```
import pandas as pd
import matplotlib.pyplot as plt
import numpy as np
from sklearn.decomposition import PCA
from sklearn.preprocessing import StandardScaler
from sklearn.model_selection import train_test_split
from sklearn.svm import SVC
from sklearn.model_selection import KFold
from sklearn.linear_model import LogisticRegression
from sklearn.neighbors import KNeighborsClassifier
from sklearn.neural_network import MLPClassifier
from keras.callbacks import EarlyStopping
from sklearn import metrics
from keras.models import Sequential
from keras.layers import Dense,Dropout
from sklearn.preprocessing import LabelEncoder
from keras.utils import to_categorical


#download the dataset file from google drive
!pip install -U -q PyDrive
from pydrive.auth import GoogleAuth
from pydrive.drive import GoogleDrive
from google.colab import auth
from oauth2client.client import GoogleCredentials
# Authenticate and create the PyDrive client.
auth.authenticate_user()
gauth = GoogleAuth()
gauth.credentials = GoogleCredentials.get_application_default()
drive = GoogleDrive(gauth)


#File id from google drive file shareable link
id = "#####"


#download the file and get the content
downloaded = drive.CreateFile({'id':id})
downloaded.GetContentFile('breastCancerDataset.csv')
dataset = pd.read_csv('breastCancerDataset.csv')


dataset.info()
```

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

```
dataset = dataset.drop(columns=['Unnamed: 32'])
```

```
 26  smoothness_worst         569 non-null    float64
```

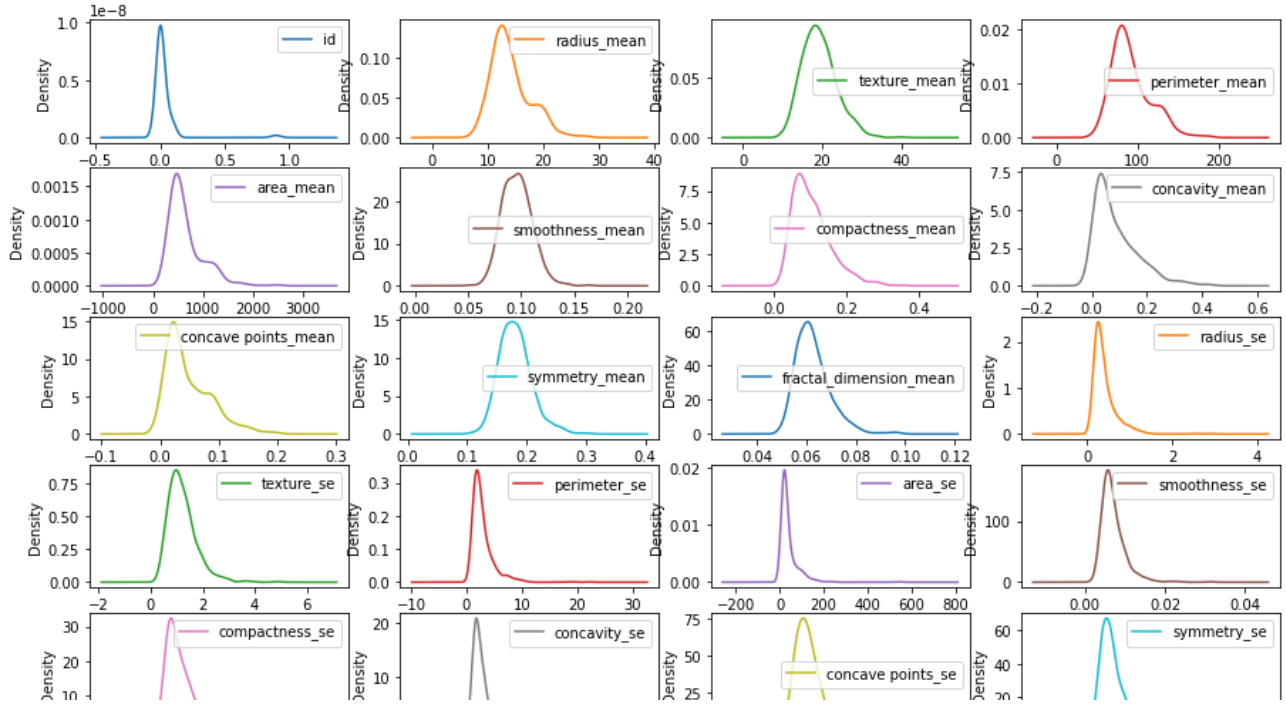
```
dataset.head(5)
```

	id	diagnosis	radius_mean	texture_mean	perimeter_mean	area_mean	smooth
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	

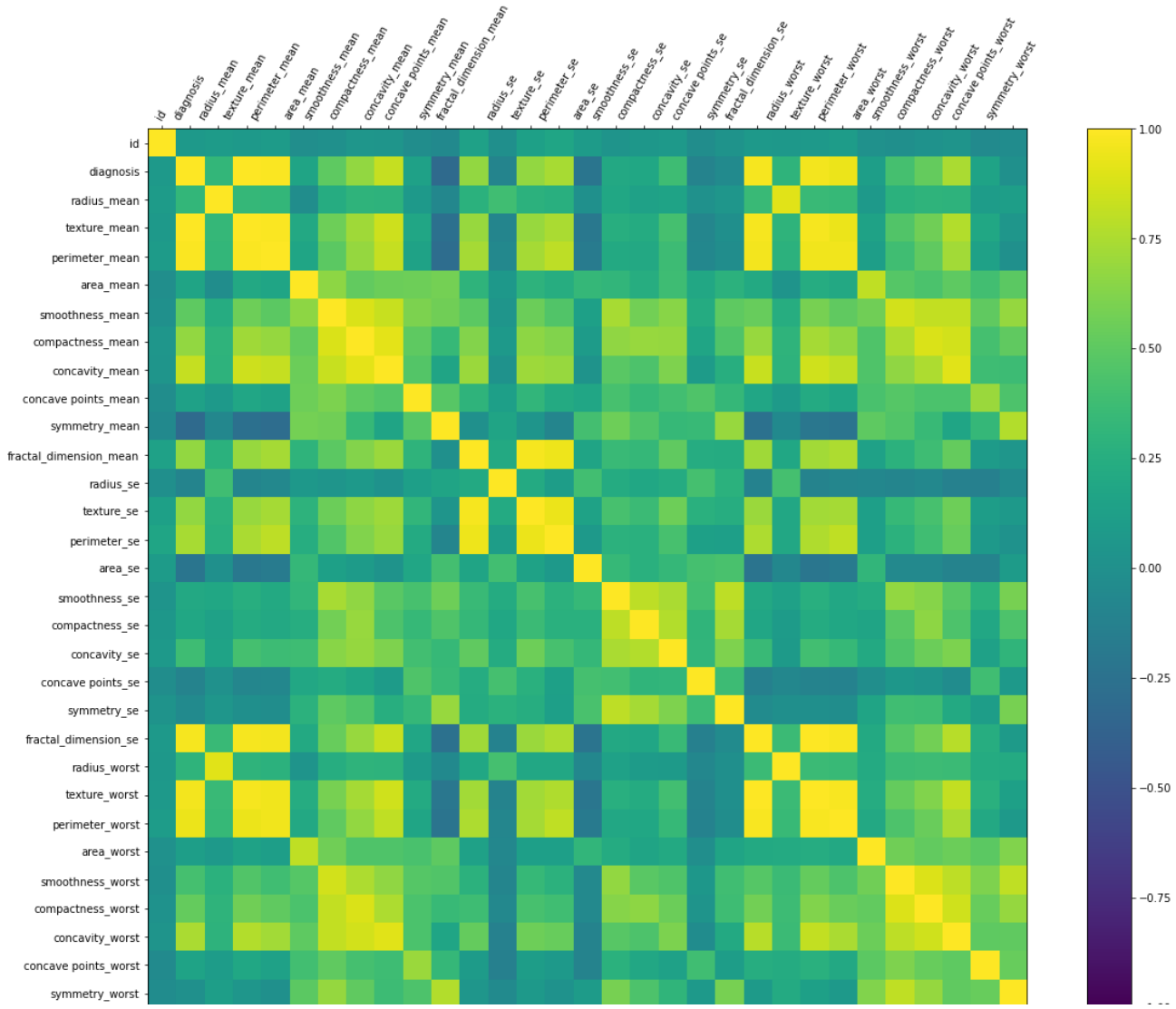
```
#Check the percentage of null values
dataset.isnull().sum()/len(dataset)*100
```

```
id                        0.0
diagnosis                 0.0
radius_mean               0.0
texture_mean              0.0
perimeter_mean            0.0
area_mean                 0.0
smoothness_mean           0.0
compactness_mean          0.0
concavity_mean            0.0
concave points_mean       0.0
symmetry_mean             0.0
fractal_dimension_mean    0.0
radius_se                 0.0
texture_se                0.0
perimeter_se              0.0
area_se                   0.0
smoothness_se             0.0
compactness_se            0.0
concavity_se              0.0
concave points_se         0.0
symmetry_se               0.0
fractal_dimension_se      0.0
radius_worst              0.0
texture_worst             0.0
perimeter_worst           0.0
area_worst                0.0
```

```
#Density plots to understand the distribution of each attribute
dataset.plot(figsize=(15,15),kind='density', subplots=True, layout=(8,4), sharex=False,)
plt.show()
```




```
#Correlation matrix between the attributes
correlations = dataset.corr()
fig = plt.figure(figsize=(20,15))
ax = fig.add_subplot(111)
cax = ax.matshow(correlations, vmin=-1, vmax=1)
fig.colorbar(cax)
ticks = np.arange(0,31,1)
ax.set_xticks(ticks)
ax.set_yticks(ticks)
ax.set_xticklabels(dataset.columns)
ax.set_yticklabels(dataset.columns)
plt.xticks(rotation=60)
plt.show()
```




```
#Scale the data and separate feature & labels
x = StandardScaler().fit_transform(dataset.drop(columns=['id','diagnosis']).values)
y = dataset['diagnosis'].values


#Study variance by 2 principal components
pca = PCA(n_components=2)
pca_result = pca.fit_transform(x)
pca_df = pd.DataFrame(data = pca_result
             , columns = ['principal component 1', 'principal component 2'])
print(pca.explained_variance_ratio_)
```

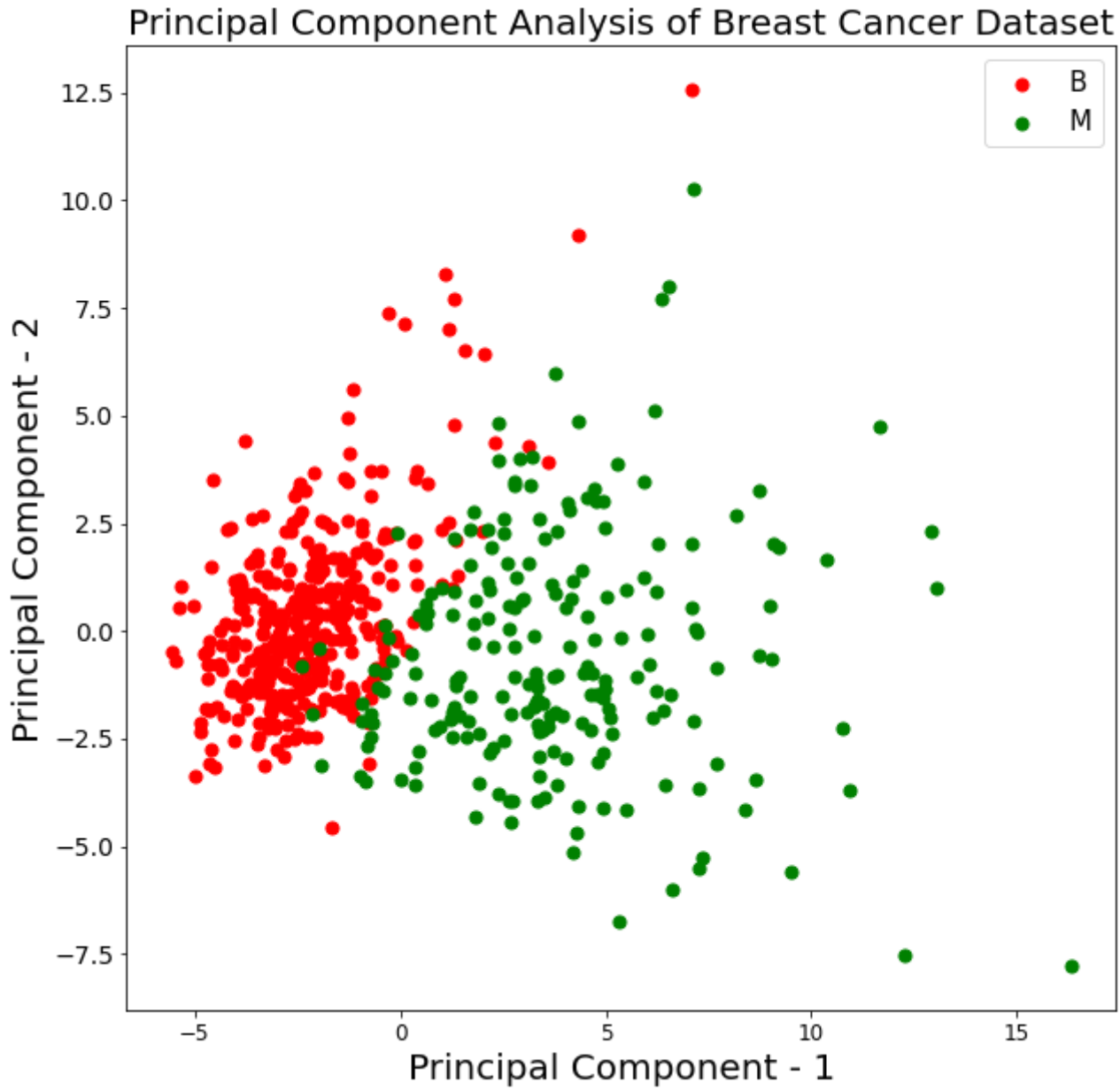
```
[0.44272026 0.18971182]
```

```
#plot of PCA
plt.figure()
plt.figure(figsize=(10,10))
plt.xticks(fontsize=12)
plt.yticks(fontsize=14)
plt.xlabel('Principal Component - 1',fontsize=20)
plt.ylabel('Principal Component - 2',fontsize=20)
plt.title("Principal Component Analysis of Breast Cancer Dataset",fontsize=20)
targets = ['B', 'M']
colors = ['r', 'g']
for target, color in zip(targets,colors):
```

```
    indicesToKeep = dataset['diagnosis'] == target
    plt.scatter(pca_df.loc[indicesToKeep, 'principal component 1']
               , pca_df.loc[indicesToKeep, 'principal component 2'], c = color, s = 50)

plt.legend(targets,prop={'size': 15})
```

```
<matplotlib.legend.Legend at 0x7fe24fcfdb00>
<Figure size 432x288 with 0 Axes>
```




```
#split the data into training and test set
X_train, X_test, y_train, y_test = train_test_split(x,y,test_size=0.2)
print(X_train.shape,X_test.shape,y_train.shape,y_test.shape)
```

```
(455, 30) (114, 30) (455,) (114,)
```

```
#Fit the data using K nearest neighbour
knn = KNeighborsClassifier(n_neighbors = 5)
knn.fit(X_train,y_train)
y_train_pred = knn.predict(X_train)
y_pred = knn.predict(X_test)
print("KNN training accuracy : {:.2f}%".format(metrics.accuracy_score(y_train_pred,y_train
```

```
print("KNN test accuracy : {:.2f}%".format(metrics.accuracy_score(y_pred,y_test)*100))
```

```
KNN training accuracy : 97.80%
KNN test accuracy : 97.37%
```

```
#Fit the data using logistic regression
reg = LogisticRegression()
reg.fit(X_train,y_train)
print("Logistic Regression accuracy : {:.2f}%".format(reg.score(X_train,y_train)*100))
print("Logistic Regression accuracy : {:.2f}%".format(reg.score(X_test,y_test)*100))
```

```
Logistic Regression accuracy : 98.68%
Logistic Regression accuracy : 99.12%
```

```
#Fit the data using SVM
svm = SVC(gamma='auto',kernel='linear',C=0.05)
svm.fit(X_train,y_train)
print("SVC training accuracy : {:.2f}%".format(svm.score(X_train,y_train)*100))
print("SVC test accuracy : {:.2f}%".format(svm.score(X_test,y_test)*100))
```

```
SVC training accuracy : 98.02%
SVC test accuracy : 98.25%
```

```
#Fit the data using MLP
#Earlystopping to avoid overfitting - training size is small
mlp = MLPClassifier(alpha=1e-5,hidden_layer_sizes=(16,8,2), random_state=1,activation='rel
mlp.fit(X_train, y_train)
print("MLP train accuracy : {:.2f}%".format(mlp.score(X_train,y_train)*100))
print("MLP test ccuracy : {:.2f}%".format(mlp.score(X_test,y_test)*100))
```

```
MLP train accuracy : 81.98%
MLP test ccuracy : 81.58%
```

```
#SVM with K fold
def predict(X,y):
  prediction = clf.predict(X)
  test_length = len(y)
  count=0
  for i in range(0,test_length):
    if prediction[i] == y[i]:
      count=count+1
  return ((count/len(y))*100)

clf = SVC(gamma='auto',kernel='linear',C=0.05)
kf = KFold(n_splits=4)
train_predict = 0
test_predict = 0
i=0
for train_index,test_index in kf.split(X_train):
  x_train, x_test, Y_train, Y_test = X_train[train_index], X_train[test_index], y_train[tr
  clf.fit(x_train,Y_train)
  train_predict = train_predict + predict(x_train,Y_train)
  test_predict = test_predict + predict(x_test,Y_test)
```

```
    i=i+1
print("Training accuracy : {:.2f}%".format(train_predict/i))
print("Test accuracy : {:.2f}%".format(predict(X_test,y_test)))
```

```
Training accuracy : 98.10%
Test accuracy : 98.25%
```

```
#One hot encoding
label_encoder = LabelEncoder()
vec1 = label_encoder.fit_transform(y_train)
y_train = to_categorical(vec1)
vec2 = label_encoder.fit_transform(y_test)
y_test = to_categorical(vec2)
print(y_train.shape,y_test.shape)

#Intialization
batch_size = 128
num_classes = 2
epochs = 20

#Model definition
model = Sequential()
model.add(Dense(1024, activation='relu', input_shape=(30,)))
model.add(Dropout(0.25))
model.add(Dense(1024, activation='relu'))
model.add(Dropout(0.25))
model.add(Dense(512, activation='relu'))
model.add(Dropout(0.25))
model.add(Dense(256, activation='relu'))
model.add(Dropout(0.25))
model.add(Dense(num_classes, activation='softmax'))
```

```
(455, 2) (114, 2)
```

```
es_callback = EarlyStopping(monitor='val_loss', patience=3)
model.compile(loss='binary_crossentropy',
              optimizer='adam',
              metrics=['accuracy'])

history = model.fit(X_train, y_train,batch_size=batch_size,epochs=epochs,verbose=1,validat
```

```
Train on 364 samples, validate on 91 samples
Epoch 1/20
364/364 [==============================] - 1s 2ms/step - loss: 0.4139 - accuracy: 0.8
Epoch 2/20
364/364 [==============================] - 0s 535us/step - loss: 0.1147 - accuracy: 0
```

```
y_pred = model.predict(X_test)
y_pred = (y_pred > 0.5)
print("Training accuracy : {:.2f}%".format(np.mean(history.history['accuracy'])*100))
print("Validation accuracy : {:.2f}%".format(np.mean(history.history['val_accuracy'])*100))
print("Test accuracy : {:.2f}%".format(metrics.accuracy_score(y_pred,y_test)*100))
```

```
Training accuracy : 96.37%
Validation accuracy : 97.80%
Test accuracy : 98.25%
Epoch 8/20
364/364 [==============================] - 0s 503us/step - loss: 0.0300 - accuracy: 0
Epoch 9/20
364/364 [==============================] - 0s 475us/step - loss: 0.0089 - accuracy: 1
```