21BAI1217 MAINAK CHATTERJEE

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[33]:
```
import numpy as np
import pandas as pd
import seaborn as sns
import matplotlib.pyplot as plt
```

[34]:
```
names = ['Sample code number','Clump Thickness','Uniformity of Cell␣
↪Size','Uniformity of Cell Shape','Marginal Adhesion','Single Epithelial Cell␣
↪Size','Bare Nuclei','Bland Chromating','Normal Nucleoli','Mitoses','Class']
```

[35]:
```
df = pd.read_csv('/content/breast-cancer-wisconsin.data',delimiter=',',␣
↪names=names)
df.to_csv('breast-cancer-wisconsin.csv', index = False)
```

[36]:
```
df = pd.read_csv('/content/breast-cancer-wisconsin.csv',index_col = 0)
```

[37]:
```
df.columns
```

[37]:
```
Index(['Clump Thickness', 'Uniformity of Cell Size',
       'Uniformity of Cell Shape', 'Marginal Adhesion',
       'Single Epithelial Cell Size', 'Bare Nuclei', 'Bland Chromating',
       'Normal Nucleoli', 'Mitoses', 'Class'],
      dtype='object')
```

[38]:
```
df.head()
```

[38]:

Sample code number	Clump Thickness	Uniformity of Cell Size	Uniformity of Cell Shape	Marginal Adhesion
1000025	5	1	1	1
1002945	5	4	4	5
1015425	3	1		
1016277	6	8		
1017023	4	1		

```
1015425                                  1                1
1016277                                  8                1
1017023                                  1                3

                    Single Epithelial Cell Size Bare Nuclei  Bland Chromating  \
Sample code number
1000025                                     2           1                 3
1002945                                     7          10                 3
1015425                                     2           2                 3
1016277                                     3           4                 3
1017023                                     2           1                 3

                    Normal Nucleoli  Mitoses  Class
Sample code number
1000025                           1        1      2
1002945                           2        1      2
1015425                           1        1      2
1016277                           7        1      2
1017023                           1        1      2
```

[39]:
```
df.info()
```

```
<class 'pandas.core.frame.DataFrame'>
Int64Index: 699 entries, 1000025 to 897471
Data columns (total 10 columns):
 #   Column                       Non-Null Count  Dtype
---  ------                       --------------  -----
 0   Clump Thickness              699 non-null    int64
 1   Uniformity of Cell Size      699 non-null    int64
 2   Uniformity of Cell Shape     699 non-null    int64
 3   Marginal Adhesion            699 non-null    int64
 4   Single Epithelial Cell Size  699 non-null    int64
 5   Bare Nuclei                  699 non-null    object
 6   Bland Chromating             699 non-null    int64
 7   Normal Nucleoli              699 non-null    int64
 8   Mitoses                      699 non-null    int64
 9   Class                        699 non-null    int64
dtypes: int64(9), object(1)
memory usage: 60.1+ KB
```

[40]:
```
df['Bare Nuclei'].unique()
```

[40]:
```
array(['1', '10', '2', '4', '3', '9', '7', '?', '5', '8', '6'],
      dtype=object)
```

[41]:
```
df['Bare Nuclei'] = df['Bare Nuclei'].replace(to_replace="?",
           value=np.nan)
```

[42]:
```
df.isnull().sum()
```

[42]:
```
Clump Thickness                0
Uniformity of Cell Size        0
Uniformity of Cell Shape       0
Marginal Adhesion              0
Single Epithelial Cell Size    0
Bare Nuclei                   16
Bland Chromating               0
Normal Nucleoli                0
Mitoses                        0
Class                          0
dtype: int64
```

[43]:
```
#we replace ? with nan to create null values
df = df.dropna(axis = 0)
```

[44]:
```
df.info()
```

```
<class 'pandas.core.frame.DataFrame'>
Int64Index: 683 entries, 1000025 to 897471
Data columns (total 10 columns):
 #   Column                       Non-Null Count  Dtype
---  ------                       --------------  -----
 0   Clump Thickness              683 non-null    int64
 1   Uniformity of Cell Size      683 non-null    int64
 2   Uniformity of Cell Shape     683 non-null    int64
 3   Marginal Adhesion            683 non-null    int64
 4   Single Epithelial Cell Size  683 non-null    int64
 5   Bare Nuclei                  683 non-null    object
 6   Bland Chromating             683 non-null    int64
 7   Normal Nucleoli              683 non-null    int64
 8   Mitoses                      683 non-null    int64
 9   Class                        683 non-null    int64
dtypes: int64(9), object(1)
memory usage: 58.7+ KB
```

[45]:
```
#now we convert object to int
df['Bare Nuclei'] = df['Bare Nuclei'].astype('int64')
```

[46]:
```
df['Uniformity of Cell Shape'] = (df['Uniformity of Cell Shape']+df['Uniformity␣
 ↪of Cell Size'])/2
df.rename(columns = {'Uniformity of Cell Shape':'Uniformity'}, inplace = True)
df = df.drop(['Uniformity of Cell Size','Mitoses'],axis=1)
```

[47]:
```
corr = df.corr()
corr
```

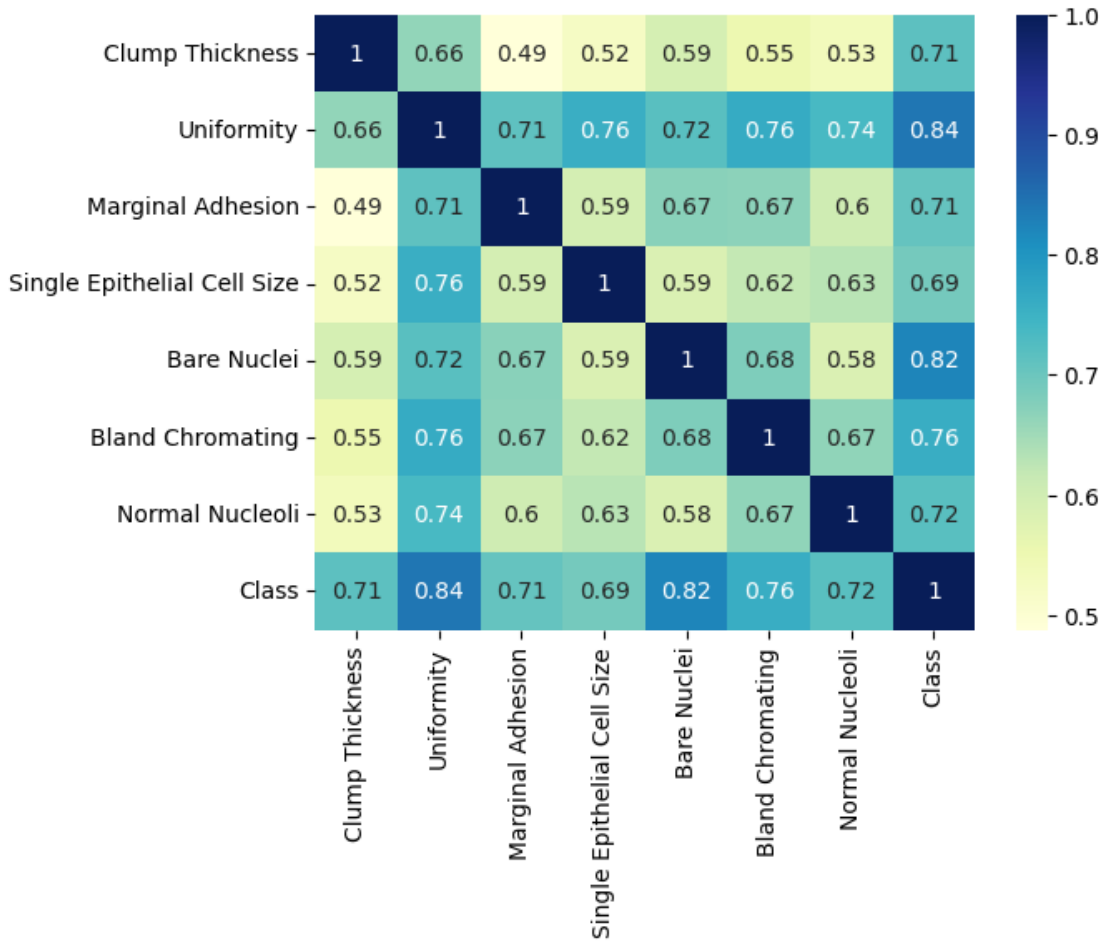
[47]:

	Clump Thickness	Uniformity	Marginal Adhesion	\
Clump Thickness	1.000000	0.663474	0.487829	
Uniformity	0.663474	1.000000	0.713334	
Marginal Adhesion	0.487829	0.713334	1.000000	
Single Epithelial Cell Size	0.523596	0.755937	0.594548	
Bare Nuclei	0.593091	0.719537	0.670648	
Bland Chromating	0.553742	0.763494	0.668567	
Normal Nucleoli	0.534066	0.735932	0.603121	
Class	0.714790	0.841075	0.706294	

