Machine Learning Experiment 2

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CSE-1

AIM:

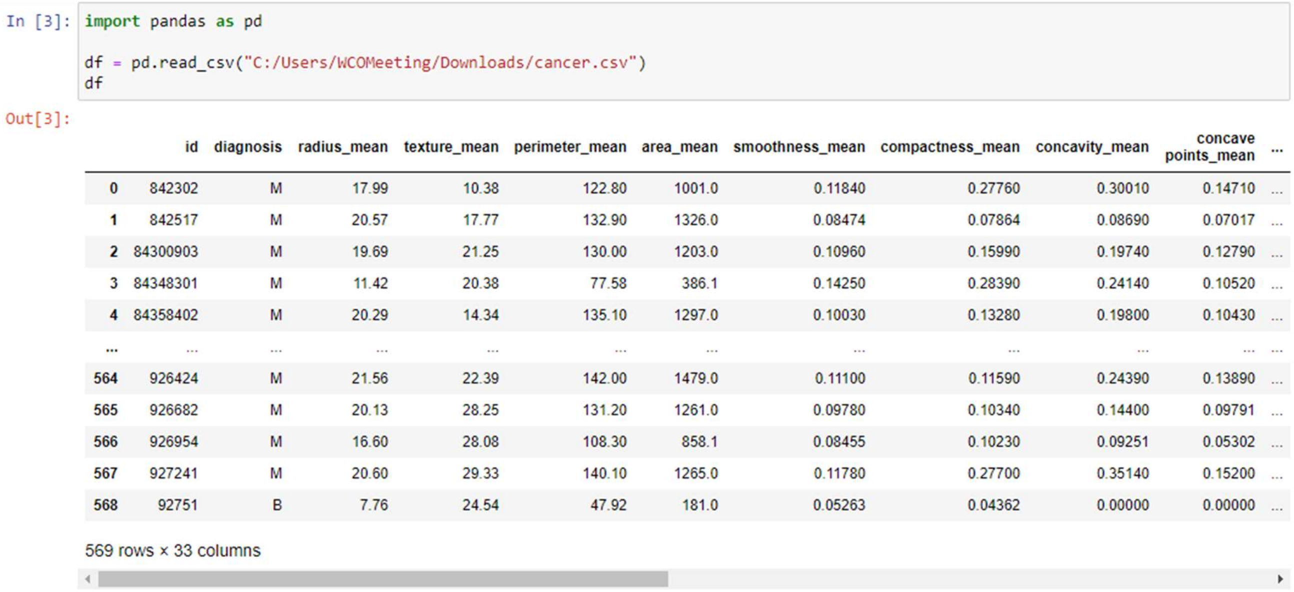
Study and implement the Decision tree using Python Sklearn on Breast Cancer dataset.

ALGORITHM:

1. Select the best attribute using Attribute Selection Measures (ASM) to split the records.
2. Make that attribute a decision node and breaks the dataset into smaller subsets.
3. Starts tree building by repeating this process recursively for each child until one of the conditions will match:
    a. All the tuples belong to the same attribute value.
    b. There are no more remaining attributes.
    c. There are no more instances.

PROGRAM CODE SNIPPET:

LOADING DATA SET:



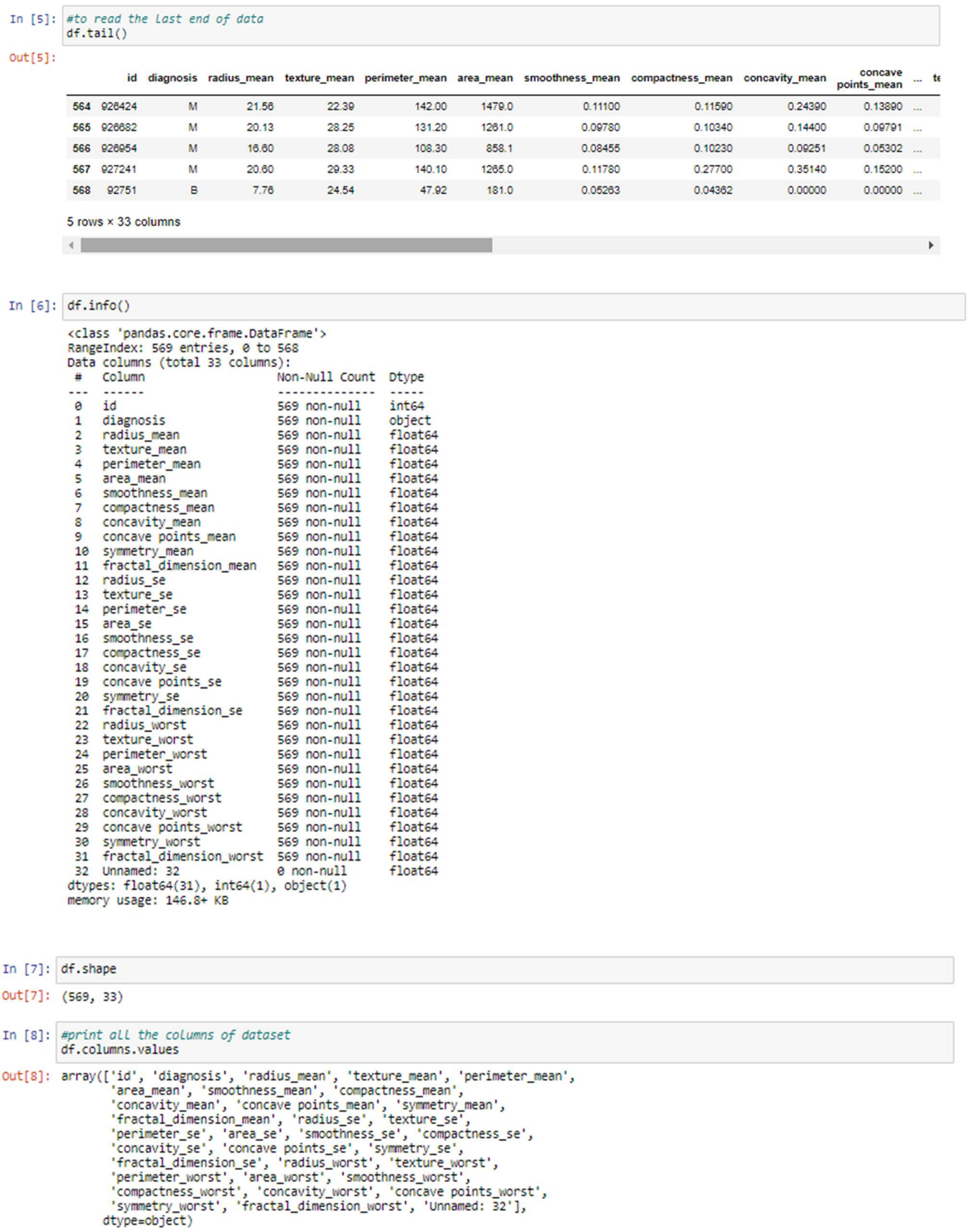
```
In [3]: import pandas as pd

        df = pd.read_csv("C:/Users/WCOMeeting/Downloads/cancer.csv")
        df
```

Out[3]:

	id	diagnosis	radius_mean	texture_mean	perimeter_mean	area_mean	smoothness_mean	compactness_mean	concavity_mean	concave points_mean	...
0	842302	M	17.99	10.38	122.80	1001.0	0.11840	0.27760	0.30010	0.14710	...
1	842517	M	20.57	17.77	132.90	1326.0	0.08474	0.07864	0.08690	0.07017	...
2	84300903	M	19.69	21.25	130.00	1203.0	0.10960	0.15990	0.19740	0.12790	...
3	84348301	M	11.42	20.38	77.58	386.1	0.14250	0.28390	0.24140	0.10520	...
4	84358402	M	20.29	14.34	135.10	1297.0	0.10030	0.13280	0.19800	0.10430	...
...	...	...	...	...	...	...	...	...	...	...	...
564	926424	M	21.56	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	B	7.76	24.54	47.92	181.0	0.05263	0.04362	0.00000	0.00000	...

569 rows × 33 columns

PREPROCESSING:



In [5]:
```
#to read the last end of data
df.tail()
```

Out[5]:

	id	diagnosis	radius_mean	texture_mean	perimeter_mean	area_mean	smoothness_mean	compactness_mean	concavity_mean	concave points_mean	...	te
564	926424	M	21.56	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	B	7.76	24.54	47.92	181.0	0.05263	0.04362	0.00000	0.00000	...	

