2.0.Feature-Selection-Methods

May 15, 2023

[128]:
```
import pandas as pd
import numpy as np
import seaborn as sns
import matplotlib.pyplot as plt
import time
from subprocess import check_output

from scipy import stats
plt.style.use("ggplot")
import warnings
warnings.filterwarnings("ignore")
from scipy import stats
```

[160]:
```
data=pd.read_csv('wdbc.data',header=None)
```

data.head()

[130]:
```
headers=['id','diagnosis','mean_radius','mean_texture','mean_perimeter','mean_area','mean_smoo
  ↪points','mean_symmetry','mean_fractal␣
  ↪dimension','SE_radius','SE_texture','SE_perimeter','SE_area','SE_smoothness','SE_compactnes
  ↪points','SE_symmetry','SE_fractal␣
  ↪dimension','worst_radius','worst_texture','worst_perimeter','worst_area','worst_smoothness'
  ↪points','worst_symmetry','worst_fractal dimension']
```

[131]:
```
data.to_csv('labeledData.csv',header=headers,index=False)
```

[161]:
```
data=pd.read_csv('labeledData.csv')
data.head()
```

[161]:
```
         id diagnosis  mean_radius  mean_texture  mean_perimeter  mean_area
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

   mean_smoothness  mean_compactness  mean_concavity  mean_concave points
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

   …  worst_radius  worst_texture  worst_perimeter  worst_area  
0  …         25.38          17.33           184.60      2019.0  \
1  …         24.99          23.41           158.80      1956.0   
2  …         23.57          25.53           152.50      1709.0   
3  …         14.91          26.50            98.87       567.7   
4  …         22.54          16.67           152.20      1575.0   

   worst_smoothness  worst_compactness  worst_concavity  worst_concave points  \
0            0.1622             0.6656           0.7119                0.2654   
1            0.1238             0.1866           0.2416                0.1860   
2            0.1444             0.4245           0.4504                0.2430   
3            0.2098             0.8663           0.6869                0.2575   
4            0.1374             0.2050           0.4000                0.1625   

   worst_symmetry  worst_fractal dimension  
0          0.4601                  0.11890  
1          0.2750                  0.08902  
2          0.3613                  0.08758  
3          0.6638                  0.17300  
4          0.2364                  0.07678  

[5 rows x 32 columns]
```

[162]:
```
data.shape
```

[162]:
```
(569, 32)
```

[163]:
```
data.isna().sum()
```

[163]:
```
id                         0
diagnosis                  0
mean_radius                0
mean_texture               0
mean_perimeter             0
mean_area                  0
mean_smoothness            0
mean_compactness           0
mean_concavity             0
mean_concave points        0
mean_symmetry              0
mean_fractal dimension     0
SE_radius                  0
```

```
SE_texture                 0
SE_perimeter               0
SE_area                    0
SE_smoothness              0
SE_compactness             0
SE_concavity               0
SE_concave points          0
SE_symmetry                0
SE_fractal dimension       0
worst_radius               0
worst_texture              0
worst_perimeter            0
worst_area                 0
worst_smoothness           0
worst_compactness          0
worst_concavity            0
worst_concave points       0
worst_symmetry             0
worst_fractal dimension    0
dtype: int64
```

[164]:
```
data['diagnosis'].value_counts()
```

[164]:
```
diagnosis
B    357
M    212
Name: count, dtype: int64
```

[165]:
```
data.dtypes
```

[165]:
```
id                           int64
diagnosis                   object
mean_radius                float64
mean_texture               float64
mean_perimeter             float64
mean_area                  float64
mean_smoothness            float64
mean_compactness           float64
mean_concavity             float64
mean_concave points        float64
mean_symmetry              float64
mean_fractal dimension     float64
SE_radius                  float64
SE_texture                 float64
SE_perimeter               float64
SE_area                    float64
SE_smoothness              float64
```

```
SE_compactness             float64
SE_concavity               float64
SE_concave points          float64
SE_symmetry                float64
SE_fractal dimension       float64
worst_radius               float64
worst_texture              float64
worst_perimeter            float64
worst_area                 float64
worst_smoothness           float64
worst_compactness          float64
worst_concavity            float64
worst_concave points       float64
worst_symmetry             float64
worst_fractal dimension    float64
dtype: object
```

[166]:

```
list=['id','diagnosis']
y=data.diagnosis
x=data.drop(list,axis=1)
x.head()
```

[166]:

```
   mean_radius  mean_texture  mean_perimeter  mean_area  mean_smoothness  \
0        17.99         10.38          122.80     1001.0          0.11840
1        20.57         17.77          132.90     1326.0          0.08474
2        19.69         21.25          130.00     1203.0          0.10960
3        11.42         20.38           77.58      386.1          0.14250
4        20.29         14.34          135.10     1297.0          0.10030

   mean_compactness  mean_concavity  mean_concave points  mean_symmetry  \
0           0.27760          0.3001              0.14710         0.2419
1           0.07864          0.0869              0.07017         0.1812
2           0.15990          0.1974              0.12790         0.2069
3           0.28390          0.2414              0.10520         0.2597
4           0.13280          0.1980              0.10430         0.1809

   mean_fractal dimension  …  worst_radius  worst_texture  worst_perimeter  \
0                 0.07871  …         25.38          17.33           184.60
1                 0.05667  …         24.99          23.41           158.80
2                 0.05999  …         23.57          25.53           152.50
3                 0.09744  …         14.91          26.50            98.87
4                 0.05883  …         22.54          16.67           152.20

   worst_area  worst_smoothness  worst_compactness  worst_concavity  \
0      2019.0            0.1622             0.6656           0.7119
1      1956.0            0.1238             0.1866           0.2416
2      1709.0            0.1444             0.4245           0.4504
```

```
3      567.7            0.2098             0.8663            0.6869
4     1575.0            0.1374             0.2050            0.4000

   worst_concave points  worst_symmetry  worst_fractal dimension
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

[5 rows x 30 columns]
```

[167]:

```
x.describe()
```

[167]:

```
       mean_radius  mean_texture  mean_perimeter    mean_area
count   569.000000    569.000000      569.000000   569.000000  \
mean     14.127292     19.289649       91.969033   654.889104
std       3.524049      4.301036       24.298981   351.914129
min       6.981000      9.710000       43.790000   143.500000
25%      11.700000     16.170000       75.170000   420.300000
50%      13.370000     18.840000       86.240000   551.100000
75%      15.780000     21.800000      104.100000   782.700000
max      28.110000     39.280000      188.500000  2501.000000

       mean_smoothness  mean_compactness  mean_concavity  mean_concave points
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

       mean_symmetry  mean_fractal dimension  …  worst_radius
count     569.000000              569.000000  …    569.000000  \
mean        0.181162                0.062798  …     16.269190
std         0.027414                0.007060  …      4.833242
min         0.106000                0.049960  …      7.930000
25%         0.161900                0.057700  …     13.010000
50%         0.179200                0.061540  …     14.970000
75%         0.195700                0.066120  …     18.790000
max         0.304000                0.097440  …     36.040000

       worst_texture  worst_perimeter  worst_area  worst_smoothness
count     569.000000       569.000000  569.000000        569.000000  \
mean       25.677223       107.261213  880.583128          0.132369
```

```
std          6.146258        33.602542   569.356993           0.022832
min         12.020000        50.410000   185.200000           0.071170
25%         21.080000        84.110000   515.300000           0.116600
50%         25.410000        97.660000   686.500000           0.131300
75%         29.720000       125.400000  1084.000000           0.146000
max         49.540000       251.200000  4254.000000           0.222600

       worst_compactness  worst_concavity  worst_concave points  \
count         569.000000       569.000000            569.000000
mean            0.254265         0.272188              0.114606
std             0.157336         0.208624              0.065732
min             0.027290         0.000000              0.000000
25%             0.147200         0.114500              0.064930
50%             0.211900         0.226700              0.099930
75%             0.339100         0.382900              0.161400
max             1.058000         1.252000              0.291000

       worst_symmetry  worst_fractal dimension
count      569.000000               569.000000
mean         0.290076                 0.083946
std          0.061867                 0.018061
min          0.156500                 0.055040
25%          0.250400                 0.071460
50%          0.282200                 0.080040
75%          0.317900                 0.092080
max          0.663800                 0.207500

[8 rows x 30 columns]
```

[169]:

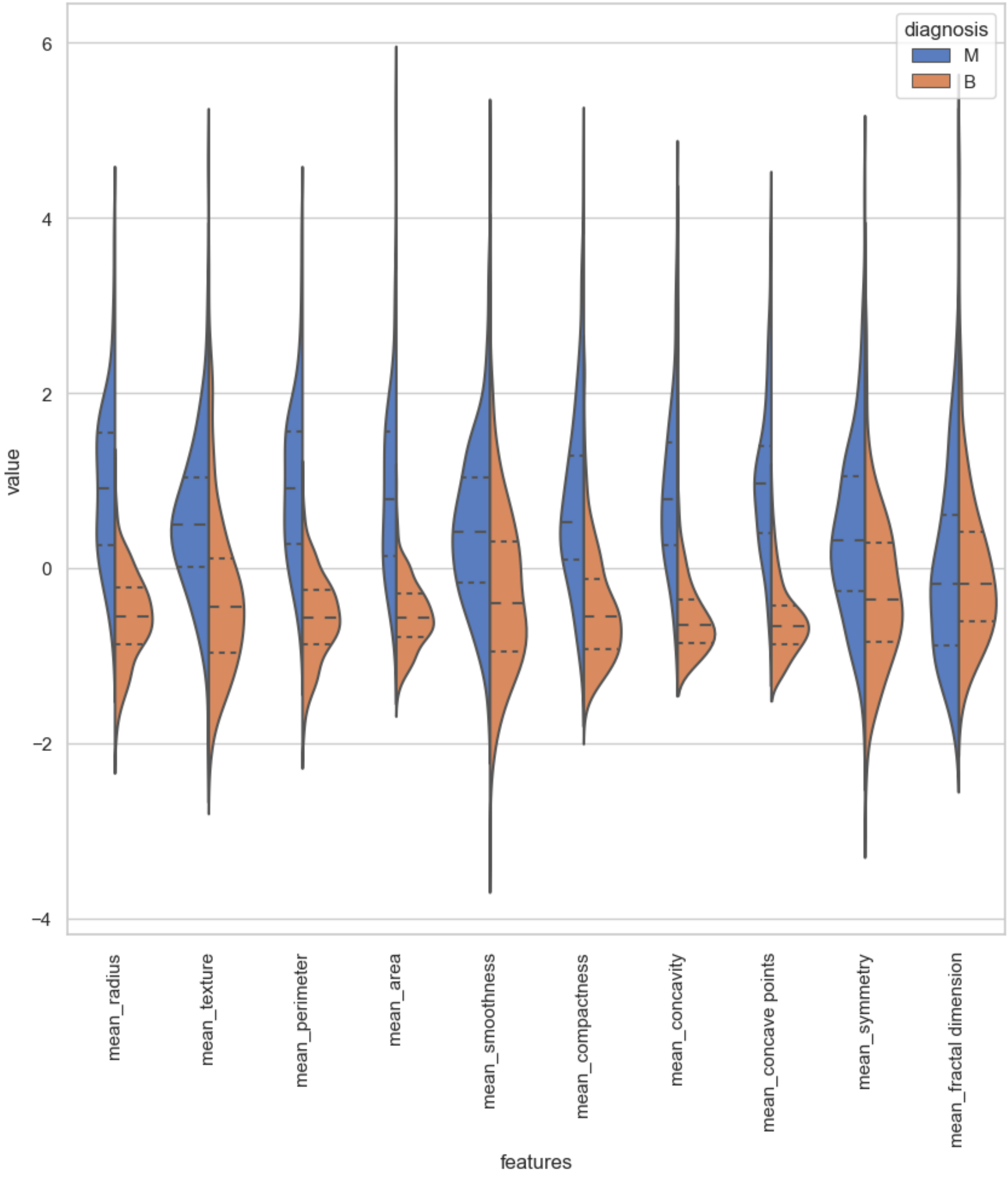
```
diag=y
data=x
data_std=(data-data.mean())/(data.std())
```

[170]:

```
data=pd.concat([y,data_std.iloc[:,0:10]],axis=1)
data=pd.melt(data,id_vars='diagnosis',var_name='features',value_name='value')
plt.figure(figsize=(10,10))
sns.
  ↪violinplot(x='features',y='value',hue='diagnosis',data=data,split=True,inner='quart')
plt.xticks(rotation=90)
```

[170]:

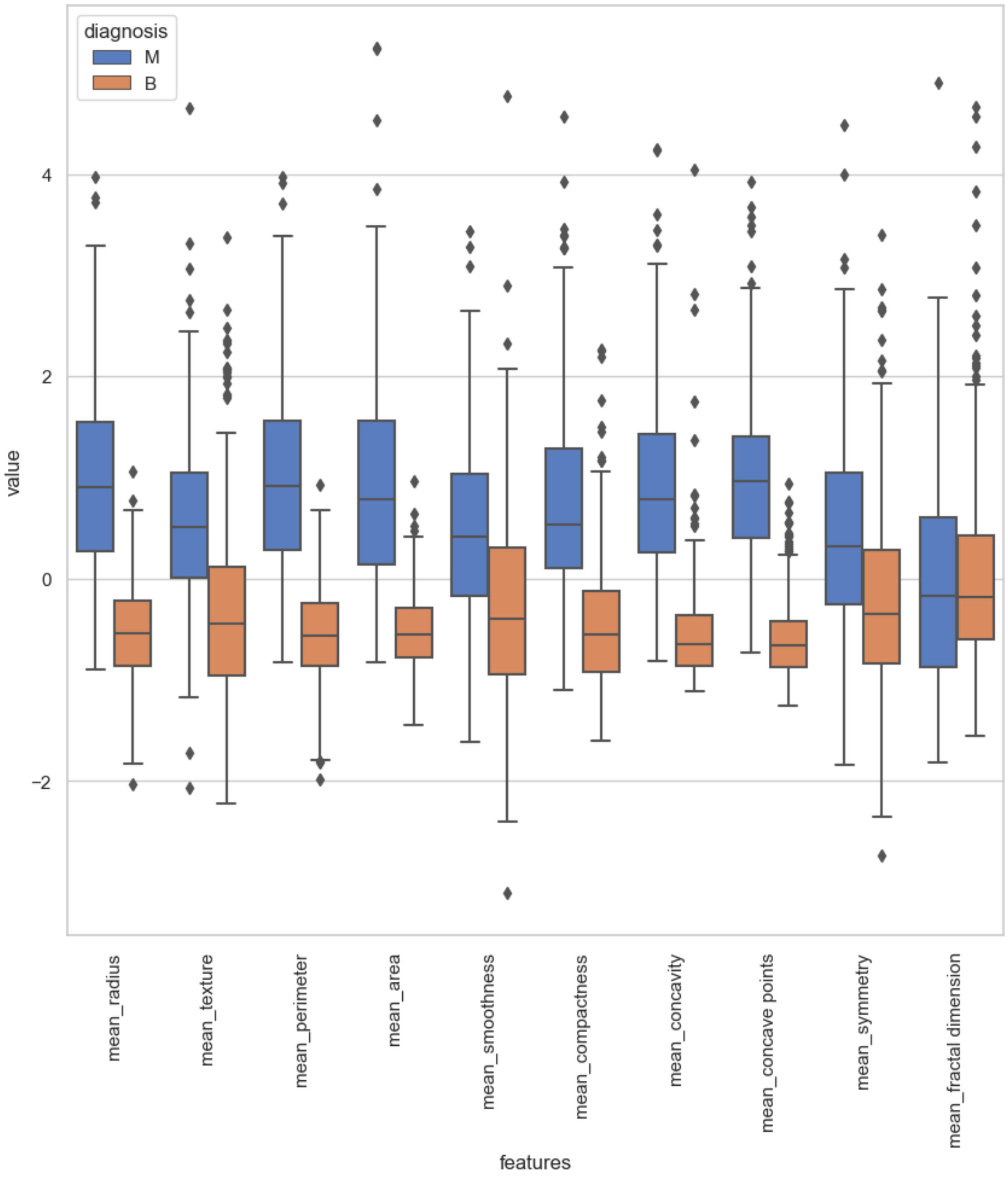
```
(array([0, 1, 2, 3, 4, 5, 6, 7, 8, 9]),
 [Text(0, 0, 'mean_radius'),
  Text(1, 0, 'mean_texture'),
  Text(2, 0, 'mean_perimeter'),
  Text(3, 0, 'mean_area'),
  Text(4, 0, 'mean_smoothness'),
  Text(5, 0, 'mean_compactness'),
  Text(6, 0, 'mean_concavity'),
  Text(7, 0, 'mean_concave points'),
  Text(8, 0, 'mean_symmetry'),
  Text(9, 0, 'mean_fractal dimension')])
```



[171]:

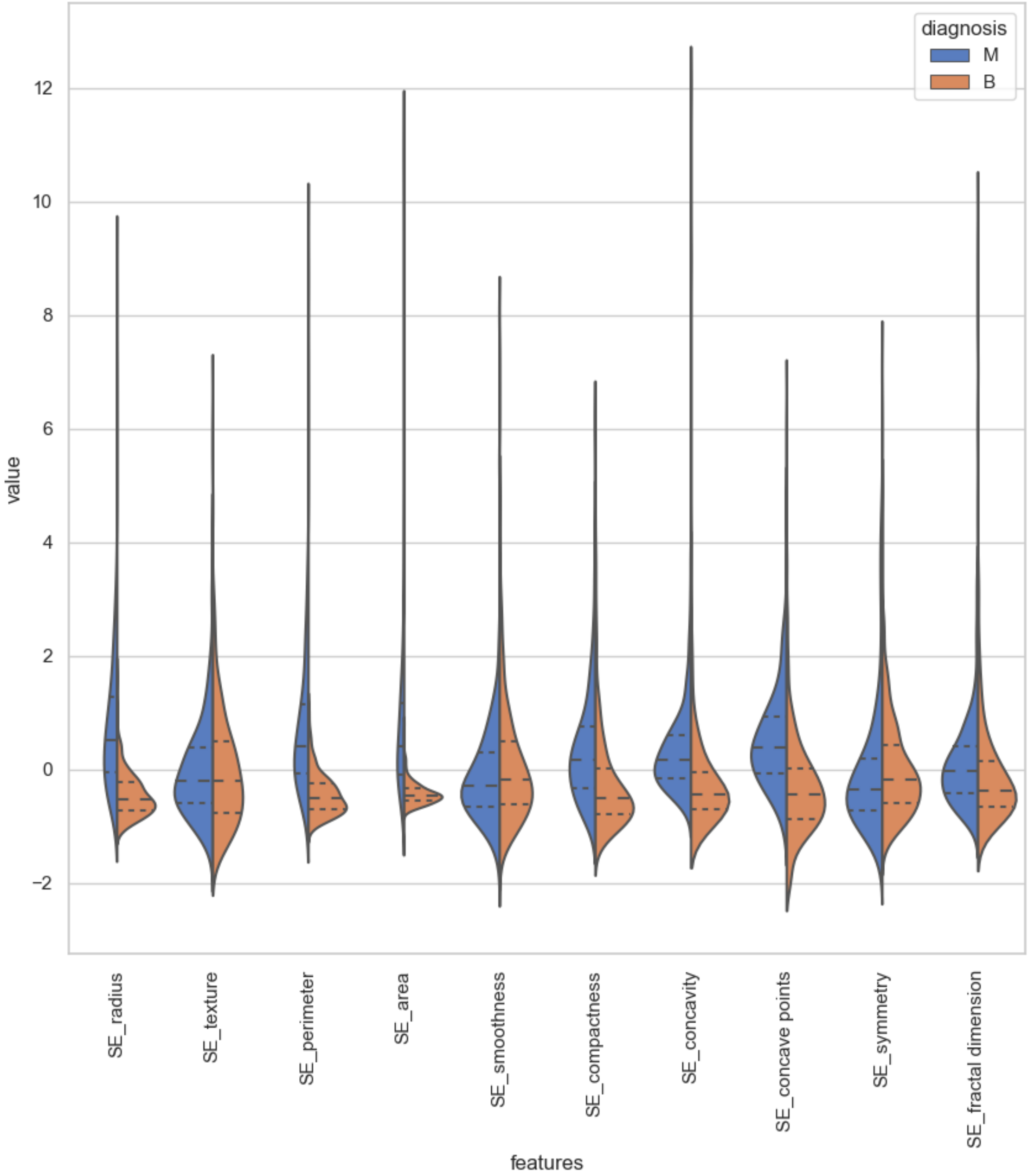
```
plt.figure(figsize=(10,10))
sns.boxplot(x="features",y="value",hue='diagnosis',data=data)
plt.xticks(rotation=90)
```

```
[171]: (array([0, 1, 2, 3, 4, 5, 6, 7, 8, 9]),
        [Text(0, 0, 'mean_radius'),
         Text(1, 0, 'mean_texture'),
         Text(2, 0, 'mean_perimeter'),
         Text(3, 0, 'mean_area'),
         Text(4, 0, 'mean_smoothness'),
         Text(5, 0, 'mean_compactness'),
         Text(6, 0, 'mean_concavity'),
         Text(7, 0, 'mean_concave points'),
         Text(8, 0, 'mean_symmetry'),
         Text(9, 0, 'mean_fractal dimension')])
```



```
[172]: data = pd.concat([y,data_std.iloc[:,10:20]],axis=1)
       data = pd.melt(data,id_vars="diagnosis",
                           var_name="features",
                           value_name='value')
       plt.figure(figsize=(10,10))
       sns.violinplot(x="features", y="value", hue="diagnosis", data=data,split=True,␣
        ↪inner="quart")
       plt.xticks(rotation=90)
```

```
[172]: (array([0, 1, 2, 3, 4, 5, 6, 7, 8, 9]),
        [Text(0, 0, 'SE_radius'),
         Text(1, 0, 'SE_texture'),
         Text(2, 0, 'SE_perimeter'),
         Text(3, 0, 'SE_area'),
         Text(4, 0, 'SE_smoothness'),
         Text(5, 0, 'SE_compactness'),
         Text(6, 0, 'SE_concavity'),
         Text(7, 0, 'SE_concave points'),
         Text(8, 0, 'SE_symmetry'),
         Text(9, 0, 'SE_fractal dimension')])
```

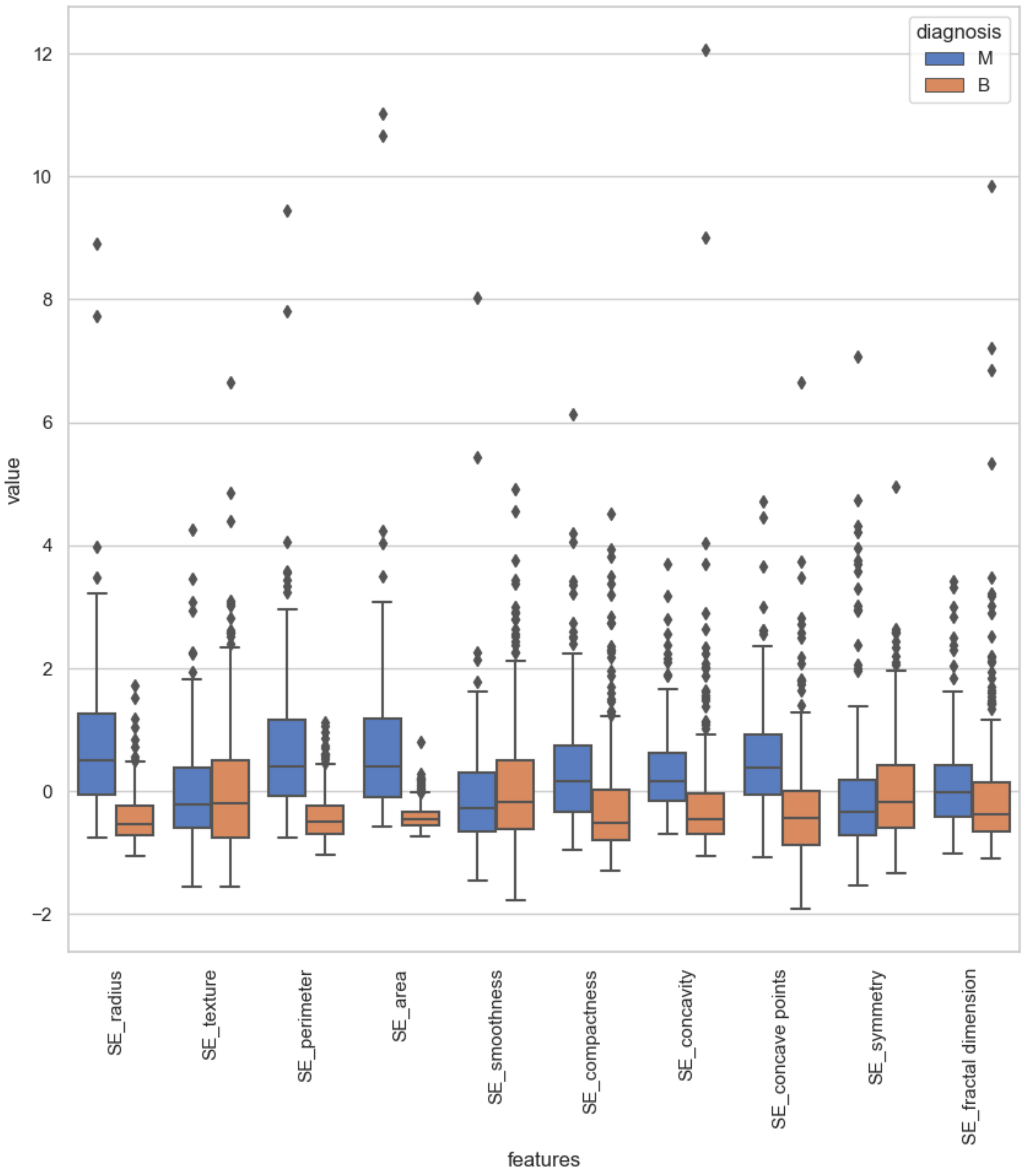


[173]:

```
plt.figure(figsize=(10,10))
sns.boxplot(x="features",y="value",hue='diagnosis',data=data)
plt.xticks(rotation=90)
```

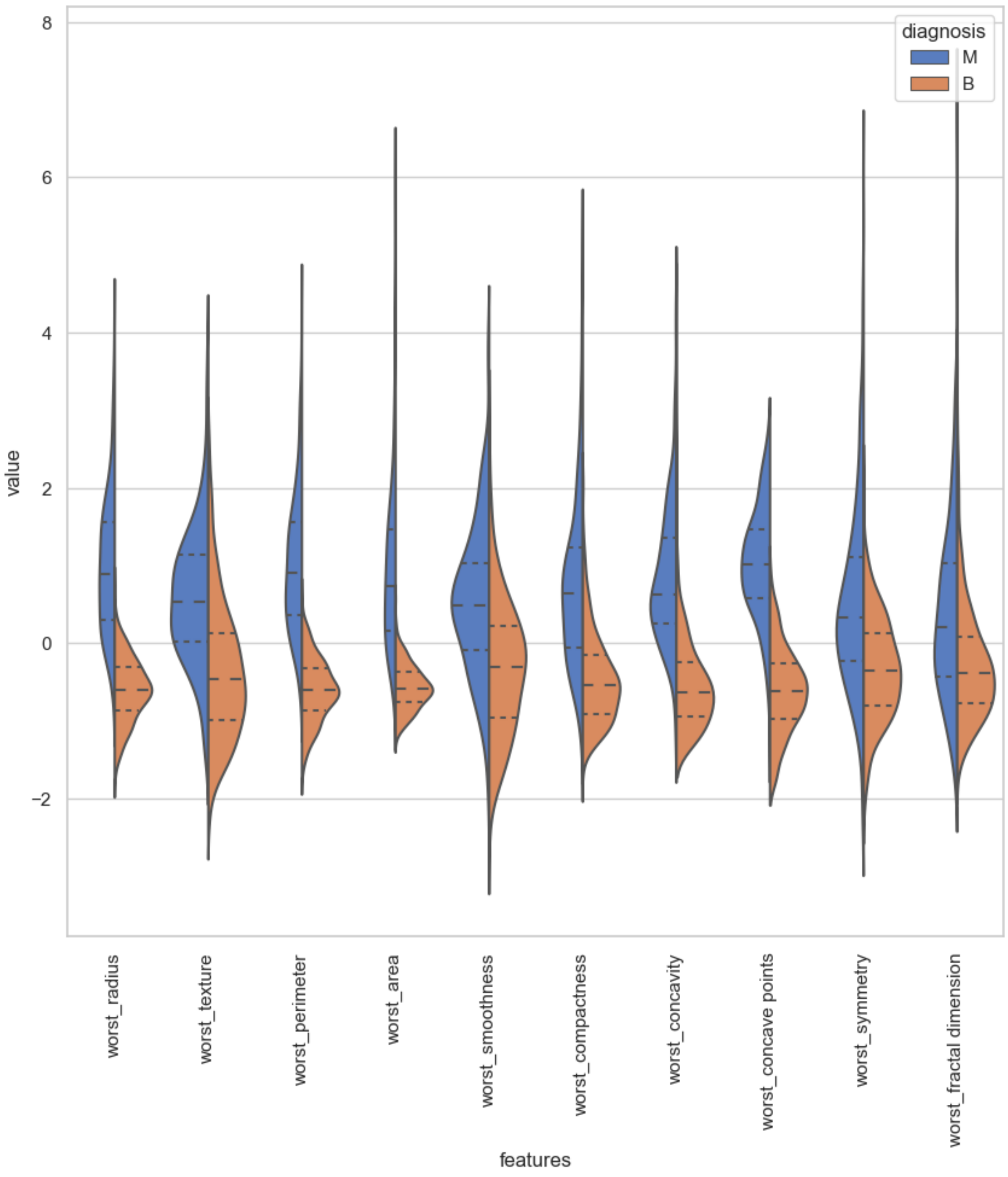
[173]:

```
(array([0, 1, 2, 3, 4, 5, 6, 7, 8, 9]),
 [Text(0, 0, 'SE_radius'),
  Text(1, 0, 'SE_texture'),
  Text(2, 0, 'SE_perimeter'),
  Text(3, 0, 'SE_area'),
  Text(4, 0, 'SE_smoothness'),
  Text(5, 0, 'SE_compactness'),
  Text(6, 0, 'SE_concavity'),
  Text(7, 0, 'SE_concave points'),
  Text(8, 0, 'SE_symmetry'),
  Text(9, 0, 'SE_fractal dimension')])
```



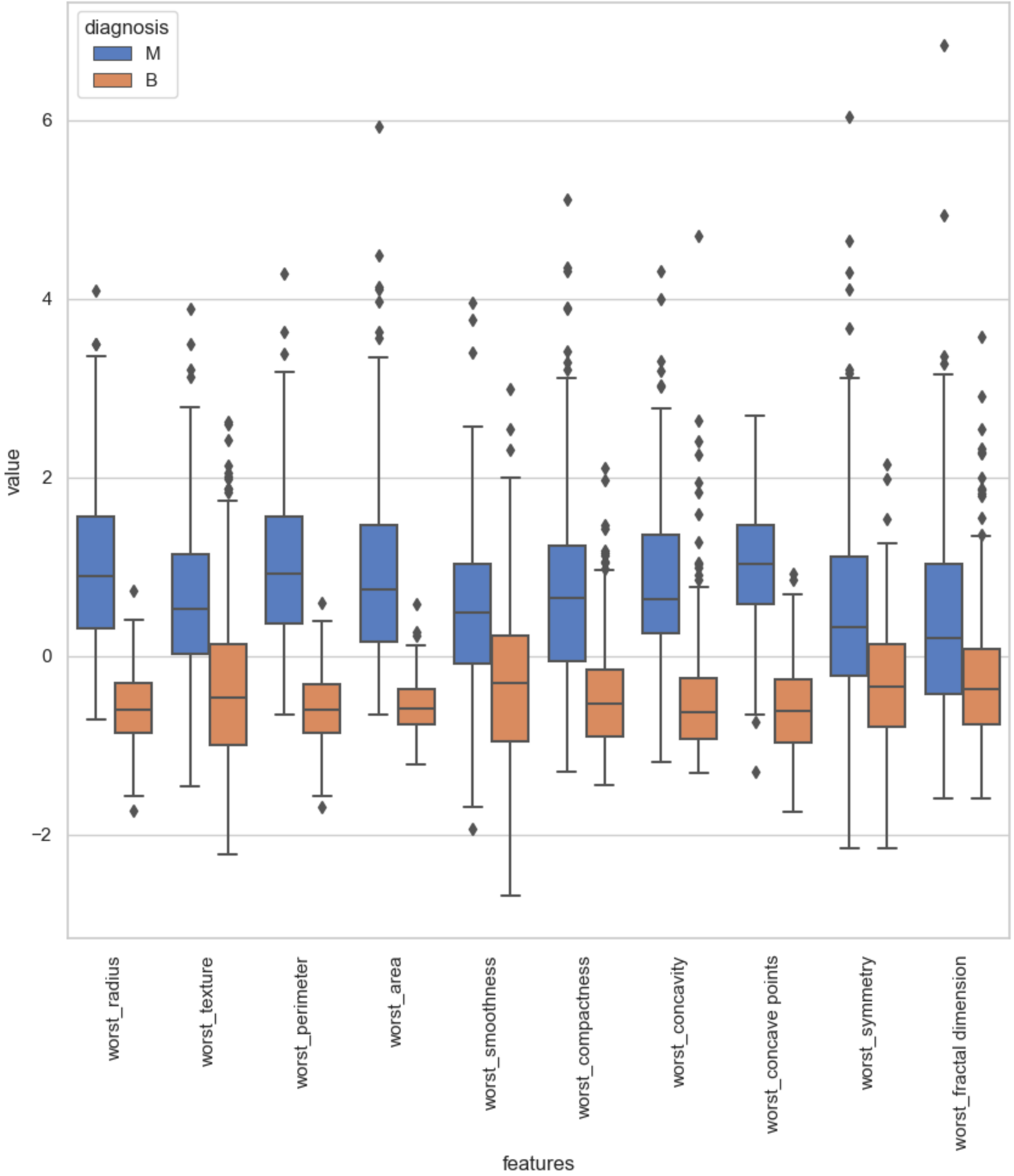
[174]:
```
data = pd.concat([y,data_std.iloc[:,20:31]],axis=1)
data = pd.melt(data,id_vars="diagnosis",
                    var_name="features",
                    value_name='value')
plt.figure(figsize=(10,10))
sns.violinplot(x="features", y="value", hue="diagnosis", data=data,split=True,␣
 ↪inner="quart")
plt.xticks(rotation=90)
```

```
[174]: (array([0, 1, 2, 3, 4, 5, 6, 7, 8, 9]),
        [Text(0, 0, 'worst_radius'),
         Text(1, 0, 'worst_texture'),
         Text(2, 0, 'worst_perimeter'),
         Text(3, 0, 'worst_area'),
         Text(4, 0, 'worst_smoothness'),
         Text(5, 0, 'worst_compactness'),
         Text(6, 0, 'worst_concavity'),
         Text(7, 0, 'worst_concave points'),
         Text(8, 0, 'worst_symmetry'),
         Text(9, 0, 'worst_fractal dimension')])
```



```
[175]: plt.figure(figsize=(10,10))
       sns.boxplot(x="features",y="value",hue='diagnosis',data=data)
       plt.xticks(rotation=90)
```

```
[175]: (array([0, 1, 2, 3, 4, 5, 6, 7, 8, 9]),
        [Text(0, 0, 'worst_radius'),
         Text(1, 0, 'worst_texture'),
         Text(2, 0, 'worst_perimeter'),
         Text(3, 0, 'worst_area'),
         Text(4, 0, 'worst_smoothness'),
         Text(5, 0, 'worst_compactness'),
         Text(6, 0, 'worst_concavity'),
         Text(7, 0, 'worst_concave points'),
         Text(8, 0, 'worst_symmetry'),
         Text(9, 0, 'worst_fractal dimension')])
```

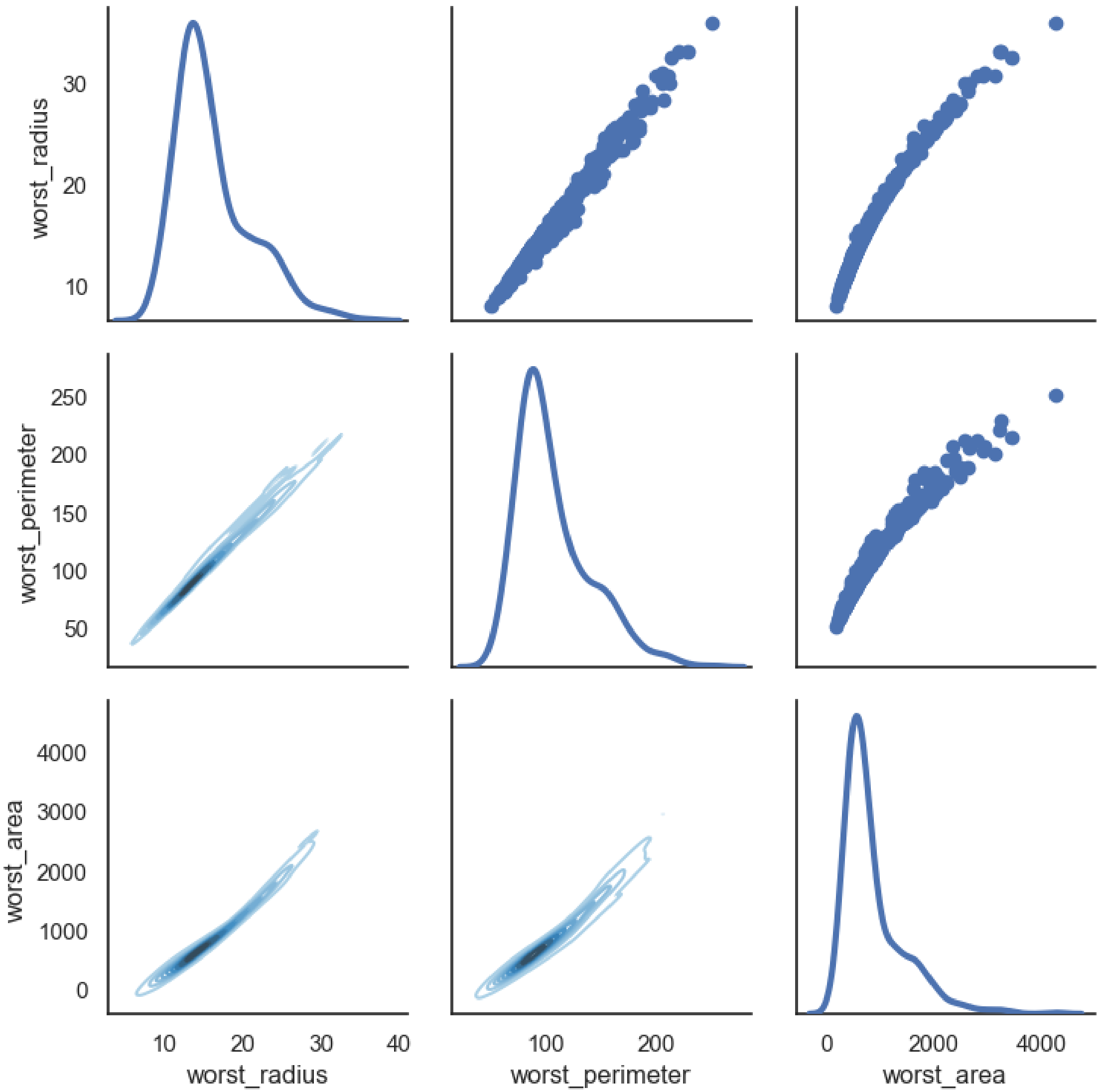


[176]:

```
sns.set(style='white')
df=x.loc[:,['worst_radius','worst_perimeter','worst_area']]
g=sns.PairGrid(df,diag_sharey=False)
g.map_lower(sns.kdeplot,cmap='Blues_d')
g.map_upper(plt.scatter)
g.map_diag(sns.kdeplot,lw=3)
```

[176]:

```
<seaborn.axisgrid.PairGrid at 0x24bf4321490>
```

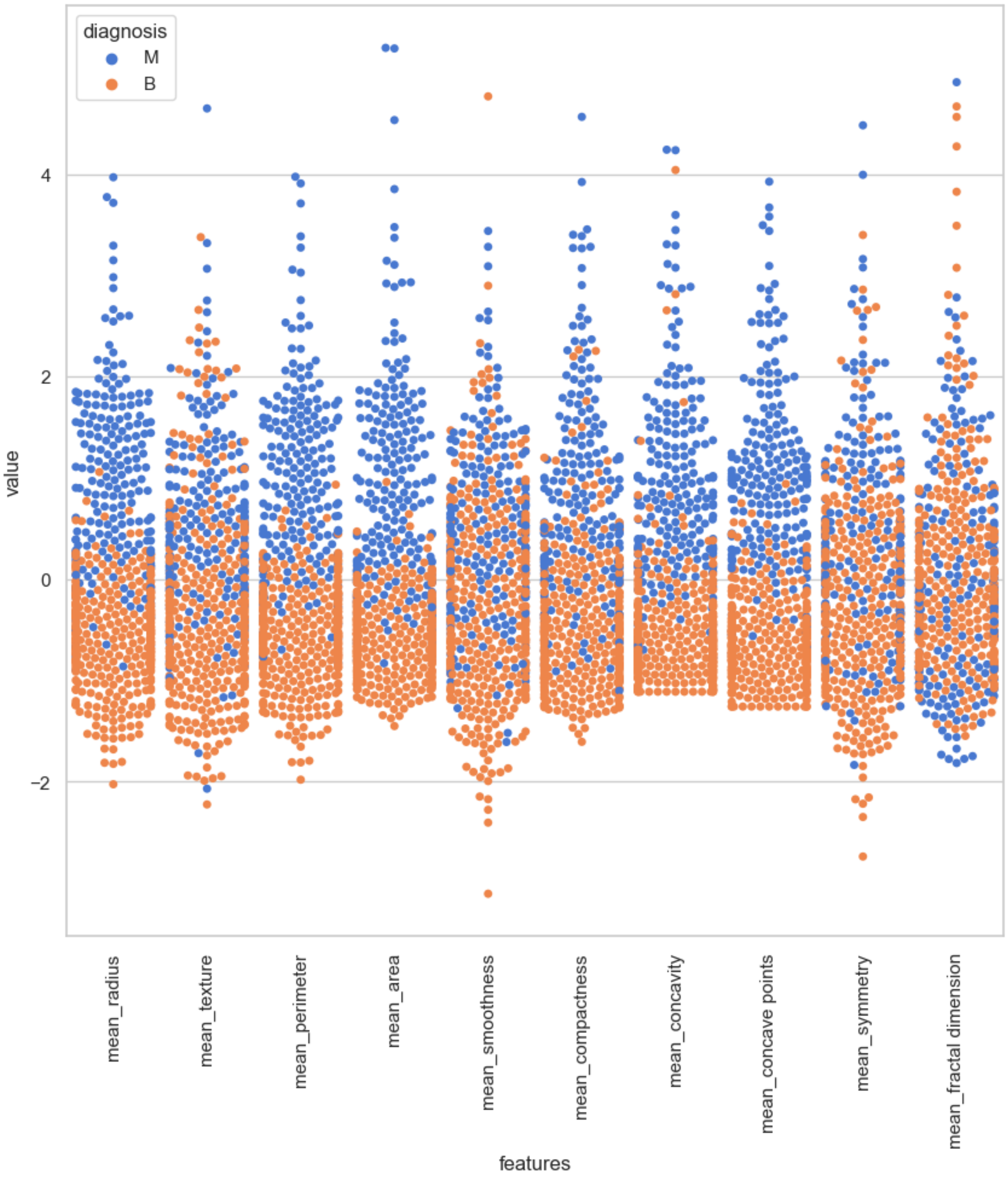


[177]:

```
sns.set(style='whitegrid',palette='muted')
diag=y
data=x
data_n=(data-data.mean())/(data.std())
```

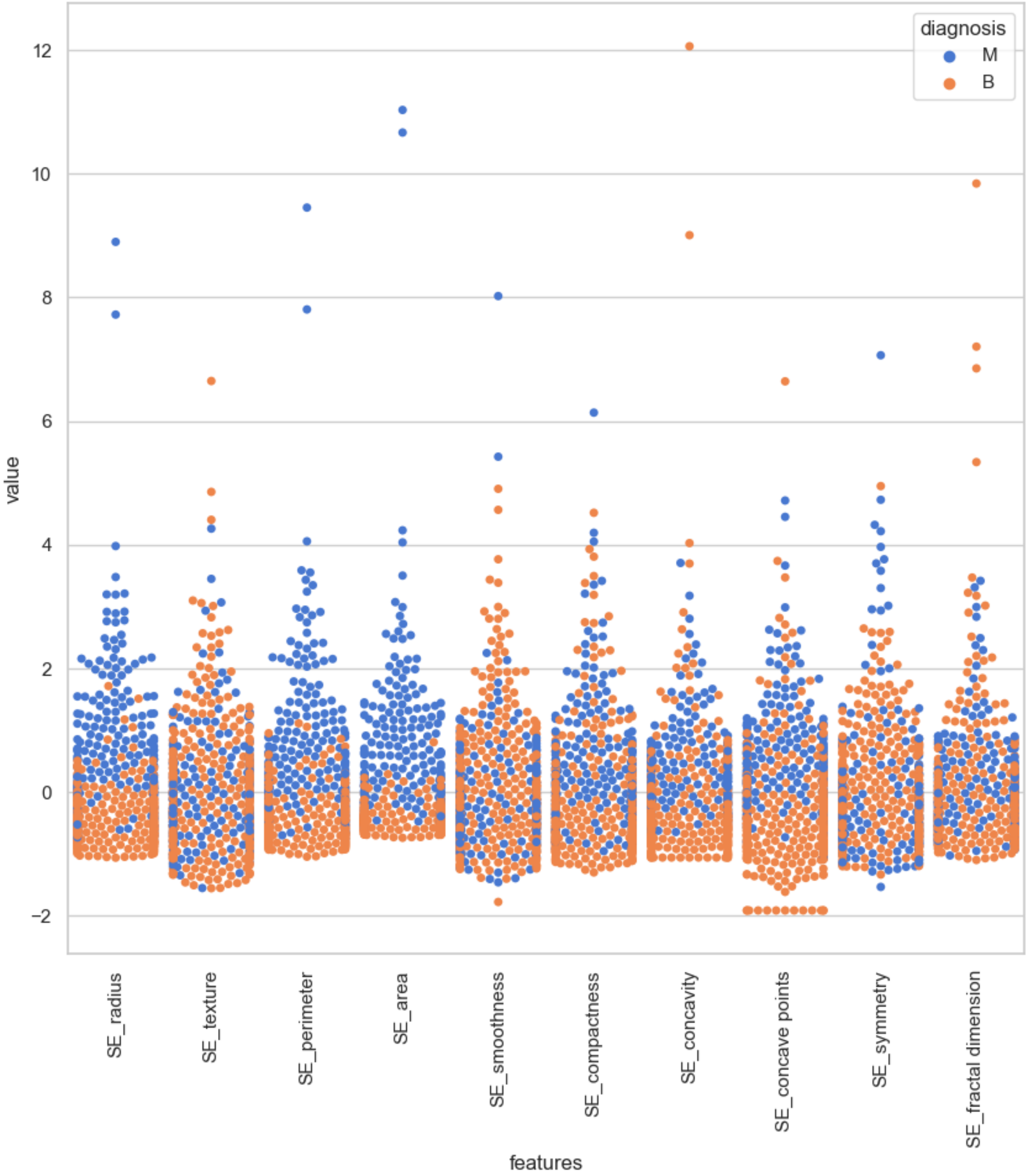
```python
data=pd.concat([y,data_n.iloc[:,0:10]],axis=1)
data=pd.melt(data,id_vars='diagnosis',var_name='features',value_name='value')
plt.figure(figsize=(10,10))
tic=time.time()
sns.swarmplot(x='features',y='value',hue='diagnosis',data=data)
plt.xticks(rotation=90)
```

```
[177]: ([0, 1, 2, 3, 4, 5, 6, 7, 8, 9],
         [Text(0, 0, 'mean_radius'),
          Text(1, 0, 'mean_texture'),
          Text(2, 0, 'mean_perimeter'),
          Text(3, 0, 'mean_area'),
          Text(4, 0, 'mean_smoothness'),
          Text(5, 0, 'mean_compactness'),
          Text(6, 0, 'mean_concavity'),
          Text(7, 0, 'mean_concave points'),
          Text(8, 0, 'mean_symmetry'),
          Text(9, 0, 'mean_fractal dimension')])
```



```
[148]: data=pd.concat([y,data_n.iloc[:,10:20]],axis=1)
       data=pd.melt(data,id_vars='diagnosis',var_name='features',value_name='value')
       plt.figure(figsize=(10,10))
       tic=time.time()
       sns.swarmplot(x='features',y='value',hue='diagnosis',data=data)
       plt.xticks(rotation=90)
```

```
[148]: ([0, 1, 2, 3, 4, 5, 6, 7, 8, 9],
        [Text(0, 0, 'SE_radius'),
         Text(1, 0, 'SE_texture'),
         Text(2, 0, 'SE_perimeter'),
         Text(3, 0, 'SE_area'),
         Text(4, 0, 'SE_smoothness'),
         Text(5, 0, 'SE_compactness'),
         Text(6, 0, 'SE_concavity'),
         Text(7, 0, 'SE_concave points'),
         Text(8, 0, 'SE_symmetry'),
         Text(9, 0, 'SE_fractal dimension')])
```

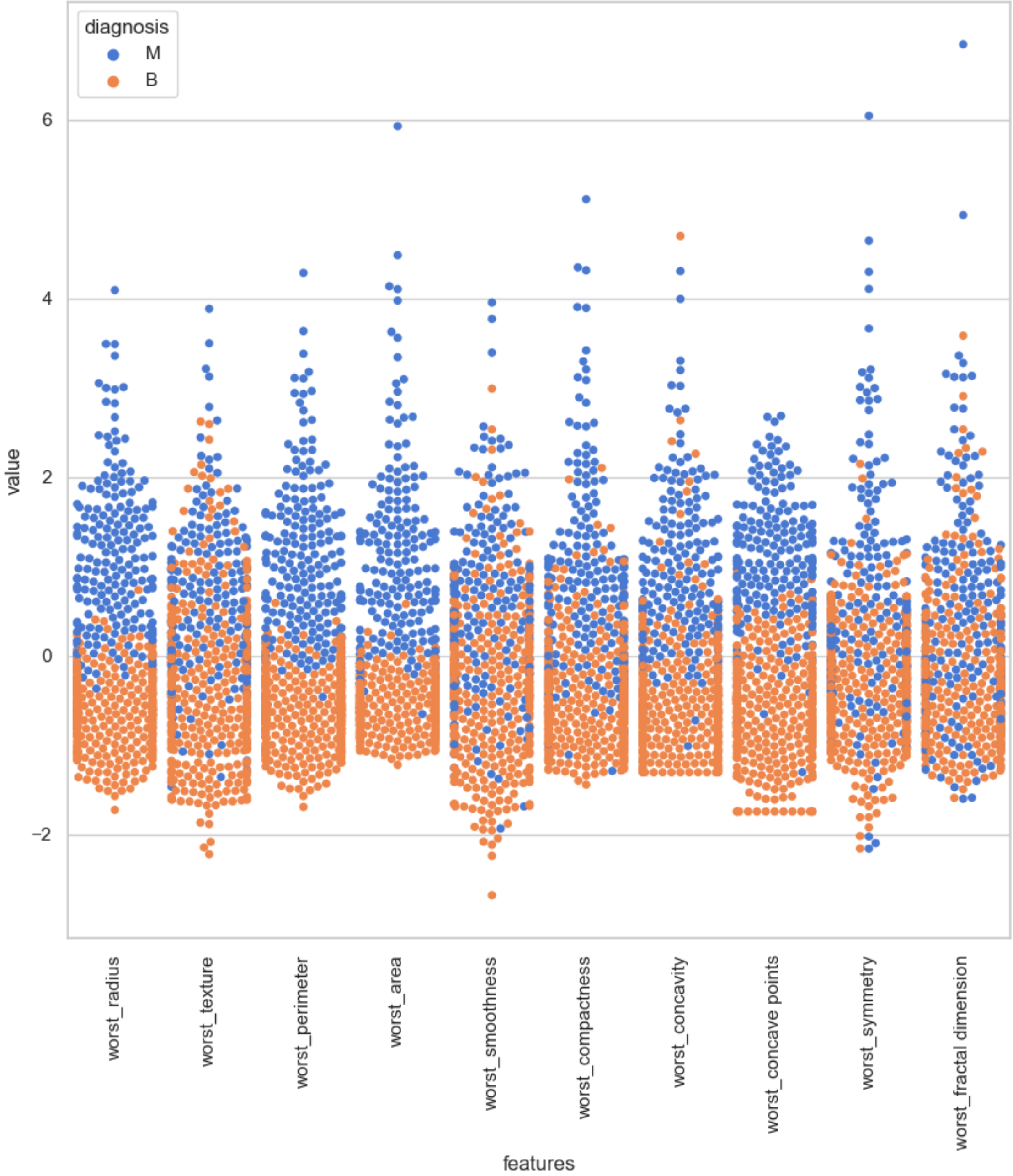


[178]:

```
data=pd.concat([y,data_n.iloc[:,20:31]],axis=1)
data=pd.melt(data,id_vars='diagnosis',var_name='features',value_name='value')
plt.figure(figsize=(10,10))
tic=time.time()
sns.swarmplot(x='features',y='value',hue='diagnosis',data=data)
plt.xticks(rotation=90)
```

[178]:

```
([0, 1, 2, 3, 4, 5, 6, 7, 8, 9],
 [Text(0, 0, 'worst_radius'),
  Text(1, 0, 'worst_texture'),
  Text(2, 0, 'worst_perimeter'),
  Text(3, 0, 'worst_area'),
  Text(4, 0, 'worst_smoothness'),
  Text(5, 0, 'worst_compactness'),
  Text(6, 0, 'worst_concavity'),
  Text(7, 0, 'worst_concave points'),
  Text(8, 0, 'worst_symmetry'),
  Text(9, 0, 'worst_fractal dimension')])
```

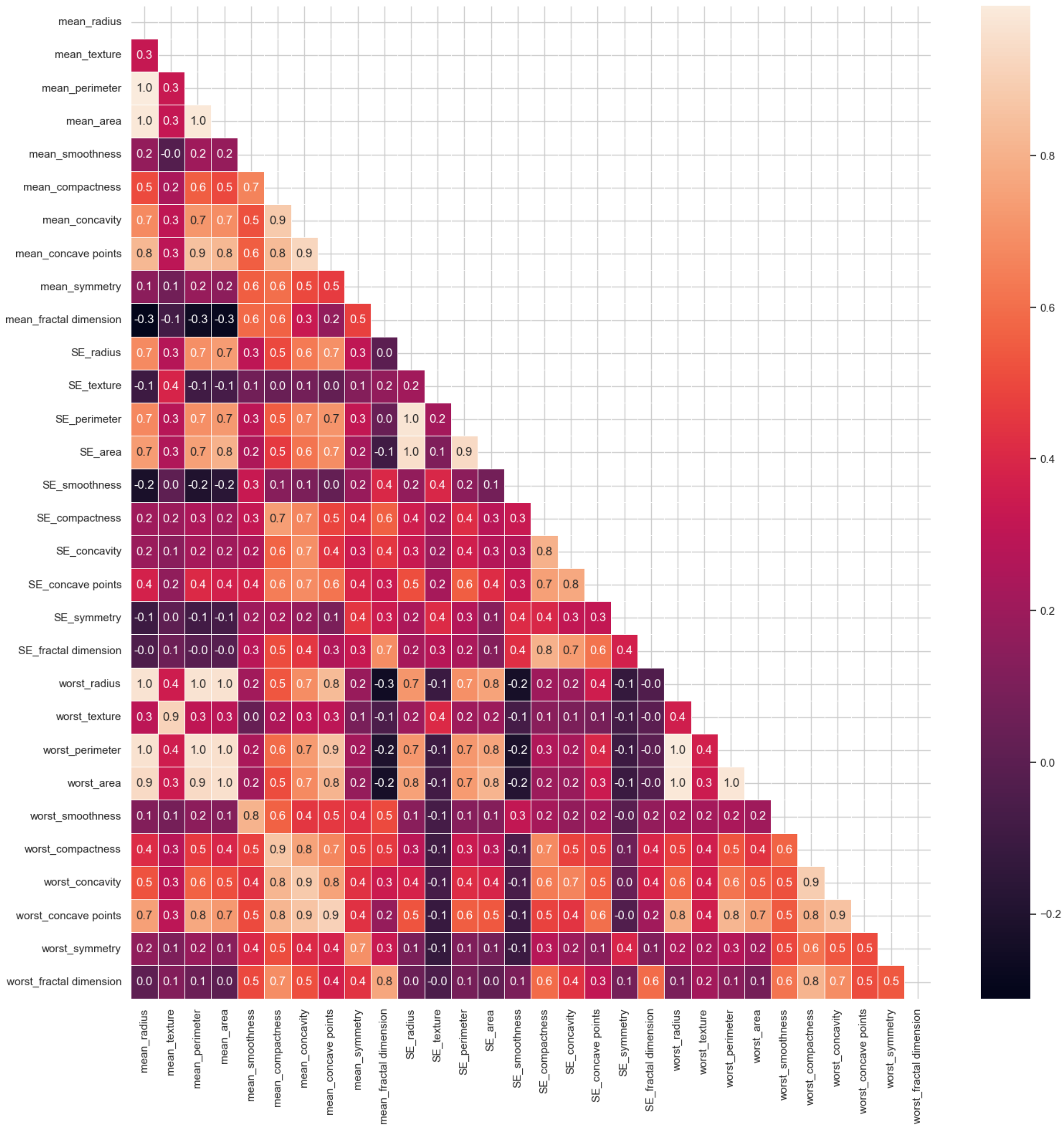


[179]:

```
f,ax = plt.subplots(figsize=(18, 18))
matrix = np.triu(x.corr())
sns.heatmap(x.corr(), annot=True, linewidths=.5, fmt= '.1f',ax=ax, mask=matrix)
```

[179]:

```
<Axes: >
```



[180]:
```
# Create correlation matrix
corr_matrix = x.corr().abs()# Select upper triangle of correlation matrix
upper = corr_matrix.where(np.triu(np.ones(corr_matrix.shape), k=1).astype(bool))


# Find index of feature columns with correlation greater than 0.8
to_drop = [column for column in upper.columns if any(upper[column] > 0.8)]
```

[181]:
```
to_drop
```

```
[181]: ['mean_perimeter',
        'mean_area',
        'mean_concavity',
        'mean_concave points',
        'SE_perimeter',
        'SE_area',
        'SE_concavity',
        'SE_fractal dimension',
        'worst_radius',
        'worst_texture',
        'worst_perimeter',
        'worst_area',
        'worst_smoothness',
        'worst_compactness',
        'worst_concavity',
        'worst_concave points',
        'worst_fractal dimension']
```

```
[182]: # Drop features
       x1 = x.drop(x[to_drop], axis=1)
       x1.columns
```

```
[182]: Index(['mean_radius', 'mean_texture', 'mean_smoothness', 'mean_compactness',
              'mean_symmetry', 'mean_fractal dimension', 'SE_radius', 'SE_texture',
              'SE_smoothness', 'SE_compactness', 'SE_concave points', 'SE_symmetry',
              'worst_symmetry'],
             dtype='object')
```

```
[183]: x1.head()
```

```
[183]:    mean_radius  mean_texture  mean_smoothness  mean_compactness  
       0        17.99         10.38          0.11840           0.27760  \
       1        20.57         17.77          0.08474           0.07864   
       2        19.69         21.25          0.10960           0.15990   
       3        11.42         20.38          0.14250           0.28390   
       4        20.29         14.34          0.10030           0.13280   

          mean_symmetry  mean_fractal dimension  SE_radius  SE_texture  
       0         0.2419                 0.07871     1.0950      0.9053  \
       1         0.1812                 0.05667     0.5435      0.7339   
       2         0.2069                 0.05999     0.7456      0.7869   
       3         0.2597                 0.09744     0.4956      1.1560   
       4         0.1809                 0.05883     0.7572      0.7813   

          SE_smoothness  SE_compactness  SE_concave points  SE_symmetry  
       0       0.006399         0.04904            0.01587      0.03003  \
       1       0.005225         0.01308            0.01340      0.01389   
```

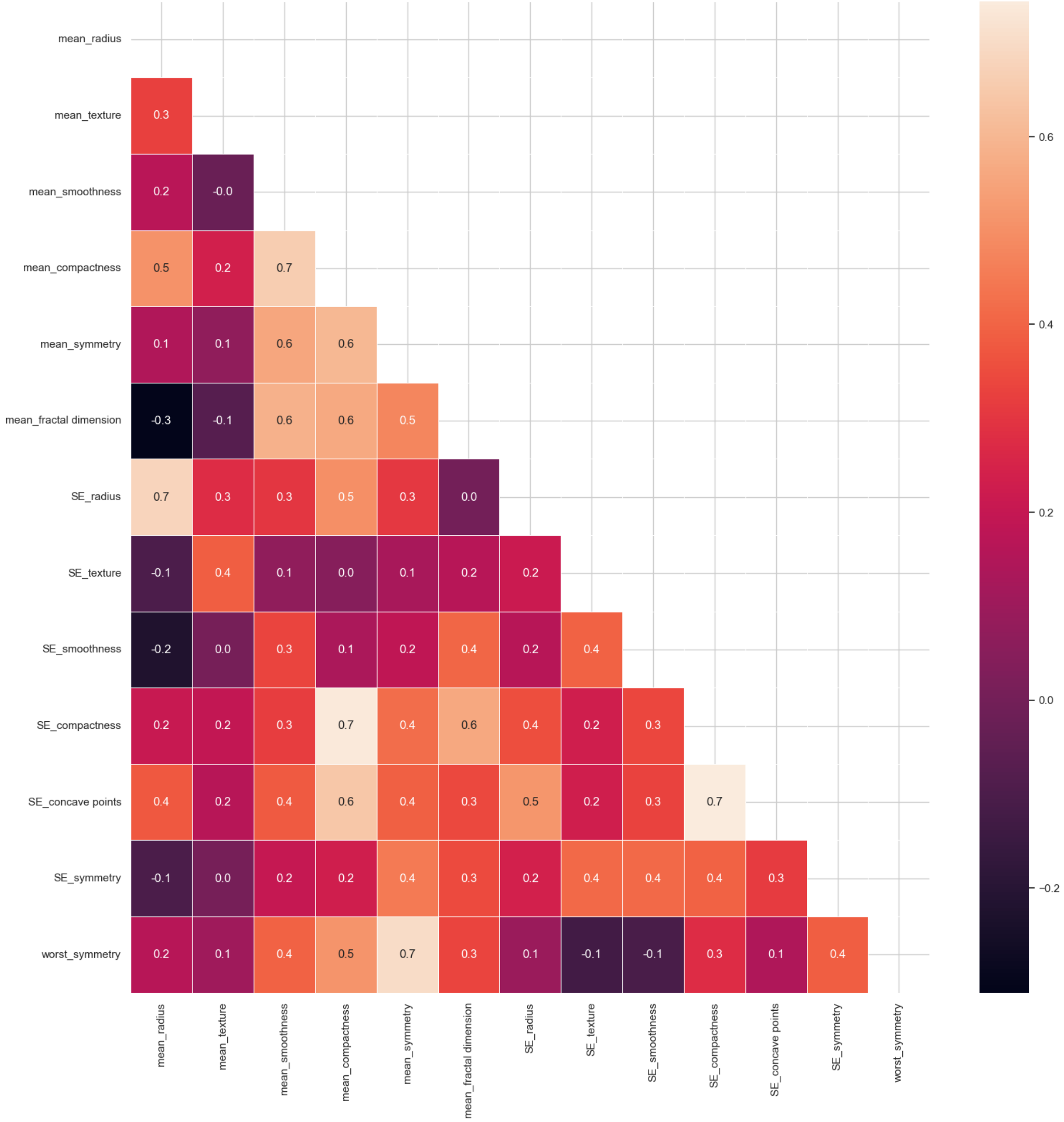
```
2       0.006150         0.04006            0.02058      0.02250
3       0.009110         0.07458            0.01867      0.05963
4       0.011490         0.02461            0.01885      0.01756

   worst_symmetry
0          0.4601
1          0.2750
2          0.3613
3          0.6638
4          0.2364
```

[184]:

```
f,ax = plt.subplots(figsize=(18, 18))
matrix = np.triu(x1.corr())
sns.heatmap(x1.corr(), annot=True, linewidths=.5, fmt= '.1f',ax=ax, mask=matrix)
```

```
[184]: <Axes: >
```



[185]:

```
from sklearn.model_selection import train_test_split
```

[186]:

```
x_train,x_test,y_train,y_test=train_test_split(x1,y,test_size=0.
 ↪3,random_state=42)
```

[187]:

```
from sklearn.feature_selection import SelectKBest
from sklearn.feature_selection import chi2
```

[189]:

```
feature_select=SelectKBest(chi2,k=5).fit(x_train,y_train)
print('Score list:',feature_select.scores_)
print('Feature list:',x_train.columns)
```

```
Score list: [1.77946492e+02 6.06916433e+01 1.00015175e-01 3.41839493e+00
 1.95982847e-01 3.42575072e-04 2.45882967e+01 4.07131026e-02
 1.32470372e-03 3.74071521e-01 2.01587194e-01 1.39557806e-03
 1.00635138e+00]
Feature list: Index(['mean_radius', 'mean_texture', 'mean_smoothness',
'mean_compactness',
       'mean_symmetry', 'mean_fractal dimension', 'SE_radius', 'SE_texture',
       'SE_smoothness', 'SE_compactness', 'SE_concave points', 'SE_symmetry',
       'worst_symmetry'],
      dtype='object')
```

```
[ ]:
```