# breast-cancer

April 9, 2024

## IMPORTING REQUIRED LIBRARIES

[1]:
```python
import numpy as np
import pandas as pd
import matplotlib.pyplot as plt
import seaborn as sns
```

## IMPORTING DATASET

[2]:
```python
df=pd.read_csv('/content/data.csv')
df
```

[2]:
```
           id diagnosis  radius_mean  texture_mean  perimeter_mean  area_mean  \
0      842302         M        17.99         10.38          122.80     1001.0
1      842517         M        20.57         17.77          132.90     1326.0
2    84300903         M        19.69         21.25          130.00     1203.0
3    84348301         M        11.42         20.38           77.58      386.1
4    84358402         M        20.29         14.34          135.10     1297.0
..        …       …          …           …             …          …
564    926424         M        21.56         22.39          142.00     1479.0
565    926682         M        20.13         28.25          131.20     1261.0
566    926954         M        16.60         28.08          108.30      858.1
567    927241         M        20.60         29.33          140.10     1265.0
568     92751         B         7.76         24.54           47.92      181.0

     smoothness_mean  compactness_mean  concavity_mean  concave points_mean  \
0            0.11840           0.27760         0.30010              0.14710
1            0.08474           0.07864         0.08690              0.07017
2            0.10960           0.15990         0.19740              0.12790
3            0.14250           0.28390         0.24140              0.10520
4            0.10030           0.13280         0.19800              0.10430
..             …              …             …                 …
564          0.11100           0.11590         0.24390              0.13890
565          0.09780           0.10340         0.14400              0.09791
566          0.08455           0.10230         0.09251              0.05302
567          0.11780           0.27700         0.35140              0.15200
568          0.05263           0.04362         0.00000              0.00000
```

```
     …  texture_worst  perimeter_worst  area_worst  smoothness_worst  \
0    …          17.33           184.60      2019.0           0.16220
1    …          23.41           158.80      1956.0           0.12380
2    …          25.53           152.50      1709.0           0.14440
3    …          26.50            98.87       567.7           0.20980
4    …          16.67           152.20      1575.0           0.13740
..   …            …               …           …                …
564  …          26.40           166.10      2027.0           0.14100
565  …          38.25           155.00      1731.0           0.11660
566  …          34.12           126.70      1124.0           0.11390
567  …          39.42           184.60      1821.0           0.16500
568  …          30.37            59.16       268.6           0.08996

     compactness_worst  concavity_worst  concave points_worst  symmetry_worst  \
0              0.66560           0.7119                0.2654          0.4601
1              0.18660           0.2416                0.1860          0.2750
2              0.42450           0.4504                0.2430          0.3613
3              0.86630           0.6869                0.2575          0.6638
4              0.20500           0.4000                0.1625          0.2364
..                 …               …                   …               …
564            0.21130           0.4107                0.2216          0.2060
565            0.19220           0.3215                0.1628          0.2572
566            0.30940           0.3403                0.1418          0.2218
567            0.86810           0.9387                0.2650          0.4087
568            0.06444           0.0000                0.0000          0.2871

     fractal_dimension_worst  Unnamed: 32
0                    0.11890          NaN
1                    0.08902          NaN
2                    0.08758          NaN
3                    0.17300          NaN
4                    0.07678          NaN
..                     …            …
564                  0.07115          NaN
565                  0.06637          NaN
566                  0.07820          NaN
567                  0.12400          NaN
568                  0.07039          NaN

[569 rows x 33 columns]
```

## DATA PREPROCESSING

[3]:
```
# printing fist 5 rows
df.head()
```

```
[3]:          id diagnosis  radius_mean  texture_mean  perimeter_mean  area_mean  \
     0    842302         M        17.99         10.38          122.80     1001.0
     1    842517         M        20.57         17.77          132.90     1326.0
     2  84300903         M        19.69         21.25          130.00     1203.0
     3  84348301         M        11.42         20.38           77.58      386.1
     4  84358402         M        20.29         14.34          135.10     1297.0

        smoothness_mean  compactness_mean  concavity_mean  concave points_mean  \
     0          0.11840           0.27760          0.3001              0.14710
     1          0.08474           0.07864          0.0869              0.07017
     2          0.10960           0.15990          0.1974              0.12790
     3          0.14250           0.28390          0.2414              0.10520
     4          0.10030           0.13280          0.1980              0.10430

        …  texture_worst  perimeter_worst  area_worst  smoothness_worst  \
     0  …          17.33           184.60      2019.0            0.1622
     1  …          23.41           158.80      1956.0            0.1238
     2  …          25.53           152.50      1709.0            0.1444
     3  …          26.50            98.87       567.7            0.2098
     4  …          16.67           152.20      1575.0            0.1374

        compactness_worst  concavity_worst  concave points_worst  symmetry_worst  \
     0             0.6656           0.7119                0.2654          0.4601
     1             0.1866           0.2416                0.1860          0.2750
     2             0.4245           0.4504                0.2430          0.3613
     3             0.8663           0.6869                0.2575          0.6638
     4             0.2050           0.4000                0.1625          0.2364

        fractal_dimension_worst  Unnamed: 32
     0                  0.11890          NaN
     1                  0.08902          NaN
     2                  0.08758          NaN
     3                  0.17300          NaN
     4                  0.07678          NaN

     [5 rows x 33 columns]
```

```
[4]: #printing last 5 rows
     df.tail()
```

```
[4]:          id diagnosis  radius_mean  texture_mean  perimeter_mean  area_mean  \
     564  926424         M        21.56         22.39          142.00     1479.0
     565  926682         M        20.13         28.25          131.20     1261.0
     566  926954         M        16.60         28.08          108.30      858.1
     567  927241         M        20.60         29.33          140.10     1265.0
     568   92751         B         7.76         24.54           47.92      181.0
     smoothness_mean  compactness_mean  concavity_mean  concave points_mean  \
564          0.11100           0.11590         0.24390              0.13890
565          0.09780           0.10340         0.14400              0.09791
566          0.08455           0.10230         0.09251              0.05302
567          0.11780           0.27700         0.35140              0.15200
568          0.05263           0.04362         0.00000              0.00000

     …  texture_worst  perimeter_worst  area_worst  smoothness_worst  \
564  …          26.40           166.10      2027.0           0.14100
565  …          38.25           155.00      1731.0           0.11660
566  …          34.12           126.70      1124.0           0.11390
567  …          39.42           184.60      1821.0           0.16500
568  …          30.37            59.16       268.6           0.08996

     compactness_worst  concavity_worst  concave points_worst  symmetry_worst  \
564            0.21130           0.4107                0.2216          0.2060
565            0.19220           0.3215                0.1628          0.2572
566            0.30940           0.3403                0.1418          0.2218
567            0.86810           0.9387                0.2650          0.4087
568            0.06444           0.0000                0.0000          0.2871

     fractal_dimension_worst  Unnamed: 32
564                  0.07115          NaN
565                  0.06637          NaN
566                  0.07820          NaN
567                  0.12400          NaN
568                  0.07039          NaN

[5 rows x 33 columns]
```

