```
from google.colab import files

uploaded = files.upload()
```

Choose Files No file chosen Upload widget is only available when the cell has been executed in the current browser session. Please rerun this cell to enable.

```
Saving ready.outcome1.csv to ready.outcome1.csv
```

```
import pandas as pd
import io

outcome1 = pd.read_csv(io.BytesIO(uploaded['ready.outcome1.csv']))
print(outcome1)
```

```
        v000  v007  v012  v013  v025  v106  v190  \
0        NG7  2018    40     6     1     4     5
1        NG7  2018    37     5     1     4     5
2        NG7  2018    27     3     1     4     5
3        NG7  2018    27     3     1     3     5
4        NG7  2018    24     2     1     3     5
...      ...   ...   ...   ...   ...   ...   ...
120648   ZW7  2015    39     5     0     2     3
120649   ZW7  2015    32     4     0     3     3
120650   ZW7  2015    24     2     0     2     2
120651   ZW7  2015    40     6     0     2     3
120652   ZW7  2015    40     6     0     2     3

                                    v501      v501a            v501b  ...  \
0                   living with partner  Unmarried    Never married  ...
1                               married    Married          Married  ...
2                               married    Married          Married  ...
3                               married    Married          Married  ...
4       no longer living together/separated  Unmarried  Formerly married  ...
...                                 ...        ...              ...  ...
120648                          married    Married          Married  ...
120649                          married    Married          Married  ...
120650                          married    Married          Married  ...
120651                          married    Married          Married  ...
120652                          married    Married          Married  ...

        v000_GH6  v000_KE6  v000_ML7  v000_NG7  v000_ZA7  v000_ZM7  v000_ZW7  \
0              0         0         0         1         0         0         0
1              0         0         0         1         0         0         0
2              0         0         0         1         0         0         0
3              0         0         0         1         0         0         0
4              0         0         0         1         0         0         0
...          ...       ...       ...       ...       ...       ...       ...
120648         0         0         0         0         0         0         1
120649         0         0         0         0         0         0         1
120650         0         0         0         0         0         0         1
120651         0         0         0         0         0         0         1
120652         0         0         0         0         0         0         1

        v501b_Formerly married  v501b_Married  v501b_Never married
0                            0              0                    1
1                            0              1                    0
2                            0              1                    0
3                            0              1                    0
4                            1              0                    0
...                        ...            ...                  ...
120648                       0              1                    0
120649                       0              1                    0
120650                       0              1                    0
120651                       0              1                    0
120652                       0              1                    0

[120653 rows x 33 columns]
```

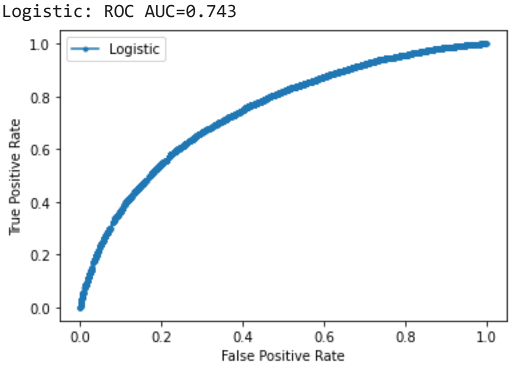
```
from sklearn.model_selection import train_test_split
outcome1_train, outcome1_test = train_test_split(
outcome1, test_size=0.20, stratify=outcome1[['v000', 'child_loss']])

x_train = outcome1_train[['v000_AO7', 'v000_EG6', 'v000_ET7', 'v000_GA6', 'v000_GH6', 'v000_KE6', 'v000_ML7', 'v000_NG7', 'v000_ZA7',
                          'v000_ZM7', 'v000_ZW7', 'v013', 'v025', 'v106', 'v190', 'v501b_Formerly married', 'v501b_Married',
                          'v501b_Never married', 'first.sex', 'v228', 'smoke']]
y_train = outcome1_train['lost_child']
y2_train = outcome1_train['child_loss']


