Data Import and Cleaning

In [1]:

```
#Importing required packages
import pandas as pd
import numpy as np
from sklearn.model_selection import KFold
from sklearn.svm import SVC
from sklearn.metrics import confusion_matrix
from sklearn.preprocessing import MinMaxScaler
import matplotlib.pyplot as plt
from sklearn.ensemble import AdaBoostClassifier

import matplotlib.pyplot as plt
from matplotlib import cm
from math import log10

from sklearn.tree import DecisionTreeClassifier
from sklearn import metrics

from sklearn.metrics import roc_auc_score
from sklearn import metrics
from sklearn.metrics import classification_report

from sklearn import tree

from sklearn.ensemble import GradientBoostingClassifier
from sklearn.model_selection import train_test_split
from sklearn.model_selection import cross_val_score
```

In [2]:

```
#read csv file
electricity_data = pd.read_csv("energydata_complete.csv")
```

In [3]:

```
#X and Y dataframes
electricity_data_appliance  = electricity_data.drop(['dat
e','lights'] , axis = 1)
x_electricity = electricity_data_appliance.drop(labels =
['Appliances'],axis = 1)
y_electricity = electricity_data_appliance[['Appliances'
]]
```

In [4]:

```
#converting to array and min max scalar
x_electricity = np.array(x_electricity)
y_electricity = np.array(y_electricity)

scaler = MinMaxScaler()

x_electricity = scaler.fit_transform(x_electricity)
y_electricity = scaler.fit_transform(y_electricity)
```

In [5]:

```
#converting the output to binary classification
pd.DataFrame(y_electricity).median()
y_electricity = np.where(y_electricity<0.04,0,1)
```

In [6]:

```
X_train, X_test, y_train, y_test = train_test_split(x_ele
ctricity, y_electricity, test_size=0.3,
                                                    random
_state=1)
```

SVM Classfication - Training Set Experimentation

In [7]:

```
#Training set accuracy
number_of_iter = [10,100,1000,5000,10000,15000,20000]
kernelList = ['linear','rbf','poly']
tolerance = [0.001,0.01,0.1,1]
accuracyList = []

kernelList_final = []
tolerance_final = []
iterationList_final = []

my_step = 0
for i in range(0,len(kernelList)):
    for j in range(0,len(tolerance)):
        for k in range(0,len(number_of_iter)):
            linear_fit = SVC(gamma='auto', kernel=kernelL
ist[i], tol=tolerance[j], max_iter=number_of_iter[k],
                             random_state=50)
            linear_fit.fit(X_train, y_train)
            predicted_svm = linear_fit.predict(X_train)
            cm = confusion_matrix(y_train, predicted_svm)

            kernelList_final.append(kernelList[i])
            tolerance_final.append(tolerance[j])
            iterationList_final.append(number_of_iter[k])
            accuracyList.append((cm[0][0] + cm[1][1]) / n
p.sum(cm))

            my_step = my_step + 1
            print("done:",my_step,"/",len(kernelList) * l
en(tolerance) * len(number_of_iter))

print('Kernel Tolerance Iterations Accuracy')
for l in range(0,len(kernelList) * len(tolerance) * len(n
umber_of_iter)):
```

```
    print(kernelList_final[l],tolerance_final[l],iteratio
nList_final[l],accuracyList[l])
```

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done: 1 / 84

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done: 2 / 84
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done: 3 / 84

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done: 4 / 84
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  % self.max_iter, ConvergenceWarning)

done: 5 / 84

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done: 6 / 84

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done: 7 / 84
done: 8 / 84
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done: 9 / 84

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done: 10 / 84

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done: 11 / 84
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done: 12 / 84

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done: 13 / 84

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done: 14 / 84
done: 15 / 84
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done: 16 / 84
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done: 17 / 84

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done: 18 / 84
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done: 20 / 84

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done: 21 / 84
done: 22 / 84
done: 23 / 84
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done: 24 / 84

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done: 25 / 84

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done: 26 / 84
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done: 27 / 84

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done: 28 / 84
done: 29 / 84
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done: 30 / 84
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done: 31 / 84

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done: 32 / 84
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done: 33 / 84

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done: 34 / 84

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done: 35 / 84
done: 36 / 84
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e-processing your data with StandardScaler o
r MinMaxScaler.
  % self.max_iter, ConvergenceWarning)

done: 37 / 84
```

```
c:\users\siddharth\appdata\local\programs\py
thon\python37-32\lib\site-packages\sklearn\u
tils\validation.py:724: DataConversionWarnin
g: A column-vector y was passed when a 1d ar
ray was expected. Please change the shape of
y to (n_samples, ), for example using ravel
().
  y = column_or_1d(y, warn=True)
c:\users\siddharth\appdata\local\programs\py
thon\python37-32\lib\site-packages\sklearn\s
vm\base.py:241: ConvergenceWarning: Solver t
erminated early (max_iter=1000).  Consider p
re-processing your data with StandardScaler
or MinMaxScaler.
  % self.max_iter, ConvergenceWarning)


done: 38 / 84

c:\users\siddharth\appdata\local\programs\py
thon\python37-32\lib\site-packages\sklearn\u
tils\validation.py:724: DataConversionWarnin
g: A column-vector y was passed when a 1d ar
ray was expected. Please change the shape of
y to (n_samples, ), for example using ravel
().
  y = column_or_1d(y, warn=True)
c:\users\siddharth\appdata\local\programs\py
thon\python37-32\lib\site-packages\sklearn\s
vm\base.py:241: ConvergenceWarning: Solver t
erminated early (max_iter=5000).  Consider p
re-processing your data with StandardScaler
or MinMaxScaler.
  % self.max_iter, ConvergenceWarning)

done: 39 / 84
```

```
c:\users\siddharth\appdata\local\programs\py
thon\python37-32\lib\site-packages\sklearn\u
tils\validation.py:724: DataConversionWarnin
g: A column-vector y was passed when a 1d ar
ray was expected. Please change the shape of
y to (n_samples, ), for example using ravel
().
  y = column_or_1d(y, warn=True)

done: 40 / 84

c:\users\siddharth\appdata\local\programs\py
thon\python37-32\lib\site-packages\sklearn\u
tils\validation.py:724: DataConversionWarnin
g: A column-vector y was passed when a 1d ar
ray was expected. Please change the shape of
y to (n_samples, ), for example using ravel
().
  y = column_or_1d(y, warn=True)

done: 41 / 84

c:\users\siddharth\appdata\local\programs\py
thon\python37-32\lib\site-packages\sklearn\u
tils\validation.py:724: DataConversionWarnin
g: A column-vector y was passed when a 1d ar
ray was expected. Please change the shape of
y to (n_samples, ), for example using ravel
().
  y = column_or_1d(y, warn=True)

done: 42 / 84
done: 43 / 84
```

```
c:\users\siddharth\appdata\local\programs\py
thon\python37-32\lib\site-packages\sklearn\u
tils\validation.py:724: DataConversionWarnin
g: A column-vector y was passed when a 1d ar
ray was expected. Please change the shape of
y to (n_samples, ), for example using ravel
().
  y = column_or_1d(y, warn=True)
c:\users\siddharth\appdata\local\programs\py
thon\python37-32\lib\site-packages\sklearn\s
vm\base.py:241: ConvergenceWarning: Solver t
erminated early (max_iter=10).  Consider pre
-processing your data with StandardScaler or
MinMaxScaler.
  % self.max_iter, ConvergenceWarning)
c:\users\siddharth\appdata\local\programs\py
thon\python37-32\lib\site-packages\sklearn\u
tils\validation.py:724: DataConversionWarnin
g: A column-vector y was passed when a 1d ar
ray was expected. Please change the shape of
y to (n_samples, ), for example using ravel
().
  y = column_or_1d(y, warn=True)
c:\users\siddharth\appdata\local\programs\py
thon\python37-32\lib\site-packages\sklearn\s
vm\base.py:241: ConvergenceWarning: Solver t
erminated early (max_iter=100).  Consider pr
e-processing your data with StandardScaler o
r MinMaxScaler.
  % self.max_iter, ConvergenceWarning)

done: 44 / 84
```

```
c:\users\siddharth\appdata\local\programs\py
thon\python37-32\lib\site-packages\sklearn\u
tils\validation.py:724: DataConversionWarnin
g: A column-vector y was passed when a 1d ar
ray was expected. Please change the shape of
y to (n_samples, ), for example using ravel
().
  y = column_or_1d(y, warn=True)
c:\users\siddharth\appdata\local\programs\py
thon\python37-32\lib\site-packages\sklearn\s
vm\base.py:241: ConvergenceWarning: Solver t
erminated early (max_iter=1000).  Consider p
re-processing your data with StandardScaler
or MinMaxScaler.
  % self.max_iter, ConvergenceWarning)


done: 45 / 84

c:\users\siddharth\appdata\local\programs\py
thon\python37-32\lib\site-packages\sklearn\u
tils\validation.py:724: DataConversionWarnin
g: A column-vector y was passed when a 1d ar
ray was expected. Please change the shape of
y to (n_samples, ), for example using ravel
().
  y = column_or_1d(y, warn=True)
c:\users\siddharth\appdata\local\programs\py
thon\python37-32\lib\site-packages\sklearn\s
vm\base.py:241: ConvergenceWarning: Solver t
erminated early (max_iter=5000).  Consider p
re-processing your data with StandardScaler
or MinMaxScaler.
  % self.max_iter, ConvergenceWarning)

done: 46 / 84
```

```
c:\users\siddharth\appdata\local\programs\py
thon\python37-32\lib\site-packages\sklearn\u
tils\validation.py:724: DataConversionWarnin
g: A column-vector y was passed when a 1d ar
ray was expected. Please change the shape of
y to (n_samples, ), for example using ravel
().
  y = column_or_1d(y, warn=True)


done: 47 / 84

c:\users\siddharth\appdata\local\programs\py
thon\python37-32\lib\site-packages\sklearn\u
tils\validation.py:724: DataConversionWarnin
g: A column-vector y was passed when a 1d ar
ray was expected. Please change the shape of
y to (n_samples, ), for example using ravel
().
  y = column_or_1d(y, warn=True)

done: 48 / 84

c:\users\siddharth\appdata\local\programs\py
thon\python37-32\lib\site-packages\sklearn\u
tils\validation.py:724: DataConversionWarnin
g: A column-vector y was passed when a 1d ar
ray was expected. Please change the shape of
y to (n_samples, ), for example using ravel
().
  y = column_or_1d(y, warn=True)

done: 49 / 84
done: 50 / 84
```

```
c:\users\siddharth\appdata\local\programs\py
thon\python37-32\lib\site-packages\sklearn\u
tils\validation.py:724: DataConversionWarnin
g: A column-vector y was passed when a 1d ar
ray was expected. Please change the shape of
y to (n_samples, ), for example using ravel
().
  y = column_or_1d(y, warn=True)
c:\users\siddharth\appdata\local\programs\py
thon\python37-32\lib\site-packages\sklearn\s
vm\base.py:241: ConvergenceWarning: Solver t
erminated early (max_iter=10).  Consider pre
-processing your data with StandardScaler or
MinMaxScaler.
  % self.max_iter, ConvergenceWarning)
c:\users\siddharth\appdata\local\programs\py
thon\python37-32\lib\site-packages\sklearn\u
tils\validation.py:724: DataConversionWarnin
g: A column-vector y was passed when a 1d ar
ray was expected. Please change the shape of
y to (n_samples, ), for example using ravel
().
  y = column_or_1d(y, warn=True)
c:\users\siddharth\appdata\local\programs\py
thon\python37-32\lib\site-packages\sklearn\s
vm\base.py:241: ConvergenceWarning: Solver t
erminated early (max_iter=100).  Consider pr
e-processing your data with StandardScaler o
r MinMaxScaler.
  % self.max_iter, ConvergenceWarning)

done: 51 / 84
```

```
c:\users\siddharth\appdata\local\programs\py
thon\python37-32\lib\site-packages\sklearn\u
tils\validation.py:724: DataConversionWarnin
g: A column-vector y was passed when a 1d ar
ray was expected. Please change the shape of
y to (n_samples, ), for example using ravel
().
  y = column_or_1d(y, warn=True)
c:\users\siddharth\appdata\local\programs\py
thon\python37-32\lib\site-packages\sklearn\s
vm\base.py:241: ConvergenceWarning: Solver t
erminated early (max_iter=1000).  Consider p
re-processing your data with StandardScaler
or MinMaxScaler.
  % self.max_iter, ConvergenceWarning)


done: 52 / 84

c:\users\siddharth\appdata\local\programs\py
thon\python37-32\lib\site-packages\sklearn\u
tils\validation.py:724: DataConversionWarnin
g: A column-vector y was passed when a 1d ar
ray was expected. Please change the shape of
y to (n_samples, ), for example using ravel
().
  y = column_or_1d(y, warn=True)

done: 53 / 84

c:\users\siddharth\appdata\local\programs\py
thon\python37-32\lib\site-packages\sklearn\u
tils\validation.py:724: DataConversionWarnin
g: A column-vector y was passed when a 1d ar
ray was expected. Please change the shape of
y to (n_samples, ), for example using ravel
().
  y = column_or_1d(y, warn=True)
```

```
done: 54 / 84

c:\users\siddharth\appdata\local\programs\py
thon\python37-32\lib\site-packages\sklearn\u
tils\validation.py:724: DataConversionWarnin
g: A column-vector y was passed when a 1d ar
ray was expected. Please change the shape of
y to (n_samples, ), for example using ravel
().
  y = column_or_1d(y, warn=True)

done: 55 / 84

c:\users\siddharth\appdata\local\programs\py
thon\python37-32\lib\site-packages\sklearn\u
tils\validation.py:724: DataConversionWarnin
g: A column-vector y was passed when a 1d ar
ray was expected. Please change the shape of
y to (n_samples, ), for example using ravel
().
  y = column_or_1d(y, warn=True)

done: 56 / 84
done: 57 / 84
```

```
c:\users\siddharth\appdata\local\programs\py
thon\python37-32\lib\site-packages\sklearn\u
tils\validation.py:724: DataConversionWarnin
g: A column-vector y was passed when a 1d ar
ray was expected. Please change the shape of
y to (n_samples, ), for example using ravel
().
  y = column_or_1d(y, warn=True)
c:\users\siddharth\appdata\local\programs\py
thon\python37-32\lib\site-packages\sklearn\s
vm\base.py:241: ConvergenceWarning: Solver t
erminated early (max_iter=10).  Consider pre
-processing your data with StandardScaler or
MinMaxScaler.
  % self.max_iter, ConvergenceWarning)
c:\users\siddharth\appdata\local\programs\py
thon\python37-32\lib\site-packages\sklearn\u
tils\validation.py:724: DataConversionWarnin
g: A column-vector y was passed when a 1d ar
ray was expected. Please change the shape of
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().
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c:\users\siddharth\appdata\local\programs\py
thon\python37-32\lib\site-packages\sklearn\s
vm\base.py:241: ConvergenceWarning: Solver t
erminated early (max_iter=100).  Consider pr
e-processing your data with StandardScaler o
r MinMaxScaler.
  % self.max_iter, ConvergenceWarning)


done: 58 / 84
```

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c:\users\siddharth\appdata\local\programs\py
thon\python37-32\lib\site-packages\sklearn\u
tils\validation.py:724: DataConversionWarnin
g: A column-vector y was passed when a 1d ar
ray was expected. Please change the shape of
y to (n_samples, ), for example using ravel
().
  y = column_or_1d(y, warn=True)
c:\users\siddharth\appdata\local\programs\py
thon\python37-32\lib\site-packages\sklearn\s
vm\base.py:241: ConvergenceWarning: Solver t
erminated early (max_iter=1000).  Consider p
re-processing your data with StandardScaler
or MinMaxScaler.
  % self.max_iter, ConvergenceWarning)

done: 59 / 84

c:\users\siddharth\appdata\local\programs\py
thon\python37-32\lib\site-packages\sklearn\u
tils\validation.py:724: DataConversionWarnin
g: A column-vector y was passed when a 1d ar
ray was expected. Please change the shape of
y to (n_samples, ), for example using ravel
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  y = column_or_1d(y, warn=True)
c:\users\siddharth\appdata\local\programs\py
thon\python37-32\lib\site-packages\sklearn\s
vm\base.py:241: ConvergenceWarning: Solver t
erminated early (max_iter=5000).  Consider p
re-processing your data with StandardScaler
or MinMaxScaler.
  % self.max_iter, ConvergenceWarning)

done: 60 / 84
```

```
c:\users\siddharth\appdata\local\programs\py
thon\python37-32\lib\site-packages\sklearn\u
tils\validation.py:724: DataConversionWarnin
g: A column-vector y was passed when a 1d ar
ray was expected. Please change the shape of
y to (n_samples, ), for example using ravel
().
  y = column_or_1d(y, warn=True)

done: 61 / 84

c:\users\siddharth\appdata\local\programs\py
thon\python37-32\lib\site-packages\sklearn\u
tils\validation.py:724: DataConversionWarnin
g: A column-vector y was passed when a 1d ar
ray was expected. Please change the shape of
y to (n_samples, ), for example using ravel
().
  y = column_or_1d(y, warn=True)

done: 62 / 84

c:\users\siddharth\appdata\local\programs\py
thon\python37-32\lib\site-packages\sklearn\u
tils\validation.py:724: DataConversionWarnin
g: A column-vector y was passed when a 1d ar
ray was expected. Please change the shape of
y to (n_samples, ), for example using ravel
().
  y = column_or_1d(y, warn=True)

done: 63 / 84
done: 64 / 84
```

```
c:\users\siddharth\appdata\local\programs\py
thon\python37-32\lib\site-packages\sklearn\u
tils\validation.py:724: DataConversionWarnin
g: A column-vector y was passed when a 1d ar
ray was expected. Please change the shape of
y to (n_samples, ), for example using ravel
().
  y = column_or_1d(y, warn=True)
c:\users\siddharth\appdata\local\programs\py
thon\python37-32\lib\site-packages\sklearn\s
vm\base.py:241: ConvergenceWarning: Solver t
erminated early (max_iter=10).  Consider pre
-processing your data with StandardScaler or
MinMaxScaler.
  % self.max_iter, ConvergenceWarning)
c:\users\siddharth\appdata\local\programs\py
thon\python37-32\lib\site-packages\sklearn\u
tils\validation.py:724: DataConversionWarnin
g: A column-vector y was passed when a 1d ar
ray was expected. Please change the shape of
y to (n_samples, ), for example using ravel
().
  y = column_or_1d(y, warn=True)
c:\users\siddharth\appdata\local\programs\py
thon\python37-32\lib\site-packages\sklearn\s
vm\base.py:241: ConvergenceWarning: Solver t
erminated early (max_iter=100).  Consider pr
e-processing your data with StandardScaler o
r MinMaxScaler.
  % self.max_iter, ConvergenceWarning)


done: 65 / 84
```

```
c:\users\siddharth\appdata\local\programs\py
thon\python37-32\lib\site-packages\sklearn\u
tils\validation.py:724: DataConversionWarnin
g: A column-vector y was passed when a 1d ar
ray was expected. Please change the shape of
y to (n_samples, ), for example using ravel
().
  y = column_or_1d(y, warn=True)
c:\users\siddharth\appdata\local\programs\py
thon\python37-32\lib\site-packages\sklearn\s
vm\base.py:241: ConvergenceWarning: Solver t
erminated early (max_iter=1000).  Consider p
re-processing your data with StandardScaler
or MinMaxScaler.
  % self.max_iter, ConvergenceWarning)

done: 66 / 84

c:\users\siddharth\appdata\local\programs\py
thon\python37-32\lib\site-packages\sklearn\u
tils\validation.py:724: DataConversionWarnin
g: A column-vector y was passed when a 1d ar
ray was expected. Please change the shape of
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().
  y = column_or_1d(y, warn=True)
c:\users\siddharth\appdata\local\programs\py
thon\python37-32\lib\site-packages\sklearn\s
vm\base.py:241: ConvergenceWarning: Solver t
erminated early (max_iter=5000).  Consider p
re-processing your data with StandardScaler
or MinMaxScaler.
  % self.max_iter, ConvergenceWarning)

done: 67 / 84
```

```
c:\users\siddharth\appdata\local\programs\py
thon\python37-32\lib\site-packages\sklearn\u
tils\validation.py:724: DataConversionWarnin
g: A column-vector y was passed when a 1d ar
ray was expected. Please change the shape of
y to (n_samples, ), for example using ravel
().
  y = column_or_1d(y, warn=True)

done: 68 / 84

c:\users\siddharth\appdata\local\programs\py
thon\python37-32\lib\site-packages\sklearn\u
tils\validation.py:724: DataConversionWarnin
g: A column-vector y was passed when a 1d ar
ray was expected. Please change the shape of
y to (n_samples, ), for example using ravel
().
  y = column_or_1d(y, warn=True)

done: 69 / 84

c:\users\siddharth\appdata\local\programs\py
thon\python37-32\lib\site-packages\sklearn\u
tils\validation.py:724: DataConversionWarnin
g: A column-vector y was passed when a 1d ar
ray was expected. Please change the shape of
y to (n_samples, ), for example using ravel
().
  y = column_or_1d(y, warn=True)

done: 70 / 84
done: 71 / 84
```

```
c:\users\siddharth\appdata\local\programs\py
thon\python37-32\lib\site-packages\sklearn\u
tils\validation.py:724: DataConversionWarnin
g: A column-vector y was passed when a 1d ar
ray was expected. Please change the shape of
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().
  y = column_or_1d(y, warn=True)
c:\users\siddharth\appdata\local\programs\py
thon\python37-32\lib\site-packages\sklearn\s
vm\base.py:241: ConvergenceWarning: Solver t
erminated early (max_iter=10).  Consider pre
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MinMaxScaler.
  % self.max_iter, ConvergenceWarning)
c:\users\siddharth\appdata\local\programs\py
thon\python37-32\lib\site-packages\sklearn\u
tils\validation.py:724: DataConversionWarnin
g: A column-vector y was passed when a 1d ar
ray was expected. Please change the shape of
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().
  y = column_or_1d(y, warn=True)
c:\users\siddharth\appdata\local\programs\py
thon\python37-32\lib\site-packages\sklearn\s
vm\base.py:241: ConvergenceWarning: Solver t
erminated early (max_iter=100).  Consider pr
e-processing your data with StandardScaler o
r MinMaxScaler.
  % self.max_iter, ConvergenceWarning)


done: 72 / 84
```

```
c:\users\siddharth\appdata\local\programs\py
thon\python37-32\lib\site-packages\sklearn\u
tils\validation.py:724: DataConversionWarnin
g: A column-vector y was passed when a 1d ar
ray was expected. Please change the shape of
y to (n_samples, ), for example using ravel
().
  y = column_or_1d(y, warn=True)
c:\users\siddharth\appdata\local\programs\py
thon\python37-32\lib\site-packages\sklearn\s
vm\base.py:241: ConvergenceWarning: Solver t
erminated early (max_iter=1000).  Consider p
re-processing your data with StandardScaler
or MinMaxScaler.
  % self.max_iter, ConvergenceWarning)

done: 73 / 84

c:\users\siddharth\appdata\local\programs\py
thon\python37-32\lib\site-packages\sklearn\u
tils\validation.py:724: DataConversionWarnin
g: A column-vector y was passed when a 1d ar
ray was expected. Please change the shape of
y to (n_samples, ), for example using ravel
().
  y = column_or_1d(y, warn=True)
c:\users\siddharth\appdata\local\programs\py
thon\python37-32\lib\site-packages\sklearn\s
vm\base.py:241: ConvergenceWarning: Solver t
erminated early (max_iter=5000).  Consider p
re-processing your data with StandardScaler
or MinMaxScaler.
  % self.max_iter, ConvergenceWarning)

done: 74 / 84
```

```
c:\users\siddharth\appdata\local\programs\py
thon\python37-32\lib\site-packages\sklearn\u
tils\validation.py:724: DataConversionWarnin
g: A column-vector y was passed when a 1d ar
ray was expected. Please change the shape of
y to (n_samples, ), for example using ravel
().
  y = column_or_1d(y, warn=True)

done: 75 / 84

c:\users\siddharth\appdata\local\programs\py
thon\python37-32\lib\site-packages\sklearn\u
tils\validation.py:724: DataConversionWarnin
g: A column-vector y was passed when a 1d ar
ray was expected. Please change the shape of
y to (n_samples, ), for example using ravel
().
  y = column_or_1d(y, warn=True)

done: 76 / 84

c:\users\siddharth\appdata\local\programs\py
thon\python37-32\lib\site-packages\sklearn\u
tils\validation.py:724: DataConversionWarnin
g: A column-vector y was passed when a 1d ar
ray was expected. Please change the shape of
y to (n_samples, ), for example using ravel
().
  y = column_or_1d(y, warn=True)

done: 77 / 84
done: 78 / 84
```

```
c:\users\siddharth\appdata\local\programs\py
thon\python37-32\lib\site-packages\sklearn\u
tils\validation.py:724: DataConversionWarnin
g: A column-vector y was passed when a 1d ar
ray was expected. Please change the shape of
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().
  y = column_or_1d(y, warn=True)
c:\users\siddharth\appdata\local\programs\py
thon\python37-32\lib\site-packages\sklearn\s
vm\base.py:241: ConvergenceWarning: Solver t
erminated early (max_iter=10).  Consider pre
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MinMaxScaler.
  % self.max_iter, ConvergenceWarning)
c:\users\siddharth\appdata\local\programs\py
thon\python37-32\lib\site-packages\sklearn\u
tils\validation.py:724: DataConversionWarnin
g: A column-vector y was passed when a 1d ar
ray was expected. Please change the shape of
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().
  y = column_or_1d(y, warn=True)
c:\users\siddharth\appdata\local\programs\py
thon\python37-32\lib\site-packages\sklearn\s
vm\base.py:241: ConvergenceWarning: Solver t
erminated early (max_iter=100).  Consider pr
e-processing your data with StandardScaler o
r MinMaxScaler.
  % self.max_iter, ConvergenceWarning)


done: 79 / 84
```

```
c:\users\siddharth\appdata\local\programs\py
thon\python37-32\lib\site-packages\sklearn\u
tils\validation.py:724: DataConversionWarnin
g: A column-vector y was passed when a 1d ar
ray was expected. Please change the shape of
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().
  y = column_or_1d(y, warn=True)
c:\users\siddharth\appdata\local\programs\py
thon\python37-32\lib\site-packages\sklearn\s
vm\base.py:241: ConvergenceWarning: Solver t
erminated early (max_iter=1000).  Consider p
re-processing your data with StandardScaler
or MinMaxScaler.
  % self.max_iter, ConvergenceWarning)

done: 80 / 84

c:\users\siddharth\appdata\local\programs\py
thon\python37-32\lib\site-packages\sklearn\u
tils\validation.py:724: DataConversionWarnin
g: A column-vector y was passed when a 1d ar
ray was expected. Please change the shape of
y to (n_samples, ), for example using ravel
().
  y = column_or_1d(y, warn=True)
c:\users\siddharth\appdata\local\programs\py
thon\python37-32\lib\site-packages\sklearn\s
vm\base.py:241: ConvergenceWarning: Solver t
erminated early (max_iter=5000).  Consider p
re-processing your data with StandardScaler
or MinMaxScaler.
  % self.max_iter, ConvergenceWarning)

done: 81 / 84
```

```
c:\users\siddharth\appdata\local\programs\py
thon\python37-32\lib\site-packages\sklearn\u
tils\validation.py:724: DataConversionWarnin
g: A column-vector y was passed when a 1d ar
ray was expected. Please change the shape of
y to (n_samples, ), for example using ravel
().
  y = column_or_1d(y, warn=True)

done: 82 / 84

c:\users\siddharth\appdata\local\programs\py
thon\python37-32\lib\site-packages\sklearn\u
tils\validation.py:724: DataConversionWarnin
g: A column-vector y was passed when a 1d ar
ray was expected. Please change the shape of
y to (n_samples, ), for example using ravel
().
  y = column_or_1d(y, warn=True)

done: 83 / 84

c:\users\siddharth\appdata\local\programs\py
thon\python37-32\lib\site-packages\sklearn\u
tils\validation.py:724: DataConversionWarnin
g: A column-vector y was passed when a 1d ar
ray was expected. Please change the shape of
y to (n_samples, ), for example using ravel
().
  y = column_or_1d(y, warn=True)
```

done: 84 / 84
Kernel Tolerance Iterations Accuracy
linear 0.001 10 0.3743038945996816
linear 0.001 100 0.6181410163602142
linear 0.001 1000 0.5564644563486318
linear 0.001 5000 0.7260749963804836
linear 0.001 10000 0.7286810482119589
linear 0.001 15000 0.7287534385406109
linear 0.001 20000 0.7287534385406109
linear 0.01 10 0.3743038945996816
linear 0.01 100 0.6181410163602142
linear 0.01 1000 0.5564644563486318
linear 0.01 5000 0.7260749963804836
linear 0.01 10000 0.7286086578833068
linear 0.01 15000 0.7286086578833068
linear 0.01 20000 0.7286086578833068
linear 0.1 10 0.3743038945996816
linear 0.1 100 0.6181410163602142
linear 0.1 1000 0.5564644563486318
linear 0.1 5000 0.7260749963804836
linear 0.1 10000 0.7291153901838714
linear 0.1 15000 0.7291153901838714
linear 0.1 20000 0.7291153901838714
linear 1 10 0.3743038945996816
linear 1 100 0.6181410163602142
linear 1 1000 0.5564644563486318
linear 1 5000 0.7276675836108296
linear 1 10000 0.7276675836108296
linear 1 15000 0.7276675836108296
linear 1 20000 0.7276675836108296
rbf 0.001 10 0.6064137831185754
rbf 0.001 100 0.5332271608513103
rbf 0.001 1000 0.645504560590705
rbf 0.001 5000 0.7212248443607934
rbf 0.001 10000 0.7213696250180975
rbf 0.001 15000 0.7213696250180975
rbf 0.001 20000 0.7213696250180975

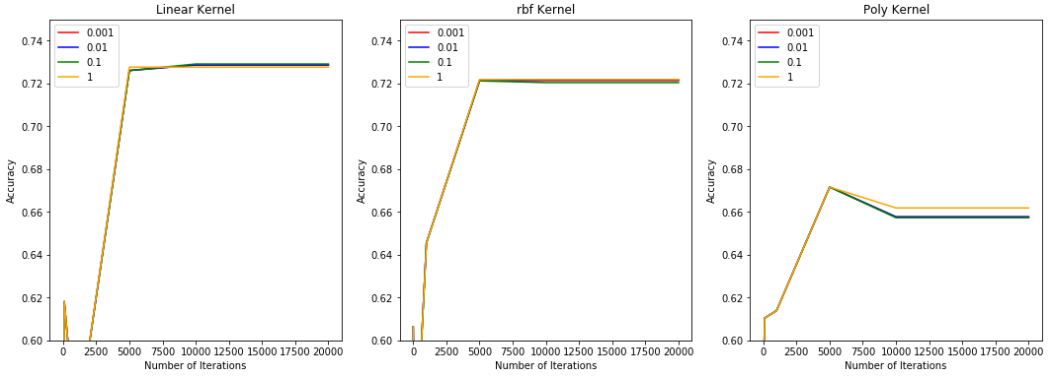
rbf 0.01 10 0.6064137831185754
rbf 0.01 100 0.5332271608513103
rbf 0.01 1000 0.645504560590705
rbf 0.01 5000 0.7212248443607934
rbf 0.01 10000 0.721659186332706
rbf 0.01 15000 0.721659186332706
rbf 0.01 20000 0.721659186332706
rbf 0.1 10 0.6064137831185754
rbf 0.1 100 0.5332271608513103
rbf 0.1 1000 0.645504560590705
rbf 0.1 5000 0.7212248443607934
rbf 0.1 10000 0.7204285507456204
rbf 0.1 15000 0.7204285507456204
rbf 0.1 20000 0.7204285507456204
rbf 1 10 0.6064137831185754
rbf 1 100 0.5332271608513103
rbf 1 1000 0.645504560590705
rbf 1 5000 0.7218763573186622
rbf 1 10000 0.7218763573186622
rbf 1 15000 0.7218763573186622
rbf 1 20000 0.7218763573186622
poly 0.001 10 0.5812943390762995
poly 0.001 100 0.6103952511944404
poly 0.001 1000 0.613942377298393
poly 0.001 5000 0.6716374692341103
poly 0.001 10000 0.6576661358042566
poly 0.001 15000 0.6576661358042566
poly 0.001 20000 0.6576661358042566
poly 0.01 10 0.5812943390762995
poly 0.01 100 0.6103952511944404
poly 0.01 1000 0.613942377298393
poly 0.01 5000 0.6716374692341103
poly 0.01 10000 0.6577385261329086
poly 0.01 15000 0.6577385261329086
poly 0.01 20000 0.6577385261329086
poly 0.1 10 0.5812943390762995
poly 0.1 100 0.6103952511944404

poly 0.1 1000 0.613942377298393
poly 0.1 5000 0.6716374692341103
poly 0.1 10000 0.6573041841609961
poly 0.1 15000 0.6573041841609961
poly 0.1 20000 0.6573041841609961
poly 1 10 0.5812943390762995
poly 1 100 0.6103952511944404
poly 1 1000 0.613942377298393
poly 1 5000 0.6716374692341103
poly 1 10000 0.6618647748660779
poly 1 15000 0.6618647748660779
poly 1 20000 0.6618647748660779

In [8]:

```
x_range = [10,100,1000,5000,10000,15000,20000]
plt.figure(figsize=(18,6))

#Linear kernel
plt.subplot(1, 3, 1)
plt.plot(x_range, accuracyList[0:7], color='r',label ='0.
001')
plt.plot(x_range, accuracyList[7:14], color='b',label =
'0.01')
plt.plot(x_range, accuracyList[14:21], color='g',label =
'0.1')
plt.plot(x_range, accuracyList[21:28], color='orange',lab
el ='1')
plt.ylim(0.60,0.75)

plt.title("Linear Kernel")
plt.legend(loc='upper left')

plt.xlabel('Number of Iterations')
plt.ylabel('Accuracy')


#rbf kernel
plt.subplot(1, 3, 2)
plt.plot(x_range, accuracyList[28:35], color='r',label =
'0.001')
plt.plot(x_range, accuracyList[35:42], color='b',label =
'0.01')
plt.plot(x_range, accuracyList[42:49], color='g',label =
'0.1')
plt.plot(x_range, accuracyList[49:56], color='orange',lab
el ='1')
plt.ylim(0.60,0.75)

plt.title("rbf Kernel")
```

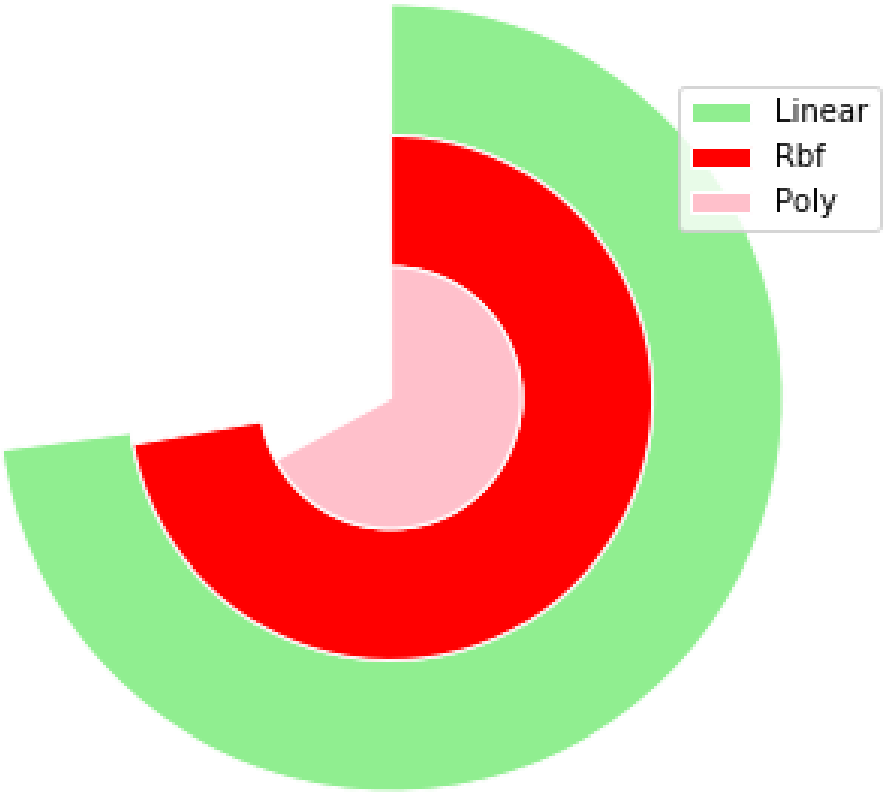
```
plt.legend(loc='upper left')
plt.xlabel('Number of Iterations')
plt.ylabel('Accuracy')


#poly kernel
plt.subplot(1, 3, 3)
plt.plot(x_range, accuracyList[56:63], color='r',label =
'0.001')
plt.plot(x_range, accuracyList[63:70], color='b',label =
'0.01')
plt.plot(x_range, accuracyList[70:77], color='g',label =
'0.1')
plt.plot(x_range, accuracyList[77:84], color='orange',lab
el ='1')
plt.ylim(0.60,0.75)

plt.title("Poly Kernel")
plt.legend(loc='upper left')

plt.xlabel('Number of Iterations')
plt.ylabel('Accuracy')


plt.show()
```



In [9]:

```
print("Maximum accuracy in each kernel")
labels = ['Linear','Rbf','Poly']
data = [max(accuracyList[0:28]),max(accuracyList[28:56]),
max(accuracyList[56:84])]
#number of data points
n = len(data)
#find max value for full ring
k = 10 ** int(log10(max(data)))
m = k * (1 + max(data) // k)

#radius of donut chart
r = 1.5
#calculate width of each ring
w = r / n

#create colors along a chosen colormap
colors = ['lightgreen','red','pink']

#create figure, axis
fig, ax = plt.subplots()
ax.axis("equal")

#create rings of donut chart
for i in range(n):
    #hide labels in segments with textprops: alpha = 0 -
 transparent, alpha = 1 - visible
    innerring, _ = ax.pie([m - data[i], data[i]], radius
= r - i * w, startangle = 90, labels = ["", labels[i]], l
abeldistance = 1 - 1 / (1.5 * (n - i)), textprops = {"alp
ha": 0}, colors = ["white", colors[i]])
    plt.setp(innerring, width = w, edgecolor = "white")

plt.legend()
plt.show()
```

Maximum accuracy in each kernel



SVM Classfication - Validation Set Experimentation

In [10]:

```
number_of_iter = [10,100,1000,5000,10000,15000,20000]
kernelList = ['linear','rbf','poly']
tolerance = [0.001,0.01,0.1,1]
accuracyList = []

kernelList_final = []
tolerance_final = []
iterationList_final = []

my_step = 0
for i in range(0,len(kernelList)):
    for j in range(0,len(tolerance)):
        for k in range(0,len(number_of_iter)):
            linear_fit = SVC(gamma='auto', kernel=kernelL
ist[i], tol=tolerance[j], max_iter=number_of_iter[k],
                             random_state=50)
            linear_fit.fit(X_train, y_train)
            predicted_svm = linear_fit.predict(X_test)
            cm = confusion_matrix(y_test, predicted_svm)

            kernelList_final.append(kernelList[i])
            tolerance_final.append(tolerance[j])
            iterationList_final.append(number_of_iter[k])
            accuracyList.append((cm[0][0] + cm[1][1]) / n
p.sum(cm))

            my_step = my_step + 1
            print("done:",my_step,"/",len(kernelList) * l
en(tolerance) * len(number_of_iter))

print('Kernel Tolerance Iterations Accuracy')
for l in range(0,len(kernelList) * len(tolerance) * len(n
umber_of_iter)):
    print(kernelList_final[l],tolerance_final[l],iteratio
nList_final[l],accuracyList[l])
```

done: 1 / 84

```
c:\users\siddharth\appdata\local\programs\py
thon\python37-32\lib\site-packages\sklearn\u
tils\validation.py:724: DataConversionWarnin
g: A column-vector y was passed when a 1d ar
ray was expected. Please change the shape of
y to (n_samples, ), for example using ravel
().
  y = column_or_1d(y, warn=True)
c:\users\siddharth\appdata\local\programs\py
thon\python37-32\lib\site-packages\sklearn\s
vm\base.py:241: ConvergenceWarning: Solver t
erminated early (max_iter=10).  Consider pre
-processing your data with StandardScaler or
MinMaxScaler.
  % self.max_iter, ConvergenceWarning)
c:\users\siddharth\appdata\local\programs\py
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tils\validation.py:724: DataConversionWarnin
g: A column-vector y was passed when a 1d ar
ray was expected. Please change the shape of
y to (n_samples, ), for example using ravel
().
  y = column_or_1d(y, warn=True)
c:\users\siddharth\appdata\local\programs\py
thon\python37-32\lib\site-packages\sklearn\s
vm\base.py:241: ConvergenceWarning: Solver t
erminated early (max_iter=100).  Consider pr
e-processing your data with StandardScaler o
r MinMaxScaler.
  % self.max_iter, ConvergenceWarning)
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tils\validation.py:724: DataConversionWarnin
g: A column-vector y was passed when a 1d ar
ray was expected. Please change the shape of
y to (n_samples, ), for example using ravel
```

```
().
  y = column_or_1d(y, warn=True)

done: 2 / 84

c:\users\siddharth\appdata\local\programs\py
thon\python37-32\lib\site-packages\sklearn\s
vm\base.py:241: ConvergenceWarning: Solver t
erminated early (max_iter=1000).  Consider p
re-processing your data with StandardScaler
or MinMaxScaler.
  % self.max_iter, ConvergenceWarning)

done: 3 / 84

c:\users\siddharth\appdata\local\programs\py
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tils\validation.py:724: DataConversionWarnin
g: A column-vector y was passed when a 1d ar
ray was expected. Please change the shape of
y to (n_samples, ), for example using ravel
().
  y = column_or_1d(y, warn=True)
c:\users\siddharth\appdata\local\programs\py
thon\python37-32\lib\site-packages\sklearn\s
vm\base.py:241: ConvergenceWarning: Solver t
erminated early (max_iter=5000).  Consider p
re-processing your data with StandardScaler
or MinMaxScaler.
  % self.max_iter, ConvergenceWarning)

done: 4 / 84
```

```
c:\users\siddharth\appdata\local\programs\py
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tils\validation.py:724: DataConversionWarnin
g: A column-vector y was passed when a 1d ar
ray was expected. Please change the shape of
y to (n_samples, ), for example using ravel
().
  y = column_or_1d(y, warn=True)
c:\users\siddharth\appdata\local\programs\py
thon\python37-32\lib\site-packages\sklearn\s
vm\base.py:241: ConvergenceWarning: Solver t
erminated early (max_iter=10000).  Consider
pre-processing your data with StandardScaler
or MinMaxScaler.
  % self.max_iter, ConvergenceWarning)

done: 5 / 84

c:\users\siddharth\appdata\local\programs\py
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tils\validation.py:724: DataConversionWarnin
g: A column-vector y was passed when a 1d ar
ray was expected. Please change the shape of
y to (n_samples, ), for example using ravel
().
  y = column_or_1d(y, warn=True)

done: 6 / 84

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tils\validation.py:724: DataConversionWarnin
g: A column-vector y was passed when a 1d ar
ray was expected. Please change the shape of
y to (n_samples, ), for example using ravel
().
  y = column_or_1d(y, warn=True)
```

```
done: 7 / 84
done: 8 / 84
done: 9 / 84
```

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tils\validation.py:724: DataConversionWarnin
g: A column-vector y was passed when a 1d ar
ray was expected. Please change the shape of
y to (n_samples, ), for example using ravel
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  y = column_or_1d(y, warn=True)
c:\users\siddharth\appdata\local\programs\py
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vm\base.py:241: ConvergenceWarning: Solver t
erminated early (max_iter=10).  Consider pre
-processing your data with StandardScaler or
MinMaxScaler.
  % self.max_iter, ConvergenceWarning)
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tils\validation.py:724: DataConversionWarnin
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  y = column_or_1d(y, warn=True)
c:\users\siddharth\appdata\local\programs\py
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vm\base.py:241: ConvergenceWarning: Solver t
erminated early (max_iter=100).  Consider pr
e-processing your data with StandardScaler o
r MinMaxScaler.
  % self.max_iter, ConvergenceWarning)
c:\users\siddharth\appdata\local\programs\py
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tils\validation.py:724: DataConversionWarnin
g: A column-vector y was passed when a 1d ar
ray was expected. Please change the shape of
y to (n_samples, ), for example using ravel
().
```

```
  y = column_or_1d(y, warn=True)
c:\users\siddharth\appdata\local\programs\py
thon\python37-32\lib\site-packages\sklearn\s
vm\base.py:241: ConvergenceWarning: Solver t
erminated early (max_iter=1000).  Consider p
re-processing your data with StandardScaler
or MinMaxScaler.
  % self.max_iter, ConvergenceWarning)

done: 10 / 84

c:\users\siddharth\appdata\local\programs\py
thon\python37-32\lib\site-packages\sklearn\u
tils\validation.py:724: DataConversionWarnin
g: A column-vector y was passed when a 1d ar
ray was expected. Please change the shape of
y to (n_samples, ), for example using ravel
().
  y = column_or_1d(y, warn=True)
c:\users\siddharth\appdata\local\programs\py
thon\python37-32\lib\site-packages\sklearn\s
vm\base.py:241: ConvergenceWarning: Solver t
erminated early (max_iter=5000).  Consider p
re-processing your data with StandardScaler
or MinMaxScaler.
  % self.max_iter, ConvergenceWarning)

done: 11 / 84

c:\users\siddharth\appdata\local\programs\py
thon\python37-32\lib\site-packages\sklearn\u
tils\validation.py:724: DataConversionWarnin
g: A column-vector y was passed when a 1d ar
ray was expected. Please change the shape of
y to (n_samples, ), for example using ravel
().
  y = column_or_1d(y, warn=True)
```

```
done: 12 / 84

c:\users\siddharth\appdata\local\programs\py
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tils\validation.py:724: DataConversionWarnin
g: A column-vector y was passed when a 1d ar
ray was expected. Please change the shape of
y to (n_samples, ), for example using ravel
().
  y = column_or_1d(y, warn=True)

done: 13 / 84

c:\users\siddharth\appdata\local\programs\py
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tils\validation.py:724: DataConversionWarnin
g: A column-vector y was passed when a 1d ar
ray was expected. Please change the shape of
y to (n_samples, ), for example using ravel
().
  y = column_or_1d(y, warn=True)

done: 14 / 84
done: 15 / 84
done: 16 / 84
```

```
c:\users\siddharth\appdata\local\programs\py
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tils\validation.py:724: DataConversionWarnin
g: A column-vector y was passed when a 1d ar
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c:\users\siddharth\appdata\local\programs\py
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vm\base.py:241: ConvergenceWarning: Solver t
erminated early (max_iter=10).  Consider pre
-processing your data with StandardScaler or
MinMaxScaler.
  % self.max_iter, ConvergenceWarning)
c:\users\siddharth\appdata\local\programs\py
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tils\validation.py:724: DataConversionWarnin
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c:\users\siddharth\appdata\local\programs\py
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vm\base.py:241: ConvergenceWarning: Solver t
erminated early (max_iter=100).  Consider pr
e-processing your data with StandardScaler o
r MinMaxScaler.
  % self.max_iter, ConvergenceWarning)
c:\users\siddharth\appdata\local\programs\py
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tils\validation.py:724: DataConversionWarnin
g: A column-vector y was passed when a 1d ar
ray was expected. Please change the shape of
y to (n_samples, ), for example using ravel
().
```

```
  y = column_or_1d(y, warn=True)
c:\users\siddharth\appdata\local\programs\py
thon\python37-32\lib\site-packages\sklearn\s
vm\base.py:241: ConvergenceWarning: Solver t
erminated early (max_iter=1000).  Consider p
re-processing your data with StandardScaler
or MinMaxScaler.
  % self.max_iter, ConvergenceWarning)


done: 17 / 84

c:\users\siddharth\appdata\local\programs\py
thon\python37-32\lib\site-packages\sklearn\u
tils\validation.py:724: DataConversionWarnin
g: A column-vector y was passed when a 1d ar
ray was expected. Please change the shape of
y to (n_samples, ), for example using ravel
().
  y = column_or_1d(y, warn=True)
c:\users\siddharth\appdata\local\programs\py
thon\python37-32\lib\site-packages\sklearn\s
vm\base.py:241: ConvergenceWarning: Solver t
erminated early (max_iter=5000).  Consider p
re-processing your data with StandardScaler
or MinMaxScaler.
  % self.max_iter, ConvergenceWarning)

done: 18 / 84

c:\users\siddharth\appdata\local\programs\py
thon\python37-32\lib\site-packages\sklearn\u
tils\validation.py:724: DataConversionWarnin
g: A column-vector y was passed when a 1d ar
ray was expected. Please change the shape of
y to (n_samples, ), for example using ravel
().
  y = column_or_1d(y, warn=True)
```

```
done: 19 / 84


c:\users\siddharth\appdata\local\programs\py
thon\python37-32\lib\site-packages\sklearn\u
tils\validation.py:724: DataConversionWarnin
g: A column-vector y was passed when a 1d ar
ray was expected. Please change the shape of
y to (n_samples, ), for example using ravel
().
  y = column_or_1d(y, warn=True)

done: 20 / 84

c:\users\siddharth\appdata\local\programs\py
thon\python37-32\lib\site-packages\sklearn\u
tils\validation.py:724: DataConversionWarnin
g: A column-vector y was passed when a 1d ar
ray was expected. Please change the shape of
y to (n_samples, ), for example using ravel
().
  y = column_or_1d(y, warn=True)

done: 21 / 84
done: 22 / 84
done: 23 / 84
```

```
c:\users\siddharth\appdata\local\programs\py
thon\python37-32\lib\site-packages\sklearn\u
tils\validation.py:724: DataConversionWarnin
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  y = column_or_1d(y, warn=True)
c:\users\siddharth\appdata\local\programs\py
thon\python37-32\lib\site-packages\sklearn\s
vm\base.py:241: ConvergenceWarning: Solver t
erminated early (max_iter=10).  Consider pre
-processing your data with StandardScaler or
MinMaxScaler.
  % self.max_iter, ConvergenceWarning)
c:\users\siddharth\appdata\local\programs\py
thon\python37-32\lib\site-packages\sklearn\u
tils\validation.py:724: DataConversionWarnin
g: A column-vector y was passed when a 1d ar
ray was expected. Please change the shape of
y to (n_samples, ), for example using ravel
().
  y = column_or_1d(y, warn=True)
c:\users\siddharth\appdata\local\programs\py
thon\python37-32\lib\site-packages\sklearn\s
vm\base.py:241: ConvergenceWarning: Solver t
erminated early (max_iter=100).  Consider pr
e-processing your data with StandardScaler o
r MinMaxScaler.
  % self.max_iter, ConvergenceWarning)
c:\users\siddharth\appdata\local\programs\py
thon\python37-32\lib\site-packages\sklearn\u
tils\validation.py:724: DataConversionWarnin
g: A column-vector y was passed when a 1d ar
ray was expected. Please change the shape of
y to (n_samples, ), for example using ravel
().
```

```
  y = column_or_1d(y, warn=True)
c:\users\siddharth\appdata\local\programs\py
thon\python37-32\lib\site-packages\sklearn\s
vm\base.py:241: ConvergenceWarning: Solver t
erminated early (max_iter=1000).  Consider p
re-processing your data with StandardScaler
or MinMaxScaler.
  % self.max_iter, ConvergenceWarning)
c:\users\siddharth\appdata\local\programs\py
thon\python37-32\lib\site-packages\sklearn\u
tils\validation.py:724: DataConversionWarnin
g: A column-vector y was passed when a 1d ar
ray was expected. Please change the shape of
y to (n_samples, ), for example using ravel
().
  y = column_or_1d(y, warn=True)


done: 24 / 84
done: 25 / 84

c:\users\siddharth\appdata\local\programs\py
thon\python37-32\lib\site-packages\sklearn\u
tils\validation.py:724: DataConversionWarnin
g: A column-vector y was passed when a 1d ar
ray was expected. Please change the shape of
y to (n_samples, ), for example using ravel
().
  y = column_or_1d(y, warn=True)

done: 26 / 84
```

```
c:\users\siddharth\appdata\local\programs\py
thon\python37-32\lib\site-packages\sklearn\u
tils\validation.py:724: DataConversionWarnin
g: A column-vector y was passed when a 1d ar
ray was expected. Please change the shape of
y to (n_samples, ), for example using ravel
().
  y = column_or_1d(y, warn=True)


done: 27 / 84

c:\users\siddharth\appdata\local\programs\py
thon\python37-32\lib\site-packages\sklearn\u
tils\validation.py:724: DataConversionWarnin
g: A column-vector y was passed when a 1d ar
ray was expected. Please change the shape of
y to (n_samples, ), for example using ravel
().
  y = column_or_1d(y, warn=True)

done: 28 / 84
done: 29 / 84
```

```
c:\users\siddharth\appdata\local\programs\py
thon\python37-32\lib\site-packages\sklearn\u
tils\validation.py:724: DataConversionWarnin
g: A column-vector y was passed when a 1d ar
ray was expected. Please change the shape of
y to (n_samples, ), for example using ravel
().
  y = column_or_1d(y, warn=True)
c:\users\siddharth\appdata\local\programs\py
thon\python37-32\lib\site-packages\sklearn\s
vm\base.py:241: ConvergenceWarning: Solver t
erminated early (max_iter=10).  Consider pre
-processing your data with StandardScaler or
MinMaxScaler.
  % self.max_iter, ConvergenceWarning)
c:\users\siddharth\appdata\local\programs\py
thon\python37-32\lib\site-packages\sklearn\u
tils\validation.py:724: DataConversionWarnin
g: A column-vector y was passed when a 1d ar
ray was expected. Please change the shape of
y to (n_samples, ), for example using ravel
().
  y = column_or_1d(y, warn=True)
c:\users\siddharth\appdata\local\programs\py
thon\python37-32\lib\site-packages\sklearn\s
vm\base.py:241: ConvergenceWarning: Solver t
erminated early (max_iter=100).  Consider pr
e-processing your data with StandardScaler o
r MinMaxScaler.
  % self.max_iter, ConvergenceWarning)

done: 30 / 84
```

```
c:\users\siddharth\appdata\local\programs\py
thon\python37-32\lib\site-packages\sklearn\u
tils\validation.py:724: DataConversionWarnin
g: A column-vector y was passed when a 1d ar
ray was expected. Please change the shape of
y to (n_samples, ), for example using ravel
().
  y = column_or_1d(y, warn=True)
c:\users\siddharth\appdata\local\programs\py
thon\python37-32\lib\site-packages\sklearn\s
vm\base.py:241: ConvergenceWarning: Solver t
erminated early (max_iter=1000).  Consider p
re-processing your data with StandardScaler
or MinMaxScaler.
  % self.max_iter, ConvergenceWarning)


done: 31 / 84

c:\users\siddharth\appdata\local\programs\py
thon\python37-32\lib\site-packages\sklearn\u
tils\validation.py:724: DataConversionWarnin
g: A column-vector y was passed when a 1d ar
ray was expected. Please change the shape of
y to (n_samples, ), for example using ravel
().
  y = column_or_1d(y, warn=True)
c:\users\siddharth\appdata\local\programs\py
thon\python37-32\lib\site-packages\sklearn\s
vm\base.py:241: ConvergenceWarning: Solver t
erminated early (max_iter=5000).  Consider p
re-processing your data with StandardScaler
or MinMaxScaler.
  % self.max_iter, ConvergenceWarning)

done: 32 / 84
```

```
c:\users\siddharth\appdata\local\programs\py
thon\python37-32\lib\site-packages\sklearn\u
tils\validation.py:724: DataConversionWarnin
g: A column-vector y was passed when a 1d ar
ray was expected. Please change the shape of
y to (n_samples, ), for example using ravel
().
  y = column_or_1d(y, warn=True)

done: 33 / 84

c:\users\siddharth\appdata\local\programs\py
thon\python37-32\lib\site-packages\sklearn\u
tils\validation.py:724: DataConversionWarnin
g: A column-vector y was passed when a 1d ar
ray was expected. Please change the shape of
y to (n_samples, ), for example using ravel
().
  y = column_or_1d(y, warn=True)

done: 34 / 84

c:\users\siddharth\appdata\local\programs\py
thon\python37-32\lib\site-packages\sklearn\u
tils\validation.py:724: DataConversionWarnin
g: A column-vector y was passed when a 1d ar
ray was expected. Please change the shape of
y to (n_samples, ), for example using ravel
().
  y = column_or_1d(y, warn=True)

done: 35 / 84
done: 36 / 84
```

```
c:\users\siddharth\appdata\local\programs\py
thon\python37-32\lib\site-packages\sklearn\u
tils\validation.py:724: DataConversionWarnin
g: A column-vector y was passed when a 1d ar
ray was expected. Please change the shape of
y to (n_samples, ), for example using ravel
().
  y = column_or_1d(y, warn=True)
c:\users\siddharth\appdata\local\programs\py
thon\python37-32\lib\site-packages\sklearn\s
vm\base.py:241: ConvergenceWarning: Solver t
erminated early (max_iter=10).  Consider pre
-processing your data with StandardScaler or
MinMaxScaler.
  % self.max_iter, ConvergenceWarning)
c:\users\siddharth\appdata\local\programs\py
thon\python37-32\lib\site-packages\sklearn\u
tils\validation.py:724: DataConversionWarnin
g: A column-vector y was passed when a 1d ar
ray was expected. Please change the shape of
y to (n_samples, ), for example using ravel
().
  y = column_or_1d(y, warn=True)
c:\users\siddharth\appdata\local\programs\py
thon\python37-32\lib\site-packages\sklearn\s
vm\base.py:241: ConvergenceWarning: Solver t
erminated early (max_iter=100).  Consider pr
e-processing your data with StandardScaler o
r MinMaxScaler.
  % self.max_iter, ConvergenceWarning)

done: 37 / 84
```

```
c:\users\siddharth\appdata\local\programs\py
thon\python37-32\lib\site-packages\sklearn\u
tils\validation.py:724: DataConversionWarnin
g: A column-vector y was passed when a 1d ar
ray was expected. Please change the shape of
y to (n_samples, ), for example using ravel
().
  y = column_or_1d(y, warn=True)
c:\users\siddharth\appdata\local\programs\py
thon\python37-32\lib\site-packages\sklearn\s
vm\base.py:241: ConvergenceWarning: Solver t
erminated early (max_iter=1000).  Consider p
re-processing your data with StandardScaler
or MinMaxScaler.
  % self.max_iter, ConvergenceWarning)


done: 38 / 84

c:\users\siddharth\appdata\local\programs\py
thon\python37-32\lib\site-packages\sklearn\u
tils\validation.py:724: DataConversionWarnin
g: A column-vector y was passed when a 1d ar
ray was expected. Please change the shape of
y to (n_samples, ), for example using ravel
().
  y = column_or_1d(y, warn=True)
c:\users\siddharth\appdata\local\programs\py
thon\python37-32\lib\site-packages\sklearn\s
vm\base.py:241: ConvergenceWarning: Solver t
erminated early (max_iter=5000).  Consider p
re-processing your data with StandardScaler
or MinMaxScaler.
  % self.max_iter, ConvergenceWarning)

done: 39 / 84
```

```
c:\users\siddharth\appdata\local\programs\py
thon\python37-32\lib\site-packages\sklearn\u
tils\validation.py:724: DataConversionWarnin
g: A column-vector y was passed when a 1d ar
ray was expected. Please change the shape of
y to (n_samples, ), for example using ravel
().
  y = column_or_1d(y, warn=True)


done: 40 / 84

c:\users\siddharth\appdata\local\programs\py
thon\python37-32\lib\site-packages\sklearn\u
tils\validation.py:724: DataConversionWarnin
g: A column-vector y was passed when a 1d ar
ray was expected. Please change the shape of
y to (n_samples, ), for example using ravel
().
  y = column_or_1d(y, warn=True)

done: 41 / 84

c:\users\siddharth\appdata\local\programs\py
thon\python37-32\lib\site-packages\sklearn\u
tils\validation.py:724: DataConversionWarnin
g: A column-vector y was passed when a 1d ar
ray was expected. Please change the shape of
y to (n_samples, ), for example using ravel
().
  y = column_or_1d(y, warn=True)

done: 42 / 84
done: 43 / 84
```

```
c:\users\siddharth\appdata\local\programs\py
thon\python37-32\lib\site-packages\sklearn\u
tils\validation.py:724: DataConversionWarnin
g: A column-vector y was passed when a 1d ar
ray was expected. Please change the shape of
y to (n_samples, ), for example using ravel
().
  y = column_or_1d(y, warn=True)
c:\users\siddharth\appdata\local\programs\py
thon\python37-32\lib\site-packages\sklearn\s
vm\base.py:241: ConvergenceWarning: Solver t
erminated early (max_iter=10).  Consider pre
-processing your data with StandardScaler or
MinMaxScaler.
  % self.max_iter, ConvergenceWarning)
c:\users\siddharth\appdata\local\programs\py
thon\python37-32\lib\site-packages\sklearn\u
tils\validation.py:724: DataConversionWarnin
g: A column-vector y was passed when a 1d ar
ray was expected. Please change the shape of
y to (n_samples, ), for example using ravel
().
  y = column_or_1d(y, warn=True)
c:\users\siddharth\appdata\local\programs\py
thon\python37-32\lib\site-packages\sklearn\s
vm\base.py:241: ConvergenceWarning: Solver t
erminated early (max_iter=100).  Consider pr
e-processing your data with StandardScaler o
r MinMaxScaler.
  % self.max_iter, ConvergenceWarning)

done: 44 / 84
```

```
c:\users\siddharth\appdata\local\programs\py
thon\python37-32\lib\site-packages\sklearn\u
tils\validation.py:724: DataConversionWarnin
g: A column-vector y was passed when a 1d ar
ray was expected. Please change the shape of
y to (n_samples, ), for example using ravel
().
  y = column_or_1d(y, warn=True)
c:\users\siddharth\appdata\local\programs\py
thon\python37-32\lib\site-packages\sklearn\s
vm\base.py:241: ConvergenceWarning: Solver t
erminated early (max_iter=1000).  Consider p
re-processing your data with StandardScaler
or MinMaxScaler.
  % self.max_iter, ConvergenceWarning)


done: 45 / 84

c:\users\siddharth\appdata\local\programs\py
thon\python37-32\lib\site-packages\sklearn\u
tils\validation.py:724: DataConversionWarnin
g: A column-vector y was passed when a 1d ar
ray was expected. Please change the shape of
y to (n_samples, ), for example using ravel
().
  y = column_or_1d(y, warn=True)
c:\users\siddharth\appdata\local\programs\py
thon\python37-32\lib\site-packages\sklearn\s
vm\base.py:241: ConvergenceWarning: Solver t
erminated early (max_iter=5000).  Consider p
re-processing your data with StandardScaler
or MinMaxScaler.
  % self.max_iter, ConvergenceWarning)

done: 46 / 84
```

```
c:\users\siddharth\appdata\local\programs\py
thon\python37-32\lib\site-packages\sklearn\u
tils\validation.py:724: DataConversionWarnin
g: A column-vector y was passed when a 1d ar
ray was expected. Please change the shape of
y to (n_samples, ), for example using ravel
().
  y = column_or_1d(y, warn=True)

done: 47 / 84

c:\users\siddharth\appdata\local\programs\py
thon\python37-32\lib\site-packages\sklearn\u
tils\validation.py:724: DataConversionWarnin
g: A column-vector y was passed when a 1d ar
ray was expected. Please change the shape of
y to (n_samples, ), for example using ravel
().
  y = column_or_1d(y, warn=True)

done: 48 / 84

c:\users\siddharth\appdata\local\programs\py
thon\python37-32\lib\site-packages\sklearn\u
tils\validation.py:724: DataConversionWarnin
g: A column-vector y was passed when a 1d ar
ray was expected. Please change the shape of
y to (n_samples, ), for example using ravel
().
  y = column_or_1d(y, warn=True)

done: 49 / 84
done: 50 / 84
```

```
c:\users\siddharth\appdata\local\programs\py
thon\python37-32\lib\site-packages\sklearn\u
tils\validation.py:724: DataConversionWarnin
g: A column-vector y was passed when a 1d ar
ray was expected. Please change the shape of
y to (n_samples, ), for example using ravel
().
  y = column_or_1d(y, warn=True)
c:\users\siddharth\appdata\local\programs\py
thon\python37-32\lib\site-packages\sklearn\s
vm\base.py:241: ConvergenceWarning: Solver t
erminated early (max_iter=10).  Consider pre
-processing your data with StandardScaler or
MinMaxScaler.
  % self.max_iter, ConvergenceWarning)
c:\users\siddharth\appdata\local\programs\py
thon\python37-32\lib\site-packages\sklearn\u
tils\validation.py:724: DataConversionWarnin
g: A column-vector y was passed when a 1d ar
ray was expected. Please change the shape of
y to (n_samples, ), for example using ravel
().
  y = column_or_1d(y, warn=True)
c:\users\siddharth\appdata\local\programs\py
thon\python37-32\lib\site-packages\sklearn\s
vm\base.py:241: ConvergenceWarning: Solver t
erminated early (max_iter=100).  Consider pr
e-processing your data with StandardScaler o
r MinMaxScaler.
  % self.max_iter, ConvergenceWarning)

done: 51 / 84
```

```
c:\users\siddharth\appdata\local\programs\py
thon\python37-32\lib\site-packages\sklearn\u
tils\validation.py:724: DataConversionWarnin
g: A column-vector y was passed when a 1d ar
ray was expected. Please change the shape of
y to (n_samples, ), for example using ravel
().
  y = column_or_1d(y, warn=True)
c:\users\siddharth\appdata\local\programs\py
thon\python37-32\lib\site-packages\sklearn\s
vm\base.py:241: ConvergenceWarning: Solver t
erminated early (max_iter=1000).  Consider p
re-processing your data with StandardScaler
or MinMaxScaler.
  % self.max_iter, ConvergenceWarning)


done: 52 / 84

c:\users\siddharth\appdata\local\programs\py
thon\python37-32\lib\site-packages\sklearn\u
tils\validation.py:724: DataConversionWarnin
g: A column-vector y was passed when a 1d ar
ray was expected. Please change the shape of
y to (n_samples, ), for example using ravel
().
  y = column_or_1d(y, warn=True)

done: 53 / 84

c:\users\siddharth\appdata\local\programs\py
thon\python37-32\lib\site-packages\sklearn\u
tils\validation.py:724: DataConversionWarnin
g: A column-vector y was passed when a 1d ar
ray was expected. Please change the shape of
y to (n_samples, ), for example using ravel
().
  y = column_or_1d(y, warn=True)
```

```
done: 54 / 84

c:\users\siddharth\appdata\local\programs\py
thon\python37-32\lib\site-packages\sklearn\u
tils\validation.py:724: DataConversionWarnin
g: A column-vector y was passed when a 1d ar
ray was expected. Please change the shape of
y to (n_samples, ), for example using ravel
().
  y = column_or_1d(y, warn=True)

done: 55 / 84

c:\users\siddharth\appdata\local\programs\py
thon\python37-32\lib\site-packages\sklearn\u
tils\validation.py:724: DataConversionWarnin
g: A column-vector y was passed when a 1d ar
ray was expected. Please change the shape of
y to (n_samples, ), for example using ravel
().
  y = column_or_1d(y, warn=True)

done: 56 / 84
done: 57 / 84
done: 58 / 84
```

```
c:\users\siddharth\appdata\local\programs\py
thon\python37-32\lib\site-packages\sklearn\u
tils\validation.py:724: DataConversionWarnin
g: A column-vector y was passed when a 1d ar
ray was expected. Please change the shape of
y to (n_samples, ), for example using ravel
().
  y = column_or_1d(y, warn=True)
c:\users\siddharth\appdata\local\programs\py
thon\python37-32\lib\site-packages\sklearn\s
vm\base.py:241: ConvergenceWarning: Solver t
erminated early (max_iter=10).  Consider pre
-processing your data with StandardScaler or
MinMaxScaler.
  % self.max_iter, ConvergenceWarning)
c:\users\siddharth\appdata\local\programs\py
thon\python37-32\lib\site-packages\sklearn\u
tils\validation.py:724: DataConversionWarnin
g: A column-vector y was passed when a 1d ar
ray was expected. Please change the shape of
y to (n_samples, ), for example using ravel
().
  y = column_or_1d(y, warn=True)
c:\users\siddharth\appdata\local\programs\py
thon\python37-32\lib\site-packages\sklearn\s
vm\base.py:241: ConvergenceWarning: Solver t
erminated early (max_iter=100).  Consider pr
e-processing your data with StandardScaler o
r MinMaxScaler.
  % self.max_iter, ConvergenceWarning)
c:\users\siddharth\appdata\local\programs\py
thon\python37-32\lib\site-packages\sklearn\u
tils\validation.py:724: DataConversionWarnin
g: A column-vector y was passed when a 1d ar
ray was expected. Please change the shape of
y to (n_samples, ), for example using ravel
().
```

```
  y = column_or_1d(y, warn=True)
c:\users\siddharth\appdata\local\programs\py
thon\python37-32\lib\site-packages\sklearn\s
vm\base.py:241: ConvergenceWarning: Solver t
erminated early (max_iter=1000).  Consider p
re-processing your data with StandardScaler
or MinMaxScaler.
  % self.max_iter, ConvergenceWarning)

done: 59 / 84

c:\users\siddharth\appdata\local\programs\py
thon\python37-32\lib\site-packages\sklearn\u
tils\validation.py:724: DataConversionWarnin
g: A column-vector y was passed when a 1d ar
ray was expected. Please change the shape of
y to (n_samples, ), for example using ravel
().
  y = column_or_1d(y, warn=True)
c:\users\siddharth\appdata\local\programs\py
thon\python37-32\lib\site-packages\sklearn\s
vm\base.py:241: ConvergenceWarning: Solver t
erminated early (max_iter=5000).  Consider p
re-processing your data with StandardScaler
or MinMaxScaler.
  % self.max_iter, ConvergenceWarning)

done: 60 / 84

c:\users\siddharth\appdata\local\programs\py
thon\python37-32\lib\site-packages\sklearn\u
tils\validation.py:724: DataConversionWarnin
g: A column-vector y was passed when a 1d ar
ray was expected. Please change the shape of
y to (n_samples, ), for example using ravel
().
  y = column_or_1d(y, warn=True)
```

```
done: 61 / 84


c:\users\siddharth\appdata\local\programs\py
thon\python37-32\lib\site-packages\sklearn\u
tils\validation.py:724: DataConversionWarnin
g: A column-vector y was passed when a 1d ar
ray was expected. Please change the shape of
y to (n_samples, ), for example using ravel
().
  y = column_or_1d(y, warn=True)

done: 62 / 84

c:\users\siddharth\appdata\local\programs\py
thon\python37-32\lib\site-packages\sklearn\u
tils\validation.py:724: DataConversionWarnin
g: A column-vector y was passed when a 1d ar
ray was expected. Please change the shape of
y to (n_samples, ), for example using ravel
().
  y = column_or_1d(y, warn=True)

done: 63 / 84
done: 64 / 84
done: 65 / 84
```

```
c:\users\siddharth\appdata\local\programs\py
thon\python37-32\lib\site-packages\sklearn\u
tils\validation.py:724: DataConversionWarnin
g: A column-vector y was passed when a 1d ar
ray was expected. Please change the shape of
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().
  y = column_or_1d(y, warn=True)
c:\users\siddharth\appdata\local\programs\py
thon\python37-32\lib\site-packages\sklearn\s
vm\base.py:241: ConvergenceWarning: Solver t
erminated early (max_iter=10).  Consider pre
-processing your data with StandardScaler or
MinMaxScaler.
  % self.max_iter, ConvergenceWarning)
c:\users\siddharth\appdata\local\programs\py
thon\python37-32\lib\site-packages\sklearn\u
tils\validation.py:724: DataConversionWarnin
g: A column-vector y was passed when a 1d ar
ray was expected. Please change the shape of
y to (n_samples, ), for example using ravel
().
  y = column_or_1d(y, warn=True)
c:\users\siddharth\appdata\local\programs\py
thon\python37-32\lib\site-packages\sklearn\s
vm\base.py:241: ConvergenceWarning: Solver t
erminated early (max_iter=100).  Consider pr
e-processing your data with StandardScaler o
r MinMaxScaler.
  % self.max_iter, ConvergenceWarning)
c:\users\siddharth\appdata\local\programs\py
thon\python37-32\lib\site-packages\sklearn\u
tils\validation.py:724: DataConversionWarnin
g: A column-vector y was passed when a 1d ar
ray was expected. Please change the shape of
y to (n_samples, ), for example using ravel
().
```

```
  y = column_or_1d(y, warn=True)
c:\users\siddharth\appdata\local\programs\py
thon\python37-32\lib\site-packages\sklearn\s
vm\base.py:241: ConvergenceWarning: Solver t
erminated early (max_iter=1000).  Consider p
re-processing your data with StandardScaler
or MinMaxScaler.
  % self.max_iter, ConvergenceWarning)

done: 66 / 84

c:\users\siddharth\appdata\local\programs\py
thon\python37-32\lib\site-packages\sklearn\u
tils\validation.py:724: DataConversionWarnin
g: A column-vector y was passed when a 1d ar
ray was expected. Please change the shape of
y to (n_samples, ), for example using ravel
().
  y = column_or_1d(y, warn=True)
c:\users\siddharth\appdata\local\programs\py
thon\python37-32\lib\site-packages\sklearn\s
vm\base.py:241: ConvergenceWarning: Solver t
erminated early (max_iter=5000).  Consider p
re-processing your data with StandardScaler
or MinMaxScaler.
  % self.max_iter, ConvergenceWarning)

done: 67 / 84

c:\users\siddharth\appdata\local\programs\py
thon\python37-32\lib\site-packages\sklearn\u
tils\validation.py:724: DataConversionWarnin
g: A column-vector y was passed when a 1d ar
ray was expected. Please change the shape of
y to (n_samples, ), for example using ravel
().
  y = column_or_1d(y, warn=True)
```

```
done: 68 / 84


c:\users\siddharth\appdata\local\programs\py
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tils\validation.py:724: DataConversionWarnin
g: A column-vector y was passed when a 1d ar
ray was expected. Please change the shape of
y to (n_samples, ), for example using ravel
().
  y = column_or_1d(y, warn=True)

done: 69 / 84

c:\users\siddharth\appdata\local\programs\py
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tils\validation.py:724: DataConversionWarnin
g: A column-vector y was passed when a 1d ar
ray was expected. Please change the shape of
y to (n_samples, ), for example using ravel
().
  y = column_or_1d(y, warn=True)

done: 70 / 84
done: 71 / 84
done: 72 / 84
```

```
c:\users\siddharth\appdata\local\programs\py
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tils\validation.py:724: DataConversionWarnin
g: A column-vector y was passed when a 1d ar
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().
  y = column_or_1d(y, warn=True)
c:\users\siddharth\appdata\local\programs\py
thon\python37-32\lib\site-packages\sklearn\s
vm\base.py:241: ConvergenceWarning: Solver t
erminated early (max_iter=10).  Consider pre
-processing your data with StandardScaler or
MinMaxScaler.
  % self.max_iter, ConvergenceWarning)
c:\users\siddharth\appdata\local\programs\py
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tils\validation.py:724: DataConversionWarnin
g: A column-vector y was passed when a 1d ar
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thon\python37-32\lib\site-packages\sklearn\s
vm\base.py:241: ConvergenceWarning: Solver t
erminated early (max_iter=100).  Consider pr
e-processing your data with StandardScaler o
r MinMaxScaler.
  % self.max_iter, ConvergenceWarning)
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tils\validation.py:724: DataConversionWarnin
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ray was expected. Please change the shape of
y to (n_samples, ), for example using ravel
().
```

```
  y = column_or_1d(y, warn=True)
c:\users\siddharth\appdata\local\programs\py
thon\python37-32\lib\site-packages\sklearn\s
vm\base.py:241: ConvergenceWarning: Solver t
erminated early (max_iter=1000).  Consider p
re-processing your data with StandardScaler
or MinMaxScaler.
  % self.max_iter, ConvergenceWarning)

done: 73 / 84

c:\users\siddharth\appdata\local\programs\py
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tils\validation.py:724: DataConversionWarnin
g: A column-vector y was passed when a 1d ar
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c:\users\siddharth\appdata\local\programs\py
thon\python37-32\lib\site-packages\sklearn\s
vm\base.py:241: ConvergenceWarning: Solver t
erminated early (max_iter=5000).  Consider p
re-processing your data with StandardScaler
or MinMaxScaler.
  % self.max_iter, ConvergenceWarning)

done: 74 / 84

c:\users\siddharth\appdata\local\programs\py
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tils\validation.py:724: DataConversionWarnin
g: A column-vector y was passed when a 1d ar
ray was expected. Please change the shape of
y to (n_samples, ), for example using ravel
().
  y = column_or_1d(y, warn=True)
```

```
done: 75 / 84


c:\users\siddharth\appdata\local\programs\py
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tils\validation.py:724: DataConversionWarnin
g: A column-vector y was passed when a 1d ar
ray was expected. Please change the shape of
y to (n_samples, ), for example using ravel
().
  y = column_or_1d(y, warn=True)

done: 76 / 84

c:\users\siddharth\appdata\local\programs\py
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tils\validation.py:724: DataConversionWarnin
g: A column-vector y was passed when a 1d ar
ray was expected. Please change the shape of
y to (n_samples, ), for example using ravel
().
  y = column_or_1d(y, warn=True)

done: 77 / 84
done: 78 / 84
done: 79 / 84
```

```
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tils\validation.py:724: DataConversionWarnin
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  y = column_or_1d(y, warn=True)
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vm\base.py:241: ConvergenceWarning: Solver t
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erminated early (max_iter=100).  Consider pr
e-processing your data with StandardScaler o
r MinMaxScaler.
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y to (n_samples, ), for example using ravel
().
```

```
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thon\python37-32\lib\site-packages\sklearn\s
vm\base.py:241: ConvergenceWarning: Solver t
erminated early (max_iter=1000).  Consider p
re-processing your data with StandardScaler
or MinMaxScaler.
  % self.max_iter, ConvergenceWarning)


done: 80 / 84

c:\users\siddharth\appdata\local\programs\py
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tils\validation.py:724: DataConversionWarnin
g: A column-vector y was passed when a 1d ar
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  y = column_or_1d(y, warn=True)
c:\users\siddharth\appdata\local\programs\py
thon\python37-32\lib\site-packages\sklearn\s
vm\base.py:241: ConvergenceWarning: Solver t
erminated early (max_iter=5000).  Consider p
re-processing your data with StandardScaler
or MinMaxScaler.
  % self.max_iter, ConvergenceWarning)

done: 81 / 84

c:\users\siddharth\appdata\local\programs\py
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tils\validation.py:724: DataConversionWarnin
g: A column-vector y was passed when a 1d ar
ray was expected. Please change the shape of
y to (n_samples, ), for example using ravel
().
  y = column_or_1d(y, warn=True)
```

```
done: 82 / 84


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tils\validation.py:724: DataConversionWarnin
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ray was expected. Please change the shape of
y to (n_samples, ), for example using ravel
().
  y = column_or_1d(y, warn=True)

done: 83 / 84

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tils\validation.py:724: DataConversionWarnin
g: A column-vector y was passed when a 1d ar
ray was expected. Please change the shape of
y to (n_samples, ), for example using ravel
().
  y = column_or_1d(y, warn=True)
```

```
done: 84 / 84
Kernel Tolerance Iterations Accuracy
linear 0.001 10 0.3649721330856274
linear 0.001 100 0.6169565951697349
linear 0.001 1000 0.5642627934470529
linear 0.001 5000 0.7253842256375612
linear 0.001 10000 0.7287620334402972
linear 0.001 15000 0.7284242526600236
linear 0.001 20000 0.7284242526600236
linear 0.01 10 0.3649721330856274
linear 0.01 100 0.6169565951697349
linear 0.01 1000 0.5642627934470529
linear 0.01 5000 0.7253842256375612
linear 0.01 10000 0.728930923830434
linear 0.01 15000 0.728930923830434
linear 0.01 20000 0.728930923830434
linear 0.1 10 0.3649721330856274
linear 0.1 100 0.6169565951697349
linear 0.1 1000 0.5642627934470529
linear 0.1 5000 0.7253842256375612
linear 0.1 10000 0.7287620334402972
linear 0.1 15000 0.7287620334402972
linear 0.1 20000 0.7287620334402972
linear 1 10 0.3649721330856274
linear 1 100 0.6169565951697349
linear 1 1000 0.5642627934470529
linear 1 5000 0.7287620334402972
linear 1 10000 0.7287620334402972
linear 1 15000 0.7287620334402972
linear 1 20000 0.7287620334402972
rbf 0.001 10 0.6046275966897483
rbf 0.001 100 0.5369025502448911
rbf 0.001 1000 0.6542813713899679
rbf 0.001 5000 0.7209930754940044
rbf 0.001 10000 0.7225130890052356
rbf 0.001 15000 0.7225130890052356
rbf 0.001 20000 0.7225130890052356
```

rbf 0.01 10 0.6046275966897483
rbf 0.01 100 0.5369025502448911
rbf 0.01 1000 0.6542813713899679
rbf 0.01 5000 0.7209930754940044
rbf 0.01 10000 0.7223441986150988
rbf 0.01 15000 0.7223441986150988
rbf 0.01 20000 0.7223441986150988
rbf 0.1 10 0.6046275966897483
rbf 0.1 100 0.5369025502448911
rbf 0.1 1000 0.6542813713899679
rbf 0.1 5000 0.7209930754940044
rbf 0.1 10000 0.7231886505657829
rbf 0.1 15000 0.7231886505657829
rbf 0.1 20000 0.7231886505657829
rbf 1 10 0.6046275966897483
rbf 1 100 0.5369025502448911
rbf 1 1000 0.6542813713899679
rbf 1 5000 0.7218375274446884
rbf 1 10000 0.7218375274446884
rbf 1 15000 0.7218375274446884
rbf 1 20000 0.7218375274446884
poly 0.001 10 0.5814896132410066
poly 0.001 100 0.6098631987839892
poly 0.001 1000 0.6242188819456173
poly 0.001 5000 0.6799527106907617
poly 0.001 10000 0.6667792602600912
poly 0.001 15000 0.6667792602600912
poly 0.001 20000 0.6667792602600912
poly 0.01 10 0.5814896132410066
poly 0.01 100 0.6098631987839892
poly 0.01 1000 0.6242188819456173
poly 0.01 5000 0.6799527106907617
poly 0.01 10000 0.6667792602600912
poly 0.01 15000 0.6667792602600912
poly 0.01 20000 0.6667792602600912
poly 0.1 10 0.5814896132410066
poly 0.1 100 0.6098631987839892

poly 0.1 1000 0.6242188819456173
poly 0.1 5000 0.6799527106907617
poly 0.1 10000 0.6667792602600912
poly 0.1 15000 0.6667792602600912
poly 0.1 20000 0.6667792602600912
poly 1 10 0.5814896132410066
poly 1 100 0.6098631987839892
poly 1 1000 0.6242188819456173
poly 1 5000 0.6799527106907617
poly 1 10000 0.6708326296233744
poly 1 15000 0.6708326296233744
poly 1 20000 0.6708326296233744

In [11]:

```
x_range = [10,100,1000,5000,10000,15000,20000]
plt.figure(figsize=(18,6))

#Linear kernel
plt.subplot(1, 3, 1)
plt.plot(x_range, accuracyList[0:7], color='r',label ='0.
001')
plt.plot(x_range, accuracyList[7:14], color='b',label =
'0.01')
plt.plot(x_range, accuracyList[14:21], color='g',label =
'0.1')
plt.plot(x_range, accuracyList[21:28], color='orange',lab
el ='1')

plt.ylim(0.60,0.75)
plt.title("Linear Kernel")
plt.legend(loc='upper left')

plt.xlabel('Number of Iterations')
plt.ylabel('Accuracy')

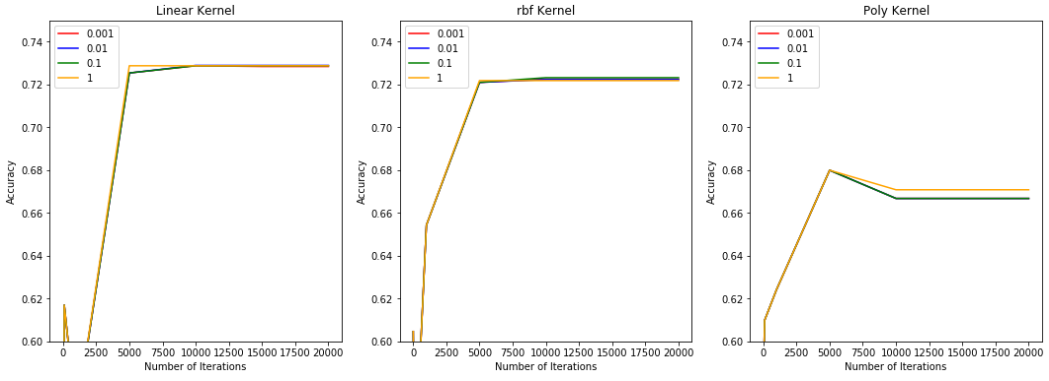

#rbf kernel
plt.subplot(1, 3, 2)
plt.plot(x_range, accuracyList[28:35], color='r',label =
'0.001')
plt.plot(x_range, accuracyList[35:42], color='b',label =
'0.01')
plt.plot(x_range, accuracyList[42:49], color='g',label =
'0.1')
plt.plot(x_range, accuracyList[49:56], color='orange',lab
el ='1')
plt.ylim(0.60,0.75)
plt.title("rbf Kernel")
plt.legend(loc='upper left')
```

```
plt.xlabel('Number of Iterations')
plt.ylabel('Accuracy')


#poly kernel
plt.subplot(1, 3, 3)
plt.plot(x_range, accuracyList[56:63], color='r',label =
'0.001')
plt.plot(x_range, accuracyList[63:70], color='b',label =
'0.01')
plt.plot(x_range, accuracyList[70:77], color='g',label =
'0.1')
plt.plot(x_range, accuracyList[77:84], color='orange',lab
el ='1')
plt.ylim(0.60,0.75)
plt.title("Poly Kernel")
plt.legend(loc='upper left')

plt.xlabel('Number of Iterations')
plt.ylabel('Accuracy')


plt.show()
```



In [12]:

```
print("Maximum accuracy in each kernel")
labels = ['Linear','Rbf','Poly']
data = [max(accuracyList[0:28]),max(accuracyList[28:56]),
max(accuracyList[56:84])]
#number of data points
n = len(data)
#find max value for full ring
k = 10 ** int(log10(max(data)))
m = k * (1 + max(data) // k)

#radius of donut chart
r = 1.5
#calculate width of each ring
w = r / n

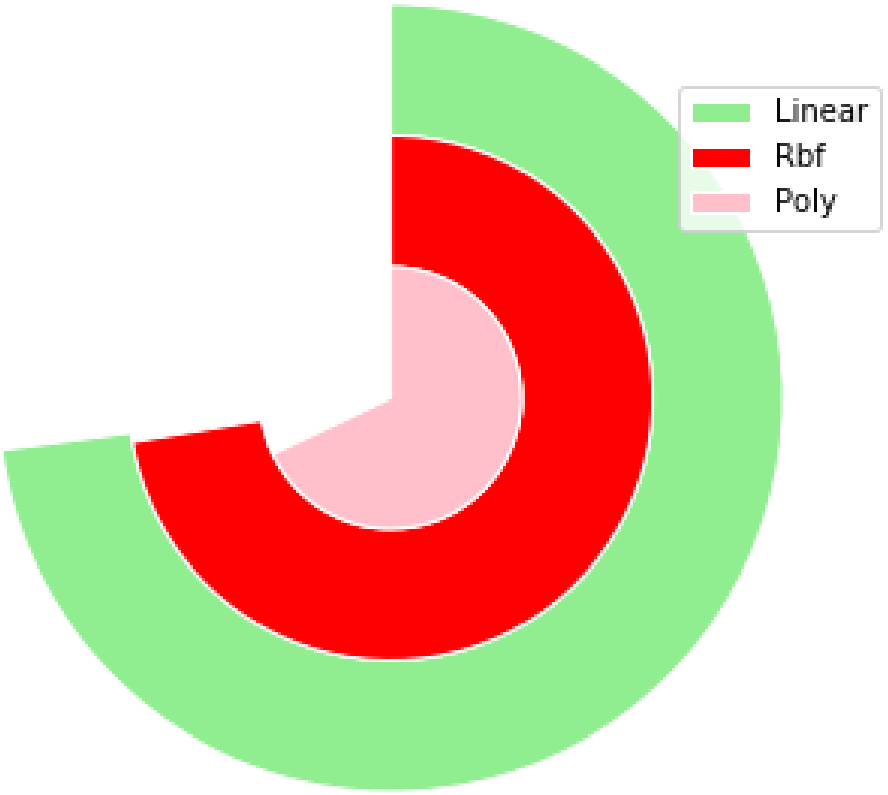
#create colors along a chosen colormap
colors = ['lightgreen','red','pink']

#create figure, axis
fig, ax = plt.subplots()
ax.axis("equal")

#create rings of donut chart
for i in range(n):
    #hide labels in segments with textprops: alpha = 0 -
 transparent, alpha = 1 - visible
    innerring, _ = ax.pie([m - data[i], data[i]], radius
= r - i * w, startangle = 90, labels = ["", labels[i]], l
abeldistance = 1 - 1 / (1.5 * (n - i)), textprops = {"alp
ha": 0}, colors = ["white", colors[i]])
    plt.setp(innerring, width = w, edgecolor = "white")

plt.legend()
plt.show()
```

Maximum accuracy in each kernel



In [13]:

```
linear_fit = SVC(gamma='auto', kernel='linear', tol=0.01,
max_iter=1000,
                                 random_state=50)
linear_fit.fit(X_train, y_train)
scores = cross_val_score(linear_fit, X_train, y_train, cv
=5)


x_range = list(range(1, 6))
plt.plot(x_range, scores, color='orange',label ='Cross va
lidation accuracy')
plt.legend()
plt.show()
```

```
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thon\python37-32\lib\site-packages\sklearn\u
tils\validation.py:724: DataConversionWarnin
g: A column-vector y was passed when a 1d ar
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().
  y = column_or_1d(y, warn=True)
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vm\base.py:241: ConvergenceWarning: Solver t
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```

```
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```

```
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y to (n_samples, ), for example using ravel
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  y = column_or_1d(y, warn=True)
c:\users\siddharth\appdata\local\programs\py
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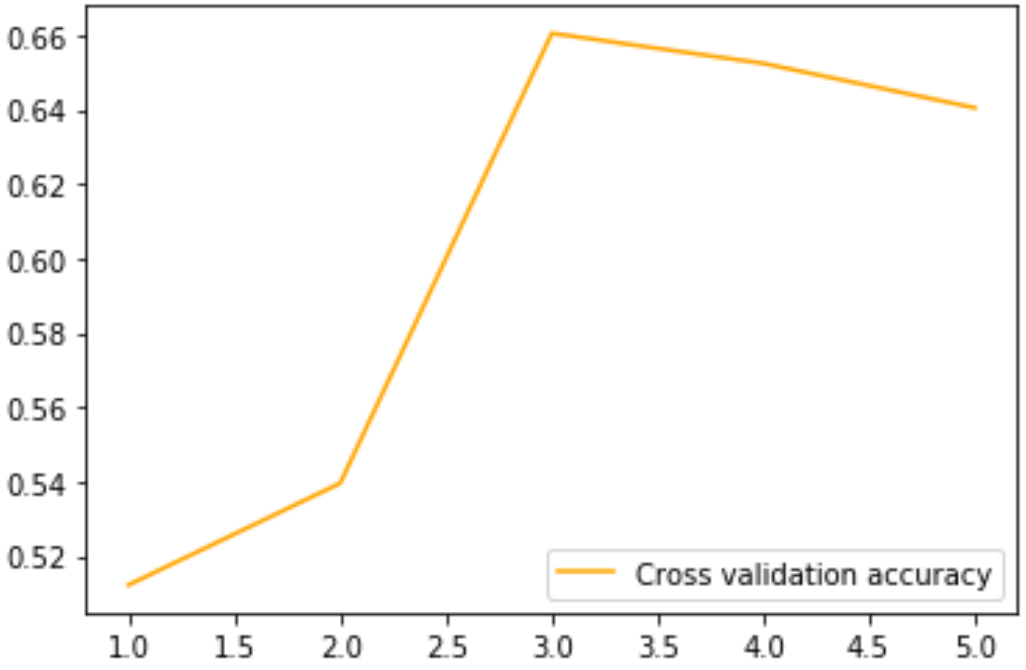
vm\base.py:241: ConvergenceWarning: Solver t
erminated early (max_iter=1000).  Consider p
re-processing your data with StandardScaler
or MinMaxScaler.
  % self.max_iter, ConvergenceWarning)
```



In [14]:

```
linear_fit = SVC(gamma='auto', kernel='rbf', tol=0.01, ma
x_iter=1000,
                                 random_state=50)
linear_fit.fit(X_train, y_train)
scores = cross_val_score(linear_fit, X_train, y_train, cv
=5)


x_range = list(range(1, 6))
plt.plot(x_range, scores, color='orange',label ='Cross va
lidation accuracy')
plt.legend()
plt.show()
```

```
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tils\validation.py:724: DataConversionWarnin
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or MinMaxScaler.
  % self.max_iter, ConvergenceWarning)
c:\users\siddharth\appdata\local\programs\py
thon\python37-32\lib\site-packages\sklearn\u
tils\validation.py:724: DataConversionWarnin
g: A column-vector y was passed when a 1d ar
ray was expected. Please change the shape of
y to (n_samples, ), for example using ravel
().
```

```
  y = column_or_1d(y, warn=True)
c:\users\siddharth\appdata\local\programs\py
thon\python37-32\lib\site-packages\sklearn\s
vm\base.py:241: ConvergenceWarning: Solver t
erminated early (max_iter=1000).  Consider p
re-processing your data with StandardScaler
or MinMaxScaler.
  % self.max_iter, ConvergenceWarning)
c:\users\siddharth\appdata\local\programs\py
thon\python37-32\lib\site-packages\sklearn\u
tils\validation.py:724: DataConversionWarnin
g: A column-vector y was passed when a 1d ar
ray was expected. Please change the shape of
y to (n_samples, ), for example using ravel
().
  y = column_or_1d(y, warn=True)
c:\users\siddharth\appdata\local\programs\py
thon\python37-32\lib\site-packages\sklearn\s
vm\base.py:241: ConvergenceWarning: Solver t
erminated early (max_iter=1000).  Consider p
re-processing your data with StandardScaler
or MinMaxScaler.
  % self.max_iter, ConvergenceWarning)
c:\users\siddharth\appdata\local\programs\py
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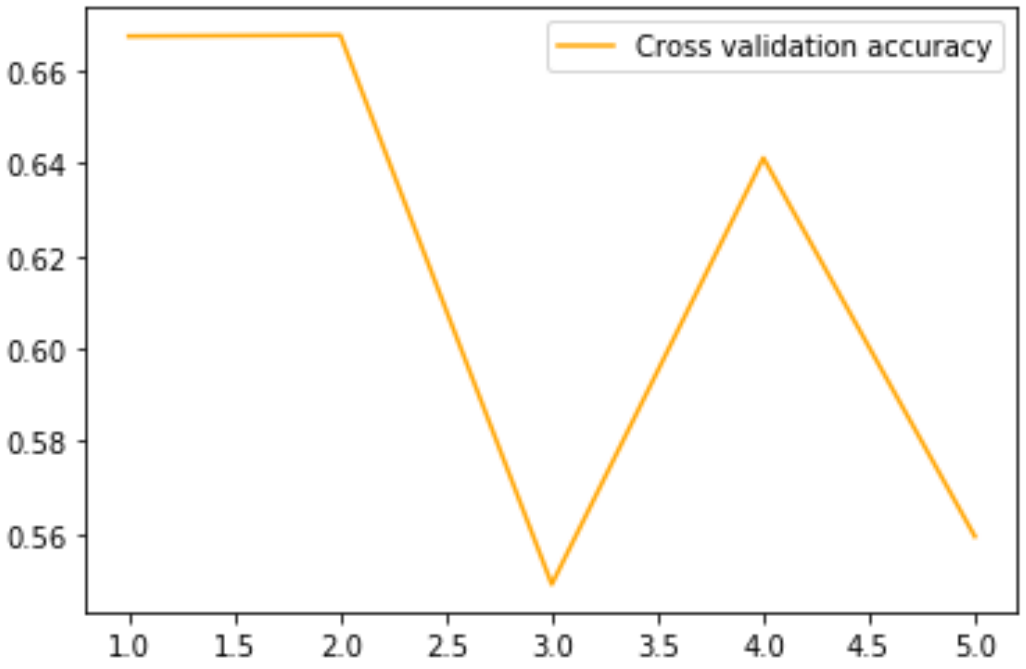
tils\validation.py:724: DataConversionWarnin
g: A column-vector y was passed when a 1d ar
ray was expected. Please change the shape of
y to (n_samples, ), for example using ravel
().
  y = column_or_1d(y, warn=True)
c:\users\siddharth\appdata\local\programs\py
thon\python37-32\lib\site-packages\sklearn\s
vm\base.py:241: ConvergenceWarning: Solver t
erminated early (max_iter=1000).  Consider p
re-processing your data with StandardScaler
or MinMaxScaler.
```

```
  % self.max_iter, ConvergenceWarning)
c:\users\siddharth\appdata\local\programs\py
thon\python37-32\lib\site-packages\sklearn\u
tils\validation.py:724: DataConversionWarnin
g: A column-vector y was passed when a 1d ar
ray was expected. Please change the shape of
y to (n_samples, ), for example using ravel
().
  y = column_or_1d(y, warn=True)
c:\users\siddharth\appdata\local\programs\py
thon\python37-32\lib\site-packages\sklearn\s
vm\base.py:241: ConvergenceWarning: Solver t
erminated early (max_iter=1000).  Consider p
re-processing your data with StandardScaler
or MinMaxScaler.
  % self.max_iter, ConvergenceWarning)
```


Cross validation accuracy
0.66
0.64
0.62
0.60
0.58
0.56
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5
5.0

In [15]:

```
linear_fit = SVC(gamma='auto', kernel='poly', tol=0.01, m
ax_iter=1000,
                                 random_state=50)
linear_fit.fit(X_train, y_train)
scores = cross_val_score(linear_fit, X_train, y_train, cv
=5)


x_range = list(range(1, 6))
plt.plot(x_range, scores, color='orange',label ='Cross va
lidation accuracy')
plt.legend()
plt.show()
```

```
c:\users\siddharth\appdata\local\programs\py
thon\python37-32\lib\site-packages\sklearn\u
tils\validation.py:724: DataConversionWarnin
g: A column-vector y was passed when a 1d ar
ray was expected. Please change the shape of
y to (n_samples, ), for example using ravel
().
  y = column_or_1d(y, warn=True)
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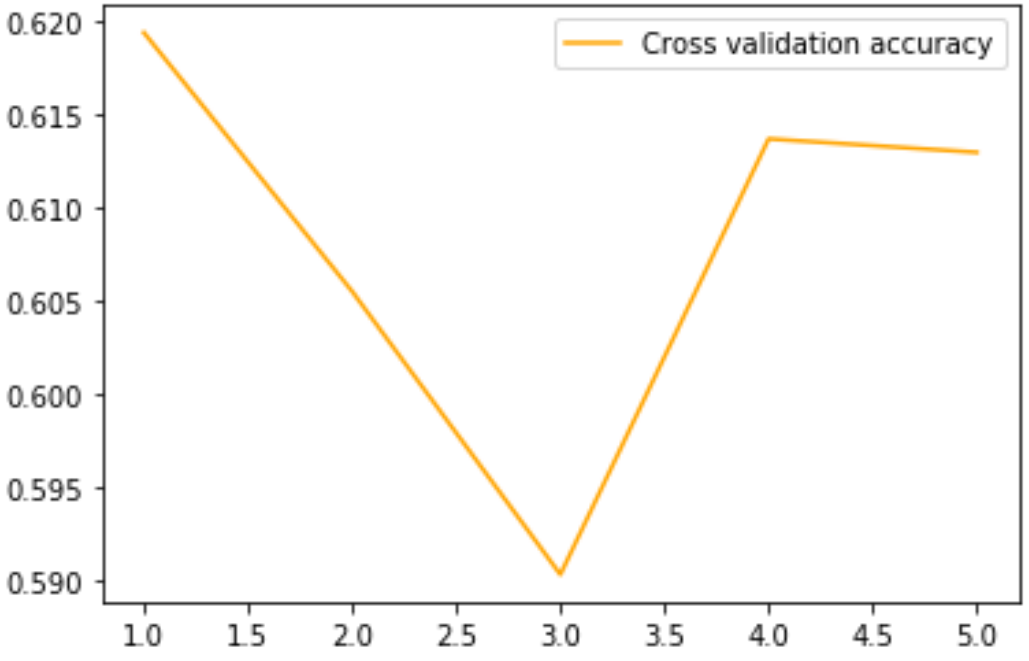
thon\python37-32\lib\site-packages\sklearn\s
vm\base.py:241: ConvergenceWarning: Solver t
erminated early (max_iter=1000).  Consider p
re-processing your data with StandardScaler
or MinMaxScaler.
  % self.max_iter, ConvergenceWarning)
c:\users\siddharth\appdata\local\programs\py
thon\python37-32\lib\site-packages\sklearn\u
tils\validation.py:724: DataConversionWarnin
g: A column-vector y was passed when a 1d ar
ray was expected. Please change the shape of
y to (n_samples, ), for example using ravel
().
  y = column_or_1d(y, warn=True)
c:\users\siddharth\appdata\local\programs\py
thon\python37-32\lib\site-packages\sklearn\s
vm\base.py:241: ConvergenceWarning: Solver t
erminated early (max_iter=1000).  Consider p
re-processing your data with StandardScaler
or MinMaxScaler.
  % self.max_iter, ConvergenceWarning)
c:\users\siddharth\appdata\local\programs\py
thon\python37-32\lib\site-packages\sklearn\u
tils\validation.py:724: DataConversionWarnin
g: A column-vector y was passed when a 1d ar
ray was expected. Please change the shape of
y to (n_samples, ), for example using ravel
().
```

```
  y = column_or_1d(y, warn=True)
c:\users\siddharth\appdata\local\programs\py
thon\python37-32\lib\site-packages\sklearn\s
vm\base.py:241: ConvergenceWarning: Solver t
erminated early (max_iter=1000).  Consider p
re-processing your data with StandardScaler
or MinMaxScaler.
  % self.max_iter, ConvergenceWarning)
c:\users\siddharth\appdata\local\programs\py
thon\python37-32\lib\site-packages\sklearn\u
tils\validation.py:724: DataConversionWarnin
g: A column-vector y was passed when a 1d ar
ray was expected. Please change the shape of
y to (n_samples, ), for example using ravel
().
  y = column_or_1d(y, warn=True)
c:\users\siddharth\appdata\local\programs\py
thon\python37-32\lib\site-packages\sklearn\s
vm\base.py:241: ConvergenceWarning: Solver t
erminated early (max_iter=1000).  Consider p
re-processing your data with StandardScaler
or MinMaxScaler.
  % self.max_iter, ConvergenceWarning)
c:\users\siddharth\appdata\local\programs\py
thon\python37-32\lib\site-packages\sklearn\u
tils\validation.py:724: DataConversionWarnin
g: A column-vector y was passed when a 1d ar
ray was expected. Please change the shape of
y to (n_samples, ), for example using ravel
().
  y = column_or_1d(y, warn=True)
c:\users\siddharth\appdata\local\programs\py
thon\python37-32\lib\site-packages\sklearn\s
vm\base.py:241: ConvergenceWarning: Solver t
erminated early (max_iter=1000).  Consider p
re-processing your data with StandardScaler
or MinMaxScaler.
```

```
  % self.max_iter, ConvergenceWarning)
c:\users\siddharth\appdata\local\programs\python\python37-32\lib\site-packages\sklearn\utils\validation.py:724: DataConversionWarning: A column-vector y was passed when a 1d array was expected. Please change the shape of y to (n_samples, ), for example using ravel().
  y = column_or_1d(y, warn=True)
c:\users\siddharth\appdata\local\programs\python\python37-32\lib\site-packages\sklearn\svm\base.py:241: ConvergenceWarning: Solver terminated early (max_iter=1000).  Consider pre-processing your data with StandardScaler or MinMaxScaler.
  % self.max_iter, ConvergenceWarning)
```



In [16]:

```
from sklearn.model_selection import cross_val_score

scores = cross_val_score(linear_fit, X_train, y_train, cv
=5)
scores

x_range = list(range(1, 6))
plt.plot(x_range, scores, color='orange',label ='Cross va
ldiation accuracy')
plt.legend()
plt.show()
```

```
c:\users\siddharth\appdata\local\programs\py
thon\python37-32\lib\site-packages\sklearn\u
tils\validation.py:724: DataConversionWarnin
g: A column-vector y was passed when a 1d ar
ray was expected. Please change the shape of
y to (n_samples, ), for example using ravel
().
  y = column_or_1d(y, warn=True)
c:\users\siddharth\appdata\local\programs\py
thon\python37-32\lib\site-packages\sklearn\s
vm\base.py:241: ConvergenceWarning: Solver t
erminated early (max_iter=1000).  Consider p
re-processing your data with StandardScaler
or MinMaxScaler.
  % self.max_iter, ConvergenceWarning)
c:\users\siddharth\appdata\local\programs\py
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tils\validation.py:724: DataConversionWarnin
g: A column-vector y was passed when a 1d ar
ray was expected. Please change the shape of
y to (n_samples, ), for example using ravel
().
  y = column_or_1d(y, warn=True)
c:\users\siddharth\appdata\local\programs\py
thon\python37-32\lib\site-packages\sklearn\s
vm\base.py:241: ConvergenceWarning: Solver t
erminated early (max_iter=1000).  Consider p
re-processing your data with StandardScaler
or MinMaxScaler.
  % self.max_iter, ConvergenceWarning)
c:\users\siddharth\appdata\local\programs\py
thon\python37-32\lib\site-packages\sklearn\u
tils\validation.py:724: DataConversionWarnin
g: A column-vector y was passed when a 1d ar
ray was expected. Please change the shape of
y to (n_samples, ), for example using ravel
().
```

```
  y = column_or_1d(y, warn=True)
c:\users\siddharth\appdata\local\programs\py
thon\python37-32\lib\site-packages\sklearn\s
vm\base.py:241: ConvergenceWarning: Solver t
erminated early (max_iter=1000).  Consider p
re-processing your data with StandardScaler
or MinMaxScaler.
  % self.max_iter, ConvergenceWarning)
c:\users\siddharth\appdata\local\programs\py
thon\python37-32\lib\site-packages\sklearn\u
tils\validation.py:724: DataConversionWarnin
g: A column-vector y was passed when a 1d ar
ray was expected. Please change the shape of
y to (n_samples, ), for example using ravel
().
  y = column_or_1d(y, warn=True)
c:\users\siddharth\appdata\local\programs\py
thon\python37-32\lib\site-packages\sklearn\s
vm\base.py:241: ConvergenceWarning: Solver t
erminated early (max_iter=1000).  Consider p
re-processing your data with StandardScaler
or MinMaxScaler.
  % self.max_iter, ConvergenceWarning)
c:\users\siddharth\appdata\local\programs\py
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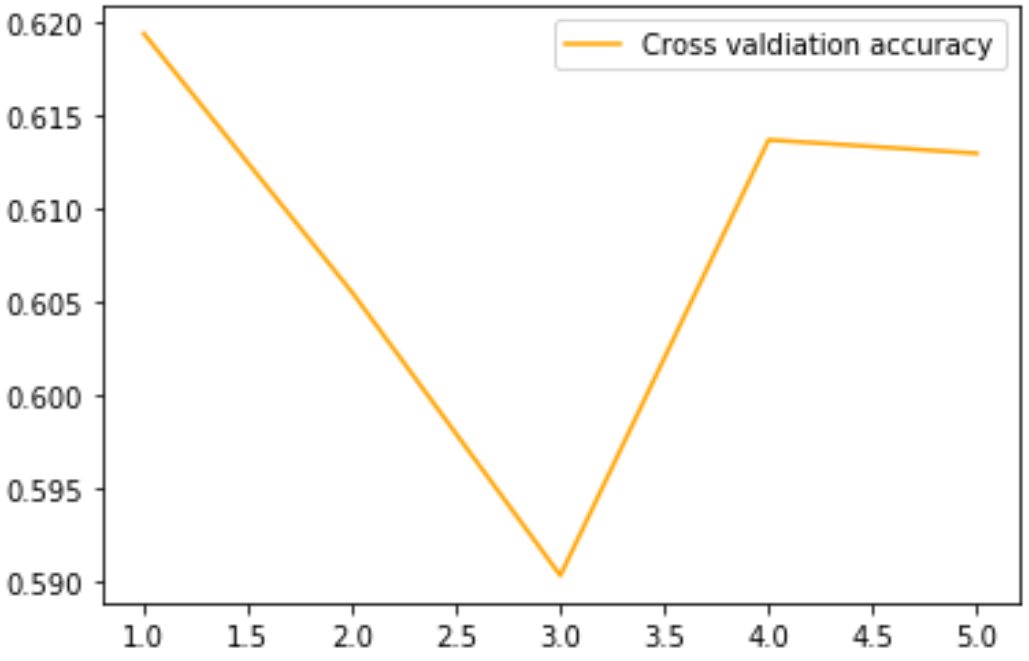
tils\validation.py:724: DataConversionWarnin
g: A column-vector y was passed when a 1d ar
ray was expected. Please change the shape of
y to (n_samples, ), for example using ravel
().
  y = column_or_1d(y, warn=True)
c:\users\siddharth\appdata\local\programs\py
thon\python37-32\lib\site-packages\sklearn\s
vm\base.py:241: ConvergenceWarning: Solver t
erminated early (max_iter=1000).  Consider p
re-processing your data with StandardScaler
```

```
or MinMaxScaler.
  % self.max_iter, ConvergenceWarning)
```



SVM - Running for best model

In [17]:

```
linear_fit = SVC(gamma='auto', kernel='linear', tol=1, ma
x_iter=5000,
                                 random_state=50)
linear_fit.fit(X_train, y_train)
predicted_svm = linear_fit.predict(X_test)
cm = confusion_matrix(y_test, predicted_svm)
cm
```

```
c:\users\siddharth\appdata\local\programs\py
thon\python37-32\lib\site-packages\sklearn\u
tils\validation.py:724: DataConversionWarnin
g: A column-vector y was passed when a 1d ar
ray was expected. Please change the shape of
y to (n_samples, ), for example using ravel
().
  y = column_or_1d(y, warn=True)
```

Out[17]:

```
array([[1298,  913],
       [ 693, 3017]], dtype=int64)
```

In [18]:

```
print("Accuracy", (cm[1][1] + cm[0][0]) / np.sum(cm) )
print("Sensitivity", cm[1][1] / (cm[1][1] + cm[1][0] ))
print("Specificity", cm[0][0] / (cm[0][0] + cm[0][1] ))
print("Precision", cm[1][1] / (cm[1][1] + cm[0][1] ))
```

```
Accuracy 0.7287620334402972
Sensitivity 0.8132075471698114
Specificity 0.5870646766169154
Precision 0.7676844783715012
```

In [19]:

```
linear_fit = SVC(gamma='auto', kernel='linear', tol=0.01,
max_iter=10000,
                                 random_state=50)
linear_fit.fit(X_train, y_train)
predicted_svm = linear_fit.predict(X_test)

print(linear_fit.coef_)
print(linear_fit.intercept_)
```

```
c:\users\siddharth\appdata\local\programs\py
thon\python37-32\lib\site-packages\sklearn\u
tils\validation.py:724: DataConversionWarnin
g: A column-vector y was passed when a 1d ar
ray was expected. Please change the shape of
y to (n_samples, ), for example using ravel
().
  y = column_or_1d(y, warn=True)

[[-6.61065227e-01  6.07910860e+00  1.1042420
1e-01 -2.42264292e+00
   2.33590583e+00 -1.43530498e+00  2.3265444
2e+00  2.82708905e+00
   1.17120313e+00  9.72539975e-01  3.5372739
6e+00  1.08421758e+00
  -2.66678652e+00  1.00554406e+00  5.0012425
0e+00 -7.06309618e+00
  -4.12924856e+00 -1.42556649e+00 -2.2913900
1e+00 -7.05366308e-01
  -2.78928453e-01  6.25684666e-01 -4.0569533
3e-02  5.04937444e-01
  -4.73250456e-03 -4.73250456e-03]]
[-0.46457078]
```

Decision Trees - Power Consumption

In [20]:

```
training_depth_Accuracy = []
for i in range(0,30):
    clf = DecisionTreeClassifier(criterion="gini", max_de
pth=(i+1),random_state=50)
    clf.fit(X_train,y_train)
    y_pred_train = clf.predict(X_train)
    training_depth_Accuracy.append(metrics.accuracy_score
(y_train, y_pred_train))

print(training_depth_Accuracy)
```

```
[0.66193716519473, 0.6884320254813957, 0.703
1272621977703, 0.7157231793832344, 0.7291153
901838714, 0.7456927754452005, 0.77327349066
16476, 0.7935427826842334, 0.820182423628203
3, 0.8429129868249602, 0.869480237440278, 0.
8931518749095121, 0.9151585348197481, 0.9344
867525698567, 0.9493267699435356, 0.96192268
71289995, 0.9704647459099465, 0.978427682061
6765, 0.9862458375561025, 0.988996670044882,
0.9937744317359201, 0.9963804835673954, 0.99
74663384971768, 0.9986245837556103, 0.998696
9740842624, 0.9994208773707832, 0.9996380483
567395, 0.9997104386853917, 0.99985521934269
58, 0.9998552193426958]
```

In [21]:

```
validation_depth_Accuracy = []
for i in range(0,30):
    clf = DecisionTreeClassifier(criterion="gini", max_de
pth=(i+1),random_state=50)
    clf.fit(X_train,y_train)
    y_pred_test = clf.predict(X_test)
    validation_depth_Accuracy.append(metrics.accuracy_sco
re(y_test, y_pred_test))

print(validation_depth_Accuracy)
```

```
[0.6645836851883128, 0.6826549569329505, 0.7
002195575071778, 0.720486404323594, 0.728593
1430501604, 0.7282553622698869, 0.7486910994
764397, 0.7552778246917751, 0.7740246579969
6, 0.7807802736024321, 0.783313629454484, 0.
7947981759837865, 0.7905759162303665, 0.7900
692450599561, 0.7871981084276305, 0.78719810
84276305, 0.7839891910150313, 0.783651410234
7576, 0.7828069582840737, 0.781624725553116,
0.7836514102347576, 0.7839891910150313, 0.78
36514102347576, 0.7843269717953049, 0.786184
7660868096, 0.7787535889207904, 0.7831447390
643472, 0.7829758486742104, 0.78044249282215
84, 0.7821313967235264]
```

In [22]:

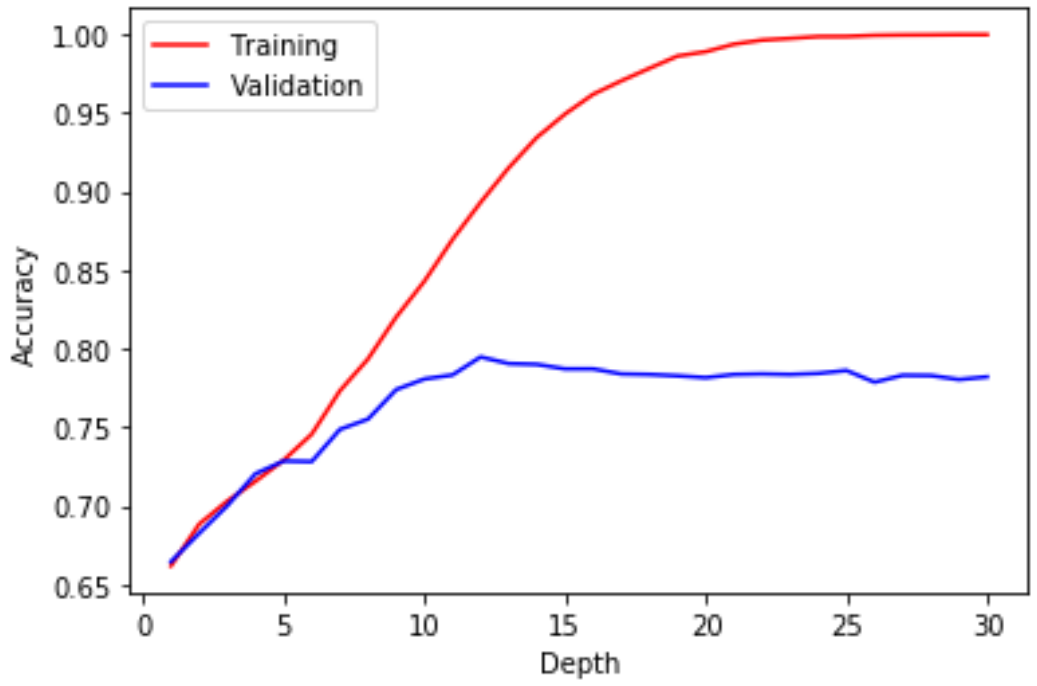
```
x_range_decision_tree = list(range(1, 31))
plt.plot(x_range_decision_tree, training_depth_Accuracy,
color='r',label ='Training')
plt.plot(x_range_decision_tree, validation_depth_Accuracy
, color='b',label ='Validation')

plt.xlabel("Depth")
plt.ylabel("Accuracy")

plt.legend()
```

Out[22]:

```
<matplotlib.legend.Legend at 0xccfb10>
```



In [23]:

```
clf = DecisionTreeClassifier(criterion="gini", max_depth=
12,random_state=50)
clf.fit(X_train,y_train)

y_pred_train = clf.predict(X_test)
print(metrics.accuracy_score(y_test, y_pred_train))
```

```
0.7947981759837865
```

In [24]:

```
conf_dec_tree = confusion_matrix(y_test, y_pred_train)
conf_dec_tree
```

Out[24]:

```
array([[1685,  526],
       [ 689, 3021]], dtype=int64)
```

In [25]:

```
print("Accuracy", (conf_dec_tree[1][1]+conf_dec_tree[0][0
])/np.sum(conf_dec_tree))
print("Sensitivity", conf_dec_tree[1][1] / (conf_dec_tree
[1][1] + conf_dec_tree[1][0] ))
print("Specificity", conf_dec_tree[0][0] / (conf_dec_tree
[0][0] + conf_dec_tree[0][1] ))
print("Precision", conf_dec_tree[1][1] / (conf_dec_tree[1
][1] + conf_dec_tree[0][1] ))
```

```
Accuracy 0.7947981759837865
Sensitivity 0.8142857142857143
Specificity 0.7620985979194934
Precision 0.8517056667606427
```

In [26]:

```
listAccuracy = []
for i in range (0,12):
    clf = DecisionTreeClassifier(criterion="gini",random_
state=50,max_depth=7, min_samples_leaf = i+1)
    clf.fit(X_train,y_train)
    y_pred_train = clf.predict(X_test)
    listAccuracy.append(metrics.accuracy_score(y_test, y_
pred_train))
listAccuracy

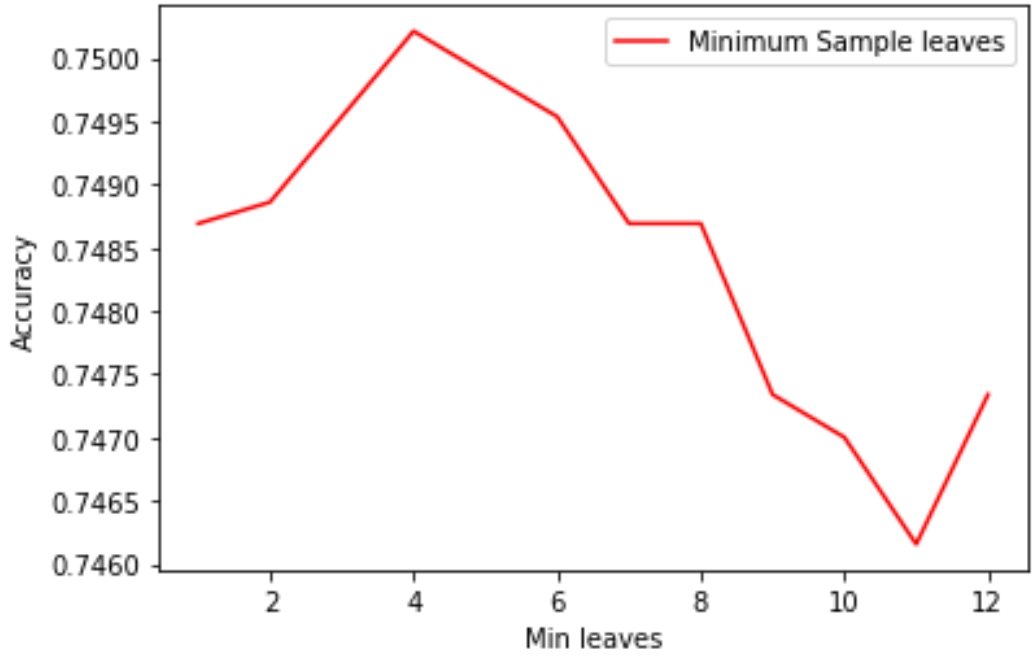
x_range_decision_tree = list(range(1, 13))
plt.plot(x_range_decision_tree, listAccuracy, color='r',l
abel ='Minimum Sample leaves')


plt.xlabel("Min leaves")
plt.ylabel("Accuracy")

plt.legend()
```

Out[26]:

```
<matplotlib.legend.Legend at 0xf705d0>
```



In [27]:

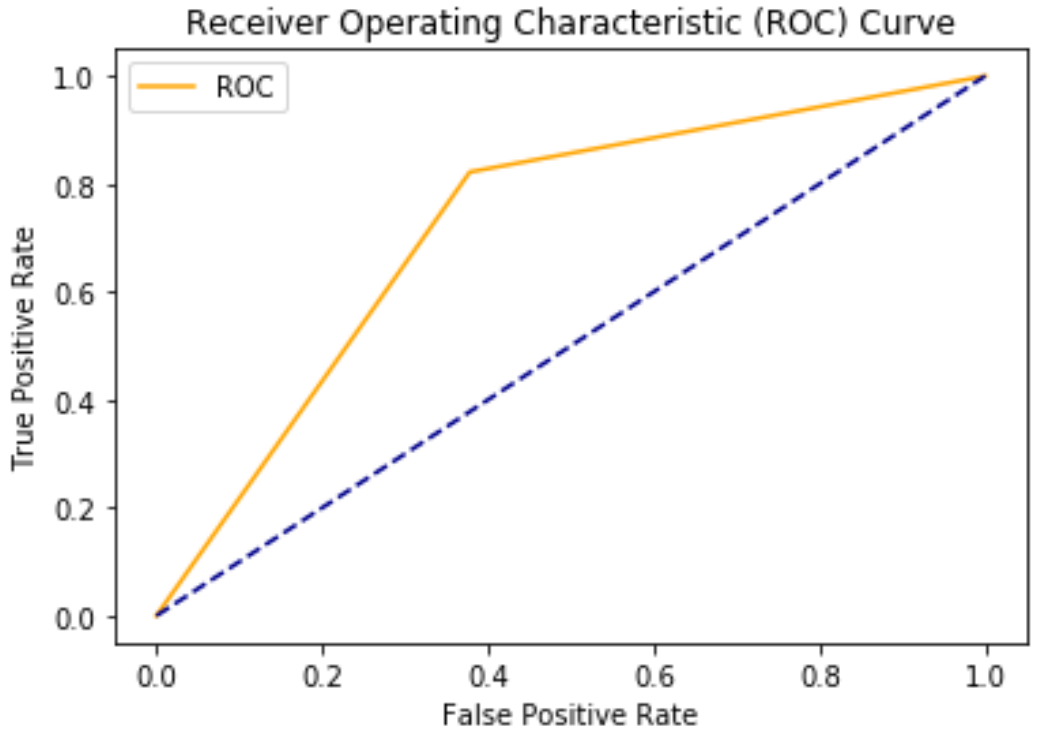
```
auc = roc_auc_score(y_test,y_pred_train)
auc
```

Out[27]:

```
0.7219964865698 46
```

In [28]:

```
fpr, tpr, _ = metrics.roc_curve(y_test,y_pred_train)
plt.plot(fpr,  tpr, color='orange', label='ROC')
plt.plot([0, 1], [0, 1], color='darkblue', linestyle='--'
)
plt.xlabel('False Positive Rate')
plt.ylabel('True Positive Rate')
plt.title('Receiver Operating Characteristic (ROC) Curve'
)
plt.legend()
plt.show()
```



In [29]:

```
plt.figure(figsize=(50,18))
tree.plot_tree(clf)
```

Out[29]:

```
[Text(1300.0625, 917.325, 'X[2] <= 0.23\nent
ropy = 0.471\nsamples = 13814\nvalue = [525
1, 8563]'),
 Text(528.9375, 795.015, 'X[17] <= 0.347\nen
tropy = 0.492\nsamples = 4711\nvalue = [264
6, 2065]'),
 Text(232.5, 672.705, 'X[7] <= 0.257\nentrop
y = 0.366\nsamples = 708\nvalue = [171, 53
7]'),
 Text(131.75, 550.395, 'X[14] <= 0.684\nentr
opy = 0.498\nsamples = 140\nvalue = [66, 7
4]'),
 Text(116.25, 428.0850000000004, 'X[15] <=
0.258\nentropy = 0.49\nsamples = 116\nvalue
= [66, 50]'),
 Text(62.0, 305.775, 'X[22] <= 0.567\nentrop
y = 0.494\nsamples = 74\nvalue = [33, 41]'),
 Text(31.0, 183.46500000000003, 'X[11] <= 0.
572\nentropy = 0.469\nsamples = 40\nvalue =
[25, 15]'),
 Text(15.5, 61.15499999999997, 'entropy = 0.
375\nsamples = 24\nvalue = [18, 6]'),
 Text(46.5, 61.15499999999997, 'entropy = 0.
492\nsamples = 16\nvalue = [7, 9]'),
 Text(93.0, 183.46500000000003, 'X[5] <= 0.2
91\nentropy = 0.36\nsamples = 34\nvalue =
[8, 26]'),
 Text(77.5, 61.15499999999997, 'entropy = 0.
5\nsamples = 14\nvalue = [7, 7]'),
 Text(108.5, 61.15499999999997, 'entropy =
0.095\nsamples = 20\nvalue = [1, 19]'),
 Text(170.5, 305.775, 'X[5] <= 0.322\nentrop
y = 0.337\nsamples = 42\nvalue = [33, 9]'),
 Text(155.0, 183.46500000000003, 'X[9] <= 0.
164\nentropy = 0.18\nsamples = 30\nvalue =
```

```
[27, 3]'),
 Text(139.5, 61.15499999999997, 'entropy =
0.355\nsamples = 13\nvalue = [10, 3]'),
 Text(170.5, 61.15499999999997, 'entropy =
0.0\nsamples = 17\nvalue = [17, 0]'),
 Text(186.0, 183.46500000000003, 'entropy =
0.5\nsamples = 12\nvalue = [6, 6]'),
 Text(147.25, 428.0850000000004, 'entropy =
0.0\nsamples = 24\nvalue = [0, 24]'),
 Text(333.25, 550.395, 'X[14] <= 0.312\nentr
opy = 0.301\nsamples = 568\nvalue = [105, 46
3]'),
 Text(232.5, 428.0850000000004, 'X[5] <= 0.
343\nentropy = 0.467\nsamples = 121\nvalue =
[45, 76]'),
 Text(217.0, 305.775, 'entropy = 0.287\nsamp
les = 23\nvalue = [19, 4]'),
 Text(248.0, 305.775, 'X[22] <= 0.521\nentro
py = 0.39\nsamples = 98\nvalue = [26, 72]'),
 Text(217.0, 183.46500000000003, 'X[23] <=
0.267\nentropy = 0.5\nsamples = 39\nvalue =
[19, 20]'),
 Text(201.5, 61.15499999999997, 'entropy =
0.417\nsamples = 27\nvalue = [19, 8]'),
 Text(232.5, 61.15499999999997, 'entropy =
0.0\nsamples = 12\nvalue = [0, 12]'),
 Text(279.0, 183.46500000000003, 'X[8] <= 0.
114\nentropy = 0.209\nsamples = 59\nvalue =
[7, 52]'),
 Text(263.5, 61.15499999999997, 'entropy =
0.401\nsamples = 18\nvalue = [5, 13]'),
 Text(294.5, 61.15499999999997, 'entropy =
0.093\nsamples = 41\nvalue = [2, 39]'),
 Text(434.0, 428.0850000000004, 'X[15] <=
0.399\nentropy = 0.232\nsamples = 447\nvalue
= [60, 387]'),
 Text(372.0, 305.775, 'X[8] <= 0.294\nentrop
```

```
y = 0.18\nsamples = 390\nvalue = [39, 35
1]'),
 Text(341.0, 183.46500000000003, 'X[13] <=
0.17\nentropy = 0.071\nsamples = 190\nvalue
= [7, 183]'),
 Text(325.5, 61.15499999999997, 'entropy =
0.408\nsamples = 14\nvalue = [4, 10]'),
 Text(356.5, 61.15499999999997, 'entropy =
0.034\nsamples = 176\nvalue = [3, 173]'),
 Text(403.0, 183.46500000000003, 'X[11] <=
0.751\nentropy = 0.269\nsamples = 200\nvalue
= [32, 168]'),
 Text(387.5, 61.15499999999997, 'entropy =
0.211\nsamples = 175\nvalue = [21, 154]'),
 Text(418.5, 61.15499999999997, 'entropy =
0.493\nsamples = 25\nvalue = [11, 14]'),
 Text(496.0, 305.775, 'X[3] <= 0.544\nentrop
y = 0.465\nsamples = 57\nvalue = [21, 36]'),
 Text(465.0, 183.46500000000003, 'X[18] <=
0.172\nentropy = 0.487\nsamples = 31\nvalue
= [18, 13]'),
 Text(449.5, 61.15499999999997, 'entropy =
0.278\nsamples = 12\nvalue = [10, 2]'),
 Text(480.5, 61.15499999999997, 'entropy =
0.488\nsamples = 19\nvalue = [8, 11]'),
 Text(527.0, 183.46500000000003, 'X[6] <= 0.
519\nentropy = 0.204\nsamples = 26\nvalue =
[3, 23]'),
 Text(511.5, 61.15499999999997, 'entropy =
0.0\nsamples = 14\nvalue = [0, 14]'),
 Text(542.5, 61.15499999999997, 'entropy =
0.375\nsamples = 12\nvalue = [3, 9]'),
 Text(825.375, 672.705, 'X[16] <= 0.287\nent
ropy = 0.472\nsamples = 4003\nvalue = [2475,
1528]'),
 Text(635.5, 550.395, 'X[16] <= 0.023\nentro
py = 0.371\nsamples = 1330\nvalue = [1003, 3
```

```
27]'),
 Text(558.0, 428.08500000000004, 'X[1] <= 0.
45\nentropy = 0.231\nsamples = 75\nvalue =
[10, 65]'),
 Text(542.5, 305.775, 'entropy = 0.5\nsample
s = 16\nvalue = [8, 8]'),
 Text(573.5, 305.775, 'X[3] <= 0.699\nentrop
y = 0.065\nsamples = 59\nvalue = [2, 57]'),
 Text(558.0, 183.46500000000003, 'entropy =
0.0\nsamples = 47\nvalue = [0, 47]'),
 Text(589.0, 183.46500000000003, 'entropy =
0.278\nsamples = 12\nvalue = [2, 10]'),
 Text(713.0, 428.08500000000004, 'X[19] <=
0.389\nentropy = 0.33\nsamples = 1255\nvalue
= [993, 262]'),
 Text(651.0, 305.775, 'X[21] <= 0.47\nentrop
y = 0.438\nsamples = 68\nvalue = [22, 46]'),
 Text(620.0, 183.46500000000003, 'X[8] <= 0.
231\nentropy = 0.499\nsamples = 42\nvalue =
[20, 22]'),
 Text(604.5, 61.15499999999997, 'entropy =
0.305\nsamples = 16\nvalue = [13, 3]'),
 Text(635.5, 61.15499999999997, 'entropy =
0.393\nsamples = 26\nvalue = [7, 19]'),
 Text(682.0, 183.46500000000003, 'X[7] <= 0.
677\nentropy = 0.142\nsamples = 26\nvalue =
[2, 24]'),
 Text(666.5, 61.15499999999997, 'entropy =
0.278\nsamples = 12\nvalue = [2, 10]'),
 Text(697.5, 61.15499999999997, 'entropy =
0.0\nsamples = 14\nvalue = [0, 14]'),
 Text(775.0, 305.775, 'X[9] <= 0.645\nentrop
y = 0.298\nsamples = 1187\nvalue = [971, 21
6]'),
 Text(744.0, 183.46500000000003, 'X[13] <=
0.301\nentropy = 0.274\nsamples = 1152\nvalu
e = [963, 189]'),
```

```
 Text(728.5, 61.15499999999997, 'entropy =
0.498\nsamples = 70\nvalue = [37, 33]'),
 Text(759.5, 61.15499999999997, 'entropy =
0.247\nsamples = 1082\nvalue = [926, 156]'),
 Text(806.0, 183.46500000000003, 'X[4] <= 0.
204\nentropy = 0.353\nsamples = 35\nvalue =
[8, 27]'),
 Text(790.5, 61.15499999999997, 'entropy =
0.0\nsamples = 19\nvalue = [0, 19]'),
 Text(821.5, 61.15499999999997, 'entropy =
0.5\nsamples = 16\nvalue = [8, 8]'),
 Text(1015.25, 550.395, 'X[10] <= 0.293\nent
ropy = 0.495\nsamples = 2673\nvalue = [1472,
1201]'),
 Text(922.25, 428.08500000000004, 'X[19] <=
0.198\nentropy = 0.472\nsamples = 1576\nvalu
e = [975, 601]'),
 Text(883.5, 305.775, 'X[4] <= 0.345\nentrop
y = 0.252\nsamples = 54\nvalue = [8, 46]'),
 Text(868.0, 183.46500000000003, 'X[15] <=
0.484\nentropy = 0.1\nsamples = 38\nvalue =
[2, 36]'),
 Text(852.5, 61.15499999999997, 'entropy =
0.278\nsamples = 12\nvalue = [2, 10]'),
 Text(883.5, 61.15499999999997, 'entropy =
0.0\nsamples = 26\nvalue = [0, 26]'),
 Text(899.0, 183.46500000000003, 'entropy =
0.469\nsamples = 16\nvalue = [6, 10]'),
 Text(961.0, 305.775, 'X[15] <= 0.45\nentrop
y = 0.463\nsamples = 1522\nvalue = [967, 55
5]'),
 Text(930.0, 183.46500000000003, 'X[14] <=
0.408\nentropy = 0.493\nsamples = 1021\nvalu
e = [571, 450]'),
 Text(914.5, 61.15499999999997, 'entropy =
0.465\nsamples = 171\nvalue = [63, 108]'),
 Text(945.5, 61.15499999999997, 'entropy =
```

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0.481\nsamples = 850\nvalue = [508, 342]'),
 Text(992.0, 183.46500000000003, 'X[11] <=
0.914\nentropy = 0.331\nsamples = 501\nvalue
= [396, 105]'),
 Text(976.5, 61.15499999999997, 'entropy =
0.305\nsamples = 474\nvalue = [385, 89]'),
 Text(1007.5, 61.15499999999997, 'entropy =
0.483\nsamples = 27\nvalue = [11, 16]'),
 Text(1108.25, 428.08500000000004, 'X[18] <=
0.281\nentropy = 0.496\nsamples = 1097\nvalu
e = [497, 600]'),
 Text(1069.5, 305.775, 'X[17] <= 0.576\nentr
opy = 0.187\nsamples = 67\nvalue = [7, 6
0]'),
 Text(1054.0, 183.46500000000003, 'X[24] <=
0.149\nentropy = 0.07\nsamples = 55\nvalue =
[2, 53]'),
 Text(1038.5, 61.15499999999997, 'entropy =
0.278\nsamples = 12\nvalue = [2, 10]'),
 Text(1069.5, 61.15499999999997, 'entropy =
0.0\nsamples = 43\nvalue = [0, 43]'),
 Text(1085.0, 183.46500000000003, 'entropy =
0.486\nsamples = 12\nvalue = [5, 7]'),
 Text(1147.0, 305.775, 'X[21] <= 0.149\nentr
opy = 0.499\nsamples = 1030\nvalue = [490, 5
40]'),
 Text(1116.0, 183.46500000000003, 'X[20] <=
0.637\nentropy = 0.474\nsamples = 324\nvalue
= [199, 125]'),
 Text(1100.5, 61.15499999999997, 'entropy =
0.231\nsamples = 15\nvalue = [2, 13]'),
 Text(1131.5, 61.15499999999997, 'entropy =
0.462\nsamples = 309\nvalue = [197, 112]'),
 Text(1178.0, 183.46500000000003, 'X[15] <=
0.591\nentropy = 0.485\nsamples = 706\nvalue
= [291, 415]'),
 Text(1162.5, 61.15499999999997, 'entropy =
```

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0.471\nsamples = 655\nvalue = [248, 407]'),
 Text(1193.5, 61.15499999999997, 'entropy =
0.265\nsamples = 51\nvalue = [43, 8]'),
 Text(2071.1875, 795.015, 'X[17] <= 0.741\ne
ntropy = 0.409\nsamples = 9103\nvalue = [260
5, 6498]'),
 Text(1668.1875, 672.705, 'X[20] <= 0.698\ne
ntropy = 0.373\nsamples = 7609\nvalue = [188
7, 5722]'),
 Text(1445.375, 550.395, 'X[14] <= 0.503\nen
tropy = 0.3\nsamples = 4046\nvalue = [745, 3
301]'),
 Text(1333.0, 428.08500000000004, 'X[16] <=
0.418\nentropy = 0.447\nsamples = 775\nvalue
= [261, 514]'),
 Text(1271.0, 305.775, 'X[7] <= 0.326\nentro
py = 0.299\nsamples = 344\nvalue = [63, 28
1]'),
 Text(1240.0, 183.46500000000003, 'X[13] <=
0.286\nentropy = 0.47\nsamples = 114\nvalue
= [43, 71]'),
 Text(1224.5, 61.15499999999997, 'entropy =
0.423\nsamples = 102\nvalue = [31, 71]'),
 Text(1255.5, 61.15499999999997, 'entropy =
0.0\nsamples = 12\nvalue = [12, 0]'),
 Text(1302.0, 183.46500000000003, 'X[14] <=
0.349\nentropy = 0.159\nsamples = 230\nvalue
= [20, 210]'),
 Text(1286.5, 61.15499999999997, 'entropy =
0.344\nsamples = 59\nvalue = [13, 46]'),
 Text(1317.5, 61.15499999999997, 'entropy =
0.079\nsamples = 171\nvalue = [7, 164]'),
 Text(1395.0, 305.775, 'X[4] <= 0.48\nentrop
y = 0.497\nsamples = 431\nvalue = [198, 23
3]'),
 Text(1364.0, 183.46500000000003, 'X[10] <=
0.381\nentropy = 0.5\nsamples = 386\nvalue =
```

```
[194, 192]'),
 Text(1348.5, 61.15499999999997, 'entropy =
0.245\nsamples = 35\nvalue = [5, 30]'),
 Text(1379.5, 61.15499999999997, 'entropy =
0.497\nsamples = 351\nvalue = [189, 162]'),
 Text(1426.0, 183.46500000000003, 'X[0] <=
0.57\nentropy = 0.162\nsamples = 45\nvalue =
[4, 41]'),
 Text(1410.5, 61.15499999999997, 'entropy =
0.0\nsamples = 32\nvalue = [0, 32]'),
 Text(1441.5, 61.15499999999997, 'entropy =
0.426\nsamples = 13\nvalue = [4, 9]'),
 Text(1557.75, 428.08500000000004, 'X[1] <=
0.42\nentropy = 0.252\nsamples = 3271\nvalue
= [484, 2787]'),
 Text(1519.0, 305.775, 'X[17] <= 0.437\nentr
opy = 0.29\nsamples = 2594\nvalue = [457, 21
37]'),
 Text(1488.0, 183.46500000000003, 'X[22] <=
0.983\nentropy = 0.231\nsamples = 1700\nvalu
e = [227, 1473]'),
 Text(1472.5, 61.15499999999997, 'entropy =
0.222\nsamples = 1684\nvalue = [214, 147
0]'),
 Text(1503.5, 61.15499999999997, 'entropy =
0.305\nsamples = 16\nvalue = [13, 3]'),
 Text(1550.0, 183.46500000000003, 'X[7] <=
0.463\nentropy = 0.382\nsamples = 894\nvalue
= [230, 664]'),
 Text(1534.5, 61.15499999999997, 'entropy =
0.451\nsamples = 489\nvalue = [168, 321]'),
 Text(1565.5, 61.15499999999997, 'entropy =
0.259\nsamples = 405\nvalue = [62, 343]'),
 Text(1596.5, 305.775, 'X[2] <= 0.259\nentro
py = 0.077\nsamples = 677\nvalue = [27, 65
0]'),
 Text(1581.0, 183.46500000000003, 'entropy =
```

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0.444\nsamples = 12\nvalue = [4, 8]'),
 Text(1612.0, 183.46500000000003, 'X[13] <=
0.543\nentropy = 0.067\nsamples = 665\nvalue
= [23, 642]'),
 Text(1596.5, 61.15499999999997, 'entropy =
0.015\nsamples = 397\nvalue = [3, 394]'),
 Text(1627.5, 61.15499999999997, 'entropy =
0.138\nsamples = 268\nvalue = [20, 248]'),
 Text(1891.0, 550.395, 'X[1] <= 0.456\nentro
py = 0.436\nsamples = 3563\nvalue = [1142, 2
421]'),
 Text(1767.0, 428.08500000000004, 'X[15] <=
0.468\nentropy = 0.46\nsamples = 2918\nvalue
= [1046, 1872]'),
 Text(1705.0, 305.775, 'X[16] <= 0.489\nentr
opy = 0.402\nsamples = 1579\nvalue = [440, 1
139]'),
 Text(1674.0, 183.46500000000003, 'X[20] <=
0.973\nentropy = 0.295\nsamples = 761\nvalue
= [137, 624]'),
 Text(1658.5, 61.15499999999997, 'entropy =
0.282\nsamples = 748\nvalue = [127, 621]'),
 Text(1689.5, 61.15499999999997, 'entropy =
0.355\nsamples = 13\nvalue = [10, 3]'),
 Text(1736.0, 183.46500000000003, 'X[19] <=
0.685\nentropy = 0.466\nsamples = 818\nvalue
= [303, 515]'),
 Text(1720.5, 61.15499999999997, 'entropy =
0.419\nsamples = 508\nvalue = [152, 356]'),
 Text(1751.5, 61.15499999999997, 'entropy =
0.5\nsamples = 310\nvalue = [151, 159]'),
 Text(1829.0, 305.775, 'X[11] <= 0.904\nentr
opy = 0.496\nsamples = 1339\nvalue = [606, 7
33]'),
 Text(1798.0, 183.46500000000003, 'X[10] <=
0.437\nentropy = 0.498\nsamples = 886\nvalue
= [474, 412]'),
```

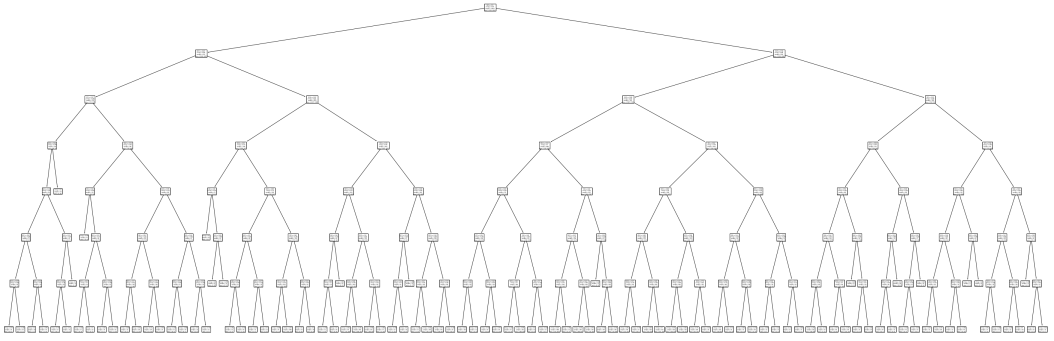
```
 Text(1782.5, 61.15499999999997, 'entropy =
0.473\nsamples = 546\nvalue = [336, 210]'),
 Text(1813.5, 61.15499999999997, 'entropy =
0.482\nsamples = 340\nvalue = [138, 202]'),
 Text(1860.0, 183.46500000000003, 'X[15] <=
0.753\nentropy = 0.413\nsamples = 453\nvalue
= [132, 321]'),
 Text(1844.5, 61.15499999999997, 'entropy =
0.351\nsamples = 409\nvalue = [93, 316]'),
 Text(1875.5, 61.15499999999997, 'entropy =
0.201\nsamples = 44\nvalue = [39, 5]'),
 Text(2015.0, 428.08500000000004, 'X[15] <=
0.748\nentropy = 0.253\nsamples = 645\nvalue
= [96, 549]'),
 Text(1953.0, 305.775, 'X[8] <= 0.634\nentro
py = 0.207\nsamples = 587\nvalue = [69, 51
8]'),
 Text(1922.0, 183.46500000000003, 'X[20] <=
0.946\nentropy = 0.151\nsamples = 487\nvalue
= [40, 447]'),
 Text(1906.5, 61.15499999999997, 'entropy =
0.12\nsamples = 436\nvalue = [28, 408]'),
 Text(1937.5, 61.15499999999997, 'entropy =
0.36\nsamples = 51\nvalue = [12, 39]'),
 Text(1984.0, 183.46500000000003, 'X[12] <=
0.764\nentropy = 0.412\nsamples = 100\nvalue
= [29, 71]'),
 Text(1968.5, 61.15499999999997, 'entropy =
0.492\nsamples = 32\nvalue = [18, 14]'),
 Text(1999.5, 61.15499999999997, 'entropy =
0.271\nsamples = 68\nvalue = [11, 57]'),
 Text(2077.0, 305.775, 'X[21] <= 0.411\nentr
opy = 0.498\nsamples = 58\nvalue = [27, 3
1]'),
 Text(2046.0, 183.46500000000003, 'X[1] <=
0.502\nentropy = 0.459\nsamples = 28\nvalue
= [18, 10]'),
```

```
 Text(2030.5, 61.15499999999997, 'entropy =
0.497\nsamples = 13\nvalue = [6, 7]'),
 Text(2061.5, 61.15499999999997, 'entropy =
0.32\nsamples = 15\nvalue = [12, 3]'),
 Text(2108.0, 183.46500000000003, 'X[21] <=
0.577\nentropy = 0.42\nsamples = 30\nvalue =
[9, 21]'),
 Text(2092.5, 61.15499999999997, 'entropy =
0.26\nsamples = 13\nvalue = [2, 11]'),
 Text(2123.5, 61.15499999999997, 'entropy =
0.484\nsamples = 17\nvalue = [7, 10]'),
 Text(2474.1875, 672.705, 'X[2] <= 0.415\nen
tropy = 0.499\nsamples = 1494\nvalue = [718,
776]'),
 Text(2321.125, 550.395, 'X[15] <= 0.809\nen
tropy = 0.475\nsamples = 915\nvalue = [559,
356]'),
 Text(2239.75, 428.08500000000004, 'X[5] <=
0.758\nentropy = 0.498\nsamples = 687\nvalue
= [364, 323]'),
 Text(2201.0, 305.775, 'X[4] <= 0.344\nentro
py = 0.471\nsamples = 544\nvalue = [337, 20
7]'),
 Text(2170.0, 183.46500000000003, 'X[19] <=
0.881\nentropy = 0.345\nsamples = 239\nvalue
= [186, 53]'),
 Text(2154.5, 61.15499999999997, 'entropy =
0.292\nsamples = 225\nvalue = [185, 40]'),
 Text(2185.5, 61.15499999999997, 'entropy =
0.133\nsamples = 14\nvalue = [1, 13]'),
 Text(2232.0, 183.46500000000003, 'X[12] <=
0.293\nentropy = 0.5\nsamples = 305\nvalue =
[151, 154]'),
 Text(2216.5, 61.15499999999997, 'entropy =
0.375\nsamples = 80\nvalue = [20, 60]'),
 Text(2247.5, 61.15499999999997, 'entropy =
0.486\nsamples = 225\nvalue = [131, 94]'),
```

```
 Text(2278.5, 305.775, 'X[14] <= 0.202\nentropy = 0.306\nsamples = 143\nvalue = [27, 116]'),
 Text(2263.0, 183.46500000000003, 'entropy = 0.495\nsamples = 20\nvalue = [9, 11]'),
 Text(2294.0, 183.46500000000003, 'X[11] <= 0.997\nentropy = 0.25\nsamples = 123\nvalue = [18, 105]'),
 Text(2278.5, 61.15499999999997, 'entropy = 0.354\nsamples = 74\nvalue = [17, 57]'),
 Text(2309.5, 61.15499999999997, 'entropy = 0.04\nsamples = 49\nvalue = [1, 48]'),
 Text(2402.5, 428.08500000000004, 'X[1] <= 0.528\nentropy = 0.248\nsamples = 228\nvalue = [195, 33]'),
 Text(2371.5, 305.775, 'X[15] <= 0.835\nentropy = 0.088\nsamples = 151\nvalue = [144, 7]'),
 Text(2356.0, 183.46500000000003, 'X[5] <= 0.767\nentropy = 0.249\nsamples = 48\nvalue = [41, 7]'),
 Text(2340.5, 61.15499999999997, 'entropy = 0.153\nsamples = 36\nvalue = [33, 3]'),
 Text(2371.5, 61.15499999999997, 'entropy = 0.444\nsamples = 12\nvalue = [8, 4]'),
 Text(2387.0, 183.46500000000003, 'entropy = 0.0\nsamples = 103\nvalue = [103, 0]'),
 Text(2433.5, 305.775, 'X[9] <= 0.393\nentropy = 0.447\nsamples = 77\nvalue = [51, 26]'),
 Text(2418.0, 183.46500000000003, 'X[9] <= 0.344\nentropy = 0.324\nsamples = 59\nvalue = [47, 12]'),
 Text(2402.5, 61.15499999999997, 'entropy = 0.153\nsamples = 36\nvalue = [33, 3]'),
 Text(2433.5, 61.15499999999997, 'entropy = 0.476\nsamples = 23\nvalue = [14, 9]'),
```

```
 Text(2449.0, 183.46500000000003, 'entropy =
0.346\nsamples = 18\nvalue = [4, 14]'),
 Text(2627.25, 550.395, 'X[7] <= 0.788\nentr
opy = 0.398\nsamples = 579\nvalue = [159, 42
0]'),
 Text(2549.75, 428.08500000000004, 'X[12] <=
0.902\nentropy = 0.482\nsamples = 330\nvalue
= [134, 196]'),
 Text(2511.0, 305.775, 'X[20] <= 0.945\nentr
opy = 0.497\nsamples = 287\nvalue = [132, 15
5]'),
 Text(2480.0, 183.46500000000003, 'X[6] <=
0.368\nentropy = 0.478\nsamples = 217\nvalue
= [86, 131]'),
 Text(2464.5, 61.15499999999997, 'entropy =
0.245\nsamples = 14\nvalue = [12, 2]'),
 Text(2495.5, 61.15499999999997, 'entropy =
0.463\nsamples = 203\nvalue = [74, 129]'),
 Text(2542.0, 183.46500000000003, 'X[15] <=
0.669\nentropy = 0.451\nsamples = 70\nvalue
= [46, 24]'),
 Text(2526.5, 61.15499999999997, 'entropy =
0.375\nsamples = 12\nvalue = [3, 9]'),
 Text(2557.5, 61.15499999999997, 'entropy =
0.383\nsamples = 58\nvalue = [43, 15]'),
 Text(2588.5, 305.775, 'X[14] <= 0.857\nentr
opy = 0.089\nsamples = 43\nvalue = [2, 4
1]'),
 Text(2573.0, 183.46500000000003, 'entropy =
0.278\nsamples = 12\nvalue = [2, 10]'),
 Text(2604.0, 183.46500000000003, 'entropy =
0.0\nsamples = 31\nvalue = [0, 31]'),
 Text(2704.75, 428.08500000000004, 'X[4] <=
0.807\nentropy = 0.181\nsamples = 249\nvalue
= [25, 224]'),
 Text(2666.0, 305.775, 'X[18] <= 0.49\nentro
py = 0.094\nsamples = 203\nvalue = [10, 19
```

```
3]'),
 Text(2635.0, 183.46500000000003, 'X[12] <=
0.3\nentropy = 0.326\nsamples = 39\nvalue =
[8, 31]'),
 Text(2619.5, 61.15499999999997, 'entropy =
0.071\nsamples = 27\nvalue = [1, 26]'),
 Text(2650.5, 61.15499999999997, 'entropy =
0.486\nsamples = 12\nvalue = [7, 5]'),
 Text(2697.0, 183.46500000000003, 'X[5] <=
0.694\nentropy = 0.024\nsamples = 164\nvalue
= [2, 162]'),
 Text(2681.5, 61.15499999999997, 'entropy =
0.278\nsamples = 12\nvalue = [2, 10]'),
 Text(2712.5, 61.15499999999997, 'entropy =
0.0\nsamples = 152\nvalue = [0, 152]'),
 Text(2743.5, 305.775, 'X[15] <= 0.807\nentr
opy = 0.44\nsamples = 46\nvalue = [15, 3
1]'),
 Text(2728.0, 183.46500000000003, 'entropy =
0.388\nsamples = 19\nvalue = [14, 5]'),
 Text(2759.0, 183.46500000000003, 'X[0] <=
0.812\nentropy = 0.071\nsamples = 27\nvalue
= [1, 26]'),
 Text(2743.5, 61.15499999999997, 'entropy =
0.0\nsamples = 15\nvalue = [0, 15]'),
 Text(2774.5, 61.15499999999997, 'entropy =
0.153\nsamples = 12\nvalue = [1, 11]')]
```

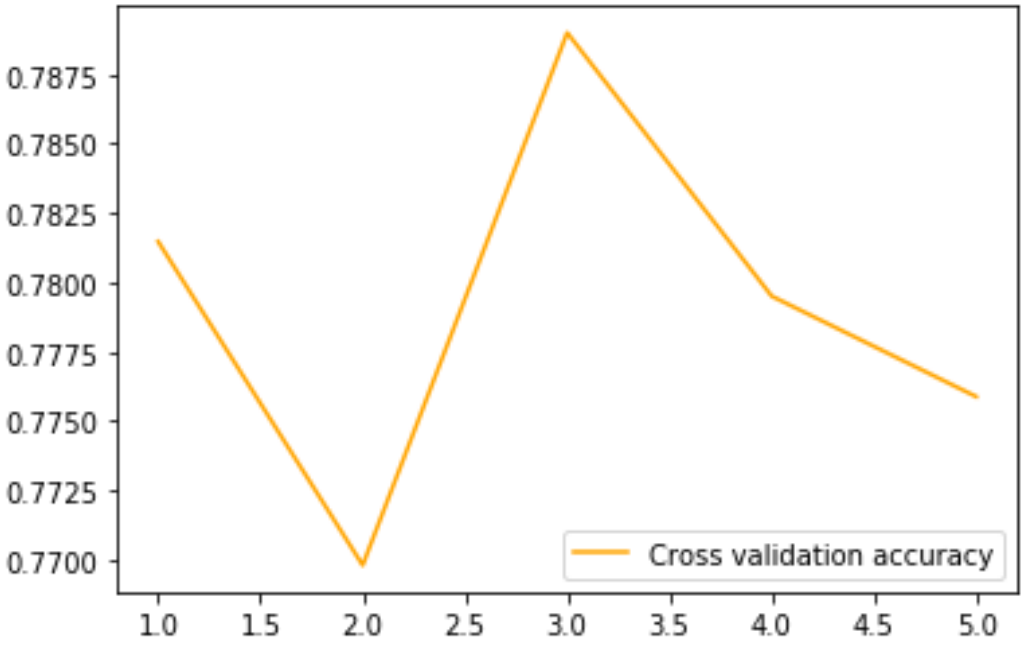


In [30]:

```
clf = DecisionTreeClassifier(criterion="gini",random_stat
e=50,max_depth=12)
clf.fit(X_train,y_train)

scores = cross_val_score(clf, X_train, y_train, cv=5)


x_range = list(range(1, 6))
plt.plot(x_range, scores, color='orange',label ='Cross va
lidation accuracy')
plt.legend()
plt.show()
```



Decision tree - Boosting

In [31]:

```
# Create adaboost classifer object
no_of_esti = list(range(1, 11,1))
training_data_boosting_accuracy = []

for j in range(0, len(no_of_esti)):
    abc = GradientBoostingClassifier(n_estimators=30,rand
om_state=50,max_depth=no_of_esti[j])
    model = abc.fit(X_train, y_train)
    y_pred_train = model.predict(X_train)
    training_data_boosting_accuracy.append(metrics.accura
cy_score(y_train, y_pred_train))
```

```
c:\users\siddharth\appdata\local\programs\py
thon\python37-32\lib\site-packages\sklearn\e
nsemble\gradient_boosting.py:1450: DataConve
rsionWarning: A column-vector y was passed w
hen a 1d array was expected. Please change t
he shape of y to (n_samples, ), for example
using ravel().
  y = column_or_1d(y, warn=True)
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nsemble\gradient_boosting.py:1450: DataConve
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using ravel().
  y = column_or_1d(y, warn=True)
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  y = column_or_1d(y, warn=True)
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  y = column_or_1d(y, warn=True)
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  y = column_or_1d(y, warn=True)
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using ravel().
  y = column_or_1d(y, warn=True)
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  y = column_or_1d(y, warn=True)
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  y = column_or_1d(y, warn=True)
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  y = column_or_1d(y, warn=True)
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thon\python37-32\lib\site-packages\sklearn\e
```

```
nsemble\gradient_boosting.py:1450: DataConve
rsionWarning: A column-vector y was passed w
hen a 1d array was expected. Please change t
he shape of y to (n_samples, ), for example
using ravel().
  y = column_or_1d(y, warn=True)
```

In [32]:

```
# Create adaboost classifer object
no_of_esti = list(range(1, 11,1))
validation_data_boosting_accuracy = []


for j in range(0, len(no_of_esti)):
    abc = GradientBoostingClassifier(n_estimators=50, ran
dom_state=50,max_depth=no_of_esti[j])
    model = abc.fit(X_train, y_train)
    y_pred_test = model.predict(X_test)
    validation_data_boosting_accuracy.append(metrics.accu
racy_score(y_test, y_pred_test))
```

```
c:\users\siddharth\appdata\local\programs\py
thon\python37-32\lib\site-packages\sklearn\e
nsemble\gradient_boosting.py:1450: DataConve
rsionWarning: A column-vector y was passed w
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he shape of y to (n_samples, ), for example
using ravel().
  y = column_or_1d(y, warn=True)
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using ravel().
  y = column_or_1d(y, warn=True)
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using ravel().
  y = column_or_1d(y, warn=True)
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using ravel().
  y = column_or_1d(y, warn=True)
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rsionWarning: A column-vector y was passed w
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he shape of y to (n_samples, ), for example
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  y = column_or_1d(y, warn=True)
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using ravel().
  y = column_or_1d(y, warn=True)
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using ravel().
  y = column_or_1d(y, warn=True)
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using ravel().
  y = column_or_1d(y, warn=True)
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using ravel().
  y = column_or_1d(y, warn=True)
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```
nsemble\gradient_boosting.py:1450: DataConve
rsionWarning: A column-vector y was passed w
hen a 1d array was expected. Please change t
he shape of y to (n_samples, ), for example
using ravel().
  y = column_or_1d(y, warn=True)
```

In [33]:

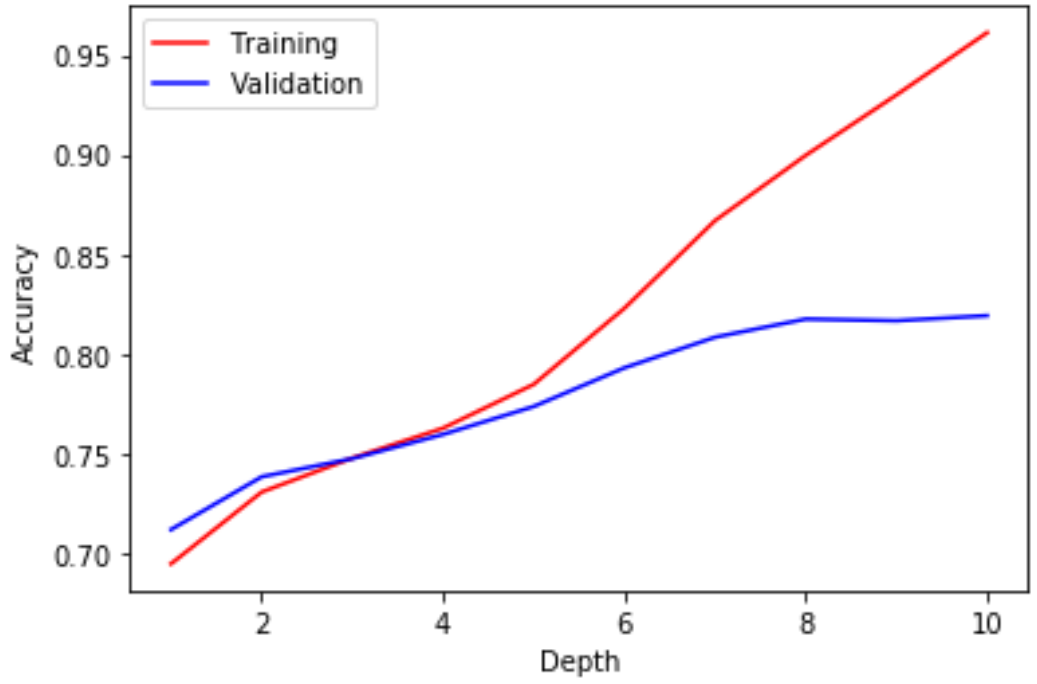
```
x_range_decision_tree = list(range(1, 11))
plt.plot(x_range_decision_tree, training_data_boosting_ac
curacy, color='r',label ='Training')
plt.plot(x_range_decision_tree, validation_data_boosting_
accuracy, color='b',label ='Validation')

plt.xlabel("Depth")
plt.ylabel("Accuracy")

plt.legend()
```

Out[33]:

```
<matplotlib.legend.Legend at 0x117e810>
```



In [34]:

```
abc = GradientBoostingClassifier(max_depth=8, random_stat
e=50)
model = abc.fit(X_train, y_train)
y_pred_test = model.predict(X_test)
cm = confusion_matrix(y_test, y_pred_test)
cm
```

```
c:\users\siddharth\appdata\local\programs\py
thon\python37-32\lib\site-packages\sklearn\e
nsemble\gradient_boosting.py:1450: DataConve
rsionWarning: A column-vector y was passed w
hen a 1d array was expected. Please change t
he shape of y to (n_samples, ), for example
using ravel().
  y = column_or_1d(y, warn=True)
```

Out[34]:

```
array([[1667,  544],
       [ 525, 3185]], dtype=int64)
```

In [35]:

```
print("Accuracy", (cm[1][1] + cm[0][0]) / np.sum(cm) )
print("Sensitivity", cm[1][1] / (cm[1][1] + cm[1][0] ))
print("Specificity", cm[0][0] / (cm[0][0] + cm[0][1] ))
print("Precision", cm[1][1] / (cm[1][1] + cm[0][1] ))
```

```
Accuracy 0.8194561729437595
Sensitivity 0.8584905660377359
Specificity 0.7539574853007689
Precision 0.8541163850898364
```

In [36]:

```
abc = GradientBoostingClassifier(max_depth=10, random_sta
te=50)
model = abc.fit(X_train, y_train)

scores = cross_val_score(model, X_train, y_train, cv=5)


x_range = list(range(1, 6))
plt.plot(x_range, scores, color='orange',label ='Cross va
lidation accuracy')
plt.legend()
plt.show()
```

```
c:\users\siddharth\appdata\local\programs\py
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using ravel().
  y = column_or_1d(y, warn=True)
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  y = column_or_1d(y, warn=True)
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```
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using ravel().
  y = column_or_1d(y, warn=True)
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using ravel().
  y = column_or_1d(y, warn=True)
```

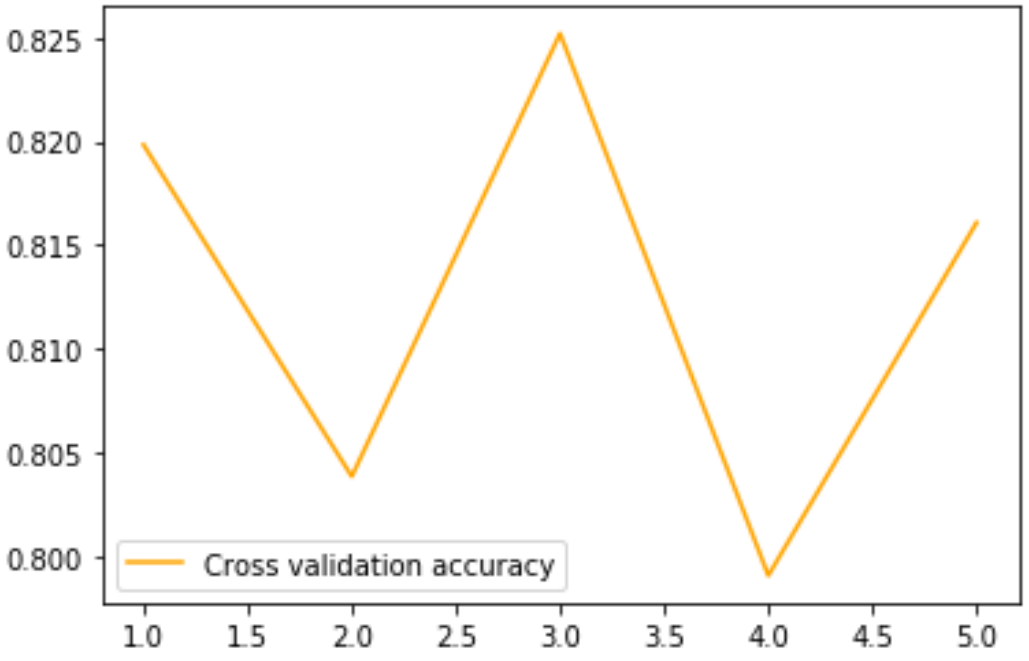

In [37]:

```
listAccuracy = []
for i in range (0,12):
    clf = GradientBoostingClassifier(random_state=50,max_
depth=10, min_samples_leaf = i+1)
    clf.fit(X_train,y_train)
    y_pred_train = clf.predict(X_test)
    listAccuracy.append(metrics.accuracy_score(y_test, y_
pred_train))
listAccuracy

x_range_decision_tree = list(range(1, 13))
plt.plot(x_range_decision_tree, listAccuracy, color='r',l
abel ='Minimum Sample leaves')


plt.xlabel("Min leaves")
plt.ylabel("Accuracy")

plt.legend()
```

```
c:\users\siddharth\appdata\local\programs\py
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nsemble\gradient_boosting.py:1450: DataConve
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  y = column_or_1d(y, warn=True)
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using ravel().
  y = column_or_1d(y, warn=True)
c:\users\siddharth\appdata\local\programs\py
thon\python37-32\lib\site-packages\sklearn\e
nsemble\gradient_boosting.py:1450: DataConve
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hen a 1d array was expected. Please change t
he shape of y to (n_samples, ), for example
using ravel().
  y = column_or_1d(y, warn=True)
c:\users\siddharth\appdata\local\programs\py
thon\python37-32\lib\site-packages\sklearn\e
```

```
nsemble\gradient_boosting.py:1450: DataConve
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using ravel().
  y = column_or_1d(y, warn=True)
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hen a 1d array was expected. Please change t
he shape of y to (n_samples, ), for example
using ravel().
  y = column_or_1d(y, warn=True)
```
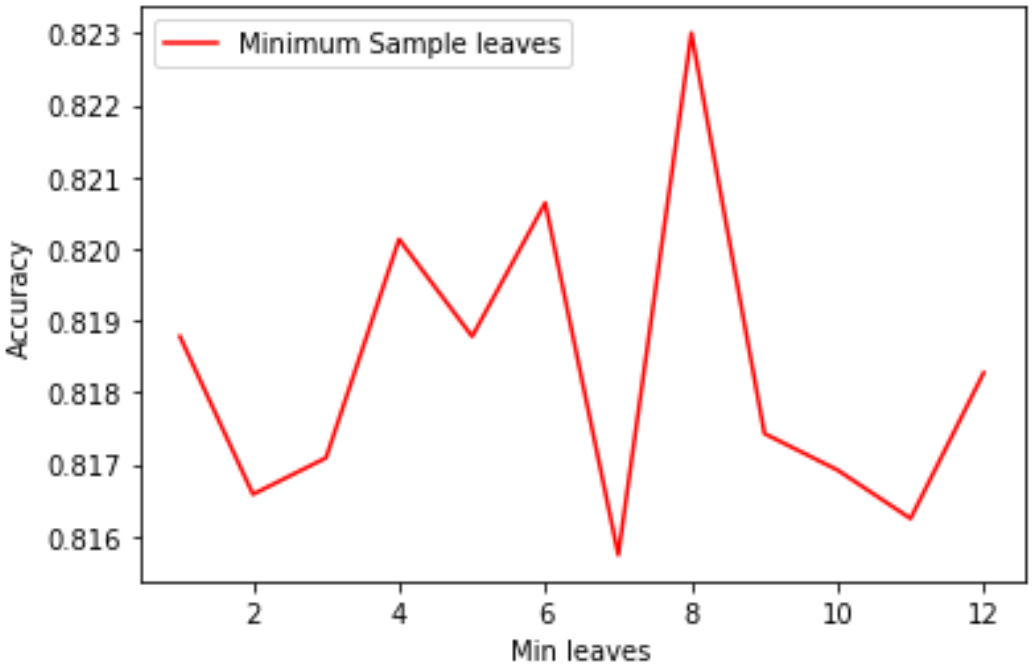

Out[37]:

```
<matplotlib.legend.Legend at 0xe9e4d0>
```


Minimum Sample leaves
0.823
0.822
0.821
0.820
0.819
0.818
0.817
0.816
Accuracy
2
4
6
8
10
12
Min leaves