision': [0.84856700232378, 0.82571649883811,
0.8733539891556933, 0.7827265685515105, 0.7861294072065091], 'avgPrecision':
0.8232986932151206, 'recall': [0.84856700232378, 0.82571649883811,
0.8733539891556933, 0.7827265685515105, 0.7861294072065091], 'avgRecall':
0.8232986932151206, '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': 'Marked & transmucosal
increase in lamina propria cellularity, Crypt architecture, Epithelial changes,
Mucosal surface, Lamina propria granulomas, Patchy lamina propria cellularity?,
Mucin depletion, Submucosal granulomas, Cryptitis extent, Lamina propria
polymorphs, Cryptitis polymorphs, Basal histiocytic cells, Active inflammation?,
Sex, Increased lamina propria cellularity?, Increased lymphoid aggregates in
lamina propria?, Age, Intraepithelial lymphocytes, Crypt abscesses polymorphs,
Crypt profiles, Crypt abscesses extent, Mild & superficial increase in lamina
propria cellularity?, Severity of Crypt Arch', 'accuracy': [0.9697908597986057,
0.9930286599535244, 0.9938032532920217, 0.9980635166537568, 0.9748159628051143],
'avgAccuracy': 0.9859004505006046, 'f1': [0.9691002688487015,
0.9965021375825883, 0.9938094503299437, 0.9990308199263424, 0.9771374854420583],
'avgF1': 0.9871160324259268, 'precision': [0.9697908597986057,
0.9930286599535244, 0.9938032532920217, 0.9980635166537568, 0.9748159628051143],
'avgPrecision': 0.9859004505006046, 'recall': [0.9697908597986057,
0.9930286599535244, 0.9938032532920217, 0.9980635166537568, 0.9748159628051143],
'avgRecall': 0.9859004505006046, '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': 'Marked & transmucosal increase in lamina
propria cellularity, Crypt architecture, Epithelial changes, Mucosal surface,
Lamina propria granulomas, Patchy lamina propria cellularity?, Mucin depletion,
Submucosal granulomas, Cryptitis extent, Lamina propria polymorphs, Cryptitis
polymorphs, Basal histiocytic cells, Active inflammation?, Sex, Increased lamina
propria cellularity?, Increased lymphoid aggregates in lamina propria?, Age,
Intraepithelial lymphocytes, Crypt abscesses polymorphs, Crypt profiles, Crypt
abscesses extent, Mild & superficial increase in lamina propria cellularity?,

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Severity of Crypt Arch', 'accuracy': [0.7447714949651433, 0.7498063516653757, 0.8024786986831913, 0.6413632842757552, 0.644711352189074], 'avgAccuracy': 0.7166262363557079, 'f1': [0.7800883034515573, 0.8570163789287295, 0.8019796875306643, 0.781500707881076, 0.769455076002716], 'avgF1': 0.7980080307589487, 'precision': [0.7447714949651433, 0.7498063516653757, 0.8024786986831913, 0.6413632842757552, 0.644711352189074], 'avgPrecision': 0.7166262363557079, 'recall': [0.7447714949651433, 0.7498063516653757, 0.8024786986831913, 0.6413632842757552, 0.644711352189074], 'avgRecall': 0.7166262363557079, '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': 'Marked & transmucosal increase in lamina propria cellularity, Crypt architecture, Epithelial changes, Mucosal surface, Lamina propria granulomas, Patchy lamina propria cellularity?, Mucin depletion, Submucosal granulomas, Cryptitis extent, Lamina propria polymorphs, Cryptitis polymorphs, Basal histiocytic cells, Active inflammation?, Sex, Increased lamina propria cellularity?, Increased lymphoid aggregates in lamina propria?, Age, Intraepithelial lymphocytes, Crypt abscesses polymorphs, Crypt profiles, Crypt abscesses extent, Mild & superficial increase in lamina propria cellularity?, Severity of Crypt Arch', 'accuracy': [0.9298993028659953, 0.9450038729666925, 0.9384198295894656, 0.8927188226181255, 0.8725300271212708], 'avgAccuracy': 0.9157143710323099, 'f1': [0.9305101722946922, 0.9717244125846276, 0.9382817272666095, 0.9433190096173522, 0.9184272413709469], 'avgF1': 0.9404525126268457, 'precision': [0.9298993028659953, 0.9450038729666925, 0.9384198295894656, 0.8927188226181255, 0.8725300271212708], 'avgPrecision': 0.9157143710323099, 'recall': [0.9298993028659953, 0.9450038729666925, 0.9384198295894656, 0.8927188226181255, 0.8725300271212708], 'avgRecall': 0.9157143710323099, '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': 'Marked & transmucosal increase in lamina propria cellularity, Crypt architecture, Epithelial changes, Mucosal surface, Lamina propria granulomas, Patchy lamina propria cellularity?,

Mucin depletion, Submucosal granulomas, Cryptitis extent, Lamina propria polymorphs, Cryptitis polymorphs, Basal histiocytic cells, Active inflammation?, Sex, Increased lamina propria cellularity?, Increased lymphoid aggregates in lamina propria?, Age, Intraepithelial lymphocytes, Crypt abscesses polymorphs, Crypt profiles, Crypt abscesses extent, Mild & superficial increase in lamina propria cellularity?, Severity of Crypt Arch', 'accuracy': [0.9748257164988381, 0.9918667699457785, 0.9961270333075135, 1.0, 0.9790778767919411], 'avgAccuracy': 0.9883794793088142, 'f1': [0.9743678853272765, 0.995916780089442, 0.9961302741477175, 1.0, 0.9793228295369784], 'avgF1': 0.9891475538202829, 'precision': [0.9748257164988381, 0.9918667699457785, 0.9961270333075135, 1.0, 0.9790778767919411], 'avgPrecision': 0.9883794793088142, 'recall': [0.9748257164988381, 0.9918667699457785, 0.9961270333075135, 1.0, 0.9790778767919411], 'avgRecall': 0.9883794793088142, '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': False, 'random_state': None, 'verbose': 0, 'warm_start': False}]}
****

	model	features \
0	RandomForestClassifier	Marked & transmucosal increase in lamina propr…
1	KNeighborsClassifier	Marked & transmucosal increase in lamina propr…
2	LogisticRegression	Marked & transmucosal increase in lamina propr…
3	GaussianNB	Marked & transmucosal increase in lamina propr…
4	AdaBoostClassifier	Marked & transmucosal increase in lamina propr…
5	DecisionTreeClassifier	Marked & transmucosal increase in lamina propr…
6	SVC	Marked & transmucosal increase in lamina propr…
7	MLPClassifier	Marked & transmucosal increase in lamina propr…

	accuracy	f1	precision	recall \
0	0.988379	0.989148	0.988379	0.988379
1	0.985823	0.987160	0.985823	0.985823
2	0.709888	0.793269	0.709888	0.709888
3	0.570719	0.569890	0.570719	0.570719
4	0.823299	0.877227	0.823299	0.823299
5	0.985900	0.987116	0.985900	0.985900
6	0.716626	0.798008	0.716626	0.716626
7	0.915714	0.940453	0.915714	0.915714

	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': 'Marked & transmucosal
increase in lamina propria cellularity, Crypt architecture, Epithelial changes,
Mucosal surface, Lamina propria granulomas, Patchy lamina propria cellularity?,
Mucin depletion, Submucosal granulomas, Cryptitis extent, Lamina propria
polymorphs, Cryptitis polymorphs, Basal histiocytic cells, Active inflammation?,
Sex, Increased lamina propria cellularity?, Increased lymphoid aggregates in
lamina propria?, Age, Intraepithelial lymphocytes, Crypt abscesses polymorphs,
Crypt profiles, Crypt abscesses extent, Mild & superficial increase in lamina
propria cellularity?', 'accuracy': [0.9736638264910922, 0.9922540666150271,
0.9961270333075135, 1.0, 0.9794653235180163], 'avgAccuracy': 0.9883020499863299,
'f1': [0.9731674659131014, 0.9961119751166407, 0.9961302741477175, 1.0,
0.9798216331902337], 'avgF1': 0.9890462696735387, 'precision':
[0.9736638264910922, 0.9922540666150271, 0.9961270333075135, 1.0,
0.9794653235180163], 'avgPrecision': 0.9883020499863299, 'recall':
[0.9736638264910922, 0.9922540666150271, 0.9961270333075135, 1.0,
0.9794653235180163], 'avgRecall': 0.9883020499863299, 'params': [{'bootstrap':
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'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': 'Marked & transmucosal
increase in lamina propria cellularity, Crypt architecture, Epithelial changes,
Mucosal surface, Lamina propria granulomas, Patchy lamina propria cellularity?,
Mucin depletion, Submucosal granulomas, Cryptitis extent, Lamina propria
polymorphs, Cryptitis polymorphs, Basal histiocytic cells, Active inflammation?,
Sex, Increased lamina propria cellularity?, Increased lymphoid aggregates in
lamina propria?, Age, Intraepithelial lymphocytes, Crypt abscesses polymorphs,
Crypt profiles, Crypt abscesses extent, Mild & superficial increase in lamina
propria cellularity?', 'accuracy': [0.9697908597986057, 0.9941905499612703,
0.9969016266460109, 0.9969016266460109, 0.9724912824486633], 'avgAccuracy':
0.9860551891001123, 'f1': [0.9689345541874661, 0.9970868129733929,
0.9969026764273867, 0.9984484096198604, 0.9758248309524068], 'avgF1':
0.9874394568321025, 'precision': [0.9697908597986057, 0.9941905499612703,

0.9969016266460109, 0.9969016266460109, 0.9724912824486633], 'avgPrecision':
0.9860551891001123, 'recall': [0.9697908597986057, 0.9941905499612703,
0.9969016266460109, 0.9969016266460109, 0.9724912824486633], 'avgRecall':
0.9860551891001123, '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': 'Marked & transmucosal
increase in lamina propria cellularity, Crypt architecture, Epithelial changes,
Mucosal surface, Lamina propria granulomas, Patchy lamina propria cellularity?,
Mucin depletion, Submucosal granulomas, Cryptitis extent, Lamina propria
polymorphs, Cryptitis polymorphs, Basal histiocytic cells, Active inflammation?,
Sex, Increased lamina propria cellularity?, Increased lymphoid aggregates in
lamina propria?, Age, Intraepithelial lymphocytes, Crypt abscesses polymorphs,
Crypt profiles, Crypt abscesses extent, Mild & superficial increase in lamina
propria cellularity?', 'accuracy': [0.7393493415956622, 0.6994577846630519,
0.7815646785437645, 0.6646010844306739, 0.6551724137931034], 'avgAccuracy':
0.7080290606052512, 'f1': [0.7764548243144944, 0.8231540565177757,
0.7829940556967838, 0.798510935318753, 0.7773747131425005], 'avgF1':
0.7916977169980615, 'precision': [0.7393493415956622, 0.6994577846630519,
0.7815646785437645, 0.6646010844306739, 0.6551724137931034], 'avgPrecision':
0.7080290606052512, 'recall': [0.7393493415956622, 0.6994577846630519,
0.7815646785437645, 0.6646010844306739, 0.6551724137931034], 'avgRecall':
0.7080290606052512, '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': 'lbfgs', 'tol': 0.0001, 'verbose': 0,
'warm_start': False}]}
****

Processing Model: GaussianNB
****
* GaussianNB
* Best Params Result:
* {'classifier': 'GaussianNB', 'features': 'Marked & transmucosal increase in
lamina propria cellularity, Crypt architecture, Epithelial changes, Mucosal
surface, Lamina propria granulomas, Patchy lamina propria cellularity?, Mucin
depletion, Submucosal granulomas, Cryptitis extent, Lamina propria polymorphs,
Cryptitis polymorphs, Basal histiocytic cells, Active inflammation?, Sex,
Increased lamina propria cellularity?, Increased lymphoid aggregates in lamina
propria?, Age, Intraepithelial lymphocytes, Crypt abscesses polymorphs, Crypt
profiles, Crypt abscesses extent, Mild & superficial increase in lamina propria
cellularity?', 'accuracy': [0.26103795507358635, 0.13168086754453912,

0.4763749031758327, 1.0, 0.9845021309569935], 'avgAccuracy': 0.5707191713501903,
'f1': [0.25640924396388326, 0.23271731690622857, 0.3812585496570828, 1.0,
0.9790648204787236], 'avgF1': 0.5698899862011836, 'precision':
[0.26103795507358635, 0.13168086754453912, 0.4763749031758327, 1.0,
0.9845021309569935], 'avgPrecision': 0.5707191713501903, 'recall':
[0.26103795507358635, 0.13168086754453912, 0.4763749031758327, 1.0,
0.9845021309569935], 'avgRecall': 0.5707191713501903, 'params': [{'priors':
None, 'var_smoothing': 1e-09}]}
****

Processing Model: AdaBoostClassifier
****
* AdaBoostClassifier
* Best Params Result:
* {'classifier': 'AdaBoostClassifier', 'features': 'Marked & transmucosal
increase in lamina propria cellularity, Crypt architecture, Epithelial changes,
Mucosal surface, Lamina propria granulomas, Patchy lamina propria cellularity?,
Mucin depletion, Submucosal granulomas, Cryptitis extent, Lamina propria
polymorphs, Cryptitis polymorphs, Basal histiocytic cells, Active inflammation?,
Sex, Increased lamina propria cellularity?, Increased lymphoid aggregates in
lamina propria?, Age, Intraepithelial lymphocytes, Crypt abscesses polymorphs,
Crypt profiles, Crypt abscesses extent, Mild & superficial increase in lamina
propria cellularity?', 'accuracy': [0.8489542989930287, 0.8187451587916343,
0.879163439194423, 0.7920216886134779, 0.7841921735761332], 'avgAccuracy':
0.8246153518337395, 'f1': [0.8637356720609862, 0.9003407155025552,
0.8795433200600168, 0.8839420791009294, 0.8650952794461256], 'avgF1':
0.8785314132341226, 'precision': [0.8489542989930287, 0.8187451587916343,
0.879163439194423, 0.7920216886134779, 0.7841921735761332], 'avgPrecision':
0.8246153518337395, 'recall': [0.8489542989930287, 0.8187451587916343,
0.879163439194423, 0.7920216886134779, 0.7841921735761332], 'avgRecall':
0.8246153518337395, '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': 'Marked & transmucosal
increase in lamina propria cellularity, Crypt architecture, Epithelial changes,
Mucosal surface, Lamina propria granulomas, Patchy lamina propria cellularity?,
Mucin depletion, Submucosal granulomas, Cryptitis extent, Lamina propria
polymorphs, Cryptitis polymorphs, Basal histiocytic cells, Active inflammation?,
Sex, Increased lamina propria cellularity?, Increased lymphoid aggregates in
lamina propria?, Age, Intraepithelial lymphocytes, Crypt abscesses polymorphs,
Crypt profiles, Crypt abscesses extent, Mild & superficial increase in lamina
propria cellularity?', 'accuracy': [0.9732765298218435, 0.9930286599535244,
0.9941905499612703, 0.9988381099922541, 0.9728787291747385], 'avgAccuracy':

0.9864425157807262, 'f1': [0.9727905244243396, 0.9965021375825883, 0.9941930054144381, 0.9994187173028483, 0.9760735647130044], 'avgF1': 0.9877955898874438, 'precision': [0.9732765298218435, 0.9930286599535244, 0.9941905499612703, 0.9988381099922541, 0.9728787291747385], 'avgPrecision': 0.9864425157807262, 'recall': [0.9732765298218435, 0.9930286599535244, 0.9941905499612703, 0.9988381099922541, 0.9728787291747385], 'avgRecall': 0.9864425157807262, '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': 'Marked & transmucosal increase in lamina propria cellularity, Crypt architecture, Epithelial changes, Mucosal surface, Lamina propria granulomas, Patchy lamina propria cellularity?, Mucin depletion, Submucosal granulomas, Cryptitis extent, Lamina propria polymorphs, Cryptitis polymorphs, Basal histiocytic cells, Active inflammation?, Sex, Increased lamina propria cellularity?, Increased lymphoid aggregates in lamina propria?, Age, Intraepithelial lymphocytes, Crypt abscesses polymorphs, Crypt profiles, Crypt abscesses extent, Mild & superficial increase in lamina propria cellularity?', 'accuracy': [0.7455460883036406, 0.737412858249419, 0.7986057319907048, 0.6409759876065065, 0.6439364587369236], 'avgAccuracy': 0.7132954249774389, 'f1': [0.7806913607465088, 0.8488631297369593, 0.798284941105791, 0.7812131224923295, 0.7688794517439788], 'avgF1': 0.7955864011651135, 'precision': [0.7455460883036406, 0.737412858249419, 0.7986057319907048, 0.6409759876065065, 0.6439364587369236], 'avgPrecision': 0.7132954249774389, 'recall': [0.7455460883036406, 0.737412858249419, 0.7986057319907048, 0.6409759876065065, 0.6439364587369236], 'avgRecall': 0.7132954249774389, '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': 'Marked & transmucosal increase in lamina propria cellularity, Crypt architecture, Epithelial changes, Mucosal surface, Lamina propria granulomas, Patchy lamina propria cellularity?, Mucin depletion, Submucosal granulomas, Cryptitis extent, Lamina propria polymorphs, Cryptitis polymorphs, Basal histiocytic cells, Active inflammation?, Sex,

Increased lamina propria cellularity?, Increased lymphoid aggregates in lamina propria?, Age, Intraepithelial lymphocytes, Crypt abscesses polymorphs, Crypt profiles, Crypt abscesses extent, Mild & superficial increase in lamina propria cellularity?', 'accuracy': [0.9360960495739736, 0.947714949651433, 0.935708752904725, 0.8826491092176607, 0.8717551336691205], 'avgAccuracy': 0.9147847990033826, 'f1': [0.936057893349985, 0.9731556969576457, 0.9356754163792643, 0.9376671466776383, 0.9179313583397674], 'avgF1': 0.9400975023408601, 'precision': [0.9360960495739736, 0.947714949651433, 0.935708752904725, 0.8826491092176607, 0.8717551336691205], 'avgPrecision': 0.9147847990033826, 'recall': [0.9360960495739736, 0.947714949651433, 0.935708752904725, 0.8826491092176607, 0.8717551336691205], 'avgRecall': 0.9147847990033826, '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': 'Marked & transmucosal increase in lamina propria cellularity, Crypt architecture, Epithelial changes, Mucosal surface, Lamina propria granulomas, Patchy lamina propria cellularity?, Mucin depletion, Submucosal granulomas, Cryptitis extent, Lamina propria polymorphs, Cryptitis polymorphs, Basal histiocytic cells, Active inflammation?, Sex, Increased lamina propria cellularity?, Increased lymphoid aggregates in lamina propria?, Age, Intraepithelial lymphocytes, Crypt abscesses polymorphs, Crypt profiles, Crypt abscesses extent, Mild & superficial increase in lamina propria cellularity?', 'accuracy': [0.9736638264910922, 0.9922540666150271, 0.9961270333075135, 1.0, 0.9794653235180163], 'avgAccuracy': 0.9883020499863299, 'f1': [0.9731674659131014, 0.9961119751166407, 0.9961302741477175, 1.0, 0.9798216331902337], 'avgF1': 0.9890462696735387, 'precision': [0.9736638264910922, 0.9922540666150271, 0.9961270333075135, 1.0, 0.9794653235180163], 'avgPrecision': 0.9883020499863299, 'recall': [0.9736638264910922, 0.9922540666150271, 0.9961270333075135, 1.0, 0.9794653235180163], 'avgRecall': 0.9883020499863299, '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  Marked & transmucosal increase in lamina propr…
1    KNeighborsClassifier  Marked & transmucosal increase in lamina propr…
```

```
2        LogisticRegression  Marked & transmucosal increase in lamina propr…
3                GaussianNB  Marked & transmucosal increase in lamina propr…
4         AdaBoostClassifier  Marked & transmucosal increase in lamina propr…
5   DecisionTreeClassifier  Marked & transmucosal increase in lamina propr…
6                       SVC  Marked & transmucosal increase in lamina propr…
7             MLPClassifier  Marked & transmucosal increase in lamina propr…


   accuracy        f1  precision    recall  \
0  0.988302  0.989046   0.988302  0.988302
1  0.986055  0.987439   0.986055  0.986055
2  0.708029  0.791698   0.708029  0.708029
3  0.570719  0.569890   0.570719  0.570719
4  0.824615  0.878531   0.824615  0.824615
5  0.986443  0.987796   0.986443  0.986443
6  0.713295  0.795586   0.713295  0.713295
7  0.914785  0.940098   0.914785  0.914785


                                                    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': 'Marked & transmucosal increase in lamina propria cellularity, Crypt architecture, Epithelial changes, Mucosal surface, Lamina propria granulomas, Patchy lamina propria cellularity?, Mucin depletion, Submucosal granulomas, Cryptitis extent, Lamina propria polymorphs, Cryptitis polymorphs, Basal histiocytic cells, Active inflammation?, Sex, Increased lamina propria cellularity?, Increased lymphoid aggregates in lamina propria?, Age, Intraepithelial lymphocytes, Crypt abscesses polymorphs, Crypt profiles, Crypt abscesses extent', 'accuracy': [0.9736638264910922, 0.9918667699457785, 0.9961270333075135, 1.0, 0.9794653235180163], 'avgAccuracy': 0.9882245906524801, 'f1': [0.9732022021645715, 0.995916780089442, 0.9961302741477175, 1.0, 0.9795870048608761], 'avgF1': 0.9889672522525215, 'precision': [0.9736638264910922, 0.9918667699457785, 0.9961270333075135, 1.0, 0.9794653235180163], 'avgPrecision': 0.9882245906524801, 'recall': [0.9736638264910922, 0.9918667699457785, 0.9961270333075135, 1.0, 0.9794653235180163], 'avgRecall': 0.9882245906524801, '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': 'Marked & transmucosal
increase in lamina propria cellularity, Crypt architecture, Epithelial changes,
Mucosal surface, Lamina propria granulomas, Patchy lamina propria cellularity?,
Mucin depletion, Submucosal granulomas, Cryptitis extent, Lamina propria
polymorphs, Cryptitis polymorphs, Basal histiocytic cells, Active inflammation?,
Sex, Increased lamina propria cellularity?, Increased lymphoid aggregates in
lamina propria?, Age, Intraepithelial lymphocytes, Crypt abscesses polymorphs,
Crypt profiles, Crypt abscesses extent', 'accuracy': [0.9697908597986057,
0.9941905499612703, 0.9969016266460109, 0.9969016266460109, 0.9724912824486633],
'avgAccuracy': 0.9860551891001123, 'f1': [0.9689345541874661,
0.9970868129733929, 0.9969026764273867, 0.9984484096198604, 0.9758248309524068],
'avgF1': 0.9874394568321025, 'precision': [0.9697908597986057,
0.9941905499612703, 0.9969016266460109, 0.9969016266460109, 0.9724912824486633],
'avgPrecision': 0.9860551891001123, 'recall': [0.9697908597986057,
0.9941905499612703, 0.9969016266460109, 0.9969016266460109, 0.9724912824486633],
'avgRecall': 0.9860551891001123, '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': 'Marked & transmucosal
increase in lamina propria cellularity, Crypt architecture, Epithelial changes,
Mucosal surface, Lamina propria granulomas, Patchy lamina propria cellularity?,
Mucin depletion, Submucosal granulomas, Cryptitis extent, Lamina propria
polymorphs, Cryptitis polymorphs, Basal histiocytic cells, Active inflammation?,
Sex, Increased lamina propria cellularity?, Increased lymphoid aggregates in
lamina propria?, Age, Intraepithelial lymphocytes, Crypt abscesses polymorphs,
Crypt profiles, Crypt abscesses extent', 'accuracy': [0.7408985282726569,
0.7006196746707978, 0.7827265685515105, 0.6653756777691712, 0.6563347539713289],
'avgAccuracy': 0.709191040647093, 'f1': [0.7776698727945794, 0.8239580961056706,
0.7841127237588575, 0.7990697674418605, 0.7782246345606274], 'avgF1':
0.79260701893231191, 'precision': [0.7408985282726569, 0.7006196746707978,
0.7827265685515105, 0.6653756777691712, 0.6563347539713289], 'avgPrecision':
0.709191040647093, 'recall': [0.7408985282726569, 0.7006196746707978,
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0.7827265685515105, 0.6653756777691712, 0.6563347539713289], 'avgRecall':
0.709191040647093, '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': 'Marked & transmucosal increase in
lamina propria cellularity, Crypt architecture, Epithelial changes, Mucosal
surface, Lamina propria granulomas, Patchy lamina propria cellularity?, Mucin
depletion, Submucosal granulomas, Cryptitis extent, Lamina propria polymorphs,
Cryptitis polymorphs, Basal histiocytic cells, Active inflammation?, Sex,
Increased lamina propria cellularity?, Increased lymphoid aggregates in lamina
propria?, Age, Intraepithelial lymphocytes, Crypt abscesses polymorphs, Crypt
profiles, Crypt abscesses extent', 'accuracy': [0.24593338497288925,
0.11347792408985283, 0.4666924864446166, 1.0, 0.9852770244091438],
'avgAccuracy': 0.5622761639833005, 'f1': [0.23210809566060528,
0.20382608695652168, 0.3642745251823215, 1.0, 0.979567660978043], 'avgF1':
0.5559552737554982, 'precision': [0.24593338497288925, 0.11347792408985283,
0.4666924864446166, 1.0, 0.9852770244091438], 'avgPrecision':
0.5622761639833005, 'recall': [0.24593338497288925, 0.11347792408985283,
0.4666924864446166, 1.0, 0.9852770244091438], 'avgRecall': 0.5622761639833005,
'params': [{'priors': None, 'var_smoothing': 1e-09}]}
****

Processing Model: AdaBoostClassifier
****
* AdaBoostClassifier
* Best Params Result:
* {'classifier': 'AdaBoostClassifier', 'features': 'Marked & transmucosal
increase in lamina propria cellularity, Crypt architecture, Epithelial changes,
Mucosal surface, Lamina propria granulomas, Patchy lamina propria cellularity?,
Mucin depletion, Submucosal granulomas, Cryptitis extent, Lamina propria
polymorphs, Cryptitis polymorphs, Basal histiocytic cells, Active inflammation?,
Sex, Increased lamina propria cellularity?, Increased lymphoid aggregates in
lamina propria?, Age, Intraepithelial lymphocytes, Crypt abscesses polymorphs,
Crypt profiles, Crypt abscesses extent', 'accuracy': [0.8454686289697909,
0.8280402788536019, 0.879163439194423, 0.7877614252517429, 0.7807051530414568],
'avgAccuracy': 0.8242277850622031, 'f1': [0.8609623792963672,
0.9059322033898305, 0.8794362077842383, 0.8812824956672444, 0.8628947564914238],
'avgF1': 0.8781016085258209, 'precision': [0.8454686289697909,
0.8280402788536019, 0.879163439194423, 0.7877614252517429, 0.7807051530414568],
'avgPrecision': 0.8242277850622031, 'recall': [0.8454686289697909,