x_test = outcome1_test[['v000_AO7', 'v000_EG6', 'v000_ET7', 'v000_GA6', 'v000_GH6', 'v000_KE6', 'v000_ML7', 'v000_NG7', 'v000_ZA7',
```

```
                          'v000_ZM7', 'v000_ZW7', 'v013', 'v025', 'v106', 'v190', 'v501b_Formerly married', 'v501b_Married',
                          'v501b_Never married', 'first.sex', 'v228', 'smoke']]
y_test = outcome1_test['lost_child']
y2_test = outcome1_test['child_loss']


print(outcome1_train.shape, outcome1_test.shape)

print(x_train.shape, x_test.shape)
```

```
(96522, 33) (24131, 33)
(96522, 21) (24131, 21)
```

```
# roc curve and auc
from sklearn.linear_model import LogisticRegression
from sklearn.model_selection import train_test_split
from sklearn.metrics import roc_curve
from sklearn.metrics import roc_auc_score
from matplotlib import pyplot

# fit a model
model = LogisticRegression(solver='lbfgs')
model.fit(x_train, y2_train)
# predict probabilities
lr_probs = model.predict_proba(x_test)
# keep probabilities for the positive outcome only
lr_probs = lr_probs[:, 1]
# calculate scores
lr_auc = roc_auc_score(y2_test, lr_probs)
# summarize scores
print('Logistic: ROC AUC=%.3f' % (lr_auc))
# calculate roc curves
lr_fpr, lr_tpr, _ = roc_curve(y2_test, lr_probs)
# plot the roc curve for the model
pyplot.plot(lr_fpr, lr_tpr, marker='.', label='Logistic')
# axis labels
pyplot.xlabel('False Positive Rate')
pyplot.ylabel('True Positive Rate')
# show the legend
pyplot.legend()
# show the plot
pyplot.show()
```

```
Logistic: ROC AUC=0.743
```

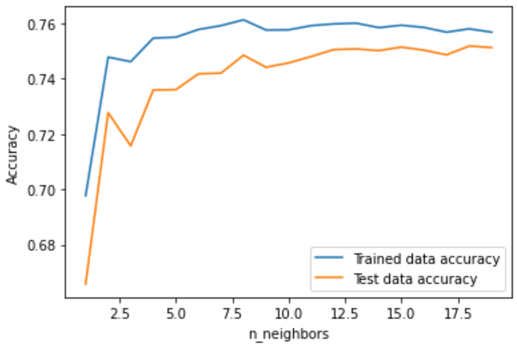



```
from sklearn.neighbors import KNeighborsClassifier
knn_train_accuracy = []
knn_test_accuracy = []

knn_train2_accuracy = []
knn_test2_accuracy = []

neighbors_settings = range(1, 20)

for n_neighbors in neighbors_settings:
    clf = KNeighborsClassifier(n_neighbors = n_neighbors)
    clf2 = KNeighborsClassifier(n_neighbors = n_neighbors)
    clf.fit(x_train, y_train)
    clf2.fit(x_train, y2_train)

    knn_train_accuracy.append(clf.score(x_train, y_train))
    knn_test_accuracy.append(clf.score(x_test, y_test))
```

```
    knn_train2_accuracy.append(clf.score(x_train, y2_train))
    knn_test2_accuracy.append(clf.score(x_test, y2_test))
```

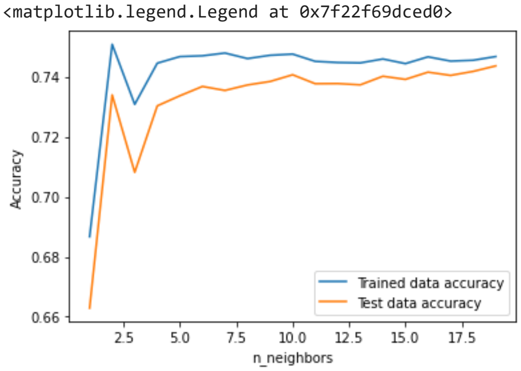
```
%matplotlib inline
import matplotlib.pyplot as plt

plt.plot(neighbors_settings, knn_train_accuracy, label= "Trained data accuracy")
plt.plot(neighbors_settings, knn_test_accuracy, label= "Test data accuracy")
plt.ylabel("Accuracy")
plt.xlabel("n_neighbors")
plt.legend()
```

```
<matplotlib.legend.Legend at 0x7f22f6aaab10>
```




```
plt.plot(neighbors_settings, knn_train2_accuracy, label= "Trained data accuracy")
plt.plot(neighbors_settings, knn_test2_accuracy, label= "Test data accuracy")
plt.ylabel("Accuracy")
plt.xlabel("n_neighbors")
plt.legend()
```

```
<matplotlib.legend.Legend at 0x7f22f69dced0>
```




```
print (knn_train_accuracy)

print (knn_train2_accuracy)
```

```
[0.6977580240774124, 0.7478087897059738, 0.7461614968608193, 0.7546776900602972, 0.7550092206957999, 0.7577857897681357, 0.7591844346366
[0.686672468452788, 0.75077184476078, 0.7307764033070181, 0.7444831230185864, 0.7466795134787924, 0.746938521787779, 0.747860591367771,
```

```
from sklearn.feature_extraction.text import TfidfVectorizer
from sklearn.naive_bayes import MultinomialNB
from sklearn.pipeline import make_pipeline
from sklearn.model_selection import cross_val_score
from sklearn.model_selection import cross_val_predict

model = MultinomialNB()
model.fit(x_train, y_train)
labels = model.predict(x_test)
nb_train_accuracy = []
nb_test_accuracy = []
nb_train_accuracy.append(model.score(x_train, y_train))
nb_test_accuracy.append(model.score(x_test, y_test))
print(nb_train_accuracy, nb_test_accuracy)
```

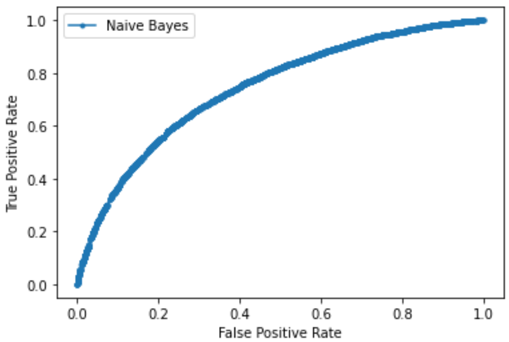
```
model_2 = MultinomialNB()
model_2.fit(x_train, y2_train)
labels_2 = model_2.predict(x_test)
nb2_train_accuracy = []
nb2_test_accuracy = []
nb2_train_accuracy.append(model_2.score(x_train, y2_train))
nb2_test_accuracy.append(model_2.score(x_test, y2_test))
print(nb2_train_accuracy, nb2_test_accuracy)

cv_train = cross_val_score(model, x_train, y_train, cv = 10, scoring = "accuracy")
cv_test = cross_val_score(model, x_test, y_test, cv = 10, scoring = "accuracy")

cv_train2 = cross_val_score(model_2, x_train, y2_train, cv = 10, scoring = "accuracy")
cv_test2 = cross_val_score(model_2, x_test, y2_test, cv = 10, scoring = "accuracy")

print("Percent accuracy within each fold (First): \n")
print(cv_train, "\n", cv_test)
print("\nMean & SD accuracy: \n")
print(cv_train.mean(), cv_test.mean())
print(cv_train.std(), cv_test.std())

print("\nPercent accuracy within each fold (Second): \n")
print(cv_train2, "\n", cv_test2)
print("\nMean & SD accuracy: \n")
print(cv_train2.mean(), cv_test2.mean())
print(cv_train2.std(), cv_test2.std())

cv_labels = cross_val_predict(model, x_test, y_test, cv=10)
cv_labels2 = cross_val_predict(model_2, x_test, y2_test, cv=10)

accuracy = pd.DataFrame()
accuracy2 = pd.DataFrame()

accuracy = accuracy.append([["Naive Baye's", (cv_train.mean()), (cv_test.mean())]])
accuracy2 = accuracy2.append([["Naive Baye's", (cv_train2.mean()), (cv_test2.mean())]])
```

```
[0.7540975114481673] [0.7543823297832664]
[0.7703425125878038] [0.7687621731382869]
Percent accuracy within each fold (First):

[0.75240858 0.75479126 0.75310816 0.75300456 0.75663075 0.75290095
 0.75476585 0.75435143 0.75486946 0.7538334 ]
 [0.75144988 0.75093245 0.75631993 0.75300456 0.75549109 0.75714878
 0.75549109 0.75259014 0.75300456 0.7538334 ]

Mean & SD accuracy:

0.7540664401177554 0.7539265872409563
0.0012051280451909068 0.0019899742075337387

Percent accuracy within each fold (Second):

[0.76898374 0.77105563 0.76543722 0.77186075 0.77289681 0.77092831
 0.77134273 0.76864898 0.77020307 0.77175715]
 [0.76677713 0.76336511 0.7708247  0.76916701 0.77786987 0.76543722
 0.77414007 0.76253626 0.76460837 0.76875259]

Mean & SD accuracy:

0.7703114376360753 0.7683478335212023
0.0020363900774159243 0.004633716958841678
```

```
from sklearn.feature_extraction.text import TfidfVectorizer
from sklearn.naive_bayes import MultinomialNB
from sklearn.pipeline import make_pipeline
from sklearn.metrics import roc_curve
from sklearn.metrics import roc_auc_score
from matplotlib import pyplot


# fit a model
model_2 = MultinomialNB()
model_2.fit(x_train, y2_train)
# predict probabilities
nb_probs = model_2.predict_proba(x_test)
# keep probabilities for the positive outcome only
nb_probs = nb_probs[:, 1]
# calculate scores
```

```
nb_auc = roc_auc_score(y2_test, nb_probs)
# summarize scores
print('Naive Bayes: ROC AUC=%.3f' % (nb_auc))
# calculate roc curves
nb_fpr, nb_tpr, _ = roc_curve(y2_test, nb_probs)
# plot the roc curve for the model
pyplot.plot(lr_fpr, lr_tpr, marker='.', label='Naive Bayes')
# axis labels
pyplot.xlabel('False Positive Rate')
pyplot.ylabel('True Positive Rate')
# show the legend
pyplot.legend()
# show the plot
pyplot.show()
```

```
Naive Bayes: ROC AUC=0.729
```



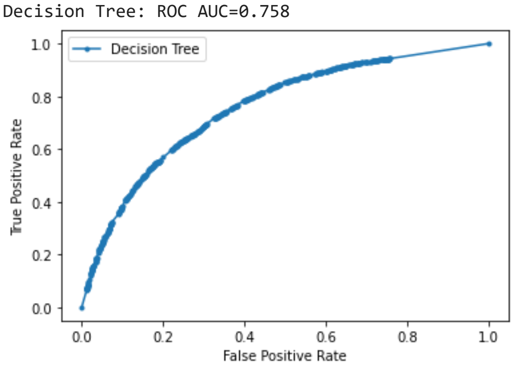

```
from sklearn.tree import DecisionTreeClassifier

tree = DecisionTreeClassifier(random_state=0)
tree.fit(x_train, y_train)
labels_tree = tree.predict(x_test)

tree_2 = DecisionTreeClassifier(random_state=0)
tree_2.fit(x_train, y2_train)
labels_tree2 = tree_2.predict(x_test)

print("Accuracy on training set: {:.3f}".format(tree.score(x_train, y_train)))
print("Accuracy on test set: {:.3f}".format(tree.score(x_test, y_test)))

print("Accuracy on training set: {:.3f}".format(tree_2.score(x_train, y2_train)))
print("Accuracy on test set: {:.3f}".format(tree_2.score(x_test, y2_test)))

cv_train = cross_val_score(tree, x_train, y_train, cv = 10, scoring = "accuracy")
cv_test = cross_val_score(tree, x_test, y_test, cv = 10, scoring = "accuracy")

cv_train2 = cross_val_score(tree_2, x_train, y2_train, cv = 10, scoring = "accuracy")
cv_test2 = cross_val_score(tree_2, x_test, y2_test, cv = 10, scoring = "accuracy")

print("Percent accuracy within each fold (First): \n")
print(cv_train, "\n", cv_test)
print("\nMean & SD accuracy: \n")
print(cv_train.mean(), cv_test.mean())
print(cv_train.std(), cv_test.std())

print("\nPercent accuracy within each fold (Second): \n")
print(cv_train2, "\n", cv_test2)
print("\nMean & SD accuracy: \n")
print(cv_train2.mean(), cv_test2.mean())
print(cv_train2.std(), cv_test2.std())

cv_labels = cross_val_predict(tree, x_test, y_test, cv=10)
cv_labels2 = cross_val_predict(tree_2, x_test, y2_test, cv=10)

accuracy = accuracy.append([["Decision Tree (Entropy)", (cv_train.mean()), (cv_test.mean())]])
accuracy2 = accuracy2.append([["Decision Tree (Entropy)", (cv_train2.mean()), (cv_test2.mean())]])
```

```
Accuracy on training set: 0.786
Accuracy on test set: 0.754
Accuracy on training set: 0.806
Accuracy on test set: 0.773
Percent accuracy within each fold (First):
```

```
[0.75044028 0.75427328 0.75321177 0.75145048 0.75393701 0.7538334
 0.75393701 0.75082884 0.75238293 0.75435143]
 [0.73363712 0.73518442 0.71653543 0.72689598 0.72813925 0.74264401
 0.72440945 0.7273104  0.73062578 0.7273104 ]

Mean & SD accuracy:

0.7528646424206326 0.7292692234928795
0.0014073972366819359 0.0065965379951465125

Percent accuracy within each fold (Second):

[0.77250596 0.77240236 0.77154994 0.7708247  0.7745545  0.77393286
 0.77496892 0.77310402 0.76978864 0.77186075]
 [0.75476388 0.74595939 0.74015748 0.75341898 0.75093245 0.76004973
 0.74513054 0.74513054 0.75134687 0.74678823]

Mean & SD accuracy:

0.7725492653510293 0.7493678092052474
0.0015552839454131431 0.005522756117813724
```

```
from sklearn.feature_extraction.text import TfidfVectorizer
from sklearn.metrics import roc_curve
from sklearn.metrics import roc_auc_score
from matplotlib import pyplot
from sklearn.tree import DecisionTreeClassifier

# fit a model
model_2 = DecisionTreeClassifier(random_state=0)
model_2.fit(x_train, y2_train)
# predict probabilities
dtc_probs = model_2.predict_proba(x_test)
# keep probabilities for the positive outcome only
dtc_probs = dtc_probs[:, 1]
# calculate scores
dtc_auc = roc_auc_score(y2_test, dtc_probs)
# summarize scores
print('Decision Tree: ROC AUC=%.3f' % (dtc_auc))
# calculate roc curves
dtc_fpr, dtc_tpr, _ = roc_curve(y2_test, dtc_probs)
# plot the roc curve for the model
pyplot.plot(dtc_fpr, dtc_tpr, marker='.', label='Decision Tree')
# axis labels
pyplot.xlabel('False Positive Rate')
pyplot.ylabel('True Positive Rate')
# show the legend
pyplot.legend()
# show the plot
pyplot.show()
```

```
Decision Tree: ROC AUC=0.758
```




```
from sklearn.tree import DecisionTreeClassifier

clf_gini = DecisionTreeClassifier(criterion = "gini", random_state = 100, max_depth = 10, min_samples_leaf=1)
clf_gini.fit(x_train, y_train)
labels_gini = clf_gini.predict(x_test)

clf_gini2 = DecisionTreeClassifier(criterion = "gini", random_state = 100, max_depth = 10, min_samples_leaf=1)
clf_gini2.fit(x_train, y2_train)
labels_gini2 = clf_gini2.predict(x_test)

print("Accuracy on training set: {:.3f}".format(clf_gini.score(x_train, y_train)))
```

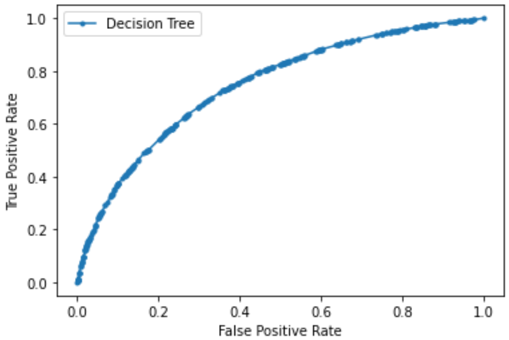
```
print("Accuracy on test set: {:.3f}".format(clf_gini.score(x_test, y_test)))

print("Accuracy on training set (Child loss): {:.3f}".format(clf_gini2.score(x_train, y2_train)))
print("Accuracy on test set (Child loss): {:.3f}".format(clf_gini2.score(x_test, y2_test)))

cv_train = cross_val_score(clf_gini, x_train, y_train, cv = 10, scoring = "accuracy")
cv_test = cross_val_score(clf_gini, x_test, y_test, cv = 10, scoring = "accuracy")

cv_train2 = cross_val_score(clf_gini2, x_train, y2_train, cv = 10, scoring = "accuracy")
cv_test2 = cross_val_score(clf_gini2, x_test, y2_test, cv = 10, scoring = "accuracy")

print("Percent accuracy within each fold (First): \n")
print(cv_train, "\n", cv_test)
print("\nMean & SD accuracy: \n")
print(cv_train.mean(), cv_test.mean())
print(cv_train.std(), cv_test.std())

print("\nPercent accuracy within each fold (Second): \n")
print(cv_train2, "\n", cv_test2)
print("\nMean & SD accuracy: \n")
print(cv_train2.mean(), cv_test2.mean())
print(cv_train2.std(), cv_test2.std())

cv_labels = cross_val_predict(clf_gini, x_test, y_test, cv=10)
cv_labels2 = cross_val_predict(clf_gini2, x_test, y2_test, cv=10)

accuracy = accuracy.append([["Decision Tree (Gini)", (cv_train.mean()), (cv_test.mean())]])
accuracy2 = accuracy2.append([["Decision Tree (Gini)", (cv_train2.mean()), (cv_test2.mean())]])
```

```
Accuracy on training set: 0.761
Accuracy on test set: 0.755
Accuracy on training set (Child loss): 0.778
Accuracy on test set (Child loss): 0.770
Percent accuracy within each fold (First):

[0.75282296 0.75675956 0.75663075 0.75393701 0.75466225 0.75714878
 0.75476585 0.75393701 0.7555947  0.7576668 ]
 [0.76056338 0.74968918 0.74305843 0.75549109 0.75051803 0.75010361
 0.74222959 0.74720265 0.74554496 0.74554496]

Mean & SD accuracy:

0.755392565452619 0.7489945891678292
0.0015318416924185215 0.005367389578657666

Percent accuracy within each fold (Second):

[0.77126282 0.77302393 0.76968504 0.77134273 0.77393286 0.77776627
 0.77092831 0.76875259 0.76989225 0.77331123]
 [0.77050539 0.76750932 0.7443017  0.77952756 0.76668048 0.76460837
 0.75631993 0.76295068 0.76502279 0.75673436]

Mean & SD accuracy:

0.7719898022508265 0.7634160586247305
0.0024944699016082104 0.008954490148631243
```

```
from sklearn.feature_extraction.text import TfidfVectorizer
from sklearn.metrics import roc_curve
from sklearn.metrics import roc_auc_score
from matplotlib import pyplot
from sklearn.tree import DecisionTreeClassifier

# fit a model
model_2 = DecisionTreeClassifier(criterion = "gini", random_state = 100, max_depth = 10, min_samples_leaf=1)
model_2.fit(x_train, y2_train)
# predict probabilities
dtc_probs = model_2.predict_proba(x_test)
# keep probabilities for the positive outcome only
dtc_probs = dtc_probs[:, 1]
# calculate scores
dtc_auc = roc_auc_score(y2_test, dtc_probs)
# summarize scores
print('Decision Tree: ROC AUC=%.3f' % (dtc_auc))
# calculate roc curves
dtc_fpr, dtc_tpr, _ = roc_curve(y2_test, dtc_probs)
# plot the roc curve for the model
pyplot.plot(dtc_fpr, dtc_tpr, marker='.', label='Decision Tree')
# axis labels
```

```
pyplot.xlabel('False Positive Rate')
pyplot.ylabel('True Positive Rate')
# show the legend
pyplot.legend()
# show the plot
pyplot.show()
```

```
Decision Tree: ROC AUC=0.745
```



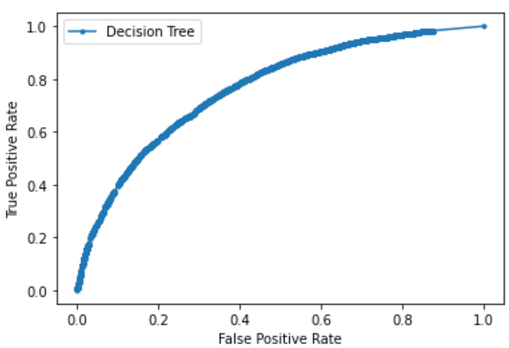

```
from sklearn.ensemble import RandomForestClassifier

forest = RandomForestClassifier(n_estimators=100, random_state=0)
forest.fit(x_train, y_train)
labels_rf = forest.predict(x_test)

forest_2 = RandomForestClassifier(n_estimators=100, random_state=0)
forest_2.fit(x_train, y2_train)
labels_rf2 = forest.predict(x_test)

print("Accuracy on training set: {:.3f}".format(forest.score(x_train, y_train)))
print("Accuracy on test set: {:.3f}".format(forest.score(x_test, y_test)))

print("Accuracy on training set (Child loss): {:.3f}".format(forest_2.score(x_train, y2_train)))
print("Accuracy on test set (Child loss): {:.3f}".format(forest_2.score(x_test, y2_test)))

cv_train = cross_val_score(forest, x_train, y_train, cv = 10, scoring = "accuracy")
cv_test = cross_val_score(forest, x_test, y_test, cv = 10, scoring = "accuracy")

cv_train2 = cross_val_score(forest_2, x_train, y2_train, cv = 10, scoring = "accuracy")
cv_test2 = cross_val_score(forest_2, x_test, y2_test, cv = 10, scoring = "accuracy")

print("Percent accuracy within each fold (First): \n")
print(cv_train, "\n", cv_test)
print("\nMean & SD accuracy: \n")
print(cv_train.mean(), cv_test.mean())
print(cv_train.std(), cv_test.std())

print("\nPercent accuracy within each fold (Second): \n")
print(cv_train2, "\n", cv_test2)
print("\nMean & SD accuracy: \n")
print(cv_train2.mean(), cv_test2.mean())
print(cv_train2.std(), cv_test2.std())

cv_labels = cross_val_predict(forest, x_test, y_test, cv=10)
cv_labels2 = cross_val_predict(forest_2, x_test, y2_test, cv=10)

accuracy = accuracy.append([["Random Forest", (cv_train.mean()), (cv_test.mean())]])
accuracy2 = accuracy2.append([["Random Forest", (cv_train2.mean()), (cv_test2.mean())]])
```

```
Accuracy on training set: 0.786
Accuracy on test set: 0.755
Accuracy on training set (Child loss): 0.806
Accuracy on test set (Child loss): 0.773
Percent accuracy within each fold (First):

[0.7518906  0.75675956 0.75486946 0.75290095 0.75497306 0.75486946
 0.75663075 0.75300456 0.75642354 0.75414422]
 [0.74316487 0.73684211 0.73186904 0.7310402  0.73559884 0.75341898
 0.73435557 0.73352673 0.73642768 0.73352673]

Mean & SD accuracy:

0.7546466157256468 0.7369770756373153
0.001592367488739728 0.006347166156062973
```

```
Percent accuracy within each fold (Second):

[0.77074485 0.77426707 0.77041028 0.77020307 0.77673021 0.77755906
 0.77818069 0.77507252 0.77527973 0.77175715]
 [0.75724938 0.74761707 0.75051803 0.76212184 0.75217571 0.76419395
 0.74968918 0.75176129 0.75176129 0.74968918]

Mean & SD accuracy:

0.7740204619569686 0.7536776937679808
0.002887619475658153 0.005317746940072504
```

```
from sklearn.feature_extraction.text import TfidfVectorizer
from sklearn.metrics import roc_curve
from sklearn.metrics import roc_auc_score
from matplotlib import pyplot
from sklearn.ensemble import RandomForestClassifier

# fit a model
model_2 = RandomForestClassifier(n_estimators=100, random_state=0)
model_2.fit(x_train, y2_train)
# predict probabilities
dtc_probs = model_2.predict_proba(x_test)
# keep probabilities for the positive outcome only
dtc_probs = dtc_probs[:, 1]
# calculate scores
dtc_auc = roc_auc_score(y2_test, dtc_probs)
# summarize scores
print('Random Forest: ROC AUC=%.3f' % (dtc_auc))
# calculate roc curves
dtc_fpr, dtc_tpr, _ = roc_curve(y2_test, dtc_probs)
# plot the roc curve for the model
pyplot.plot(dtc_fpr, dtc_tpr, marker='.', label='Random Forest')
# axis labels
pyplot.xlabel('False Positive Rate')
pyplot.ylabel('True Positive Rate')
# show the legend
pyplot.legend()
# show the plot
pyplot.show()
```

```
Decision Tree: ROC AUC=0.766
```



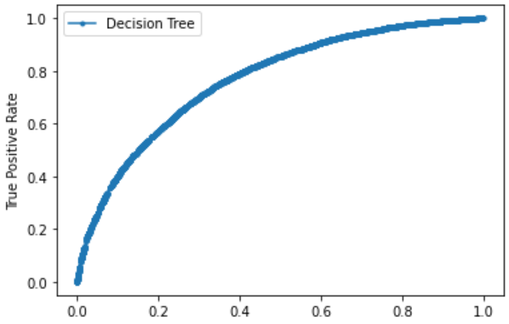

```
from sklearn.ensemble import GradientBoostingClassifier

gbrt = GradientBoostingClassifier(random_state=0, max_depth = 10)
gbrt.fit(x_train, y_train)
labels_gbrt = gbrt.predict(x_test)

gbrt_2 = GradientBoostingClassifier(random_state=0, max_depth = 10)
gbrt_2.fit(x_train, y2_train)
labels_gbrt2 = gbrt_2.predict(x_test)

print("Accuracy on training set: {:.3f}".format(gbrt.score(x_train, y_train)))
print("Accuracy on test set: {:.3f}".format(gbrt.score(x_test, y_test)))

print("Accuracy on training set (Child loss): {:.3f}".format(gbrt_2.score(x_train, y2_train)))
print("Accuracy on test set (Child loss): {:.3f}".format(gbrt_2.score(x_test, y2_test)))

cv_train = cross_val_score(gbrt, x_train, y_train, cv = 10, scoring = "accuracy")
cv_test = cross_val_score(gbrt, x_test, y_test, cv = 10, scoring = "accuracy")
```

```
cv_train2 = cross_val_score(gbrt_2, x_train, y2_train, cv = 10, scoring = "accuracy")
cv_test2 = cross_val_score(gbrt_2, x_test, y2_test, cv = 10, scoring = "accuracy")

print("Percent accuracy within each fold (First): \n")
print(cv_train, "\n", cv_test)
print("\nMean & SD accuracy: \n")
print(cv_train.mean(), cv_test.mean())
print(cv_train.std(), cv_test.std())

print("\nPercent accuracy within each fold (Second): \n")
print(cv_train2, "\n", cv_test2)
print("\nMean & SD accuracy: \n")
print(cv_train2.mean(), cv_test2.mean())
print(cv_train2.std(), cv_test2.std())

cv_labels = cross_val_predict(gbrt, x_test, y_test, cv=10)
cv_labels2 = cross_val_predict(gbrt_2, x_test, y2_test, cv=10)

accuracy = accuracy.append([["Gradient Boost", (cv_train.mean()), (cv_test.mean())]])
accuracy2 = accuracy2.append([["Gradient Boost", (cv_train2.mean()), (cv_test2.mean())]])
```

```
Accuracy on training set: 0.782
Accuracy on test set: 0.758
Accuracy on training set (Child loss): 0.798
Accuracy on test set (Child loss): 0.774
Percent accuracy within each fold (First):

[0.75479126 0.75945302 0.75880646 0.75528388 0.75714878 0.7595317
 0.7595317  0.75549109 0.75787402 0.75797762]
 [0.73943662 0.74222959 0.73228346 0.73518442 0.73849979 0.74844592
 0.73062578 0.74098632 0.73974306 0.73477   ]

Mean & SD accuracy:

0.7575889531260217 0.7382204957886565
0.0017456579478918016 0.0049619438942587885

Percent accuracy within each fold (Second):

[0.77374909 0.77654615 0.77289681 0.7727932  0.77911314 0.78201409
 0.77704103 0.77445089 0.77486531 0.77807708]
 [0.76636288 0.76626606 0.75466225 0.76336511 0.75507667 0.76792375
 0.75507667 0.75839204 0.76170742 0.75466225]

Mean & SD accuracy:

0.776154679908361 0.7603495083761633
0.0028281639056204184 0.0051342023407811325
```

```
from sklearn.feature_extraction.text import TfidfVectorizer
from sklearn.metrics import roc_curve
from sklearn.metrics import roc_auc_score
from matplotlib import pyplot
from sklearn.ensemble import GradientBoostingClassifier

# fit a model
model_2 = GradientBoostingClassifier(random_state=0, max_depth = 10)
model_2.fit(x_train, y2_train)
# predict probabilities
dtc_probs = model_2.predict_proba(x_test)
# keep probabilities for the positive outcome only
dtc_probs = dtc_probs[:, 1]
# calculate scores
dtc_auc = roc_auc_score(y2_test, dtc_probs)
# summarize scores
print('Decision Tree: ROC AUC=%.3f' % (dtc_auc))
# calculate roc curves
dtc_fpr, dtc_tpr, _ = roc_curve(y2_test, dtc_probs)
# plot the roc curve for the model
pyplot.plot(dtc_fpr, dtc_tpr, marker='.', label='Gradient Boosting')
# axis labels
pyplot.xlabel('False Positive Rate')
pyplot.ylabel('True Positive Rate')
# show the legend
pyplot.legend()
# show the plot
pyplot.show()
```

```
Decision Tree: ROC AUC=0.769
```




```
from sklearn.svm import SVC

svc = SVC()
svc.fit(x_train, y_train)
labels_svc = svc.predict(x_test)

svc_2 = SVC()
svc_2.fit(x_train, y2_train)
labels_svc2 = svc_2.predict(x_test)

print("Accuracy on training set: {:.3f}".format(svc.score(x_train, y_train)))
print("Accuracy on test set: {:.3f}".format(svc.score(x_test, y_test)))

print("Accuracy on training set (Child loss): {:.3f}".format(svc_2.score(x_train, y2_train)))
print("Accuracy on test set (Child loss): {:.3f}".format(svc_2.score(x_test, y2_test)))

cv_train = cross_val_score(svc, x_train, y_train, cv = 10, scoring = "accuracy")
cv_test = cross_val_score(svc, x_test, y_test, cv = 10, scoring = "accuracy")

cv_train2 = cross_val_score(svc_2, x_train, y2_train, cv = 10, scoring = "accuracy")
cv_test2 = cross_val_score(svc_2, x_test, y2_test, cv = 10, scoring = "accuracy")

print("Percent accuracy within each fold (First): \n")
print(cv_train, "\n", cv_test)
print("\nMean & SD accuracy: \n")
print(cv_train.mean(), cv_test.mean())
print(cv_train.std(), cv_test.std())

print("\nPercent accuracy within each fold (Second): \n")
print(cv_train2, "\n", cv_test2)
print("\nMean & SD accuracy: \n")
print(cv_train2.mean(), cv_test2.mean())
print(cv_train2.std(), cv_test2.std())

cv_labels = cross_val_predict(svc, x_test, y_test, cv=10)
cv_labels2 = cross_val_predict(svc_2, x_test, y2_test, cv=10)

accuracy = accuracy.append([["SVM", (cv_train.mean()), (cv_test.mean())]])
accuracy2 = accuracy2.append([["SVM", (cv_train2.mean()), (cv_test2.mean())]])
```

```
Accuracy on training set: 0.755
Accuracy on test set: 0.755
Accuracy on training set (Child loss): 0.769
Accuracy on test set (Child loss): 0.768
---------------------------------------------------------------------------
NameError                                 Traceback (most recent call last)
<ipython-input-4-f4c30bb4500c> in <module>
     15 print("Accuracy on test set (Child loss): {:.3f}".format(svc_2.score(x_test, y2_test)))
     16 
---> 17 cv_train = cross_val_score(svc, x_train, y_train, cv = 10, scoring = "accuracy")
     18 cv_test = cross_val_score(svc, x_test, y_test, cv = 10, scoring = "accuracy")
     19 

NameError: name 'cross_val_score' is not defined
```

SEARCH STACK OVERFLOW

```
cv_train = cross_val_score(svc, x_train, y_train, cv = 10, scoring = "accuracy")
cv_test = cross_val_score(svc, x_test, y_test, cv = 10, scoring = "accuracy")

cv_train2 = cross_val_score(svc_2, x_train, y2_train, cv = 10, scoring = "accuracy")
cv_test2 = cross_val_score(svc_2, x_test, y2_test, cv = 10, scoring = "accuracy")
```

```
print("Percent accuracy within each fold (First): \n")
print(cv_train, "\n", cv_test)
print("\nMean & SD accuracy: \n")
print(cv_train.mean(), cv_test.mean())
print(cv_train.std(), cv_test.std())

print("\nPercent accuracy within each fold (Second): \n")
print(cv_train2, "\n", cv_test2)
print("\nMean & SD accuracy: \n")
print(cv_train2.mean(), cv_test2.mean())
print(cv_train2.std(), cv_test2.std())

cv_labels = cross_val_predict(svc, x_test, y_test, cv=10)
cv_labels2 = cross_val_predict(svc_2, x_test, y2_test, cv=10)

accuracy = accuracy.append([["SVM", (cv_train.mean()), (cv_test.mean())]])
accuracy2 = accuracy2.append([["SVM", (cv_train2.mean()), (cv_test2.mean())]])
```

```
Percent accuracy within each fold (First):

[0.75427328 0.75530923 0.75435143 0.75528388 0.75528388 0.75590551
 0.75600912 0.75507667 0.75777041 0.75497306]
 [0.75144988 0.75217571 0.75217571 0.75259014 0.75176129 0.75341898
 0.75300456 0.75134687 0.75259014 0.75217571]

Mean & SD accuracy:

0.7554236470937297 0.752268899715055
0.0009450310292319527 0.0006224884138372644

Percent accuracy within each fold (Second):

[0.7677406  0.76680825 0.76844177 0.76719851 0.77206797 0.76792375
 0.76906341 0.76875259 0.76947783 0.76989225]
 [0.76594863 0.75839204 0.77248239 0.7670949  0.77041028 0.76626606
 0.76999586 0.76336511 0.76295068 0.76585164]

Mean & SD accuracy:

0.768736691371271 0.7662757584486957
0.0014461655059533117 0.003899930540227518
```

```
from sklearn.feature_extraction.text import TfidfVectorizer
from sklearn.metrics import roc_curve
from sklearn.metrics import roc_auc_score
from matplotlib import pyplot
from sklearn.svm import SVC

# fit a model
model_2 = SVC()
model_2.fit(x_train, y2_train)
# predict probabilities
dtc_probs = model_2.predict_proba(x_test)
# keep probabilities for the positive outcome only
dtc_probs = dtc_probs[:, 1]
# calculate scores
dtc_auc = roc_auc_score(y2_test, dtc_probs)
# summarize scores
print('Decision Tree: ROC AUC=%.3f' % (dtc_auc))
# calculate roc curves
dtc_fpr, dtc_tpr, _ = roc_curve(y2_test, dtc_probs)
# plot the roc curve for the model
pyplot.plot(dtc_fpr, dtc_tpr, marker='.', label='Decision Tree')
# axis labels
pyplot.xlabel('False Positive Rate')
pyplot.ylabel('True Positive Rate')
# show the legend
pyplot.legend()
# show the plot
pyplot.show()
```

```
---------------------------------------------------------------------------
AttributeError                            Traceback (most recent call last)
<ipython-input-12-695de4de1df7> in <module>
      9 model_2.fit(x_train, y2_train)
     10 # predict probabilities
---> 11 dtc_probs = model_2.predict_proba(x_test)
     12 # keep probabilities for the positive outcome only
     13 dtc_probs = dtc_probs[:, 1]

1 frames
/usr/local/lib/python3.8/dist-packages/sklearn/svm/_base.py in _check_proba(self)
    798     def _check_proba(self):
    799         if not self.probability:
```

```
from sklearn.neighbors import KNeighborsClassifier
from sklearn.model_selection import cross_val_score
from sklearn.model_selection import cross_val_predict

clf = KNeighborsClassifier(n_neighbors = 8)
clf2 = KNeighborsClassifier(n_neighbors = 2)
clf.fit(x_train, y_train)
clf2.fit(x_train, y2_train)

print("Accuracy on training set: {:.3f}".format(clf.score(x_train, y_train)))
print("Accuracy on test set: {:.3f}".format(clf.score(x_test, y_test)))

print("Accuracy on training set (Child loss): {:.3f}".format(clf2.score(x_train, y2_train)))
print("Accuracy on test set (Child loss): {:.3f}".format(clf2.score(x_test, y2_test)))

cv_train = cross_val_score(clf, x_train, y_train, cv = 10, scoring = "accuracy")
cv_test = cross_val_score(clf, x_test, y_test, cv = 10, scoring = "accuracy")

cv_train2 = cross_val_score(clf2, x_train, y2_train, cv = 10, scoring = "accuracy")
cv_test2 = cross_val_score(clf2, x_test, y2_test, cv = 10, scoring = "accuracy")

print("Percent accuracy within each fold (First): \n")
print(cv_train, "\n", cv_test)
print("\nMean & SD accuracy: \n")
print(cv_train.mean(), cv_test.mean())
print(cv_train.std(), cv_test.std())

print("\nPercent accuracy within each fold (Second): \n")
print(cv_train2, "\n", cv_test2)
print("\nMean & SD accuracy: \n")
print(cv_train2.mean(), cv_test2.mean())
print(cv_train2.std(), cv_test2.std())


cv_labels = cross_val_predict(clf, x_test, y_test, cv=10)
cv_labels2 = cross_val_predict(clf2, x_test, y2_test, cv=10)

accuracy = accuracy.append([["KNN", (cv_train.mean()), (cv_test.mean())]])
accuracy2 = accuracy2.append([["KNN", (cv_train2.mean()), (cv_test2.mean())]])
```

```
Accuracy on training set: 0.759
Accuracy on test set: 0.748
Accuracy on training set (Child loss): 0.775
Accuracy on test set (Child loss): 0.758
Percent accuracy within each fold (First):

[0.74484616 0.73572982 0.73767095 0.74181517 0.74316204 0.74823871
 0.74005387 0.74564857 0.74254041 0.74088272]
 [0.74606462 0.7405719  0.74140075 0.74264401 0.75217571 0.74388728
 0.74761707 0.74595939 0.7405719  0.74264401]

Mean & SD accuracy:

0.7420588419396318 0.7443536649555311
0.0035364894759353153 0.003474572792013889

Percent accuracy within each fold (Second):

[0.7518906  0.74743603 0.7555947  0.7537298  0.75580191 0.75435143
 0.75145048 0.7594281  0.75528388 0.75300456]
 [0.74606462 0.75051803 0.7480315  0.74595939 0.75051803 0.75134687
 0.75922089 0.74098632 0.74388728 0.74720265]

Mean & SD accuracy:

0.7537971474654559 0.748373557205842
0.0030284279033088975 0.004722795807931974
---------------------------------------------------------------------------
NameError                                 Traceback (most recent call last)
<ipython-input-8-d594213c5a2b> in <module>
     36 cv_labels2 = cross_val_predict(clf2, x_test, y2_test, cv=10)
     37 
---> 38 accuracy = accuracy.append([["KNN", (cv_train.mean()), (cv_test.mean())]])
     39 accuracy2 = accuracy2.append([["KNN", (cv_train2.mean()), (cv_test2.mean())]])

NameError: name 'accuracy' is not defined
```