```
import numpy as np
import pandas as pd
import matplotlib.pyplot as plt
from sklearn.metrics import classification_report
from sklearn.metrics import confusion_matrix
from sklearn.metrics import accuracy_score
from sklearn.model_selection import train_test_split
from sklearn.model_selection import cross_val_score
from sklearn.model_selection import KFold
from sklearn.tree import DecisionTreeClassifier
from sklearn.neighbors import KNeighborsClassifier
from sklearn.naive_bayes import GaussianNB
from sklearn.pipeline import Pipeline
from sklearn.preprocessing import StandardScaler
from sklearn.model_selection import GridSearchCV
from sklearn.svm import SVC
import time
```

```
data = pd.read_csv('data.csv', index_col=False)
data.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	

5 rows × 33 columns

```
print(data.shape)
```

```
(569, 33)
```

```
data.describe()
```

	id	radius_mean	texture_mean	perimeter_mean	area_mean	smoothne
count	5.690000e+02	569.000000	569.000000	569.000000	569.000000	569
mean	3.037183e+07	14.127292	19.289649	91.969033	654.889104	(
std	1.250206e+08	3.524049	4.301036	24.298981	351.914129	(
min	8.670000e+03	6.981000	9.710000	43.790000	143.500000	(
25%	8.692180e+05	11.700000	16.170000	75.170000	420.300000	(
50%	9.060240e+05	13.370000	18.840000	86.240000	551.100000	(
75%	8.813129e+06	15.780000	21.800000	104.100000	782.700000	(

DATA VISUALIZATION & PRE-PROCESSING

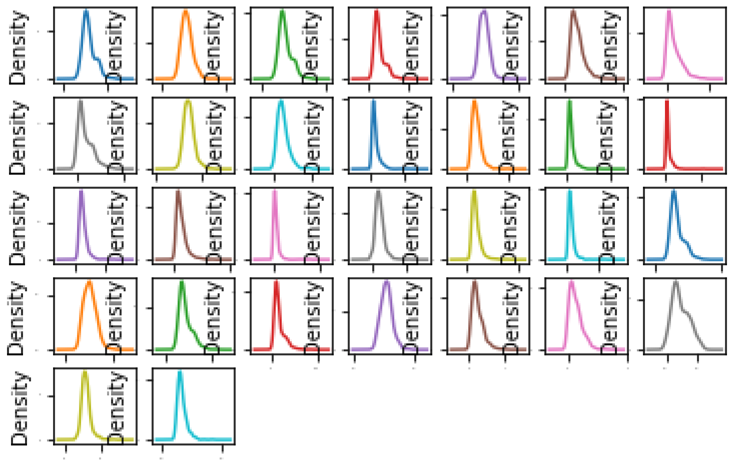
8 rows x 32 columns

```
data['diagnosis'] = data['diagnosis'].apply(lambda x: '1' if x == 'M' else '0')
data = data.set_index('id')
del data['Unnamed: 32']
print(data.groupby('diagnosis').size())
```

```
diagnosis
0    357
1    212
dtype: int64
```

GENERAL GAUSEAN DISTRIBUTION

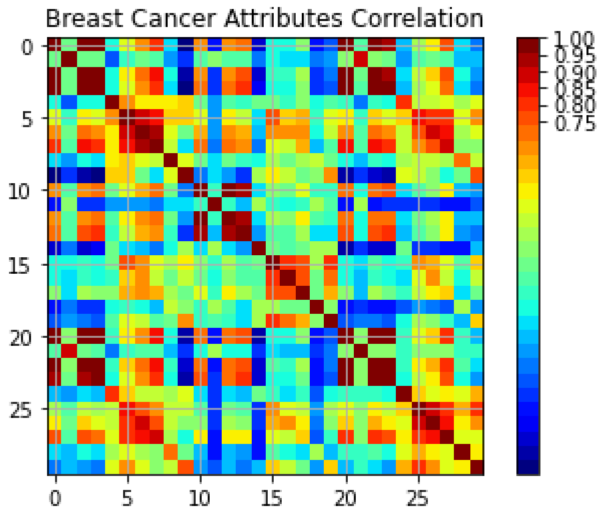
```
data.plot(kind='density', subplots=True, layout=(5,7), sharex=False, legend=False, fontsiz
plt.show()
```



ATTRIBUTE CORRELATION GRAPH

```
from matplotlib import cm as cm

fig = plt.figure()
ax1 = fig.add_subplot(111)
```

```
cmap = cm.get_cmap('jet', 30)
cax = ax1.imshow(data.corr(), interpolation="none", cmap=cmap)
ax1.grid(True)
plt.title('Breast Cancer Attributes Correlation')
# Add colorbar, make sure to specify tick locations to match desired ticklabels
fig.colorbar(cax, ticks=[.75,.8,.85,.90,.95,1])
plt.show()
```



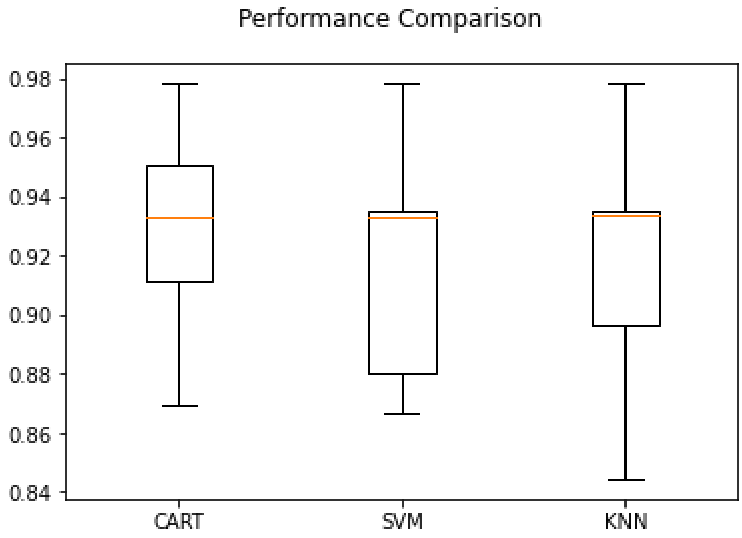
SETTING VARIABLES FOR TESTING DATAASET

```
Y = data['diagnosis'].values
X = data.drop('diagnosis', axis=1).values

X_train, X_test, Y_train, Y_test = train_test_split (X, Y, test_size = 0.20, random_state=


models_list = []
models_list.append(('CART', DecisionTreeClassifier()))
models_list.append(('SVM', SVC()))
models_list.append(('KNN', KNeighborsClassifier()))

num_folds = 10
results = []
names = []

for name, model in models_list:
    kfold = KFold(n_splits=num_folds, random_state=123, shuffle=True)
    start = time.time()
    cv_results = cross_val_score(model, X_train, Y_train, cv=kfold, scoring='accuracy')
    end = time.time()
    results.append(cv_results)
    names.append(name)
    print( "%s: %f (%f) (run time: %f)" % (name, cv_results.mean(), cv_results.std(), end-
```

```
CART: 0.927391 (0.031126) (run time: 0.311767)
SVM: 0.916329 (0.035471) (run time: 0.114384)
KNN: 0.922947 (0.038805) (run time: 0.136421)
```

PERFORMANCE COMPARISION

```
fig = plt.figure()
fig.suptitle('Performance Comparison')
ax = fig.add_subplot(111)
plt.boxplot(results)
ax.set_xticklabels(names)
plt.show()
```

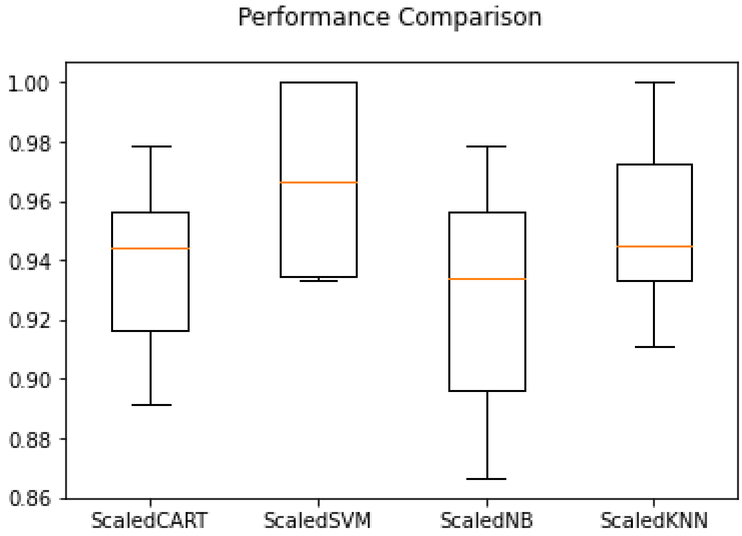


ACCURACY TEST

```
import warnings
# Standardize the dataset
pipelines = []
pipelines.append(('ScaledCART', Pipeline([('Scaler', StandardScaler()),('CART', DecisionTr
pipelines.append(('ScaledSVM', Pipeline([('Scaler', StandardScaler()),('SVM', SVC( ))])))
pipelines.append(('ScaledNB', Pipeline([('Scaler', StandardScaler()),('NB', GaussianNB())]
pipelines.append(('ScaledKNN', Pipeline([('Scaler', StandardScaler()),('KNN', KNeighborsCl
results = []
names = []
with warnings.catch_warnings():
    warnings.simplefilter("ignore")
    kfold = KFold(n_splits=num_folds, random_state=123 , shuffle=True)
    for name, model in pipelines:
        start = time.time()
        cv_results = cross_val_score(model, X_train, Y_train, cv=kfold, scoring='accuracy'
        end = time.time()
        results.append(cv_results)
        names.append(name)
        print( "%s: %f (%f) (run time: %f)" % (name, cv_results.mean(), cv_results.std(),
```

```
ScaledCART: 0.940531 (0.028004) (run time: 0.200314)
ScaledSVM: 0.966957 (0.029910) (run time: 0.121262)
ScaledNB: 0.929565 (0.038096) (run time: 0.044516)
ScaledKNN: 0.949469 (0.027808) (run time: 0.134204)
```

```
fig = plt.figure()
fig.suptitle('Performance Comparison')
ax = fig.add_subplot(111)
plt.boxplot(results)
ax.set_xticklabels(names)
plt.show()
```



```
scaler = StandardScaler().fit(X_train)
rescaledX = scaler.transform(X_train)
c_values = [0.1, 0.3, 0.5, 0.7, 0.9, 1.0, 1.3, 1.5, 1.7, 2.0]
kernel_values = ['linear', 'poly', 'rbf', 'sigmoid']
param_grid = dict(C=c_values, kernel=kernel_values)
model = SVC()
kfold = KFold(n_splits=num_folds, random_state=21, shuffle=True)
grid = GridSearchCV(estimator=model, param_grid=param_grid, scoring='accuracy', cv=kfold)
grid_result = grid.fit(rescaledX, Y_train)
print("Best: %f using %s" % (grid_result.best_score_, grid_result.best_params_))
means = grid_result.cv_results_['mean_test_score']
stds = grid_result.cv_results_['std_test_score']
params = grid_result.cv_results_['params']
for mean, stdev, param in zip(means, stds, params):
    print("%f (%f) with: %r" % (mean, stdev, param))
```

```
# prepare the model
with warnings.catch_warnings():
    warnings.simplefilter("ignore")
    scaler = StandardScaler().fit(X_train)
X_train_scaled = scaler.transform(X_train)
model = SVC(C=2.0, kernel='rbf')
start = time.time()
model.fit(X_train_scaled, Y_train)
end = time.time()
print( "Run Time: %f" % (end-start))
```

```
Run Time: 0.008085
```

```
# estimate accuracy on test dataset
```

```
with warnings.catch_warnings():
    warnings.simplefilter("ignore")
    X_test_scaled = scaler.transform(X_test)
predictions = model.predict(X_test_scaled)


print("Accuracy score %f" % accuracy_score(Y_test, predictions))
print(classification_report(Y_test, predictions))
```

```
Accuracy score 0.991228
              precision    recall  f1-score   support

           0       1.00      0.99      0.99        75
           1       0.97      1.00      0.99        39

    accuracy                           0.99       114
   macro avg       0.99      0.99      0.99       114
weighted avg       0.99      0.99      0.99       114
```

```
print(confusion_matrix(Y_test, predictions))
```

```
[[74  1]
 [ 0 39]]
```