Breast Cancer Classification

### → import libraries

```
import numpy as np
import pandas as pd
import matplotlib.pyplot as plt
import seaborn as sns
```

### load the data

```
df_cancer = pd.read_csv('data.csv')
df_cancer.head()
```

	id	diagnosis	radius_mean	texture_mean	perimeter_mean	area_mean	smoothness_mea
0	842302	М	17.99	10.38	122.80	1001.0	0.11840
1	842517	М	20.57	17.77	132.90	1326.0	0.08474
2	84300903	M	19.69	21.25	130.00	1203.0	0.10960
3	84348301	M	11.42	20.38	77.58	386.1	0.14250
4	84358402	М	20.29	14.34	135.10	1297.0	0.10030
5 rc	5 rows × 33 columns						
7							

## Mapping Diagnosis variable which is our Target variable to 0,1 : 1 for Malignant 0: Benign

# df\_cancer.loc[:,'diagnosis'] = df\_cancer.diagnosis.map({'M':1, 'B':0})

<ipython-input-22-1f716a526d65>:1: DeprecationWarning: In a future version, `df.iloc[:, i] = newvals` will attempt to set the value
 df\_cancer.loc[:,'diagnosis'] = df\_cancer.diagnosis.map({'M':1, 'B':0})

df\_cancer.head()

	id	diagnosis	radius_mean	texture_mean	perimeter_mean	area_mean	smoothness_mean
0	842302	1	17.99	10.38	122.80	1001.0	0.11840
1	842517	1	20.57	17.77	132.90	1326.0	0.08474
2	84300903	1	19.69	21.25	130.00	1203.0	0.10960
3	84348301	1	11.42	20.38	77.58	386.1	0.14250
4	84358402	1	20.29	14.34	135.10	1297.0	0.10030
5 rows × 33 columns							

1

→ Just looking at the tail or last 5 entries to know the distribution of data

df\_cancer.tail()

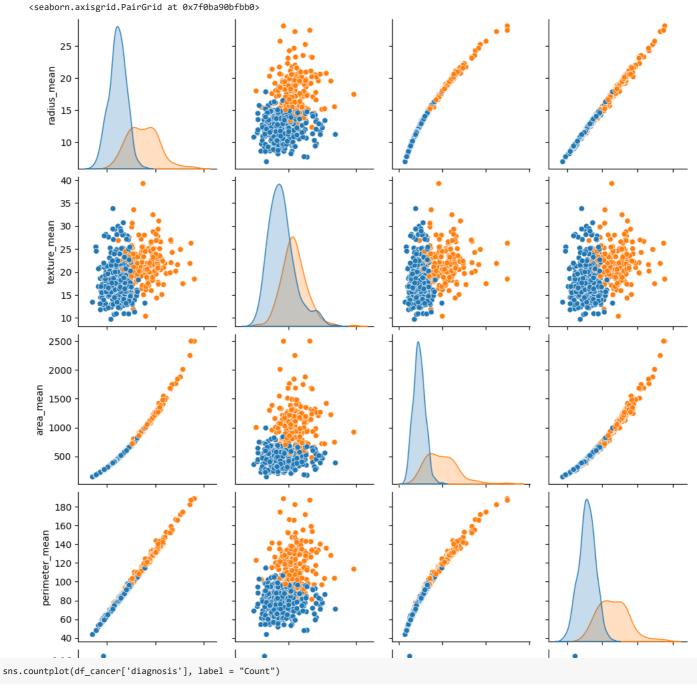
	id	diagnosis	radius_mean	texture_mean	perimeter_mean	area_mean	smoothness_mean	compactness_mean	concavity_mean	ро
564	926424	1	21.56	22.39	142.00	1479.0	0.11100	0.11590	0.24390	
565	926682	1	20.13	28.25	131.20	1261.0	0.09780	0.10340	0.14400	
566	926954	1	16.60	28.08	108.30	858.1	0.08455	0.10230	0.09251	
567	927241	1	20.60	29.33	140.10	1265.0	0.11780	0.27700	0.35140	
568	92751	0	7.76	24.54	47.92	181.0	0.05263	0.04362	0.00000	
5 rows	s × 33 colu	umns								
7										
4										•
ncer.	shape									
(569,	33)									

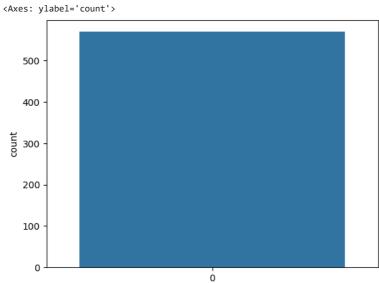
## - Checking if there are any nulls in any column

```
df_cancer.isnull().sum()
                                 0
     diagnosis
     radius_mean
                                 0
     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
                                 0
     fractal_dimension_worst
                                 0
     Unnamed: 32
                                569
     dtype: int64
```

As we have seen there are no null entries except Unnamed:32 so we will delete it later before training. Looking at the Visualization of important features in relation to target variable diagnosis to see on which features it is more related

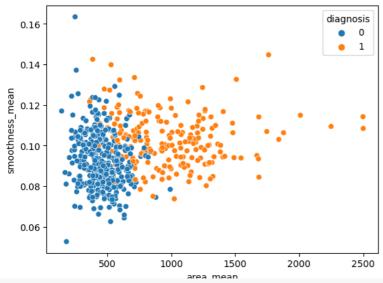
```
sns.pairplot(df_cancer, hue = 'diagnosis', vars = ['radius_mean', 'texture_mean', 'area_mean', 'perimeter_mean', 'smoothness_mean'] )
```





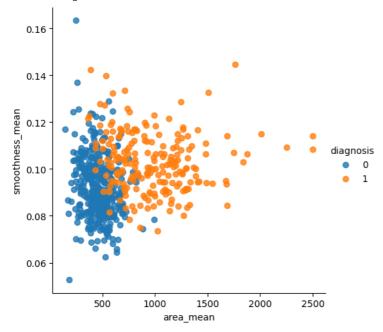
```
sns.scatterplot(x = 'area_mean', y = 'smoothness_mean', hue = 'diagnosis', data = df_cancer)
```

<Axes: xlabel='area\_mean', ylabel='smoothness\_mean'>



 $sns.lmplot(x=('area\_mean'),y=('smoothness\_mean'), \ hue = 'diagnosis', \ data = df\_cancer \ , \ fit\_reg=False)$ 





```
fig = sns.FacetGrid(df_cancer, hue="diagnosis",aspect=4)

# Next use map to plot all the possible kdeplots for the 'Age' column by the hue choice
fig.map(sns.kdeplot,'smoothness_mean',shade= True)

# Set the x max limit by the oldest passenger
oldest = df_cancer['smoothness_mean'].max()

#Since we know no one can be negative years old set the x lower limit at 0
fig.set(xlim=(0,oldest))

#Finally add a legend
fig.add_legend()
```

```
/usr/local/lib/python3.9/dist-packages/seaborn/axisgrid.py:848: FutureWarning:
     `shade` is now deprecated in favor of `fill`; setting `fill=True`.
     This will become an error in seaborn v0.14.0; please update your code.
       func(*plot_args, **plot_kwargs)
     /usr/local/lib/python3.9/dist-packages/seaborn/axisgrid.py:848: FutureWarning:
     `shade` is now deprecated in favor of `fill`; setting `fill=True`.
     This will become an error in seaborn v0.14.0; please update your code.
       func(*plot_args, **plot_kwargs)
     <seaborn.axisgrid.FacetGrid at 0x7f0ba363d7c0>
         30
         25
         20
         15
         10
          5
           0.00
                              0.02
                                                 0.04
                                                                    0.06
                                                                                      0.08
                                                                                                         0.10
                                                                                                                            0.12
                                                                                 smoothness_mean
fig = sns.FacetGrid(df_cancer, hue="diagnosis",aspect=4)
# Next use map to plot all the possible kdeplots for the 'Age' column by the hue choice
fig.map(sns.kdeplot, 'texture mean', shade= True)
# Set the x max limit by the oldest passenger
oldest = df_cancer['texture_mean'].max()
\#Since\ \ we\ know\ \ no\ \ one\ \ can\ \ be\ \ negative\ \ years\ \ old\ \ set\ \ the\ \ x\ \ lower\ \ limit\ \ at\ \ 0
fig.set(xlim=(0,oldest))
#Finally add a legend
fig.add_legend()
     /usr/local/lib/python3.9/dist-packages/seaborn/axisgrid.py:848: FutureWarning:
     `shade` is now deprecated in favor of `fill`; setting `fill=True`.
     This will become an error in seaborn v0.14.0; please update your code.
       func(*plot_args, **plot_kwargs)
     /usr/local/lib/python3.9/dist-packages/seaborn/axisgrid.py:848: FutureWarning:
      `shade` is now deprecated in favor of `fill`; setting `fill=True`
     This will become an error in seaborn v0.14.0; please update your code.
       func(*plot args, **plot kwargs)
     <seaborn.axisgrid.FacetGrid at 0x7f0ba358a9a0>
        0.12
        0.10
        0.08
      Density
                                                                                                                                        diagnosis
        0.06
                                                                                                                                        0
        0.04
        0.02
        0.00
                                                                                                                       35
                                           10
                                                          15
                                                                         20
                                                                                         25
                                                                                                        30
                                                                    texture_mean
```

```
fig = sns.FacetGrid(df_cancer, hue="diagnosis",aspect=4)

# Next use map to plot all the possible kdeplots for the 'Age' column by the hue choice
fig.map(sns.kdeplot, 'area_mean', shade= True)

# Set the x max limit by the oldest passenger
oldest = df_cancer['area_mean'].max()
```

1500

2000

```
#Since we know no one can be negative years old set the x lower limit at 0
fig.set(xlim=(0,oldest))

#Finally add a legend
fig.add_legend()

/usr/local/lib/python3.9/dist-packages/seaborn/axisgrid.py:848: FutureWarning:
    `shade` is now deprecated in favor of `fill`; setting `fill=True`.
```

```
/usr/local/lib/python3.9/dist-packages/seaborn/axisgrid.py:848: FutureWarning:

`shade` is now deprecated in favor of `fill`; setting `fill=True`.

This will become an error in seaborn v0.14.0; please update your code.

func(*plot_args, **plot_kwargs)
/usr/local/lib/python3.9/dist-packages/seaborn/axisgrid.py:848: FutureWarning:

`shade` is now deprecated in favor of `fill`; setting `fill=True`.

This will become an error in seaborn v0.14.0; please update your code.

func(*plot_args, **plot_kwargs)
<seaborn.axisgrid.FacetGrid at 0x7f0ba356c790>

0.0030
0.0025
0.00010
0.0005
```

1000

#### pip install -U seaborn

0.0000

500

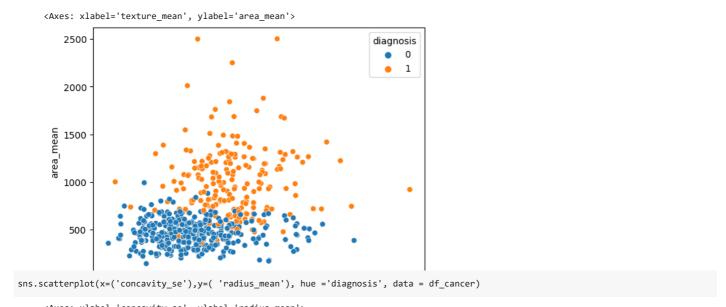
```
Looking in indexes: <a href="https://pypi.org/simple">https://us-python.pkg.dev/colab-wheels/public/simple/</a>
Requirement already satisfied: seaborn in /usr/local/lib/python3.9/dist-packages (0.12.2)
Requirement already satisfied: matplotlib!=3.6.1,>=3.1 in /usr/local/lib/python3.9/dist-packages (from seaborn) (3.7.1)
Requirement already satisfied: pandas>=0.25 in /usr/local/lib/python3.9/dist-packages (from seaborn) (1.5.3)
Requirement already satisfied: numpy!=1.24.0,>=1.17 in /usr/local/lib/python3.9/dist-packages (from seaborn) (1.22.4)
Requirement already satisfied: importlib-resources>=3.2.0 in /usr/local/lib/python3.9/dist-packages (from matplotlib!=3.6.1,>=3.1->
Requirement already satisfied: fonttools>=4.22.0 in /usr/local/lib/python3.9/dist-packages (from matplotlib!=3.6.1,>=3.1->seaborn)
Requirement already satisfied: pillow>=6.2.0 in /usr/local/lib/python3.9/dist-packages (from matplotlib!=3.6.1,>=3.1->seaborn) (8.4
Requirement already satisfied: cycler>=0.10 in /usr/local/lib/python3.9/dist-packages (from matplotlib!=3.6.1,>=3.1->seaborn) (0.11
Requirement already satisfied: kiwisolver>=1.0.1 in /usr/local/lib/python3.9/dist-packages (from matplotlib!=3.6.1,>=3.1->seaborn)
Requirement already satisfied: pyparsing>=2.3.1 in /usr/local/lib/python3.9/dist-packages (from matplotlib!=3.6.1,>=3.1->seaborn) (
Requirement already satisfied: contourpy>=1.0.1 in /usr/local/lib/python3.9/dist-packages (from matplotlib!=3.6.1,>=3.1->seaborn) (
Requirement already satisfied: python-dateutil>=2.7 in /usr/local/lib/python3.9/dist-packages (from matplotlib!=3.6.1,>=3.1->seabor
Requirement already satisfied: packaging>=20.0 in /usr/local/lib/python3.9/dist-packages (from matplotlib!=3.6.1,>=3.1->seaborn) (2
Requirement already satisfied: pytz>=2020.1 in /usr/local/lib/python3.9/dist-packages (from pandas>=0.25->seaborn) (2022.7.1)
Requirement already satisfied: zipp>=3.1.0 in /usr/local/lib/python3.9/dist-packages (from importlib-resources>=3.2.0->matplotlib!=
Requirement already satisfied: six>=1.5 in /usr/local/lib/python3.9/dist-packages (from python-dateutil>=2.7->matplotlib!=3.6.1,>=3
```

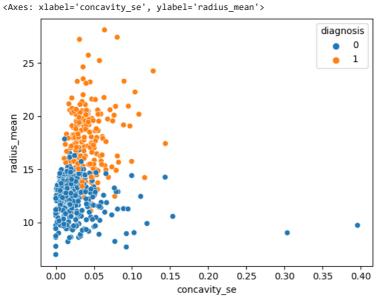
area\_mean

diagnosis

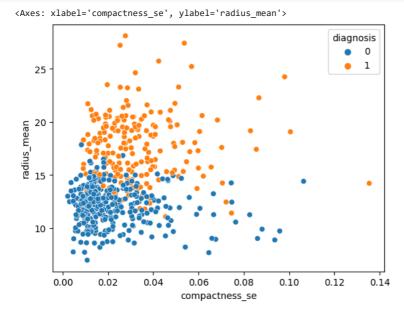
1

2500





sns.scatterplot(x=('compactness\_se'), y=('radius\_mean'), hue ='diagnosis', data = df\_cancer)



→ Spearman rank order correlation Pearson's Rank Correlation.

Double-click (or enter) to edit

```
plt.figure(figsize=(24,12))
sns.heatmap(df_cancer.corr(), annot=True)
      <Axes: >
                                                                 0.073 0.097 -0.0139.6e-05 0.05 0.044 -0.022-0.053 0.14 -0.0075 0.14
                                id -
                                            0.04
                                                  0.075
                                                           0.1
                                                                                                                                               0.18 0.097 0.034
                                       1
                        diagnosis
                                     0.04
                                              1
                                                   0.73
                                                                 0.74
                                                                        0.71
                                                                               0.36
                                                                                                     0.78
                                                                                                            0.33
                                                                                                                  -0.013
                                                                                                                                -0.00830.56
                                                                                                                                                      -0.067 0.29
                                                          0.42
                                                                                                                  -0.31
                                                                                                                                                0.74
                                            0.73
                                                                        0.99
                                                                                0.17
                                                                                                     0.82
                                                                                                            0.15
                                                                                                                                -0.097
                                                                                                                                                      -0.22
                                                                                                                                                             0.21
                    radius_mean
                                    0.075
                                                     1
                                                          0.32
                                                                   1
                   texture mean
                                     0.1
                                            0.42
                                                   0.32
                                                                               -0.023
                                                                                       0.24
                                                                                              0.3
                                                                                                     0.29
                                                                                                           0.071
                                                                                                                  -0.076
                                                                                                                          0.28
                                                                                                                                 0.39
                                                                                                                                        0.28
                                                                                                                                               0.26 0.0066 0.19
                                                            1
                                                                 0.33
                                                                        0.32
                perimeter_mean - 0.073
                                                                                              0.72
                                                                                                                                -0.087
                                                                                                                                               0.74
                                            0.74
                                                     1
                                                          0.33
                                                                   1
                                                                        0.99
                                                                               0.21
                                                                                       0.56
                                                                                                     0.85
                                                                                                            0.18
                                                                                                                  -0.26
                                                                                                                                                       -0.2
                                                                                                                                                              0.25
                                                                                                                   -0.28
                      area mean - 0.097
                                            0.71
                                                   0.99
                                                                  0.99
                                                                               0.18
                                                                                       0.5
                                                                                                     0.82
                                                                                                            0.15
                                                                                                                          0.73
                                                                                                                                 -0.066
                                                                                                                                        0.73
                                                                                                                                                0.8
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                                                          0.32
                                                                          1
                                                                                                                                         0.3
                                                                                                                                                0.25
                                    -0.013
                                            0.36
                                                   0.17
                                                         -0.023
                                                                 0.21
                                                                        0.18
                                                                                 1
                                                                                                                           0.3
                                                                                                                                 0.068
                                                                                                                                                       0.33
                                                                                                                                                              0.32
              smoothness mean
                                                                                                                                                             0.74
            compactness_mean -9.6e-05
                                                          0.24
                                                                  0.56
                                                                         0.5
                                                                                        1
                                                                                              0.88
                                                                                                     0.83
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                                                                                                                                 0.046
                                                                                                                                                0.46
                                                                                                                                                      0.14
                                     0.05
                                                           0.3
                                                                  0.72
                                                                                       0.88
                                                                                                     0.92
                                                                                                             0.5
                                                                                                                   0.34
                                                                                                                                0.076
                                                                                                                                                      0.099
                concavity mean -
                                                                                               1
          concave points_mean - 0.044
                                            0.78
                                                   0.82
                                                                 0.85
                                                                        0.82
                                                                                       0.83
                                                                                              0.92
                                                                                                      1
                                                                                                                   0.17
                                                                                                                                 0.021
                                                                                                                                        0.71
                                                                                                                                                      0.028
                                                                                                                                                             0.49
                                                          0.29
                                                                                                            0.46
                symmetry_mean
                                            0.33
                                                                                                     0.46
                                   --0.022
                                                   0.15
                                                         0.071
                                                                 0.18
                                                                        0.15
                                                                                0.56
                                                                                               0.5
                                                                                                             1
                                                                                                                   0.48
                                                                                                                           0.3
                                                                                                                                 0.13
                                                                                                                                        0.31
                                                                                                                                                0.22
                                                                                                                                                       0.19
                                                                                                                                                              0.42
        fractal_dimension_mean --0.053-0.013 -0.31 -0.076
                                                                 -0.26
                                                                        -0.28
                                                                                0.58
                                                                                              0.34
                                                                                                     0.17
                                                                                                            0.48
                                                                                                                     1
                                                                                                                          0.000110.16
                                                                                                                                        0.04
                                                                                                                                               -0.09
                                                                                                                                                       0.4
                                                                                                                                                              0.56
                                                                                       0.57
                                                                                                                 0.0001
                                                                                                                                        0.97
                                                                                                                                               0.95
                        radius_se -
                                     0.14
                                                                         0.73
                                                                                0.3
                                                                                       0.5
                                                                                                             0.3
                                                                                                                            1
                                                                                                                                 0.21
                                                                                                                                                       0.16
                                                                                                                                                             0.36
                                                          0.28
                       texture se -0.00750.00830.097
                                                                -0.087-0.066 0.068
                                                                                      0.046 0.076 0.021
                                                                                                                   0.16
                                                                                                                          0.21
                                                                                                                                   1
                                                                                                                                               0.11
                                                                                                                                                       0.4
                                                                                                                                                              0.23
                                                          0.39
                                                                                                            0.13
                                                                                                                                        0.22
                                                                                                                          0.97
                                                                                                                                 0.22
                    perimeter_se
                                     0.14
                                                          0.28
                                                                                 0.3
                                                                                                     0.71
                                                                                                                   0.04
                                                                                                                                          1
                                                                                                                                                0.94
                                                                                                                                                      0.15
                                                                                                                                                              0.42
                                                                                                            0.31
                          area se
                                     0.18
                                                   0.74
                                                          0.26
                                                                 0.74
                                                                         0.8
                                                                                0.25
                                                                                       0.46
                                                                                                                  -0.09
                                                                                                                          0.95
                                                                                                                                 0.11
                                                                                                                                        0.94
                                                                                                                                                 1
                                                                                                                                                      0.075
                                                                                                                                                             0.28
                                                                                                                          0.16
                                                                                                                                        0.15
                                                                                                                                                        1
                  smoothness se
                                   - 0.097 -0.067 -0.22 0.0066
                                                                 -0.2
                                                                        -0.17
                                                                               0.33
                                                                                       0.14
                                                                                             0.099 0.028
                                                                                                            0.19
                                                                                                                    0.4
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                                                                                                                                               0.075
                                                                                                                                                              0.34
                compactness se
                                   -0.034
                                            0.29
                                                   0.21
                                                                  0.25
                                                                        0.21
                                                                                0.32
                                                                                       0.74
                                                                                                     0.49
                                                                                                            0.42
                                                                                                                   0.56
                                                                                                                          0.36
                                                                                                                                 0.23
                                                                                                                                        0.42
                                                                                                                                                0.28
                                                                                                                                                      0.34
                                                                                                                                                               1
                                                          0.19
                    concavity_se - 0.055
                                            0.25
                                                   0.19
                                                                        0.21
                                                                                0.25
                                                                                                     0.44
                                                                                                            0.34
                                                                                                                   0.45
                                                                                                                          0.33
                                                                                                                                 0.19
                                                                                                                                                0.27
                                                                                                                                                      0.27
                                                                                                                                                               0.8
                                                          0.14
                                                                  0.23
                                                                                                                                        0.36
                                            0.41
                                                                                                                   0.34
                                                                                                                                                              0.74
              concave points se - 0.079
                                                   0.38
                                                          0.16
                                                                 0.41
                                                                        0.37
                                                                                0.38
                                                                                                            0.39
                                                                                                                                 0.23
                                                                                                                                               0.42
                                                                                                                                                      0.33
                    symmetry_se --0.017-0.0065 -0.1 0.0091-0.082-0.072
                                                                                              0.18
                                                                                                    0.095
                                                                                                                                               0.13
                                                                                                                                                             0.39
                                                                                0.2
                                                                                       0.23
                                                                                                            0.45
                                                                                                                   0.35
                                                                                                                          0.24
                                                                                                                                 0.41
                                                                                                                                        0.27
                                                                                                                                                      0.41
           fractal dimension se
                                   -0.026 0.078 -0.043 0.054-0.0055 -0.02
                                                                                              0.45
                                                                                                            0.33
                                                                                                                                 0.28
                                                                                                                                               0.13
                                                                                                                                                      0.43
                                                                                                                                                              0.8
                                                                               0.28
                                                                                                     0.26
                                                                                                                          0.23
                                                                                                                                        0.24
                                            0.78
                                                   0.97
                                                                  0.97
                                                                        0.96
                                                                                       0.54
                                                                                                     0.83
                                                                                                                  -0.25
                                                                                                                          0.72
                                                                                                                                 -0.11
                                                                                                                                                0.76
                                                                                                                                                      -0.23
                                                                                                                                                              0.2
                    radius worst
                                   -0.082
                                                          0.35
                                                                                0.21
                                                                                                            0.19
                                                                                                           0.091 -0.051
                                                                                                                                                      -0.075
                   texture worst - 0.065
                                                          0.91
                                                                               0.036
                                                                                       0.25
                                                                                                                          0.19
                                                                                                                                 0.41
                                                                                                                                         0.2
                                                                                                                                                             0.14
                                            0.46
                                                    0.3
                                                                  0.3
                                                                        0.29
                                                                                              0.3
                                                                                                     0.29
                                                                                                                                                0.2
                                                   0.97
                                                                 0.97
                                                                        0.96
                                                                                              0.73
                                                                                                     0.86
                                                                                                                                  -0.1
                                                                                                                                        0.72
                                                                                                                                               0.76
                                                                                                                                                       -0.22
                perimeter_worst
                                     0.08
                                            0.78
                                                          0.36
                                                                                0.24
                                                                                                                   -0.21
                                                                                                                          0.72
                                                                                                                                                             0.26
                                                                                                            0.22
                      area worst -
                                            0.73
                                                                  0.94
                                                                                                                   -0.23
                                                                                                                                 -0.083
                                                                                                                                        0.73
                                                                                                                                               0.81
                                                                                                                                                       -0.18
                                     0.11
                                                   0.94
                                                          0.34
                                                                        0.96
                                                                               0.21
                                                                                                     0.81
                                                                                                            0.18
                                                                                                                          0.75
                                                                                                                                                              0.2
              smoothness worst
                                     0.01
                                            0.42
                                                   0.12
                                                          0.078
                                                                 0.15
                                                                        0.12
                                                                               0.81
                                                                                              0.45
                                                                                                     0.45
                                                                                                                          0.14
                                                                                                                                -0.074
                                                                                                                                        0.13
                                                                                                                                                0.13
                                                                                                                                                      0.31
                                                                                                                                                              0.23
             compactness_worst --0.003
                                                                                0.47
                                                                                       0.87
                                                                                              0.75
                                                                                                                                -0.092
                                                                                                                                                     -0.056
                                                   0.41
                                                          0.28
                                                                  0.46
                                                                        0.39
                                                                                                            0.47
                                                                                                                   0.46
                                                                                                                          0.29
                                                                                                                                        0.34
                                                                                                                                                0.28
                                                                  0.56
                                                                                              0.88
                                                                                                                                -0.069
                                                                                                                                                      -0.058
                 concavity_worst - 0.023
                                                           0.3
                                                                                0.43
                                                                                       0.82
                                                                                                     0.75
                                                                                                            0.43
                                                                                                                   0.35
                                                                                                                          0.38
                                                                                                                                        0.42
                                                                                                                                                0.39
                                            0.79
                                                   0.74
                                                                 0.77
                                                                        0.72
                                                                                       0.82
                                                                                                     0.91
                                                                                                            0.43
                                                                                                                   0.18
                                                                                                                                                0.54
                                                                                                                                                              0.48
           concave points worst - 0.035
                                                           0.3
                                                                                0.5
                                                                                              0.86
                                                                                                                                 -0.12
                                                                                                                                                       -0.1
                symmetry_worst --0.044
                                            0.42
                                                   0.16
                                                          0.11
                                                                 0.19
                                                                        0.14
                                                                               0.39
                                                                                              0.41
                                                                                                     0.38
                                                                                                                   0.33
                                                                                                                         0.095
                                                                                                                                 -0.13
                                                                                                                                        0.11
                                                                                                                                               0.074
                                                                                                                                                      -0.11
                                                                                                                                                             0.28
                                            0.32 0.0071 0.12 0.051 0.0037
                                                                                                            0.44
                                                                                                                   0.77
                                                                                                                                -0.046 0.085 0.018
        fractal dimension worst -
                                     -0.03
                                                                                                     0.37
                                                                                                                          0.05
                                                                                                                                                       0.1
                   Unnamed: 32
                                             diagnosis
                                      .□
                                                                                                                                  texture_se
                                                    adius_mean
                                                                  perimeter_mean
                                                                          area_mean
                                                                                 smoothness_mean
                                                                                        compactness_mean
                                                                                               concavity_mean
                                                                                                      concave points_mean
                                                                                                             symmetry_mean
                                                                                                                    fractal_dimension_mean
                                                                                                                           adius_se
                                                                                                                                         perimeter_se
                                                                                                                                                 area se
                                                                                                                                                        smoothness_se
                                                                                                                                                               compactness_se
                                                           texture_mean
     4
unwantedcolumnlist=["diagnosis","Unnamed: 32","id"]
```

```
X = df_cancer.drop(unwantedcolumnlist,axis=1)
y = df_cancer['diagnosis']
```

# Now, we will split training and testing dataset using sklearn to X\_train, X\_test,y\_train,y\_test

```
from sklearn.model_selection import train_test_split
X_train, X_test, y_train, y_test = train_test_split(X, y, test_size = 0.20, random_state=5)
from sklearn.svm import SVC
from sklearn.metrics import classification_report, confusion_matrix
svc_model = SVC()
svc_model.fit(X_train, y_train)
      ▼ SVC
     SVC()
y_predict = svc_model.predict(X_test)
cm = confusion_matrix(y_test, y_predict)
     array([[66, 0],
            [ 7, 41]])
sns.heatmap(cm, annot=True)
     <Axes: >
                                                                    60
                                                                    50
                     66
      0
                                                                    40
                                                                    30
                                                                    - 20
                                                                    10
                                                1
                      0
print(classification_report(y_test, y_predict))
                   precision
                               recall f1-score
                                                   support
                0
                                  1.00
                                            0.95
                                                        66
                1
                        1.00
                                  0.85
                                            0.92
                                                        48
                                            0.94
                                                       114
         accuracy
                        0.95
                                  0.93
        macro avg
                                            0.94
                                                       114
     weighted avg
                        0.94
                                  0.94
                                            0.94
                                                       114
min_train = X_train.min()
min_train
                                  6.981000
     radius_mean
     texture_mean
                                  9.710000
     perimeter_mean
                                 43.790000
     area_mean
                                143.500000
     smoothness_mean
                                  0.052630
     compactness_mean
                                  0.019380
     concavity_mean
                                  0.000000
     concave points_mean
                                  0.000000
                                  0.106000
     symmetry mean
     fractal_dimension_mean
                                  0.049960
     radius_se
                                  0.111500
     texture_se
                                  0.362100
```

```
perimeter_se
                          0.757000
                          6.802000
area_se
smoothness_se
                          0.001713
compactness_se
                          0.002252
concavity_se
                          0.000000
concave points_se
                          0.000000
symmetry_se
                          0.007882
fractal_dimension_se
                          0.000950
radius_worst
                          7.930000
texture_worst
                         12.020000
perimeter_worst
                         50.410000
area_worst
                        185.200000
smoothness_worst
                         0.071170
compactness_worst
                          0.027290
                          0.000000
concavity worst
concave points_worst
                          0.000000
                          0.156500
symmetry_worst
fractal_dimension_worst
                          0.055040
dtype: float64
```

range\_train = (X\_train - min\_train).max()
range\_train

radius\_mean 21,129000 29.570000 texture\_mean perimeter\_mean 144.710000 area\_mean 2355.500000 smoothness\_mean 0.110770 compactness\_mean 0.326020 concavity\_mean 0.426800 concave points\_mean 0.201200 symmetry\_mean 0.198000 fractal\_dimension\_mean 0.045790 radius se 2.761500 texture\_se 4.522900 21.223000 perimeter\_se 518.798000 area\_se smoothness\_se 0.029417 compactness\_se 0.133148 concavity\_se 0.396000 0.052790 concave points\_se 0.071068 symmetry\_se fractal\_dimension\_se 0.028890 radius\_worst 25.190000 37.520000 texture worst 170.390000 perimeter\_worst 3246.800000 area worst smoothness\_worst 0.129430 compactness\_worst 1.030710 concavity\_worst 1.105000 0.291000 concave points\_worst symmetry\_worst 0.420900 fractal\_dimension\_worst 0.152460 dtype: float64

 $X_{\text{train\_scaled}} = (X_{\text{train}} - \min_{\text{train}})/\text{range\_train}$ 

X\_train\_scaled.head()

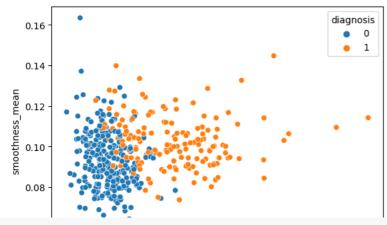
	radius_mean	texture_mean	perimeter_mean	area_mean	smoothness_mean	compactness_mean
306	0.294335	0.206628	0.278350	0.167183	0.293220	0.101620
410	0.207251	0.265810	0.198328	0.108809	0.324546	0.103521
197	0.525297	0.410213	0.508673	0.373806	0.190304	0.205632
376	0.169861	0.355428	0.182157	0.082700	0.343956	0.449727
244	0.587770	0.466351	0.589524	0.429421	0.452018	0.418441

5 rows × 30 columns



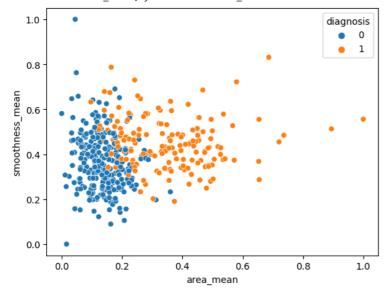
 $sns.scatterplot(x = X\_train['area\_mean'], \ y = X\_train['smoothness\_mean'], \ hue = y\_train)$ 

```
<Axes: xlabel='area_mean', ylabel='smoothness_mean'>
```



 $sns.scatterplot(x = X\_train\_scaled['area\_mean'], \ y = X\_train\_scaled['smoothness\_mean'], \ hue = y\_train)$ 

<Axes: xlabel='area\_mean', ylabel='smoothness\_mean'>

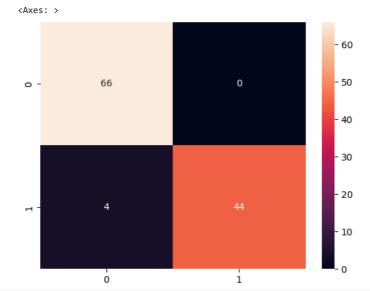


```
min_test = X_test.min()
range_test = (X_test - min_test).max()
X_test_scaled = (X_test - min_test)/range_test
```

```
from sklearn.svm import SVC
from sklearn.metrics import classification_report, confusion_matrix
svc_model = SVC()
svc_model.fit(X_train_scaled, y_train)
```

▼ SVC SVC()

```
y_predict = svc_model.predict(X_test_scaled)
cm = confusion_matrix(y_test, y_predict)
sns.heatmap(cm,annot=True,fmt="d")
```



print(classification\_report(y\_test,y\_predict))

	precision	recall	f1-score	support
0 1	0.94 1.00	1.00 0.92	0.97 0.96	66 48
accuracy macro avg weighted avg	0.97 0.97	0.96 0.96	0.96 0.96 0.96	114 114 114

param\_grid = {'C': [0.1, 1, 10, 100], 'gamma': [1, 0.1, 0.01, 0.001], 'kernel': ['rbf']}

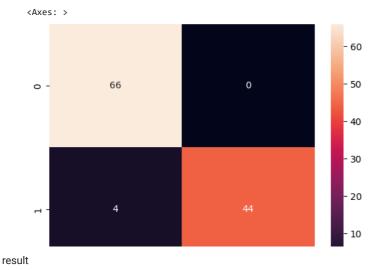
 ${\tt from \ sklearn.model\_selection \ import \ GridSearchCV}$ 

grid = GridSearchCV(SVC(),param\_grid,refit=True,verbose=4)

grid.fit(X\_train\_scaled,y\_train)

₽

```
Fitting 5 folds for each of 16 candidates, totalling 80 fits
     [CV 1/5] END ......C=0.1, gamma=1, kernel=rbf;, score=1.000 total time=
                                                                                 0.05
     [CV 2/5] END ......C=0.1, gamma=1, kernel=rbf;, score=0.945 total time= \frac{1}{2}
                                                                                 0.05
     [CV 3/5] END ......C=0.1, gamma=1, kernel=rbf;, score=0.912 total time=
                                                                                 0.0s
     [CV 4/5] END ......C=0.1, gamma=1, kernel=rbf;, score=0.956 total time= \,
                                                                                 0.0s
     [CV 5/5] END ......C=0.1, gamma=1, kernel=rbf;, score=0.934 total time= \,
                                                                                 9.95
     [CV 1/5] END ......C=0.1, gamma=0.1, kernel=rbf;, score=0.945 total time=
                                                                                 0.05
     [CV 2/5] END .....C=0.1, gamma=0.1, kernel=rbf;, score=0.901 total time=
                                                                                 0.05
     [CV 3/5] END .....C=0.1, gamma=0.1, kernel=rbf;, score=0.890 total time=
     [CV 4/5] END .....C=0.1, gamma=0.1, kernel=rbf;, score=0.923 total time=
     [CV 5/5] END .....C=0.1, gamma=0.1, kernel=rbf;, score=0.868 total time=
                                                                                 0.0s
     [CV 1/5] END .....C=0.1, gamma=0.01, kernel=rbf;, score=0.648 total time=
                                                                                 0.05
     [CV 2/5] END .....C=0.1, gamma=0.01, kernel=rbf;, score=0.637 total time=
                                                                                 0.05
     [CV 3/5] END .....C=0.1, gamma=0.01, kernel=rbf;, score=0.637 total time=
                                                                                 0.0s
     [CV 4/5] END .....C=0.1, gamma=0.01, kernel=rbf;, score=0.637 total time= \,
                                                                                 0.0s
     [CV 5/5] END .....C=0.1, gamma=0.01, kernel=rbf;, score=0.637 total time= \frac{1}{2}
                                                                                 0.05
     [CV 1/5] END ....C=0.1, gamma=0.001, kernel=rbf;, score=0.648 total time=
                                                                                 0.05
     [CV 2/5] END ....C=0.1, gamma=0.001, kernel=rbf;, score=0.637 total time=
                                                                                 0.05
     [CV 3/5] END ....C=0.1, gamma=0.001, kernel=rbf;, score=0.637 total time=
                                                                                 0.0s
     [CV 4/5] END ....C=0.1, gamma=0.001, kernel=rbf;, score=0.637 total time=
     [CV 5/5] END ....C=0.1, gamma=0.001, kernel=rbf;, score=0.637 total time=
     [CV 1/5] END ......C=1, gamma=1, kernel=rbf;, score=1.000 total time=
                                                                                 0.05
     [CV 2/5] END ......C=1, gamma=1, kernel=rbf;, score=0.956 total time=
                                                                                 0.05
     [CV 3/5] END ......C=1, gamma=1, kernel=rbf;, score=0.967 total time=
                                                                                 0.0s
     [CV 4/5] END ......C=1, gamma=1, kernel=rbf;, score=1.000 total time= \frac{1}{2}
                                                                                 0.05
     [CV 5/5] END .........C=1, gamma=1, kernel=rbf;, score=0.967 total time=
                                                                                 0.05
     [CV 1/5] END ......C=1, gamma=0.1, kernel=rbf;, score=0.989 total time=
                                                                                 0.05
     [CV 2/5] END ......C=1, gamma=0.1, kernel=rbf;, score=0.945 total time=
                                                                                 0.05
     [CV 3/5] END ......C=1, gamma=0.1, kernel=rbf;, score=0.923 total time=
                                                                                 0.0s
     [CV 4/5] END ......C=1, gamma=0.1, kernel=rbf;, score=0.967 total time=
                                                                                 0.0s
     [CV 5/5] END ......C=1, gamma=0.1, kernel=rbf;, score=0.934 total time=
     [CV 1/5] END .....C=1, gamma=0.01, kernel=rbf;, score=0.945 total time=
     [CV 2/5] END ......C=1, gamma=0.01, kernel=rbf;, score=0.901 total time=
                                                                                 0.05
     [CV 3/5] END ......C=1, gamma=0.01, kernel=rbf;, score=0.879 total time=
                                                                                 0.0s
     [CV 4/5] END ......C=1, gamma=0.01, kernel=rbf;, score=0.923 total time= \,
                                                                                 0.0s
     [CV 5/5] END ......C=1, gamma=0.01, kernel=rbf;, score=0.868 total time=
                                                                                 0.05
     [CV 1/5] END .....C=1, gamma=0.001, kernel=rbf;, score=0.648 total time=
                                                                                 0.05
     [CV 2/5] END .....C=1, gamma=0.001, kernel=rbf;, score=0.637 total time=
                                                                                 0.05
     [CV 3/5] END .....C=1, gamma=0.001, kernel=rbf;, score=0.637 total time=
                                                                                 0.0s
     [CV 4/5] END .....C=1, gamma=0.001, kernel=rbf;, score=0.637 total time=
                                                                                 0.0s
     [CV 5/5] END .....C=1, gamma=0.001, kernel=rbf;, score=0.637 total time=
     [CV 1/5] END ......C=10, gamma=1, kernel=rbf;, score=1.000 total time=
                                                                                 0.05
     [CV 2/5] END .....C=10, gamma=1, kernel=rbf;, score=0.967 total time=
     [CV 3/5] END ......C=10, gamma=1, kernel=rbf;, score=0.956 total time=
                                                                                 0.0s
     [CV 4/5] END ......C=10, gamma=1, kernel=rbf;, score=1.000 total time=
                                                                                 0.0s
     [CV 5/5] END ......C=10, gamma=1, kernel=rbf;, score=0.956 total time=
                                                                                 0.05
     [CV 1/5] END ......C=10, gamma=0.1, kernel=rbf;, score=1.000 total time=
                                                                                 0.05
     [CV 2/5] END ......C=10, gamma=0.1, kernel=rbf;, score=0.967 total time=
                                                                                 0.0s
     [CV 3/5] END ......C=10, gamma=0.1, kernel=rbf;, score=0.967 total time=
                                                                                 0.0s
     [CV 4/5] END ......C=10, gamma=0.1, kernel=rbf;, score=0.989 total time= \frac{1}{2}
                                                                                 0.0s
     [CV 5/5] END ......C=10, gamma=0.1, kernel=rbf;, score=0.945 total time=
     [CV 1/5] END .....C=10, gamma=0.01, kernel=rbf;, score=0.989 total time=
     [CV 2/5] END .....C=10, gamma=0.01, kernel=rbf;, score=0.945 total time=
                                                                                 0.0s
     [CV 3/5] END .....C=10, gamma=0.01, kernel=rbf;, score=0.923 total time=
                                                                                 0.0s
     [CV 4/5] END .....C=10, gamma=0.01, kernel=rbf;, score=0.967 total time=
                                                                                 0.05
     [0. 2,5] 2.B ..... 25, Bamma 0.002, No....2 .0., 500.0 0.502 cour came
grid.best_params_
     {'C': 1, 'gamma': 1, 'kernel': 'rbf'}
     [COL 4/5] FND C 400 ------ 1 |-----1 mbC. ----- 0 000 +-+-1 +---
grid.best_estimator_
             SVC
     SVC(C=1, gamma=1)
     [CV 1/5] FND
                       C=100 gamma=0 01 kernel=rhf· score=1 000 total time= 0 0s
grid_predictions = grid.predict(X_test_scaled)
                       C-100 gamma-0 01 kannal-nhf. ccone-0 000 total time-
cm = confusion_matrix(y_test, grid_predictions)
sns.heatmap(cm,annot=True,fmt="d")
```



print(classification\_report(y\_test,grid\_predictions))

	precision	recall	f1-score	support	
0	0.94	1.00	0.97	66	
1	1.00	0.92	0.96	48	
accuracy			0.96	114	
macro avg	0.97	0.96	0.96	114	
weighted avg	0.97	0.96	0.96	114	

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