0.8280402788536019, 0.879163439194423, 0.7877614252517429, 0.7807051530414568],
'avgRecall': 0.8242277850622031, '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': 'Marked & transmucosal
increase in lamina propria cellularity, Crypt architecture, Epithelial changes,
Mucosal surface, Lamina propria granulomas, Patchy lamina propria cellularity?,
Mucin depletion, Submucosal granulomas, Cryptitis extent, Lamina propria
polymorphs, Cryptitis polymorphs, Basal histiocytic cells, Active inflammation?,
Sex, Increased lamina propria cellularity?, Increased lymphoid aggregates in
lamina propria?, Age, Intraepithelial lymphocytes, Crypt abscesses polymorphs,
Crypt profiles, Crypt abscesses extent', 'accuracy': [0.9732765298218435,
0.9918667699457785, 0.9938032532920217, 0.993415956622773, 0.9767531964354901],
'avgAccuracy': 0.9858231412235814, 'f1': [0.9728605242690611, 0.995916780089442,
0.9938084386363477, 0.9966971051097725, 0.9779936838309122], 'avgF1':
0.9874553063871071, 'precision': [0.9732765298218435, 0.9918667699457785,
0.9938032532920217, 0.993415956622773, 0.9767531964354901], 'avgPrecision':
0.9858231412235814, 'recall': [0.9732765298218435, 0.9918667699457785,
0.9938032532920217, 0.993415956622773, 0.9767531964354901], 'avgRecall':
0.9858231412235814, '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': 'Marked & transmucosal increase in lamina
propria cellularity, Crypt architecture, Epithelial changes, Mucosal surface,
Lamina propria granulomas, Patchy lamina propria cellularity?, Mucin depletion,
Submucosal granulomas, Cryptitis extent, Lamina propria polymorphs, Cryptitis
polymorphs, Basal histiocytic cells, Active inflammation?, Sex, Increased lamina
propria cellularity?, Increased lymphoid aggregates in lamina propria?, Age,
Intraepithelial lymphocytes, Crypt abscesses polymorphs, Crypt profiles, Crypt
abscesses extent', 'accuracy': [0.7451587916343919, 0.7397366382649109,
0.7986057319907048, 0.6413632842757552, 0.6439364587369236], 'avgAccuracy':
0.7137601809805373, 'f1': [0.7803898504701119, 0.85040071237756,
0.798284941105791, 0.781500707881076, 0.7688794517439788], 'avgF1':
0.7958911327157036, 'precision': [0.7451587916343919, 0.7397366382649109,

0.7986057319907048, 0.6413632842757552, 0.6439364587369236], 'avgPrecision': 0.7137601809805373, 'recall': [0.7451587916343919, 0.7397366382649109, 0.7986057319907048, 0.6413632842757552, 0.6439364587369236], 'avgRecall': 0.7137601809805373, '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': 'Marked & transmucosal increase in lamina propria cellularity, Crypt architecture, Epithelial changes, Mucosal surface, Lamina propria granulomas, Patchy lamina propria cellularity?, Mucin depletion, Submucosal granulomas, Cryptitis extent, Lamina propria polymorphs, Cryptitis polymorphs, Basal histiocytic cells, Active inflammation?, Sex, Increased lamina propria cellularity?, Increased lymphoid aggregates in lamina propria?, Age, Intraepithelial lymphocytes, Crypt abscesses polymorphs, Crypt profiles, Crypt abscesses extent', 'accuracy': [0.9213787761425252, 0.947714949651433, 0.941130906274206, 0.8993028659953525, 0.8857032158078264], 'avgAccuracy': 0.9190461427742687, 'f1': [0.9230897102695093, 0.9731556969576457, 0.9409482185752528, 0.9469820554649266, 0.9260389794402553], 'avgF1': 0.9420429321415179, 'precision': [0.9213787761425252, 0.947714949651433, 0.941130906274206, 0.8993028659953525, 0.8857032158078264], 'avgPrecision': 0.9190461427742687, 'recall': [0.9213787761425252, 0.947714949651433, 0.941130906274206, 0.8993028659953525, 0.8857032158078264], 'avgRecall': 0.9190461427742687, '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': 'Marked & transmucosal increase in lamina propria cellularity, Crypt architecture, Epithelial changes, Mucosal surface, Lamina propria granulomas, Patchy lamina propria cellularity?, Mucin depletion, Submucosal granulomas, Cryptitis extent, Lamina propria polymorphs, Cryptitis polymorphs, Basal histiocytic cells, Active inflammation?, Sex, Increased lamina propria cellularity?, Increased lymphoid aggregates in lamina propria?, Age, Intraepithelial lymphocytes, Crypt abscesses polymorphs, Crypt profiles, Crypt abscesses extent', 'accuracy': [0.9736638264910922, 0.9918667699457785, 0.9961270333075135, 1.0, 0.9794653235180163], 'avgAccuracy':

0.9882245906524801, 'f1': [0.9732022021645715, 0.995916780089442,
0.9961302741477175, 1.0, 0.9795870048608761], 'avgF1': 0.9889672522525215,
'precision': [0.9736638264910922, 0.9918667699457785, 0.9961270333075135, 1.0,
0.9794653235180163], 'avgPrecision': 0.9882245906524801, 'recall':
[0.9736638264910922, 0.9918667699457785, 0.9961270333075135, 1.0,
0.9794653235180163], 'avgRecall': 0.9882245906524801, '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	Marked & transmucosal increase in lamina propr…
1	KNeighborsClassifier	Marked & transmucosal increase in lamina propr…
2	LogisticRegression	Marked & transmucosal increase in lamina propr…
3	GaussianNB	Marked & transmucosal increase in lamina propr…
4	AdaBoostClassifier	Marked & transmucosal increase in lamina propr…
5	DecisionTreeClassifier	Marked & transmucosal increase in lamina propr…
6	SVC	Marked & transmucosal increase in lamina propr…
7	MLPClassifier	Marked & transmucosal increase in lamina propr…

	accuracy	f1	precision	recall \
0	0.988225	0.988967	0.988225	0.988225
1	0.986055	0.987439	0.986055	0.986055
2	0.709191	0.792607	0.709191	0.709191
3	0.562276	0.555955	0.562276	0.562276
4	0.824228	0.878102	0.824228	0.824228
5	0.985823	0.987455	0.985823	0.985823
6	0.713760	0.795891	0.713760	0.713760
7	0.919046	0.942043	0.919046	0.919046

	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': 'Marked & transmucosal
increase in lamina propria cellularity, Crypt architecture, Epithelial changes,
Mucosal surface, Lamina propria granulomas, Patchy lamina propria cellularity?,
Mucin depletion, Submucosal granulomas, Cryptitis extent, Lamina propria
polymorphs, Cryptitis polymorphs, Basal histiocytic cells, Active inflammation?,
Sex, Increased lamina propria cellularity?, Increased lymphoid aggregates in
lamina propria?, Age, Intraepithelial lymphocytes, Crypt abscesses polymorphs,
Crypt profiles', 'accuracy': [0.9732765298218435, 0.9922540666150271,
0.9965143299767621, 1.0, 0.9798527702440915], 'avgAccuracy': 0.9883795393315449,
'f1': [0.9727905244243396, 0.9961119751166407, 0.9965169604138426, 1.0,
0.9798527702440915], 'avgF1': 0.9890544460397829, 'precision':
[0.9732765298218435, 0.9922540666150271, 0.9965143299767621, 1.0,
0.9798527702440915], 'avgPrecision': 0.9883795393315449, 'recall':
[0.9732765298218435, 0.9922540666150271, 0.9965143299767621, 1.0,
0.9798527702440915], 'avgRecall': 0.9883795393315449, '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': 'Marked & transmucosal
increase in lamina propria cellularity, Crypt architecture, Epithelial changes,
Mucosal surface, Lamina propria granulomas, Patchy lamina propria cellularity?,
Mucin depletion, Submucosal granulomas, Cryptitis extent, Lamina propria
polymorphs, Cryptitis polymorphs, Basal histiocytic cells, Active inflammation?,
Sex, Increased lamina propria cellularity?, Increased lymphoid aggregates in
lamina propria?, Age, Intraepithelial lymphocytes, Crypt abscesses polymorphs,
Crypt profiles', 'accuracy': [0.9697908597986057, 0.9941905499612703,
0.9969016266460109, 0.9969016266460109, 0.9736536226268888], 'avgAccuracy':
0.9862876571357573, 'f1': [0.9689345541874661, 0.9970868129733929,
0.9969026764273867, 0.9984484096198604, 0.9765737004271536], 'avgF1':
0.987589230727052, 'precision': [0.9697908597986057, 0.9941905499612703,
0.9969016266460109, 0.9969016266460109, 0.9736536226268888], 'avgPrecision':
0.9862876571357573, 'recall': [0.9697908597986057, 0.9941905499612703,
0.9969016266460109, 0.9969016266460109, 0.9736536226268888], 'avgRecall':
0.9862876571357573, 'params': [{'algorithm': 'auto', 'leaf_size': 30, 'metric':
'minkowski', 'metric_params': None, 'n_jobs': -1, 'n_neighbors': 12, 'p': 2,
'weights': 'distance'}]}
****

Processing Model: LogisticRegression

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****************************************************
* LogisticRegression
* Best Params Result:
* {'classifier': 'LogisticRegression', 'features': 'Marked & transmucosal
increase in lamina propria cellularity, Crypt architecture, Epithelial changes,
Mucosal surface, Lamina propria granulomas, Patchy lamina propria cellularity?,
Mucin depletion, Submucosal granulomas, Cryptitis extent, Lamina propria
polymorphs, Cryptitis polymorphs, Basal histiocytic cells, Active inflammation?,
Sex, Increased lamina propria cellularity?, Increased lymphoid aggregates in
lamina propria?, Age, Intraepithelial lymphocytes, Crypt abscesses polymorphs,
Crypt profiles', 'accuracy': [0.7443841982958946, 0.7029434546862897,
0.7862122385747483, 0.6618900077459334, 0.6648585819449826], 'avgAccuracy':
0.7120576962495697, 'f1': [0.7806325273130154, 0.8255628837843983,
0.7875879074837805, 0.7965509205313449, 0.7843592268776751], 'avgF1':
0.7949386931980429, 'precision': [0.7443841982958946, 0.7029434546862897,
0.7862122385747483, 0.6618900077459334, 0.6648585819449826], 'avgPrecision':
0.7120576962495697, 'recall': [0.7443841982958946, 0.7029434546862897,
0.7862122385747483, 0.6618900077459334, 0.6648585819449826], 'avgRecall':
0.7120576962495697, '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': 'Marked & transmucosal increase in
lamina propria cellularity, Crypt architecture, Epithelial changes, Mucosal
surface, Lamina propria granulomas, Patchy lamina propria cellularity?, Mucin
depletion, Submucosal granulomas, Cryptitis extent, Lamina propria polymorphs,
Cryptitis polymorphs, Basal histiocytic cells, Active inflammation?, Sex,
Increased lamina propria cellularity?, Increased lymphoid aggregates in lamina
propria?, Age, Intraepithelial lymphocytes, Crypt abscesses polymorphs, Crypt
profiles', 'accuracy': [0.24593338497288925, 0.11347792408985283,
0.4666924864446166, 1.0, 0.9852770244091438], 'avgAccuracy': 0.5622761639833005,
'f1': [0.23210809566060528, 0.20382608695652168, 0.3642745251823215, 1.0,
0.979567660978043], 'avgF1': 0.5559552737554982, 'precision':
[0.24593338497288925, 0.11347792408985283, 0.4666924864446166, 1.0,
0.9852770244091438], 'avgPrecision': 0.5622761639833005, 'recall':
[0.24593338497288925, 0.11347792408985283, 0.4666924864446166, 1.0,
0.9852770244091438], 'avgRecall': 0.5622761639833005, 'params': [{'priors':
None, 'var_smoothing': 1e-09}]}
****************************************************

Processing Model: AdaBoostClassifier
```

```
****************************************************
* AdaBoostClassifier
* Best Params Result:
* {'classifier': 'AdaBoostClassifier', 'features': 'Marked & transmucosal
increase in lamina propria cellularity, Crypt architecture, Epithelial changes,
Mucosal surface, Lamina propria granulomas, Patchy lamina propria cellularity?,
Mucin depletion, Submucosal granulomas, Cryptitis extent, Lamina propria
polymorphs, Cryptitis polymorphs, Basal histiocytic cells, Active inflammation?,
Sex, Increased lamina propria cellularity?, Increased lymphoid aggregates in
lamina propria?, Age, Intraepithelial lymphocytes, Crypt abscesses polymorphs,
Crypt profiles', 'accuracy': [0.8272656855151046, 0.8121611154144074,
0.8826491092176607, 0.7757552285050349, 0.7826423866718326], 'avgAccuracy':
0.8160947050648081, 'f1': [0.8463246441406662, 0.8963453729429365,
0.8828871178796518, 0.8737186477644493, 0.8641182709362619], 'avgF1':
0.8726788107327932, 'precision': [0.8272656855151046, 0.8121611154144074,
0.8826491092176607, 0.7757552285050349, 0.7826423866718326], 'avgPrecision':
0.8160947050648081, 'recall': [0.8272656855151046, 0.8121611154144074,
0.8826491092176607, 0.7757552285050349, 0.7826423866718326], 'avgRecall':
0.8160947050648081, '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': 'Marked & transmucosal
increase in lamina propria cellularity, Crypt architecture, Epithelial changes,
Mucosal surface, Lamina propria granulomas, Patchy lamina propria cellularity?,
Mucin depletion, Submucosal granulomas, Cryptitis extent, Lamina propria
polymorphs, Cryptitis polymorphs, Basal histiocytic cells, Active inflammation?,
Sex, Increased lamina propria cellularity?, Increased lymphoid aggregates in
lamina propria?, Age, Intraepithelial lymphocytes, Crypt abscesses polymorphs,
Crypt profiles', 'accuracy': [0.9709527498063517, 0.9926413632842758,
0.9953524399690162, 0.9980635166537568, 0.9728787291747385], 'avgAccuracy':
0.9859777597776278, 'f1': [0.9704626603534707, 0.9963070942662778,
0.9953555638756445, 0.9990308199263424, 0.9758846916161877], 'avgF1':
0.9874081660075846, 'precision': [0.9709527498063517, 0.9926413632842758,
0.9953524399690162, 0.9980635166537568, 0.9728787291747385], 'avgPrecision':
0.9859777597776278, 'recall': [0.9709527498063517, 0.9926413632842758,
0.9953524399690162, 0.9980635166537568, 0.9728787291747385], 'avgRecall':
0.9859777597776278, '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': 'Marked & transmucosal increase in lamina
propria cellularity, Crypt architecture, Epithelial changes, Mucosal surface,
Lamina propria granulomas, Patchy lamina propria cellularity?, Mucin depletion,
Submucosal granulomas, Cryptitis extent, Lamina propria polymorphs, Cryptitis
polymorphs, Basal histiocytic cells, Active inflammation?, Sex, Increased lamina
propria cellularity?, Increased lymphoid aggregates in lamina propria?, Age,
Intraepithelial lymphocytes, Crypt abscesses polymorphs, Crypt profiles',
'accuracy': [0.7443841982958946, 0.7378001549186677, 0.7955073586367157,
0.6432997676219985, 0.6512979465323518], 'avgAccuracy': 0.7144578852011256,
'f1': [0.7797223424168295, 0.8491196790728773, 0.7954013243870571,
0.7829366014612302, 0.774395356274719], 'avgF1': 0.7963150607225427,
'precision': [0.7443841982958946, 0.7378001549186677, 0.7955073586367157,
0.6432997676219985, 0.6512979465323518], 'avgPrecision': 0.7144578852011256,
'recall': [0.7443841982958946, 0.7378001549186677, 0.7955073586367157,
0.6432997676219985, 0.6512979465323518], 'avgRecall': 0.7144578852011256,
'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': 'Marked & transmucosal increase in
lamina propria cellularity, Crypt architecture, Epithelial changes, Mucosal
surface, Lamina propria granulomas, Patchy lamina propria cellularity?, Mucin
depletion, Submucosal granulomas, Cryptitis extent, Lamina propria polymorphs,
Cryptitis polymorphs, Basal histiocytic cells, Active inflammation?, Sex,
Increased lamina propria cellularity?, Increased lymphoid aggregates in lamina
propria?, Age, Intraepithelial lymphocytes, Crypt abscesses polymorphs, Crypt
profiles', 'accuracy': [0.9186676994577847, 0.9473276529821844,
0.942292796281952, 0.8923315259488769, 0.8860906625339016], 'avgAccuracy':
0.9173420674409399, 'f1': [0.9210585051803777, 0.9729514717581542,
0.9421193137385487, 0.9431027425296765, 0.9261480658251595], 'avgF1':
0.9410760198063833, 'precision': [0.9186676994577847, 0.9473276529821844,
0.942292796281952, 0.8923315259488769, 0.8860906625339016], 'avgPrecision':
0.9173420674409399, 'recall': [0.9186676994577847, 0.9473276529821844,
0.942292796281952, 0.8923315259488769, 0.8860906625339016], 'avgRecall':
0.9173420674409399, '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':
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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': 'Marked & transmucosal increase in lamina propria cellularity, Crypt architecture, Epithelial changes, Mucosal surface, Lamina propria granulomas, Patchy lamina propria cellularity?, Mucin depletion, Submucosal granulomas, Cryptitis extent, Lamina propria polymorphs, Cryptitis polymorphs, Basal histiocytic cells, Active inflammation?, Sex, Increased lamina propria cellularity?, Increased lymphoid aggregates in lamina propria?, Age, Intraepithelial lymphocytes, Crypt abscesses polymorphs, Crypt profiles', 'accuracy': [0.9732765298218435, 0.9922540666150271, 0.9965143299767621, 1.0, 0.9798527702440915], 'avgAccuracy': 0.9883795393315449, 'f1': [0.9727905244243396, 0.9961119751166407, 0.9965169604138426, 1.0, 0.9798527702440915], 'avgF1': 0.9890544460397829, 'precision': [0.9732765298218435, 0.9922540666150271, 0.9965143299767621, 1.0, 0.9798527702440915], 'avgPrecision': 0.9883795393315449, 'recall': [0.9732765298218435, 0.9922540666150271, 0.9965143299767621, 1.0, 0.9798527702440915], 'avgRecall': 0.9883795393315449, '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}]}
****

	model	features	\
0	RandomForestClassifier	Marked & transmucosal increase in lamina propr…	
1	KNeighborsClassifier	Marked & transmucosal increase in lamina propr…	
2	LogisticRegression	Marked & transmucosal increase in lamina propr…	
3	GaussianNB	Marked & transmucosal increase in lamina propr…	
4	AdaBoostClassifier	Marked & transmucosal increase in lamina propr…	
5	DecisionTreeClassifier	Marked & transmucosal increase in lamina propr…	
6	SVC	Marked & transmucosal increase in lamina propr…	
7	MLPClassifier	Marked & transmucosal increase in lamina propr…	

	accuracy	f1	precision	recall	\
0	0.988380	0.989054	0.988380	0.988380	
1	0.986288	0.987589	0.986288	0.986288	
2	0.712058	0.794939	0.712058	0.712058	
3	0.562276	0.555955	0.562276	0.562276	
4	0.816095	0.872679	0.816095	0.816095	
5	0.985978	0.987408	0.985978	0.985978	
6	0.714458	0.796315	0.714458	0.714458	
7	0.917342	0.941076	0.917342	0.917342	

```
                                                      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': 'Marked & transmucosal
increase in lamina propria cellularity, Crypt architecture, Epithelial changes,
Mucosal surface, Lamina propria granulomas, Patchy lamina propria cellularity?,
Mucin depletion, Submucosal granulomas, Cryptitis extent, Lamina propria
polymorphs, Cryptitis polymorphs, Basal histiocytic cells, Active inflammation?,
Sex, Increased lamina propria cellularity?, Increased lymphoid aggregates in
lamina propria?, Age, Intraepithelial lymphocytes, Crypt abscesses polymorphs',
'accuracy': [0.9732765298218435, 0.9922540666150271, 0.9965143299767621, 1.0,
0.9798527702440915], 'avgAccuracy': 0.9883795393315449, 'f1':
[0.9727551528306728, 0.9961119751166407, 0.9965169604138426, 1.0,
0.9798527702440915], 'avgF1': 0.9890473717210495, 'precision':
[0.9732765298218435, 0.9922540666150271, 0.9965143299767621, 1.0,
0.9798527702440915], 'avgPrecision': 0.9883795393315449, 'recall':
[0.9732765298218435, 0.9922540666150271, 0.9965143299767621, 1.0,
0.9798527702440915], 'avgRecall': 0.9883795393315449, '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': 'Marked & transmucosal
increase in lamina propria cellularity, Crypt architecture, Epithelial changes,
Mucosal surface, Lamina propria granulomas, Patchy lamina propria cellularity?,
Mucin depletion, Submucosal granulomas, Cryptitis extent, Lamina propria
polymorphs, Cryptitis polymorphs, Basal histiocytic cells, Active inflammation?,
Sex, Increased lamina propria cellularity?, Increased lymphoid aggregates in

lamina propria?, Age, Intraepithelial lymphocytes, Crypt abscesses polymorphs',
'accuracy': [0.9697908597986057, 0.994577846630519, 0.9972889233152595,
0.9972889233152595, 0.9736536226268888], 'avgAccuracy': 0.9865200351373065,
'f1': [0.9689345541874661, 0.9972815533980581, 0.9972896136271163,
0.9986426216792708, 0.9765737004271536], 'avgF1': 0.987744408663813,
'precision': [0.9697908597986057, 0.994577846630519, 0.9972889233152595,
0.9972889233152595, 0.9736536226268888], 'avgPrecision': 0.9865200351373065,
'recall': [0.9697908597986057, 0.994577846630519, 0.9972889233152595,
0.9972889233152595, 0.9736536226268888], 'avgRecall': 0.9865200351373065,
'params': [{'algorithm': 'auto', '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': 'Marked & transmucosal
increase in lamina propria cellularity, Crypt architecture, Epithelial changes,
Mucosal surface, Lamina propria granulomas, Patchy lamina propria cellularity?,
Mucin depletion, Submucosal granulomas, Cryptitis extent, Lamina propria
polymorphs, Cryptitis polymorphs, Basal histiocytic cells, Active inflammation?,
Sex, Increased lamina propria cellularity?, Increased lymphoid aggregates in
lamina propria?, Age, Intraepithelial lymphocytes, Crypt abscesses polymorphs',
'accuracy': [0.7513555383423702, 0.703718048024787, 0.790859798605732,
0.6595662277304415, 0.6536226268888028], 'avgAccuracy': 0.7118244479184267,
'f1': [0.786274850083763, 0.8260968401909524, 0.7921825020771343,
0.7948658109684947, 0.776172039127646], 'avgF1': 0.795118408489598, 'precision':
[0.7513555383423702, 0.703718048024787, 0.790859798605732, 0.6595662277304415,
0.6536226268888028], 'avgPrecision': 0.7118244479184267, 'recall':
[0.7513555383423702, 0.703718048024787, 0.790859798605732, 0.6595662277304415,
0.6536226268888028], 'avgRecall': 0.7118244479184267, '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': 'Marked & transmucosal increase in
lamina propria cellularity, Crypt architecture, Epithelial changes, Mucosal
surface, Lamina propria granulomas, Patchy lamina propria cellularity?, Mucin
depletion, Submucosal granulomas, Cryptitis extent, Lamina propria polymorphs,
Cryptitis polymorphs, Basal histiocytic cells, Active inflammation?, Sex,

Increased lamina propria cellularity?, Increased lymphoid aggregates in lamina propria?, Age, Intraepithelial lymphocytes, Crypt abscesses polymorphs', 'accuracy': [0.24593338497288925, 0.11347792408985283, 0.4666924864446166, 1.0, 0.9852770244091438], 'avgAccuracy': 0.5622761639833005, 'f1': [0.23210809566060528, 0.20382608695652168, 0.3642745251823215, 1.0, 0.979567660978043], 'avgF1': 0.5559552737554982, 'precision': [0.24593338497288925, 0.11347792408985283, 0.4666924864446166, 1.0, 0.9852770244091438], 'avgPrecision': 0.5622761639833005, 'recall': [0.24593338497288925, 0.11347792408985283, 0.4666924864446166, 1.0, 0.9852770244091438], 'avgRecall': 0.5622761639833005, 'params': [{'priors': None, 'var_smoothing': 1e-09}]}
****

Processing Model: AdaBoostClassifier
****
* AdaBoostClassifier
* Best Params Result:
* {'classifier': 'AdaBoostClassifier', 'features': 'Marked & transmucosal increase in lamina propria cellularity, Crypt architecture, Epithelial changes, Mucosal surface, Lamina propria granulomas, Patchy lamina propria cellularity?, Mucin depletion, Submucosal granulomas, Cryptitis extent, Lamina propria polymorphs, Cryptitis polymorphs, Basal histiocytic cells, Active inflammation?, Sex, Increased lamina propria cellularity?, Increased lymphoid aggregates in lamina propria?, Age, Intraepithelial lymphocytes, Crypt abscesses polymorphs', 'accuracy': [0.8264910921766073, 0.7877614252517429, 0.8683191324554609, 0.7602633617350891, 0.774118558698179], 'avgAccuracy': 0.8033907140634159, 'f1': [0.8461028615839487, 0.8812824956672444, 0.868733105193608, 0.8638063806380638, 0.8587159127126046], 'avgF1': 0.8637281511590938, 'precision': [0.8264910921766073, 0.7877614252517429, 0.8683191324554609, 0.7602633617350891, 0.774118558698179], 'avgPrecision': 0.8033907140634159, 'recall': [0.8264910921766073, 0.7877614252517429, 0.8683191324554609, 0.7602633617350891, 0.774118558698179], 'avgRecall': 0.8033907140634159, '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': 'Marked & transmucosal increase in lamina propria cellularity, Crypt architecture, Epithelial changes, Mucosal surface, Lamina propria granulomas, Patchy lamina propria cellularity?, Mucin depletion, Submucosal granulomas, Cryptitis extent, Lamina propria polymorphs, Cryptitis polymorphs, Basal histiocytic cells, Active inflammation?, Sex, Increased lamina propria cellularity?, Increased lymphoid aggregates in lamina propria?, Age, Intraepithelial lymphocytes, Crypt abscesses polymorphs', 'accuracy': [0.9740511231603408, 0.9903175832687839, 0.9953524399690162,

```
0.9988381099922541, 0.9744285160790391], 'avgAccuracy': 0.9865975544938869,
'f1': [0.9735792048758081, 0.9951352403191283, 0.9953563289772609,
0.9994187173028483, 0.9757930522140035], 'avgF1': 0.9878565087378098,
'precision': [0.9740511231603408, 0.9903175832687839, 0.9953524399690162,
0.9988381099922541, 0.9744285160790391], 'avgPrecision': 0.9865975544938869,
'recall': [0.9740511231603408, 0.9903175832687839, 0.9953524399690162,
0.9988381099922541, 0.9744285160790391], 'avgRecall': 0.9865975544938869,
'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': 'Marked & transmucosal increase in lamina
propria cellularity, Crypt architecture, Epithelial changes, Mucosal surface,
Lamina propria granulomas, Patchy lamina propria cellularity?, Mucin depletion,
Submucosal granulomas, Cryptitis extent, Lamina propria polymorphs, Cryptitis
polymorphs, Basal histiocytic cells, Active inflammation?, Sex, Increased lamina
propria cellularity?, Increased lymphoid aggregates in lamina propria?, Age,
Intraepithelial lymphocytes, Crypt abscesses polymorphs', 'accuracy':
[0.7536793183578622, 0.750580945003873, 0.8067389620449265, 0.6367157242447715,
0.6443239054629989], 'avgAccuracy': 0.7184077710228864, 'f1':
[0.7870151680116803, 0.8575221238938054, 0.806195271360556, 0.7780407004259348,
0.7692399404136899], 'avgF1': 0.7996026408211333, 'precision':
[0.7536793183578622, 0.750580945003873, 0.8067389620449265, 0.6367157242447715,
0.6443239054629989], 'avgPrecision': 0.7184077710228864, 'recall':
[0.7536793183578622, 0.750580945003873, 0.8067389620449265, 0.6367157242447715,
0.6443239054629989], 'avgRecall': 0.7184077710228864, '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': 'Marked & transmucosal increase in
lamina propria cellularity, Crypt architecture, Epithelial changes, Mucosal
surface, Lamina propria granulomas, Patchy lamina propria cellularity?, Mucin
depletion, Submucosal granulomas, Cryptitis extent, Lamina propria polymorphs,
Cryptitis polymorphs, Basal histiocytic cells, Active inflammation?, Sex,
```

Increased lamina propria cellularity?, Increased lymphoid aggregates in lamina
propria?, Age, Intraepithelial lymphocytes, Crypt abscesses polymorphs',
'accuracy': [0.9186676994577847, 0.9457784663051898, 0.9391944229279628,
0.8818745158791634, 0.8655559860519179], 'avgAccuracy': 0.9102142181244037,
'f1': [0.9209775162588809, 0.9721337579617836, 0.93897590349354,
0.9372298826919118, 0.9143682896876353], 'avgF1': 0.9367370700187503,
'precision': [0.9186676994577847, 0.9457784663051898, 0.9391944229279628,
0.8818745158791634, 0.8655559860519179], 'avgPrecision': 0.9102142181244037,
'recall': [0.9186676994577847, 0.9457784663051898, 0.9391944229279628,
0.8818745158791634, 0.8655559860519179], 'avgRecall': 0.9102142181244037,
'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': 'Marked & transmucosal
increase in lamina propria cellularity, Crypt architecture, Epithelial changes,
Mucosal surface, Lamina propria granulomas, Patchy lamina propria cellularity?,
Mucin depletion, Submucosal granulomas, Cryptitis extent, Lamina propria
polymorphs, Cryptitis polymorphs, Basal histiocytic cells, Active inflammation?,
Sex, Increased lamina propria cellularity?, Increased lymphoid aggregates in
lamina propria?, Age, Intraepithelial lymphocytes, Crypt abscesses polymorphs',
'accuracy': [0.9732765298218435, 0.9922540666150271, 0.9965143299767621, 1.0,
0.9798527702440915], 'avgAccuracy': 0.9883795393315449, 'f1':
[0.9727551528306728, 0.9961119751166407, 0.9965169604138426, 1.0,
0.9798527702440915], 'avgF1': 0.9890473717210495, 'precision':
[0.9732765298218435, 0.9922540666150271, 0.9965143299767621, 1.0,
0.9798527702440915], 'avgPrecision': 0.9883795393315449, 'recall':
[0.9732765298218435, 0.9922540666150271, 0.9965143299767621, 1.0,
0.9798527702440915], 'avgRecall': 0.9883795393315449, '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  Marked & transmucosal increase in lamina propr…
1    KNeighborsClassifier  Marked & transmucosal increase in lamina propr…
2      LogisticRegression  Marked & transmucosal increase in lamina propr…
3              GaussianNB  Marked & transmucosal increase in lamina propr…
```

```
4          AdaBoostClassifier  Marked & transmucosal increase in lamina propr…
5   DecisionTreeClassifier  Marked & transmucosal increase in lamina propr…
6                      SVC  Marked & transmucosal increase in lamina propr…
7            MLPClassifier  Marked & transmucosal increase in lamina propr…

     accuracy         f1  precision     recall  \
0    0.988380   0.989047   0.988380   0.988380
1    0.986520   0.987744   0.986520   0.986520
2    0.711824   0.795118   0.711824   0.711824
3    0.562276   0.555955   0.562276   0.562276
4    0.803391   0.863728   0.803391   0.803391
5    0.986598   0.987857   0.986598   0.986598
6    0.718408   0.799603   0.718408   0.718408
7    0.910214   0.936737   0.910214   0.910214


                                                  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': 'Marked & transmucosal
increase in lamina propria cellularity, Crypt architecture, Epithelial changes,
Mucosal surface, Lamina propria granulomas, Patchy lamina propria cellularity?,
Mucin depletion, Submucosal granulomas, Cryptitis extent, Lamina propria
polymorphs, Cryptitis polymorphs, Basal histiocytic cells, Active inflammation?,
Sex, Increased lamina propria cellularity?, Increased lymphoid aggregates in
lamina propria?, Age, Intraepithelial lymphocytes', 'accuracy':
[0.9728892331525949, 0.9914794732765299, 0.9965143299767621, 0.9996127033307514,
0.9790778767919411], 'avgAccuracy': 0.9879147233057158, 'f1':
[0.9723782737340749, 0.9957215091404122, 0.9965169604138426, 0.999806314158435,
0.9793228295369784], 'avgF1': 0.9887491773967486, 'precision':
[0.9728892331525949, 0.9914794732765299, 0.9965143299767621, 0.9996127033307514,
0.9790778767919411], 'avgPrecision': 0.9879147233057158, 'recall':
[0.9728892331525949, 0.9914794732765299, 0.9965143299767621, 0.9996127033307514,
0.9790778767919411], 'avgRecall': 0.9879147233057158, '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': 'Marked & transmucosal
increase in lamina propria cellularity, Crypt architecture, Epithelial changes,
Mucosal surface, Lamina propria granulomas, Patchy lamina propria cellularity?,
Mucin depletion, Submucosal granulomas, Cryptitis extent, Lamina propria
polymorphs, Cryptitis polymorphs, Basal histiocytic cells, Active inflammation?,
Sex, Increased lamina propria cellularity?, Increased lymphoid aggregates in
lamina propria?, Age, Intraepithelial lymphocytes', 'accuracy':
[0.9697908597986057, 0.994577846630519, 0.9972889233152595, 0.9961270333075135,
0.974041069352964], 'avgAccuracy': 0.9863651464809723, 'f1':
[0.9689345541874661, 0.9972815533980581, 0.9972896136271163, 0.9980597594101667,
0.9766334901142151], 'avgF1': 0.9876397941474044, 'precision':
[0.9697908597986057, 0.994577846630519, 0.9972889233152595, 0.9961270333075135,
0.974041069352964], 'avgPrecision': 0.9863651464809723, 'recall':
[0.9697908597986057, 0.994577846630519, 0.9972889233152595, 0.9961270333075135,
0.974041069352964], 'avgRecall': 0.9863651464809723, 'params': [{'algorithm':
'auto', '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': 'Marked & transmucosal
increase in lamina propria cellularity, Crypt architecture, Epithelial changes,
Mucosal surface, Lamina propria granulomas, Patchy lamina propria cellularity?,
Mucin depletion, Submucosal granulomas, Cryptitis extent, Lamina propria
polymorphs, Cryptitis polymorphs, Basal histiocytic cells, Active inflammation?,
Sex, Increased lamina propria cellularity?, Increased lymphoid aggregates in
lamina propria?, Age, Intraepithelial lymphocytes', 'accuracy':
[0.7532920216886135, 0.7114639814097599, 0.7900852052672347, 0.6638264910921766,
0.6621464548624564], 'avgAccuracy': 0.7161628308640482, 'f1':
[0.7877340247253514, 0.8314098212265219, 0.7914359526380598, 0.797951582867784,
0.7824565269482253], 'avgF1': 0.7981975816811885, 'precision':
[0.7532920216886135, 0.7114639814097599, 0.7900852052672347, 0.6638264910921766,
0.6621464548624564], 'avgPrecision': 0.7161628308640482, 'recall':
[0.7532920216886135, 0.7114639814097599, 0.7900852052672347, 0.6638264910921766,
0.6621464548624564], 'avgRecall': 0.7161628308640482, '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': 'Marked & transmucosal increase in
lamina propria cellularity, Crypt architecture, Epithelial changes, Mucosal
surface, Lamina propria granulomas, Patchy lamina propria cellularity?, Mucin
depletion, Submucosal granulomas, Cryptitis extent, Lamina propria polymorphs,
Cryptitis polymorphs, Basal histiocytic cells, Active inflammation?, Sex,
Increased lamina propria cellularity?, Increased lymphoid aggregates in lamina
propria?, Age, Intraepithelial lymphocytes', 'accuracy': [0.24593338497288925,
0.11347792408985283, 0.4666924864446166, 1.0, 0.9852770244091438],
'avgAccuracy': 0.5622761639833005, 'f1': [0.23210809566060528,
0.20382608695652168, 0.3642745251823215, 1.0, 0.979567660978043], 'avgF1':
0.5559552737554982, 'precision': [0.24593338497288925, 0.11347792408985283,
0.4666924864446166, 1.0, 0.9852770244091438], 'avgPrecision':
0.5622761639833005, 'recall': [0.24593338497288925, 0.11347792408985283,
0.4666924864446166, 1.0, 0.9852770244091438], 'avgRecall': 0.5622761639833005,
'params': [{'priors': None, 'var_smoothing': 1e-09}]}
****

Processing Model: AdaBoostClassifier
****
* AdaBoostClassifier
* Best Params Result:
* {'classifier': 'AdaBoostClassifier', 'features': 'Marked & transmucosal
increase in lamina propria cellularity, Crypt architecture, Epithelial changes,
Mucosal surface, Lamina propria granulomas, Patchy lamina propria cellularity?,
Mucin depletion, Submucosal granulomas, Cryptitis extent, Lamina propria
polymorphs, Cryptitis polymorphs, Basal histiocytic cells, Active inflammation?,
Sex, Increased lamina propria cellularity?, Increased lymphoid aggregates in
lamina propria?, Age, Intraepithelial lymphocytes', 'accuracy':
[0.8164213787761425, 0.78001549186677, 0.8675445391169636, 0.790859798605732,
0.7644323905462999], 'avgAccuracy': 0.8038547197823815, 'f1':
[0.8372517832882455, 0.8764142732811141, 0.8679986680680337, 0.8832179930795847,
0.8525553749749708], 'avgF1': 0.8634876185383897, 'precision':
[0.8164213787761425, 0.78001549186677, 0.8675445391169636, 0.790859798605732,
0.7644323905462999], 'avgPrecision': 0.8038547197823815, 'recall':
[0.8164213787761425, 0.78001549186677, 0.8675445391169636, 0.790859798605732,
0.7644323905462999], 'avgRecall': 0.8038547197823815, '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': 'Marked & transmucosal
increase in lamina propria cellularity, Crypt architecture, Epithelial changes,
Mucosal surface, Lamina propria granulomas, Patchy lamina propria cellularity?,
Mucin depletion, Submucosal granulomas, Cryptitis extent, Lamina propria
polymorphs, Cryptitis polymorphs, Basal histiocytic cells, Active inflammation?,
Sex, Increased lamina propria cellularity?, Increased lymphoid aggregates in
lamina propria?, Age, Intraepithelial lymphocytes', 'accuracy':
[0.969403563129357, 0.9910921766072812, 0.9957397366382649, 0.9965143299767621,
0.9755908562572646], 'avgAccuracy': 0.985668132521786, 'f1':
[0.9688066242554079, 0.9955261622252479, 0.99574082141404, 0.9982541222114452,
0.9774420173402057], 'avgF1': 0.9871539494892694, 'precision':
[0.969403563129357, 0.9910921766072812, 0.9957397366382649, 0.9965143299767621,
0.9755908562572646], 'avgPrecision': 0.985668132521786, 'recall':
[0.969403563129357, 0.9910921766072812, 0.9957397366382649, 0.9965143299767621,
0.9755908562572646], 'avgRecall': 0.985668132521786, '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': 'Marked & transmucosal increase in lamina
propria cellularity, Crypt architecture, Epithelial changes, Mucosal surface,
Lamina propria granulomas, Patchy lamina propria cellularity?, Mucin depletion,
Submucosal granulomas, Cryptitis extent, Lamina propria polymorphs, Cryptitis
polymorphs, Basal histiocytic cells, Active inflammation?, Sex, Increased lamina
propria cellularity?, Increased lymphoid aggregates in lamina propria?, Age,
Intraepithelial lymphocytes', 'accuracy': [0.7532920216886135,
0.7517428350116189, 0.7970565453137103, 0.62858249419055, 0.6369624176675707],
'avgAccuracy': 0.7135272627744127, 'f1': [0.7867820788492016,
0.8582799027194339, 0.7971253059938356, 0.7719381688466113, 0.7638266856189538],
'avgF1': 0.7955904284056072, 'precision': [0.7532920216886135,
0.7517428350116189, 0.7970565453137103, 0.62858249419055, 0.6369624176675707],
'avgPrecision': 0.7135272627744127, 'recall': [0.7532920216886135,
0.7517428350116189, 0.7970565453137103, 0.62858249419055, 0.6369624176675707],
'avgRecall': 0.7135272627744127, '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}]}
```

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

Processing Model: MLPClassifier
**************************************************
* MLPClassifier
* Best Params Result:
* {'classifier': 'MLPClassifier', 'features': 'Marked & transmucosal increase in
lamina propria cellularity, Crypt architecture, Epithelial changes, Mucosal
surface, Lamina propria granulomas, Patchy lamina propria cellularity?, Mucin
depletion, Submucosal granulomas, Cryptitis extent, Lamina propria polymorphs,
Cryptitis polymorphs, Basal histiocytic cells, Active inflammation?, Sex,
Increased lamina propria cellularity?, Increased lymphoid aggregates in lamina
propria?, Age, Intraepithelial lymphocytes', 'accuracy': [0.9182804027885361,
0.947714949651433, 0.9403563129357088, 0.831138652207591, 0.8833785354513755],
'avgAccuracy': 0.9041737706069288, 'f1': [0.920560326588896, 0.9731556969576457,
0.9402613094813305, 0.907783417935702, 0.924646238552518], 'avgF1':
0.9332813979032184, 'precision': [0.9182804027885361, 0.947714949651433,
0.9403563129357088, 0.831138652207591, 0.8833785354513755], 'avgPrecision':
0.9041737706069288, 'recall': [0.9182804027885361, 0.947714949651433,
0.9403563129357088, 0.831138652207591, 0.8833785354513755], 'avgRecall':
0.9041737706069288, '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': 'Marked & transmucosal
increase in lamina propria cellularity, Crypt architecture, Epithelial changes,
Mucosal surface, Lamina propria granulomas, Patchy lamina propria cellularity?,
Mucin depletion, Submucosal granulomas, Cryptitis extent, Lamina propria
polymorphs, Cryptitis polymorphs, Basal histiocytic cells, Active inflammation?,
Sex, Increased lamina propria cellularity?, Increased lymphoid aggregates in
lamina propria?, Age, Intraepithelial lymphocytes', 'accuracy':
[0.9728892331525949, 0.9914794732765299, 0.9965143299767621, 0.9996127033307514,
0.9790778767919411], 'avgAccuracy': 0.9879147233057158, 'f1':
[0.9723782737340749, 0.9957215091404122, 0.9965169604138426, 0.999806314158435,
0.9793228295369784], 'avgF1': 0.9887491773967486, 'precision':
[0.9728892331525949, 0.9914794732765299, 0.9965143299767621, 0.9996127033307514,
0.9790778767919411], 'avgPrecision': 0.9879147233057158, 'recall':
[0.9728892331525949, 0.9914794732765299, 0.9965143299767621, 0.9996127033307514,
0.9790778767919411], 'avgRecall': 0.9879147233057158, '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  Marked & transmucosal increase in lamina propr…
1    KNeighborsClassifier  Marked & transmucosal increase in lamina propr…
2      LogisticRegression  Marked & transmucosal increase in lamina propr…
3              GaussianNB  Marked & transmucosal increase in lamina propr…
4       AdaBoostClassifier  Marked & transmucosal increase in lamina propr…
5  DecisionTreeClassifier  Marked & transmucosal increase in lamina propr…
6                     SVC  Marked & transmucosal increase in lamina propr…
7           MLPClassifier  Marked & transmucosal increase in lamina propr…

   accuracy        f1  precision    recall  \
0  0.987915  0.988749   0.987915  0.987915
1  0.986365  0.987640   0.986365  0.986365
2  0.716163  0.798198   0.716163  0.716163
3  0.562276  0.555955   0.562276  0.562276
4  0.803855  0.863488   0.803855  0.803855
5  0.985668  0.987154   0.985668  0.985668
6  0.713527  0.795590   0.713527  0.713527
7  0.904174  0.933281   0.904174  0.904174

                                                       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': 'Marked & transmucosal
increase in lamina propria cellularity, Crypt architecture, Epithelial changes,
Mucosal surface, Lamina propria granulomas, Patchy lamina propria cellularity?,
Mucin depletion, Submucosal granulomas, Cryptitis extent, Lamina propria
polymorphs, Cryptitis polymorphs, Basal histiocytic cells, Active inflammation?,
Sex, Increased lamina propria cellularity?, Increased lymphoid aggregates in
lamina propria?, Age', 'accuracy': [0.9721146398140976, 0.9910921766072812,
0.9965143299767621, 0.9996127033307514, 0.9802402169701666], 'avgAccuracy':
0.9879148133398118, 'f1': [0.9715890815550484, 0.9955261622252479,

0.9965169604138426, 0.999806314158435, 0.98012018747861], 'avgF1':
0.9887117411662368, 'precision': [0.9721146398140976, 0.9910921766072812,
0.9965143299767621, 0.9996127033307514, 0.9802402169701666], 'avgPrecision':
0.9879148133398118, 'recall': [0.9721146398140976, 0.9910921766072812,
0.9965143299767621, 0.9996127033307514, 0.9802402169701666], 'avgRecall':
0.9879148133398118, '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': 'Marked & transmucosal
increase in lamina propria cellularity, Crypt architecture, Epithelial changes,
Mucosal surface, Lamina propria granulomas, Patchy lamina propria cellularity?,
Mucin depletion, Submucosal granulomas, Cryptitis extent, Lamina propria
polymorphs, Cryptitis polymorphs, Basal histiocytic cells, Active inflammation?,
Sex, Increased lamina propria cellularity?, Increased lymphoid aggregates in
lamina propria?, Age', 'accuracy': [0.9697908597986057, 0.994577846630519,
0.9972889233152595, 0.9961270333075135, 0.9736536226268888], 'avgAccuracy':
0.9862876571357573, 'f1': [0.9689345541874661, 0.9972815533980581,
0.9972896136271163, 0.9980597594101667, 0.9763829613145928], 'avgF1':
0.98758968838748, 'precision': [0.9697908597986057, 0.994577846630519,
0.9972889233152595, 0.9961270333075135, 0.9736536226268888], 'avgPrecision':
0.9862876571357573, 'recall': [0.9697908597986057, 0.994577846630519,
0.9972889233152595, 0.9961270333075135, 0.9736536226268888], 'avgRecall':
0.9862876571357573, 'params': [{'algorithm': 'auto', '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': 'Marked & transmucosal
increase in lamina propria cellularity, Crypt architecture, Epithelial changes,
Mucosal surface, Lamina propria granulomas, Patchy lamina propria cellularity?,
Mucin depletion, Submucosal granulomas, Cryptitis extent, Lamina propria
polymorphs, Cryptitis polymorphs, Basal histiocytic cells, Active inflammation?,
Sex, Increased lamina propria cellularity?, Increased lymphoid aggregates in
lamina propria?, Age', 'accuracy': [0.7606506584043378, 0.7223082881487219,
0.7978311386522076, 0.6642137877614253, 0.6598217745060054], 'avgAccuracy':

0.7209651294945396, 'f1': [0.7933676263388896, 0.8387677085675735,
0.7989463800654896, 0.7982313241796601, 0.7807027206038801], 'avgF1':
0.8020031519510986, 'precision': [0.7606506584043378, 0.7223082881487219,
0.7978311386522076, 0.6642137877614253, 0.6598217745060054], 'avgPrecision':
0.7209651294945396, 'recall': [0.7606506584043378, 0.7223082881487219,
0.7978311386522076, 0.6642137877614253, 0.6598217745060054], 'avgRecall':
0.7209651294945396, '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': 'Marked & transmucosal increase in
lamina propria cellularity, Crypt architecture, Epithelial changes, Mucosal
surface, Lamina propria granulomas, Patchy lamina propria cellularity?, Mucin
depletion, Submucosal granulomas, Cryptitis extent, Lamina propria polymorphs,
Cryptitis polymorphs, Basal histiocytic cells, Active inflammation?, Sex,
Increased lamina propria cellularity?, Increased lymphoid aggregates in lamina
propria?, Age', 'accuracy': [0.24593338497288925, 0.11347792408985283,
0.4666924864446166, 1.0, 0.9852770244091438], 'avgAccuracy': 0.5622761639833005,
'f1': [0.23210809566060528, 0.20382608695652168, 0.3642745251823215, 1.0,
0.979567660978043], 'avgF1': 0.5559552737554982, 'precision':
[0.24593338497288925, 0.11347792408985283, 0.4666924864446166, 1.0,
0.9852770244091438], 'avgPrecision': 0.5622761639833005, 'recall':
[0.24593338497288925, 0.11347792408985283, 0.4666924864446166, 1.0,
0.9852770244091438], 'avgRecall': 0.5622761639833005, 'params': [{'priors':
None, 'var_smoothing': 1e-09}]}
****

Processing Model: AdaBoostClassifier
****
* AdaBoostClassifier
* Best Params Result:
* {'classifier': 'AdaBoostClassifier', 'features': 'Marked & transmucosal
increase in lamina propria cellularity, Crypt architecture, Epithelial changes,
Mucosal surface, Lamina propria granulomas, Patchy lamina propria cellularity?,
Mucin depletion, Submucosal granulomas, Cryptitis extent, Lamina propria
polymorphs, Cryptitis polymorphs, Basal histiocytic cells, Active inflammation?,
Sex, Increased lamina propria cellularity?, Increased lymphoid aggregates in
lamina propria?, Age', 'accuracy': [0.8121611154144074, 0.7966692486444616,
0.8733539891556933, 0.784275755228505, 0.7679194110809764], 'avgAccuracy':
0.8068759039048088, 'f1': [0.834074527907235, 0.8868290579866351,
0.8736302403662103, 0.8790970262643802, 0.8547786046065992], 'avgF1':

0.865681891426212, 'precision': [0.8121611154144074, 0.7966692486444616, 0.8733539891556933, 0.784275755228505, 0.7679194110809764], 'avgPrecision': 0.8068759039048088, 'recall': [0.8121611154144074, 0.7966692486444616, 0.8733539891556933, 0.784275755228505, 0.7679194110809764], 'avgRecall': 0.8068759039048088, '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': 'Marked & transmucosal increase in lamina propria cellularity, Crypt architecture, Epithelial changes, Mucosal surface, Lamina propria granulomas, Patchy lamina propria cellularity?, Mucin depletion, Submucosal granulomas, Cryptitis extent, Lamina propria polymorphs, Cryptitis polymorphs, Basal histiocytic cells, Active inflammation?, Sex, Increased lamina propria cellularity?, Increased lymphoid aggregates in lamina propria?, Age', 'accuracy': [0.9728892331525949, 0.9926413632842758, 0.9953524399690162, 0.9965143299767621, 0.9748159628051143], 'avgAccuracy': 0.9864426658375527, 'f1': [0.9723059961548532, 0.9963070942662778, 0.9953563289772609, 0.9982541222114452, 0.9762780159978284], 'avgF1': 0.9877003115215331, 'precision': [0.9728892331525949, 0.9926413632842758, 0.9953524399690162, 0.9965143299767621, 0.9748159628051143], 'avgPrecision': 0.9864426658375527, 'recall': [0.9728892331525949, 0.9926413632842758, 0.9953524399690162, 0.9965143299767621, 0.9748159628051143], 'avgRecall': 0.9864426658375527, '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': 'Marked & transmucosal increase in lamina propria cellularity, Crypt architecture, Epithelial changes, Mucosal surface, Lamina propria granulomas, Patchy lamina propria cellularity?, Mucin depletion, Submucosal granulomas, Cryptitis extent, Lamina propria polymorphs, Cryptitis polymorphs, Basal histiocytic cells, Active inflammation?, Sex, Increased lamina propria cellularity?, Increased lymphoid aggregates in lamina propria?, Age', 'accuracy': [0.7552285050348567, 0.7575522850503486, 0.7997676219984509, 0.62858249419055, 0.6369624176675707], 'avgAccuracy': 0.7156186647883553, 'f1': [0.7882181347268206, 0.8620537681798148, 0.7995753784801307, 0.7719381688466113, 0.7638266856189538], 'avgF1': 0.7971224271704662, 'precision': [0.7552285050348567, 0.7575522850503486, 0.7997676219984509, 0.62858249419055,

0.6369624176675707], 'avgPrecision': 0.7156186647883553, 'recall':
[0.7552285050348567, 0.7575522850503486, 0.7997676219984509, 0.62858249419055,
0.6369624176675707], 'avgRecall': 0.7156186647883553, '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': 'Marked & transmucosal increase in
lamina propria cellularity, Crypt architecture, Epithelial changes, Mucosal
surface, Lamina propria granulomas, Patchy lamina propria cellularity?, Mucin
depletion, Submucosal granulomas, Cryptitis extent, Lamina propria polymorphs,
Cryptitis polymorphs, Basal histiocytic cells, Active inflammation?, Sex,
Increased lamina propria cellularity?, Increased lymphoid aggregates in lamina
propria?, Age', 'accuracy': [0.9264136328427576, 0.929124709527498,
0.9573973663826492, 0.8315259488768396, 0.8454087562960093], 'avgAccuracy':
0.8979740827851508, 'f1': [0.9275046500660639, 0.9632603894800242,
0.9570873638940116, 0.9080143793613872, 0.9025412197478779], 'avgF1':
0.9316816005098729, 'precision': [0.9264136328427576, 0.929124709527498,
0.9573973663826492, 0.8315259488768396, 0.8454087562960093], 'avgPrecision':
0.8979740827851508, 'recall': [0.9264136328427576, 0.929124709527498,
0.9573973663826492, 0.8315259488768396, 0.8454087562960093], 'avgRecall':
0.8979740827851508, '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': 'Marked & transmucosal
increase in lamina propria cellularity, Crypt architecture, Epithelial changes,
Mucosal surface, Lamina propria granulomas, Patchy lamina propria cellularity?,
Mucin depletion, Submucosal granulomas, Cryptitis extent, Lamina propria
polymorphs, Cryptitis polymorphs, Basal histiocytic cells, Active inflammation?,
Sex, Increased lamina propria cellularity?, Increased lymphoid aggregates in
lamina propria?, Age', 'accuracy': [0.9721146398140976, 0.9910921766072812,
0.9965143299767621, 0.9996127033307514, 0.9802402169701666], 'avgAccuracy':
0.9879148133398118, 'f1': [0.9715890815550484, 0.9955261622252479,
0.99651969604138426, 0.999806314158435, 0.98012018747861], 'avgF1':
0.9887117411662368, 'precision': [0.9721146398140976, 0.9910921766072812,

0.9965143299767621, 0.9996127033307514, 0.9802402169701666], 'avgPrecision':
0.9879148133398118, 'recall': [0.9721146398140976, 0.9910921766072812,
0.9965143299767621, 0.9996127033307514, 0.9802402169701666], 'avgRecall':
0.9879148133398118, '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   Marked & transmucosal increase in lamina propr…
1     KNeighborsClassifier   Marked & transmucosal increase in lamina propr…
2       LogisticRegression   Marked & transmucosal increase in lamina propr…
3               GaussianNB   Marked & transmucosal increase in lamina propr…
4           AdaBoostClassifier   Marked & transmucosal increase in lamina propr…
5    DecisionTreeClassifier   Marked & transmucosal increase in lamina propr…
6                      SVC   Marked & transmucosal increase in lamina propr…
7            MLPClassifier   Marked & transmucosal increase in lamina propr…

   accuracy        f1  precision    recall  \
0  0.987915  0.988712   0.987915  0.987915
1  0.986288  0.987590   0.986288  0.986288
2  0.720965  0.802003   0.720965  0.720965
3  0.562276  0.555955   0.562276  0.562276
4  0.806876  0.865682   0.806876  0.806876
5  0.986443  0.987700   0.986443  0.986443
6  0.715619  0.797122   0.715619  0.715619
7  0.897974  0.931682   0.897974  0.897974

                                               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': 'Marked & transmucosal
increase in lamina propria cellularity, Crypt architecture, Epithelial changes,
Mucosal surface, Lamina propria granulomas, Patchy lamina propria cellularity?,
```

Mucin depletion, Submucosal granulomas, Cryptitis extent, Lamina propria polymorphs, Cryptitis polymorphs, Basal histiocytic cells, Active inflammation?, Sex, Increased lamina propria cellularity?, Increased lymphoid aggregates in lamina propria?', 'accuracy': [0.9329976762199845, 0.9701781564678543, 0.924864446165763, 0.8063516653756778, 0.7923285548237118], 'avgAccuracy': 0.8853440998105983, 'f1': [0.9318672032153393, 0.984863377236092, 0.9239980821952671, 0.8927958833619212, 0.8701985112564117], 'avgF1': 0.9207446114530062, 'precision': [0.9329976762199845, 0.9701781564678543, 0.924864446165763, 0.8063516653756778, 0.7923285548237118], 'avgPrecision': 0.8853440998105983, 'recall': [0.9329976762199845, 0.9701781564678543, 0.924864446165763, 0.8063516653756778, 0.7923285548237118], 'avgRecall': 0.8853440998105983, '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': 'Marked & transmucosal increase in lamina propria cellularity, Crypt architecture, Epithelial changes, Mucosal surface, Lamina propria granulomas, Patchy lamina propria cellularity?, Mucin depletion, Submucosal granulomas, Cryptitis extent, Lamina propria polymorphs, Cryptitis polymorphs, Basal histiocytic cells, Active inflammation?, Sex, Increased lamina propria cellularity?, Increased lymphoid aggregates in lamina propria?', 'accuracy': [0.9306738962044926, 0.9442292796281953, 0.9260263361735089, 0.814872192099148, 0.797752808988764], 'avgAccuracy': 0.8827109026188218, 'f1': [0.9292289271642805, 0.9713147410358566, 0.9245789359229387, 0.897994024754588, 0.8735873898087486], 'avgF1': 0.9193408037372824, 'precision': [0.9306738962044926, 0.9442292796281953, 0.9260263361735089, 0.814872192099148, 0.797752808988764], 'avgPrecision': 0.8827109026188218, 'recall': [0.9306738962044926, 0.9442292796281953, 0.9260263361735089, 0.814872192099148, 0.797752808988764], 'avgRecall': 0.8827109026188218, 'params': [{'algorithm': 'auto', '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': 'Marked & transmucosal increase in lamina propria cellularity, Crypt architecture, Epithelial changes,

Mucosal surface, Lamina propria granulomas, Patchy lamina propria cellularity?,
Mucin depletion, Submucosal granulomas, Cryptitis extent, Lamina propria
polymorphs, Cryptitis polymorphs, Basal histiocytic cells, Active inflammation?,
Sex, Increased lamina propria cellularity?, Increased lymphoid aggregates in
lamina propria?', 'accuracy': [0.7931835786212239, 0.6192873741285825,
0.8059643687064292, 0.6673121611154144, 0.6582719876017048], 'avgAccuracy':
0.7088038940346709, 'f1': [0.8170071032689387, 0.7648887825878976,
0.8057433323606248, 0.8004645760743322, 0.7795732053514963], 'avgF1':
0.793535399928658, 'precision': [0.7931835786212239, 0.6192873741285825,
0.8059643687064292, 0.6673121611154144, 0.6582719876017048], 'avgPrecision':
0.7088038940346709, 'recall': [0.7931835786212239, 0.6192873741285825,
0.8059643687064292, 0.6673121611154144, 0.6582719876017048], 'avgRecall':
0.7088038940346709, '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': 'Marked & transmucosal increase in
lamina propria cellularity, Crypt architecture, Epithelial changes, Mucosal
surface, Lamina propria granulomas, Patchy lamina propria cellularity?, Mucin
depletion, Submucosal granulomas, Cryptitis extent, Lamina propria polymorphs,
Cryptitis polymorphs, Basal histiocytic cells, Active inflammation?, Sex,
Increased lamina propria cellularity?, Increased lymphoid aggregates in lamina
propria?', 'accuracy': [0.24593338497288925, 0.11347792408985283,
0.4666924864446166, 1.0, 0.9852770244091438], 'avgAccuracy': 0.5622761639833005,
'f1': [0.23210809566060528, 0.20382608695652168, 0.3642745251823215, 1.0,
0.979567660978043], 'avgF1': 0.5559552737554982, 'precision':
[0.24593338497288925, 0.11347792408985283, 0.4666924864446166, 1.0,
0.9852770244091438], 'avgPrecision': 0.5622761639833005, 'recall':
[0.24593338497288925, 0.11347792408985283, 0.4666924864446166, 1.0,
0.9852770244091438], 'avgRecall': 0.5622761639833005, 'params': [{'priors':
None, 'var_smoothing': 1e-09}]}
****

Processing Model: AdaBoostClassifier
****
* AdaBoostClassifier
* Best Params Result:
* {'classifier': 'AdaBoostClassifier', 'features': 'Marked & transmucosal
increase in lamina propria cellularity, Crypt architecture, Epithelial changes,
Mucosal surface, Lamina propria granulomas, Patchy lamina propria cellularity?,
Mucin depletion, Submucosal granulomas, Cryptitis extent, Lamina propria

polymorphs, Cryptitis polymorphs, Basal histiocytic cells, Active inflammation?, Sex, Increased lamina propria cellularity?, Increased lymphoid aggregates in lamina propria?', 'accuracy': [0.8032532920216886, 0.7831138652207591, 0.8195197521301317, 0.6785437645236251, 0.6780317706315382], 'avgAccuracy': 0.7524924889055485, 'f1': [0.8251407686907716, 0.8783666377063423, 0.8194261688719104, 0.8084910013844023, 0.7938195078211951], 'avgF1': 0.8250488168949244, 'precision': [0.8032532920216886, 0.7831138652207591, 0.8195197521301317, 0.6785437645236251, 0.6780317706315382], 'avgPrecision': 0.7524924889055485, 'recall': [0.8032532920216886, 0.7831138652207591, 0.8195197521301317, 0.6785437645236251, 0.6780317706315382], 'avgRecall': 0.7524924889055485, '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': 'Marked & transmucosal increase in lamina propria cellularity, Crypt architecture, Epithelial changes, Mucosal surface, Lamina propria granulomas, Patchy lamina propria cellularity?, Mucin depletion, Submucosal granulomas, Cryptitis extent, Lamina propria polymorphs, Cryptitis polymorphs, Basal histiocytic cells, Active inflammation?, Sex, Increased lamina propria cellularity?, Increased lymphoid aggregates in lamina propria?', 'accuracy': [0.9306738962044926, 0.9686289697908598, 0.9244771494965144, 0.8044151820294345, 0.7900038744672607], 'avgAccuracy': 0.8836398143977124, 'f1': [0.9290421309803026, 0.9840645288215619, 0.9235778993761502, 0.8916076411247048, 0.8687425347188019], 'avgF1': 0.9194069470043043, 'precision': [0.9306738962044926, 0.9686289697908598, 0.9244771494965144, 0.8044151820294345, 0.7900038744672607], 'avgPrecision': 0.8836398143977124, 'recall': [0.9306738962044926, 0.9686289697908598, 0.9244771494965144, 0.8044151820294345, 0.7900038744672607], 'avgRecall': 0.8836398143977124, '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': 'Marked & transmucosal increase in lamina propria cellularity, Crypt architecture, Epithelial changes, Mucosal surface, Lamina propria granulomas, Patchy lamina propria cellularity?, Mucin depletion, Submucosal granulomas, Cryptitis extent, Lamina propria polymorphs, Cryptitis polymorphs, Basal histiocytic cells, Active inflammation?, Sex, Increased lamina

propria cellularity?, Increased lymphoid aggregates in lamina propria?',
'accuracy': [0.8109992254066615, 0.8024786986831913, 0.8171959721146398,
0.6332300542215337, 0.6338628438589694], 'avgAccuracy': 0.7395533588569991,
'f1': [0.8310493187351712, 0.8904168457241083, 0.815700526111898,
0.7754327721128764, 0.7613468292498494], 'avgF1': 0.8147892583867806,
'precision': [0.8109992254066615, 0.8024786986831913, 0.8171959721146398,
0.6332300542215337, 0.6338628438589694], 'avgPrecision': 0.7395533588569991,
'recall': [0.8109992254066615, 0.8024786986831913, 0.8171959721146398,
0.6332300542215337, 0.6338628438589694], 'avgRecall': 0.7395533588569991,
'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': 'Marked & transmucosal increase in
lamina propria cellularity, Crypt architecture, Epithelial changes, Mucosal
surface, Lamina propria granulomas, Patchy lamina propria cellularity?, Mucin
depletion, Submucosal granulomas, Cryptitis extent, Lamina propria polymorphs,
Cryptitis polymorphs, Basal histiocytic cells, Active inflammation?, Sex,
Increased lamina propria cellularity?, Increased lymphoid aggregates in lamina
propria?', 'accuracy': [0.9287374128582494, 0.965143299767622,
0.919442292796282, 0.8067389620449265, 0.7942657884540876], 'avgAccuracy':
0.8828655511842335, 'f1': [0.9275816441579903, 0.9822625147812375,
0.918431958676894, 0.8930332261521973, 0.8714083132864341], 'avgF1':
0.9185435314109506, 'precision': [0.9287374128582494, 0.965143299767622,
0.919442292796282, 0.8067389620449265, 0.7942657884540876], 'avgPrecision':
0.8828655511842335, 'recall': [0.9287374128582494, 0.965143299767622,
0.919442292796282, 0.8067389620449265, 0.7942657884540876], 'avgRecall':
0.8828655511842335, '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': 'Marked & transmucosal
increase in lamina propria cellularity, Crypt architecture, Epithelial changes,
Mucosal surface, Lamina propria granulomas, Patchy lamina propria cellularity?,
Mucin depletion, Submucosal granulomas, Cryptitis extent, Lamina propria
polymorphs, Cryptitis polymorphs, Basal histiocytic cells, Active inflammation?,

Sex, Increased lamina propria cellularity?, Increased lymphoid aggregates in lamina propria?', 'accuracy': [0.9329976762199845, 0.9701781564678543, 0.924864446165763, 0.8063516653756778, 0.7923285548237118], 'avgAccuracy': 0.8853440998105983, 'f1': [0.9318672032153393, 0.984863377236092, 0.9239980821952671, 0.8927958833619212, 0.8701985112564117], 'avgF1': 0.9207446114530062, 'precision': [0.9329976762199845, 0.9701781564678543, 0.924864446165763, 0.8063516653756778, 0.7923285548237118], 'avgPrecision': 0.8853440998105983, 'recall': [0.9329976762199845, 0.9701781564678543, 0.924864446165763, 0.8063516653756778, 0.7923285548237118], 'avgRecall': 0.8853440998105983, '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  Marked & transmucosal increase in lamina propr…
1    KNeighborsClassifier  Marked & transmucosal increase in lamina propr…
2      LogisticRegression  Marked & transmucosal increase in lamina propr…
3              GaussianNB  Marked & transmucosal increase in lamina propr…
4      AdaBoostClassifier  Marked & transmucosal increase in lamina propr…
5  DecisionTreeClassifier  Marked & transmucosal increase in lamina propr…
6                     SVC  Marked & transmucosal increase in lamina propr…
7           MLPClassifier  Marked & transmucosal increase in lamina propr…

   accuracy        f1  precision    recall  \
0  0.885344  0.920745   0.885344  0.885344
1  0.882711  0.919341   0.882711  0.882711
2  0.708804  0.793535   0.708804  0.708804
3  0.562276  0.555955   0.562276  0.562276
4  0.752492  0.825049   0.752492  0.752492
5  0.883640  0.919407   0.883640  0.883640
6  0.739553  0.814789   0.739553  0.739553
7  0.882866  0.918544   0.882866  0.882866

                                              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': 'Marked & transmucosal
increase in lamina propria cellularity, Crypt architecture, Epithelial changes,
Mucosal surface, Lamina propria granulomas, Patchy lamina propria cellularity?,
Mucin depletion, Submucosal granulomas, Cryptitis extent, Lamina propria
polymorphs, Cryptitis polymorphs, Basal histiocytic cells, Active inflammation?,
Sex, Increased lamina propria cellularity?', 'accuracy': [0.9329976762199845,
0.9701781564678543, 0.924864446165763, 0.8059643687064292, 0.7938783417280124],
'avgAccuracy': 0.8855765978576087, 'f1': [0.9320414800091605, 0.984863377236092,
0.9239980821952671, 0.8925584387733219, 0.8711665843469139], 'avgF1':
0.9209255925121511, 'precision': [0.9329976762199845, 0.9701781564678543,
0.924864446165763, 0.8059643687064292, 0.7938783417280124], 'avgPrecision':
0.8855765978576087, 'recall': [0.9329976762199845, 0.9701781564678543,
0.924864446165763, 0.8059643687064292, 0.7938783417280124], 'avgRecall':
0.8855765978576087, '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': 'Marked & transmucosal
increase in lamina propria cellularity, Crypt architecture, Epithelial changes,
Mucosal surface, Lamina propria granulomas, Patchy lamina propria cellularity?,
Mucin depletion, Submucosal granulomas, Cryptitis extent, Lamina propria
polymorphs, Cryptitis polymorphs, Basal histiocytic cells, Active inflammation?,
Sex, Increased lamina propria cellularity?', 'accuracy': [0.9295120061967467,
0.9852827265685515, 0.9190549961270333, 0.8152594887683966, 0.7888415342890353],
'avgAccuracy': 0.8875901503899527, 'f1': [0.9281835117085948,
0.9925868123293016, 0.9175891771378678, 0.8982291444420738, 0.86800510951162222],
'avgF1': 0.9209187510268121, 'precision': [0.9295120061967467,
0.9852827265685515, 0.9190549961270333, 0.8152594887683966, 0.7888415342890353],
'avgPrecision': 0.8875901503899527, 'recall': [0.9295120061967467,
0.9852827265685515, 0.9190549961270333, 0.8152594887683966, 0.7888415342890353],
'avgRecall': 0.8875901503899527, 'params': [{'algorithm': 'brute', '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': 'Marked & transmucosal increase in lamina propria cellularity, Crypt architecture, Epithelial changes, Mucosal surface, Lamina propria granulomas, Patchy lamina propria cellularity?, Mucin depletion, Submucosal granulomas, Cryptitis extent, Lamina propria polymorphs, Cryptitis polymorphs, Basal histiocytic cells, Active inflammation?, Sex, Increased lamina propria cellularity?', 'accuracy': [0.7885360185902401, 0.6014717273431448, 0.80286599535244, 0.656855151045701, 0.651685393258427], 'avgAccuracy': 0.7002828571179905, 'f1': [0.8135087148490493, 0.751148730350665, 0.8027809827234254, 0.7928938756428238, 0.7745422804888014], 'avgF1': 0.786974916810953, 'precision': [0.7885360185902401, 0.6014717273431448, 0.80286599535244, 0.656855151045701, 0.651685393258427], 'avgPrecision': 0.7002828571179905, 'recall': [0.7885360185902401, 0.6014717273431448, 0.80286599535244, 0.656855151045701, 0.651685393258427], 'avgRecall': 0.7002828571179905, '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': 'Marked & transmucosal increase in lamina propria cellularity, Crypt architecture, Epithelial changes, Mucosal surface, Lamina propria granulomas, Patchy lamina propria cellularity?, Mucin depletion, Submucosal granulomas, Cryptitis extent, Lamina propria polymorphs, Cryptitis polymorphs, Basal histiocytic cells, Active inflammation?, Sex, Increased lamina propria cellularity?', 'accuracy': [0.24593338497288925, 0.11347792408985283, 0.4666924864446166, 1.0, 0.9852770244091438], 'avgAccuracy': 0.5622761639833005, 'f1': [0.23210809566060528, 0.20382608695652168, 0.3642745251823215, 1.0, 0.979567660978043], 'avgF1': 0.5559552737554982, 'precision': [0.24593338497288925, 0.11347792408985283, 0.4666924864446166, 1.0, 0.9852770244091438], 'avgPrecision': 0.5622761639833005, 'recall': [0.24593338497288925, 0.11347792408985283, 0.4666924864446166, 1.0, 0.9852770244091438], 'avgRecall': 0.5622761639833005, 'params': [{'priors': None, 'var_smoothing': 1e-09}]}
****

Processing Model: AdaBoostClassifier
****
* AdaBoostClassifier
* Best Params Result:
* {'classifier': 'AdaBoostClassifier', 'features': 'Marked & transmucosal increase in lamina propria cellularity, Crypt architecture, Epithelial changes,

Mucosal surface, Lamina propria granulomas, Patchy lamina propria cellularity?, Mucin depletion, Submucosal granulomas, Cryptitis extent, Lamina propria polymorphs, Cryptitis polymorphs Basal histiocytic cells, Active inflammation?, Sex, Increased lamina propria cellularity?', 'accuracy': [0.8032532920216886, 0.7831138652207591, 0.8226181254841208, 0.7122385747482571, 0.7047655947307245], 'avgAccuracy': 0.7651978904411101, 'f1': [0.8251407686907716, 0.8783666377063423, 0.822400087921541, 0.8319384754580411, 0.8125309123058684], 'avgF1': 0.8340753764165129, 'precision': [0.8032532920216886, 0.7831138652207591, 0.8226181254841208, 0.7122385747482571, 0.7047655947307245], 'avgPrecision': 0.7651978904411101, 'recall': [0.8032532920216886, 0.7831138652207591, 0.8226181254841208, 0.7122385747482571, 0.7047655947307245], 'avgRecall': 0.7651978904411101, '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': 'Marked & transmucosal increase in lamina propria cellularity, Crypt architecture, Epithelial changes, Mucosal surface, Lamina propria granulomas, Patchy lamina propria cellularity?, Mucin depletion, Submucosal granulomas, Cryptitis extent, Lamina propria polymorphs, Cryptitis polymorphs, Basal histiocytic cells, Active inflammation?, Sex, Increased lamina propria cellularity?', 'accuracy': [0.9298993028659953, 0.9705654531371031, 0.923702556158017, 0.8040278853601859, 0.7892289810151104], 'avgAccuracy': 0.8834848357072823, 'f1': [0.9286244191421082, 0.9850628930817611, 0.9228132529623144, 0.8913696865607557, 0.8682488838367678], 'avgF1': 0.9192238271167414, 'precision': [0.9298993028659953, 0.9705654531371031, 0.923702556158017, 0.8040278853601859, 0.7892289810151104], 'avgPrecision': 0.8834848357072823, 'recall': [0.9298993028659953, 0.9705654531371031, 0.923702556158017, 0.8040278853601859, 0.7892289810151104], 'avgRecall': 0.8834848357072823, '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': 'Marked & transmucosal increase in lamina propria cellularity, Crypt architecture, Epithelial changes, Mucosal surface, Lamina propria granulomas, Patchy lamina propria cellularity?, Mucin depletion, Submucosal granulomas, Cryptitis extent, Lamina propria polymorphs, Cryptitis

polymorphs, Basal histiocytic cells, Active inflammation?, Sex, Increased lamina propria cellularity?', 'accuracy': [0.7974438419829589, 0.7424477149496514, 0.8156467854376452, 0.639426800929512, 0.6268888027896165], 'avgAccuracy': 0.7243707892178768, 'f1': [0.8203832924383659, 0.8521893754167594, 0.8145075947224464, 0.7800614221592251, 0.7559959193065631], 'avgF1': 0.804627520808672, 'precision': [0.7974438419829589, 0.7424477149496514, 0.8156467854376452, 0.639426800929512, 0.6268888027896165], 'avgPrecision': 0.7243707892178768, 'recall': [0.7974438419829589, 0.7424477149496514, 0.8156467854376452, 0.639426800929512, 0.6268888027896165], 'avgRecall': 0.7243707892178768, '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': 'Marked & transmucosal increase in lamina propria cellularity, Crypt architecture, Epithelial changes, Mucosal surface, Lamina propria granulomas, Patchy lamina propria cellularity?, Mucin depletion, Submucosal granulomas, Cryptitis extent, Lamina propria polymorphs, Cryptitis polymorphs, Basal histiocytic cells, Active inflammation?, Sex, Increased lamina propria cellularity?', 'accuracy': [0.9264136328427576, 0.9624322230828815, 0.9190549961270333, 0.7947327652982185, 0.7950406819062379], 'avgAccuracy': 0.8795348598514258, 'f1': [0.925692038022254, 0.9808565225971977, 0.9180707244508202, 0.8856279671989642, 0.8718899656420951], 'avgF1': 0.9164274435822662, 'precision': [0.9264136328427576, 0.9624322230828815, 0.9190549961270333, 0.7947327652982185, 0.7950406819062379], 'avgPrecision': 0.8795348598514258, 'recall': [0.9264136328427576, 0.9624322230828815, 0.9190549961270333, 0.7947327652982185, 0.7950406819062379], 'avgRecall': 0.8795348598514258, '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': 'Marked & transmucosal increase in lamina propria cellularity, Crypt architecture, Epithelial changes, Mucosal surface, Lamina propria granulomas, Patchy lamina propria cellularity?, Mucin depletion, Submucosal granulomas, Cryptitis extent, Lamina propria polymorphs, Cryptitis polymorphs, Basal histiocytic cells, Active inflammation?,

```
Sex, Increased lamina propria cellularity?', 'accuracy': [0.9295120061967467,
0.9852827265685515, 0.9190549961270333, 0.8152594887683966, 0.7888415342890353],
'avgAccuracy': 0.8875901503899527, 'f1': [0.9281835117085948,
0.9925868123293016, 0.9175891771378678, 0.8982291444420738, 0.86800510951622222],
'avgF1': 0.9209187510268121, 'precision': [0.9295120061967467,
0.9852827265685515, 0.9190549961270333, 0.8152594887683966, 0.7888415342890353],
'avgPrecision': 0.8875901503899527, 'recall': [0.9295120061967467,
0.9852827265685515, 0.9190549961270333, 0.8152594887683966, 0.7888415342890353],
'avgRecall': 0.8875901503899527, 'params': [{'algorithm': 'brute', 'leaf_size':
30, 'metric': 'minkowski', 'metric_params': None, 'n_jobs': -1, 'n_neighbors':
12, 'p': 2, 'weights': 'distance'}]}
******************************************************
```

```
                    model                                    features  \
0  RandomForestClassifier  Marked & transmucosal increase in lamina propr…
1    KNeighborsClassifier  Marked & transmucosal increase in lamina propr…
2      LogisticRegression  Marked & transmucosal increase in lamina propr…
3              GaussianNB  Marked & transmucosal increase in lamina propr…
4      AdaBoostClassifier  Marked & transmucosal increase in lamina propr…
5  DecisionTreeClassifier  Marked & transmucosal increase in lamina propr…
6                     SVC  Marked & transmucosal increase in lamina propr…
7           MLPClassifier  Marked & transmucosal increase in lamina propr…


   accuracy        f1  precision    recall  \
0  0.885577  0.920926   0.885577  0.885577
1  0.887590  0.920919   0.887590  0.887590
2  0.700283  0.786975   0.700283  0.700283
3  0.562276  0.555955   0.562276  0.562276
4  0.765198  0.834075   0.765198  0.765198
5  0.883485  0.919224   0.883485  0.883485
6  0.724371  0.804628   0.724371  0.724371
7  0.879535  0.916427   0.879535  0.879535


                                                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': 'Marked & transmucosal
```

increase in lamina propria cellularity, Crypt architecture, Epithelial changes,
Mucosal surface, Lamina propria granulomas, Patchy lamina propria cellularity?,
Mucin depletion, Submucosal granulomas, Cryptitis extent, Lamina propria
polymorphs, Cryptitis polymorphs, Basal histiocytic cells, Active inflammation?,
Sex', 'accuracy': [0.9326103795507359, 0.9701781564678543, 0.924864446165763,
0.8079008520526724, 0.8163502518403719], 'avgAccuracy': 0.8903808172154795,
'f1': [0.9315174243667953, 0.984863377236092, 0.9239980821952671,
0.8937446443873178, 0.885076746436222], 'avgF1': 0.9238400549243388,
'precision': [0.9326103795507359, 0.9701781564678543, 0.924864446165763,
0.8079008520526724, 0.8163502518403719], 'avgPrecision': 0.8903808172154795,
'recall': [0.9326103795507359, 0.9701781564678543, 0.924864446165763,
0.8079008520526724, 0.8163502518403719], 'avgRecall': 0.8903808172154795,
'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': 'Marked & transmucosal
increase in lamina propria cellularity, Crypt architecture, Epithelial changes,
Mucosal surface, Lamina propria granulomas, Patchy lamina propria cellularity?,
Mucin depletion, Submucosal granulomas, Cryptitis extent, Lamina propria
polymorphs, Cryptitis polymorphs, Basal histiocytic cells, Active inflammation?,
Sex', 'accuracy': [0.9295120061967467, 0.9848954298993029, 0.9233152594887684,
0.8032532920216886, 0.7872917473847346], 'avgAccuracy': 0.8856535469982483,
'f1': [0.9282764822640005, 0.9923902439024389, 0.9224118228753246,
0.890893470790378, 0.8670290327476512], 'avgF1': 0.9202002105159587,
'precision': [0.9295120061967467, 0.9848954298993029, 0.9233152594887684,
0.8032532920216886, 0.7872917473847346], 'avgPrecision': 0.8856535469982483,
'recall': [0.9295120061967467, 0.9848954298993029, 0.9233152594887684,
0.8032532920216886, 0.7872917473847346], 'avgRecall': 0.8856535469982483,
'params': [{'algorithm': 'brute', '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': 'Marked & transmucosal
increase in lamina propria cellularity, Crypt architecture, Epithelial changes,

Mucosal surface, Lamina propria granulomas, Patchy lamina propria cellularity?,
Mucin depletion, Submucosal granulomas, Cryptitis extent, Lamina propria
polymorphs, Cryptitis polymorphs, Basal histiocytic cells, Active inflammation?,
Sex', 'accuracy': [0.6537567776917118, 0.6065065840433772, 0.8226181254841208,
0.6301316808675446, 0.6218519953506393], 'avgAccuracy': 0.6669730326874788,
'f1': [0.7078962045168463, 0.7550626808100289, 0.8201163419931231,
0.7731052506533619, 0.7521595579342258], 'avgF1': 0.7616680071815172,
'precision': [0.6537567776917118, 0.6065065840433772, 0.8226181254841208,
0.6301316808675446, 0.6218519953506393], 'avgPrecision': 0.6669730326874788,
'recall': [0.6537567776917118, 0.6065065840433772, 0.8226181254841208,
0.6301316808675446, 0.6218519953506393], 'avgRecall': 0.6669730326874788,
'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': 'Marked & transmucosal increase in
lamina propria cellularity, Crypt architecture, Epithelial changes, Mucosal
surface, Lamina propria granulomas, Patchy lamina propria cellularity?, Mucin
depletion, Submucosal granulomas, Cryptitis extent, Lamina propria polymorphs,
Cryptitis polymorphs, Basal histiocytic cells, Active inflammation?, Sex',
'accuracy': [0.24593338497288925, 0.11347792408985283, 0.4666924864446166, 1.0,
0.9852770244091438], 'avgAccuracy': 0.5622761639833005, 'f1':
[0.23210809566060528, 0.20382608695652168, 0.3642745251823215, 1.0,
0.979567660978043], 'avgF1': 0.5559552737554982, 'precision':
[0.24593338497288925, 0.11347792408985283, 0.4666924864446166, 1.0,
0.9852770244091438], 'avgPrecision': 0.5622761639833005, 'recall':
[0.24593338497288925, 0.11347792408985283, 0.4666924864446166, 1.0,
0.9852770244091438], 'avgRecall': 0.5622761639833005, 'params': [{'priors':
None, 'var_smoothing': 1e-09}]}
****

Processing Model: AdaBoostClassifier
****
* AdaBoostClassifier
* Best Params Result:
* {'classifier': 'AdaBoostClassifier', 'features': 'Marked & transmucosal
increase in lamina propria cellularity, Crypt architecture, Epithelial changes,
Mucosal surface, Lamina propria granulomas, Patchy lamina propria cellularity?,
Mucin depletion, Submucosal granulomas, Cryptitis extent, Lamina propria
polymorphs, Cryptitis polymorphs, Basal histiocytic cells, Active inflammation?,
Sex', 'accuracy': [0.6440743609604958, 0.6177381874515879, 0.8315259488768396,
0.7122385747482571, 0.7047655947307245], 'avgAccuracy': 0.702068533353581, 'f1':

[0.6997310918189729, 0.7637060090974384, 0.8306460431433276, 0.8319384754580411, 0.8125309123058684], 'avgF1': 0.7877105063647296, 'precision': [0.6440743609604958, 0.6177381874515879, 0.8315259488768396, 0.7122385747482571, 0.7047655947307245], 'avgPrecision': 0.702068533353581, 'recall': [0.6440743609604958, 0.6177381874515879, 0.8315259488768396, 0.7122385747482571, 0.7047655947307245], 'avgRecall': 0.702068533353581, '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': 'Marked & transmucosal increase in lamina propria cellularity, Crypt architecture, Epithelial changes, Mucosal surface, Lamina propria granulomas, Patchy lamina propria cellularity?, Mucin depletion, Submucosal granulomas, Cryptitis extent, Lamina propria polymorphs, Cryptitis polymorphs, Basal histiocytic cells, Active inflammation?, Sex', 'accuracy': [0.9298993028659953, 0.9682416731216111, 0.923702556158017, 0.8059643687064292, 0.8159628051142968], 'avgAccuracy': 0.8887541411932699, 'f1': [0.9288080419231897, 0.9838646202282565, 0.9228132529623144, 0.8925584387733219, 0.8848593922885515], 'avgF1': 0.9225807492351268, 'precision': [0.9298993028659953, 0.9682416731216111, 0.923702556158017, 0.8059643687064292, 0.8159628051142968], 'avgPrecision': 0.8887541411932699, 'recall': [0.9298993028659953, 0.9682416731216111, 0.923702556158017, 0.8059643687064292, 0.8159628051142968], 'avgRecall': 0.8887541411932699, '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': 'Marked & transmucosal increase in lamina propria cellularity, Crypt architecture, Epithelial changes, Mucosal surface, Lamina propria granulomas, Patchy lamina propria cellularity?, Mucin depletion, Submucosal granulomas, Cryptitis extent, Lamina propria polymorphs, Cryptitis polymorphs, Basal histiocytic cells, Active inflammation?, Sex', 'accuracy': [0.808288148721921, 0.6340046475600309, 0.8272656855151046, 0.6204492641363284, 0.6013173188686556], 'avgAccuracy': 0.6982650129604081, 'f1': [0.8284850975609559, 0.7760132732875089, 0.8242609930903515, 0.765774378585086, 0.7361743533334244], 'avgF1': 0.7861416191714653, 'precision': [0.808288148721921, 0.6340046475600309, 0.8272656855151046, 0.6204492641363284,

0.6013173188686556], 'avgPrecision': 0.6982650129604081, 'recall':
[0.808288148721921, 0.6340046475600309, 0.8272656855151046, 0.6204492641363284,
0.6013173188686556], 'avgRecall': 0.6982650129604081, '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': 'Marked & transmucosal increase in
lamina propria cellularity, Crypt architecture, Epithelial changes, Mucosal
surface, Lamina propria granulomas, Patchy lamina propria cellularity?, Mucin
depletion, Submucosal granulomas, Cryptitis extent, Lamina propria polymorphs,
Cryptitis polymorphs, Basal histiocytic cells, Active inflammation?, Sex',
'accuracy': [0.9268009295120062, 0.9604957397366383, 0.9186676994577847,
0.8237800154918667, 0.8066640836884929], 'avgAccuracy': 0.8872816935773578,
'f1': [0.9260369304242264, 0.9798498617147372, 0.9176683932444094,
0.9033765130600976, 0.8791246839616708], 'avgF1': 0.9212112764810283,
'precision': [0.9268009295120062, 0.9604957397366383, 0.9186676994577847,
0.8237800154918667, 0.8066640836884929], 'avgPrecision': 0.8872816935773578,
'recall': [0.9268009295120062, 0.9604957397366383, 0.9186676994577847,
0.8237800154918667, 0.8066640836884929], 'avgRecall': 0.8872816935773578,
'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': 'Marked & transmucosal
increase in lamina propria cellularity, Crypt architecture, Epithelial changes,
Mucosal surface, Lamina propria granulomas, Patchy lamina propria cellularity?,
Mucin depletion, Submucosal granulomas, Cryptitis extent, Lamina propria
polymorphs, Cryptitis polymorphs, Basal histiocytic cells, Active inflammation?,
Sex', 'accuracy': [0.9326103795507359, 0.9701781564678543, 0.924864446165763,
0.8079008520526724, 0.8163502518403719], 'avgAccuracy': 0.8903808172154795,
'f1': [0.9315174243667953, 0.984863377236092, 0.9239980821952671,
0.8937446443873178, 0.885076746436222], 'avgF1': 0.9238400549243388,
'precision': [0.9326103795507359, 0.9701781564678543, 0.924864446165763,
0.8079008520526724, 0.8163502518403719], 'avgPrecision': 0.8903808172154795,
'recall': [0.9326103795507359, 0.9701781564678543, 0.924864446165763,

0.8079008520526724, 0.8163502518403719], 'avgRecall': 0.8903808172154795,
'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  Marked & transmucosal increase in lamina propr…
1    KNeighborsClassifier  Marked & transmucosal increase in lamina propr…
2      LogisticRegression  Marked & transmucosal increase in lamina propr…
3              GaussianNB  Marked & transmucosal increase in lamina propr…
4      AdaBoostClassifier  Marked & transmucosal increase in lamina propr…
5  DecisionTreeClassifier  Marked & transmucosal increase in lamina propr…
6                     SVC  Marked & transmucosal increase in lamina propr…
7           MLPClassifier  Marked & transmucosal increase in lamina propr…


   accuracy        f1  precision    recall  \
0  0.890381  0.923840   0.890381  0.890381
1  0.885654  0.920200   0.885654  0.885654
2  0.666973  0.761668   0.666973  0.666973
3  0.562276  0.555955   0.562276  0.562276
4  0.702069  0.787711   0.702069  0.702069
5  0.888754  0.922581   0.888754  0.888754
6  0.698265  0.786142   0.698265  0.698265
7  0.887282  0.921211   0.887282  0.887282


                                                 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': 'Marked & transmucosal
increase in lamina propria cellularity, Crypt architecture, Epithelial changes,
Mucosal surface, Lamina propria granulomas, Patchy lamina propria cellularity?,
Mucin depletion, Submucosal granulomas, Cryptitis extent, Lamina propria
polymorphs, Cryptitis polymorphs, Basal histiocytic cells, Active

inflammation?', 'accuracy': [0.9124709527498064, 0.9512006196746708,
0.9097598760650658, 0.8094500387296669, 0.7838047268500581], 'avgAccuracy':
0.8733372428138536, 'f1': [0.9134793606749531, 0.9749900754267568,
0.9083038949258901, 0.8946917808219178, 0.8648212048724403], 'avgF1':
0.9112572633443916, 'precision': [0.9124709527498064, 0.9512006196746708,
0.9097598760650658, 0.8094500387296669, 0.7838047268500581], 'avgPrecision':
0.8733372428138536, 'recall': [0.9124709527498064, 0.9512006196746708,
0.9097598760650658, 0.8094500387296669, 0.7838047268500581], 'avgRecall':
0.8733372428138536, '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': 'Marked & transmucosal
increase in lamina propria cellularity, Crypt architecture, Epithelial changes,
Mucosal surface, Lamina propria granulomas, Patchy lamina propria cellularity?,
Mucin depletion, Submucosal granulomas, Cryptitis extent, Lamina propria
polymorphs, Cryptitis polymorphs, Basal histiocytic cells, Active
inflammation?', 'accuracy': [0.9027885360185902, 0.9508133230054222,
0.9078233927188226, 0.8117738187451587, 0.77644323905463], 'avgAccuracy':
0.8699284619085248, 'f1': [0.9045965385958659, 0.9747865793130831,
0.9062460614636522, 0.8961094484822573, 0.8601426360762431], 'avgF1':
0.9083762527862203, 'precision': [0.9027885360185902, 0.9508133230054222,
0.9078233927188226, 0.8117738187451587, 0.77644323905463], 'avgPrecision':
0.8699284619085248, 'recall': [0.9027885360185902, 0.9508133230054222,
0.9078233927188226, 0.8117738187451587, 0.77644323905463], 'avgRecall':
0.8699284619085248, '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': 'Marked & transmucosal
increase in lamina propria cellularity, Crypt architecture, Epithelial changes,
Mucosal surface, Lamina propria granulomas, Patchy lamina propria cellularity?,
Mucin depletion, Submucosal granulomas, Cryptitis extent, Lamina propria
polymorphs, Cryptitis polymorphs, Basal histiocytic cells, Active
inflammation?', 'accuracy': [0.8036405886909372, 0.7486444616576298,

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0.8164213787761425, 0.6150271107668474, 0.5966679581557536], 'avgAccuracy':
0.7160802996094621, 'f1': [0.8247083735709287, 0.8562569213732003,
0.8154433366621827, 0.7616306954436451, 0.732808466145676], 'avgF1':
0.7981695586391265, 'precision': [0.8036405886909372, 0.7486444616576298,
0.8164213787761425, 0.6150271107668474, 0.5966679581557536], 'avgPrecision':
0.7160802996094621, 'recall': [0.8036405886909372, 0.7486444616576298,
0.8164213787761425, 0.6150271107668474, 0.5966679581557536], 'avgRecall':
0.7160802996094621, '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': 'Marked & transmucosal increase in
lamina propria cellularity, Crypt architecture, Epithelial changes, Mucosal
surface, Lamina propria granulomas, Patchy lamina propria cellularity?, Mucin
depletion, Submucosal granulomas, Cryptitis extent, Lamina propria polymorphs,
Cryptitis polymorphs, Basal histiocytic cells, Active inflammation?',
'accuracy': [0.24593338497288925, 0.11347792408985283, 0.4666924864446166, 1.0,
0.9852770244091438], 'avgAccuracy': 0.5622761639833005, 'f1':
[0.23210809566060528, 0.20382608695652168, 0.3642745251823215, 1.0,
0.979567660978043], 'avgF1': 0.5559552737554982, 'precision':
[0.24593338497288925, 0.11347792408985283, 0.4666924864446166, 1.0,
0.9852770244091438], 'avgPrecision': 0.5622761639833005, 'recall':
[0.24593338497288925, 0.11347792408985283, 0.4666924864446166, 1.0,
0.9852770244091438], 'avgRecall': 0.5622761639833005, 'params': [{'priors':
None, 'var_smoothing': 1e-09}]}
****

Processing Model: AdaBoostClassifier
****
* AdaBoostClassifier
* Best Params Result:
* {'classifier': 'AdaBoostClassifier', 'features': 'Marked & transmucosal
increase in lamina propria cellularity, Crypt architecture, Epithelial changes,
Mucosal surface, Lamina propria granulomas, Patchy lamina propria cellularity?,
Mucin depletion, Submucosal granulomas, Cryptitis extent, Lamina propria
polymorphs, Cryptitis polymorphs, Basal histiocytic cells, Active
inflammation?', 'accuracy': [0.7970565453137103, 0.7827265685515105,
0.8175832687838884, 0.7114639814097599, 0.6985664471135219], 'avgAccuracy':
0.7614793622344782, 'f1': [0.8198155911067191, 0.8781229632848142,
0.8166686000561928, 0.8314098212265219, 0.8084146843926965], 'avgF1':
0.8308863320133889, 'precision': [0.7970565453137103, 0.7827265685515105,

0.8175832687838884, 0.7114639814097599, 0.6985664471135219], 'avgPrecision':
0.7614793622344782, 'recall': [0.7970565453137103, 0.7827265685515105,
0.8175832687838884, 0.7114639814097599, 0.6985664471135219], 'avgRecall':
0.7614793622344782, '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': 'Marked & transmucosal
increase in lamina propria cellularity, Crypt architecture, Epithelial changes,
Mucosal surface, Lamina propria granulomas, Patchy lamina propria cellularity?,
Mucin depletion, Submucosal granulomas, Cryptitis extent, Lamina propria
polymorphs, Cryptitis polymorphs, Basal histiocytic cells, Active
inflammation?', 'accuracy': [0.9120836560805577, 0.9500387296669248,
0.9082106893880713, 0.8067389620449265, 0.7799302595893065], 'avgAccuracy':
0.8714004593539574, 'f1': [0.9125480515766394, 0.9743793445878849,
0.9067042559189009, 0.8930332261521973, 0.8623710770429008], 'avgF1':
0.9098071910557046, 'precision': [0.9120836560805577, 0.9500387296669248,
0.9082106893880713, 0.8067389620449265, 0.7799302595893065], 'avgPrecision':
0.8714004593539574, 'recall': [0.9120836560805577, 0.9500387296669248,
0.9082106893880713, 0.8067389620449265, 0.7799302595893065], 'avgRecall':
0.8714004593539574, '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': 'Marked & transmucosal increase in lamina
propria cellularity, Crypt architecture, Epithelial changes, Mucosal surface,
Lamina propria granulomas, Patchy lamina propria cellularity?, Mucin depletion,
Submucosal granulomas, Cryptitis extent, Lamina propria polymorphs, Cryptitis
polymorphs, Basal histiocytic cells, Active inflammation?', 'accuracy':
[0.7804027885360186, 0.761425251742835, 0.8160340821068939, 0.620836560805577,
0.642386671832623], 'avgAccuracy': 0.7242170710047895, 'f1':
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0.7675787821565135], 'avgF1': 0.8037667655904419, 'precision':
[0.7804027885360186, 0.761425251742835, 0.8160340821068939, 0.620836560805577,
0.642386671832623], 'avgPrecision': 0.7242170710047895, 'recall':
[0.7804027885360186, 0.761425251742835, 0.8160340821068939, 0.620836560805577,
0.642386671832623], 'avgRecall': 0.7242170710047895, 'params': [{'C': 1.0,

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'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': 'Marked & transmucosal increase in
lamina propria cellularity, Crypt architecture, Epithelial changes, Mucosal
surface, Lamina propria granulomas, Patchy lamina propria cellularity?, Mucin
depletion, Submucosal granulomas, Cryptitis extent, Lamina propria polymorphs,
Cryptitis polymorphs, Basal histiocytic cells, Active inflammation?',
'accuracy': [0.9043377226955848, 0.9388071262587142, 0.9000774593338497,
0.784275755228505, 0.759783029833398], 'avgAccuracy': 0.8574562186700103, 'f1':
[0.9058081232777009, 0.9684378745505393, 0.8985338577449483, 0.8790970262643802,
0.8494006558466097], 'avgF1': 0.9002555075368357, 'precision':
[0.9043377226955848, 0.9388071262587142, 0.9000774593338497, 0.784275755228505,
0.759783029833398], 'avgPrecision': 0.8574562186700103, 'recall':
[0.9043377226955848, 0.9388071262587142, 0.9000774593338497, 0.784275755228505,
0.759783029833398], 'avgRecall': 0.8574562186700103, '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': 'Marked & transmucosal
increase in lamina propria cellularity, Crypt architecture, Epithelial changes,
Mucosal surface, Lamina propria granulomas, Patchy lamina propria cellularity?,
Mucin depletion, Submucosal granulomas, Cryptitis extent, Lamina propria
polymorphs, Cryptitis polymorphs, Basal histiocytic cells, Active
inflammation?', 'accuracy': [0.9124709527498064, 0.9512006196746708,
0.9097598760650658, 0.8094500387296669, 0.7838047268500581], 'avgAccuracy':
0.8733372428138536, 'f1': [0.9134793606749531, 0.9749900754267568,
0.9083038949258901, 0.8946917808219178, 0.8648212048724403], 'avgF1':
0.9112572633443916, 'precision': [0.9124709527498064, 0.9512006196746708,
0.9097598760650658, 0.8094500387296669, 0.7838047268500581], 'avgPrecision':
0.8733372428138536, 'recall': [0.9124709527498064, 0.9512006196746708,
0.9097598760650658, 0.8094500387296669, 0.7838047268500581], 'avgRecall':
0.8733372428138536, 'params': [{'bootstrap': True, 'ccp_alpha': 0.0,
'class_weight': None, 'criterion': 'entropy', 'max_depth': None, 'max_features':
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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  Marked & transmucosal increase in lamina propr…
1    KNeighborsClassifier  Marked & transmucosal increase in lamina propr…
2      LogisticRegression  Marked & transmucosal increase in lamina propr…
3              GaussianNB  Marked & transmucosal increase in lamina propr…
4      AdaBoostClassifier  Marked & transmucosal increase in lamina propr…
5  DecisionTreeClassifier  Marked & transmucosal increase in lamina propr…
6                     SVC  Marked & transmucosal increase in lamina propr…
7           MLPClassifier  Marked & transmucosal increase in lamina propr…

   accuracy        f1  precision    recall  \
0  0.873337  0.911257   0.873337  0.873337
1  0.869928  0.908376   0.869928  0.869928
2  0.716080  0.798170   0.716080  0.716080
3  0.562276  0.555955   0.562276  0.562276
4  0.761479  0.830886   0.761479  0.761479
5  0.871400  0.909807   0.871400  0.871400
6  0.724217  0.803767   0.724217  0.724217
7  0.857456  0.900256   0.857456  0.857456

                                             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': 'Marked & transmucosal
increase in lamina propria cellularity, Crypt architecture, Epithelial changes,
Mucosal surface, Lamina propria granulomas, Patchy lamina propria cellularity?,
Mucin depletion, Submucosal granulomas, Cryptitis extent, Lamina propria
polymorphs, Cryptitis polymorphs, Basal histiocytic cells', 'accuracy':
[0.9124709527498064, 0.9512006196746708, 0.9097598760650658, 0.8094500387296669,
0.7838047268500581], 'avgAccuracy': 0.8733372428138536, 'f1':
[0.9133815972723025, 0.9749900754267568, 0.9083038949258901, 0.8946917808219178,
```

```
0.8648271003331741], 'avgF1': 0.9112388897560083, 'precision':
[0.9124709527498064, 0.9512006196746708, 0.9097598760650658, 0.8094500387296669,
0.7838047268500581], 'avgPrecision': 0.8733372428138536, 'recall':
[0.9124709527498064, 0.9512006196746708, 0.9097598760650658, 0.8094500387296669,
0.7838047268500581], 'avgRecall': 0.8733372428138536, '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': True, 'random_state': None, 'verbose': 0,
'warm_start': False}]}
*****************************************************

Processing Model: KNeighborsClassifier
*****************************************************
* KNeighborsClassifier
* Best Params Result:
* {'classifier': 'KNeighborsClassifier', 'features': 'Marked & transmucosal
increase in lamina propria cellularity, Crypt architecture, Epithelial changes,
Mucosal surface, Lamina propria granulomas, Patchy lamina propria cellularity?,
Mucin depletion, Submucosal granulomas, Cryptitis extent, Lamina propria
polymorphs, Cryptitis polymorphs, Basal histiocytic cells', 'accuracy':
[0.9016266460108443, 0.9341595662277304, 0.9016266460108443, 0.8013168086754454,
0.7733436652460287], 'avgAccuracy': 0.8624146664341786, 'f1':
[0.9031920905673471, 0.9659591509811776, 0.9002910214348246, 0.889701139539884,
0.8581618283570202], 'avgF1': 0.9034610461760507, 'precision':
[0.9016266460108443, 0.9341595662277304, 0.9016266460108443, 0.8013168086754454,
0.7733436652460287], 'avgPrecision': 0.8624146664341786, 'recall':
[0.9016266460108443, 0.9341595662277304, 0.9016266460108443, 0.8013168086754454,
0.7733436652460287], 'avgRecall': 0.8624146664341786, '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': 'Marked & transmucosal
increase in lamina propria cellularity, Crypt architecture, Epithelial changes,
Mucosal surface, Lamina propria granulomas, Patchy lamina propria cellularity?,
Mucin depletion, Submucosal granulomas, Cryptitis extent, Lamina propria
polymorphs, Cryptitis polymorphs, Basal histiocytic cells', 'accuracy':
[0.8067389620449265, 0.7583268783888458, 0.8175832687838884, 0.6123160340821069,
0.5955056179775281], 'avgAccuracy': 0.7180941522554591, 'f1':
[0.8270991185513474, 0.8625550660792951, 0.8165922249067556, 0.759548402594283,
0.7318926918225436], 'avgF1': 0.799537500790845, 'precision':
[0.8067389620449265, 0.7583268783888458, 0.8175832687838884, 0.6123160340821069,
```

0.5955056179775281], 'avgPrecision': 0.7180941522554591, 'recall':
[0.8067389620449265, 0.7583268783888458, 0.8175832687838884, 0.6123160340821069,
0.5955056179775281], 'avgRecall': 0.7180941522554591, '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': 'Marked & transmucosal increase in
lamina propria cellularity, Crypt architecture, Epithelial changes, Mucosal
surface, Lamina propria granulomas, Patchy lamina propria cellularity?, Mucin
depletion, Submucosal granulomas, Cryptitis extent, Lamina propria polymorphs,
Cryptitis polymorphs, Basal histiocytic cells', 'accuracy':
[0.24593338497288925, 0.11347792408985283, 0.4666924864446166, 1.0,
0.9852770244091438], 'avgAccuracy': 0.5622761639833005, 'f1':
[0.23210809566060528, 0.20382608695652168, 0.3642745251823215, 1.0,
0.979567660978043], 'avgF1': 0.5559552737554982, 'precision':
[0.24593338497288925, 0.11347792408985283, 0.4666924864446166, 1.0,
0.9852770244091438], 'avgPrecision': 0.5622761639833005, 'recall':
[0.24593338497288925, 0.11347792408985283, 0.4666924864446166, 1.0,
0.9852770244091438], 'avgRecall': 0.5622761639833005, 'params': [{'priors':
None, 'var_smoothing': 1e-09}]}
****

Processing Model: AdaBoostClassifier
****
* AdaBoostClassifier
* Best Params Result:
* {'classifier': 'AdaBoostClassifier', 'features': 'Marked & transmucosal
increase in lamina propria cellularity, Crypt architecture, Epithelial changes,
Mucosal surface, Lamina propria granulomas, Patchy lamina propria cellularity?,
Mucin depletion, Submucosal granulomas, Cryptitis extent, Lamina propria
polymorphs, Cryptitis polymorphs, Basal histiocytic cells', 'accuracy':
[0.7970565453137103, 0.7827265685515105, 0.8175832687838884, 0.7114639814097599,
0.6985664471135219], 'avgAccuracy': 0.7614793622344782, 'f1':
[0.8198155911067191, 0.8781229632848142, 0.8166686000561928, 0.8314098212265219,
0.8084146843926965], 'avgF1': 0.8308863320133889, 'precision':
[0.7970565453137103, 0.7827265685515105, 0.8175832687838884, 0.7114639814097599,
0.6985664471135219], 'avgPrecision': 0.7614793622344782, 'recall':
[0.7970565453137103, 0.7827265685515105, 0.8175832687838884, 0.7114639814097599,
0.6985664471135219], 'avgRecall': 0.7614793622344782, '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': 'Marked & transmucosal
increase in lamina propria cellularity, Crypt architecture, Epithelial changes,
Mucosal surface, Lamina propria granulomas, Patchy lamina propria cellularity?,
Mucin depletion, Submucosal granulomas, Cryptitis extent, Lamina propria
polymorphs, Cryptitis polymorphs, Basal histiocytic cells', 'accuracy':
[0.9047250193648335, 0.9512006196746708, 0.9093725793958172, 0.8071262587141751,
0.7822549399457575], 'avgAccuracy': 0.8709358834190508, 'f1':
[0.9058226669293736, 0.9749900754267568, 0.907922863761689, 0.8932704672096015,
0.8638521812514545], 'avgF1': 0.909171650915775, 'precision':
[0.9047250193648335, 0.9512006196746708, 0.9093725793958172, 0.8071262587141751,
0.7822549399457575], 'avgPrecision': 0.8709358834190508, 'recall':
[0.9047250193648335, 0.9512006196746708, 0.9093725793958172, 0.8071262587141751,
0.7822549399457575], 'avgRecall': 0.8709358834190508, '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': 'Marked & transmucosal increase in lamina
propria cellularity, Crypt architecture, Epithelial changes, Mucosal surface,
Lamina propria granulomas, Patchy lamina propria cellularity?, Mucin depletion,
Submucosal granulomas, Cryptitis extent, Lamina propria polymorphs, Cryptitis
polymorphs, Basal histiocytic cells', 'accuracy': [0.7796281951975214,
0.7687838884585593, 0.8160340821068939, 0.6134779240898528, 0.5974428516079039],
'avgAccuracy': 0.7150733882921463, 'f1': [0.805336920369519, 0.8692796146266697,
0.8139814356233989, 0.7604416706673068, 0.733128262891943], 'avgF1':
0.7964335808357674, 'precision': [0.7796281951975214, 0.7687838884585593,
0.8160340821068939, 0.6134779240898528, 0.5974428516079039], 'avgPrecision':
0.7150733882921463, 'recall': [0.7796281951975214, 0.7687838884585593,
0.8160340821068939, 0.6134779240898528, 0.5974428516079039], 'avgRecall':
0.7150733882921463, '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': 'Marked & transmucosal increase in
lamina propria cellularity, Crypt architecture, Epithelial changes, Mucosal
surface, Lamina propria granulomas, Patchy lamina propria cellularity?, Mucin
depletion, Submucosal granulomas, Cryptitis extent, Lamina propria polymorphs,
Cryptitis polymorphs, Basal histiocytic cells', 'accuracy': [0.9024012393493416,
0.9384198295894656, 0.9004647560030984, 0.7835011618900077, 0.7593955831073227],
'avgAccuracy': 0.8568365139878472, 'f1': [0.9042683325944265,
0.9682317682317682, 0.8986047311033807, 0.8786102062975025, 0.8491306029432546],
'avgF1': 0.8997691282340665, 'precision': [0.9024012393493416,
0.9384198295894656, 0.9004647560030984, 0.7835011618900077, 0.7593955831073227],
'avgPrecision': 0.8568365139878472, 'recall': [0.9024012393493416,
0.9384198295894656, 0.9004647560030984, 0.7835011618900077, 0.7593955831073227],
'avgRecall': 0.8568365139878472, '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': 'Marked & transmucosal
increase in lamina propria cellularity, Crypt architecture, Epithelial changes,
Mucosal surface, Lamina propria granulomas, Patchy lamina propria cellularity?,
Mucin depletion, Submucosal granulomas, Cryptitis extent, Lamina propria
polymorphs, Cryptitis polymorphs, Basal histiocytic cells', 'accuracy':
[0.9124709527498064, 0.9512006196746708, 0.9097598760650658, 0.8094500387296669,
0.7838047268500581], 'avgAccuracy': 0.8733372428138536, 'f1':
[0.9133815972723025, 0.9749900754267568, 0.9083038949258901, 0.8946917808219178,
0.8648271003331741], 'avgF1': 0.9112388897560083, 'precision':
[0.9124709527498064, 0.9512006196746708, 0.9097598760650658, 0.8094500387296669,
0.7838047268500581], 'avgPrecision': 0.8733372428138536, 'recall':
[0.9124709527498064, 0.9512006196746708, 0.9097598760650658, 0.8094500387296669,
0.7838047268500581], 'avgRecall': 0.8733372428138536, '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': True, 'random_state': None, 'verbose': 0,
'warm_start': False}]}
*****************************************************

                    model                                          features  \
```

```
0    RandomForestClassifier   Marked & transmucosal increase in lamina propr…
1      KNeighborsClassifier   Marked & transmucosal increase in lamina propr…
2        LogisticRegression   Marked & transmucosal increase in lamina propr…
3                GaussianNB   Marked & transmucosal increase in lamina propr…
4         AdaBoostClassifier   Marked & transmucosal increase in lamina propr…
5     DecisionTreeClassifier   Marked & transmucosal increase in lamina propr…
6                       SVC   Marked & transmucosal increase in lamina propr…
7             MLPClassifier   Marked & transmucosal increase in lamina propr…

   accuracy         f1  precision     recall  \
0  0.873337   0.911239   0.873337   0.873337
1  0.862415   0.903461   0.862415   0.862415
2  0.718094   0.799538   0.718094   0.718094
3  0.562276   0.555955   0.562276   0.562276
4  0.761479   0.830886   0.761479   0.761479
5  0.870936   0.909172   0.870936   0.870936
6  0.715073   0.796434   0.715073   0.715073
7  0.856837   0.899769   0.856837   0.856837


                                                 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': 'Marked & transmucosal
increase in lamina propria cellularity, Crypt architecture, Epithelial changes,
Mucosal surface, Lamina propria granulomas, Patchy lamina propria cellularity?,
Mucin depletion, Submucosal granulomas, Cryptitis extent, Lamina propria
polymorphs, Cryptitis polymorphs', 'accuracy': [0.9120836560805577,
0.9512006196746708, 0.907436096049574, 0.808288148721921, 0.7791553661371562],
'avgAccuracy': 0.871632777332776, 'f1': [0.9129489803012953, 0.9749900754267568,
0.905865172416312, 0.8939815806382522, 0.8618786720632232], 'avgF1':
0.909932896169168, 'precision': [0.9120836560805577, 0.9512006196746708,
0.907436096049574, 0.808288148721921, 0.7791553661371562], 'avgPrecision':
0.871632777332776, 'recall': [0.9120836560805577, 0.9512006196746708,
0.907436096049574, 0.808288148721921, 0.7791553661371562], 'avgRecall':
0.871632777332776, '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:
* {'classifier': 'KNeighborsClassifier', 'features': 'Marked & transmucosal
increase in lamina propria cellularity, Crypt architecture, Epithelial changes,
Mucosal surface, Lamina propria granulomas, Patchy lamina propria cellularity?,
Mucin depletion, Submucosal granulomas, Cryptitis extent, Lamina propria
polymorphs, Cryptitis polymorphs', 'accuracy': [0.9144074360960496,
0.9368706429124709, 0.907436096049574, 0.8013168086754454, 0.7702440914374273],
'avgAccuracy': 0.8660550150341935, 'f1': [0.9136219438937164,
0.9674065186962608, 0.9058128139987781, 0.889701139539884, 0.8561744926373911],
'avgF1': 0.906543381753206, 'precision': [0.9144074360960496,
0.9368706429124709, 0.907436096049574, 0.8013168086754454, 0.7702440914374273],
'avgPrecision': 0.8660550150341935, 'recall': [0.9144074360960496,
0.9368706429124709, 0.907436096049574, 0.8013168086754454, 0.7702440914374273],
'avgRecall': 0.8660550150341935, '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': 'Marked & transmucosal
increase in lamina propria cellularity, Crypt architecture, Epithelial changes,
Mucosal surface, Lamina propria granulomas, Patchy lamina propria cellularity?,
Mucin depletion, Submucosal granulomas, Cryptitis extent, Lamina propria
polymorphs, Cryptitis polymorphs', 'accuracy': [0.8067389620449265,
0.7583268783888458, 0.8175832687838884, 0.6119287374128582, 0.5955056179775281],
'avgAccuracy': 0.7180166929216094, 'f1': [0.8270991185513474,
0.8625550660792951, 0.8165922249067556, 0.7592503604036521, 0.7318926918225436],
'avgF1': 0.7994778923527188, 'precision': [0.8067389620449265,
0.7583268783888458, 0.8175832687838884, 0.6119287374128582, 0.5955056179775281],
'avgPrecision': 0.7180166929216094, 'recall': [0.8067389620449265,
0.7583268783888458, 0.8175832687838884, 0.6119287374128582, 0.5955056179775281],
'avgRecall': 0.7180166929216094, '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': 'Marked & transmucosal increase in
lamina propria cellularity, Crypt architecture, Epithelial changes, Mucosal
surface, Lamina propria granulomas, Patchy lamina propria cellularity?, Mucin
depletion, Submucosal granulomas, Cryptitis extent, Lamina propria polymorphs,
Cryptitis polymorphs', 'accuracy': [0.24593338497288925, 0.11347792408985283,
0.4666924864446166, 1.0, 0.9852770244091438], 'avgAccuracy': 0.5622761639833005,
'f1': [0.23210809566060528, 0.20382608695652168, 0.3642745251823215, 1.0,
0.979567660978043], 'avgF1': 0.5559552737554982, 'precision':
[0.24593338497288925, 0.11347792408985283, 0.4666924864446166, 1.0,
0.9852770244091438], 'avgPrecision': 0.5622761639833005, 'recall':
[0.24593338497288925, 0.11347792408985283, 0.4666924864446166, 1.0,
0.9852770244091438], 'avgRecall': 0.5622761639833005, 'params': [{'priors':
None, 'var_smoothing': 1e-09}]}
********************************************************

Processing Model: AdaBoostClassifier
********************************************************
* AdaBoostClassifier
* Best Params Result:
* {'classifier': 'AdaBoostClassifier', 'features': 'Marked & transmucosal
increase in lamina propria cellularity, Crypt architecture, Epithelial changes,
Mucosal surface, Lamina propria granulomas, Patchy lamina propria cellularity?,
Mucin depletion, Submucosal granulomas, Cryptitis extent, Lamina propria
polymorphs, Cryptitis polymorphs', 'accuracy': [0.8009295120061968,
0.7823392718822618, 0.8175832687838884, 0.7099147947327653, 0.6997287872917474],
'avgAccuracy': 0.762099126939372, 'f1': [0.8228027997729285, 0.8778791829639285,
0.8166686000561928, 0.8303510758776897, 0.8092211059284697], 'avgF1':
0.8313845529198418, 'precision': [0.8009295120061968, 0.7823392718822618,
0.8175832687838884, 0.7099147947327653, 0.6997287872917474], 'avgPrecision':
0.762099126939372, 'recall': [0.8009295120061968, 0.7823392718822618,
0.8175832687838884, 0.7099147947327653, 0.6997287872917474], 'avgRecall':
0.762099126939372, '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': 'Marked & transmucosal
increase in lamina propria cellularity, Crypt architecture, Epithelial changes,
Mucosal surface, Lamina propria granulomas, Patchy lamina propria cellularity?,
Mucin depletion, Submucosal granulomas, Cryptitis extent, Lamina propria
```

polymorphs, Cryptitis polymorphs', 'accuracy': [0.9089852827265685, 0.9512006196746708, 0.9066615027110767, 0.8024786986831913, 0.774118558698179], 'avgAccuracy': 0.8686889324987372, 'f1': [0.9091471938599553, 0.9749900754267568, 0.9050511083456165, 0.8904168457241083, 0.858657640209762], 'avgF1': 0.9076525727132397, 'precision': [0.9089852827265685, 0.9512006196746708, 0.9066615027110767, 0.8024786986831913, 0.774118558698179], 'avgPrecision': 0.8686889324987372, 'recall': [0.9089852827265685, 0.9512006196746708, 0.9066615027110767, 0.8024786986831913, 0.774118558698179], 'avgRecall': 0.8686889324987372, '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': 'Marked & transmucosal increase in lamina propria cellularity, Crypt architecture, Epithelial changes, Mucosal surface, Lamina propria granulomas, Patchy lamina propria cellularity?, Mucin depletion, Submucosal granulomas, Cryptitis extent, Lamina propria polymorphs, Cryptitis polymorphs', 'accuracy': [0.7796281951975214, 0.7668474051123161, 0.814872192099148, 0.6103795507358637, 0.5939558310732275], 'avgAccuracy': 0.7131366348436153, 'f1': [0.805336920369519, 0.8680403331871986, 0.8127836382107109, 0.7580567580567581, 0.7303740855092412], 'avgF1': 0.7949183470666855, 'precision': [0.7796281951975214, 0.7668474051123161, 0.814872192099148, 0.6103795507358637, 0.5939558310732275], 'avgPrecision': 0.7131366348436153, 'recall': [0.7796281951975214, 0.7668474051123161, 0.814872192099148, 0.6103795507358637, 0.5939558310732275], 'avgRecall': 0.7131366348436153, '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': 'Marked & transmucosal increase in lamina propria cellularity, Crypt architecture, Epithelial changes, Mucosal surface, Lamina propria granulomas, Patchy lamina propria cellularity?, Mucin depletion, Submucosal granulomas, Cryptitis extent, Lamina propria polymorphs, Cryptitis polymorphs', 'accuracy': [0.8934934159566228, 0.930286599535244, 0.8938807126258714, 0.7819519752130132, 0.7528089887640449], 'avgAccuracy':

0.8504843384189592, 'f1': [0.8966769958192552, 0.963884430176565,
0.8919130556138197, 0.8776352966746359, 0.844829384749791], 'avgF1':
0.8949878326068134, 'precision': [0.8934934159566228, 0.930286599535244,
0.8938807126258714, 0.7819519752130132, 0.7528089887640449], 'avgPrecision':
0.8504843384189592, 'recall': [0.8934934159566228, 0.930286599535244,
0.8938807126258714, 0.7819519752130132, 0.7528089887640449], 'avgRecall':
0.8504843384189592, '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': 'Marked & transmucosal
increase in lamina propria cellularity, Crypt architecture, Epithelial changes,
Mucosal surface, Lamina propria granulomas, Patchy lamina propria cellularity?,
Mucin depletion, Submucosal granulomas, Cryptitis extent, Lamina propria
polymorphs, Cryptitis polymorphs', 'accuracy': [0.9120836560805577,
0.9512006196746708, 0.907436096049574, 0.808288148721921, 0.77915536613371562],
'avgAccuracy': 0.871632777332776, 'f1': [0.9129489803012953, 0.9749900754267568,
0.905865172416312, 0.8939815806382522, 0.8618786720632232], 'avgF1':
0.909932896169168, 'precision': [0.9120836560805577, 0.9512006196746708,
0.907436096049574, 0.808288148721921, 0.7791553661371562], 'avgPrecision':
0.871632777332776, 'recall': [0.9120836560805577, 0.9512006196746708,
0.907436096049574, 0.808288148721921, 0.7791553661371562], 'avgRecall':
0.871632777332776, '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}]}
****

```
                     model                                        features  \
0   RandomForestClassifier  Marked & transmucosal increase in lamina propr…
1     KNeighborsClassifier  Marked & transmucosal increase in lamina propr…
2       LogisticRegression  Marked & transmucosal increase in lamina propr…
3               GaussianNB  Marked & transmucosal increase in lamina propr…
4       AdaBoostClassifier  Marked & transmucosal increase in lamina propr…
5   DecisionTreeClassifier  Marked & transmucosal increase in lamina propr…
6                      SVC  Marked & transmucosal increase in lamina propr…
7            MLPClassifier  Marked & transmucosal increase in lamina propr…


   accuracy        f1  precision    recall  \
0  0.871633  0.909933   0.871633  0.871633
```

```
1  0.866055  0.906543    0.866055   0.866055
2  0.718017  0.799478    0.718017   0.718017
3  0.562276  0.555955    0.562276   0.562276
4  0.762099  0.831385    0.762099   0.762099
5  0.868689  0.907653    0.868689   0.868689
6  0.713137  0.794918    0.713137   0.713137
7  0.850484  0.894988    0.850484   0.850484


                                                        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': 'Marked & transmucosal
increase in lamina propria cellularity, Crypt architecture, Epithelial changes,
Mucosal surface, Lamina propria granulomas, Patchy lamina propria cellularity?,
Mucin depletion, Submucosal granulomas, Cryptitis extent, Lamina propria
polymorphs', 'accuracy': [0.9093725793958172, 0.9512006196746708,
0.9062742060418281, 0.8079008520526724, 0.7791553661371562], 'avgAccuracy':
0.8707807246604289, 'f1': [0.910617074792847, 0.9749900754267568,
0.904927397758066, 0.8937446443873178, 0.861862044195941], 'avgF1':
0.9092282473121858, 'precision': [0.9093725793958172, 0.9512006196746708,
0.9062742060418281, 0.8079008520526724, 0.7791553661371562], 'avgPrecision':
0.8707807246604289, 'recall': [0.9093725793958172, 0.9512006196746708,
0.9062742060418281, 0.8079008520526724, 0.7791553661371562], 'avgRecall':
0.8707807246604289, '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': 'Marked & transmucosal
increase in lamina propria cellularity, Crypt architecture, Epithelial changes,

                                291

Mucosal surface, Lamina propria granulomas, Patchy lamina propria cellularity?, Mucin depletion, Submucosal granulomas, Cryptitis extent, Lamina propria polymorphs', 'accuracy': [0.9054996127033308, 0.9589465530596437, 0.9043377226955848, 0.8001549186676995, 0.771793878341728], 'avgAccuracy': 0.8681465370935973, 'f1': [0.906583363039315, 0.9790431000395413, 0.9029503227136623, 0.8889845094664374, 0.857168979814244], 'avgF1': 0.9069470496675633, 'precision': [0.9054996127033308, 0.9589465530596437, 0.9043377226955848, 0.8001549186676995, 0.771793878341728], 'avgPrecision': 0.8681465370935973, 'recall': [0.9054996127033308, 0.9589465530596437, 0.9043377226955848, 0.8001549186676995, 0.771793878341728], 'avgRecall': 0.8681465370935973, 'params': [{'algorithm': 'brute', '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': 'Marked & transmucosal increase in lamina propria cellularity, Crypt architecture, Epithelial changes, Mucosal surface, Lamina propria granulomas, Patchy lamina propria cellularity?, Mucin depletion, Submucosal granulomas, Cryptitis extent, Lamina propria polymorphs', 'accuracy': [0.7986057319907048, 0.7540666150271108, 0.8171959721146398, 0.6026336173508908, 0.5900813638124758], 'avgAccuracy': 0.7125166600591644, 'f1': [0.820641128506535, 0.8597924486641644, 0.8162220567606543, 0.7520541324311262, 0.7276013289453526], 'avgF1': 0.7952622190615666, 'precision': [0.7986057319907048, 0.7540666150271108, 0.8171959721146398, 0.6026336173508908, 0.5900813638124758], 'avgPrecision': 0.7125166600591644, 'recall': [0.7986057319907048, 0.7540666150271108, 0.8171959721146398, 0.6026336173508908, 0.5900813638124758], 'avgRecall': 0.7125166600591644, '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': 'Marked & transmucosal increase in lamina propria cellularity, Crypt architecture, Epithelial changes, Mucosal surface, Lamina propria granulomas, Patchy lamina propria cellularity?, Mucin depletion, Submucosal granulomas, Cryptitis extent, Lamina propria polymorphs', 'accuracy': [0.24593338497288925, 0.11386522075910147, 0.4666924864446166, 1.0, 0.9852770244091438], 'avgAccuracy': 0.5623536233171502, 'f1':

[0.23210809566060528, 0.20445062586926283, 0.3642745251823215, 1.0, 0.979567660978043], 'avgF1': 0.5560801815380465, 'precision': [0.24593338497288925, 0.11386522075910147, 0.4666924864446166, 1.0, 0.9852770244091438], 'avgPrecision': 0.5623536233171502, 'recall': [0.24593338497288925, 0.11386522075910147, 0.4666924864446166, 1.0, 0.9852770244091438], 'avgRecall': 0.5623536233171502, 'params': [{'priors': None, 'var_smoothing': 1e-09}]}
****

Processing Model: AdaBoostClassifier
****
* AdaBoostClassifier
* Best Params Result:
* {'classifier': 'AdaBoostClassifier', 'features': 'Marked & transmucosal increase in lamina propria cellularity, Crypt architecture, Epithelial changes, Mucosal surface, Lamina propria granulomas, Patchy lamina propria cellularity?, Mucin depletion, Submucosal granulomas, Cryptitis extent, Lamina propria polymorphs', 'accuracy': [0.7993803253292022, 0.7776917118512781, 0.8113865220759101, 0.7149496514329977, 0.6912049593180938], 'avgAccuracy': 0.7589226340014964, 'f1': [0.8215160665131502, 0.8749455337690631, 0.8102413246989624, 0.8337850045167119, 0.8030842271732835], 'avgF1': 0.8287144313342343, 'precision': [0.7993803253292022, 0.7776917118512781, 0.8113865220759101, 0.7149496514329977, 0.6912049593180938], 'avgPrecision': 0.7589226340014964, 'recall': [0.7993803253292022, 0.7776917118512781, 0.8113865220759101, 0.7149496514329977, 0.6912049593180938], 'avgRecall': 0.7589226340014964, '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': 'Marked & transmucosal increase in lamina propria cellularity, Crypt architecture, Epithelial changes, Mucosal surface, Lamina propria granulomas, Patchy lamina propria cellularity?, Mucin depletion, Submucosal granulomas, Cryptitis extent, Lamina propria polymorphs', 'accuracy': [0.9035631293570875, 0.9512006196746708, 0.9043377226955848, 0.8059643687064292, 0.7768306857807051], 'avgAccuracy': 0.8683793052428955, 'f1': [0.9050454360167915, 0.9749900754267568, 0.9029503227136623, 0.8925584387733219, 0.8603801813279701], 'avgF1': 0.9071848908517005, 'precision': [0.9035631293570875, 0.9512006196746708, 0.9043377226955848, 0.8059643687064292, 0.7768306857807051], 'avgPrecision': 0.8683793052428955, 'recall': [0.9035631293570875, 0.9512006196746708, 0.9043377226955848, 0.8059643687064292, 0.7768306857807051], 'avgRecall': 0.8683793052428955, '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': 'Marked & transmucosal increase in lamina
propria cellularity, Crypt architecture, Epithelial changes, Mucosal surface,
Lamina propria granulomas, Patchy lamina propria cellularity?, Mucin depletion,
Submucosal granulomas, Cryptitis extent, Lamina propria polymorphs', 'accuracy':
[0.7807900852052673, 0.7645236250968241, 0.8121611154144074, 0.6096049573973664,
0.6334753971328942], 'avgAccuracy': 0.7201110360493519, 'f1': [0.80631773797358,
0.8665496049165935, 0.8105596685886568, 0.757459095283927, 0.7609770506087514],
'avgF1': 0.8003726314743017, 'precision': [0.7807900852052673,
0.7645236250968241, 0.8121611154144074, 0.6096049573973664, 0.6334753971328942],
'avgPrecision': 0.7201110360493519, 'recall': [0.7807900852052673,
0.7645236250968241, 0.8121611154144074, 0.6096049573973664, 0.6334753971328942],
'avgRecall': 0.7201110360493519, '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': 'Marked & transmucosal increase in
lamina propria cellularity, Crypt architecture, Epithelial changes, Mucosal
surface, Lamina propria granulomas, Patchy lamina propria cellularity?, Mucin
depletion, Submucosal granulomas, Cryptitis extent, Lamina propria polymorphs',
'accuracy': [0.9051123160340822, 0.9275755228505035, 0.888845855925639,
0.7738187451587917, 0.7462223944207671], 'avgAccuracy': 0.8483149668779567,
'f1': [0.9059391834928153, 0.9624271649588104, 0.8866709665438921,
0.8724890829694323, 0.84044762324625], 'avgF1': 0.89359480424224, 'precision':
[0.9051123160340822, 0.9275755228505035, 0.888845855925639, 0.7738187451587917,
0.7462223944207671], 'avgPrecision': 0.8483149668779567, 'recall':
[0.9051123160340822, 0.9275755228505035, 0.888845855925639, 0.7738187451587917,
0.7462223944207671], 'avgRecall': 0.8483149668779567, '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': 'Marked & transmucosal
increase in lamina propria cellularity, Crypt architecture, Epithelial changes,
Mucosal surface, Lamina propria granulomas, Patchy lamina propria cellularity?,
Mucin depletion, Submucosal granulomas, Cryptitis extent, Lamina propria
polymorphs', 'accuracy': [0.9093725793958172, 0.9512006196746708,
0.9062742060418281, 0.8079008520526724, 0.7791553661371562], 'avgAccuracy':
0.8707807246604289, 'f1': [0.910617074792847, 0.9749900754267568,
0.904927397758066, 0.8937446443873178, 0.861862044195941], 'avgF1':
0.9092282473121858, 'precision': [0.9093725793958172, 0.9512006196746708,
0.9062742060418281, 0.8079008520526724, 0.7791553661371562], 'avgPrecision':
0.8707807246604289, 'recall': [0.9093725793958172, 0.9512006196746708,
0.9062742060418281, 0.8079008520526724, 0.7791553661371562], 'avgRecall':
0.8707807246604289, '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  Marked & transmucosal increase in lamina propr…
1    KNeighborsClassifier  Marked & transmucosal increase in lamina propr…
2      LogisticRegression  Marked & transmucosal increase in lamina propr…
3              GaussianNB  Marked & transmucosal increase in lamina propr…
4       AdaBoostClassifier  Marked & transmucosal increase in lamina propr…
5  DecisionTreeClassifier  Marked & transmucosal increase in lamina propr…
6                     SVC  Marked & transmucosal increase in lamina propr…
7           MLPClassifier  Marked & transmucosal increase in lamina propr…

   accuracy        f1  precision    recall  \
0  0.870781  0.909228   0.870781  0.870781
1  0.868147  0.906947   0.868147  0.868147
2  0.712517  0.795262   0.712517  0.712517
3  0.562354  0.556080   0.562354  0.562354
4  0.758923  0.828714   0.758923  0.758923
5  0.868379  0.907185   0.868379  0.868379
6  0.720111  0.800373   0.720111  0.720111
7  0.848315  0.893595   0.848315  0.848315


                                              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': 'Marked & transmucosal increase in lamina propria cellularity, Crypt architecture, Epithelial changes, Mucosal surface, Lamina propria granulomas, Patchy lamina propria cellularity?, Mucin depletion, Submucosal granulomas, Cryptitis extent', 'accuracy': [0.907436096049574, 0.9469403563129357, 0.9047250193648335, 0.8036405886909372, 0.7779930259589306], 'avgAccuracy': 0.8681470172754422, 'f1': [0.9089591438613208, 0.9727471653073403, 0.9033304862958237, 0.8911316298045953, 0.8611215657346356], 'avgF1': 0.9074579982007431, 'precision': [0.907436096049574, 0.9469403563129357, 0.9047250193648335, 0.8036405886909372, 0.7779930259589306], 'avgPrecision': 0.8681470172754422, 'recall': [0.907436096049574, 0.9469403563129357, 0.9047250193648335, 0.8036405886909372, 0.7779930259589306], 'avgRecall': 0.8681470172754422, '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': 'Marked & transmucosal increase in lamina propria cellularity, Crypt architecture, Epithelial changes, Mucosal surface, Lamina propria granulomas, Patchy lamina propria cellularity?, Mucin depletion, Submucosal granulomas, Cryptitis extent', 'accuracy': [0.9047250193648335, 0.9264136328427576, 0.9031758326878389, 0.7467079783113865, 0.7659821774506005], 'avgAccuracy': 0.8494009281314834, 'f1': [0.9060333350386341, 0.9618013671089667, 0.9020107293732391, 0.8549889135254989, 0.8534311499792596], 'avgF1': 0.8956530990051197, 'precision': [0.9047250193648335, 0.9264136328427576, 0.9031758326878389, 0.7467079783113865, 0.7659821774506005], 'avgPrecision': 0.8494009281314834, 'recall': [0.9047250193648335, 0.9264136328427576, 0.9031758326878389, 0.7467079783113865, 0.7659821774506005], 'avgRecall': 0.8494009281314834, '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': 'Marked & transmucosal
increase in lamina propria cellularity, Crypt architecture, Epithelial changes,
Mucosal surface, Lamina propria granulomas, Patchy lamina propria cellularity?,
Mucin depletion, Submucosal granulomas, Cryptitis extent', 'accuracy':
[0.7893106119287374, 0.7316034082106894, 0.813710302091402, 0.6041828040278854,
0.5916311507167764], 'avgAccuracy': 0.7060876553950981, 'f1':
[0.8133089364082086, 0.8450011183180496, 0.8122921048657172, 0.7532592950265572,
0.7288304256934545], 'avgF1': 0.7905383760623974, 'precision':
[0.7893106119287374, 0.7316034082106894, 0.813710302091402, 0.6041828040278854,
0.5916311507167764], 'avgPrecision': 0.7060876553950981, 'recall':
[0.7893106119287374, 0.7316034082106894, 0.813710302091402, 0.6041828040278854,
0.5916311507167764], 'avgRecall': 0.7060876553950981, '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': 'Marked & transmucosal increase in
lamina propria cellularity, Crypt architecture, Epithelial changes, Mucosal
surface, Lamina propria granulomas, Patchy lamina propria cellularity?, Mucin
depletion, Submucosal granulomas, Cryptitis extent', 'accuracy':
[0.24593338497288925, 0.11386522075910147, 0.4666924864446166, 1.0,
0.9852770244091438], 'avgAccuracy': 0.5623536233171502, 'f1':
[0.23210809566060528, 0.20445062586926283, 0.3642745251823215, 1.0,
0.979567660978043], 'avgF1': 0.5560801815380465, 'precision':
[0.24593338497288925, 0.11386522075910147, 0.4666924864446166, 1.0,
0.9852770244091438], 'avgPrecision': 0.5623536233171502, 'recall':
[0.24593338497288925, 0.11386522075910147, 0.4666924864446166, 1.0,
0.9852770244091438], 'avgRecall': 0.5623536233171502, 'params': [{'priors':
None, 'var_smoothing': 1e-09}]}
****************************************************

Processing Model: AdaBoostClassifier
****************************************************
* AdaBoostClassifier
* Best Params Result:
* {'classifier': 'AdaBoostClassifier', 'features': 'Marked & transmucosal
```

increase in lamina propria cellularity, Crypt architecture, Epithelial changes, Mucosal surface, Lamina propria granulomas, Patchy lamina propria cellularity?, Mucin depletion, Submucosal granulomas, Cryptitis extent', 'accuracy': [0.7831138652207591, 0.7796281951975214, 0.8125484120836561, 0.7006196746707978, 0.694304533126695], 'avgAccuracy': 0.7540429360598859, 'f1': [0.8082803494249249, 0.8761697497279651, 0.8115102256268, 0.8239580961056706, 0.8053049218925732], 'avgF1': 0.8250446685555868, 'precision': [0.7831138652207591, 0.7796281951975214, 0.8125484120836561, 0.7006196746707978, 0.694304533126695], 'avgPrecision': 0.7540429360598859, 'recall': [0.7831138652207591, 0.7796281951975214, 0.8125484120836561, 0.7006196746707978, 0.694304533126695], 'avgRecall': 0.7540429360598859, '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': 'Marked & transmucosal increase in lamina propria cellularity, Crypt architecture, Epithelial changes, Mucosal surface, Lamina propria granulomas, Patchy lamina propria cellularity?, Mucin depletion, Submucosal granulomas, Cryptitis extent', 'accuracy': [0.9058869093725794, 0.9465530596436871, 0.9039504260263361, 0.7982184353214562, 0.7729562185199536], 'avgAccuracy': 0.8655130097768025, 'f1': [0.9072308539360908, 0.9725427775567052, 0.9025445552900987, 0.8877880680594443, 0.8578784379915173], 'avgF1': 0.9055969385667713, 'precision': [0.9058869093725794, 0.9465530596436871, 0.9039504260263361, 0.7982184353214562, 0.7729562185199536], 'avgPrecision': 0.8655130097768025, 'recall': [0.9058869093725794, 0.9465530596436871, 0.9039504260263361, 0.7982184353214562, 0.7729562185199536], 'avgRecall': 0.8655130097768025, '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': 'Marked & transmucosal increase in lamina propria cellularity, Crypt architecture, Epithelial changes, Mucosal surface, Lamina propria granulomas, Patchy lamina propria cellularity?, Mucin depletion, Submucosal granulomas, Cryptitis extent', 'accuracy': [0.7792408985282726, 0.7652982184353214, 0.8106119287374128, 0.6080557707203718, 0.6385122045718714], 'avgAccuracy': 0.72034380419865, 'f1': [0.8047639669500705, 0.8670469504168494, 0.8087749101136529, 0.75626204238921, 0.7648348961392571], 'avgF1':

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0.800336553201808, 'precision': [0.7792408985282726, 0.7652982184353214, 0.8106119287374128, 0.6080557707203718, 0.6385122045718714], 'avgPrecision': 0.72034380419865, 'recall': [0.7792408985282726, 0.7652982184353214, 0.8106119287374128, 0.6080557707203718, 0.6385122045718714], 'avgRecall': 0.72034380419865, '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': 'Marked & transmucosal increase in lamina propria cellularity, Crypt architecture, Epithelial changes, Mucosal surface, Lamina propria granulomas, Patchy lamina propria cellularity?, Mucin depletion, Submucosal granulomas, Cryptitis extent', 'accuracy': [0.8915569326103796, 0.9078233927188226, 0.8900077459333849, 0.778853601859024, 0.7493219682293685], 'avgAccuracy': 0.843512728270196, 'f1': [0.8954807035948079, 0.9516849370686156, 0.8880317078810531, 0.8756803831918136, 0.8424693327575392], 'avgF1': 0.8906694128987659, 'precision': [0.8915569326103796, 0.9078233927188226, 0.8900077459333849, 0.778853601859024, 0.7493219682293685], 'avgPrecision': 0.843512728270196, 'recall': [0.8915569326103796, 0.9078233927188226, 0.8900077459333849, 0.778853601859024, 0.7493219682293685], 'avgRecall': 0.843512728270196, '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': 'Marked & transmucosal increase in lamina propria cellularity, Crypt architecture, Epithelial changes, Mucosal surface, Lamina propria granulomas, Patchy lamina propria cellularity?, Mucin depletion, Submucosal granulomas, Cryptitis extent', 'accuracy': [0.907436096049574, 0.9469403563129357, 0.9047250193648335, 0.8036405886909372, 0.7779930259589306], 'avgAccuracy': 0.8681470172754422, 'f1': [0.9089591438613208, 0.9727471653073403, 0.9033304862958237, 0.8911316298045953, 0.8611215657346356], 'avgF1': 0.9074579982007431, 'precision': [0.907436096049574, 0.9469403563129357, 0.9047250193648335, 0.8036405886909372, 0.7779930259589306], 'avgPrecision': 0.8681470172754422, 'recall': [0.907436096049574, 0.9469403563129357, 0.9047250193648335, 0.8036405886909372, 0.7779930259589306], 'avgRecall': 0.8681470172754422, '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  Marked & transmucosal increase in lamina propr…
1    KNeighborsClassifier  Marked & transmucosal increase in lamina propr…
2      LogisticRegression  Marked & transmucosal increase in lamina propr…
3              GaussianNB  Marked & transmucosal increase in lamina propr…
4      AdaBoostClassifier  Marked & transmucosal increase in lamina propr…
5  DecisionTreeClassifier  Marked & transmucosal increase in lamina propr…
6                     SVC  Marked & transmucosal increase in lamina propr…
7           MLPClassifier  Marked & transmucosal increase in lamina propr…

   accuracy        f1  precision    recall  \
0  0.868147  0.907458   0.868147  0.868147
1  0.849401  0.895653   0.849401  0.849401
2  0.706088  0.790538   0.706088  0.706088
3  0.562354  0.556080   0.562354  0.562354
4  0.754043  0.825045   0.754043  0.754043
5  0.865513  0.905597   0.865513  0.865513
6  0.720344  0.800337   0.720344  0.720344
7  0.843513  0.890669   0.843513  0.843513

                                              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': 'Marked & transmucosal
increase in lamina propria cellularity, Crypt architecture, Epithelial changes,
Mucosal surface, Lamina propria granulomas, Patchy lamina propria cellularity?,
Mucin depletion, Submucosal granulomas', 'accuracy': [0.9012393493415957,
0.9461657629744384, 0.8919442292796282, 0.7757552285050349, 0.7489345215032933],
'avgAccuracy': 0.8528078183207981, 'f1': [0.9022114095895609,
```

0.9723383084577115, 0.8900492682245151, 0.8737186477644493, 0.8422848050693988],
'avgF1': 0.8961204878211272, 'precision': [0.9012393493415957,
0.9461657629744384, 0.8919442292796282, 0.7757552285050349, 0.7489345215032933],
'avgPrecision': 0.8528078183207981, 'recall': [0.9012393493415957,
0.9461657629744384, 0.8919442292796282, 0.7757552285050349, 0.7489345215032933],
'avgRecall': 0.8528078183207981, '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': True, 'random_state': None, 'verbose': 0,
'warm_start': False}]}
****

Processing Model: KNeighborsClassifier
****
* KNeighborsClassifier
* Best Params Result:
* {'classifier': 'KNeighborsClassifier', 'features': 'Marked & transmucosal
increase in lamina propria cellularity, Crypt architecture, Epithelial changes,
Mucosal surface, Lamina propria granulomas, Patchy lamina propria cellularity?,
Mucin depletion, Submucosal granulomas', 'accuracy': [0.9155693261037955,
0.9457784663051898, 0.8911696359411309, 0.7234701781564679, 0.7446726075164665],
'avgAccuracy': 0.8441320428046101, 'f1': [0.9131760617034314,
0.9721337579617836, 0.8895032429297922, 0.8395505617977529, 0.8394983217203529],
'avgF1': 0.8907723892226226, 'precision': [0.9155693261037955,
0.9457784663051898, 0.8911696359411309, 0.7234701781564679, 0.7446726075164665],
'avgPrecision': 0.8441320428046101, 'recall': [0.9155693261037955,
0.9457784663051898, 0.8911696359411309, 0.7234701781564679, 0.7446726075164665],
'avgRecall': 0.8441320428046101, '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': 'Marked & transmucosal
increase in lamina propria cellularity, Crypt architecture, Epithelial changes,
Mucosal surface, Lamina propria granulomas, Patchy lamina propria cellularity?,
Mucin depletion, Submucosal granulomas', 'accuracy': [0.7726568551510457,
0.7773044151820294, 0.7997676219984509, 0.5945003872966692, 0.5769081751259202],
'avgAccuracy': 0.704227490950823, 'f1': [0.8003500340001569, 0.8747003704510786,
0.7993560957994182, 0.745886082098615, 0.7167332306608132], 'avgF1':
0.7873656678242656, 'precision': [0.7726568551510457, 0.7773044151820294,
0.7997676219984509, 0.5945003872966692, 0.5769081751259202], 'avgPrecision':
0.704227490950823, 'recall': [0.7726568551510457, 0.7773044151820294,

```
0.7997676219984509, 0.5945003872966692, 0.5769081751259202], 'avgRecall':
0.704227490950823, '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': 'Marked & transmucosal increase in
lamina propria cellularity, Crypt architecture, Epithelial changes, Mucosal
surface, Lamina propria granulomas, Patchy lamina propria cellularity?, Mucin
depletion, Submucosal granulomas', 'accuracy': [0.24593338497288925,
0.11386522075910147, 0.4666924864446166, 1.0, 0.9852770244091438],
'avgAccuracy': 0.5623536233171502, 'f1': [0.23210809566060528,
0.20445062586926283, 0.3642745251823215, 1.0, 0.979567660978043], 'avgF1':
0.5560801815380465, 'precision': [0.24593338497288925, 0.11386522075910147,
0.4666924864446166, 1.0, 0.9852770244091438], 'avgPrecision':
0.5623536233171502, 'recall': [0.24593338497288925, 0.11386522075910147,
0.4666924864446166, 1.0, 0.9852770244091438], 'avgRecall': 0.5623536233171502,
'params': [{'priors': None, 'var_smoothing': 1e-09}]}
*********************************************************

Processing Model: AdaBoostClassifier
*********************************************************
* AdaBoostClassifier
* Best Params Result:
* {'classifier': 'AdaBoostClassifier', 'features': 'Marked & transmucosal
increase in lamina propria cellularity, Crypt architecture, Epithelial changes,
Mucosal surface, Lamina propria granulomas, Patchy lamina propria cellularity?,
Mucin depletion, Submucosal granulomas', 'accuracy': [0.7989930286599535,
0.7796281951975214, 0.801704105344694, 0.703718048024787, 0.6838434715226657],
'avgAccuracy': 0.7535773697499243, 'f1': [0.8198695777300405,
0.8761697497279651, 0.8013882497041634, 0.8260968401909524, 0.7978933029226667],
'avgF1': 0.8242835440551577, 'precision': [0.7989930286599535,
0.7796281951975214, 0.801704105344694, 0.703718048024787, 0.6838434715226657],
'avgPrecision': 0.7535773697499243, 'recall': [0.7989930286599535,
0.7796281951975214, 0.801704105344694, 0.703718048024787, 0.6838434715226657],
'avgRecall': 0.7535773697499243, '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': 'Marked & transmucosal increase in lamina propria cellularity, Crypt architecture, Epithelial changes, Mucosal surface, Lamina propria granulomas, Patchy lamina propria cellularity?, Mucin depletion, Submucosal granulomas', 'accuracy': [0.8993028659953525, 0.9461657629744384, 0.8903950426026336, 0.772269558481797, 0.7477721813250678], 'avgAccuracy': 0.8511810822758579, 'f1': [0.9001232520618444, 0.9723383084577115, 0.8884729136470888, 0.8715034965034966, 0.8414954182769057], 'avgF1': 0.8947866777894093, 'precision': [0.8993028659953525, 0.9461657629744384, 0.8903950426026336, 0.772269558481797, 0.7477721813250678], 'avgPrecision': 0.8511810822758579, 'recall': [0.8993028659953525, 0.9461657629744384, 0.8903950426026336, 0.772269558481797, 0.7477721813250678], 'avgRecall': 0.8511810822758579, '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': 'Marked & transmucosal increase in lamina propria cellularity, Crypt architecture, Epithelial changes, Mucosal surface, Lamina propria granulomas, Patchy lamina propria cellularity?, Mucin depletion, Submucosal granulomas', 'accuracy': [0.7668474051123161, 0.7664601084430674, 0.7900852052672347, 0.6034082106893881, 0.5749709414955444], 'avgAccuracy': 0.7003543742015101, 'f1': [0.7956388374535504, 0.8677921508441132, 0.7891835710619003, 0.7526570048309179, 0.7147264846694119], 'avgF1': 0.7839996097719787, 'precision': [0.7668474051123161, 0.7664601084430674, 0.7900852052672347, 0.6034082106893881, 0.5749709414955444], 'avgPrecision': 0.7003543742015101, 'recall': [0.7668474051123161, 0.7664601084430674, 0.7900852052672347, 0.6034082106893881, 0.5749709414955444], 'avgRecall': 0.7003543742015101, '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': 'Marked & transmucosal increase in lamina propria cellularity, Crypt architecture, Epithelial changes, Mucosal surface, Lamina propria granulomas, Patchy lamina propria cellularity?, Mucin

depletion, Submucosal granulomas', 'accuracy': [0.8702556158017041, 0.9217660728117738, 0.8667699457784663, 0.7223082881487219, 0.7047655947307245], 'avgAccuracy': 0.8171731034542782, 'f1': [0.8763107903750196, 0.959290608625554, 0.8648554744990689, 0.8387677085675735, 0.8124433204575152], 'avgF1': 0.8703335805049462, 'precision': [0.8702556158017041, 0.9217660728117738, 0.8667699457784663, 0.7223082881487219, 0.7047655947307245], 'avgPrecision': 0.8171731034542782, 'recall': [0.8702556158017041, 0.9217660728117738, 0.8667699457784663, 0.7223082881487219, 0.7047655947307245], 'avgRecall': 0.8171731034542782, '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': 'Marked & transmucosal increase in lamina propria cellularity, Crypt architecture, Epithelial changes, Mucosal surface, Lamina propria granulomas, Patchy lamina propria cellularity?, Mucin depletion, Submucosal granulomas', 'accuracy': [0.9012393493415957, 0.9461657629744384, 0.8919442292796282, 0.7757552285050349, 0.7489345215032933], 'avgAccuracy': 0.8528078183207981, 'f1': [0.9022114095895609, 0.9723383084577115, 0.8900492682245151, 0.8737186477644493, 0.8422848050693988], 'avgF1': 0.8961204878211272, 'precision': [0.9012393493415957, 0.9461657629744384, 0.8919442292796282, 0.7757552285050349, 0.7489345215032933], 'avgPrecision': 0.8528078183207981, 'recall': [0.9012393493415957, 0.9461657629744384, 0.8919442292796282, 0.7757552285050349, 0.7489345215032933], 'avgRecall': 0.8528078183207981, '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': True, 'random_state': None, 'verbose': 0, 'warm_start': False}]}
****

```
                    model                                     features  \
0  RandomForestClassifier  Marked & transmucosal increase in lamina propr…
1    KNeighborsClassifier  Marked & transmucosal increase in lamina propr…
2      LogisticRegression  Marked & transmucosal increase in lamina propr…
3              GaussianNB  Marked & transmucosal increase in lamina propr…
4      AdaBoostClassifier  Marked & transmucosal increase in lamina propr…
5  DecisionTreeClassifier  Marked & transmucosal increase in lamina propr…
6                     SVC  Marked & transmucosal increase in lamina propr…
7           MLPClassifier  Marked & transmucosal increase in lamina propr…
```

```
     accuracy         f1  precision     recall  \
0    0.852808   0.896120   0.852808   0.852808
1    0.844132   0.890772   0.844132   0.844132
2    0.704227   0.787366   0.704227   0.704227
3    0.562354   0.556080   0.562354   0.562354
4    0.753577   0.824284   0.753577   0.753577
5    0.851181   0.894787   0.851181   0.851181
6    0.700354   0.784000   0.700354   0.700354
7    0.817173   0.870334   0.817173   0.817173


                                                  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': 'Marked & transmucosal
increase in lamina propria cellularity, Crypt architecture, Epithelial changes,
Mucosal surface, Lamina propria granulomas, Patchy lamina propria cellularity?,
Mucin depletion', 'accuracy': [0.9012393493415957, 0.94616576297744384,
0.8927188226181255, 0.7757552285050349, 0.7485470747772182], 'avgAccuracy':
0.8528852476432826, 'f1': [0.9022114095895609, 0.9723383084577115,
0.8908068506388271, 0.8737186477644493, 0.8420297532151674], 'avgF1':
0.8962209939331433, 'precision': [0.9012393493415957, 0.94616576297744384,
0.8927188226181255, 0.7757552285050349, 0.7485470747772182], 'avgPrecision':
0.8528852476432826, 'recall': [0.9012393493415957, 0.94616576297744384,
0.8927188226181255, 0.7757552285050349, 0.7485470747772182], 'avgRecall':
0.8528852476432826, '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':
True, 'random_state': None, 'verbose': 0, 'warm_start': False}]}
*******************************************************


Processing Model: KNeighborsClassifier
*******************************************************
* KNeighborsClassifier
* Best Params Result:
* {'classifier': 'KNeighborsClassifier', 'features': 'Marked & transmucosal
```

increase in lamina propria cellularity, Crypt architecture, Epithelial changes, Mucosal surface, Lamina propria granulomas, Patchy lamina propria cellularity?, Mucin depletion', 'accuracy': [0.9252517428350117, 0.9910921766072812, 0.87141750580945, 0.663439194422928, 0.6458736923672995], 'avgAccuracy': 0.8194148624083941, 'f1': [0.9172195641892283, 0.9955261622252479, 0.8653575275121729, 0.7976717112922003, 0.7702454308694038], 'avgF1': 0.8692040792176506, 'precision': [0.9252517428350117, 0.9910921766072812, 0.87141750580945, 0.663439194422928, 0.6458736923672995], 'avgPrecision': 0.8194148624083941, 'recall': [0.9252517428350117, 0.9910921766072812, 0.87141750580945, 0.663439194422928, 0.6458736923672995], 'avgRecall': 0.8194148624083941, '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': 'Marked & transmucosal increase in lamina propria cellularity, Crypt architecture, Epithelial changes, Mucosal surface, Lamina propria granulomas, Patchy lamina propria cellularity?, Mucin depletion', 'accuracy': [0.7730441518202944, 0.7780790085205267, 0.7993803253292022, 0.5941130906274206, 0.5769081751259202], 'avgAccuracy': 0.7043049502846728, 'f1': [0.8006471460744299, 0.8751905902853409, 0.7984777645297028, 0.7453838678328474, 0.7167332306608132], 'avgF1': 0.7872865198766268, 'precision': [0.7730441518202944, 0.7780790085205267, 0.7993803253292022, 0.5941130906274206, 0.5769081751259202], 'avgPrecision': 0.7043049502846728, 'recall': [0.7730441518202944, 0.7780790085205267, 0.7993803253292022, 0.5941130906274206, 0.5769081751259202], 'avgRecall': 0.7043049502846728, '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': 'Marked & transmucosal increase in lamina propria cellularity, Crypt architecture, Epithelial changes, Mucosal surface, Lamina propria granulomas, Patchy lamina propria cellularity?, Mucin depletion', 'accuracy': [0.7478698683191325, 0.7548412083656081, 0.7641363284275755, 0.679705654531371, 0.654010073614878], 'avgAccuracy': 0.720112626651713, 'f1': [0.7820267569039114, 0.8602957404546456, 0.7642360198261849, 0.8093151948351396, 0.7764561954959115], 'avgF1': 0.7984659815031586, 'precision': [0.7478698683191325, 0.7548412083656081,

0.7641363284275755, 0.679705654531371, 0.654010073614878], 'avgPrecision':
0.720112626651713, 'recall': [0.7478698683191325, 0.7548412083656081,
0.7641363284275755, 0.679705654531371, 0.654010073614878], 'avgRecall':
0.720112626651713, 'params': [{'priors': None, 'var_smoothing': 1e-09}]}
****

Processing Model: AdaBoostClassifier
****
* AdaBoostClassifier
* Best Params Result:
* {'classifier': 'AdaBoostClassifier', 'features': 'Marked & transmucosal
increase in lamina propria cellularity, Crypt architecture, Epithelial changes,
Mucosal surface, Lamina propria granulomas, Patchy lamina propria cellularity?,
Mucin depletion', 'accuracy': [0.7989930286599535, 0.7796281951975214,
0.8036405886909372, 0.7017815646785438, 0.6819062378922898], 'avgAccuracy':
0.7531899230238491, 'f1': [0.8198695777300405, 0.8761697497279651,
0.803125804689984, 0.8247610377787892, 0.7965198184597836], 'avgF1':
0.8240891976773125, 'precision': [0.7989930286599535, 0.7796281951975214,
0.8036405886909372, 0.7017815646785438, 0.6819062378922898], 'avgPrecision':
0.7531899230238491, 'recall': [0.7989930286599535, 0.7796281951975214,
0.8036405886909372, 0.7017815646785438, 0.6819062378922898], 'avgRecall':
0.7531899230238491, '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': 'Marked & transmucosal
increase in lamina propria cellularity, Crypt architecture, Epithelial changes,
Mucosal surface, Lamina propria granulomas, Patchy lamina propria cellularity?,
Mucin depletion', 'accuracy': [0.8993028659953525, 0.9438419829589465,
0.8915569326103796, 0.7749806351665376, 0.7454475009686168], 'avgAccuracy':
0.8510259835399666, 'f1': [0.8998928645511427, 0.971109782825264,
0.8896705786217454, 0.8732271437922758, 0.8399854284829621], 'avgF1':
0.894777159654678, 'precision': [0.8993028659953525, 0.9438419829589465,
0.8915569326103796, 0.7749806351665376, 0.7454475009686168], 'avgPrecision':
0.8510259835399666, 'recall': [0.8993028659953525, 0.9438419829589465,
0.8915569326103796, 0.7749806351665376, 0.7454475009686168], 'avgRecall':
0.8510259835399666, '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': 'Marked & transmucosal increase in lamina
propria cellularity, Crypt architecture, Epithelial changes, Mucosal surface,
Lamina propria granulomas, Patchy lamina propria cellularity?, Mucin depletion',
'accuracy': [0.7668474051123161, 0.7668474051123161, 0.7877614252517429,
0.6502711076684741, 0.6365749709414955], 'avgAccuracy': 0.7216604628172689,
'f1': [0.7956388374535504, 0.8680403331871986, 0.7870196635072528,
0.7880779159821638, 0.7633072687128298], 'avgF1': 0.8004168037685991,
'precision': [0.7668474051123161, 0.7668474051123161, 0.7877614252517429,
0.6502711076684741, 0.6365749709414955], 'avgPrecision': 0.7216604628172689,
'recall': [0.7668474051123161, 0.7668474051123161, 0.7877614252517429,
0.6502711076684741, 0.6365749709414955], 'avgRecall': 0.7216604628172689,
'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': 'Marked & transmucosal increase in
lamina propria cellularity, Crypt architecture, Epithelial changes, Mucosal
surface, Lamina propria granulomas, Patchy lamina propria cellularity?, Mucin
depletion', 'accuracy': [0.8783888458559257, 0.8973663826491092,
0.8702556158017041, 0.7207591014717274, 0.717551336691205], 'avgAccuracy':
0.8168642564939342, 'f1': [0.882789074745606, 0.9459073280261276,
0.8677169818543689, 0.8377222597344136, 0.8211514397895884], 'avgF1':
0.8710574168300209, 'precision': [0.8783888458559257, 0.8973663826491092,
0.8702556158017041, 0.7207591014717274, 0.717551336691205], 'avgPrecision':
0.8168642564939342, 'recall': [0.8783888458559257, 0.8973663826491092,
0.8702556158017041, 0.7207591014717274, 0.717551336691205], 'avgRecall':
0.8168642564939342, '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': 'Marked & transmucosal
increase in lamina propria cellularity, Crypt architecture, Epithelial changes,
Mucosal surface, Lamina propria granulomas, Patchy lamina propria cellularity?,
```

```
Mucin depletion', 'accuracy': [0.9012393493415957, 0.9461657629744384,
0.8927188226181255, 0.7757552285050349, 0.7485470747772182], 'avgAccuracy':
0.8528852476432826, 'f1': [0.9022114095895609, 0.9723383084577115,
0.8908068506388271, 0.8737186477644493, 0.8420297532151674], 'avgF1':
0.8962209939331433, 'precision': [0.9012393493415957, 0.9461657629744384,
0.8927188226181255, 0.7757552285050349, 0.7485470747772182], 'avgPrecision':
0.8528852476432826, 'recall': [0.9012393493415957, 0.9461657629744384,
0.8927188226181255, 0.7757552285050349, 0.7485470747772182], 'avgRecall':
0.8528852476432826, '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':
True, 'random_state': None, 'verbose': 0, 'warm_start': False}]}
******************************************************

                      model                                        features  \
0  RandomForestClassifier  Marked & transmucosal increase in lamina propr…
1    KNeighborsClassifier  Marked & transmucosal increase in lamina propr…
2      LogisticRegression  Marked & transmucosal increase in lamina propr…
3              GaussianNB  Marked & transmucosal increase in lamina propr…
4       AdaBoostClassifier  Marked & transmucosal increase in lamina propr…
5  DecisionTreeClassifier  Marked & transmucosal increase in lamina propr…
6                     SVC  Marked & transmucosal increase in lamina propr…
7           MLPClassifier  Marked & transmucosal increase in lamina propr…


   accuracy        f1  precision    recall  \
0  0.852885  0.896221   0.852885  0.852885
1  0.819415  0.869204   0.819415  0.819415
2  0.704305  0.787287   0.704305  0.704305
3  0.720113  0.798466   0.720113  0.720113
4  0.753190  0.824089   0.753190  0.753190
5  0.851026  0.894777   0.851026  0.851026
6  0.721660  0.800417   0.721660  0.721660
7  0.816864  0.871057   0.816864  0.816864


                                              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…
```

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

```
Current date and time :
2021-06-06 04:16:12
```

0.7.2 Creation of novel ML Models

```
[ ]:
```

0.7.3 Running Models

```
[ ]:
```

0.7.4 Results

```
[210]: smotePrintoutBytes = open('smotePrintout_onlyibd.txt','r')
        smotePrintout       = smotePrintoutBytes.read()
        smotePrintout[:100]
```

```
[210]: '**********************************************\nStarting SMOTE data
        set…\n**************************'
```

```
[211]: originalPrintoutBytes = open('originalDatasetPrintout_onlyibd.txt','r')
        originalPrintout       = originalPrintoutBytes.read()
        originalPrintout[:100]
```

```
[211]: '**********************************************\nStarting Original data
        set…\n***********************'
```

```
[212]: msmotePrintoutBytes = open('msmotePrintout_onlyibd.txt','r')
        msmotePrintout       = msmotePrintoutBytes.read()
        msmotePrintout[:100]
```

```
[212]: '**********************************************\nStarting MSMOTE data
        set…\n*************************'
```

```
[213]: '''
        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)
```

```python
msmoteModelDictionaries = re.findall('Best Params Result: \n\*␣
 ↪\{([^}]+)\}',msmotePrintout)
```

[214]:
```python
'''
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
```

[215]:
```python
smoteDictList    = getMetricsForAllModels(smoteModelDictionaries,'smote')
originalDictList = getMetricsForAllModels(originalModelDictionaries,'no smote')
msmoteDictList   = getMetricsForAllModels(msmoteModelDictionaries,'msmote')
```

[216]:
```python
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
```

[217]:
```python
smoteCompareDf = createModelCompareDf(smoteDictList)
originalCompareDf = createModelCompareDf(originalDictList)
msmoteCompareDf = createModelCompareDf(msmoteDictList)
modelCompare     = pd.concat([smoteCompareDf,␣
 ↪originalCompareDf,msmoteCompareDf], ignore_index=True)
modelCompare.head()
```

[217]:
```
                 classifier         avgAccuracy                  avgF1  \
0     RandomForestClassifier   0.778552920071756     0.7952724325649522
1       KNeighborsClassifier   0.7462959271809182      0.77386163218242
2         LogisticRegression    0.648169556840077     0.692048322178302
3                 GaussianNB   0.5866985582353332     0.5370210108736294
4          AdaBoostClassifier   0.7207893163244967     0.7549521900542933
..                        …                   …                      …
```

```
403                GaussianNB   0.720112626651713   0.7984659815031586
404         AdaBoostClassifier   0.7531899230238491  0.8240891976773125
405  DecisionTreeClassifier     0.8510259835399666   0.894777159654678
406                       SVC   0.7216604628172689   0.8004168037685991
407             MLPClassifier   0.8168642564939342   0.8710574168300209


          avgPrecision              avgRecall   smote
0     0.778552920071756    0.778552920071756   smote
1     0.7462959271809182   0.7462959271809182  smote
2     0.648169556840077    0.648169556840077   smote
3     0.5866985582353332   0.5866985582353332  smote
4     0.7207893163244967   0.7207893163244967  smote
..                   …                    …     …
403   0.720112626651713    0.720112626651713   msmote
404   0.7531899230238491   0.7531899230238491  msmote
405   0.8510259835399666   0.8510259835399666  msmote
406   0.7216604628172689   0.7216604628172689  msmote
407   0.8168642564939342   0.8168642564939342  msmote

[408 rows x 6 columns]
```

```python
[276]: modelCompare[['avgAccuracy','avgF1','avgPrecision','avgRecall']] =
       modelCompare[['avgAccuracy','avgF1','avgPrecision','avgRecall']].
       astype(float)
```

```python
[277]: 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','avgF1'].max().reset_index(),
       on=['classifier','avgAccuracy','avgF1'])
```

```
<ipython-input-277-a0afa624f181>:3: FutureWarning:

Indexing with multiple keys (implicitly converted to a tuple of keys) will be
deprecated, use a list instead.
```

```python
[278]: 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')
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)
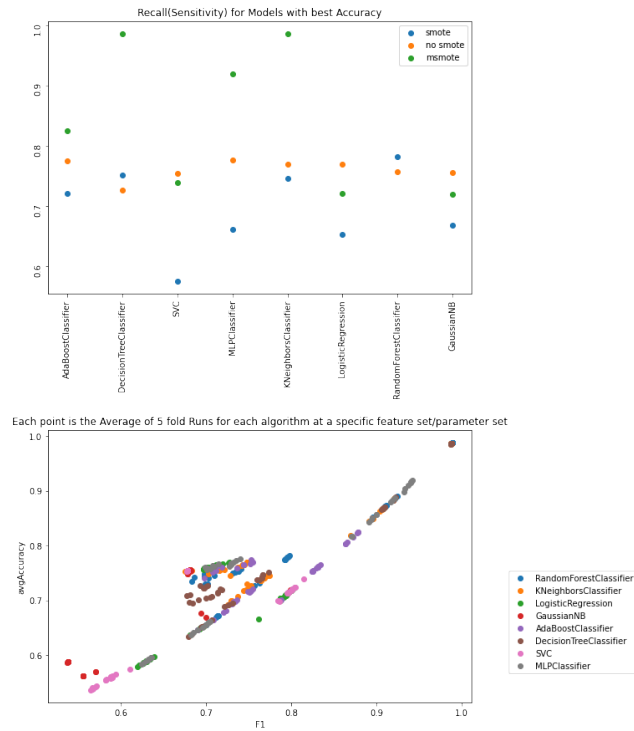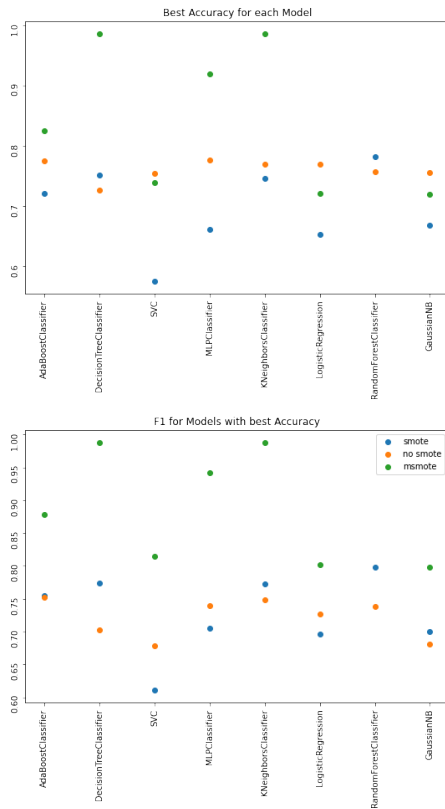ax[0][0].set(title='Best Accuracy for each Model')

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['avgF1'],subdf['avgAccuracy'],label=classifier)
ax[1][1].set(xlabel='F1',ylabel='avgAccuracy',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))
```

[278]: <matplotlib.legend.Legend at 0x22b3ff5e910>

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

[279]:
```
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()
```

[279]: <matplotlib.legend.Legend at 0x22b40793e20>

Precision/Recall for Models with best Accuracy
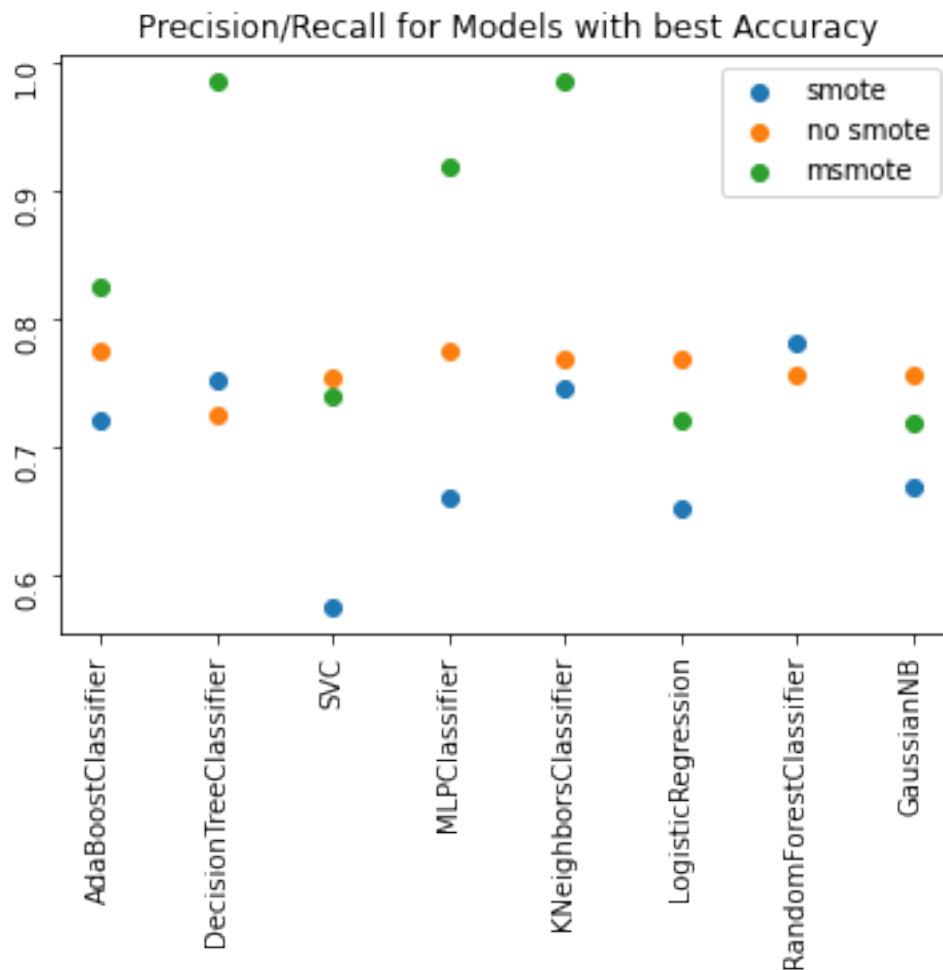
```
[280]: fig,ax=plt.subplots()
       ax.scatter(bestModels['classifier'].unique(),bestModels['avgF1'].
        ↪unique(),label='smote')
       ax.scatter(bestModelsNo['classifier'].unique(),bestModelsNo['avgF1'].
        ↪unique(),label='no smote')
       ax.scatter(bestModelsM['classifier'].unique(),bestModelsM['avgF1'].
        ↪unique(),label='msmote')
       ax.tick_params(rotation=90)
       ax.set(title='F1 for Models with best Accuracy')
       ax.legend()
```

```
[280]: <matplotlib.legend.Legend at 0x22b4071c2e0>
```

F1 for Models with best Accuracy
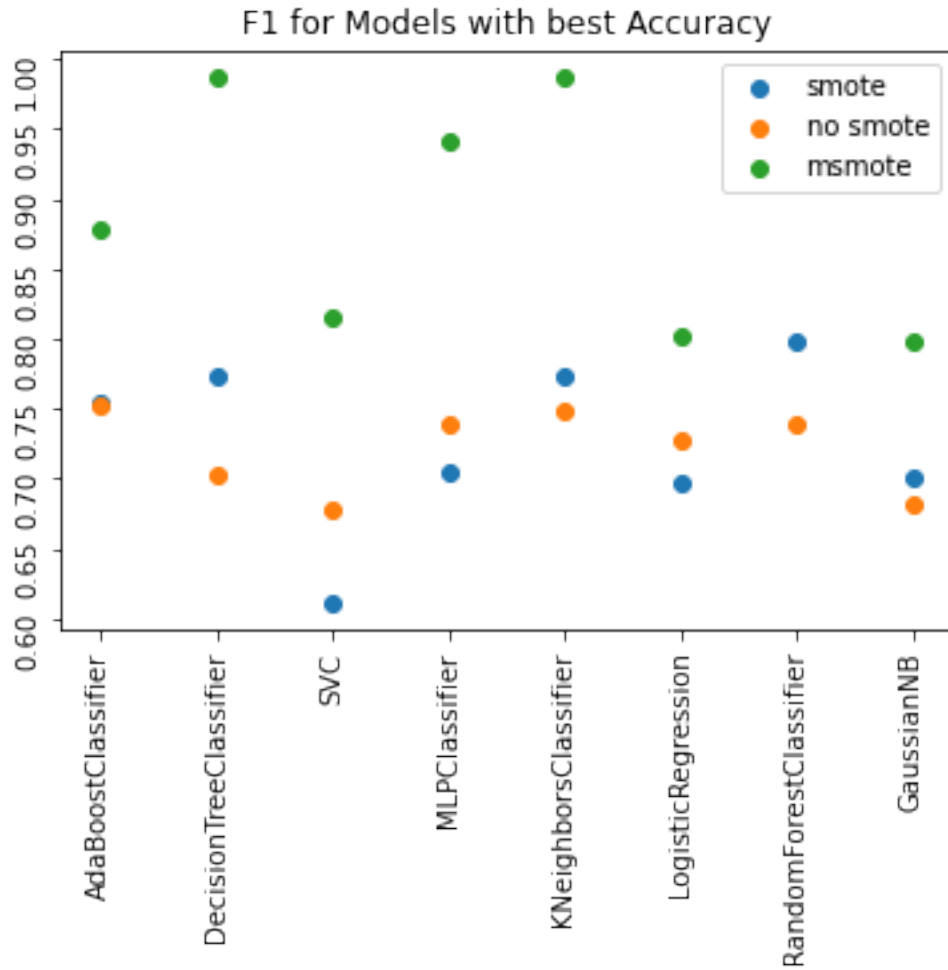

```
[281]: fig,ax=plt.subplots()
       for classifier in modelCompare['classifier'].unique():
           subdf = modelCompare[modelCompare['classifier']==classifier]
           ax.scatter(subdf['avgAccuracy'],subdf['avgF1'],label=classifier)
       ax.set(xlabel='Accuracy',ylabel='F1',title='Each point 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))
```

[281]: <matplotlib.legend.Legend at 0x22b408d8eb0>

Each point is the Average of 5 fold Runs for each algorithm at a specific feature set/parameter set
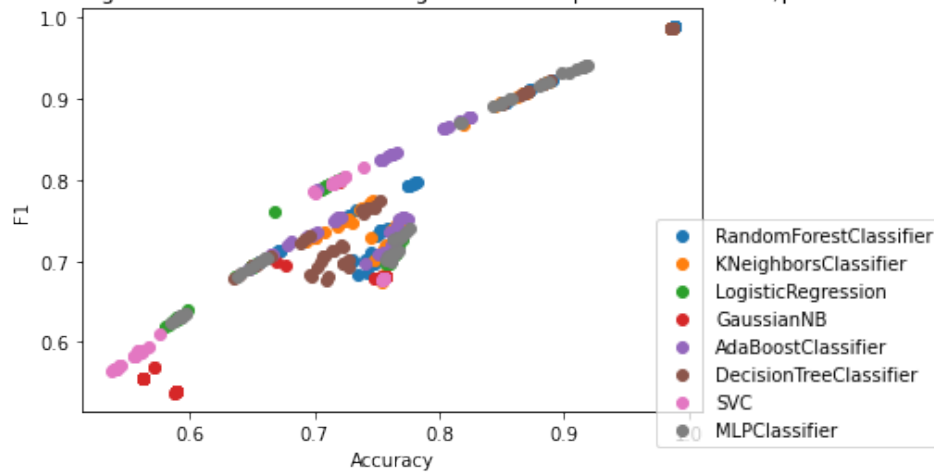
[282]:
```
classifiers = list(bestModels['classifier'].unique())
f1s        = list(bestModels['avgPrecision'].astype(float).unique())
classifiers2 = list(bestModelsNo['classifier'].unique())
f1s2         = list(bestModelsNo['avgPrecision'].astype(float).unique())
classifiers3 = list(bestModelsM['classifier'].unique())
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()
```

[282]: <matplotlib.legend.Legend at 0x22b41fe1850>

Precision for Models with best Accuracy
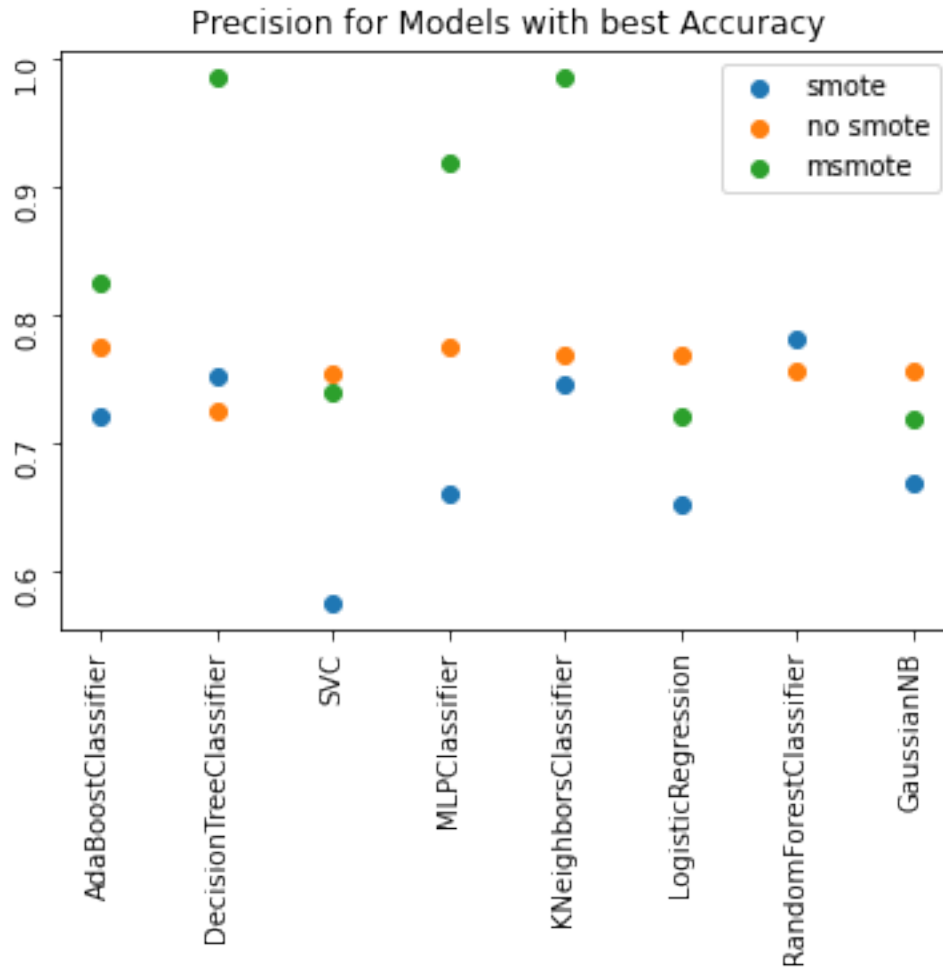

```
[283]: classifiers  = list(bestModels['classifier'].unique())
       f1s          = list(bestModels['avgAccuracy'].astype(float).unique())
       classifiers2 = list(bestModelsNo['classifier'].unique())
       f1s2         = list(bestModelsNo['avgAccuracy'].astype(float).unique())
       classifiers3 = 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))
```

[283]: <matplotlib.legend.Legend at 0x22b4203c9a0>

Best Accuracy for each Model
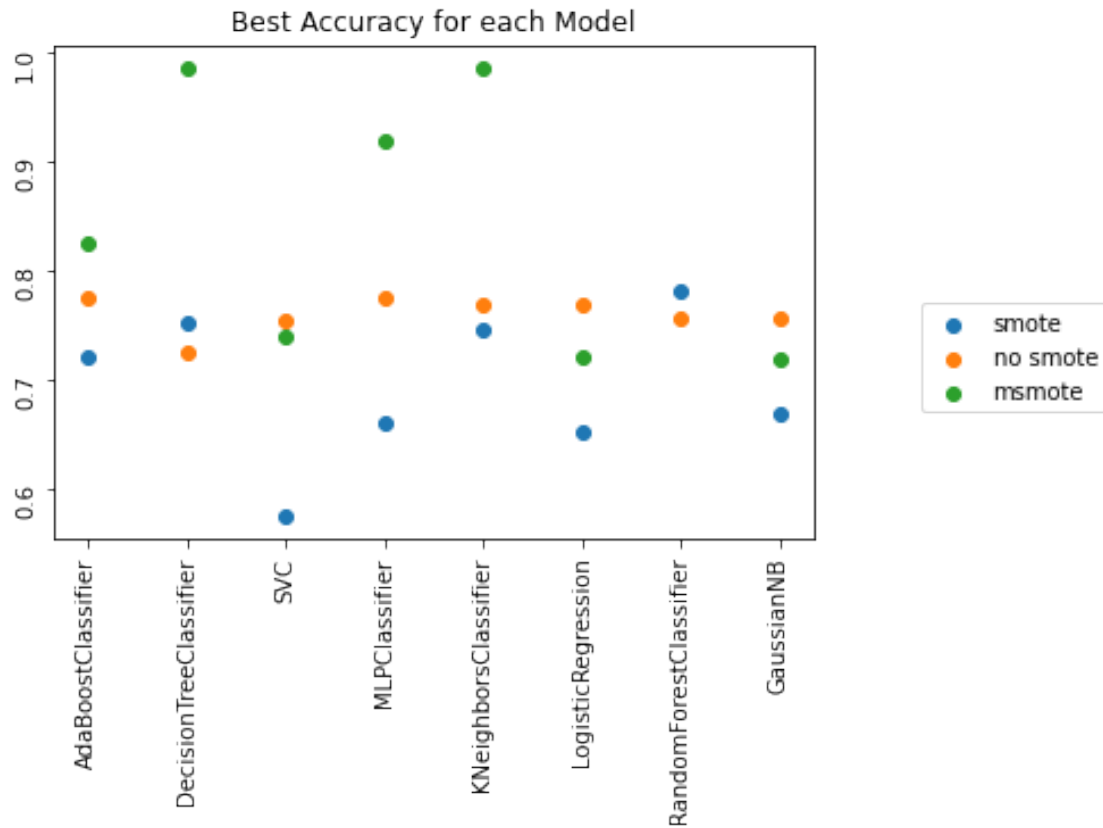

```
[293]: bestRf = pd.merge( modelCompare,
       modelCompare[modelCompare['classifier']=='RandomForestClassifier'].
        ↪groupby(['smote','classifier'])['avgAccuracy'].max().reset_index(),
       on = ['classifier','avgAccuracy'])

       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=[0.5,1])
       ax.set(title='Best SMOTE vs Best No Smote Models for Random Forest (the best␣
        ↪out of all models)')
```

```
[293]: [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)
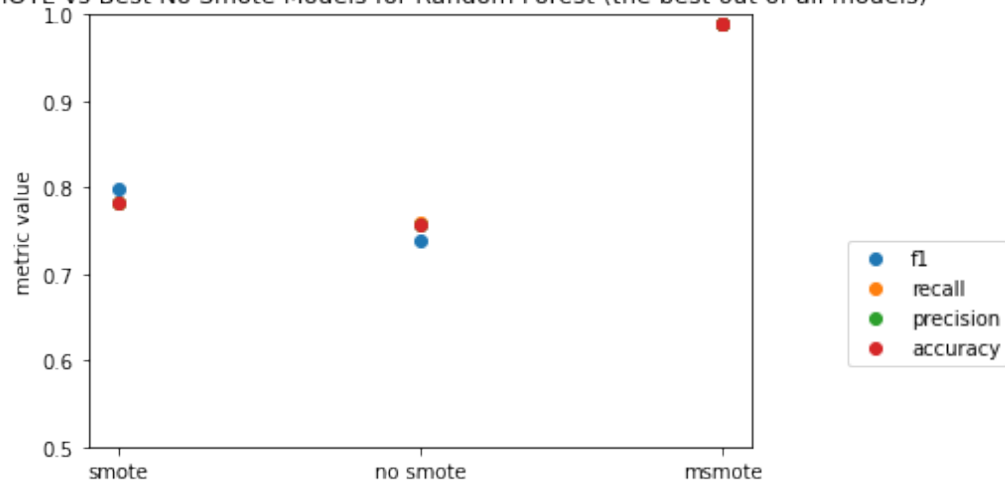

```
[285]: bestRf
```

```
[285]:              classifier  avgAccuracy      avgF1  avgPrecision  avgRecall  \
       0  RandomForestClassifier     0.781981  0.797991      0.781981   0.781981
       1  RandomForestClassifier     0.757655  0.738540      0.757655   0.757655
       2  RandomForestClassifier     0.988380  0.989054      0.988380   0.988380
       3  RandomForestClassifier     0.988380  0.989047      0.988380   0.988380

          smote_x   smote_y
       0    smote     smote
       1  no smote  no smote
       2   msmote    msmote
       3   msmote    msmote
```

```
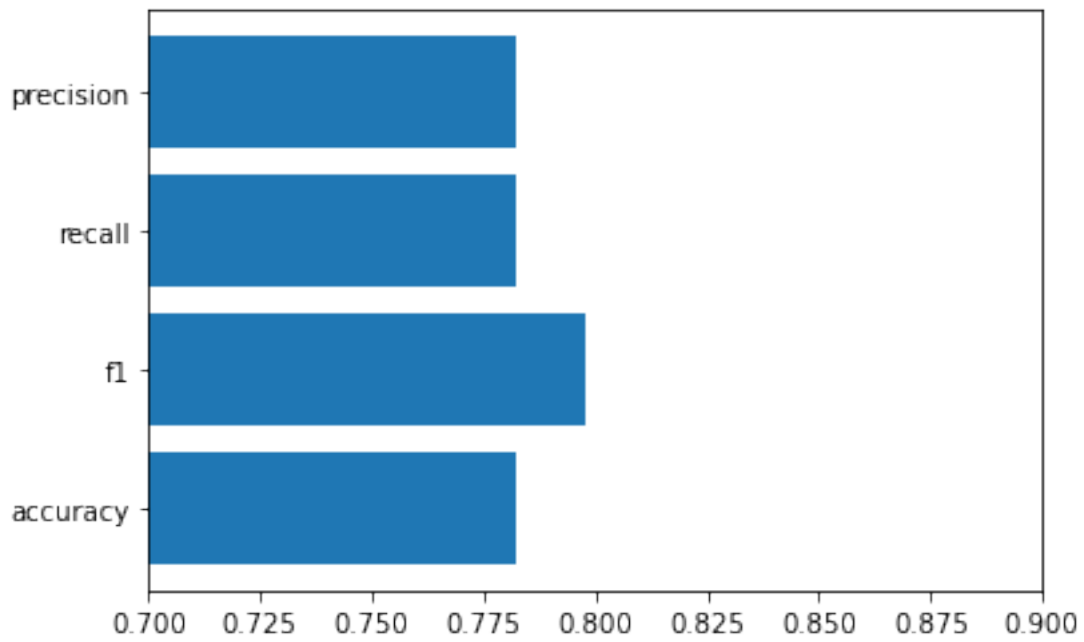[286]: '''

       acc
       recall
       f1
       precision

       '''
```

```
[286]: '\n\nacc            \nrecall\nf1\nprecision\n\n'
```

```
[299]: fig,ax=plt.subplots()
       ax.barh(['accuracy','f1','recall','precision'],
               [0.781981, 0.797991, 0.781981, 0.781981], label='smote')
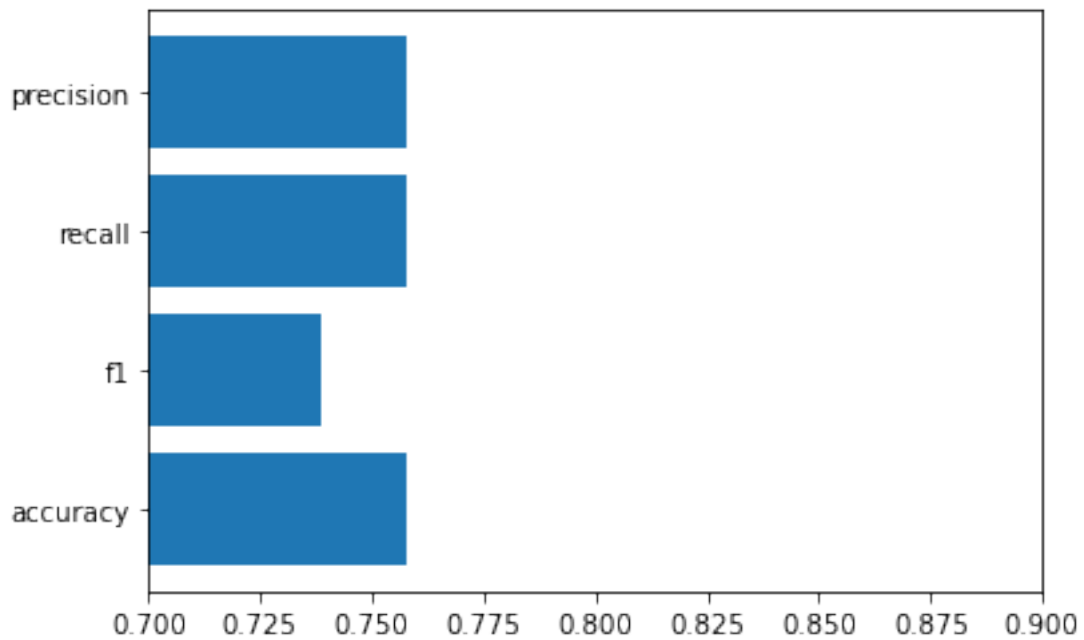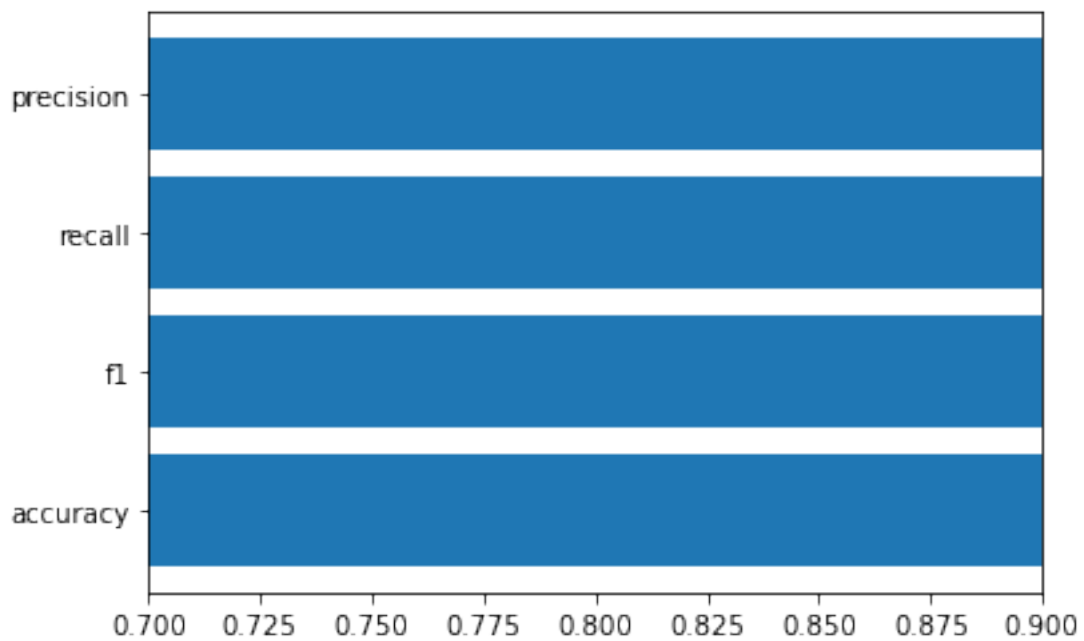       ax.set(xlim=[0.7,0.9])
```

```
[302]: fig,ax= plt.subplots()
       ax.barh(['accuracy','f1','recall','precision'],
               [0.757655, 0.738540, 0.757655, 0.757655], label='no smote')
       ax.set(xlim=[0.7, 0.9])
```

[302]: [(0.7, 0.9)]

```
[303]: fig,ax= plt.subplots()
       ax.barh(['accuracy','f1','recall','precision'],
               [0.988380, 0.989054, 0.988380, 0.988380], label='msmote')
       ax.set(xlim=[0.7, 0.9])
```

[303]: [(0.7, 0.9)]

0.7.5 Statistics

[ ]:

0.7.6 Visualizations

[ ]:

0.7.7 Discussion

[ ]:

0.7.8 Conclusions

[ ]: