Damandeep Singh 00213207218 CSE- 1

MACHINE LEARNING LAB PROGRAM Submission -1

Github link:

https://github.com/Daman-x/ML_Works/tree/Labprogram1

EXPERIMENT-1

AIM:

Study and implement the Naive Bayes learner on a breast cancer dataset

ALGORITHM:

- 1. Convert the data set into a frequency table
- 2. Create a Likelihood table by finding the probabilities.
- 3. Now, use Naive_Bayesian equation to calculate the posterior probability for each class. The class with the highest posterior probability is the outcome of prediction

PROGRAM CODE SNIPPET:

LOADING DATA SET:

	id	diagnosis	radius_mean	texture_mean	perimeter_mean	area_mean	smoothness_mean	compactness_mean	concavity_mean	concav points_mea
0	842302	M	17.99	10.38	122.80	1001.0	0.11840	0.27760	0.30010	0.1471
1	842517	M	20.57	17.77	132.90	1326.0	0.08474	0.07864	0.08690	0.0701
2	84300903	М	19.69	21.25	130.00	1203.0	0.10960	0.15990	0.19740	0.1279
3	84348301	M	11.42	20.38	77.58	386.1	0.14250	0.28390	0.24140	0.1052
4	84358402	M	20.29	14.34	135.10	1297.0	0.10030	0.13280	0.19800	0.1043
•••	5550	1555	(202)	1000	M505W	1000	-	200	1555	
564	926424	M	21.56	22.39	142.00	1479.0	0.11100	0.11590	0.24390	0.1389
565	926682	M	20.13	28.25	131.20	1261.0	0.09780	0.10340	0.14400	0.0979
566	926954	M	16.60	28.08	108.30	858.1	0.08455	0.10230	0.09251	0.0530
567	927241	M	20.60	29.33	140.10	1265.0	0.11780	0.27700	0.35140	0.1520
568	92751	В	7.76	24.54	47.92	181.0	0.05263	0.04362	0.00000	0.0000

PREPROCESSING:

	id	diagnosis	radius_mean	texture_mean	perimeter_mean	area_mean	smoothness_mean	compactness_mean	concavity_mean	concave points_mean
564	926424	M	21.58	22.39	142.00	1479.0	0.11100	0.11590	0.24390	0.13890
565	926682	M	20.13	28.25	131.20	1261.0	0.09780	0.10340	0.14400	0.09791
566	926954	M	16.60	28.08	108.30	858.1	0.08455	0.10230	0.09251	0.05302
567	927241	M	20.60	29.33	140.10	1265.0	0.11780	0.27700	0.35140	0.15200
568	92751	В	7.76	24.54	47.92	181.0	0.05263	0.04362	0.00000	0.00000

```
In [6]: df.info()
               <class 'pandas.core.frame.DataFrame'>
              RangeIndex: 569 entries, 0 to 568
Data columns (total 33 columns):
                                                           Non-Null Count Dtype
                     Column
               ___
                                                           569 non-null
               0
                     id
                                                                                   int64
                      diagnosis
                                                           569 non-null
                                                                                   object
                      radius_mean
                                                           569 non-null
                                                                                   float64
                      texture_mean
                                                           569 non-null
                                                                                   float64
                4
                      perimeter_mean
                                                           569 non-null
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               5
                      area mean
                      smoothness_mean
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                      concavity_mean
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                9
                      concave points_mean
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                11
                      fractal_dimension_mean
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                                                           569 non-null
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                14
                      perimeter_se
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                      smoothness_se
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                      texture_worst
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                     symmetry_worst 569 non-null fractal_dimension_worst 569 non-null
                30
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                                                                                   float64
                31
                32 Unnamed: 32
                                                           0 non-null
                                                                                   float64
              dtypes: float64(31), int64(1), object(1) memory usage: 146.8+ KB
In [7]: df.shape
Out[7]: (569, 33)
In [8]: #print all the columns of dataset
             df.columns.values
Out[8]: array(['id', 'diagnosis', 'radius_mean', 'texture_mean', 'perimeter_mean', 'area_mean', 'smoothness_mean', 'compactness_mean', 'concavity_mean', 'concave points_mean', 'symmetry_mean', 'fractal_dimension_mean', 'radius_se', 'texture_se', 'perimeter_se', 'area_se', 'smoothness_se', 'compactness_se', 'concavity_se', 'concave points_se', 'symmetry_se', 'fractal_dimension_se', 'radius_worst', 'texture_worst', 'perimeter_worst', 'area_worst', 'smoothness_worst', 'compactness_worst', 'concavity_worst', 'concave points_worst', 'symmetry_worst', 'fractal_dimension_worst', 'Unnamed: 32'], dtype=object)
```

Out[9]:

	id	radius_mean	texture_mean	perimeter_mean	area_mean	smoothness_mean	compactness_mean	concavity_mean	cond points_m
id	1.000000	0.074626	0.099770	0.073159	0.096893	-0.012968	0.000096	0.050080	0.044
radius_mean	0.074626	1.000000	0.323782	0.997855	0.987357	0.170581	0.506124	0.676764	0.822
texture_mean	0.099770	0.323782	1.000000	0.329533	0.321086	-0.023389	0.236702	0.302418	0.293
perimeter_mean	0.073159	0.997855	0.329533	1.000000	0.986507	0.207278	0.556936	0.716136	0.850
area_mean	0.098893	0.987357	0.321086	0.986507	1.000000	0.177028	0.498502	0.685983	0.823
smoothness_mean	-0.012968	0.170581	-0.023389	0.207278	0.177028	1.000000	0.659123	0.521984	0.550
compactness_mean	0.000098	0.508124	0.236702	0.556936	0.498502	0.659123	1.000000	0.883121	0.83
concavity_mean	0.050080	0.676764	0.302418	0.716136	0.685983	0.521984	0.883121	1.000000	0.921
concave points_mean	0.044158	0.822529	0.293464	0.850977	0.823269	0.553695	0.831135	0.921391	1.000
symmetry_mean	-0.022114	0.147741	0.071401	0.183027	0.151293	0.557775	0.602641	0.500667	0.462
fractal_dimension_mean	-0.052511	-0.311631	-0.076437	-0.261477	-0.283110	0.584792	0.565369	0.336783	0.168
radius_se	0.143048	0.679090	0.275869	0.691765	0.732562	0.301467	0.497473	0.631925	0.698
texture_se	-0.007526	-0.097317	0.386358	-0.088761	-0.066280	0.068408	0.046205	0.076218	0.021
perimeter_se	0.137331	0.674172	0.281673	0.693135	0.726628	0.296092	0.548905	0.660391	0.710
area_se	0.177742	0.735864	0.259845	0.744983	0.800086	0.246552	0.455653	0.617427	0.690
smoothness_se	0.098781	-0.222600	0.008614	-0.202694	-0.168777	0.332375	0.135299	0.098564	0.027
compactness_se	0.033961	0.208000	0.191975	0.250744	0.212583	0.318943	0.738722	0.670279	0.490
concavity_se	0.055239	0.194204	0.143293	0.228082	0.207660	0.248396	0.570517	0.691270	0.438
concave points_se	0.078768	0.376169	0.163851	0.407217	0.372320	0.380676	0.642262	0.683260	0.618
symmetry_se	-0.017306	-0.104321	0.009127	-0.081629	-0.072497	0.200774	0.229977	0.178009	0.098
fractal_dimension_se	0.025725	-0.042641	0.054458	-0.005523	-0.019887	0.283607	0.507318	0.449301	0.257
radius_worst	0.082405	0.969539	0.352573	0.969476	0.962746	0.213120	0.535315	0.688236	0.830
texture_worst	0.064720	0.297008	0.912045	0.303038	0.287489	0.036072	0.248133	0.299879	0.292
perimeter_worst	0.079986	0.965137	0.358040	0.970387	0.959120	0.238853	0.590210	0.729565	0.858

In [10]: #check for the null value
df.isnull().sum()

