```
from google.colab import files

uploaded = files.upload()
```

Choose Files ready.outcome2.csv

- **ready.outcome2.csv**(text/csv) - 9167835 bytes, last modified: 11/19/2022 - 100% done

```
Saving ready.outcome2.csv to ready.outcome2.csv
```

```
import pandas as pd
import io

outcome2 = pd.read_csv(io.BytesIO(uploaded['ready.outcome2.csv']))
print(outcome2)
```

```
       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   
...     ...   ...   ...   ...   ...   ...   ...   
88392   ZW7  2015    31     4     0     2     2   
88393   ZW7  2015    39     5     0     2     3   
88394   ZW7  2015    32     4     0     3     3   
88395   ZW7  2015    24     2     0     2     2   
88396   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  ...   
...                                  ...        ...               ...  ...   
88392                           married    Married           Married  ...   
88393                           married    Married           Married  ...   
88394                           married    Married           Married  ...   
88395                           married    Married           Married  ...   
88396                           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   
...         ...       ...       ...       ...       ...       ...       ...   
88392         0         0         0         0         0         0         1   
88393         0         0         0         0         0         0         1   
88394         0         0         0         0         0         0         1   
88395         0         0         0         0         0         0         1   
88396         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  
...                       ...            ...                  ...  
88392                       0              1                    0  
88393                       0              1                    0  
88394                       0              1                    0  
88395                       0              1                    0  
88396                       0              1                    0  

[88397 rows x 33 columns]
```

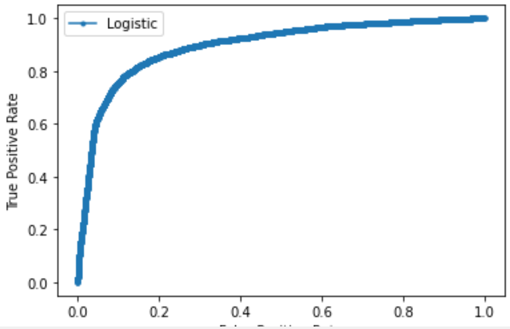
```
from sklearn.model_selection import train_test_split
outcome2_train, outcome2_test = train_test_split(
outcome2, test_size=0.35, stratify=outcome2[['v000', 'v481']])

x_train = outcome2_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', 'v213', 'v228', 'm14', 'ANC.facility', 'v312', 'm15', 'v401', 'child_loss']]
y_train = outcome2_train['v481']


x_test = outcome2_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', 'v213', 'v228', 'm14', 'ANC.facility', 'v312', 'm15', 'v401', 'child_loss']]
y_test = outcome2_test['v481']
```

```
print(outcome2_train.shape, outcome2_test.shape)
print(x_train.shape, x_test.shape)
```

```
(57458, 33) (30939, 33)
(57458, 26) (30939, 26)
```

```
# 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, y_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(y_test, lr_probs)
# summarize scores
print('Logistic: ROC AUC=%.3f' % (lr_auc))
# calculate roc curves
lr_fpr, lr_tpr, _ = roc_curve(y_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()
```

```
/usr/local/lib/python3.8/dist-packages/sklearn/linear_model/_logistic.py:814: Convergenc
STOP: TOTAL NO. of ITERATIONS REACHED LIMIT.

Increase the number of iterations (max_iter) or scale the data as shown in:
    https://scikit-learn.org/stable/modules/preprocessing.html
Please also refer to the documentation for alternative solver options:
    https://scikit-learn.org/stable/modules/linear_model.html#logistic-regression
  n_iter_i = _check_optimize_result(
Logistic: ROC AUC=0.897
```



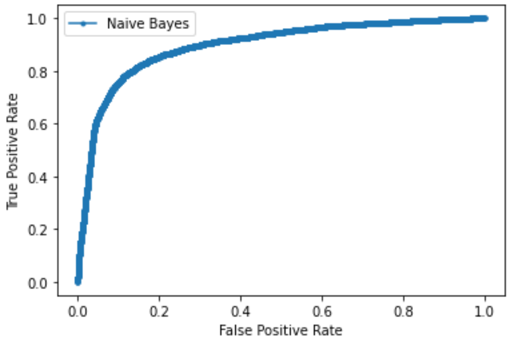
```
from sklearn.feature_extraction.text import TfidfVectorizer
from sklearn.naive_bayes import MultinomialNB
from sklearn.pipeline import make_pipeline
from sklearn.model_selection import cross_val_score
from sklearn.model_selection import cross_val_predict

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)

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")

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())

cv_labels = cross_val_predict(model, x_test, y_test, cv=10)

accuracy = pd.DataFrame()
accuracy = accuracy.append([["Naive Baye's", (cv_train.mean()), (cv_test.mean())]])
```

```
[0.9135716523373595] [0.912505252270597]
Percent accuracy within each fold (First):

[0.91106857 0.91385312 0.91176471 0.91420118 0.91646363 0.9096763
 0.91924817 0.90898016 0.91818973 0.91122715]
 [0.91758242 0.9114415  0.90723982 0.91305753 0.90950226 0.91338074
 0.91758242 0.91628959 0.91241112 0.90688652]

Mean & SD accuracy:

0.9134672714389879 0.9125373912901725
0.003369901614323646 0.003693114477089309
```

```
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, y_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(y_test, nb_probs)
# summarize scores
print('Naive Bayes: ROC AUC=%.3f' % (nb_auc))
# calculate roc curves
nb_fpr, nb_tpr, _ = roc_curve(y_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=0.853
```



```
from sklearn.tree import DecisionTreeClassifier

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

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")

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())

cv_labels = cross_val_predict(tree, x_test, y_test, cv=10)

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

```
Accuracy on training set: 0.961
Accuracy on test set: 0.898
Percent accuracy within each fold (First):

[0.90184476 0.90288897 0.90219283 0.90236686 0.89784198 0.89906022
 0.90584755 0.8964497  0.89817232 0.89939077]
 [0.89010989 0.88946348 0.88914027 0.8804137  0.88623142 0.88849386
 0.89657401 0.88429218 0.89366516 0.88975105]

Mean & SD accuracy:

0.9006055962947851 0.8888135019731985
0.0027302483319281198 0.00429675810289282
```

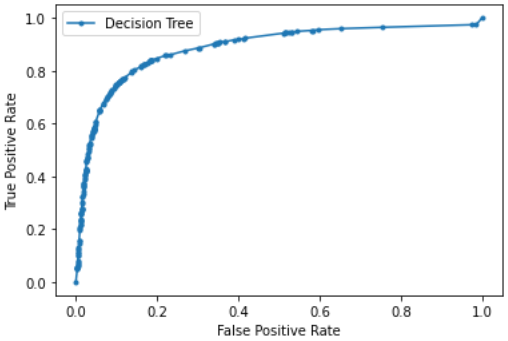
```
from sklearn.tree import DecisionTreeClassifier

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)

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)))

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")

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())

cv_labels = cross_val_predict(clf_gini, x_test, y_test, cv=10)

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

```
Accuracy on training set: 0.929
Accuracy on test set: 0.916
Percent accuracy within each fold (First):

[0.91820397 0.91489732 0.91576749 0.92064045 0.91507135 0.9178559
 0.91715976 0.9173338  0.91818973 0.91662315]
 [0.91305753 0.91241112 0.91111829 0.90497738 0.91531997 0.91079509
 0.91693601 0.91338074 0.91790562 0.90817976]

Mean & SD accuracy:

0.9171742919053386 0.9124081506063589
0.0016274399443618715 0.0037139120256914947
```

```
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
```

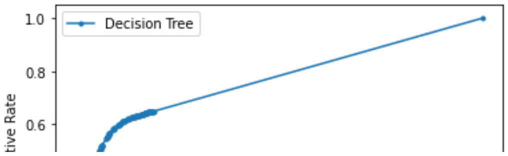
```
# fit a model
model_2 = DecisionTreeClassifier(criterion = "gini", random_state = 100, max_depth = 10, min_samples_leaf=1)
model_2.fit(x_train, y_train)
# predict probabilities
dtc_probs = model_2.predict_proba(x_test)
# keep probabilities for the positive outcome only
dtc_probs = dtc_probs[:, 1]
# calculate scores
dtc_auc = roc_auc_score(y_test, dtc_probs)
# summarize scores
print('Decision Tree: ROC AUC=%.3f' % (dtc_auc))
# calculate roc curves
dtc_fpr, dtc_tpr, _ = roc_curve(y_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=0.886
```



```
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, y_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(y_test, dtc_probs)
# summarize scores
print('Decision Tree: ROC AUC=%.3f' % (dtc_auc))
# calculate roc curves
dtc_fpr, dtc_tpr, _ = roc_curve(y_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=0.763
```

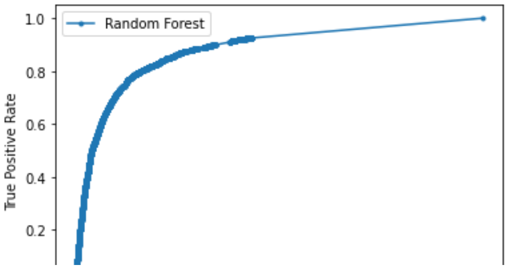


```
from sklearn.ensemble import RandomForestClassifier

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

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)))

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")

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())

cv_labels = cross_val_predict(forest, x_test, y_test, cv=10)

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

```
Accuracy on training set: 0.961
Accuracy on test set: 0.909
Percent accuracy within each fold (First):

[0.91333101 0.91507135 0.91193874 0.9168117  0.91211277 0.91089454
 0.91350505 0.90880613 0.91314186 0.90966057]
 [0.90562379 0.9062702  0.90788623 0.90077569 0.90174531 0.90077569
 0.91241112 0.90820944 0.90982547 0.9033301 ]

Mean & SD accuracy:

0.9125273721273389 0.9056853047866913
0.002281606652174675 0.0037844126928809284
```

```
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, y_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(y_test, dtc_probs)
# summarize scores
print('Random Forest: ROC AUC=%.3f' % (dtc_auc))
# calculate roc curves
dtc_fpr, dtc_tpr, _ = roc_curve(y_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()
```

```
Random Forest: ROC AUC=0.880
```

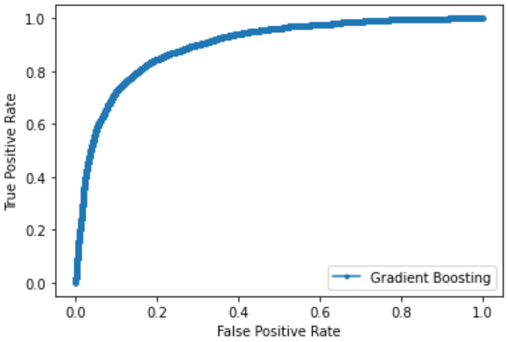


```
from sklearn.ensemble import GradientBoostingClassifier

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

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)))

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")

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())

cv_labels = cross_val_predict(gbrt, x_test, y_test, cv=10)

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

```
Accuracy on training set: 0.952
Accuracy on test set: 0.912
Percent accuracy within each fold (First):

[0.91646363 0.91350505 0.91367908 0.918378   0.91385312 0.91541942
 0.91872607 0.91141664 0.91679721 0.91470844]
 [0.90982547 0.90400776 0.90950226 0.90077569 0.90271493 0.90982547
 0.91758242 0.90885585 0.90982547 0.909473   ]

Mean & SD accuracy:

0.91529466595296 0.908238832353056
0.002195332906168908 0.0044996540716247405
```

```
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, y_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(y_test, dtc_probs)
# summarize scores
print('Decision Tree: ROC AUC=%.3f' % (dtc_auc))
# calculate roc curves
dtc_fpr, dtc_tpr, _ = roc_curve(y_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=0.899
```



```
from sklearn.svm import SVC

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

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")

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())

cv_labels = cross_val_predict(svc, x_test, y_test, cv=10)

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

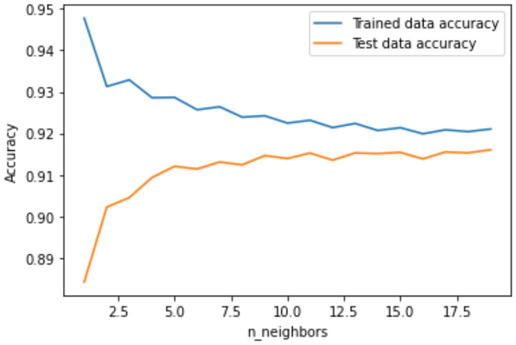
```
Accuracy on training set: 0.918
Accuracy on test set: 0.917
Percent accuracy within each fold (First):

[0.91420118 0.91768187 0.9168117  0.91994431 0.92220675 0.91507135
 0.9244692  0.91176471 0.91993037 0.9129678 ]
 [0.92049127 0.91822883 0.90982547 0.91758242 0.91467356 0.91596639
 0.92146089 0.91725921 0.91467356 0.9123828 ]

Mean & SD accuracy:

0.9175049233931836 0.9162544402973454
0.0039156881758704775 0.003363507145887208
```

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

neighbors_settings = range(1, 20)

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

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

print (knn_train_accuracy)
print (knn_test_accuracy)
```

```
[0.9477531414250409, 0.9312889414876954, 0.9328727070207804, 0.9285913188763967, 0.928660934943785, 0.9256848480629329, 0.92639841275366
[0.8841591518795048, 0.90222696273312, 0.9045218009631856, 0.9093377290798021, 0.9120527489576263, 0.9114063156533825, 0.913087042244416
```

```
%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 0x7f1859247490>
```



```
clf = KNeighborsClassifier(n_neighbors = 20)

clf.fit(x_train, y_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)))

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")

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())

cv_labels = cross_val_predict(clf, x_test, y_test, cv=10)

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

```
Accuracy on training set: 0.920
Accuracy on test set: 0.915
Percent accuracy within each fold (First):

[0.91176471 0.91750783 0.91576749 0.91176471 0.91663766 0.90985033
 0.918378   0.90898016 0.91331593 0.91523064]
 [0.90465417 0.90950226 0.90853264 0.91014867 0.90723982 0.91047188
 0.91370394 0.91370394 0.90659341 0.90850307]

Mean & SD accuracy:

0.9139197449801989 0.9093053814825938
0.003096493187079155 0.0027441077092316643
```

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