5 rows × 33 columns

In [6]:
```
df.info()
```

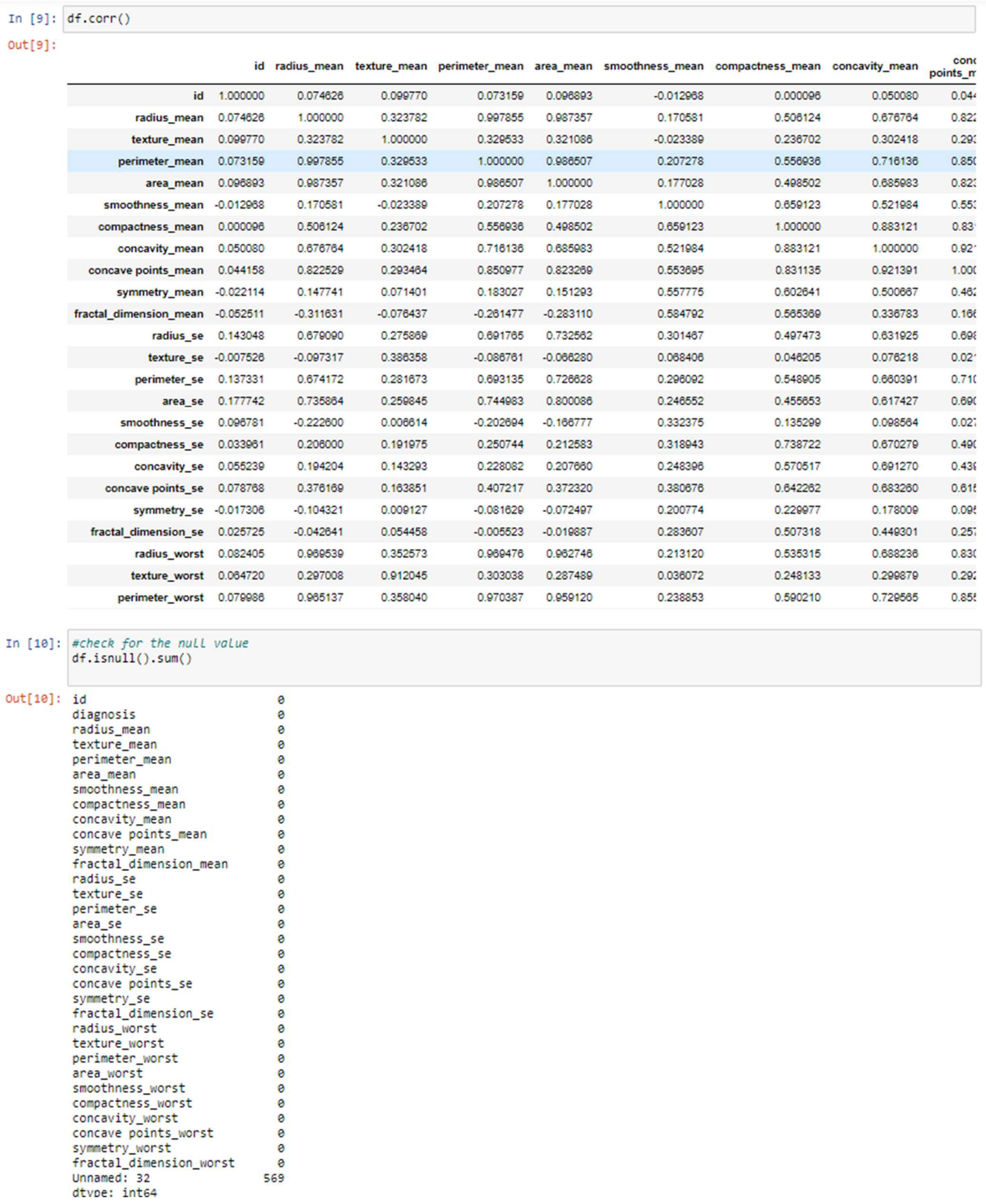
```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 569 entries, 0 to 568
Data columns (total 33 columns):
 #   Column                   Non-Null Count  Dtype  
---  ------                   --------------  -----  
 0   id                       569 non-null    int64  
 1   diagnosis                569 non-null    object 
 2   radius_mean              569 non-null    float64
 3   texture_mean             569 non-null    float64
 4   perimeter_mean           569 non-null    float64
 5   area_mean                569 non-null    float64
 6   smoothness_mean          569 non-null    float64
 7   compactness_mean         569 non-null    float64
 8   concavity_mean           569 non-null    float64
 9   concave points_mean      569 non-null    float64
 10  symmetry_mean            569 non-null    float64
 11  fractal_dimension_mean   569 non-null    float64
 12  radius_se                569 non-null    float64
 13  texture_se               569 non-null    float64
 14  perimeter_se             569 non-null    float64
 15  area_se                  569 non-null    float64
 16  smoothness_se            569 non-null    float64
 17  compactness_se           569 non-null    float64
 18  concavity_se             569 non-null    float64
 19  concave points_se        569 non-null    float64
 20  symmetry_se              569 non-null    float64
 21  fractal_dimension_se     569 non-null    float64
 22  radius_worst             569 non-null    float64
 23  texture_worst            569 non-null    float64
 24  perimeter_worst          569 non-null    float64
 25  area_worst               569 non-null    float64
 26  smoothness_worst         569 non-null    float64
 27  compactness_worst        569 non-null    float64
 28  concavity_worst          569 non-null    float64
 29  concave points_worst     569 non-null    float64
 30  symmetry_worst           569 non-null    float64
 31  fractal_dimension_worst  569 non-null    float64
 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)
```



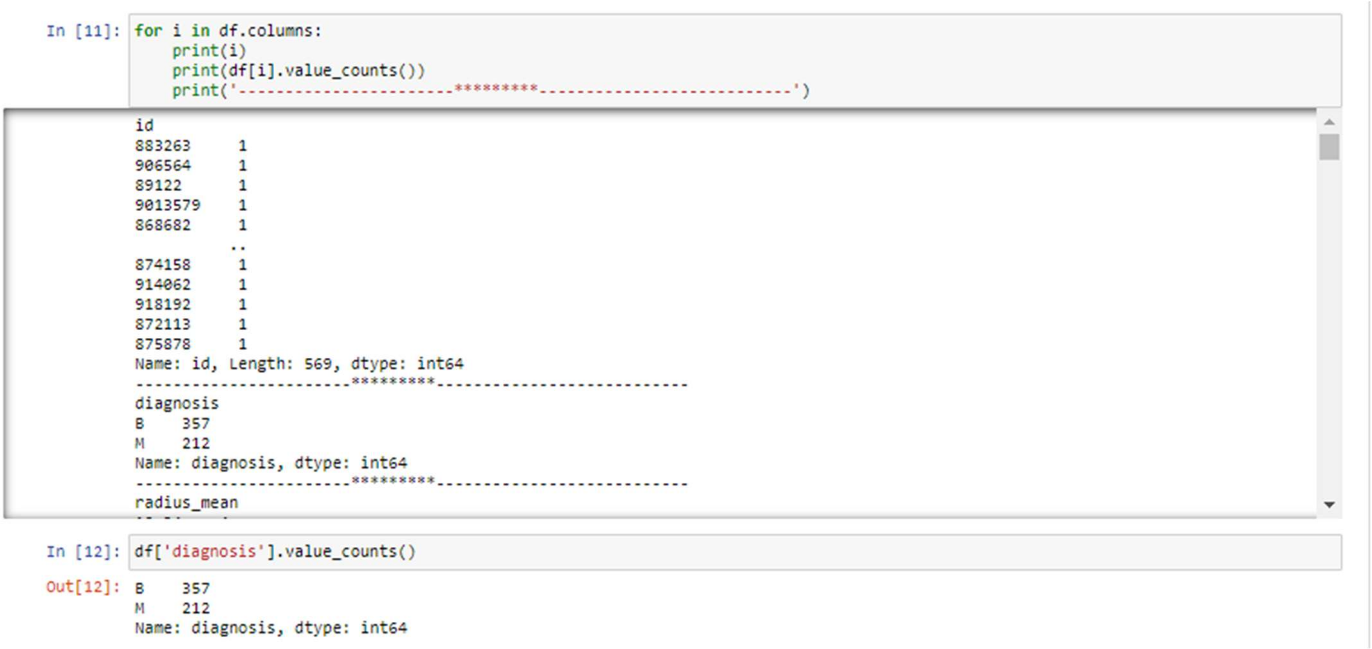
In [9]:
```
df.corr()
```

Out[9]:

	id	radius_mean	texture_mean	perimeter_mean	area_mean	smoothness_mean	compactness_mean	concavity_mean	conc 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	0.096893	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	0.553
compactness_mean	0.000096	0.506124	0.236702	0.556936	0.498502	0.659123	1.000000	0.883121	0.831
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	0.166
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	-0.086761	-0.066280	0.068406	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	0.096781	-0.222600	0.006614	-0.202694	-0.166777	0.332375	0.135299	0.098564	0.027
compactness_se	0.033961	0.206000	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	0.615
symmetry_se	-0.017306	-0.104321	0.009127	-0.081629	-0.072497	0.200774	0.229977	0.178009	0.095
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	0.855

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

Out[10]:
```
id                          0
diagnosis                   0
radius_mean                 0
texture_mean                0
perimeter_mean              0
area_mean                   0
smoothness_mean             0
compactness_mean            0
concavity_mean              0
concave points_mean         0
symmetry_mean               0
fractal_dimension_mean      0
radius_se                   0
texture_se                  0
perimeter_se                0
area_se                     0
smoothness_se               0
compactness_se              0
concavity_se                0
concave points_se           0
symmetry_se                 0
fractal_dimension_se        0
radius_worst                0
texture_worst               0
perimeter_worst             0
area_worst                  0
smoothness_worst            0
compactness_worst           0
concavity_worst             0
concave points_worst        0
symmetry_worst              0
fractal_dimension_worst     0
Unnamed: 32               569
dtype: int64
```

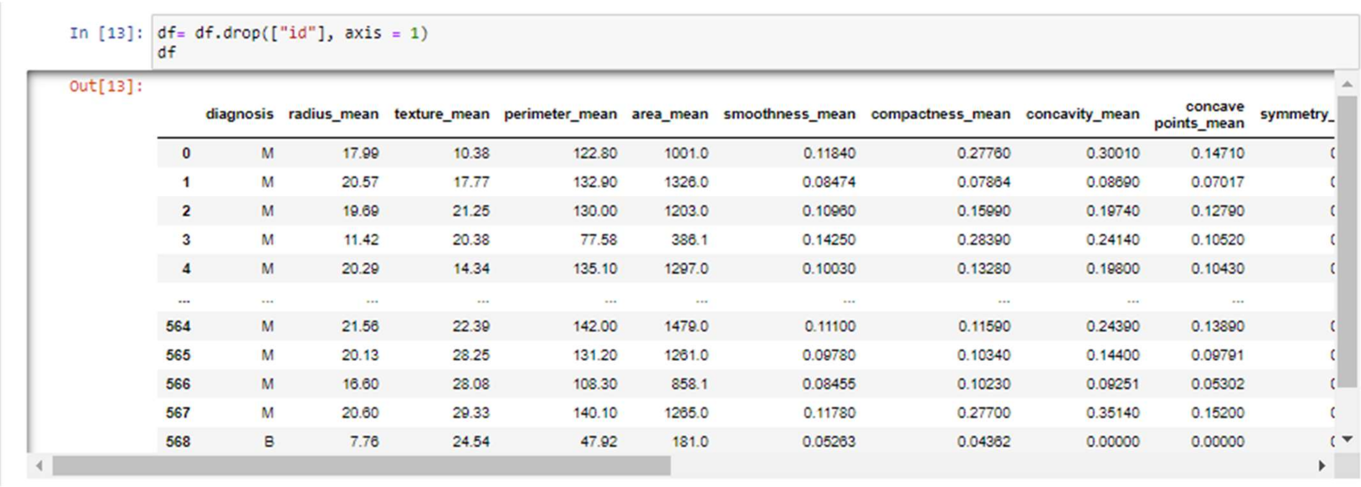


```
In [11]: for i in df.columns:
             print(i)
             print(df[i].value_counts())
             print('----------------------*********--------------------------')
```

```
id
883263     1
906564     1
89122      1
9013579    1
868682     1
          ..
874158     1
914062     1
918192     1
872113     1
875878     1
Name: id, Length: 569, dtype: int64
----------------------*********--------------------------
diagnosis
B    357
M    212
Name: diagnosis, dtype: int64
----------------------*********--------------------------
radius_mean
```

```
In [12]: df['diagnosis'].value_counts()
```

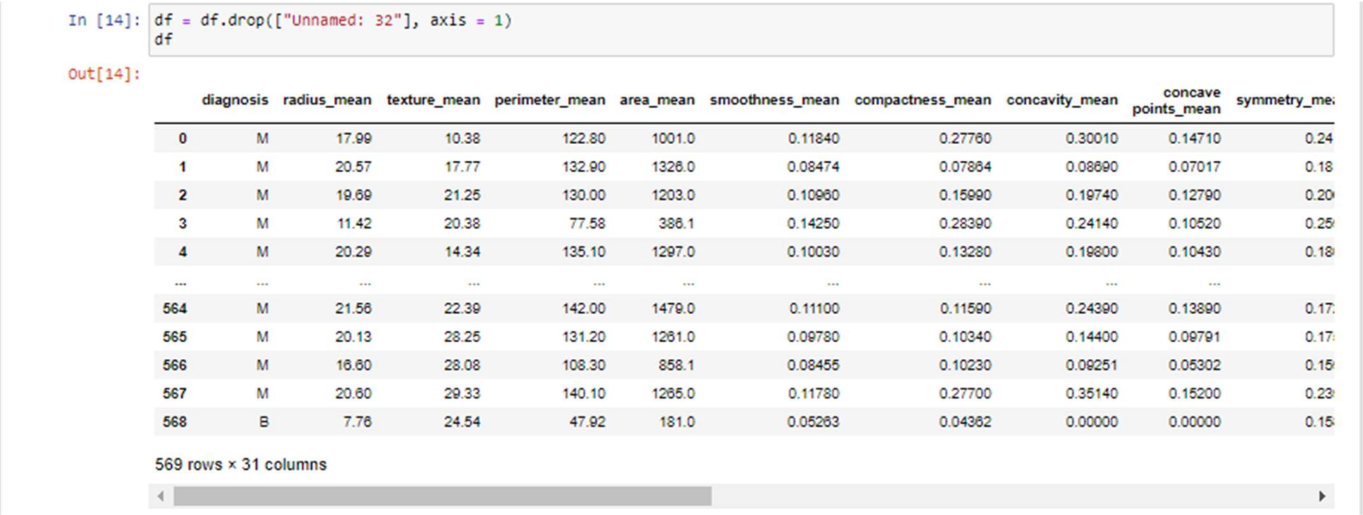
```
Out[12]: B    357
         M    212
         Name: diagnosis, dtype: int64
```



```
In [13]: df= df.drop(["id"], axis = 1)
         df
```

Out[13]:

	diagnosis	radius_mean	texture_mean	perimeter_mean	area_mean	smoothness_mean	compactness_mean	concavity_mean	concave points_mean	symmetry_
0	M	17.99	10.38	122.80	1001.0	0.11840	0.27760	0.30010	0.14710	(
1	M	20.57	17.77	132.90	1326.0	0.08474	0.07864	0.08690	0.07017	(
2	M	19.69	21.25	130.00	1203.0	0.10960	0.15990	0.19740	0.12790	(
3	M	11.42	20.38	77.58	386.1	0.14250	0.28390	0.24140	0.10520	(
4	M	20.29	14.34	135.10	1297.0	0.10030	0.13280	0.19800	0.10430	(
...	...	...	...	...	...	...	...	...	...	
564	M	21.56	22.39	142.00	1479.0	0.11100	0.11590	0.24390	0.13890	(
565	M	20.13	28.25	131.20	1261.0	0.09780	0.10340	0.14400	0.09791	(
566	M	16.60	28.08	108.30	858.1	0.08455	0.10230	0.09251	0.05302	(
567	M	20.60	29.33	140.10	1265.0	0.11780	0.27700	0.35140	0.15200	(
568	B	7.76	24.54	47.92	181.0	0.05263	0.04362	0.00000	0.00000	(



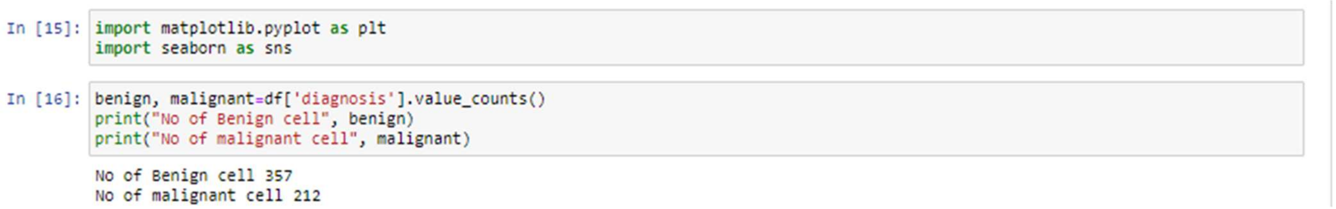
```
In [14]: df = df.drop(["Unnamed: 32"], axis = 1)
         df
```

Out[14]:

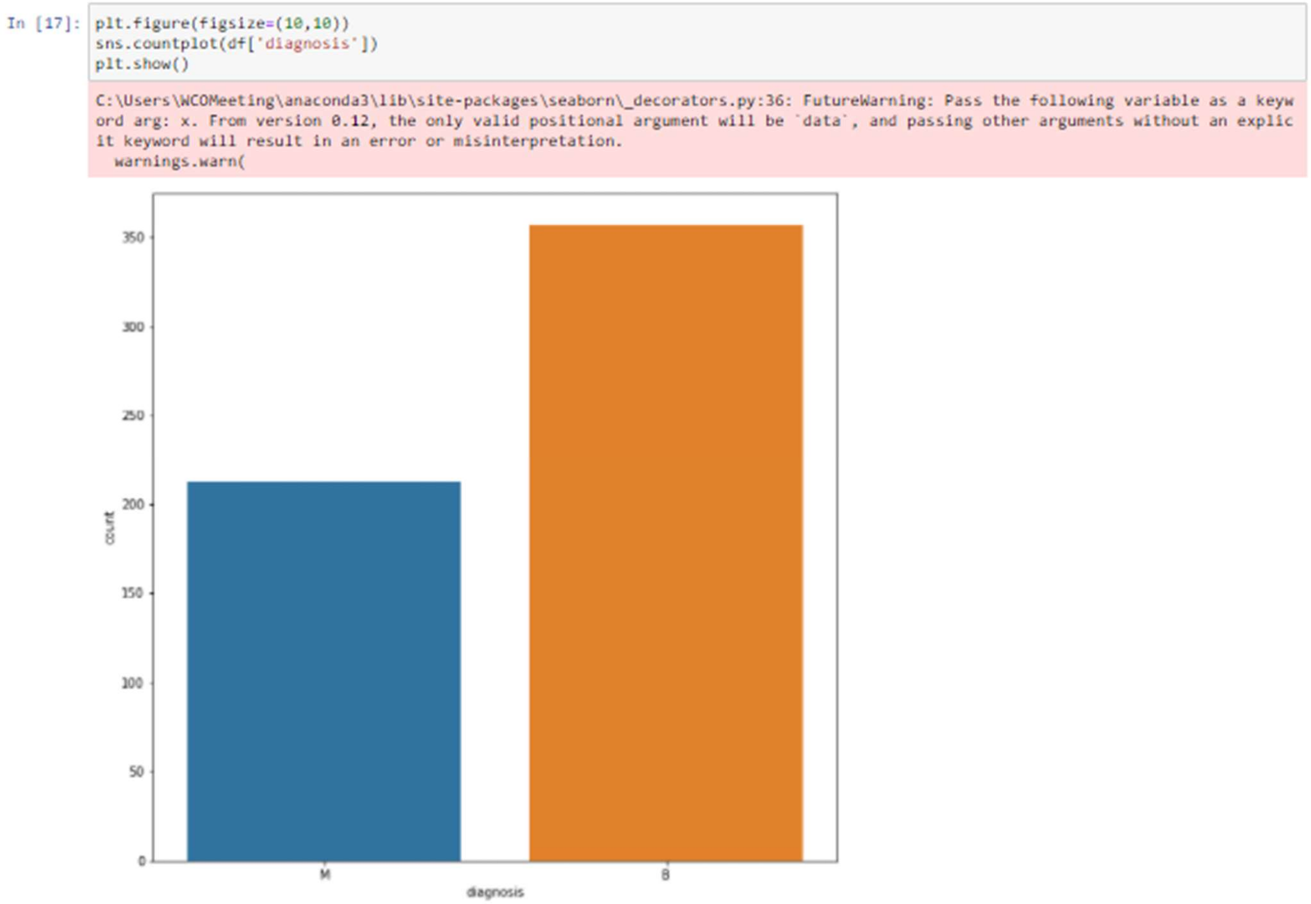
	diagnosis	radius_mean	texture_mean	perimeter_mean	area_mean	smoothness_mean	compactness_mean	concavity_mean	concave points_mean	symmetry_me
0	M	17.99	10.38	122.80	1001.0	0.11840	0.27760	0.30010	0.14710	0.24
1	M	20.57	17.77	132.90	1326.0	0.08474	0.07864	0.08690	0.07017	0.18
2	M	19.69	21.25	130.00	1203.0	0.10960	0.15990	0.19740	0.12790	0.20
3	M	11.42	20.38	77.58	386.1	0.14250	0.28390	0.24140	0.10520	0.25
4	M	20.29	14.34	135.10	1297.0	0.10030	0.13280	0.19800	0.10430	0.18
...	...	...	...	...	...	...	...	...	...	
564	M	21.56	22.39	142.00	1479.0	0.11100	0.11590	0.24390	0.13890	0.17
565	M	20.13	28.25	131.20	1261.0	0.09780	0.10340	0.14400	0.09791	0.17
566	M	16.60	28.08	108.30	858.1	0.08455	0.10230	0.09251	0.05302	0.15
567	M	20.60	29.33	140.10	1265.0	0.11780	0.27700	0.35140	0.15200	0.23
568	B	7.76	24.54	47.92	181.0	0.05263	0.04362	0.00000	0.00000	0.15

569 rows × 31 columns

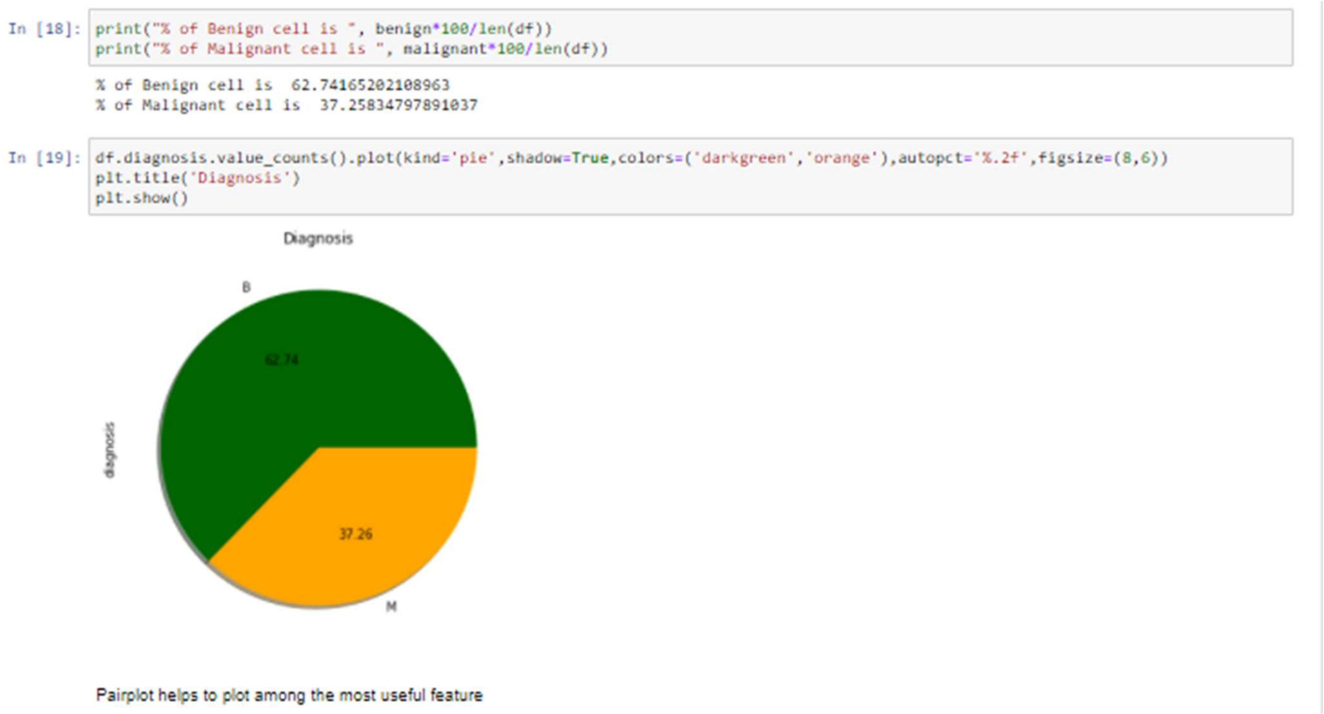
VISUALIZATION:



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

         C:\Users\WCOMeeting\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(
```

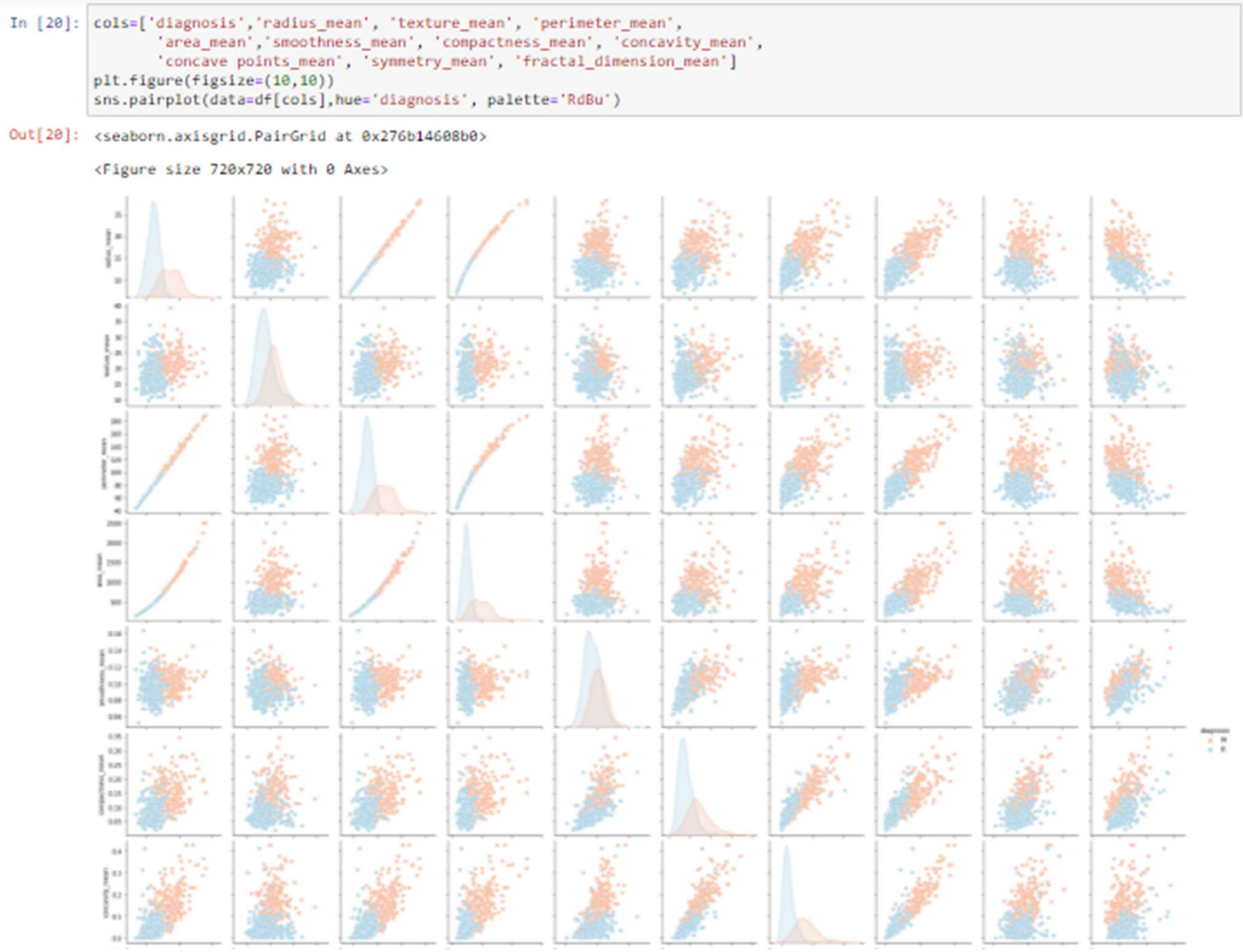


In [18]:
```
print("% of Benign cell is ", benign*100/len(df))
print("% of Malignant cell is ", malignant*100/len(df))
```

```
% 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()
```

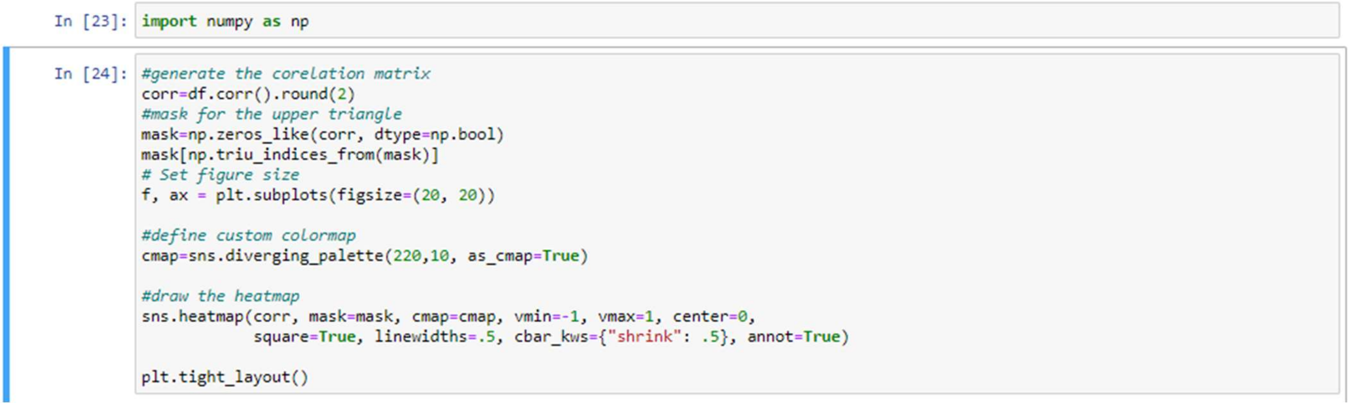
Pairplot helps to plot among the most useful feature



In [20]:
```
cols=['diagnosis','radius_mean', 'texture_mean', 'perimeter_mean',
       'area_mean','smoothness_mean', 'compactness_mean', 'concavity_mean',
       'concave points_mean', 'symmetry_mean', 'fractal_dimension_mean']
plt.figure(figsize=(10,10))
sns.pairplot(data=df[cols],hue='diagnosis', palette='RdBu')
```

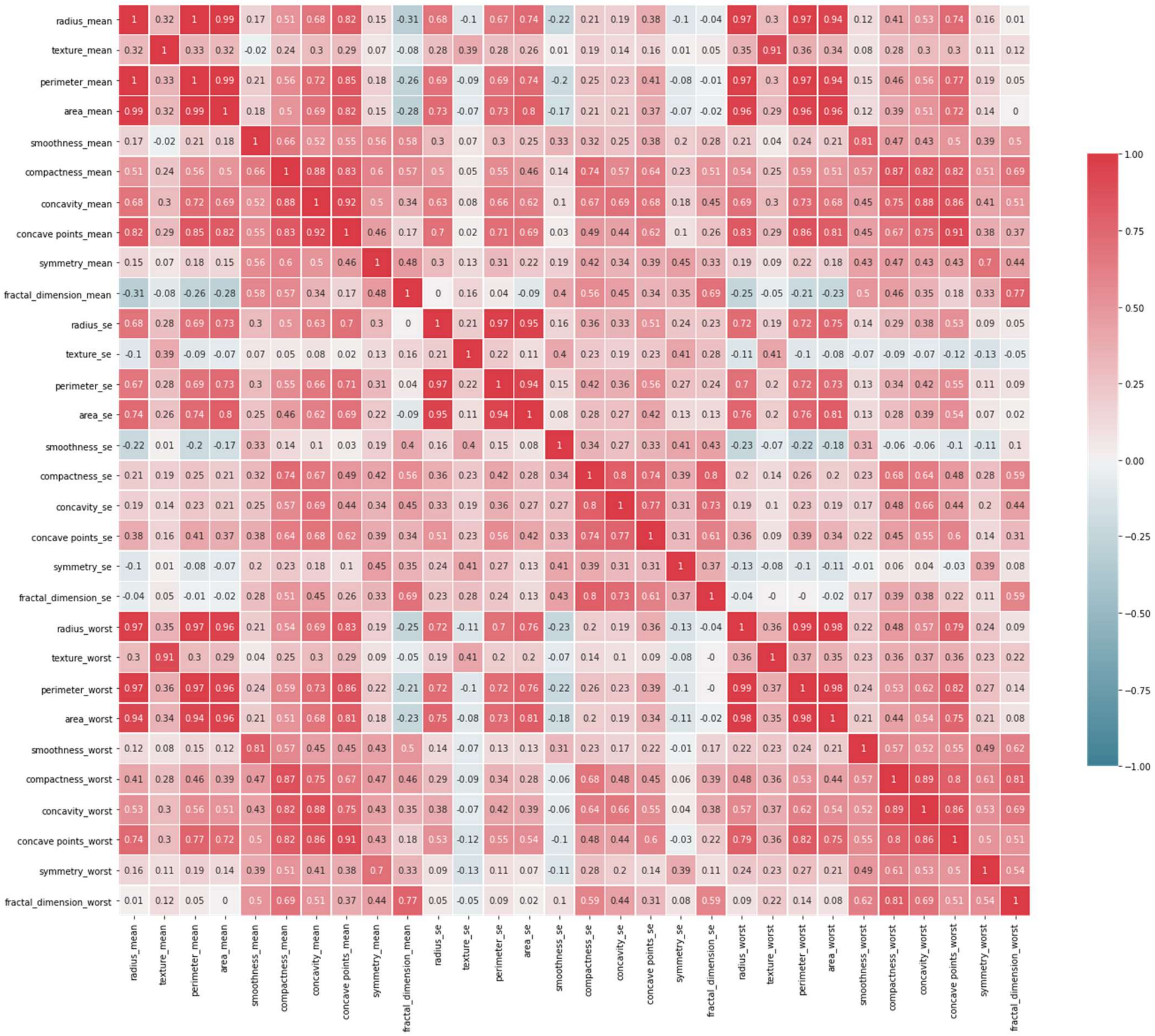
Out[20]:
```
<seaborn.axisgrid.PairGrid at 0x276b14608b0>
```

```
<Figure size 720x720 with 0 Axes>
```

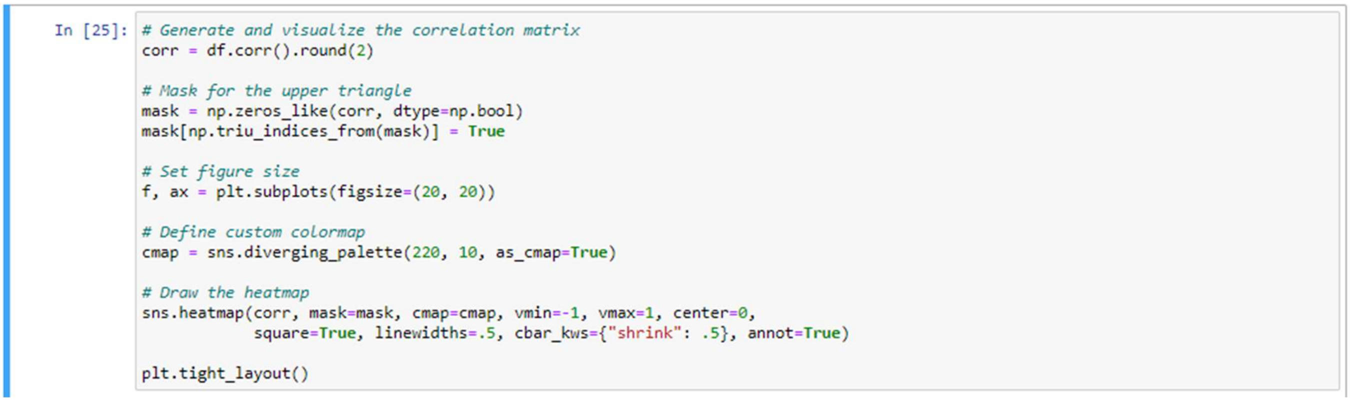


```
In [23]: import numpy as np
```

```
In [24]: #generate the corelation matrix
         corr=df.corr().round(2)
         #mask for the upper triangle
         mask=np.zeros_like(corr, dtype=np.bool)
         mask[np.triu_indices_from(mask)]
         # Set figure size
         f, ax = plt.subplots(figsize=(20, 20))

         #define custom colormap
         cmap=sns.diverging_palette(220,10, as_cmap=True)

         #draw the heatmap
         sns.heatmap(corr, mask=mask, cmap=cmap, vmin=-1, vmax=1, center=0,
                     square=True, linewidths=.5, cbar_kws={"shrink": .5}, annot=True)

         plt.tight_layout()
```

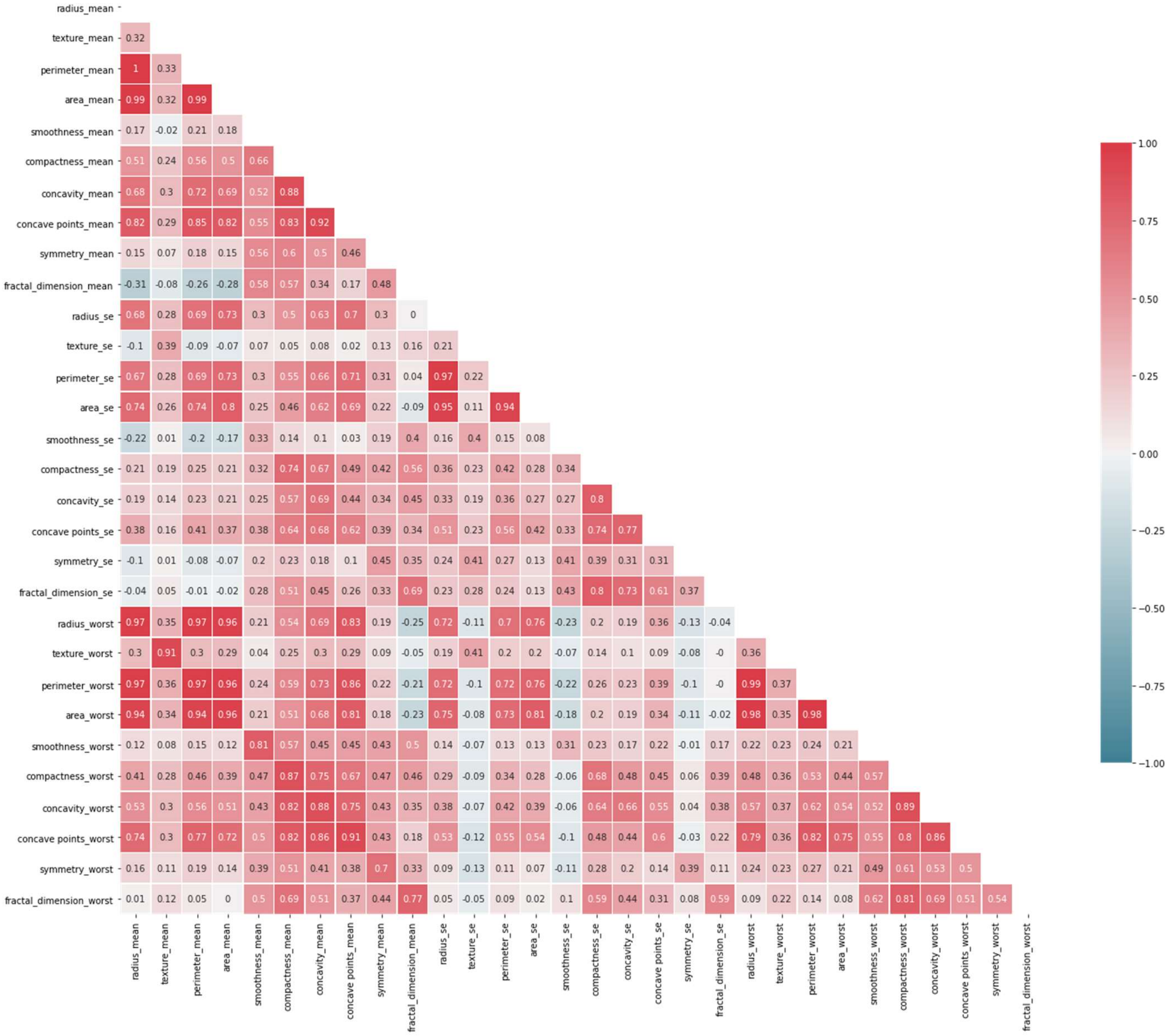


	radius_mean	texture_mean	perimeter_mean	area_mean	smoothness_mean	compactness_mean	concavity_mean	concave points_mean	symmetry_mean	fractal_dimension_mean	radius_se	texture_se	perimeter_se	area_se	smoothness_se	compactness_se	concavity_se	concave points_se	symmetry_se	fractal_dimension_se	radius_worst	texture_worst	perimeter_worst	area_worst	smoothness_worst	compactness_worst	concavity_worst	concave points_worst	symmetry_worst	fractal_dimension_worst
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	0.5	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	0.51	0.72	0.14	0
smoothness_mean	0.17	-0.02	0.21	0.18	1	0.66	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	0.88	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	0.57	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	0.5	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	0.57	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	0.51	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	0.59	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	0.51	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	0.5	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	0.82	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	0.53	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

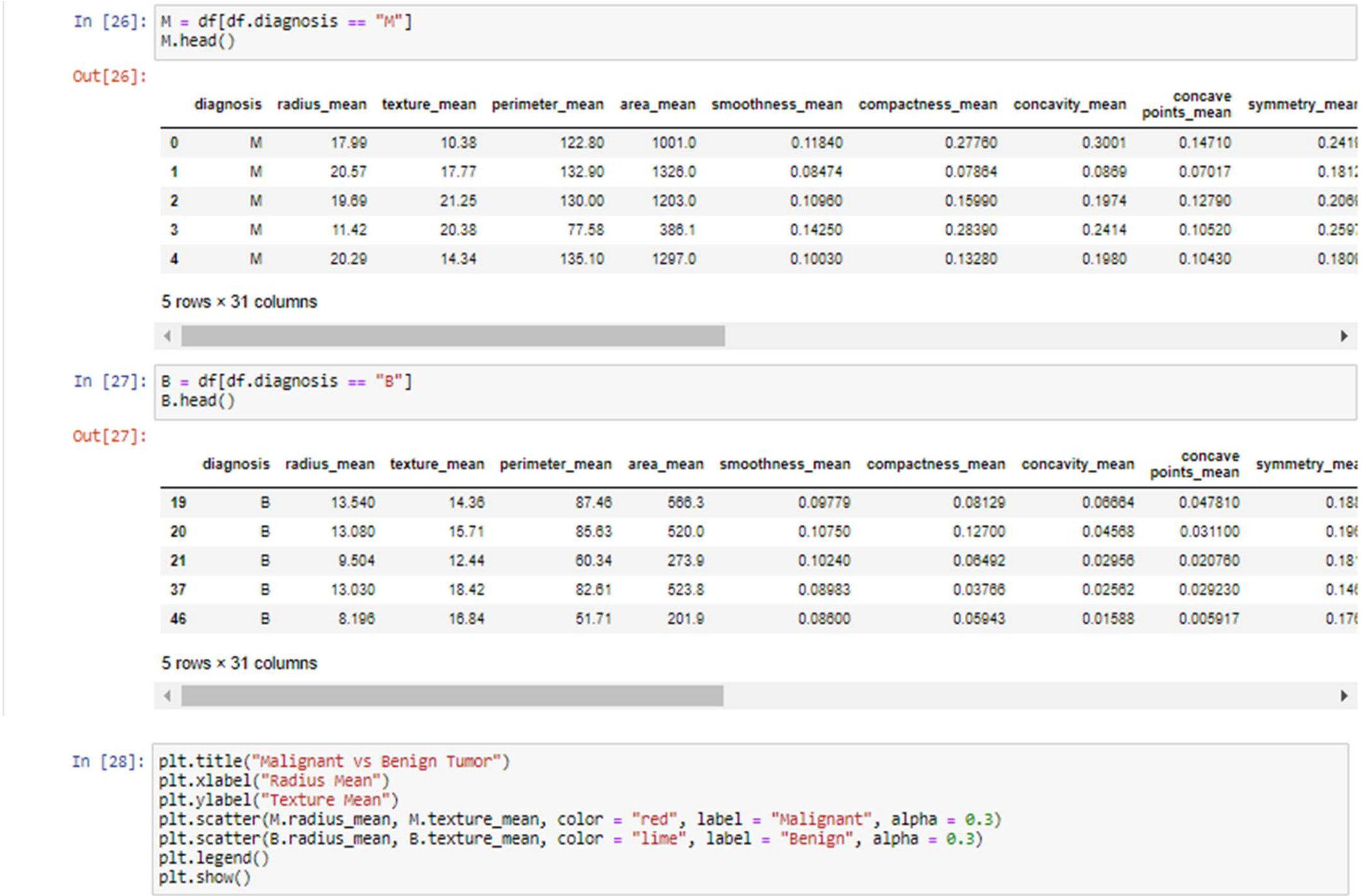


In [25]:

```
# Generate and visualize the correlation matrix
corr = df.corr().round(2)

# Mask for the upper triangle
mask = np.zeros_like(corr, dtype=np.bool)
mask[np.triu_indices_from(mask)] = True

# Set figure size
f, ax = plt.subplots(figsize=(20, 20))

# Define custom colormap
cmap = sns.diverging_palette(220, 10, as_cmap=True)

# Draw the heatmap
sns.heatmap(corr, mask=mask, cmap=cmap, vmin=-1, vmax=1, center=0,
            square=True, linewidths=.5, cbar_kws={"shrink": .5}, annot=True)

plt.tight_layout()
```



	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
radius_mean																														
texture_mean	0.32																													
perimeter_mean	1	0.33																												
area_mean	0.99	0.32	0.99																											
smoothness_mean	0.17	-0.02	0.21	0.18																										
compactness_mean	0.51	0.24	0.56	0.5	0.66																									
concavity_mean	0.68	0.3	0.72	0.69	0.52	0.88																								
concave points_mean	0.82	0.29	0.85	0.82	0.55	0.83	0.92																							
symmetry_mean	0.15	0.07	0.18	0.15	0.56	0.6	0.5	0.46																						
fractal_dimension_mean	-0.31	-0.08	-0.26	-0.28	0.58	0.57	0.34	0.17	0.48																					
radius_se	0.68	0.28	0.69	0.73	0.3	0.5	0.63	0.7	0.3	0																				
texture_se	-0.1	0.39	-0.09	-0.07	0.07	0.05	0.08	0.02	0.13	0.16	0.21																			
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																		
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																	
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																
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															
concavity_se	0.19	0.14	0.23	0.21	0.25	0.57	0.69	0.44	0.34	0.45	0.33	0.19	0.36	0.27	0.27	0.8														
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													
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												
fractal_dimension_se	-0.04	0.05	-0.01	-0.02	0.28	0.51	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											
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										
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									
perimeter_worst	0.97	0.36	0.97	0.96	0.24	0.59	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								
area_worst	0.94	0.34	0.94	0.96	0.21	0.51	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							
smoothness_worst	0.12	0.08	0.15	0.12	0.81	0.57	0.45	0.45	0.43	0.5	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						
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					
concavity_worst	0.53	0.3	0.56	0.51	0.43	0.82	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				
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			
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		
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	



```
In [26]: M = df[df.diagnosis == "M"]
         M.head()
```

Out[26]:

	diagnosis	radius_mean	texture_mean	perimeter_mean	area_mean	smoothness_mean	compactness_mean	concavity_mean	concave points_mean	symmetry_mear
0	M	17.99	10.38	122.80	1001.0	0.11840	0.27760	0.3001	0.14710	0.241
1	M	20.57	17.77	132.90	1326.0	0.08474	0.07864	0.0869	0.07017	0.181
2	M	19.69	21.25	130.00	1203.0	0.10960	0.15990	0.1974	0.12790	0.206
3	M	11.42	20.38	77.58	386.1	0.14250	0.28390	0.2414	0.10520	0.259
4	M	20.29	14.34	135.10	1297.0	0.10030	0.13280	0.1980	0.10430	0.180

5 rows × 31 columns

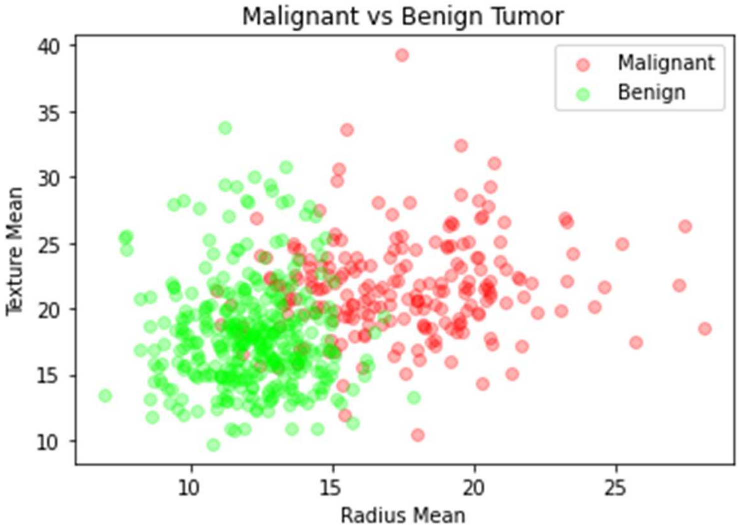
```
In [27]: B = df[df.diagnosis == "B"]
         B.head()
```

Out[27]:

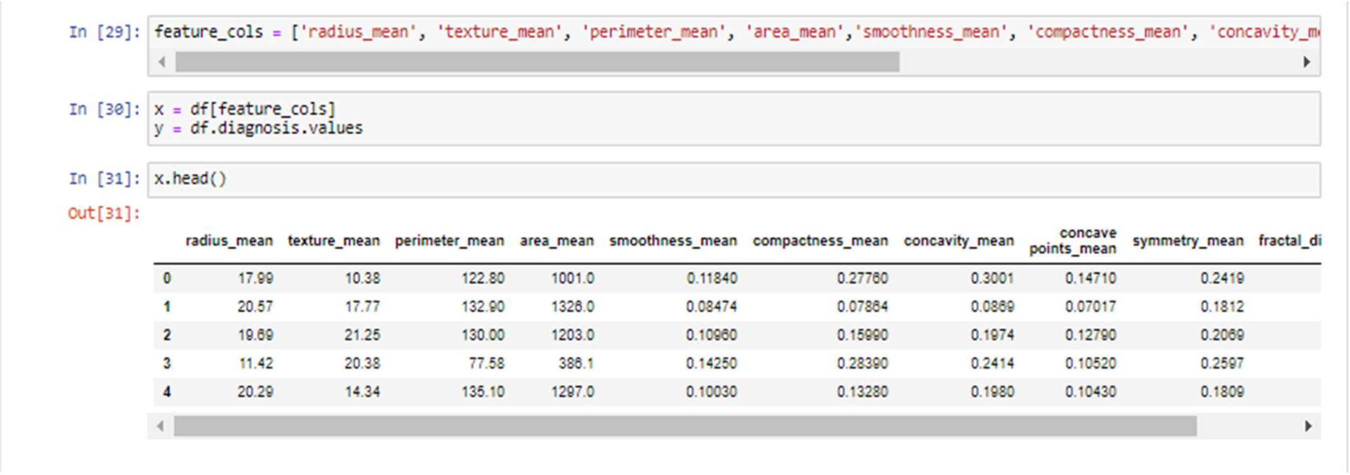
	diagnosis	radius_mean	texture_mean	perimeter_mean	area_mean	smoothness_mean	compactness_mean	concavity_mean	concave points_mean	symmetry_mea
19	B	13.540	14.36	87.46	566.3	0.09779	0.08129	0.06664	0.047810	0.18
20	B	13.080	15.71	85.63	520.0	0.10750	0.12700	0.04568	0.031100	0.19
21	B	9.504	12.44	60.34	273.9	0.10240	0.06492	0.02956	0.020760	0.18
37	B	13.030	18.42	82.61	523.8	0.08983	0.03766	0.02562	0.029230	0.14
46	B	8.196	16.84	51.71	201.9	0.08600	0.05943	0.01588	0.005917	0.17

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.legend()
         plt.show()
```



ML ALGORITHM IMPLEMENTATION:



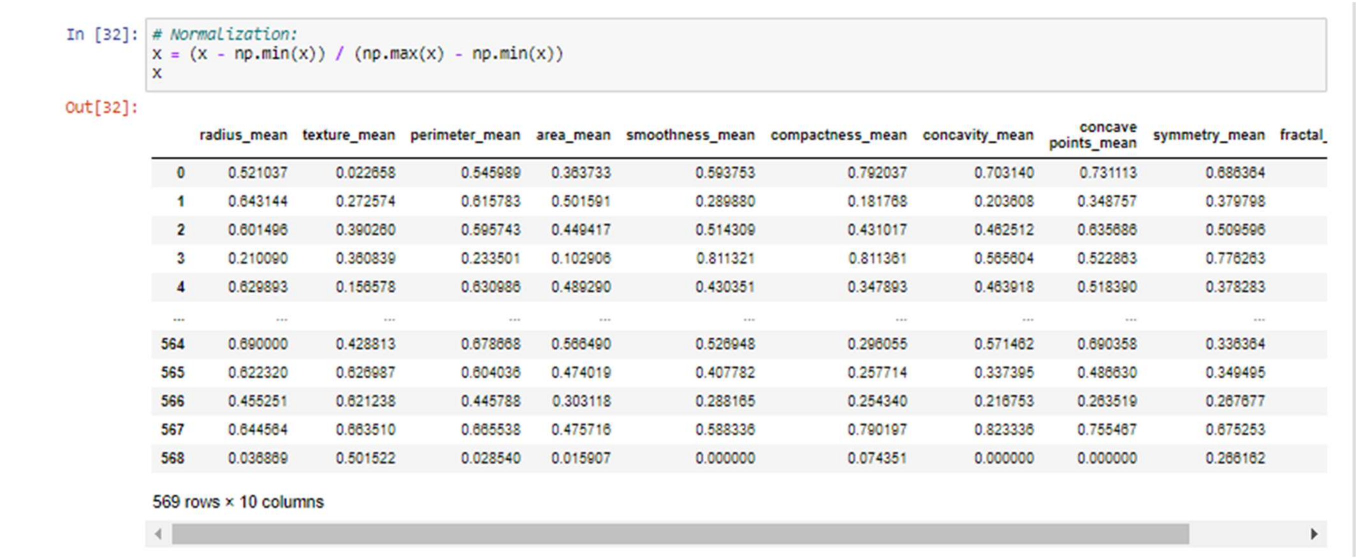
```
In [29]: feature_cols = ['radius_mean', 'texture_mean', 'perimeter_mean', 'area_mean','smoothness_mean', 'compactness_mean', 'concavity_m
```

```
In [30]: x = df[feature_cols]
         y = df.diagnosis.values
```

```
In [31]: x.head()
```

Out[31]:

	radius_mean	texture_mean	perimeter_mean	area_mean	smoothness_mean	compactness_mean	concavity_mean	concave points_mean	symmetry_mean	fractal_di
0	17.99	10.38	122.80	1001.0	0.11840	0.27760	0.3001	0.14710	0.2419	
1	20.57	17.77	132.90	1326.0	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	
3	11.42	20.38	77.58	386.1	0.14250	0.28390	0.2414	0.10520	0.2597	
4	20.29	14.34	135.10	1297.0	0.10030	0.13280	0.1980	0.10430	0.1809	

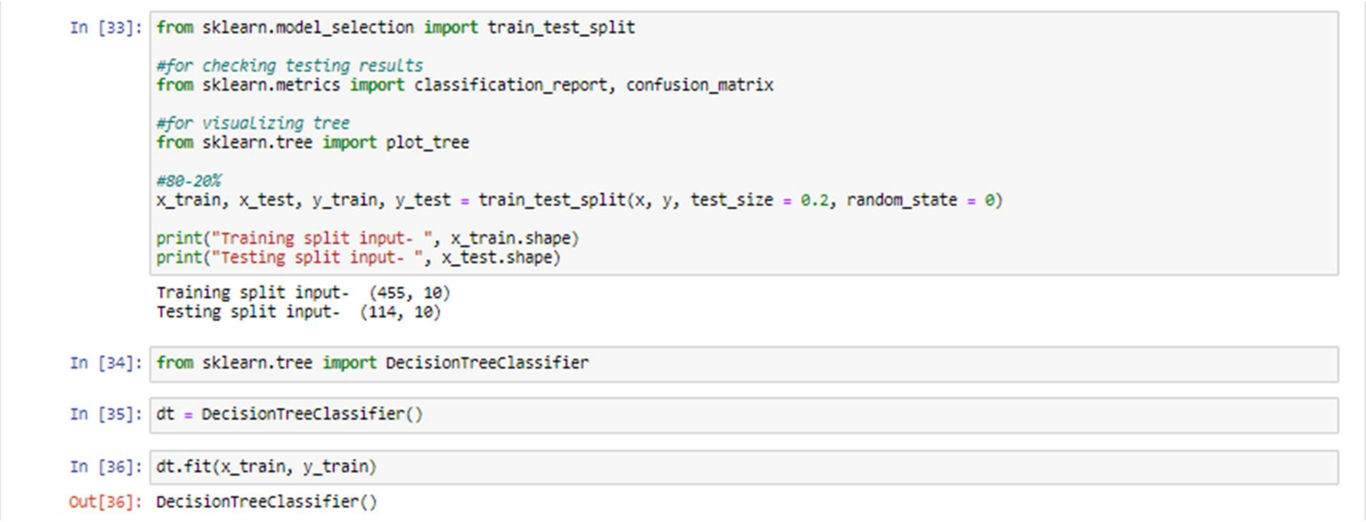


```
In [32]: # Normalization:
         x = (x - np.min(x)) / (np.max(x) - np.min(x))
         x
```

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	0.203608	0.348757	0.379798	
2	0.601496	0.390260	0.595743	0.449417	0.514309	0.431017	0.462512	0.635686	0.509596	
3	0.210090	0.360839	0.233501	0.102906	0.811321	0.811361	0.565604	0.522863	0.776263	
4	0.629893	0.156578	0.630986	0.489290	0.430351	0.347893	0.463918	0.518390	0.378283	
...	...	...	...	...	...	...	...	...	...	
564	0.690000	0.428813	0.678668	0.566490	0.526948	0.296055	0.571462	0.690358	0.336364	
565	0.622320	0.626987	0.604036	0.474019	0.407782	0.257714	0.337395	0.486630	0.349495	
566	0.455251	0.621238	0.445788	0.303118	0.288165	0.254340	0.216753	0.263519	0.267677	
567	0.644564	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

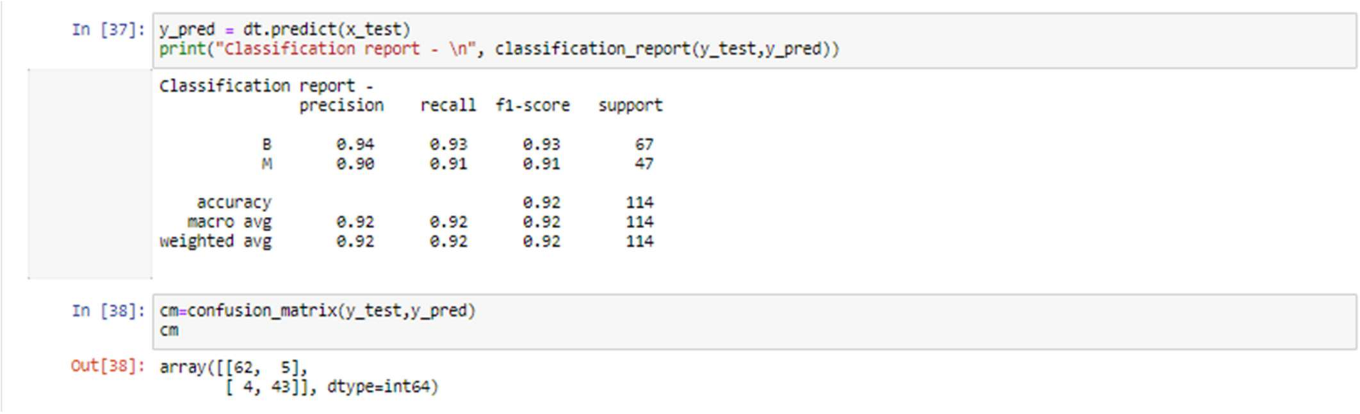


```
In [33]: from sklearn.model_selection import train_test_split

         #for checking testing results
         from sklearn.metrics import classification_report, confusion_matrix

         #for visualizing tree
         from sklearn.tree import plot_tree

         #80-20%
         x_train, x_test, y_train, y_test = train_test_split(x, y, test_size = 0.2, random_state = 0)

         print("Training split input- ", x_train.shape)
         print("Testing split input- ", x_test.shape)

         Training split input-  (455, 10)
         Testing split input-  (114, 10)
```

```
In [34]: from sklearn.tree import DecisionTreeClassifier
```

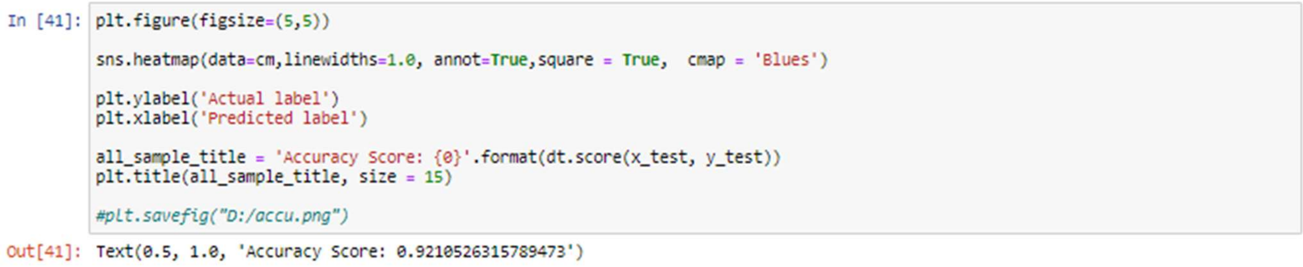
```
In [35]: dt = DecisionTreeClassifier()
```

```
In [36]: dt.fit(x_train, y_train)
Out[36]: DecisionTreeClassifier()
```

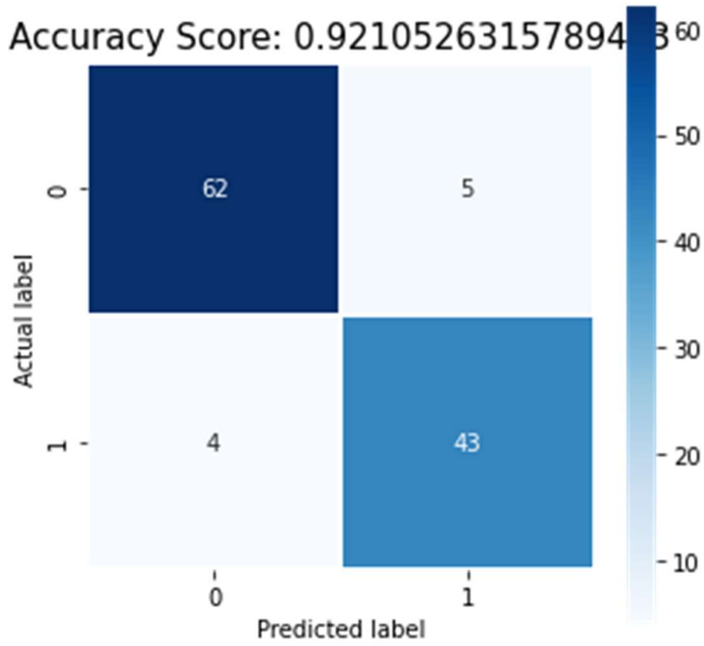


```
In [37]: y_pred = dt.predict(x_test)
         print("Classification report - \n", classification_report(y_test,y_pred))

         Classification report -
                        precision    recall  f1-score   support

                   B       0.94      0.93      0.93        67
                   M       0.90      0.91      0.91        47

            accuracy                           0.92       114
           macro avg       0.92      0.92      0.92       114
        weighted avg       0.92      0.92      0.92       114
```

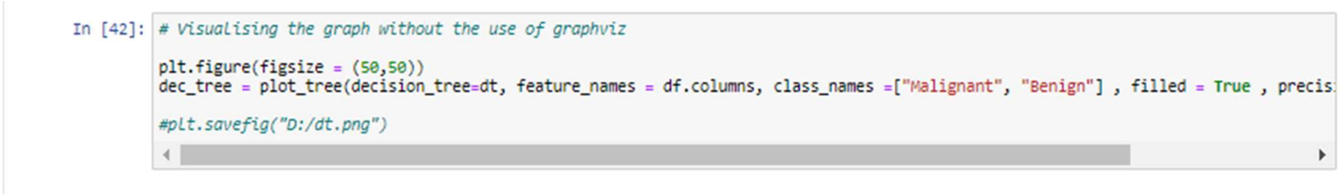
```
In [38]: cm=confusion_matrix(y_test,y_pred)
         cm

Out[38]: array([[62,  5],
                [ 4, 43]], dtype=int64)
```



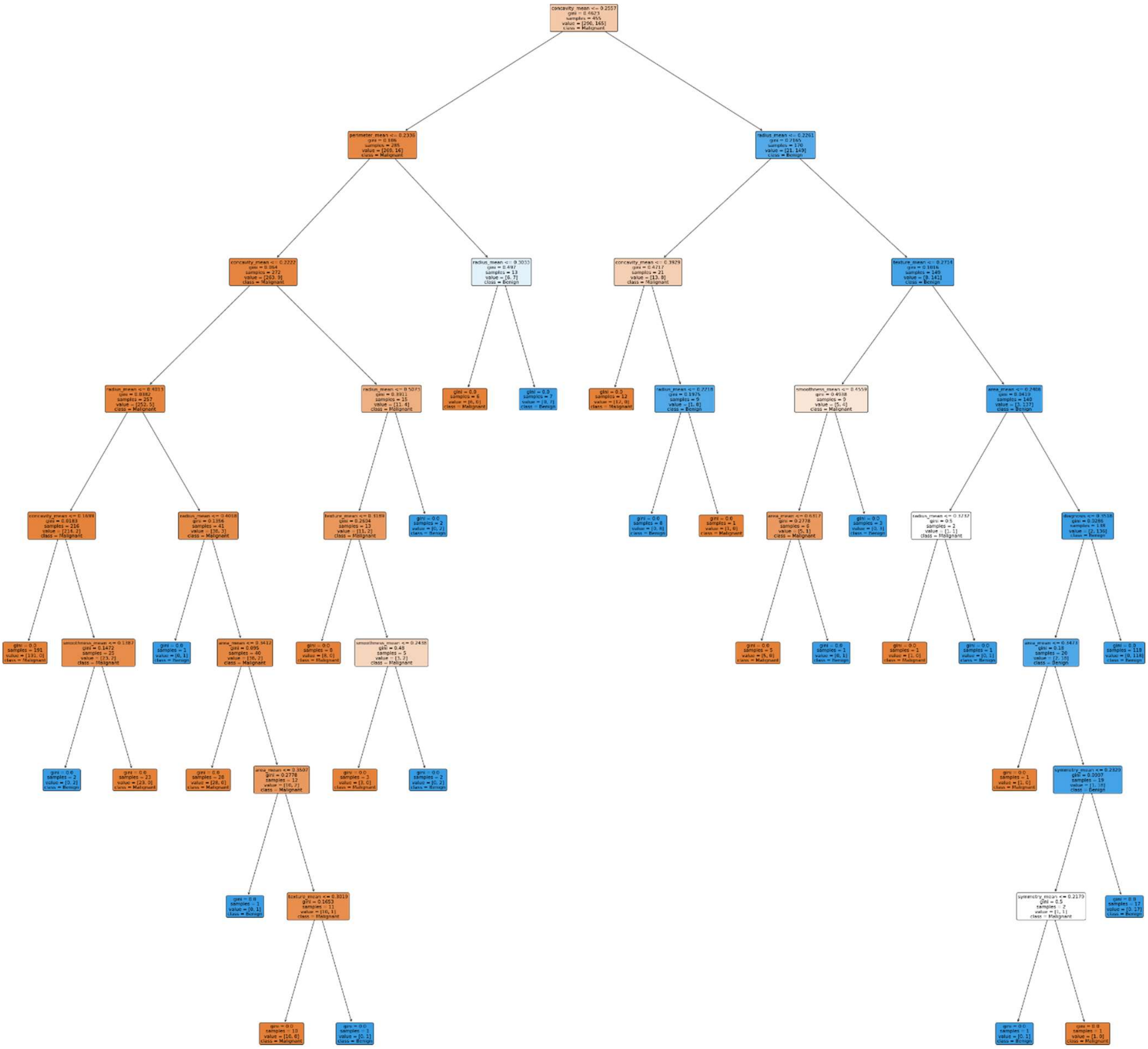
```
In [41]: plt.figure(figsize=(5,5))

         sns.heatmap(data=cm,linewidths=1.0, annot=True,square = True,  cmap = 'Blues')

         plt.ylabel('Actual label')
         plt.xlabel('Predicted label')

         all_sample_title = 'Accuracy Score: {0}'.format(dt.score(x_test, y_test))
         plt.title(all_sample_title, size = 15)

         #plt.savefig("D:/accu.png")

Out[41]: Text(0.5, 1.0, 'Accuracy Score: 0.9210526315789473')
```



FINAL GRAPHS:



```
In [42]: # Visualising the graph without the use of graphviz

         plt.figure(figsize = (50,50))
         dec_tree = plot_tree(decision_tree=dt, feature_names = df.columns, class_names =["Malignant", "Benign"] , filled = True , precis

         #plt.savefig("D:/dt.png")
```


concavity_mean <= 0.2557 gini = 0.4623 samples = 455 value = [290, 165] class = Malignant
perimeter_mean <= 0.2336 gini = 0.106 samples = 285 value = [269, 16] class = Malignant
radius_mean <= 0.2261 gini = 0.2165 samples = 170 value = [21, 149] class = Benign
concavity_mean <= 0.2222 gini = 0.064 samples = 272 value = [263, 9] class = Malignant
radius_mean <= 0.3033 gini = 0.497 samples = 13 value = [6, 7] class = Benign
concavity_mean <= 0.3929 gini = 0.4717 samples = 21 value = [13, 8] class = Malignant
texture_mean <= 0.2714 gini = 0.1016 samples = 149 value = [8, 141] class = Benign
radius_mean <= 0.4013 gini = 0.0382 samples = 257 value = [252, 5] class = Malignant
radius_mean <= 0.5073 gini = 0.3911 samples = 15 value = [11, 4] class = Malignant
gini = 0.0 samples = 6 value = [6, 0] class = Malignant
gini = 0.0 samples = 7 value = [0, 7] class = Benign
gini = 0.0 samples = 12 value = [12, 0] class = Malignant
radius_mean <= 0.2218 gini = 0.1975 samples = 9 value = [1, 8] class = Benign
smoothness_mean <= 0.4559 gini = 0.4938 samples = 9 value = [5, 4] class = Malignant
area_mean <= 0.2406 gini = 0.0419 samples = 140 value = [3, 137] class = Benign
concavity_mean <= 0.1699 gini = 0.0183 samples = 216 value = [214, 2] class = Malignant
radius_mean <= 0.4018 gini = 0.1356 samples = 41 value = [38, 3] class = Malignant
texture_mean <= 0.3189 gini = 0.2604 samples = 13 value = [11, 2] class = Malignant
gini = 0.0 samples = 2 value = [0, 2] class = Benign
gini = 0.0 samples = 8 value = [0, 8] class = Benign
gini = 0.0 samples = 1 value = [1, 0] class = Malignant
area_mean <= 0.6317 gini = 0.2778 samples = 6 value = [5, 1] class = Malignant
gini = 0.0 samples = 3 value = [0, 3] class = Benign
radius_mean <= 0.3737 gini = 0.5 samples = 2 value = [1, 1] class = Malignant
diagnosis <= 0.3538 gini = 0.0286 samples = 138 value = [2, 136] class = Benign
gini = 0.0 samples = 191 value = [191, 0] class = Malignant
smoothness_mean <= 0.1387 gini = 0.1472 samples = 25 value = [23, 2] class = Malignant
gini = 0.0 samples = 1 value = [0, 1] class = Benign
area_mean <= 0.3412 gini = 0.095 samples = 40 value = [38, 2] class = Malignant
gini = 0.0 samples = 8 value = [8, 0] class = Malignant
smoothness_mean <= 0.2438 gini = 0.48 samples = 5 value = [3, 2] class = Malignant
gini = 0.0 samples = 5 value = [5, 0] class = Malignant
gini = 0.0 samples = 1 value = [0, 1] class = Benign
gini = 0.0 samples = 1 value = [1, 0] class = Malignant
gini = 0.0 samples = 1 value = [0, 1] class = Benign
area_mean <= 0.3473 gini = 0.18 samples = 20 value = [2, 18] class = Benign
gini = 0.0 samples = 118 value = [0, 118] class = Benign
gini = 0.0 samples = 2 value = [0, 2] class = Benign
gini = 0.0 samples = 23 value = [23, 0] class = Malignant
gini = 0.0 samples = 28 value = [28, 0] class = Malignant
area_mean <= 0.3507 gini = 0.2778 samples = 12 value = [10, 2] class = Malignant
gini = 0.0 samples = 3 value = [3, 0] class = Malignant
gini = 0.0 samples = 2 value = [0, 2] class = Benign
gini = 0.0 samples = 1 value = [1, 0] class = Malignant
symmetry_mean <= 0.2320 gini = 0.0997 samples = 19 value = [1, 18] class = Benign
gini = 0.0 samples = 1 value = [0, 1] class = Benign
texture_mean <= 0.3019 gini = 0.1653 samples = 11 value = [10, 1] class = Malignant
symmetry_mean <= 0.2179 gini = 0.5 samples = 2 value = [1, 1] class = Malignant
gini = 0.0 samples = 17 value = [0, 17] class = Benign
gini = 0.0 samples = 10 value = [10, 0] class = Malignant
gini = 0.0 samples = 1 value = [0, 1] class = Benign
gini = 0.0 samples = 1 value = [0, 1] class = Benign
gini = 0.0 samples = 1 value = [1, 0] class = Malignant

GITHUB LINK:

https://github.com/SethiGuneet/ML-Lab-Work/blob/main/Machine%20Learning%20Experiment%202.ipynb