Out[10]: id diagnosis 0 0 radius_mean texture_mean perimeter_mean area_mean 0 0 smoothness_mean compactness_mean concavity_mean 0 concave points_mean symmetry_mean fractal_dimension_mean 0 0 radius_se texture_se perimeter_se 0 0 area_se smoothness_se 0 0 compactness_se concavity_se
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concavity_worst
concave points_worst
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fractal_dimension_worst
Unnamed: 32
dtvoe: int64 0 0 0 569

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In [11]: for i in df.columns:
                              print(i)
                              print(df[i].value_counts())
                                                                                                 _********'_____')
                              print('---
                      id
                     883263
                      906564
                      89122
                      9013579
                      868682
                     874158
                      914062
                      918192
                     872113
                     Name: id, Length: 569, dtype: int64
                      diagnosis
                     B 357
                                212
                      Name: diagnosis, dtype: int64
                     radius mean
In [12]: df['diagnosis'].value_counts()
Out[12]: B
                                357
                                212
                     Name: diagnosis, dtype: int64
 In [13]: df= df.drop(["id"], axis = 1)
 Out[13]:
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In [14]: df = df.drop(["Unnamed: 32"], axis = 1)
Out[14]:
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```

VISUALIZATION:

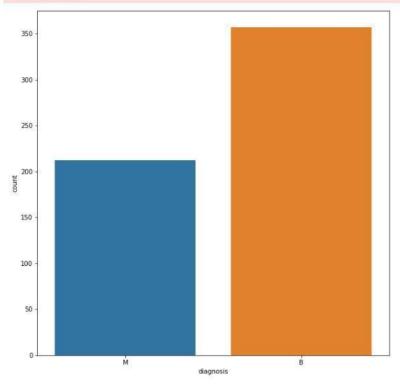
```
In [15]: import matplotlib.pyplot as plt
import seaborn as sns

In [16]: benign, malignant=df['diagnosis'].value_counts()
print("No of Benign cell", benign)
print("No of malignant cell", malignant)

No of Benign cell 357
No of malignant cell 212
```

```
In [19]: plt.figure(figsize=(10,10))
    sns.countplot(df['diagnosis'])
    plt.show()

C:\Users\Is_dhillon\anaconda3\lib\site-packages\seaborn\_decorators.py:36: FutureWarning: Pass the following variable as a keyw
    ord arg: x. From version 0.12, the only valid positional argument will be `data`, and passing other arguments without an explic
    it keyword will result in an error or misinterpretation.
    warnings.warn(
```



```
In [18]: print("% of Benign cell is ", benign*100/len(df))
    print("% of Malignant cell is ", malignant*100/len(df))

% of Benign cell is 62.74165202108963
% of Malignant cell is 37.25834797891037
```

In [19]: df.diagnosis.value_counts().plot(kind='pie',shadow=True,colors=('darkgreen','orange'),autopct='%.2f',figsize=(8,6))
plt.title('Diagnosis')
plt.show()

Diagnosis B Q 74

Pairplot helps to plot among the most useful feature

Out[20]: <seaborn.axisgrid.PairGrid at 0x276b14608b0>

<Figure size 720x720 with 0 Axes>



```
In [23]: import numpy as np
```

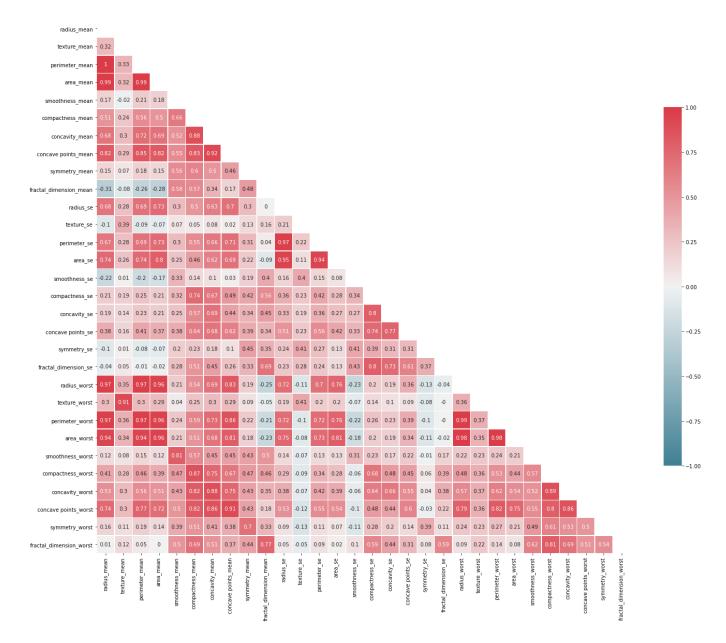
radius mean :	1	0.32	1	0.99	0.17	0.51	0.68	0.82	0.15	-0.31	0.68	-0.1	0.67	0.74	-0.22	0.21	0.19	0.38	-0.1	-0.04	0.97	0.3	0.97	0.94	0.12	0.41	0.53	0.74	0.16	0.01
texture_mean ·	0.32	1	0.33	0.32	-0.02	0.24	0.3	0.29	0.07	-0.08	0.28	0.39	0.28	0.26	0.01	0.19	0.14	0.16	0.01	0.05	0.35	0.91	0.36	0.34	0.08	0.28	0.3	0.3	0.11	0.12
perimeter mean	1	0.33	1	0.99	0.21	0.56	0.72	0.85	0.18	-0.26	0.69	-0.09	0.69	0.74	-0.2	0.25	0.23	0.41	-0.08	-0.01	0.97	0.3	0.97	0.94	0.15	0.46	0.56	0.77	0.19	0.05
area_mean -	0.99	0.32	0.99	1	0.18		0.69	0.82	0.15	-0.28	0.73	-0.07	0.73	0.8	-0.17	0.21	0.21	0.37	-0.07	-0.02	0.96	0.29	0.96	0.96	0.12	0.39		0.72	0.14	0
smoothness_mean	- 0.17	-0.02	0.21	0.18	1		0.52	0.55	0.56	0.58	0.3	0.07	0.3	0.25	0.33	0.32	0.25	0.38	0.2	0.28	0.21	0.04	0.24	0.21	0.81	0.47	0.43	0.5	0.39	0.5
compactness_mean ·	0.51	0.24	0.56	0.5	0.66	1	0.88	0.83	0.6	0.57	0.5	0.05	0.55	0.46	0.14	0.74	0.57	0.64	0.23	0.51	0.54	0.25	0.59	0.51	0.57	0.87	0.82	0.82	0.51	0.69
concavity mean	0.68	0.3	0.72	0.69	0.52		1	0.92	0.5	0.34	0.63	0.08	0.66	0.62	0.1	0.67	0.69	0.68	0.18	0.45	0.69	0.3	0.73	0.68	0.45	0.75	0.88	0.86	0.41	0.51
concave points_mean	0.82	0.29	0.85	0.82	0.55	0.83	0.92	1	0.46	0.17	0.7	0.02	0.71	0.69	0.03	0.49	0.44	0.62	0.1	0.26	0.83	0.29	0.86	0.81	0.45	0.67	0.75	0.91	0.38	0.37
symmetry_mean	0.15	0.07	0.18	0.15	0.56	0.6	0.5	0.46	1	0.48	0.3	0.13	0.31	0.22	0.19	0.42	0.34	0.39	0.45	0.33	0.19	0.09	0.22	0.18	0.43	0.47	0.43	0.43	0.7	0.44
fractal_dimension_mean	-0.31	-0.08	-0.26	-0.28	0.58		0.34	0.17	0.48	1	0	0.16	0.04	-0.09	0.4	0.56	0.45	0.34	0.35	0.69	-0.25	-0.05	-0.21	-0.23	0.5	0.46	0.35	0.18	0.33	0.77
radius_se	0.68	0.28	0.69	0.73	0.3		0.63	0.7	0.3	0	1	0.21	0.97	0.95	0.16	0.36	0.33	0.51	0.24	0.23	0.72	0.19	0.72	0.75	0.14	0.29	0.38	0.53	0.09	0.05
texture_se ·	-0.1	0.39	-0.09	-0.07	0.07	0.05	0.08	0.02	0.13	0.16	0.21	1	0.22	0.11	0.4	0.23	0.19	0.23	0.41	0.28	-0.11	0.41	-0.1	-0.08	-0.07	-0.09	-0.07	-0.12	-0.13	-0.05
perimeter_se	0.67	0.28	0.69	0.73	0.3	0.55	0.66	0.71	0.31	0.04	0.97	0.22	1	0.94	0.15	0.42	0.36	0.56	0.27	0.24	0.7	0.2	0.72	0.73	0.13	0.34	0.42	0.55	0.11	0.09
area_se	0.74	0.26	0.74	0.8	0.25	0.46	0.62	0.69	0.22	-0.09	0.95	0.11	0.94	1	0.08	0.28	0.27	0.42	0.13	0.13	0.76	0.2	0.76	0.81	0.13	0.28	0.39	0.54	0.07	0.02
smoothness_se	-0.22	0.01	-0.2	-0.17	0.33	0.14	0.1	0.03	0.19	0.4	0.16	0.4	0.15	0.08	1	0.34	0.27	0.33	0.41	0.43	-0.23	-0.07	-0.22	-0.18	0.31	-0.06	-0.06	-0.1	-0.11	0.1
compactness_se	0.21	0.19	0.25	0.21	0.32	0.74	0.67	0.49	0.42	0.56	0.36	0.23	0.42	0.28	0.34	1	0.8	0.74	0.39	0.8	0.2	0.14	0.26	0.2	0.23	0.68	0.64	0.48	0.28	0.59
concavity_se	0.19	0.14	0.23	0.21	0.25		0.69	0.44	0.34	0.45	0.33	0.19	0.36	0.27	0.27	0.8	1	0.77	0.31	0.73	0.19	0.1	0.23	0.19	0.17	0.48	0.66	0.44	0.2	0.44
concave points_se	0.38	0.16	0.41	0.37	0.38	0.64	0.68	0.62	0.39	0.34	0.51	0.23	0.56	0.42	0.33	0.74	0.77	1	0.31	0.61	0.36	0.09	0.39	0.34	0.22	0.45	0.55	0.6	0.14	0.31
symmetry_se	0.1	0.01	-0.08	-0.07	0.2	0.23	0.18	0.1	0.45	0.35	0.24	0.41	0.27	0.13	0.41	0.39	0.31	0.31	1	0.37	-0.13	-0.08	-0.1	-0.11	-0.01	0.06	0.04	-0.03	0.39	0.08
fractal_dimension_se	0.04	0.05	-0.01	-0.02	0.28		0.45	0.26	0.33	0.69	0.23	0.28	0.24	0.13	0.43	0.8	0.73	0.61	0.37	1	-0.04	-0	-0	-0.02	0.17	0.39	0.38	0.22	0.11	0.59
radius_worst	0.97	0.35	0.97	0.96	0.21	0.54	0.69	0.83	0.19	-0.25	0.72	-0.11	0.7	0.76	-0.23	0.2	0.19	0.36	-0.13	-0.04	1	0.36	0.99	0.98	0.22	0.48	0.57	0.79	0.24	0.09
texture_worst	0.3	0.91	0.3	0.29	0.04	0.25	0.3	0.29	0.09	-0.05	0.19	0.41	0.2	0.2	-0.07	0.14	0.1	0.09	-0.08	-0	0.36	1	0.37	0.35	0.23	0.36	0.37	0.36	0.23	0.22
perimeter_worst	0.97	0.36	0.97	0.96	0.24		0.73	0.86	0.22	-0.21	0.72	-0.1	0.72	0.76	-0.22	0.26	0.23	0.39	-0.1	-0	0.99	0.37	1	0.98	0.24	0.53	0.62	0.82	0.27	0.14
area_worst	0.94	0.34	0.94	0.96	0.21		0.68	0.81	0.18	-0.23	0.75	-0.08	0.73	0.81	-0.18	0.2	0.19	0.34	-0.11	-0.02	0.98	0.35	0.98	1	0.21	0.44	0.54	0.75	0.21	0.08
smoothness_worst	0.12	0.08	0.15	0.12	0.81	0.57	0.45	0.45	0.43		0.14	-0.07	0.13	0.13	0.31	0.23	0.17	0.22	-0.01	0.17	0.22	0.23	0.24	0.21	1	0.57	0.52	0.55	0.49	0.62
compactness_worst	0.41	0.28	0.46	0.39	0.47	0.87	0.75	0.67	0.47	0.46	0.29	-0.09	0.34	0.28	-0.06	0.68	0.48	0.45	0.06	0.39	0.48	0.36	0.53	0.44	0.57	1	0.89	0.8	0.61	0.81
concavity_worst	0.53	0.3	0.56	0.51	0.43		0.88	0.75	0.43	0.35	0.38	-0.07	0.42	0.39	-0.06	0.64	0.66	0.55	0.04	0.38	0.57	0.37	0.62	0.54	0.52	0.89	1	0.86		0.69
concave points_worst	0.74	0.3	0.77	0.72	0.5	0.82	0.86	0.91	0.43	0.18	0.53	-0.12	0.55	0.54	-0.1	0.48	0.44	0.6	-0.03	0.22	0.79	0.36	0.82	0.75	0.55	0.8	0.86	1	0.5	0.51
symmetry_worst	0.16	0.11	0.19	0.14	0.39	0.51	0.41	0.38	0.7	0.33	0.09	-0.13	0.11	0.07	-0.11	0.28	0.2	0.14	0.39	0.11	0.24	0.23	0.27	0.21	0.49	0.61	0.53	0.5	1	0.54
fractal_dimension_worst	0.01	0.12	0.05	0	0.5	0.69	0.51	0.37	0.44	0.77	0.05	-0.05	0.09	0.02	0.1	0.59	0.44	0.31	0.08	0.59	0.09	0.22	0.14	0.08	0.62	0.81	0.69	0.51	0.54	1
	radius_mean	texture_mean	perimeter_mean	area_mean	smoothness_mean	compactness_mean	concavity_mean	concave points_mean	symmetry_mean	fractal dimension mean	radius_se	texture_se	perimeter_se	area_se	smoothness_se	compactness_se	concavity_se	concave points_se	symmetry_se	fractal dimension se	radius_worst	texture_worst	perimeter_worst	area_worst	smoothness_worst	compactness_worst	concavity_worst	concave points_worst	symmetry_worst	fractal_dimension_worst

1.00

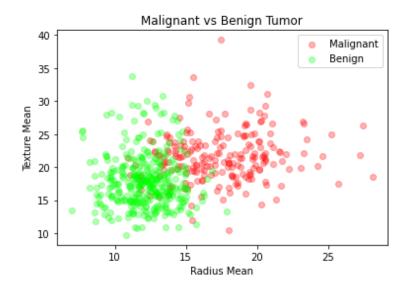
- 0.50

--0.25 --0.50

- -0.75



```
In [26]: M = df[df.diagnosis == "M"]
              M.head()
Out[26]:
                                                                                                                                                                       concave points_mean
                   diagnosis radius_mean texture_mean perimeter_mean area_mean smoothness_mean compactness_mean concavity_mean
                                                          10.38
                                                                             122.80
                                                                                           1001.0
                                                                                                                 0.11840
                                                                                                                                        0.27760
                                                                                                                                                              0.3001
                                                                                                                                                                             0.14710
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               2
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               3
                            М
                                         11.42
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                                                                                            386.1
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                                                                                                                                                              0.2414
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               4
                            М
                                        20.29
                                                          14.34
                                                                             135.10
                                                                                           1297.0
                                                                                                                0.10030
                                                                                                                                        0.13280
                                                                                                                                                              0.1980
                                                                                                                                                                             0.10430
                                                                                                                                                                                                   0.1809
              5 rows × 31 columns
In [27]: B = df[df.diagnosis == "B"]
Out[27]:
                                                                                                                                                                        concave 
points_mean
                    diagnosis radius_mean texture_mean perimeter_mean area_mean smoothness_mean compactness_mean concavity_mean
                                                                                                                                                                                         symmetry mea
              19
                                                                                                                                                                                                    0.188
                                        13.540
                                                           14.38
                                                                              87.46
                                                                                             566.3
                                                                                                                 0.09779
                                                                                                                                         0.08129
                                                                                                                                                              0.06664
                                                                                                                                                                             0.047810
               20
                                                           15.71
                                                                                                                                                                                                    0.196
                                         13.080
                                                                               85.63
                                                                                             520.0
                                                                                                                  0.10750
                                                                                                                                         0.12700
                                                                                                                                                              0.04568
                                                                                                                                                                              0.031100
               21
                                         9.504
                                                           12.44
                                                                               60.34
                                                                                             273.9
                                                                                                                 0.10240
                                                                                                                                         0.06492
                                                                                                                                                              0.02956
                                                                                                                                                                             0.020760
                                                                                                                                                                                                    0.18
               37
                                         13.030
                                                           18.42
                                                                               82.61
                                                                                             523.8
                                                                                                                 0.08983
                                                                                                                                          0.03766
                                                                                                                                                              0.02562
                                                                                                                                                                             0.029230
                                                                                                                                                                                                    0.146
                              В
                                                           16.84
                                                                                             201.9
                                                                                                                                          0.05943
                                                                                                                                                              0.01588
                                         8.196
                                                                               51.71
                                                                                                                  0.08800
                                                                                                                                                                             0.005917
                                                                                                                                                                                                    0.176
              5 rows × 31 columns
In [28]: plt.title("Malignant vs Benign Tumor")
plt.xlabel("Radius Mean")
plt.ylabel("Texture Mean")
plt.scatter(M.radius_mean, M.texture_mean, color = "red", label = "Malignant", alpha = 0.3)
plt.scatter(B.radius_mean, B.texture_mean, color = "lime", label = "Benign", alpha = 0.3)
plt.scatter(B.radius_mean, B.texture_mean, color = "lime", label = "Benign", alpha = 0.3)
              plt.legend()
```



plt.show()

ML ALGORITHM IMPLEMENTATION:

```
In [29]: feature_cols = ['radius_mean', 'texture_mean', 'perimeter_mean', 'area_mean', 'smoothness_mean', 'compactness_mean', 'concavity_mean'
In [30]: x = df[feature_cols]
            = df.diagnosis.values
In [31]: x.head()
Out[31]:
              radius_mean texture_mean perimeter_mean area_mean smoothness_mean compactness_mean concavity_mean concavity_mean symmetry_mean fractal_di
           0
                    17.99
                                  10.38
                                                122.80
                                                           1001.0
                                                                            0.11840
                                                                                              0.27760
                                                                                                               0.3001
                                                                                                                          0.14710
                                                                                                                                           0.2419
                     20.57
                                                132.90
                                                                            0.08474
                                                                                              0.07864
                                                                                                               0.0869
                                                                                                                          0.07017
                                                                                                                                           0.1812
           2
                    19.69
                                 21.25
                                                130.00
                                                           1203.0
                                                                           0.10960
                                                                                              0.15990
                                                                                                              0.1974
                                                                                                                          0.12790
                                                                                                                                           0.2069
                                                 77.58
                     11.42
                                 20.38
                                                            386.1
                                                                            0.14250
                                                                                              0.28390
                                                                                                                                           0.2597
                                                                                                               0.2414
                                                                                                                          0.10520
                    20.29
                                 14.34
                                                135.10
                                                           1297.0
                                                                           0.10030
                                                                                              0.13280
                                                                                                              0.1980
                                                                                                                          0.10430
                                                                                                                                           0.1809
```

```
In [32]: # Normalization:
          x = (x - np.min(x)) / (np.max(x) - np.min(x))
Out[32]:
               radius_mean texture_mean perimeter_mean area_mean smoothness_mean compactness_mean concavity_mean concave points_mean
                                                                                                                             symmetry_mean fractal_
           0
                  0.521037
                              0.022658
                                            0.545989 0.363733
                                                                         0.593753
                                                                                          0.792037
                                                                                                         0.703140
                                                                                                                     0.731113
                                                                                                                                    0.686364
            1
                  0.643144
                               0.272574
                                             0.615783
                                                       0.501591
                                                                         0.289880
                                                                                          0.181768
                                                                                                         0.203808
                                                                                                                     0.348757
                                                                                                                                    0.379798
          2
               0.601496 0.390260
                                           0.595743 0.449417
                                                                         0.514309
                                                                                          0.431017
                                                                                                         0.482512
                                                                                                                     0.635686
                                                                                                                                    0.509596
                  0.210090
                               0.360839
                                             0.233501 0.102906
                                                                         0.811321
                                                                                          0.811361
                                                                                                         0.565604
                                                                                                                     0.522863
                                                                                                                                    0.776263
          4 0.829893 0.158578 0.830986 0.489290
                                                                         0.430351
                                                                                                         0.463918
                                                                                                                     0.518390
          564 0.690000 0.428813
                                         0.678668 0.566490
                                                                         0.526948
                                                                                          0.298055
                                                                                                         0.571482
                                                                                                                   0.690358
                                                                                                                                    0.338384
           565
                  0.622320
                               0.626987
                                             0.604036
                                                       0.474019
                                                                         0.407782
                                                                                          0.257714
                                                                                                         0.337395
                                                                                                                     0.488830
                                                                                                                                    0.349495
           566
                  0.455251 0.621238
                                                      0.303118
                                                                         0.288165
                                             0.445788
                                                                                          0.254340
                                                                                                         0.216753
                                                                                                                     0.263519
                                                                                                                                    0.267677
                               0.663510
                                              0.665538
                                                        0.475716
                                                                         0.588336
                                                                                          0.790197
                                                                                                         0.823336
                                                                                                                     0.755467
                                                                                                                                    0.675253
           568
                 0.036869 0.501522
                                             0.028540
                                                       0.015907
                                                                         0.000000
                                                                                          0.074351
                                                                                                         0.000000
                                                                                                                     0.000000
                                                                                                                                    0.266162
          569 rows × 10 columns
         4
```

```
In [30]: ## Splitting the Dataset
    from sklearn.model_selection import train_test_split

In [31]: x_train, x_test, y_train, y_test = train_test_split(x, y, test_size = 0.3)

In [32]: x_train.shape, x_test.shape, y_train.shape, y_test.shape
Out[32]: ((398, 30), (171, 30), (398,), (171,))
```

```
In [39]: ## Applying the Naive Bayes
          from sklearn.naive_bayes import GaussianNB
nb = GaussianNB()
          nb.fit(x_train, y_train)
          print("Naive Bayes score: ",nb.score(x_test, y_test))
          Naive Bayes score: 0.9239766081871345
In [40]: from sklearn.model_selection import train_test_split
           from sklearn.metrics import classification_report, confusion_matrix
          from sklearn.tree import plot_tree
y_pred = nb.predict(x_test)
cm=confusion_matrix(y_test,y_pred)
Out[40]: array([[103, 5], [ 8, 55]], dtype=int64)
In [41]: import matplotlib.pyplot as plt
          import materials.pypic as pit
import seaborn as sns
pd.set_option('display.float_format', lambda x: '%.3f' % x)
In [42]: plt.figure(figsize=(5,5))
Out[42]: <Figure size 360x360 with 0 Axes>
          <Figure size 360x360 with 0 Axes>
In [45]: sns.heatmap(data=cm,linewidths=1.0, annot=True,square = True, cmap = 'Blues', fmt='g')
               plt.ylabel('Actual label')
plt.xlabel('Predicted label')
 Out[45]: Text(0.5, 15.0, 'Predicted label')
                                                                         100
                                                                         80
                                                       5
                   0
                Actual label
                                                                        - 60
                                                                        - 40
                                 8
                                                                        - 20
                                      Predicted label
```

FINAL RESULT: