3.2.PCA-Random-Forest

May 15, 2023

[58]:
```
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")
```

[59]:
```
data=pd.read_csv('wdbc.data',header=None)
```

data.head()

[60]:
```
data.head()
```

[60]:

	0	1	2	3	4	5	6	7	8	\
0	842302	M	17.99	10.38	122.80	1001.0	0.11840	0.27760	0.3001	\
1	842517	M	20.57	17.77	132.90	1326.0	0.08474	0.07864	0.0869	
2	84300903	M	19.69	21.25	130.00	1203.0	0.10960	0.15990	0.1974	
3	84348301	M	11.42	20.38	77.58	386.1	0.14250	0.28390	0.2414	
4	84358402	M	20.29	14.34	135.10	1297.0	0.10030	0.13280	0.1980	

	9	…	22	23	24	25	26	27	28	29	\
0	0.14710	…	25.38	17.33	184.60	2019.0	0.1622	0.6656	0.7119	0.2654	\
1	0.07017	…	24.99	23.41	158.80	1956.0	0.1238	0.1866	0.2416	0.1860	
2	0.12790	…	23.57	25.53	152.50	1709.0	0.1444	0.4245	0.4504	0.2430	
3	0.10520	…	14.91	26.50	98.87	567.7	0.2098	0.8663	0.6869	0.2575	
4	0.10430	…	22.54	16.67	152.20	1575.0	0.1374	0.2050	0.4000	0.1625	

	30	31
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]
```

[61]:
```
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']
```

[62]:
```
data.to_csv('labeledData.csv',header=headers,index=False)
```

[63]:
```
data=pd.read_csv('labeledData.csv')
data.head()
```

[63]:

	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]
```

[64]:
```
def diag(z):
    if z=='M':
        return 1
    else:
        return 0
z=data['diagnosis'].apply(diag)
data.diagnosis=z
```

[65]:
```
df=pd.DataFrame(data)
df=df.drop('id',axis=1)
df
```

[65]:
```
     diagnosis  mean_radius  mean_texture  mean_perimeter  mean_area
0            1        17.99         10.38          122.80     1001.0  \
1            1        20.57         17.77          132.90     1326.0
2            1        19.69         21.25          130.00     1203.0
3            1        11.42         20.38           77.58      386.1
4            1        20.29         14.34          135.10     1297.0
..         ...          ...           ...             ...        ...
564          1        21.56         22.39          142.00     1479.0
565          1        20.13         28.25          131.20     1261.0
566          1        16.60         28.08          108.30      858.1
567          1        20.60         29.33          140.10     1265.0
568          0         7.76         24.54           47.92      181.0

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

     mean_symmetry  ...  worst_radius  worst_texture  worst_perimeter
0           0.2419  ...        25.380          17.33           184.60  \
1           0.1812  ...        24.990          23.41           158.80
2           0.2069  ...        23.570          25.53           152.50
3           0.2597  ...        14.910          26.50            98.87
```

```
4           0.1809  …        22.540          16.67           152.20
..             …  …           …             …               …
564         0.1726  …        25.450          26.40           166.10
565         0.1752  …        23.690          38.25           155.00
566         0.1590  …        18.980          34.12           126.70
567         0.2397  …        25.740          39.42           184.60
568         0.1587  …         9.456          30.37            59.16

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

     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
..                    …               …                       …
564                0.2216          0.2060                  0.07115
565                0.1628          0.2572                  0.06637
566                0.1418          0.2218                  0.07820
567                0.2650          0.4087                  0.12400
568                0.0000          0.2871                  0.07039

[569 rows x 31 columns]
```

[66]:
```
x=df.drop('diagnosis',axis=1)
x.shape
```

[66]:
```
(569, 30)
```

[67]:
```
y=df.iloc[:,0:1]
y.shape
```

[67]:
```
(569, 1)
```

[68]:
```
pip install scikit-learn
```

```
Requirement already satisfied: scikit-learn in
c:\users\sheel\appdata\local\programs\python\python311\lib\site-packages (1.2.2)
Requirement already satisfied: numpy>=1.17.3 in
c:\users\sheel\appdata\local\programs\python\python311\lib\site-packages (from
scikit-learn) (1.24.3)
Requirement already satisfied: scipy>=1.3.2 in
c:\users\sheel\appdata\local\programs\python\python311\lib\site-packages (from
scikit-learn) (1.10.1)
Requirement already satisfied: joblib>=1.1.1 in
c:\users\sheel\appdata\local\programs\python\python311\lib\site-packages (from
scikit-learn) (1.2.0)
Requirement already satisfied: threadpoolctl>=2.0.0 in
c:\users\sheel\appdata\local\programs\python\python311\lib\site-packages (from
scikit-learn) (3.1.0)
Note: you may need to restart the kernel to use updated packages.


[notice] A new release of pip available: 22.3.1 -> 23.1.2
[notice] To update, run: python.exe -m pip install --upgrade pip
```

[69]:
```
from sklearn.preprocessing import StandardScaler
x = df.iloc[:,:-1]
y = df.iloc[:,-1]
# performing standardization
sc = StandardScaler()
x_scaled = sc.fit_transform(x)
```

[70]:
```
from sklearn.decomposition import PCA
components=None
pca=PCA(n_components=components)
pca.fit(x_scaled)
```

[70]:
```
PCA()
```

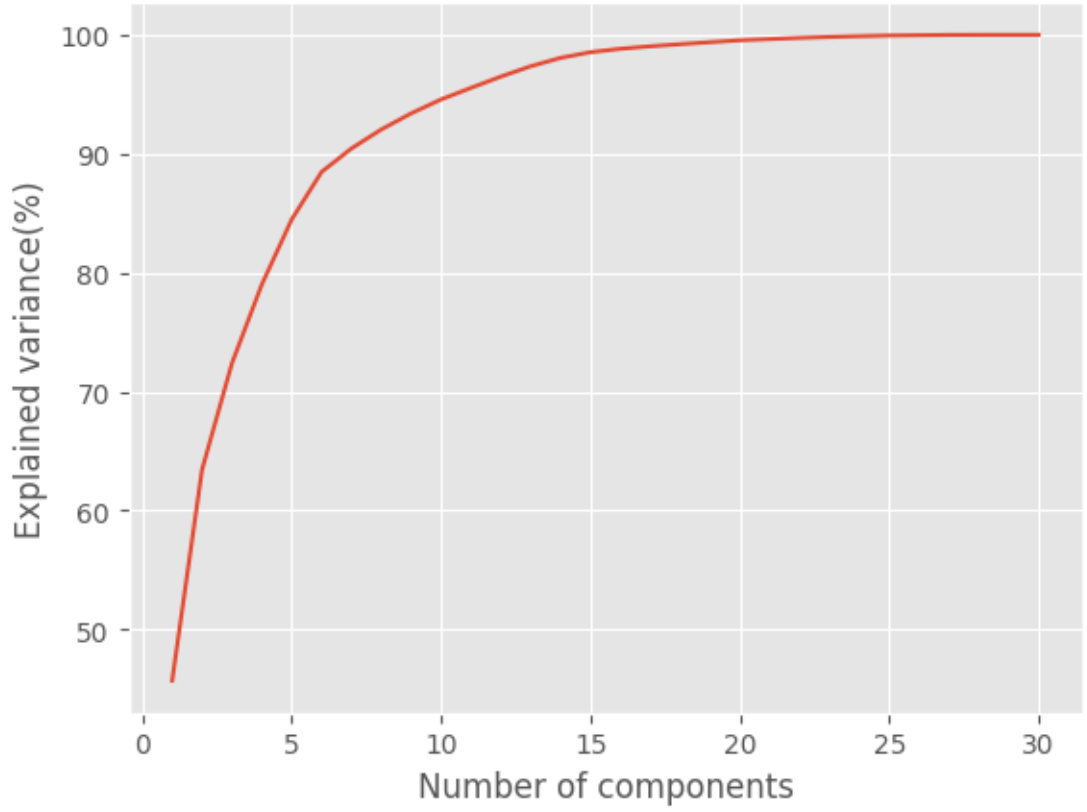
[71]:
```
print('Cumulative Variances Percentage:')
print(pca.explained_variance_ratio_.cumsum()*100)
```

```
Cumulative Variances Percentage:
[ 45.70482024  63.43807513  72.38144906  79.00927945  84.47359555
  88.47267763  90.44353313  92.04384397  93.39708966  94.56672126
  95.5371204   96.48654887  97.35602624  98.06158498  98.53894853
  98.82464805  99.03516744  99.21059817  99.38127455  99.54166534
  99.64391818  99.74210062  99.82305224  99.8830052   99.94149718
  99.96835313  99.99168096  99.99706656  99.99955739 100.        ]
```

[72]:
```
components=len(pca.explained_variance_ratio_)\
    if components is None else components
plt.plot(range(1,components+1),
```

```
        np.cumsum(pca.explained_variance_ratio_*100))
plt.xlabel('Number of components')
plt.ylabel('Explained variance(%)')
```

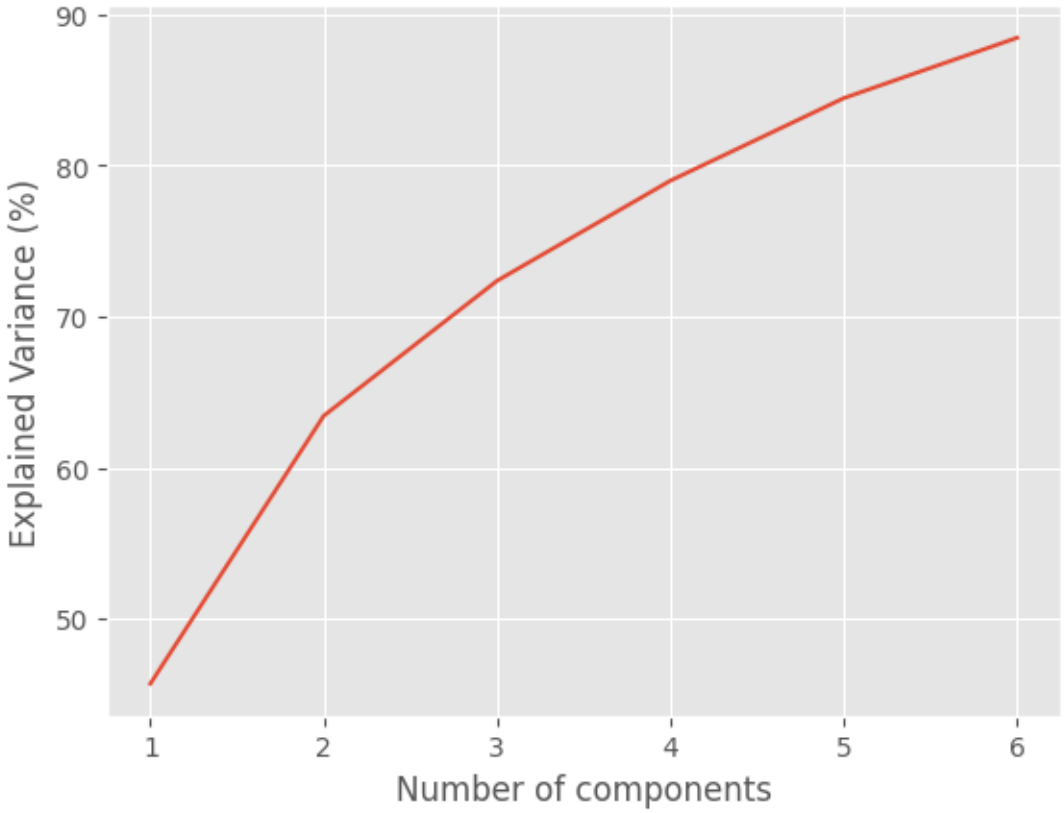
[72]: Text(0, 0.5, 'Explained variance(%)')



[73]:
```
from sklearn.decomposition import PCA
pca=PCA(n_components=0.85)
pca.fit(x_scaled)
print('Cumulative Variances (Percentage):')
print(np.cumsum(pca.explained_variance_ratio_*100))
components=len(pca.explained_variance_ratio_)
print(f'Number of components:{components}')
plt.plot(range(1,components+1),
np.cumsum(pca.explained_variance_ratio_*100))
plt.xlabel('Number of components')
plt.ylabel('Explained Variance (%)')
```

```
Cumulative Variances (Percentage):
[45.70482024 63.43807513 72.38144906 79.00927945 84.47359555 88.47267763]
Number of components:6
```

[73]: Text(0, 0.5, 'Explained Variance (%)')



[74]:
```
pca_components=abs(pca.components_)
print(pca_components)
```

```
[[0.21946075 0.22327147 0.1053675  0.23103393 0.22492103 0.13445769
  0.22899318 0.25161962 0.25792787 0.13031253 0.04899745 0.20622073
  0.01582104 0.21057403 0.20387997 0.00910145 0.1582188  0.1434352
  0.17645803 0.03719747 0.08953781 0.23171618 0.10566991 0.23935141
  0.22817589 0.12069915 0.20012565 0.22073753 0.24704713 0.11695725]
 [0.07527256 0.22054497 0.05604209 0.20063176 0.21506452 0.20205704
  0.17192616 0.08570235 0.01229753 0.21196099 0.37647526 0.07087837
  0.11858407 0.05388621 0.12318004 0.2364953  0.26339904 0.23030467
  0.17047432 0.22040844 0.30600865 0.21009518 0.05035212 0.18876594
  0.20748237 0.16936642 0.14271038 0.10471416 0.00081362 0.13905316]
 [0.10381349 0.02078243 0.08656462 0.01724522 0.05956234 0.15956682
  0.10068951 0.01046439 0.03298289 0.09744592 0.06879573 0.2831986
  0.36669189 0.28069702 0.24095374 0.26840399 0.13395417 0.15592669
  0.20074335 0.24173635 0.19370193 0.01903268 0.02431895 0.02253289
  0.01916973 0.3058468  0.25009862 0.18447942 0.17829786 0.3172018 ]
 [0.10782484 0.05598946 0.5964038  0.05604853 0.0689083  0.12181867
```

```
 0.0290586  0.02469142 0.06382697 0.03194798 0.03636076 0.10476435
 0.36603356 0.09828958 0.12069604 0.02262799 0.01017672 0.02116795
 0.0825686  0.01874927 0.03337408 0.02696833 0.63235721 0.02579059
 0.03916518 0.01945712 0.08802775 0.06645568 0.00523576 0.07097062]
[0.068848   0.03552887 0.00068558 0.03627585 0.0024271  0.35814432
 0.03106979 0.09944786 0.03717768 0.280422   0.04035745 0.18967918
 0.18511124 0.15281022 0.16114979 0.25940583 0.28622685 0.36003656
 0.18895704 0.2570678  0.24837444 0.00391082 0.03207867 0.0099555
 0.03237304 0.30066745 0.15878282 0.22212248 0.06679247 0.19599699]
[0.01708368 0.01969708 0.03586663 0.01780585 0.00419642 0.28976943
 0.02281195 0.02119414 0.05782111 0.3547249  0.1175639  0.00151703
 0.01980376 0.02711379 0.01468767 0.33965698 0.05611072 0.0326232
 0.05110283 0.50061342 0.05492689 0.00414661 0.05566962 0.01189957
 0.01549578 0.37729742 0.0355155  0.00833758 0.04581019 0.49327568]]
```

[78]:
```
print('Top 4 most important features in each component')
print('================================================')
for row in range(pca_components.shape[0]):
    # get the indices of the top 4 values in each row
    temp = np.argpartition(-(pca_components[row]), 4)

    # sort the indices in descending order
    indices = temp[np.argsort((-pca_components[row])[temp])][:4]

    # print the top 4 feature names
    df2=df.drop('diagnosis',axis=1)
    print(f'Component {row}: {df2.columns[indices].to_list()}')
```

```
Top 4 most important features in each component
================================================
Component 0: ['mean_symmetry', 'mean_concave points', 'worst_symmetry',
'worst_area']
Component 1: ['SE_radius', 'worst_radius', 'SE_concavity', 'SE_compactness']
Component 2: ['SE_perimeter', 'worst_fractal dimension', 'worst_compactness',
'SE_texture']
Component 3: ['worst_perimeter', 'mean_perimeter', 'SE_perimeter',
'mean_compactness']
Component 4: ['SE_concave points', 'mean_compactness', 'worst_compactness',
'SE_concavity']
Component 5: ['SE_fractal dimension', 'worst_fractal dimension',
'worst_compactness', 'mean_fractal dimension']
```

[79]:
```
x_pca=pca.transform(x_scaled)
print(x_pca.shape)
print(x_pca)
```

```
(569, 6)
[[ 9.00574762  2.13297193 -1.3058032   3.58251042 -1.3601952   1.5555042 ]
```

```
[ 2.72416163 -3.86854352 -0.06524162  1.23678875  0.36458132  0.11451479]
[ 5.9312751  -0.77891015 -0.63084536  0.87193931 -0.1362758   0.49621953]
…
[ 1.62139901 -1.8598167   0.76477174 -1.98279168  1.85452804 -0.6155452 ]
[10.15343163  1.73263141 -1.79963412 -2.27017331  0.41465922  0.52109452]
[-5.43024181 -0.82933047  1.65896772 -2.27087421 -0.17550628  1.72452175]]
```

[465]:
```
x_train,x_test,y_train,y_test=train_test_split(x_pca,y,test_size=0.
↪3,random_state=42)
```

[467]:
```
Rfor=RandomForestClassifier(random_state=42)
Rfor=Rfor.fit(x_train,y_train)
acc=accuracy_score(y_test,Rfor.predict(x_test))
print('Accuracy is:',acc)
```

```
Accuracy is: 0.9590643274853801
```

[468]:
```
cm=confusion_matrix(y_test,Rfor.predict(x_test))
sns.heatmap(cm,annot=True,fmt='d')
```

[468]: <Axes: >