[5]:
```
df.columns
```

[5]:
```
Index(['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')
```

[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
```

[7]:
```
#printing datatypes
df.dtypes
```

[7]:
```
id                           int64
diagnosis                   object
radius_mean                float64
texture_mean               float64
perimeter_mean             float64
```

```
area_mean                  float64
smoothness_mean            float64
compactness_mean           float64
concavity_mean             float64
concave points_mean        float64
symmetry_mean              float64
fractal_dimension_mean     float64
radius_se                  float64
texture_se                 float64
perimeter_se               float64
area_se                    float64
smoothness_se              float64
compactness_se             float64
concavity_se               float64
concave points_se          float64
symmetry_se                float64
fractal_dimension_se       float64
radius_worst               float64
texture_worst              float64
perimeter_worst            float64
area_worst                 float64
smoothness_worst           float64
compactness_worst          float64
concavity_worst            float64
concave points_worst       float64
symmetry_worst             float64
fractal_dimension_worst    float64
Unnamed: 32                float64
dtype: object
```

[8]:
```
#finding out missing values
df.isna().sum()
```

[8]:
```
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
```

[9]:
```
df.describe()
```

[9]:
```
                 id  radius_mean  texture_mean  perimeter_mean    area_mean  \
count  5.690000e+02   569.000000    569.000000      569.000000   569.000000
mean   3.037183e+07    14.127292     19.289649       91.969033   654.889104
std    1.250206e+08     3.524049      4.301036       24.298981   351.914129
min    8.670000e+03     6.981000      9.710000       43.790000   143.500000
25%    8.692180e+05    11.700000     16.170000       75.170000   420.300000
50%    9.060240e+05    13.370000     18.840000       86.240000   551.100000
75%    8.813129e+06    15.780000     21.800000      104.100000   782.700000
max    9.113205e+08    28.110000     39.280000      188.500000  2501.000000

       smoothness_mean  compactness_mean  concavity_mean  concave points_mean  \
count       569.000000        569.000000      569.000000           569.000000
mean          0.096360          0.104341        0.088799             0.048919
std           0.014064          0.052813        0.079720             0.038803
min           0.052630          0.019380        0.000000             0.000000
25%           0.086370          0.064920        0.029560             0.020310
50%           0.095870          0.092630        0.061540             0.033500
75%           0.105300          0.130400        0.130700             0.074000
max           0.163400          0.345400        0.426800             0.201200

       symmetry_mean  …  texture_worst  perimeter_worst   area_worst  \
count     569.000000  …     569.000000       569.000000   569.000000
mean        0.181162  …      25.677223       107.261213   880.583128
std         0.027414  …       6.146258        33.602542   569.356993
```

```
min          0.106000  …      12.020000        50.410000   185.200000
25%          0.161900  …      21.080000        84.110000   515.300000
50%          0.179200  …      25.410000        97.660000   686.500000
75%          0.195700  …      29.720000       125.400000  1084.000000
max          0.304000  …      49.540000       251.200000  4254.000000

       smoothness_worst  compactness_worst  concavity_worst  \
count        569.000000         569.000000       569.000000
mean           0.132369           0.254265         0.272188
std            0.022832           0.157336         0.208624
min            0.071170           0.027290         0.000000
25%            0.116600           0.147200         0.114500
50%            0.131300           0.211900         0.226700
75%            0.146000           0.339100         0.382900
max            0.222600           1.058000         1.252000

       concave points_worst  symmetry_worst  fractal_dimension_worst  \
count            569.000000      569.000000               569.000000
mean               0.114606        0.290076                 0.083946
std                0.065732        0.061867                 0.018061
min                0.000000        0.156500                 0.055040
25%                0.064930        0.250400                 0.071460
50%                0.099930        0.282200                 0.080040
75%                0.161400        0.317900                 0.092080
max                0.291000        0.663800                 0.207500

       Unnamed: 32
count          0.0
mean           NaN
std            NaN
min            NaN
25%            NaN
50%            NaN
75%            NaN
max            NaN

[8 rows x 32 columns]
```

[10]:
```
df.drop(['id','Unnamed: 32'],axis=1,inplace=True)
df
```

[10]:
```
    diagnosis  radius_mean  texture_mean  perimeter_mean  area_mean  \
0           M        17.99         10.38          122.80     1001.0
1           M        20.57         17.77          132.90     1326.0
2           M        19.69         21.25          130.00     1203.0
3           M        11.42         20.38           77.58      386.1
4           M        20.29         14.34          135.10     1297.0
```

```
..       …         …           …            …        …
564       M     21.56        22.39         142.00   1479.0
565       M     20.13        28.25         131.20   1261.0
566       M     16.60        28.08         108.30    858.1
567       M     20.60        29.33         140.10   1265.0
568       B      7.76        24.54          47.92    181.0

     smoothness_mean  compactness_mean  concavity_mean  concave points_mean  \
0            0.11840           0.27760         0.30010              0.14710
1            0.08474           0.07864         0.08690              0.07017
2            0.10960           0.15990         0.19740              0.12790
3            0.14250           0.28390         0.24140              0.10520
4            0.10030           0.13280         0.19800              0.10430
..               …                …               …                  …
564          0.11100           0.11590         0.24390              0.13890
565          0.09780           0.10340         0.14400              0.09791
566          0.08455           0.10230         0.09251              0.05302
567          0.11780           0.27700         0.35140              0.15200
568          0.05263           0.04362         0.00000              0.00000

     symmetry_mean  …  radius_worst  texture_worst  perimeter_worst  \
0           0.2419  …        25.380          17.33           184.60
1           0.1812  …        24.990          23.41           158.80
2           0.2069  …        23.570          25.53           152.50
3           0.2597  …        14.910          26.50            98.87
4           0.1809  …        22.540          16.67           152.20
..             …  …           …              …               …
564         0.1726  …        25.450          26.40           166.10
565         0.1752  …        23.690          38.25           155.00
566         0.1590  …        18.980          34.12           126.70
567         0.2397  …        25.740          39.42           184.60
568         0.1587  …         9.456          30.37            59.16

     area_worst  smoothness_worst  compactness_worst  concavity_worst  \
0        2019.0           0.16220            0.66560           0.7119
1        1956.0           0.12380            0.18660           0.2416
2        1709.0           0.14440            0.42450           0.4504
3         567.7           0.20980            0.86630           0.6869
4        1575.0           0.13740            0.20500           0.4000
..          …                …                  …               …
564      2027.0           0.14100            0.21130           0.4107
565      1731.0           0.11660            0.19220           0.3215
566      1124.0           0.11390            0.30940           0.3403
567      1821.0           0.16500            0.86810           0.9387
568       268.6           0.08996            0.06444           0.0000

     concave points_worst  symmetry_worst  fractal_dimension_worst
```

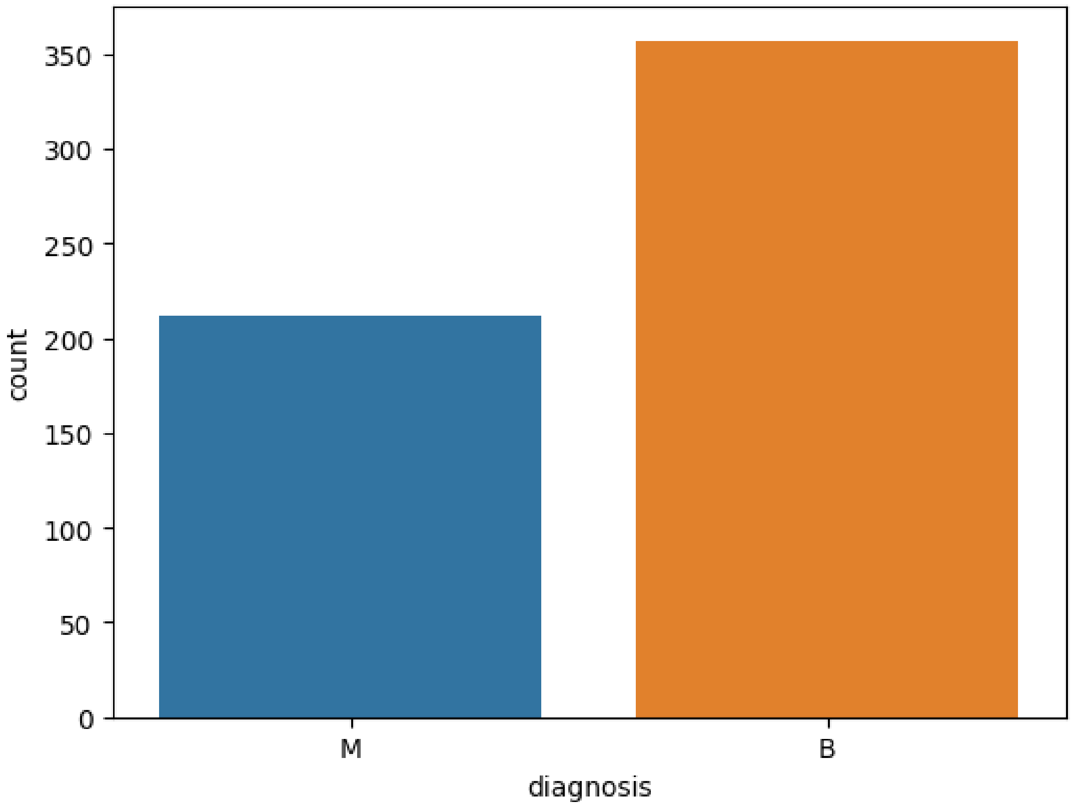
```
0         0.2654     0.4601           0.11890
1         0.1860     0.2750           0.08902
2         0.2430     0.3613           0.08758
3         0.2575     0.6638           0.17300
4         0.1625     0.2364           0.07678
..           …          …                …
564       0.2216     0.2060           0.07115
565       0.1628     0.2572           0.06637
566       0.1418     0.2218           0.07820
567       0.2650     0.4087           0.12400
568       0.0000     0.2871           0.07039

[569 rows x 31 columns]
```

**DATA VISUALIZATION**

[11]:
```python
sns.countplot(x='diagnosis',data=df,hue='diagnosis')
```

[11]:
```
<Axes: xlabel='diagnosis', ylabel='count'>
```

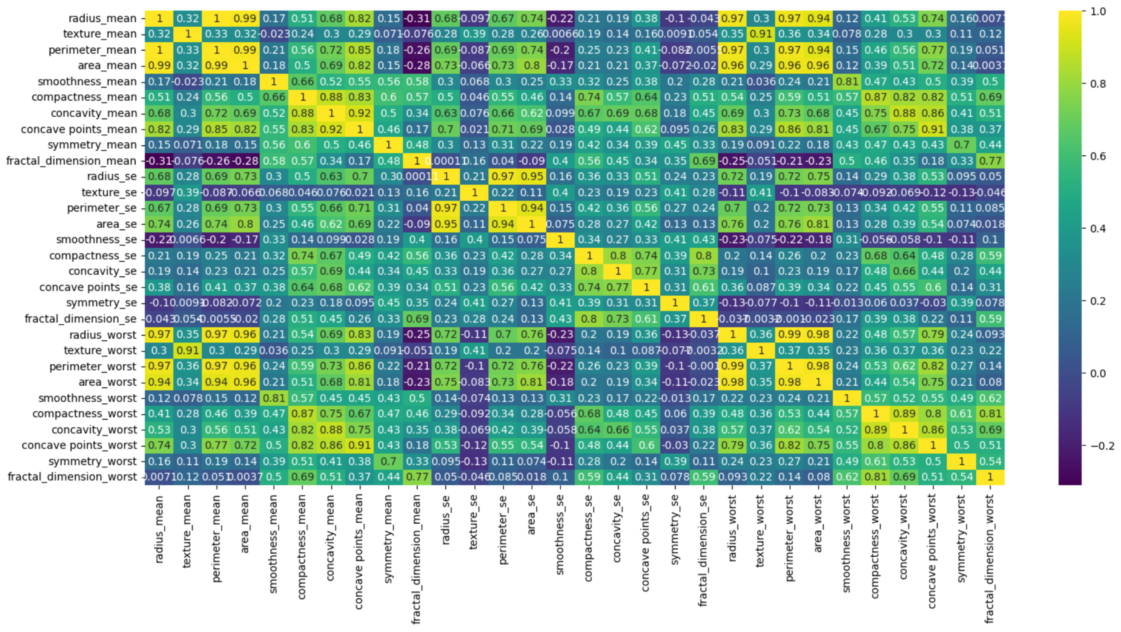


```
[12]: plt.figure(figsize=(3,3))
      features = ['diagnosis','radius_mean', 'texture_mean', 'perimeter_mean',␣
       ↪'area_mean','smoothness_mean','compactness_mean', 'concavity_mean',
                  'concave points_mean', 'symmetry_mean', 'fractal_dimension_mean']
      sns.pairplot(df[features],hue='diagnosis',height=2)
      plt.show()
```

```
Output hidden; open in https://colab.research.google.com to view.
```

```
[28]: plt.figure(figsize=(18,8))
      sns.heatmap(df.corr(),annot=True,cmap='viridis')
      plt.show()
```

```
<ipython-input-28-2bf37515dabc>:2: FutureWarning: The default value of
numeric_only in DataFrame.corr is deprecated. In a future version, it will
default to False. Select only valid columns or specify the value of numeric_only
to silence this warning.
  sns.heatmap(df.corr(),annot=True,cmap='viridis')
```



## SEPERATING X AND Y

```
[14]: # seperating input values
      x=df.drop(['diagnosis'],axis=1).values
      x
```

```
[14]: array([[1.799e+01, 1.038e+01, 1.228e+02, …, 2.654e-01, 4.601e-01,
              1.189e-01],
             [2.057e+01, 1.777e+01, 1.329e+02, …, 1.860e-01, 2.750e-01,
              8.902e-02],
             [1.969e+01, 2.125e+01, 1.300e+02, …, 2.430e-01, 3.613e-01,
              8.758e-02],
             …,
             [1.660e+01, 2.808e+01, 1.083e+02, …, 1.418e-01, 2.218e-01,
              7.820e-02],
             [2.060e+01, 2.933e+01, 1.401e+02, …, 2.650e-01, 4.087e-01,
              1.240e-01],
             [7.760e+00, 2.454e+01, 4.792e+01, …, 0.000e+00, 2.871e-01,
              7.039e-02]])
```

[15]:
```python
# seperating output values
y=df['diagnosis'].values
y
```

[15]:
```
array(['M', 'M', 'M', 'M', 'M', 'M', 'M', 'M', 'M', 'M', 'M', 'M', 'M',
       'M', 'M', 'M', 'M', 'M', 'M', 'B', 'B', 'B', 'M', 'M', 'M', 'M',
       'M', 'M', 'M', 'M', 'M', 'M', 'M', 'M', 'M', 'M', 'M', 'B', 'M',
       'M', 'M', 'M', 'M', 'M', 'M', 'M', 'B', 'M', 'B', 'B', 'B', 'B',
       'B', 'M', 'M', 'B', 'M', 'M', 'B', 'B', 'B', 'B', 'M', 'B', 'M',
       'M', 'B', 'B', 'B', 'B', 'M', 'B', 'M', 'M', 'B', 'M', 'B', 'M',
       'M', 'B', 'B', 'B', 'M', 'M', 'B', 'M', 'M', 'M', 'B', 'B', 'B',
       'M', 'B', 'B', 'M', 'M', 'B', 'B', 'B', 'M', 'M', 'B', 'B', 'B',
       'B', 'M', 'B', 'B', 'M', 'B', 'B', 'B', 'B', 'B', 'B', 'B', 'B',
       'M', 'M', 'M', 'B', 'M', 'M', 'B', 'B', 'B', 'M', 'M', 'B', 'M',
       'B', 'M', 'M', 'B', 'M', 'M', 'B', 'B', 'M', 'B', 'B', 'M', 'B',
       'B', 'B', 'B', 'M', 'B', 'B', 'B', 'B', 'B', 'B', 'B', 'B', 'B',
       'M', 'B', 'B', 'B', 'B', 'M', 'M', 'B', 'M', 'B', 'B', 'M', 'M',
       'B', 'B', 'M', 'M', 'B', 'B', 'B', 'B', 'M', 'B', 'B', 'M', 'M',
       'M', 'B', 'M', 'B', 'M', 'B', 'B', 'B', 'M', 'B', 'B', 'M', 'M',
       'B', 'M', 'M', 'M', 'M', 'B', 'M', 'M', 'M', 'B', 'M', 'B', 'M',
       'B', 'B', 'M', 'B', 'M', 'M', 'M', 'M', 'B', 'B', 'M', 'M', 'B',
       'B', 'B', 'M', 'B', 'B', 'B', 'B', 'B', 'M', 'M', 'B', 'B', 'M',
       'B', 'B', 'M', 'M', 'B', 'M', 'B', 'B', 'B', 'B', 'M', 'B', 'B',
       'B', 'B', 'B', 'M', 'B', 'M', 'M', 'M', 'M', 'M', 'M', 'M', 'M',
       'M', 'M', 'M', 'M', 'M', 'M', 'B', 'B', 'B', 'B', 'B', 'B', 'M',
       'B', 'M', 'B', 'B', 'M', 'B', 'B', 'M', 'B', 'M', 'M', 'B', 'B',
       'B', 'B', 'B', 'B', 'B', 'B', 'B', 'B', 'B', 'B', 'B', 'M', 'B',
       'B', 'M', 'B', 'M', 'B', 'B', 'B', 'B', 'B', 'B', 'B', 'B', 'B',
       'B', 'B', 'B', 'B', 'B', 'M', 'B', 'B', 'B', 'M', 'B', 'M', 'B',
       'B', 'B', 'B', 'M', 'M', 'M', 'B', 'B', 'B', 'B', 'M', 'B', 'M',
       'B', 'M', 'B', 'B', 'B', 'M', 'B', 'B', 'B', 'B', 'B', 'B', 'B',
       'M', 'M', 'M', 'B', 'B', 'B', 'B', 'B', 'B', 'B', 'B', 'B', 'B',
       'B', 'M', 'M', 'B', 'M', 'M', 'M', 'B', 'M', 'M', 'B', 'B', 'B',
       'B', 'B', 'M', 'B', 'B', 'B', 'B', 'B', 'M', 'B', 'B', 'B', 'M',
       'B', 'B', 'M', 'M', 'B', 'B', 'B', 'B', 'B', 'B', 'M', 'B', 'B',
          'B', 'B', 'B', 'B', 'B', 'M', 'B', 'B', 'B', 'B', 'B', 'M', 'B',
          'B', 'M', 'B', 'B', 'B', 'B', 'B', 'B', 'B', 'B', 'B', 'B', 'B',
          'B', 'M', 'B', 'M', 'M', 'B', 'M', 'B', 'B', 'B', 'B', 'B', 'M',
          'B', 'B', 'M', 'B', 'M', 'B', 'B', 'M', 'B', 'M', 'B', 'B', 'B',
          'B', 'B', 'B', 'B', 'B', 'M', 'M', 'B', 'B', 'B', 'B', 'B', 'B',
          'M', 'B', 'B', 'B', 'B', 'B', 'B', 'B', 'B', 'B', 'B', 'M', 'B',
          'B', 'B', 'B', 'B', 'B', 'B', 'M', 'B', 'M', 'B', 'B', 'M', 'B',
          'B', 'B', 'B', 'B', 'M', 'M', 'B', 'M', 'B', 'M', 'B', 'B', 'B',
          'B', 'B', 'M', 'B', 'B', 'M', 'B', 'M', 'B', 'M', 'M', 'B', 'B',
          'B', 'M', 'B', 'B', 'B', 'B', 'B', 'B', 'B', 'B', 'B', 'B', 'B',
          'M', 'B', 'M', 'M', 'B', 'B', 'B', 'B', 'B', 'B', 'B', 'B', 'B',
          'B', 'B', 'B', 'B', 'B', 'B', 'B', 'B', 'B', 'B', 'B', 'B', 'B',
          'B', 'B', 'B', 'M', 'M', 'M', 'M', 'M', 'M', 'B'], dtype=object)
```

[16]:
```
# convert into training and testing and data
from sklearn.model_selection import train_test_split
x_train,x_test,y_train,y_test=train_test_split(x,y,test_size=0.
 ↪30,random_state=42)
x_train
```

[16]:
```
array([[1.374e+01, 1.791e+01, 8.812e+01, …, 6.019e-02, 2.350e-01,
        7.014e-02],
       [1.337e+01, 1.639e+01, 8.610e+01, …, 8.978e-02, 2.048e-01,
        7.628e-02],
       [1.469e+01, 1.398e+01, 9.822e+01, …, 1.108e-01, 2.827e-01,
        9.208e-02],
       …,
       [1.429e+01, 1.682e+01, 9.030e+01, …, 3.333e-02, 2.458e-01,
        6.120e-02],
       [1.398e+01, 1.962e+01, 9.112e+01, …, 1.827e-01, 3.179e-01,
        1.055e-01],
       [1.218e+01, 2.052e+01, 7.722e+01, …, 7.431e-02, 2.694e-01,
        6.878e-02]])
```

[17]:
```
x_test
```

[17]:
```
array([[1.247e+01, 1.860e+01, 8.109e+01, …, 1.015e-01, 3.014e-01,
        8.750e-02],
       [1.894e+01, 2.131e+01, 1.236e+02, …, 1.789e-01, 2.551e-01,
        6.589e-02],
       [1.546e+01, 1.948e+01, 1.017e+02, …, 1.514e-01, 2.837e-01,
        8.019e-02],
       …,
       [9.904e+00, 1.806e+01, 6.460e+01, …, 9.910e-02, 2.614e-01,
        1.162e-01],
       [1.382e+01, 2.449e+01, 9.233e+01, …, 1.521e-01, 3.651e-01,
        1.183e-01],
       [1.289e+01, 1.411e+01, 8.495e+01, …, 1.561e-01, 2.639e-01,
        1.178e-01]])
```

```
[18]: y_train
```

```
[18]: array(['B', 'B', 'B', 'B', 'B', 'M', 'B', 'B', 'B', 'B', 'B', 'B', 'M',
             'M', 'M', 'B', 'B', 'M', 'B', 'M', 'B', 'B', 'B', 'B', 'M', 'B',
             'B', 'M', 'B', 'B', 'B', 'M', 'B', 'M', 'M', 'B', 'B', 'B', 'M',
             'B', 'B', 'B', 'B', 'M', 'B', 'B', 'B', 'B', 'B', 'M', 'B', 'M',
             'M', 'B', 'B', 'M', 'B', 'B', 'B', 'B', 'B', 'B', 'B', 'M', 'M',
             'M', 'B', 'B', 'M', 'B', 'B', 'M', 'B', 'M', 'B', 'M', 'B', 'M',
             'B', 'B', 'M', 'B', 'B', 'B', 'M', 'B', 'M', 'B', 'M', 'B', 'M',
             'B', 'B', 'M', 'B', 'B', 'B', 'B', 'M', 'B', 'B', 'B', 'M', 'B',
             'B', 'M', 'B', 'B', 'M', 'B', 'B', 'B', 'B', 'B', 'B', 'B', 'M',
             'B', 'B', 'B', 'M', 'B', 'M', 'B', 'B', 'B', 'M', 'B', 'M', 'M',
             'B', 'B', 'M', 'B', 'M', 'M', 'M', 'B', 'B', 'B', 'M', 'B', 'B',
             'M', 'B', 'M', 'B', 'B', 'B', 'M', 'B', 'M', 'B', 'B', 'M', 'M',
             'B', 'B', 'M', 'B', 'M', 'M', 'B', 'M', 'M', 'B', 'B', 'M', 'M',
             'M', 'B', 'B', 'B', 'B', 'M', 'B', 'M', 'M', 'M', 'M', 'B', 'B',
             'B', 'B', 'B', 'B', 'B', 'B', 'M', 'M', 'B', 'B', 'M', 'B', 'B',
             'B', 'B', 'B', 'M', 'B', 'B', 'M', 'M', 'B', 'M', 'B', 'M', 'B',
             'B', 'B', 'B', 'B', 'B', 'M', 'B', 'B', 'M', 'B', 'B', 'B', 'B',
             'B', 'B', 'M', 'B', 'B', 'M', 'B', 'M', 'M', 'M', 'B', 'M', 'B',
             'B', 'M', 'M', 'M', 'B', 'B', 'B', 'B', 'B', 'B', 'B', 'M', 'B',
             'B', 'B', 'M', 'B', 'B', 'M', 'M', 'B', 'M', 'B', 'M', 'M', 'B',
             'B', 'M', 'B', 'M', 'M', 'B', 'M', 'M', 'B', 'B', 'M', 'B', 'M',
             'B', 'B', 'M', 'B', 'B', 'M', 'M', 'M', 'B', 'B', 'B', 'M', 'M',
             'B', 'M', 'M', 'B', 'B', 'B', 'M', 'B', 'M', 'M', 'M', 'M', 'B',
             'B', 'M', 'B', 'B', 'M', 'M', 'M', 'M', 'M', 'M', 'B', 'B', 'B',
             'B', 'B', 'B', 'B', 'M', 'M', 'M', 'M', 'B', 'B', 'B', 'B', 'M',
             'B', 'M', 'B', 'B', 'B', 'B', 'B', 'M', 'M', 'M', 'B', 'B', 'M',
             'B', 'B', 'M', 'M', 'M', 'M', 'B', 'B', 'M', 'M', 'B', 'B', 'B',
             'M', 'M', 'M', 'B', 'B', 'M', 'B', 'B', 'B', 'B', 'M', 'B', 'B',
             'B', 'B', 'B', 'B', 'B', 'B', 'B', 'M', 'B', 'B', 'B', 'B', 'B',
             'B', 'M', 'B', 'B', 'M', 'B', 'B', 'M', 'M', 'M', 'B', 'M', 'M',
             'B', 'M', 'B', 'B', 'B', 'B', 'M', 'B'], dtype=object)
```

```
[19]: y_test
```

```
[19]: array(['B', 'M', 'M', 'B', 'B', 'M', 'M', 'M', 'B', 'B', 'B', 'M', 'B',
             'M', 'B', 'M', 'B', 'B', 'B', 'M', 'M', 'B', 'M', 'B', 'B', 'B',
             'B', 'B', 'B', 'M', 'B', 'B', 'B', 'B', 'B', 'B', 'M', 'B', 'M',
             'B', 'B', 'M', 'B', 'B', 'B', 'B', 'B', 'B', 'B', 'B', 'M', 'M',
             'B', 'B', 'B', 'B', 'B', 'M', 'M', 'B', 'B', 'M', 'M', 'B', 'B',
             'B', 'M', 'M', 'B', 'B', 'M', 'M', 'B', 'M', 'B', 'B', 'B', 'M',
             'B', 'B', 'M', 'B', 'M', 'M', 'M', 'M', 'M', 'M', 'B', 'B', 'B',
             'B', 'B', 'B', 'B', 'B', 'M', 'M', 'B', 'M', 'M', 'B', 'M', 'M',
       'B', 'B', 'B', 'M', 'B', 'B', 'M', 'B', 'B', 'M', 'B', 'M', 'B',
       'B', 'B', 'M', 'B', 'B', 'B', 'M', 'B', 'M', 'M', 'B', 'B', 'M',
       'M', 'M', 'B', 'B', 'B', 'M', 'B', 'B', 'B', 'M', 'B', 'M', 'B',
       'B', 'M', 'B', 'M', 'M', 'M', 'B', 'M', 'B', 'B', 'B', 'B', 'M',
       'M', 'B', 'B', 'B', 'B', 'B', 'B', 'B', 'M', 'B', 'B', 'B', 'B',
       'M', 'B'], dtype=object)
```

[20]:
```
#normalization
from sklearn.preprocessing import StandardScaler
scaler=StandardScaler()
scaler.fit(x_train)
x_train=scaler.transform(x_train)
x_test=scaler.transform(x_test)
x_train
```

[20]:
```
array([[-0.12348985, -0.29680142, -0.17050713, …, -0.84082156,
        -0.8563616 , -0.76574773],
       [-0.22826757, -0.65795149, -0.25377521, …, -0.37706655,
        -1.3415819 , -0.41480748],
       [ 0.14553402, -1.23056444,  0.24583328, …, -0.04762652,
        -0.08997059,  0.4882635 ],
       …,
       [ 0.03226081, -0.55578404, -0.08064356, …, -1.26179013,
        -0.6828391 , -1.27672587],
       [-0.05552593,  0.10949242, -0.04684166, …,  1.07924018,
         0.4755842 ,  1.25530227],
       [-0.56525537,  0.32333128, -0.619825  , …, -0.61952313,
        -0.30366032, -0.84348042]])
```

[21]:
```
x_test
```

[21]:
```
array([[-0.48313229, -0.13285829, -0.46029654, …, -0.19338258,
         0.21048039,  0.22648723],
       [ 1.34906186,  0.51103428,  1.29204314, …,  1.01968394,
        -0.53341696, -1.00866239],
       [ 0.36358494,  0.0762286 ,  0.38928522, …,  0.58868486,
        -0.07390369, -0.19132599],
       …,
       [-1.20977993, -0.2611616 , -1.1400444 , …, -0.23099704,
        -0.4321955 ,  1.86687566],
       [-0.10083521,  1.26659826,  0.00303674, …,  0.59965574,
         1.23394176,  1.98690408],
       [-0.36419542, -1.19967661, -0.30118031, …,  0.66234652,
        -0.39202826,  1.95832589]])
```

**MODEL CREATION**

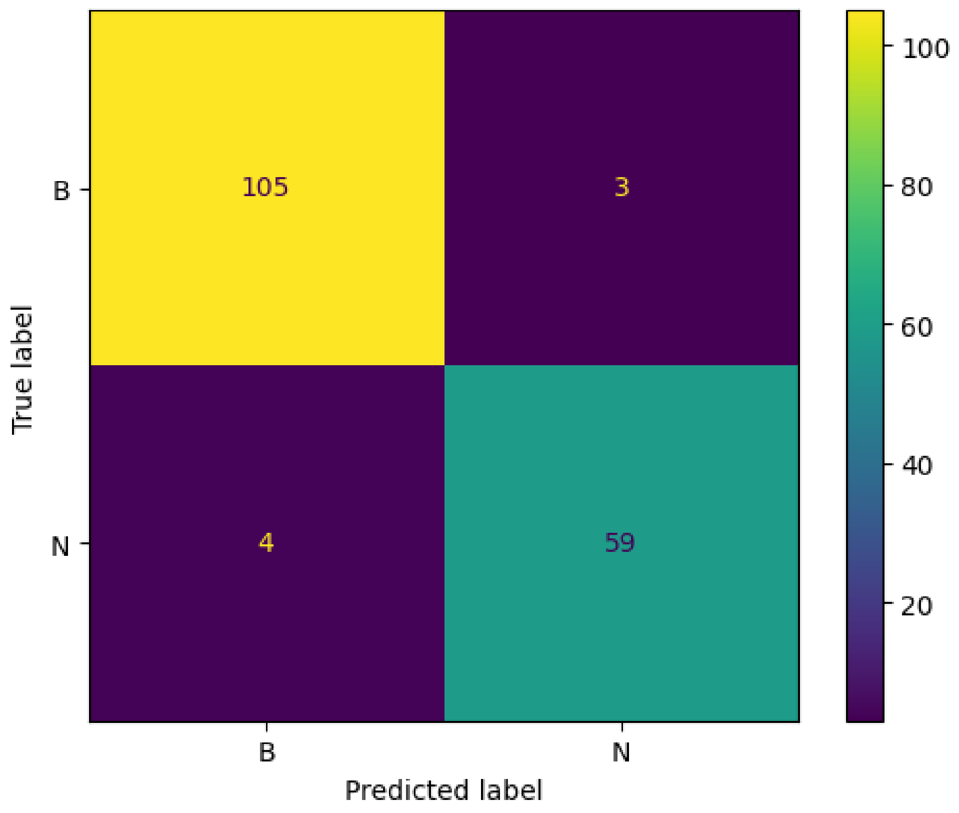
[22]:
```
from sklearn.neighbors import KNeighborsClassifier
from sklearn.ensemble import RandomForestClassifier
from sklearn.tree import DecisionTreeClassifier
from sklearn.metrics import␣
  ↪accuracy_score,confusion_matrix,ConfusionMatrixDisplay,classification_report
knn=KNeighborsClassifier(n_neighbors=7)
rfc=RandomForestClassifier(n_estimators=100,random_state=42)
tree=DecisionTreeClassifier(criterion='entropy')
```

[23]:
```
print('MODEL IS KNN')
knn.fit(x_train,y_train)
knn_pred=knn.predict(x_test)
cm=confusion_matrix(y_test,knn_pred)
print('MATRIX IS',cm)
cmd=ConfusionMatrixDisplay(cm,display_labels=['B','N'])
print('MATRIX DISPLAY IS',cmd.plot())
print('REPORT IS',classification_report(y_test,knn_pred))
```

```
MODEL IS KNN
MATRIX IS [[105   3]
 [  4  59]]
MATRIX DISPLAY IS <sklearn.metrics._plot.confusion_matrix.ConfusionMatrixDisplay
object at 0x7e3f66dfff40>
REPORT IS                precision    recall  f1-score   support

           B       0.96      0.97      0.97       108
           M       0.95      0.94      0.94        63

    accuracy                           0.96       171
   macro avg       0.96      0.95      0.96       171
weighted avg       0.96      0.96      0.96       171
```



```
[24]: print('MODEL IS DECISION TREE')
      tree.fit(x_train,y_train)
      tree_pred=tree.predict(x_test)
      cm_tree=confusion_matrix(y_test,tree_pred)
      print('MATRIX IS',cm_tree)
      print('REPORT IS',classification_report(y_test,tree_pred))
```

```
MODEL IS DECISION TREE
MATRIX IS [[106   2]
 [  5  58]]
REPORT IS               precision    recall  f1-score   support

           B       0.95      0.98      0.97       108
           M       0.97      0.92      0.94        63

    accuracy                           0.96       171
   macro avg       0.96      0.95      0.96       171
weighted avg       0.96      0.96      0.96       171
```

[25]:
```python
print('MODEL IS RANDOM FOREST')
rfc.fit(x_train,y_train)
rfc_pred=rfc.predict(x_test)
cm_rfc=confusion_matrix(y_test,rfc_pred)
print('MATRIX IS',cm_rfc)
print('REPORT IS',classification_report(y_test,rfc_pred))
```

```
MODEL IS RANDOM FOREST
MATRIX IS [[107   1]
 [  4  59]]
REPORT IS               precision    recall  f1-score   support

           B       0.96      0.99      0.98       108
           M       0.98      0.94      0.96        63

    accuracy                           0.97       171
   macro avg       0.97      0.96      0.97       171
weighted avg       0.97      0.97      0.97       171
```