	Single Epithelial Cell Size	Bare Nuclei	\
Clump Thickness	0.523596	0.593091	
Uniformity	0.755937	0.719537	
Marginal Adhesion	0.594548	0.670648	
Single Epithelial Cell Size	1.000000	0.585716	
Bare Nuclei	0.585716	1.000000	
Bland Chromating	0.618128	0.680615	
Normal Nucleoli	0.628926	0.584280	
Class	0.690958	0.822696	

	Bland Chromating	Normal Nucleoli	Class
Clump Thickness	0.553742	0.534066	0.714790
Uniformity	0.763494	0.735932	0.841075
Marginal Adhesion	0.668567	0.603121	0.706294
Single Epithelial Cell Size	0.618128	0.628926	0.690958
Bare Nuclei	0.680615	0.584280	0.822696
Bland Chromating	1.000000	0.665602	0.758228
Normal Nucleoli	0.665602	1.000000	0.718677
Class	0.758228	0.718677	1.000000

[48]:
```
dataplot = sns.heatmap(corr, cmap="YlGnBu", annot=True)
plt.show()
```



[49]:
```
from sklearn.model_selection import train_test_split, cross_val_score
from sklearn.linear_model import LogisticRegression
```

[50]:
```
X = df.drop('Class',axis=1)
y=df['Class']
X_train, X_test, y_train, y_test = train_test_split(X, y, random_state=42)
```

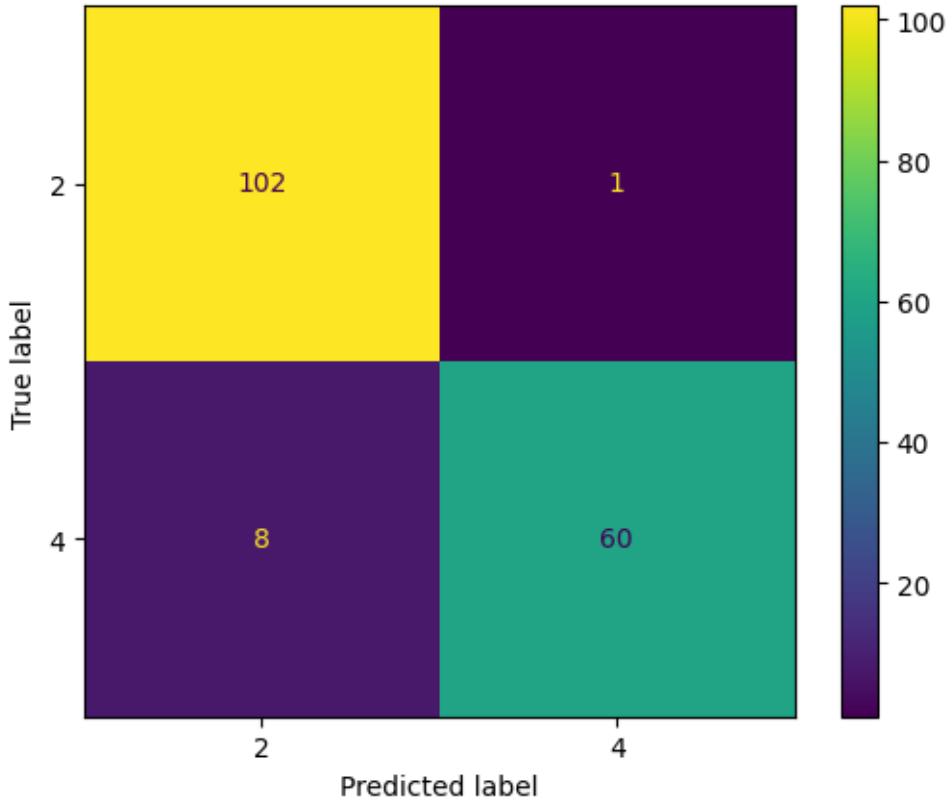
[51]:
```
clf = LogisticRegression(random_state=42)
scores = cross_val_score(clf, X, y, cv=5)
scores
```

[51]:
```
array([0.9270073 , 0.94160584, 0.98540146, 0.97794118, 0.98529412])
```

[52]:
```
clf.fit(X_train,y_train)
y_pred_class = clf.predict(X_test)
```

[53]:
```
from sklearn.metrics import confusion_matrix, ConfusionMatrixDisplay
from sklearn.metrics import accuracy_score
from sklearn.metrics import classification_report
```

[54]:
```
cm = confusion_matrix(y_test, y_pred_class, labels=clf.classes_)
disp = ConfusionMatrixDisplay(confusion_matrix=cm,display_labels=clf.classes_)
disp.plot()
plt.show()
```



[55]:
```
print (accuracy_score(y_test,y_pred_class))
```

```
0.9473684210526315
```

[56]:
```
print (classification_report(y_test,y_pred_class))
```

```
              precision    recall  f1-score   support

           2       0.93      0.99      0.96       103
           4       0.98      0.88      0.93        68

    accuracy                           0.95       171
```

```
   macro avg       0.96      0.94      0.94       171
weighted avg       0.95      0.95      0.95       171
```

[63]:
```
y_pred_class.shape
```

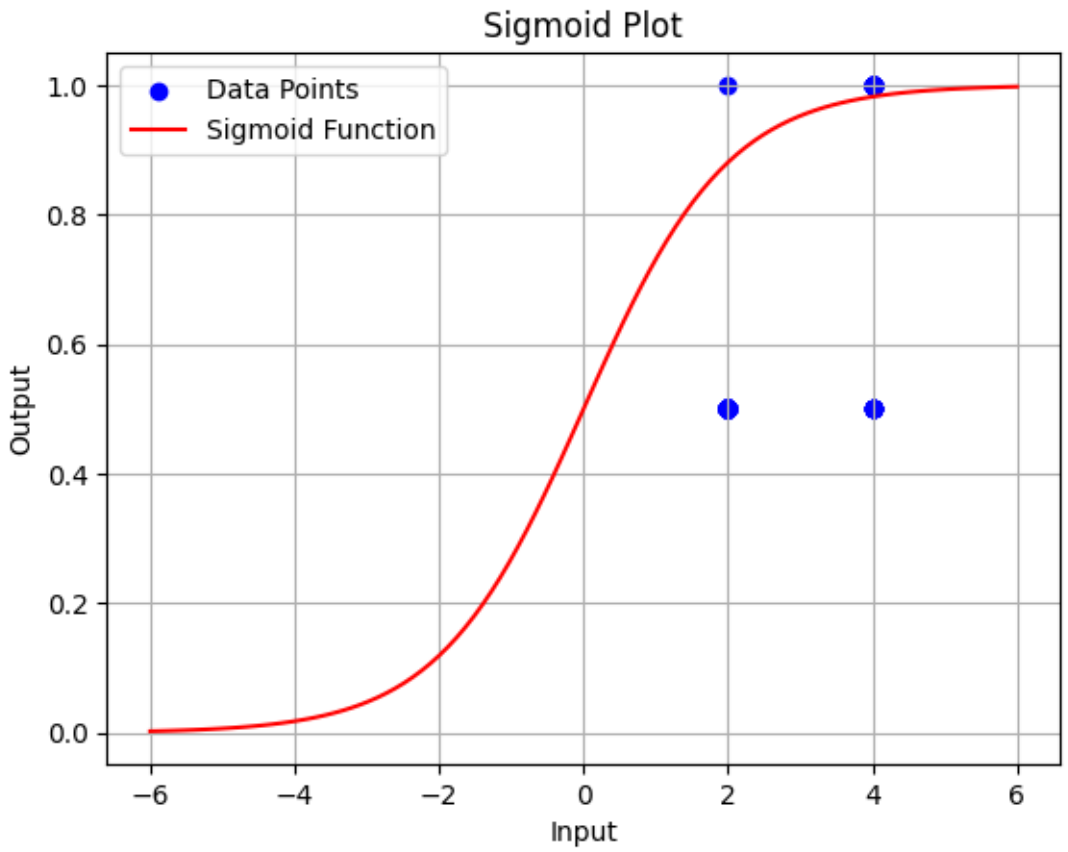
[63]:
```
(171,)
```

[62]:
```
X_test.shape
```

[62]:
```
(171, 7)
```

[71]:
```
def sigmoid(x):
    return 1 / (1 + np.exp(-x))

# Plotting
plt.scatter(y_test, y_pred_class/4, color='blue', label='Data Points')#we␣
 ↪normalize the points as x/4
x = np.linspace(-(min(y_test)+max(y_test)), min(y_test)+max(y_test), 100)
y = sigmoid(x)
plt.plot(x, y, color='red', label='Sigmoid Function')
plt.xlabel('Input')
plt.ylabel('Output')
plt.title('Sigmoid Plot')
plt.legend()
plt.grid(True)
plt.show()
```



[72]:
```python
def sigmoid(z):
    return 1 / (1 + np.exp(-z))

def cost_function(theta, X, y):
    m = len(y)
    h = sigmoid(np.dot(X, theta))
    cost = (-1/m) * np.sum(y * np.log(h) + (1-y) * np.log(1-h))
    return cost

def gradient_descent(theta, X, y, learning_rate, num_iterations):
    m = len(y)
    cost_history = []

    for iteration in range(num_iterations):
        h = sigmoid(np.dot(X, theta))
        gradient = (1/m) * np.dot(X.T, (h - y))
        theta = theta - learning_rate * gradient
        cost = cost_function(theta, X, y)
        cost_history.append(cost)
```

```
    return theta, cost_history

theta = np.zeros((X_test.shape[1], 1))
learning_rate = 0.01
num_iterations = 1000
theta_optimized, cost_history = gradient_descent(theta, X, y, learning_rate,␣
 ↪num_iterations)

# Print the optimized parameters
print("Optimized Parameters:")
print(theta_optimized)

# Print the cost history
print("Cost History:")
print(cost_history)
```

```
Optimized Parameters:
[[-0.51798946 -0.50184642 -0.4862143  -0.47128537 -0.4572325  -0.44420399
  -0.43231719 -0.42165083 -0.41223694 -0.40405414 -0.39701644 -0.39093257
  -0.38540954 -0.37978941 -0.37334616 -0.36568648 -0.3569198  -0.34747088
  -0.33780135 -0.32824224 -0.31895753 -0.30998262 -0.30128117 -0.29278832
  -0.28443224 -0.27613976 -0.26783523 -0.25943967 -0.25087292 -0.24205902
  -0.23293267 -0.22344469 -0.2135649  -0.20328181 -0.19260022 -0.18153784
  -0.1701221  -0.15838752 -0.1463735  -0.1341223  -0.12167716 -0.10908032
  -0.09637124 -0.08358489 -0.07075052 -0.05789085 -0.04502185 -0.03215315
  -0.00944715  0.00728545 -0.00728545  0.00944715  0.03215315  0.04502185
   0.05789085  0.07075052  0.08358489  0.09637124  0.10908032  0.12167716
   0.1341223   0.1463735   0.15838752  0.1701221   0.18153784  0.19260022
   0.20328181  0.2135649   0.22344469  0.23293267  0.24205902  0.25087292
   0.25943967  0.26783523  0.27613976  0.28443224  0.29278832  0.30128117
   0.30998262  0.31895753  0.32824224  0.33780135  0.34747088  0.3569198
   0.36568648  0.37334616  0.37978941  0.38540954  0.39093257  0.39701644
   0.40405414  0.41223694  0.42165083  0.43231719  0.44420399  0.4572325
   0.47128537  0.4862143   0.50184642  0.51798946]
 [-0.26067885 -0.23916091 -0.21602036 -0.19109302 -0.16419137 -0.13511256
  -0.10365187 -0.06962629 -0.0329189   0.00643693  0.04811246  0.09129151
   0.13455375  0.17604401  0.21393544  0.24686555  0.27411815  0.29558196
   0.31157761  0.32265223  0.32942195  0.3324862   0.33239539  0.32964435
   0.32467341  0.31786888  0.30956213  0.30002838  0.28948774  0.27810984
   0.26602241  0.25332289  0.2400908   0.22639902  0.21232217  0.19794137
   0.18334531  0.16862818  0.15388552  0.13920908  0.12468181  0.11037343
   0.0963371   0.08260711  0.06919772  0.05610287  0.04329703  0.03073683
   0.02652363  0.01761239 -0.01761239 -0.02652363 -0.03073683 -0.04329703
  -0.05610287 -0.06919772 -0.08260711 -0.0963371  -0.11037343 -0.12468181
  -0.13920908 -0.15388552 -0.16862818 -0.18334531 -0.19794137 -0.21232217
  -0.22639902 -0.2400908  -0.25332289 -0.26602241 -0.27810984 -0.28948774
  -0.30002838 -0.30956213 -0.31786888 -0.32467341 -0.32964435 -0.33239539
```

```
 -0.3324862  -0.32942195 -0.32265223 -0.31157761 -0.29558196 -0.27411815
 -0.24686555 -0.21393544 -0.17604401 -0.13455375 -0.09129151 -0.04811246
 -0.00643693  0.0329189   0.06962629  0.10365187  0.13511256  0.16419137
  0.19109302  0.21602036  0.23916091  0.26067885]
[-0.30201908 -0.288097   -0.27358792 -0.25847755 -0.24274967 -0.22639497
 -0.20942298 -0.19187859 -0.17386855 -0.15560781 -0.13749235 -0.12016864
 -0.1044775  -0.09112945 -0.08027321 -0.07142397 -0.06384609 -0.05698289
 -0.05061924 -0.04479884 -0.03966202 -0.03532287 -0.0318175  -0.0291048
 -0.02709085 -0.02565495 -0.02466771 -0.02400029 -0.02352849 -0.02313601
 -0.02271951 -0.02219498 -0.02150361 -0.02061479 -0.01952533 -0.01825543
 -0.01684255 -0.01533421 -0.01378077 -0.01222908 -0.01071784 -0.00927489
 -0.00791652 -0.0066484  -0.00546761 -0.00436504 -0.00332784 -0.0023414
  0.00571474  0.00958766 -0.00958766 -0.00571474  0.0023414   0.00332784
  0.00436504  0.00546761  0.0066484   0.00791652  0.00927489  0.01071784
  0.01222908  0.01378077  0.01533421  0.01684255  0.01825543  0.01952533
  0.02061479  0.02150361  0.02219498  0.02271951  0.02313601  0.02352849
  0.02400029  0.02466771  0.02565495  0.02709085  0.0291048   0.0318175
  0.03532287  0.03966202  0.04479884  0.05061924  0.05698289  0.06384609
  0.07142397  0.08027321  0.09112945  0.1044775   0.12016864  0.13749235
  0.15560781  0.17386855  0.19187859  0.20942298  0.22639497  0.24274967
  0.25847755  0.27358792  0.288097    0.30201908]
[-0.68412232 -0.68984968 -0.69780779 -0.708231   -0.72133687 -0.73732182
 -0.75634866 -0.7785179  -0.80381027 -0.831982   -0.86239191 -0.8937671
 -0.92402764 -0.95047223 -0.97051273 -0.98249964 -0.98596105 -0.98126728
 -0.9691723  -0.95050353 -0.92602901 -0.89643917 -0.86237853 -0.82448696
 -0.78343114 -0.73991897 -0.69469477 -0.64851685 -0.60212223 -0.55618653
 -0.5112885  -0.46788772 -0.42631952 -0.38680588 -0.34947531 -0.31438417
 -0.28153393 -0.25088326 -0.22235635 -0.19584917 -0.17123463 -0.14836737
 -0.12708792 -0.1072263  -0.08860486 -0.07104046 -0.05434592 -0.03833102
 -0.01580106  0.00244326 -0.00244326  0.01580106  0.03833102  0.05434592
  0.07104046  0.08860486  0.1072263   0.12708792  0.14836737  0.17123463
  0.19584917  0.22235635  0.25088326  0.28153393  0.31438417  0.34947531
  0.38680588  0.42631952  0.46788772  0.5112885   0.55618653  0.60212223
  0.64851685  0.69469477  0.73991897  0.78343114  0.82448696  0.86237853
  0.89643917  0.92602901  0.95050353  0.9691723   0.98126728  0.98596105
  0.98249964  0.97051273  0.95047223  0.92402764  0.8937671   0.86239191
  0.831982    0.80381027  0.7785179   0.75634866  0.73732182  0.72133687
  0.708231    0.69780779  0.68984968  0.68412232]
[-0.20317993 -0.17494572 -0.14471173 -0.11246248 -0.07825563 -0.04227072
 -0.00487511  0.03329181  0.07122051  0.10743788  0.1399708   0.16648531
  0.1847896   0.19372992  0.19390115  0.18739617  0.17681275  0.1643922
  0.1516811   0.13957689  0.12851524  0.11865073  0.1099813   0.10241929
  0.09582944  0.0900511   0.08491478  0.08025593  0.07592624  0.07180168
  0.06778707  0.06381709  0.05985392  0.05588272  0.05190581  0.04793709
  0.04399715  0.04010932  0.03629653  0.03257886  0.0289718   0.02548527
  0.02212324  0.01888395  0.01576051  0.01274164  0.00981256  0.00695581
  0.01348482  0.01445433 -0.01445433 -0.01348482 -0.00695581 -0.00981256
 -0.01274164 -0.01576051 -0.01888395 -0.02212324 -0.02548527 -0.0289718
```

```
  -0.03257886 -0.03629653 -0.04010932 -0.04399715 -0.04793709 -0.05190581
  -0.05588272 -0.05985392 -0.06381709 -0.06778707 -0.07180168 -0.07592624
  -0.08025593 -0.08491478 -0.0900511  -0.09582944 -0.10241929 -0.1099813
  -0.11865073 -0.12851524 -0.13957689 -0.1516811  -0.1643922  -0.17681275
  -0.18739617 -0.19390115 -0.19372992 -0.1847896  -0.16648531 -0.1399708
  -0.10743788 -0.07122051 -0.03329181  0.00487511  0.04227072  0.07825563
   0.11246248  0.14471173  0.17494572  0.20317993]
 [-0.56633832 -0.56146168 -0.55740961 -0.5542542  -0.5520389  -0.5507784
  -0.55045653 -0.55101901 -0.55235612 -0.55426628 -0.55638641 -0.55808038
  -0.5583321  -0.55581507 -0.54930669 -0.53822471 -0.52282229 -0.50397929
  -0.48286317 -0.46065463 -0.438381   -0.41683464 -0.39654494 -0.37778323
  -0.3605906  -0.34482313 -0.33020853 -0.31640679 -0.30306712 -0.2898742
  -0.27657919 -0.26301365 -0.24908824 -0.23478077 -0.22011962 -0.20516757
  -0.19000853 -0.1747373  -0.15945154 -0.1442449  -0.12920135 -0.11439049
  -0.09986417 -0.08565443 -0.07177258 -0.05820954 -0.04493704 -0.03190981
  -0.01124131  0.00473288 -0.00473288  0.01124131  0.03190981  0.04493704
   0.05820954  0.07177258  0.08565443  0.09986417  0.11439049  0.12920135
   0.1442449   0.15945154  0.1747373   0.19000853  0.20516757  0.22011962
   0.23478077  0.24908824  0.26301365  0.27657919  0.2898742   0.30306712
   0.31640679  0.33020853  0.34482313  0.3605906   0.37778323  0.39654494
   0.41683464  0.438381    0.46065463  0.48286317  0.50397929  0.52282229
   0.53822471  0.54930669  0.55581507  0.5583321   0.55808038  0.55638641
   0.55426628  0.55235612  0.55101901  0.55045653  0.5507784   0.5520389
   0.5542542   0.55740961  0.56146168  0.56633832]
 [-0.25426391 -0.23590787 -0.21618464 -0.19494424 -0.17201366 -0.14720492
  -0.12032919 -0.09122302 -0.05979951 -0.02614911  0.00927858  0.04541693
   0.08039851  0.11177557  0.13727014  0.15557295  0.16662525  0.17135959
   0.17121225  0.16768224  0.16205577  0.15529469  0.14803683  0.14065268
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```
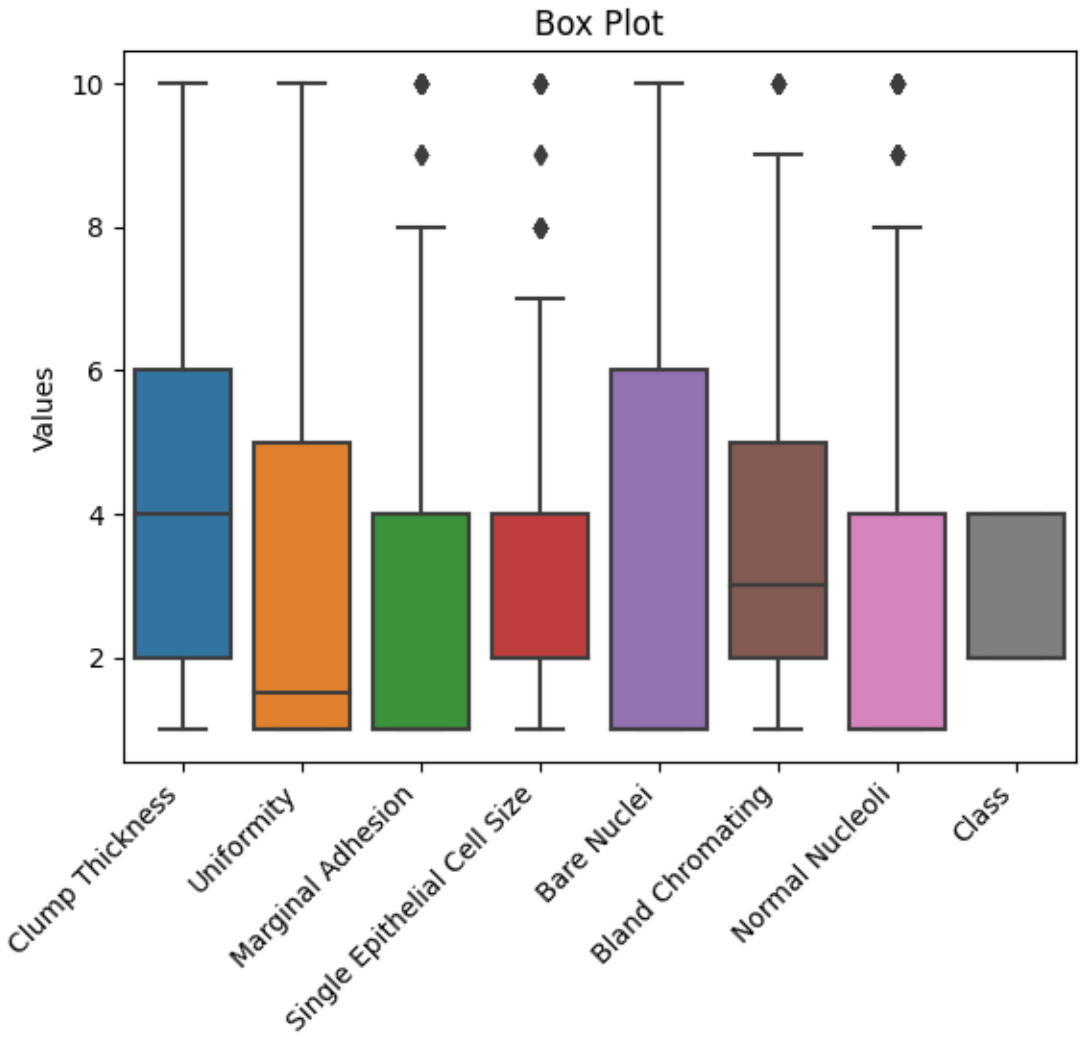
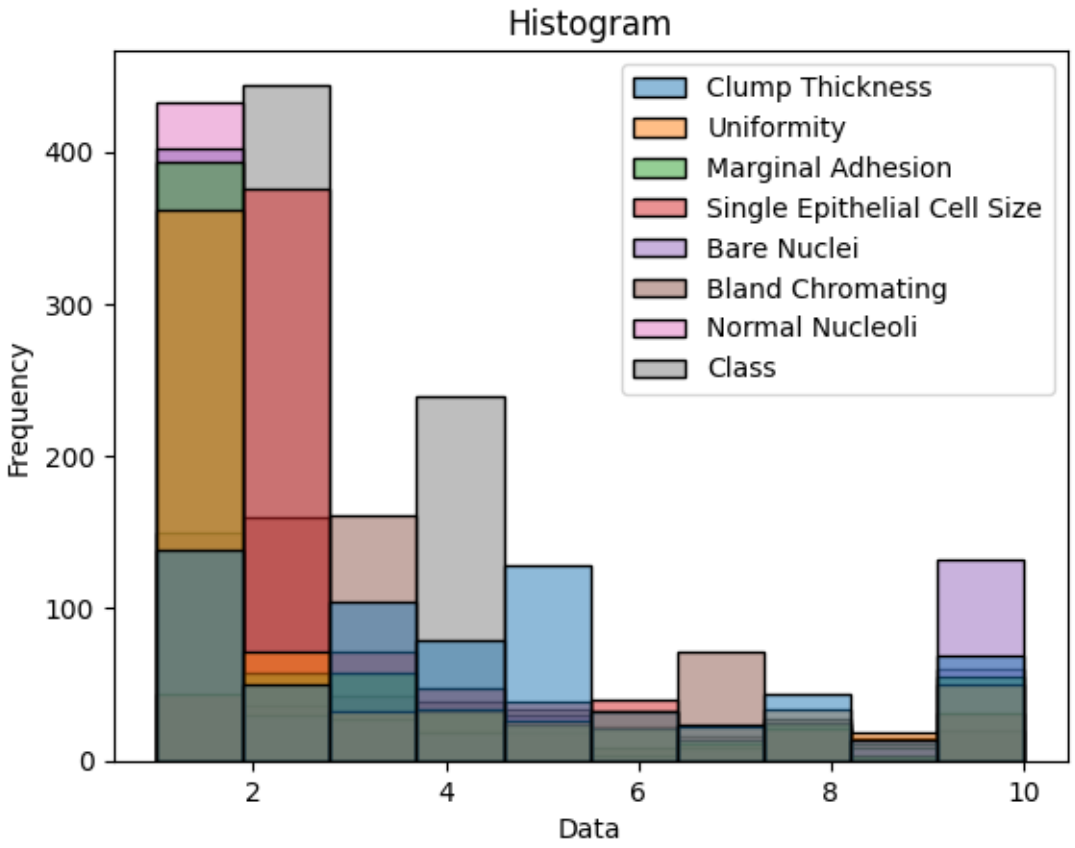

[89]:
```
sns.boxplot(data=df)
plt.xticks(rotation=45, ha='right')
plt.ylabel('Values')
plt.title('Box Plot')
plt.show()
```



[82]:
```
sns.histplot(data=df, bins=10)
plt.xlabel('Data')
plt.ylabel('Frequency')
plt.title('Histogram')
```

```
plt.show()
```


Histogram
Clump Thickness
Uniformity
Marginal Adhesion
Single Epithelial Cell Size
Bare Nuclei
Bland Chromating
Normal Nucleoli
Class
Frequency
0
100
200
300
400
2
4
6
8
10
Data

[ ]: