4.Decision Tree (SKLearn)

November 19, 2021

Classification using Decision Tree - Using SK-Learn

Given input features Company name, job title, and degree obtained, we should predict that employee receives salary over 100k or not.

[44]:
```
# Import necessary package
import pandas as pd
import numpy as np
import matplotlib.pyplot as plt
import seaborn as sns
```

0.0.1 Step 1: Load the dataset

[45]:
```
df = pd.read_csv("E:\\MY LECTURES\\8.2021-09-03 DATA SCIENCE (KNU)\\3.
↪Programs\\dataset\\salaries.csv")
df.head()
```

[45]:

	company	job	degree	salary_more_then_100k
0	google	sales executive	bachelors	0
1	google	sales executive	masters	0
2	google	business manager	bachelors	1
3	google	business manager	masters	1
4	google	computer programmer	bachelors	0

0.0.2 Step 2: Apply EDA

[46]:
```
df['company'].unique()
```

[46]:
```
array(['google', 'abc pharma', 'facebook'], dtype=object)
```

[47]:
```
df['job'].unique()
```

[47]:
```
array(['sales executive', 'business manager', 'computer programmer'],
      dtype=object)
```

[48]:
```
df['degree'].unique()
```

[48]:
```
array(['bachelors', 'masters'], dtype=object)
```

[49]:
```
df['salary_more_then_100k'].unique()
```

[49]:
```
array([0, 1], dtype=int64)
```

0.0.3 Step 3. Pre-process and extract the features

[50]:
```
X = df.drop('salary_more_then_100k',axis='columns')
Y = df['salary_more_then_100k']
```

[51]:
```
# Input feature set
X.head()
```

[51]:

	company	job	degree
0	google	sales executive	bachelors
1	google	sales executive	masters
2	google	business manager	bachelors
3	google	business manager	masters
4	google	computer programmer	bachelors

[52]:
```
# Output feature
Y.head()
```

[52]:
```
0    0
1    0
2    1
3    1
4    0
Name: salary_more_then_100k, dtype: int64
```

Label encoding Converting categorical values to numerical values

[53]:
```
from sklearn.preprocessing import LabelEncoder
le_company = LabelEncoder()
le_job = LabelEncoder()
le_degree = LabelEncoder()
```

[54]:
```
X['company_n'] = le_company.fit_transform(X['company'])
X['job_n'] = le_job.fit_transform(X['job'])
X['degree_n'] = le_degree.fit_transform(X['degree'])
```

[55]:
```
X.head()
```

[55]:

	company	job	degree	company_n	job_n	degree_n
0	google	sales executive	bachelors	2	2	0
1	google	sales executive	masters	2	2	1
2	google	business manager	bachelors	2	0	0
3	google	business manager	masters	2	0	1
4	google	computer programmer	bachelors	2	1	0

[56]:
```
# Drop the label columns
pre_processed_X = X.drop(['company','job','degree'],axis='columns')
pre_processed_X.head()
```

[56]:

	company_n	job_n	degree_n
0	2	2	0
1	2	2	1
2	2	0	0
3	2	0	1
4	2	1	0

0.0.4 Step 4. Split the data for training and testing

[57]:
```
# Splitting dataset into training and testing set
from sklearn.model_selection import train_test_split
x_train, x_test, y_train, y_test = train_test_split(pre_processed_X, Y,␣
 ↪test_size = 0.2, random_state = 0)
```

0.0.5 Step 5. Training the model

[58]:
```
from sklearn import tree
DT_model = tree.DecisionTreeClassifier()
```

[59]:
```
DT_model.fit(x_train, y_train)
```

[59]:
```
DecisionTreeClassifier()
```

[60]:
```
y_train_pred = DT_model.predict(x_train)
y_train_pred
```

[60]:
```
array([1, 0, 1, 1, 1, 0, 1, 1, 1, 0, 1, 1], dtype=int64)
```

[61]:
```
DT_Train_RS = DT_model.score(x_train, y_train)
DT_Train_RS
```

[61]:
```
1.0
```

[62]:
```
train_predicted_prob = DT_model.predict_proba(x_train)
train_predicted_prob
```

[62]:
```
array([[0., 1.],
       [1., 0.],
       [0., 1.],
       [0., 1.],
       [0., 1.],
       [1., 0.],
       [0., 1.],
       [0., 1.],
       [0., 1.],
       [1., 0.],
       [0., 1.],
       [0., 1.]])
```

Performance score

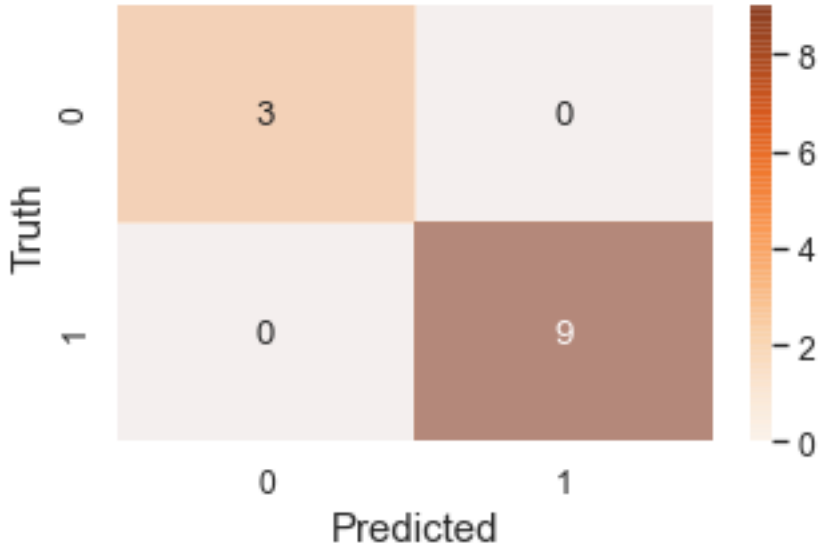
[63]:
```
out = DT_model.score(x_train, y_train)
DT_Train_RS = np.round(out,2)*100
print("Performance score for training set :",DT_Train_RS,"%")
```

```
Performance score for training set : 100.0 %
```

Confusion matrix We are interested to know how many has been correctly and wrongly classified.

[64]:
```
from sklearn.metrics import confusion_matrix
cm = confusion_matrix(y_train,y_train_pred)

plt.figure(figsize = (5,3))
sns.set(font_scale=1.1)

axes = plt.gca()
axes.xaxis.label.set_size(15)
axes.yaxis.label.set_size(15)

sns.heatmap(cm, annot=True,cmap=plt.cm.Oranges, alpha=0.5)

plt.xlabel('Predicted')
plt.ylabel('Truth')
```

[64]:
```
Text(19.5, 0.5, 'Truth')
```



Precison, Recall, F1, Accuracy

[65]:
```
# Total report
from sklearn import metrics
print(metrics.classification_report(y_train,y_train_pred))
```

```
              precision    recall  f1-score   support

           0       1.00      1.00      1.00         3
           1       1.00      1.00      1.00         9

    accuracy                           1.00        12
   macro avg       1.00      1.00      1.00        12
weighted avg       1.00      1.00      1.00        12
```

[66]:
```
# Accuracy score
temp = metrics.accuracy_score(y_train,y_train_pred)
DT_Train_Accuracy = np.round(temp,2)*100
print("Accuracy score : ",DT_Train_Accuracy,"%")
```

```
Accuracy score :  100.0 %
```

[67]:
```
# Precision score
temp = metrics.precision_score(y_train,y_train_pred)
DT_Train_Precision = np.round(temp,2)*100
print("Precision score : ",DT_Train_Precision,"%")
```

```
Precision score :  100.0 %
```

[68]:
```
# Recall score
temp = metrics.recall_score(y_train,y_train_pred)
DT_Train_Recall = np.round(temp,2)*100
print("Recall score : ",DT_Train_Recall,"%")
```

```
Recall score :  100.0 %
```

[69]:
```
# F1 score
temp = metrics.f1_score(y_train,y_train_pred)
DT_Train_F1 = np.round(temp,2)*100
print("F1 score : ",DT_Train_F1,"%")
```

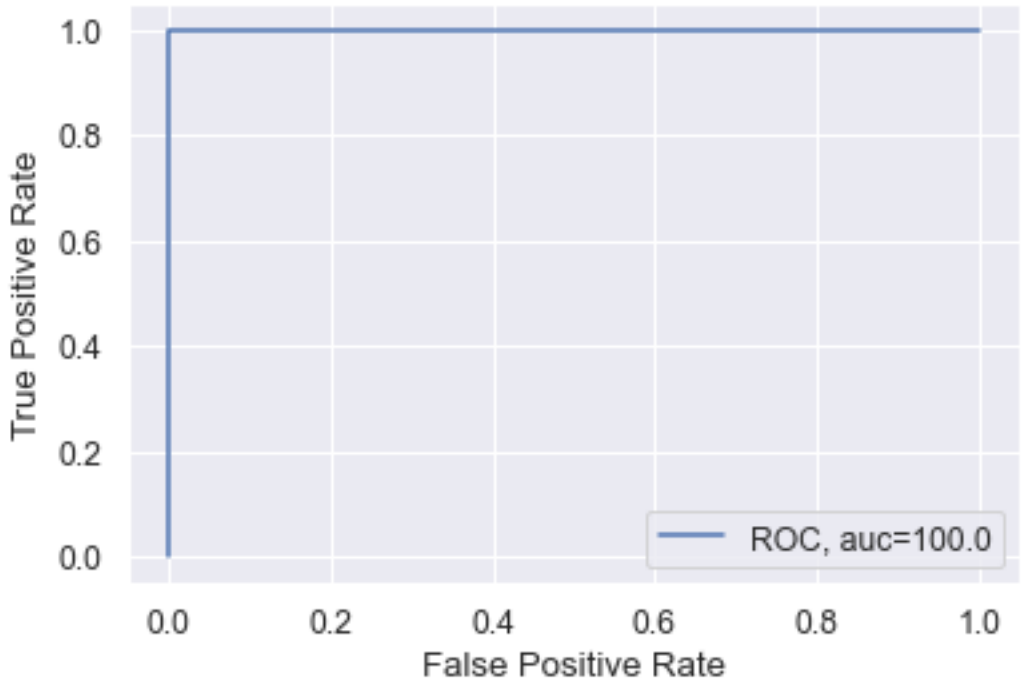
```
F1 score :  100.0 %
```

[70]:
```
# Cohen Kappa score
temp = metrics.cohen_kappa_score(y_train,y_train_pred)
DT_Train_CK = np.round(temp,2)*100
print("Cohen Kappa score : ",DT_Train_CK,"%")
```

```
Cohen Kappa score :  100.0 %
```

ROC

[71]:
```
prob = train_predicted_prob[:,1]
fpr, tpr, _ = metrics.roc_curve(y_train, prob)
DT_Train_AUC = np.round(metrics.roc_auc_score(y_train, prob),2)*100
plt.plot(fpr,tpr,label="ROC, auc="+str(DT_Train_AUC))
plt.xlabel('False Positive Rate')
plt.ylabel('True Positive Rate')
plt.legend(loc=4)
plt.show()
```



0.0.6 Step 6. Testing the model

[72]:
```
y_test_pred = DT_model.predict(x_test)
y_test_pred
```

[72]:
```
array([1, 0, 0, 0], dtype=int64)
```

[73]:
```
test_predicted_prob = DT_model.predict_proba(x_test)
test_predicted_prob
```

[73]:
```
array([[0., 1.],
       [1., 0.],
       [1., 0.],
       [1., 0.]])
```

Performance score

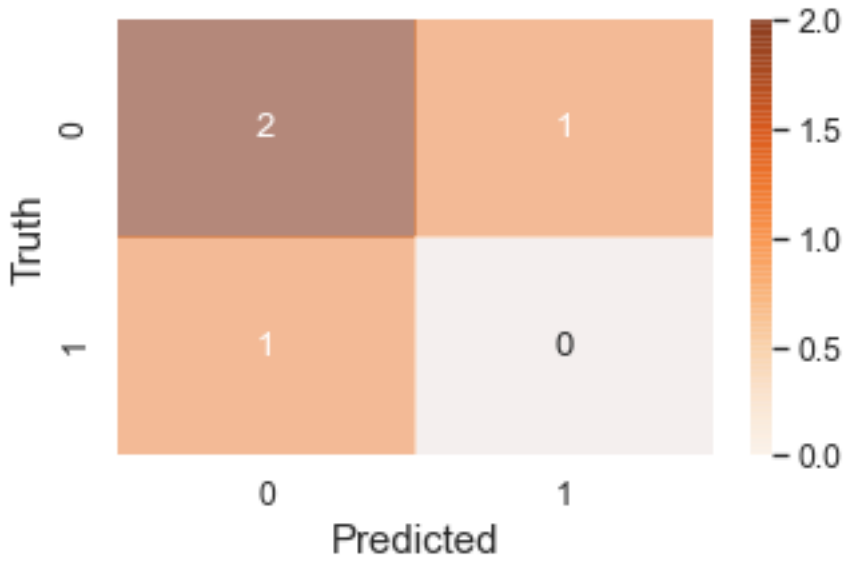
[74]:
```
out = DT_model.score(x_test, y_test)
DT_Test_RS = np.round(out,2)*100
print("Performance score for training set :",DT_Test_RS,"%")
```

```
Performance score for training set : 50.0 %
```

Confusion matrix We are interested to know how many has been correctly and wrongly classified.

[75]:
```
from sklearn.metrics import confusion_matrix
cm = confusion_matrix(y_test,y_test_pred)

plt.figure(figsize = (5,3))
sns.set(font_scale=1.1)

axes = plt.gca()
axes.xaxis.label.set_size(15)
axes.yaxis.label.set_size(15)

sns.heatmap(cm, annot=True,cmap=plt.cm.Oranges, alpha=0.5)

plt.xlabel('Predicted')
plt.ylabel('Truth')
```

[75]:
```
Text(19.5, 0.5, 'Truth')
```



Precison, Recall, F1, Accuracy

[76]:
```
# Total report
from sklearn import metrics
print(metrics.classification_report(y_test,y_test_pred))
```

```
              precision    recall  f1-score   support
```

```
              0       0.67      0.67      0.67         3
              1       0.00      0.00      0.00         1

    accuracy                            0.50         4
   macro avg       0.33      0.33      0.33         4
weighted avg       0.50      0.50      0.50         4
```

[77]:
```
# Accuracy score
temp = metrics.accuracy_score(y_test,y_test_pred)
DT_Test_Accuracy = np.round(temp,2)*100
print("Accuracy score : ",DT_Test_Accuracy,"%")
```

```
Accuracy score :  50.0 %
```

[78]:
```
# Precision score
temp = metrics.precision_score(y_test,y_test_pred)
DT_Test_Precision = np.round(temp,2)*100
print("Precision score : ",DT_Test_Precision,"%")
```

```
Precision score :  0.0 %
```

[79]:
```
# Recall score
temp = metrics.recall_score(y_test,y_test_pred)
DT_Test_Recall = np.round(temp,2)*100
print("Recall score : ",DT_Test_Recall,"%")
```

```
Recall score :  0.0 %
```

[80]:
```
# F1 score
temp = metrics.f1_score(y_test,y_test_pred)
DT_Test_F1 = np.round(temp,2)*100
print("F1 score : ",DT_Test_F1,"%")
```

```
F1 score :  0.0 %
```

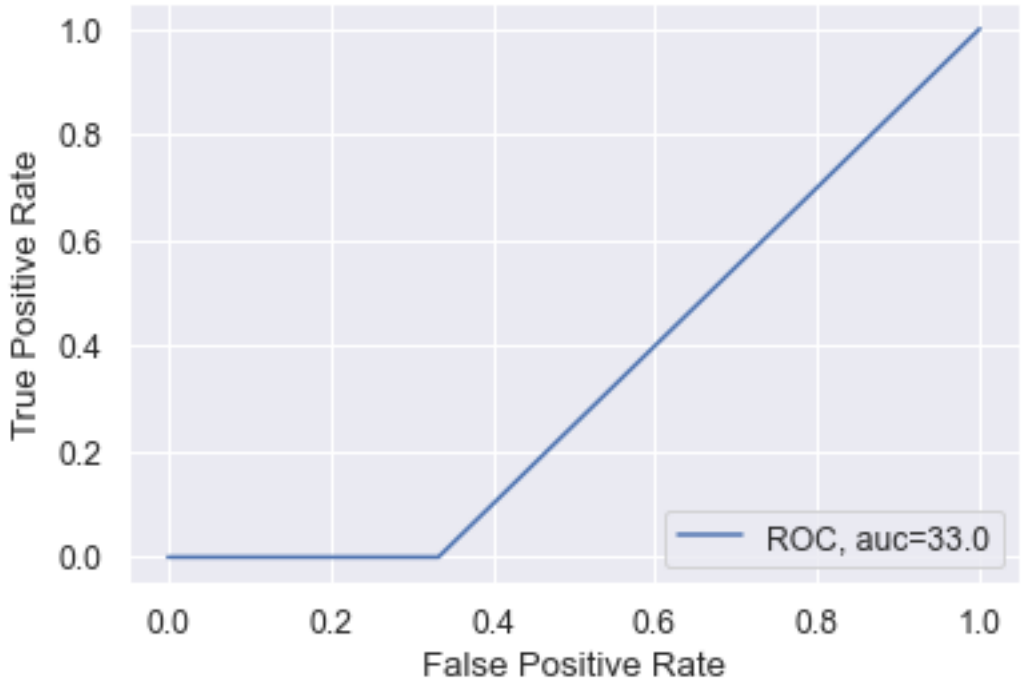
[81]:
```
# Cohen Kappa score
temp = metrics.cohen_kappa_score(y_test,y_test_pred)
DT_Test_CK = np.round(temp,2)*100
print("Cohen Kappa score : ",DT_Test_CK,"%")
```

```
Cohen Kappa score :  -33.0 %
```

ROC

[82]:
```
prob = test_predicted_prob[:,1]
fpr, tpr, _ = metrics.roc_curve(y_test, prob)
DT_Test_AUC = np.round(metrics.roc_auc_score(y_test, prob),2)*100
```

```
plt.plot(fpr,tpr,label="ROC, auc="+str(DT_Test_AUC))
plt.xlabel('False Positive Rate')
plt.ylabel('True Positive Rate')
plt.legend(loc=4)
plt.show()
```



0.0.7 Step 7. Prediction using the model

Is salary of Google, Computer Engineer, Bachelors degree > 100 k ?

[83]:
```
DT_model.predict([[2,1,0]])
```

[83]:
```
array([0], dtype=int64)
```

Is salary of Google, Computer Engineer, Masters degree > 100 k ?

[84]:
```
DT_model.predict([[2,1,1]])
```

[84]:
```
array([1], dtype=int64)
```

0.0.8 Step 8. Summary

[85]:
```
print("             Decision Tree      ")
print("================================================")
print("\t\tTraining phase       Testing phase ")
print("================================================")
print("RS\t\t   ",DT_Train_RS,"%\t\t", DT_Test_RS,"%")
print("Accuracy\t   ",DT_Train_Accuracy,"%\t\t", DT_Test_Accuracy,"%")
print("Precision\t   ",DT_Train_Precision,"%\t\t", DT_Test_Precision,"%")
print("Recall\t\t   ",DT_Train_Recall,"%\t\t", DT_Test_Recall,"%")
print("F1\t\t   ",DT_Train_F1,"%\t\t", DT_Test_F1,"%")
print("CK\t\t   ",DT_Train_CK,"%\t\t", DT_Test_CK,"%")
print("AUC\t\t   ",DT_Train_AUC,"%\t\t", DT_Test_AUC,"%")
print("================================================")
```

```
             Decision Tree
================================================
                Training phase       Testing phase
================================================
RS                   100.0 %              50.0 %
Accuracy             100.0 %              50.0 %
Precision            100.0 %              0.0 %
Recall               100.0 %              0.0 %
F1                   100.0 %              0.0 %
CK                   100.0 %              -33.0 %
AUC                  100.0 %              33.0 %
================================================
```

0.0.9 Exercise

Build decision tree model to predict the survival of a passanger in Titanic datast. CSV file is available here https://github.com/codebasics/py/blob/master/ML/9_decision_tree/Exercise/titanic.csv Input features: Pclass, Sex, Age, Fare Output feature: Survived Calculate score of your model. Find whether a passanger with Pclass: 1, Sex: 0, Age: 43, Fare: 50 survived?