UCS2612 Machine Learning Laboratory

Ex. No. : 7 . Predicting Diabetes using decision tree

Name : **Mega V**

Roll No : **3122 21 5001 051**

Develop a python program to predict diabetics using Decision Tree Model. Visualize the features from the dataset and interpret the results obtained by the model using Matplotlib library.

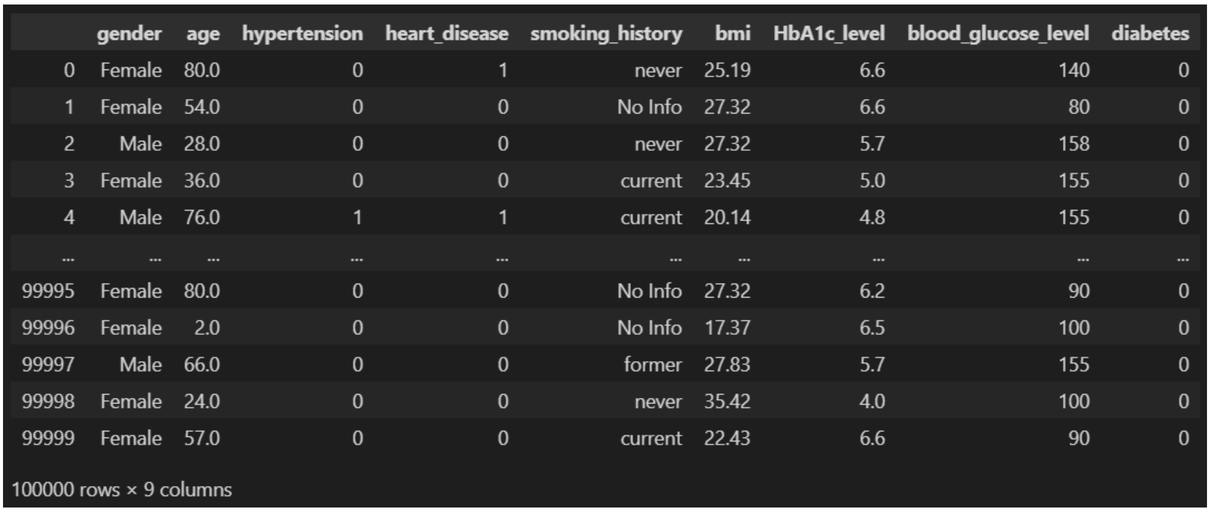
Code and Output

```
Importing Necessary Libraries
```

```
import pandas as pd
import numpy as np
import seaborn as sns

import matplotlib.pyplot as plt

from sklearn import preprocessing
from sklearn.preprocessing import MinMaxScaler
from sklearn.model_selection import train_test_split

from sklearn.metrics import accuracy_score

from sklearn.tree import DecisionTreeClassifier
from sklearn.tree import plot_tree

from sklearn.feature_selection import SelectKBest
from sklearn.feature_selection import f_classif
```

```
Reading Dataset
```

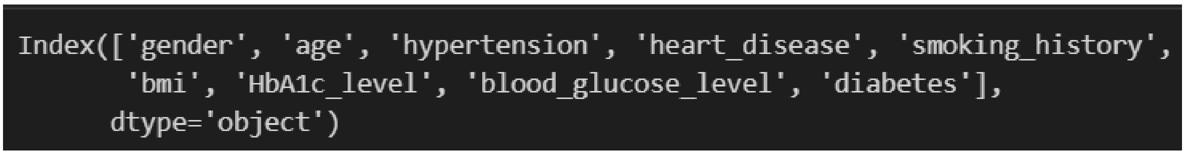
```
df=pd.read_csv("diabetes_prediction_dataset.csv")
df
```



	gender	age	hypertension	heart_disease	smoking_history	bmi	HbA1c_level	blood_glucose_level	diabetes
0	Female	80.0	0	1	never	25.19	6.6	140	0
1	Female	54.0	0	0	No Info	27.32	6.6	80	0
2	Male	28.0	0	0	never	27.32	5.7	158	0
3	Female	36.0	0	0	current	23.45	5.0	155	0
4	Male	76.0	1	1	current	20.14	4.8	155	0
...	...	...	...	...	...	...	...	...	...
99995	Female	80.0	0	0	No Info	27.32	6.2	90	0
99996	Female	2.0	0	0	No Info	17.37	6.5	100	0
99997	Male	66.0	0	0	former	27.83	5.7	155	0
99998	Female	24.0	0	0	never	35.42	4.0	100	0
99999	Female	57.0	0	0	current	22.43	6.6	90	0

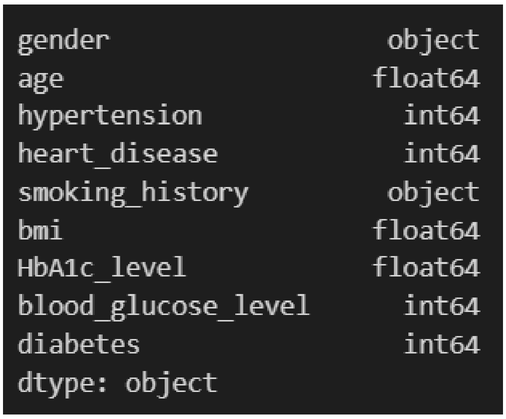
100000 rows × 9 columns

```
df.columns
```



```
Index(['gender', 'age', 'hypertension', 'heart_disease', 'smoking_history',
       'bmi', 'HbA1c_level', 'blood_glucose_level', 'diabetes'],
      dtype='object')
```

```
df.dtypes
```

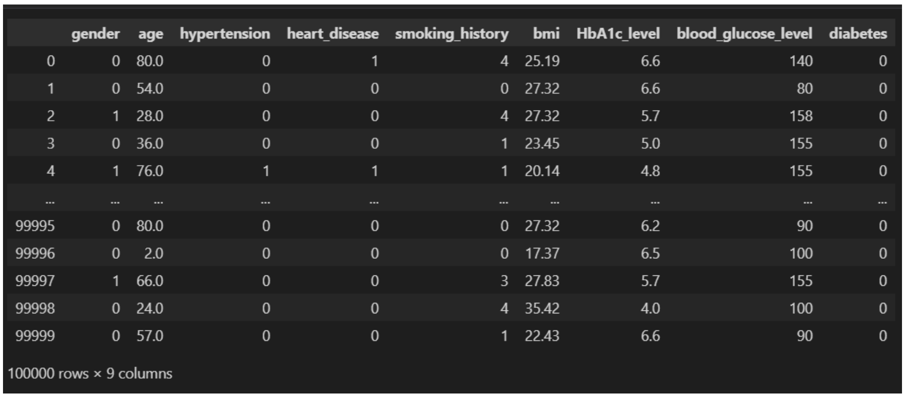


```
gender                  object
age                    float64
hypertension             int64
heart_disease            int64
smoking_history         object
bmi                    float64
HbA1c_level            float64
blood_glucose_level      int64
diabetes                 int64
dtype: object
```

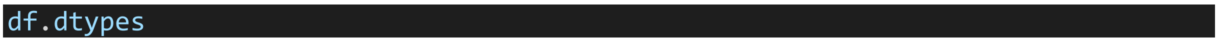
```
Converting Categorical values to Numerical Values
```

```
encoder=preprocessing.LabelEncoder()
df["gender"]=encoder.fit_transform(df["gender"])
df["smoking_history"]=encoder.fit_transform(df["smoking_history"])
```

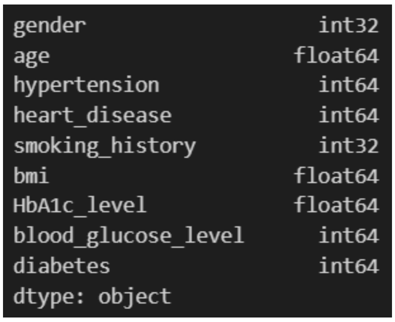
```
df
```



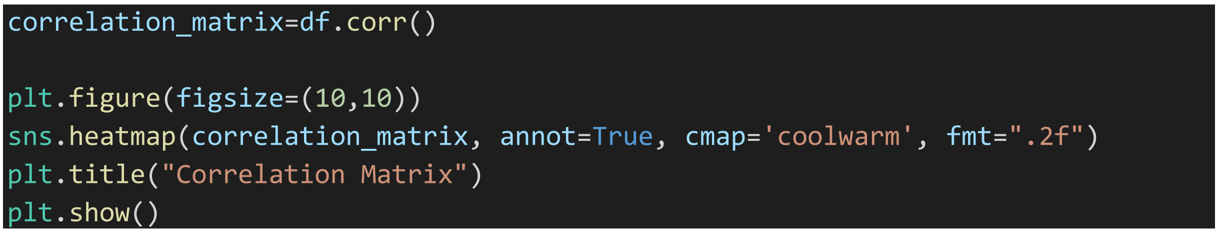
```
       gender   age  hypertension  heart_disease  smoking_history    bmi  HbA1c_level  blood_glucose_level  diabetes
0           0  80.0             0              1                4  25.19          6.6                  140         0
1           0  54.0             0              0                0  27.32          6.6                   80         0
2           1  28.0             0              0                4  27.32          5.7                  158         0
3           0  36.0             0              0                1  23.45          5.0                  155         0
4           1  76.0             1              1                1  20.14          4.8                  155         0
...       ...   ...           ...            ...              ...    ...          ...                  ...       ...
99995       0  80.0             0              0                0  27.32          6.2                   90         0
99996       0   2.0             0              0                0  17.37          6.5                  100         0
99997       1  66.0             0              0                3  27.83          5.7                  155         0
99998       0  24.0             0              0                4  35.42          4.0                  100         0
99999       0  57.0             0              0                1  22.43          6.6                   90         0

100000 rows × 9 columns
```



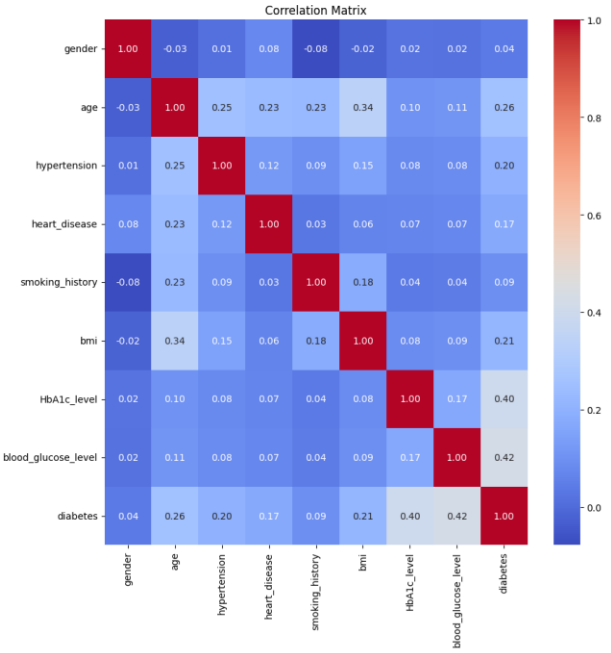
```
df.dtypes
```



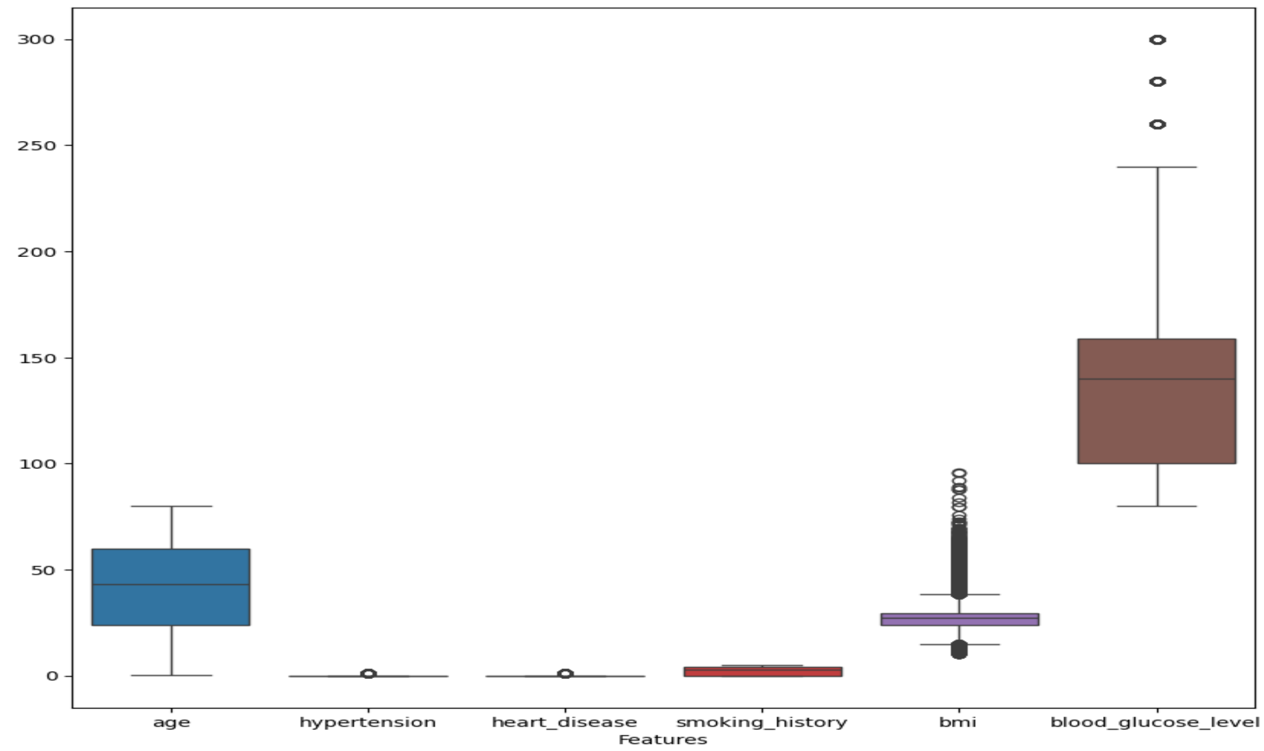
```
gender                   int32
age                    float64
hypertension             int64
heart_disease            int64
smoking_history          int32
bmi                    float64
HbA1c_level            float64
blood_glucose_level      int64
diabetes                 int64
dtype: object
```



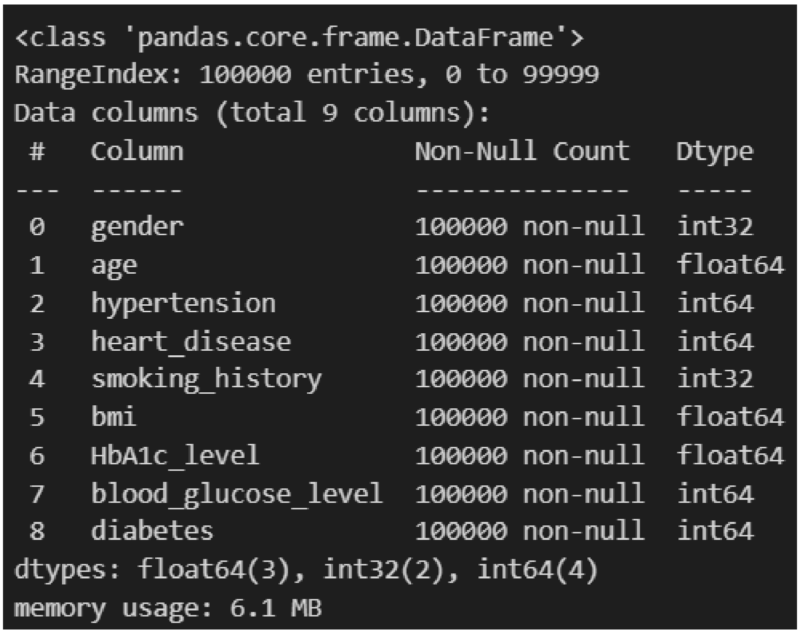
```
correlation_matrix=df.corr()

plt.figure(figsize=(10,10))
sns.heatmap(correlation_matrix, annot=True, cmap='coolwarm', fmt=".2f")
plt.title("Correlation Matrix")
plt.show()
```



```
plt.figure(figsize=(10,10))
sns.boxplot(data=df[["age","hypertension","heart_disease","smoking_history","b
mi","blood_glucose_level"]])
plt.xlabel("Features")
plt.show()
```

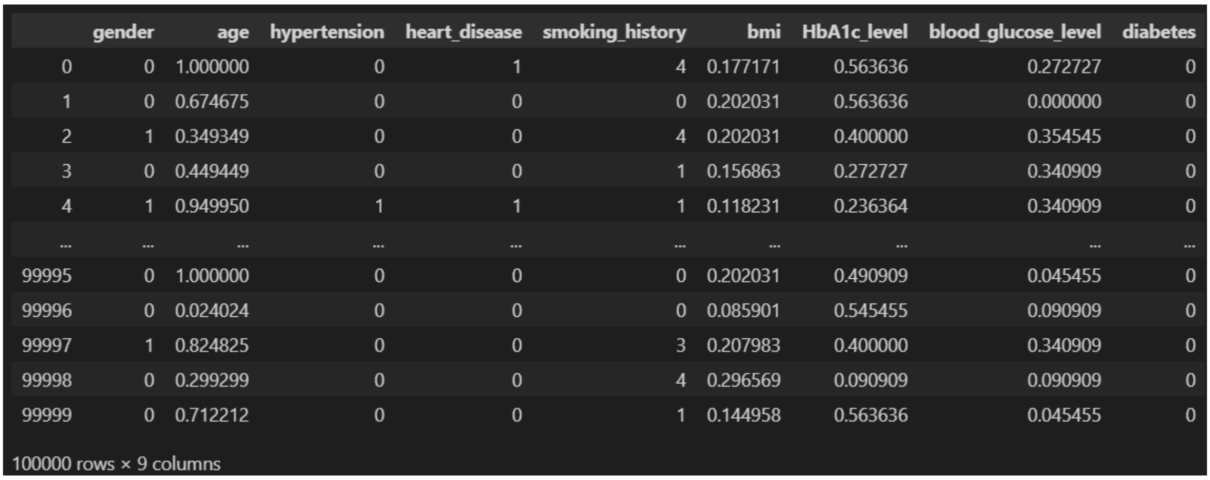


```
Data Preprocessing
df.info()
```



```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 100000 entries, 0 to 99999
Data columns (total 9 columns):
 #   Column               Non-Null Count   Dtype  
---  ------               --------------   -----  
 0   gender               100000 non-null  int32  
 1   age                  100000 non-null  float64
 2   hypertension         100000 non-null  int64  
 3   heart_disease        100000 non-null  int64  
 4   smoking_history      100000 non-null  int32  
 5   bmi                  100000 non-null  float64
 6   HbA1c_level          100000 non-null  float64
 7   blood_glucose_level  100000 non-null  int64  
 8   diabetes             100000 non-null  int64  
dtypes: float64(3), int32(2), int64(4)
memory usage: 6.1 MB
```

```
cols=["age","bmi","HbA1c_level","blood_glucose_level"]
normalizar=MinMaxScaler()
df[cols]=normalizar.fit_transform(df[cols])
```



	gender	age	hypertension	heart_disease	smoking_history	bmi	HbA1c_level	blood_glucose_level	diabetes
0	0	1.000000	0	1	4	0.177171	0.563636	0.272727	0
1	0	0.674675	0	0	0	0.202031	0.563636	0.000000	0
2	1	0.349349	0	0	4	0.202031	0.400000	0.354545	0
3	0	0.449449	0	0	1	0.156863	0.272727	0.340909	0
4	1	0.949950	1	1	1	0.118231	0.236364	0.340909	0
...	...	...	...	...	...	...	...	...	...
99995	0	1.000000	0	0	0	0.202031	0.490909	0.045455	0
99996	0	0.024024	0	0	0	0.085901	0.545455	0.090909	0
99997	1	0.824825	0	0	3	0.207983	0.400000	0.340909	0
99998	0	0.299299	0	0	4	0.296569	0.090909	0.090909	0
99999	0	0.712212	0	0	1	0.144958	0.563636	0.045455	0

100000 rows × 9 columns

```
x = df.drop(columns=["diabetes"])
y = df["diabetes"]
```

```
x_train,x_test,y_train,y_test=train_test_split(x,y,test_size=0.25,random_state
=42)
print("Size of The Training Dataset : ",x_train.shape)
print("Size of The Testing Dataset  : ",x_test.shape)
```

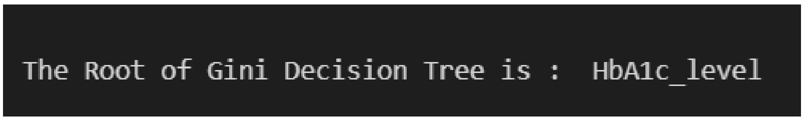
Size of The Training Dataset : (75000, 8)

Size of The Testing Dataset : (25000, 8)

```
Decision Tree Model Without Feature Selection
```

```
Decision Tree Using Gini Impurity
```

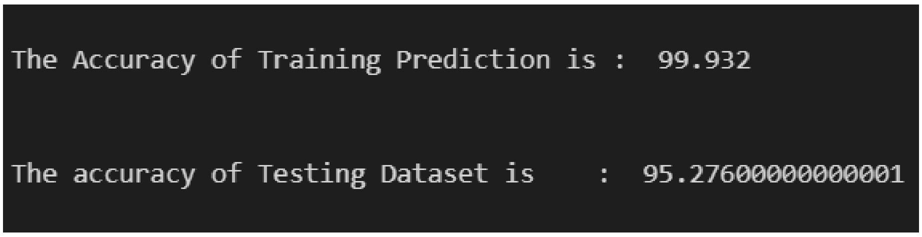
```
gini_decision_tree=DecisionTreeClassifier(criterion="gini",random_state=42)
gini_decision_tree.fit(x_train,y_train)
root_index=gini_decision_tree.tree_.feature[0]

print("\nThe Root of Gini Decision Tree is : ",x.columns[root_index],"\n")
```



```
The Root of Gini Decision Tree is :  HbA1c_level
```

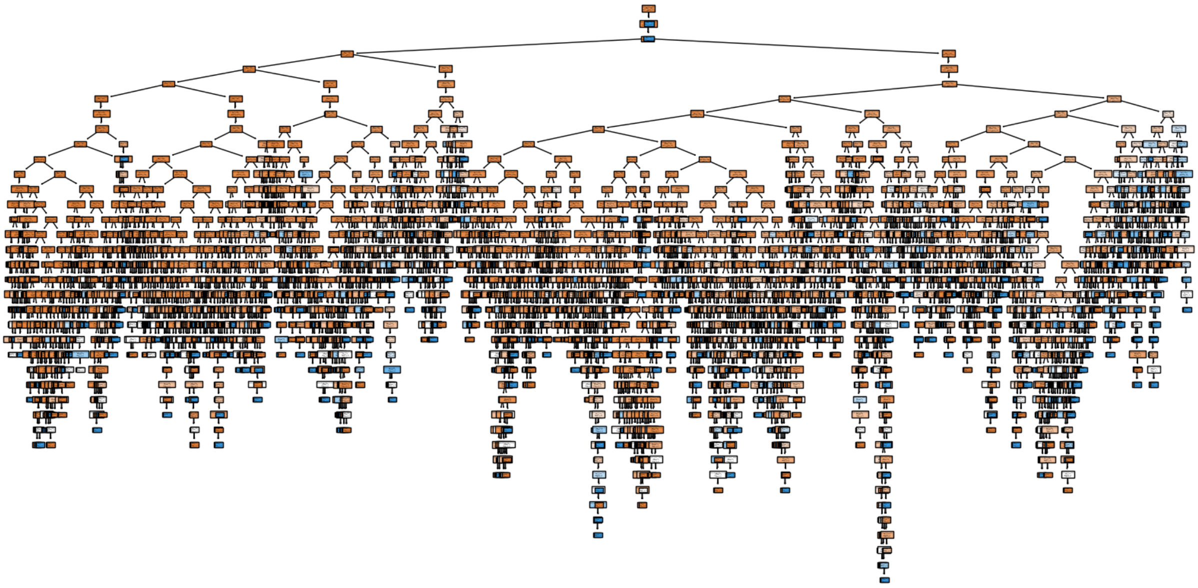
```
training_prediction=gini_decision_tree.predict(x_train)
accuracy13=accuracy_score(y_train,training_prediction)
```

```
print("\nThe Accuracy of Training Prediction is : ",100*accuracy13,"\n")
testing_prediction=gini_decision_tree.predict(x_test)
accuracy14=accuracy_score(y_test,testing_prediction)
print("\nThe accuracy of Testing Dataset is     : ",100*accuracy14,"\n")
```



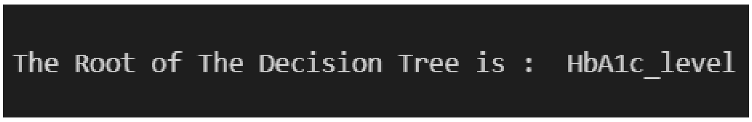
```
The Accuracy of Training Prediction is :  99.932


The accuracy of Testing Dataset is     :  95.27600000000001
```

```
plt.figure(figsize=(20,10))
plot_tree(gini_decision_tree, filled=True, feature_names=x.columns,
class_names=["0", "1"])
plt.show()
```

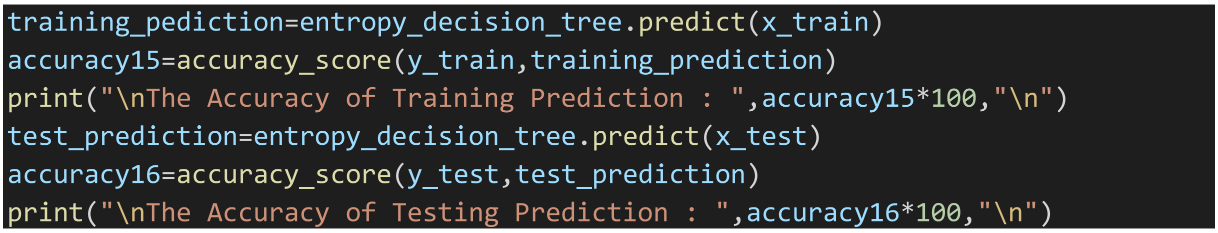


```
Decision Tree Using Entropy
```

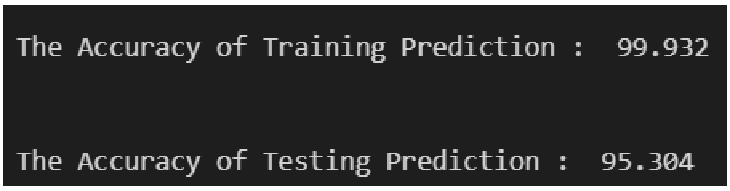
```
entropy_decision_tree=DecisionTreeClassifier(criterion="entropy",random_state=
42)
entropy_decision_tree.fit(x_train,y_train)
root_index=entropy_decision_tree.tree_.feature[0]

print("\nThe Root of The Decision Tree is : ",x.columns[root_index],"\n")
```



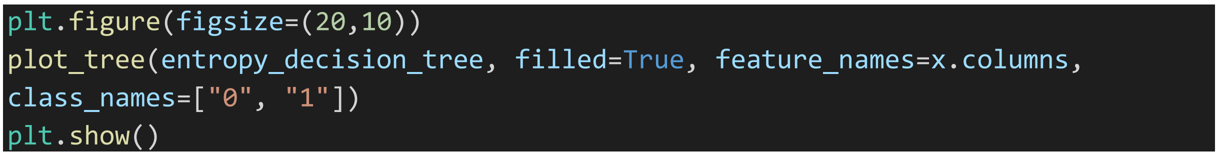
```
The Root of The Decision Tree is :  HbA1c_level
```



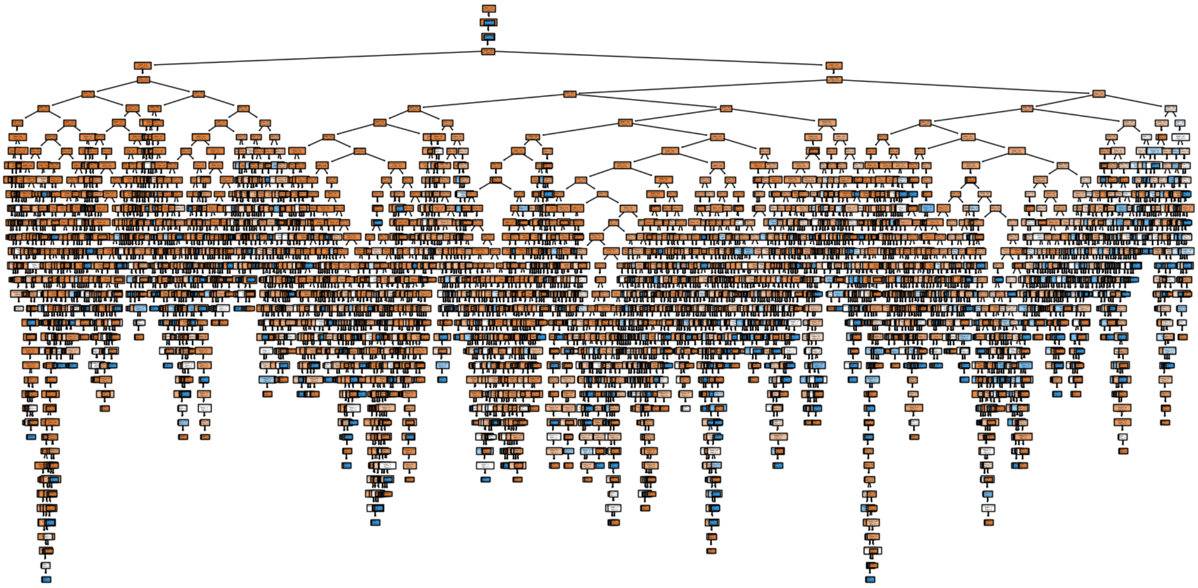
```
training_pediction=entropy_decision_tree.predict(x_train)
accuracy15=accuracy_score(y_train,training_prediction)
print("\nThe Accuracy of Training Prediction : ",accuracy15*100,"\n")
test_prediction=entropy_decision_tree.predict(x_test)
accuracy16=accuracy_score(y_test,test_prediction)
print("\nThe Accuracy of Testing Prediction : ",accuracy16*100,"\n")
```

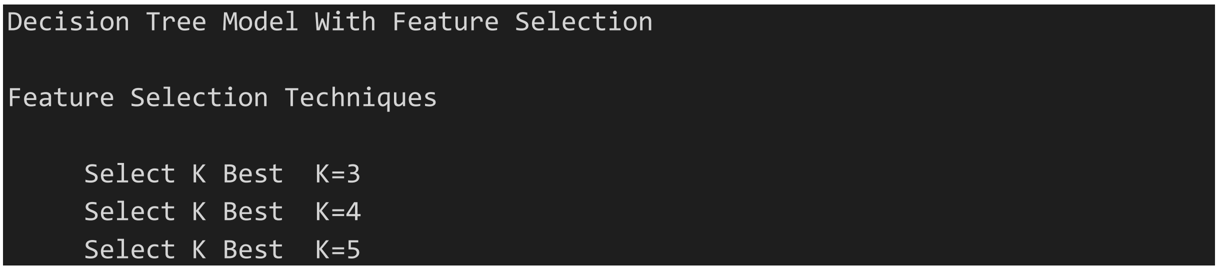


```
The Accuracy of Training Prediction :  99.932


The Accuracy of Testing Prediction :  95.304
```

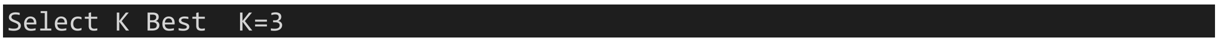


```
plt.figure(figsize=(20,10))
plot_tree(entropy_decision_tree, filled=True, feature_names=x.columns,
class_names=["0", "1"])
plt.show()
```

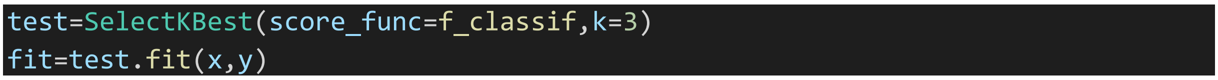




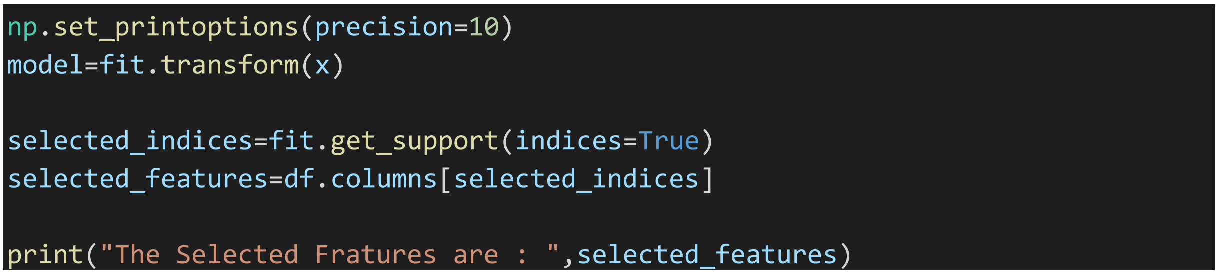
```
Decision Tree Model With Feature Selection

Feature Selection Techniques

     Select K Best  K=3
     Select K Best  K=4
     Select K Best  K=5
```



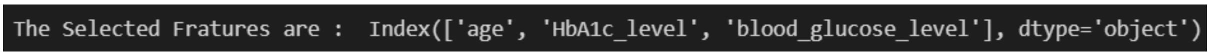
```
Select K Best  K=3
```



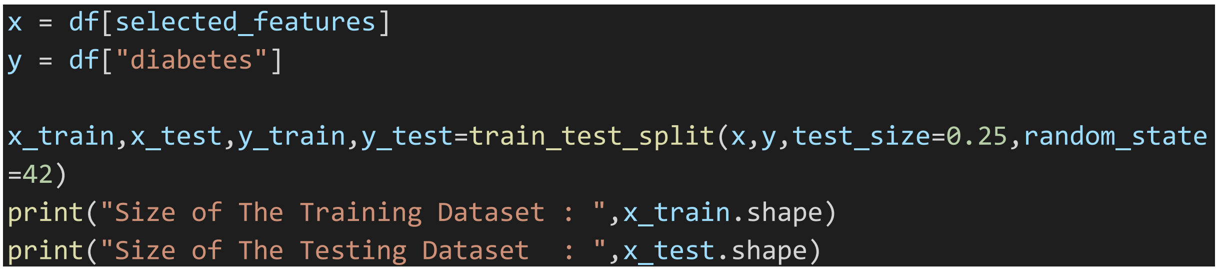
```
test=SelectKBest(score_func=f_classif,k=3)
fit=test.fit(x,y)
```



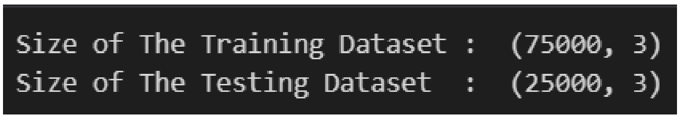
```
np.set_printoptions(precision=10)
model=fit.transform(x)

selected_indices=fit.get_support(indices=True)
selected_features=df.columns[selected_indices]

print("The Selected Fratures are : ",selected_features)
```



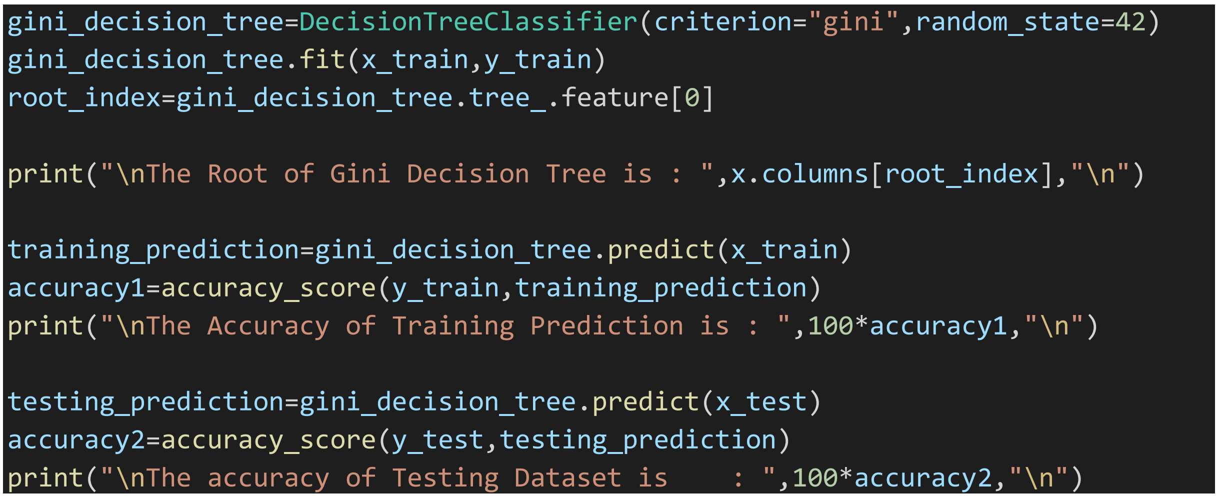
```
The Selected Fratures are :  Index(['age', 'HbA1c_level', 'blood_glucose_level'], dtype='object')
```



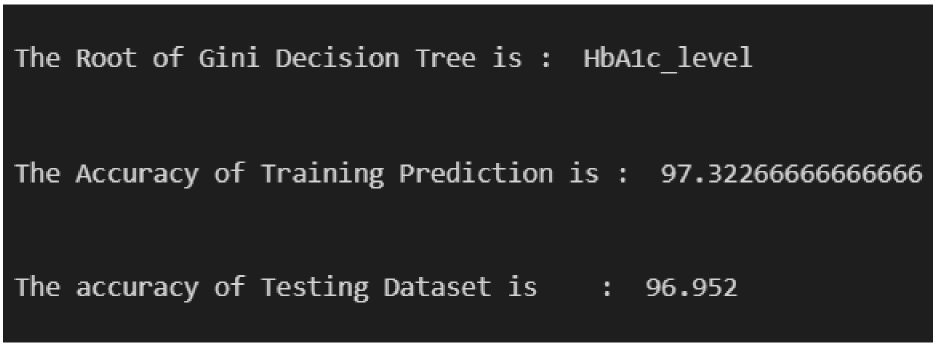
```
x = df[selected_features]
y = df["diabetes"]

x_train,x_test,y_train,y_test=train_test_split(x,y,test_size=0.25,random_state
=42)
print("Size of The Training Dataset : ",x_train.shape)
print("Size of The Testing Dataset  : ",x_test.shape)
```



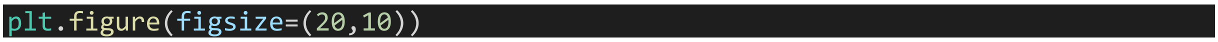
```
Size of The Training Dataset :  (75000, 3)
Size of The Testing Dataset  :  (25000, 3)
```



```
gini_decision_tree=DecisionTreeClassifier(criterion="gini",random_state=42)
gini_decision_tree.fit(x_train,y_train)
root_index=gini_decision_tree.tree_.feature[0]

print("\nThe Root of Gini Decision Tree is : ",x.columns[root_index],"\n")

training_prediction=gini_decision_tree.predict(x_train)
accuracy1=accuracy_score(y_train,training_prediction)
print("\nThe Accuracy of Training Prediction is : ",100*accuracy1,"\n")

testing_prediction=gini_decision_tree.predict(x_test)
accuracy2=accuracy_score(y_test,testing_prediction)
print("\nThe accuracy of Testing Dataset is     : ",100*accuracy2,"\n")
```

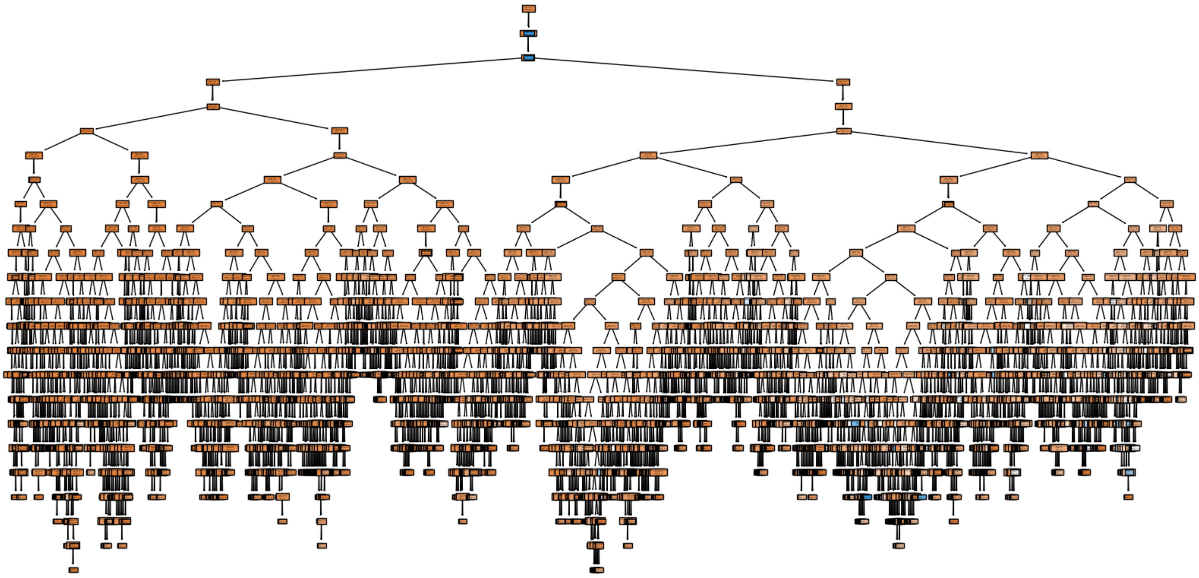


```
The Root of Gini Decision Tree is :  HbA1c_level


The Accuracy of Training Prediction is :  97.32266666666666


The accuracy of Testing Dataset is     :  96.952
```



```
plt.figure(figsize=(20,10))
```

```
plot_tree(gini_decision_tree, filled=True, feature_names=x.columns,
class_names=["0", "1"])
plt.show()
```

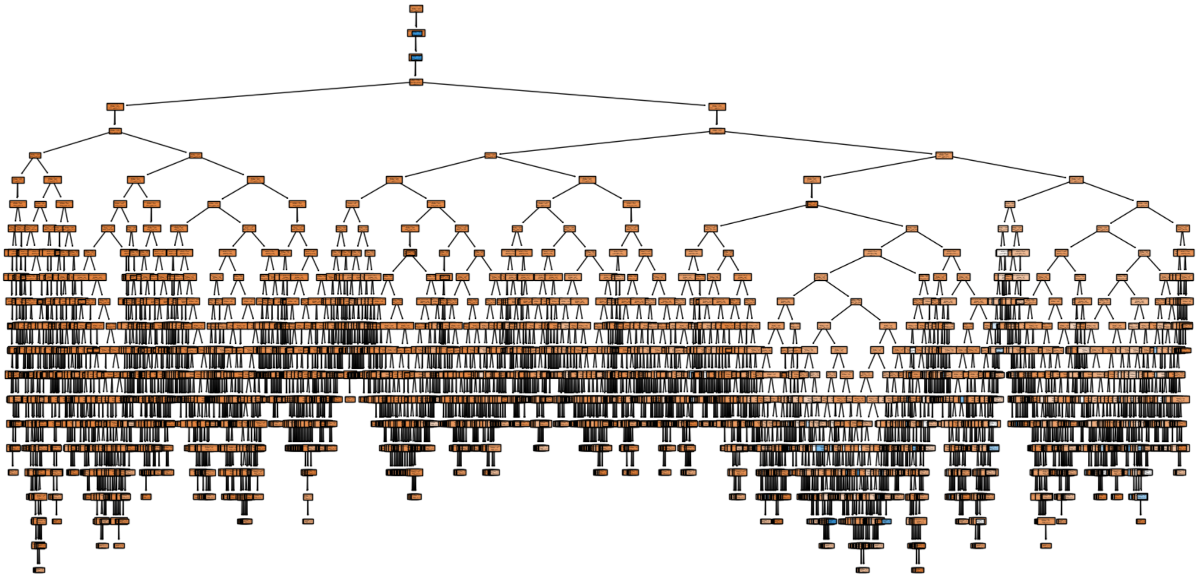


```
entropy_decision_tree=DecisionTreeClassifier(criterion="entropy",random_state=
42)
entropy_decision_tree.fit(x_train,y_train)
root_index=entropy_decision_tree.tree_.feature[0]

print("\nThe Root of The Decision Tree is : ",x.columns[root_index],"\n")

training_pediction=entropy_decision_tree.predict(x_train)
accuracy3=accuracy_score(y_train,training_prediction)
print("\nThe Accuracy of Training Prediction : ",accuracy3*100,"\n")

test_prediction=entropy_decision_tree.predict(x_test)
accuracy4=accuracy_score(y_test,test_prediction)
print("\nThe Accuracy of Testing Prediction : ",accuracy4*100,"\n")
```

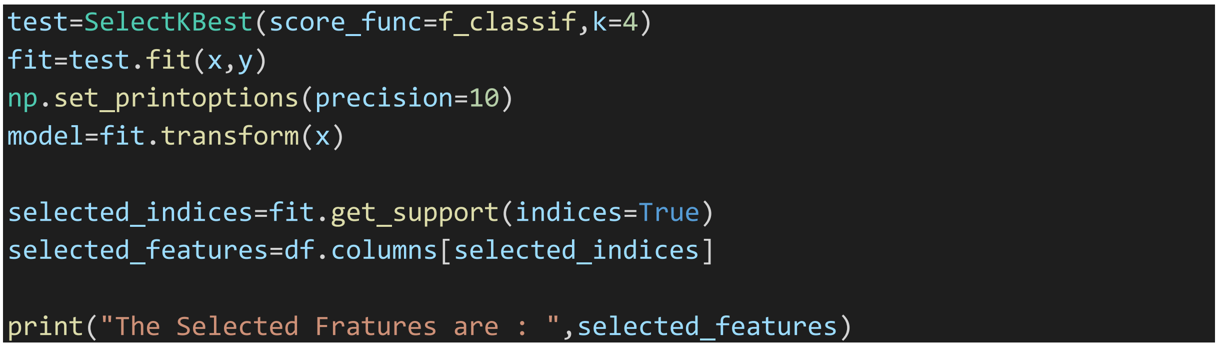
```

The Root of The Decision Tree is :  HbA1c_level



The Accuracy of Training Prediction :  97.32266666666666



The Accuracy of Testing Prediction :  96.952
```

```
plt.figure(figsize=(20,10))
plot_tree(entropy_decision_tree, filled=True, feature_names=x.columns,
class_names=["0", "1"])
```

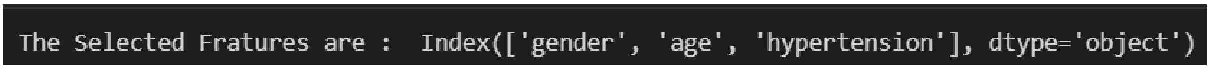
```
plt.show()
```



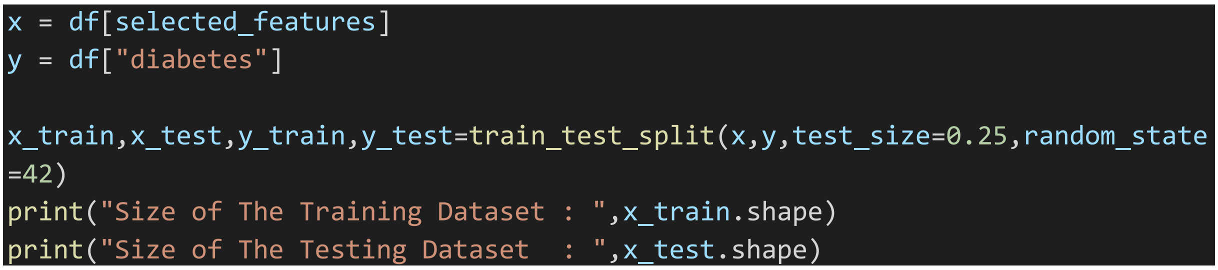
```
Select K Best  K=4
```



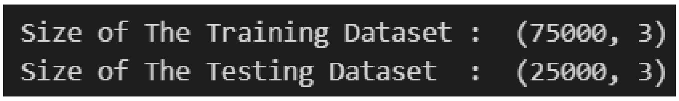
```
test=SelectKBest(score_func=f_classif,k=4)
fit=test.fit(x,y)
np.set_printoptions(precision=10)
model=fit.transform(x)

selected_indices=fit.get_support(indices=True)
selected_features=df.columns[selected_indices]

print("The Selected Fratures are : ",selected_features)
```



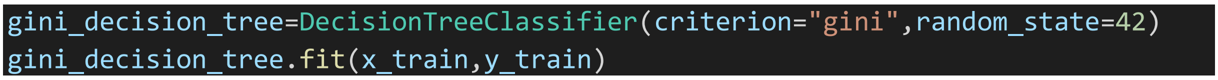
```
The Selected Fratures are :  Index(['gender', 'age', 'hypertension'], dtype='object')
```



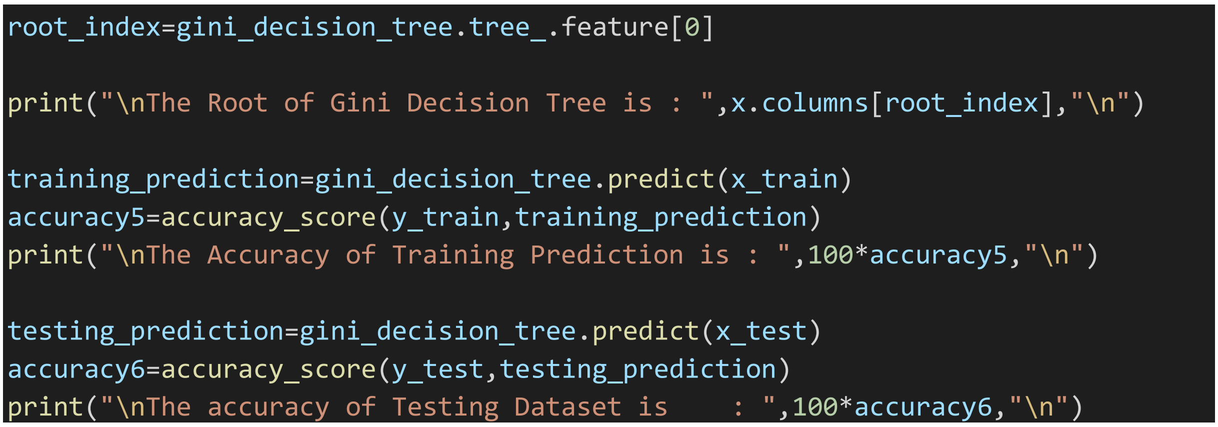
```
x = df[selected_features]
y = df["diabetes"]

x_train,x_test,y_train,y_test=train_test_split(x,y,test_size=0.25,random_state
=42)
print("Size of The Training Dataset : ",x_train.shape)
print("Size of The Testing Dataset  : ",x_test.shape)
```



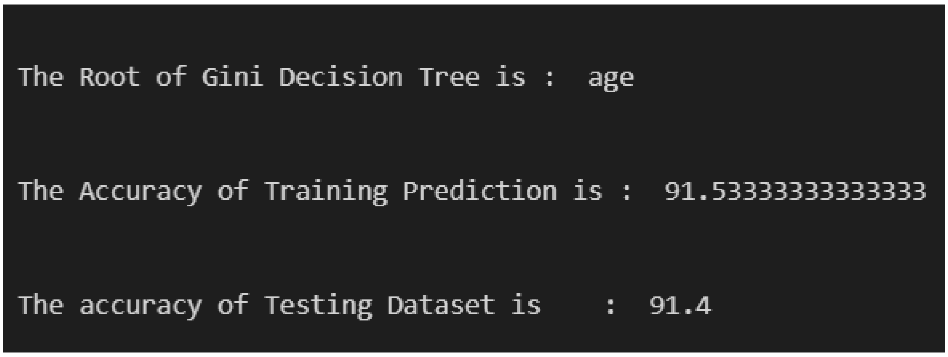
```
Size of The Training Dataset :  (75000, 3)
Size of The Testing Dataset  :  (25000, 3)
```



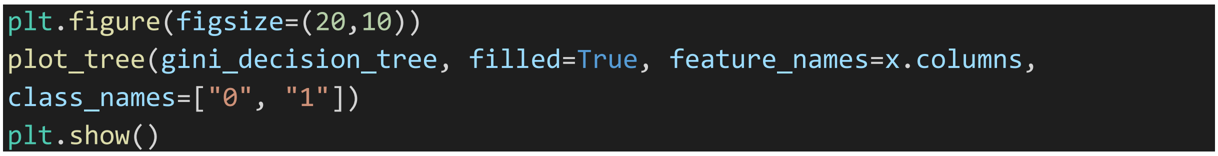
```
gini_decision_tree=DecisionTreeClassifier(criterion="gini",random_state=42)
gini_decision_tree.fit(x_train,y_train)
```



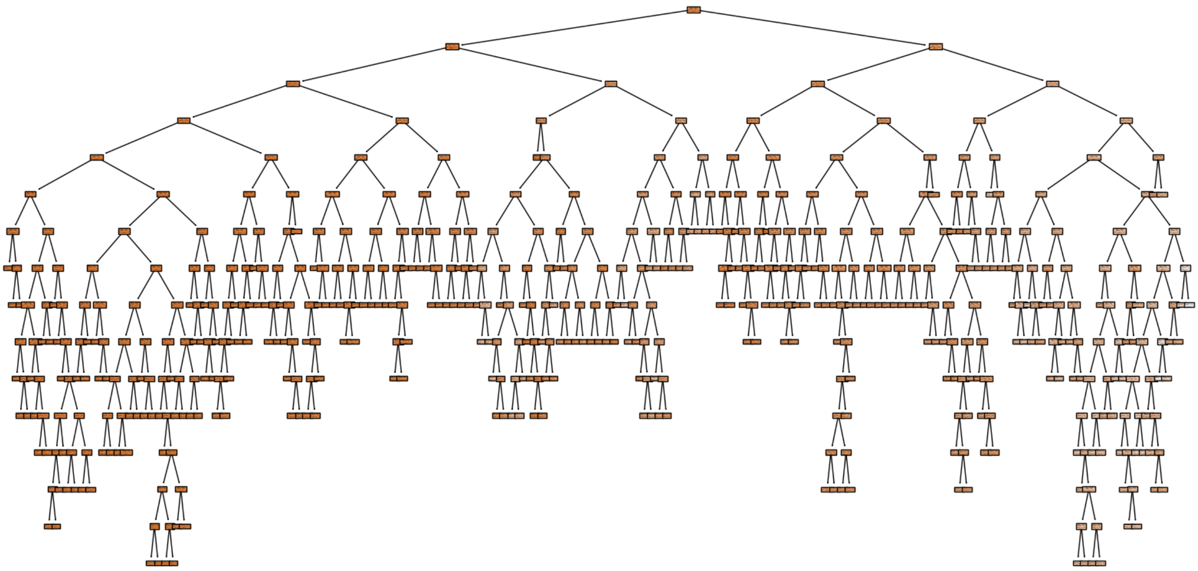
```
root_index=gini_decision_tree.tree_.feature[0]

print("\nThe Root of Gini Decision Tree is : ",x.columns[root_index],"\n")

training_prediction=gini_decision_tree.predict(x_train)
accuracy5=accuracy_score(y_train,training_prediction)
print("\nThe Accuracy of Training Prediction is : ",100*accuracy5,"\n")

testing_prediction=gini_decision_tree.predict(x_test)
accuracy6=accuracy_score(y_test,testing_prediction)
print("\nThe accuracy of Testing Dataset is     : ",100*accuracy6,"\n")
```

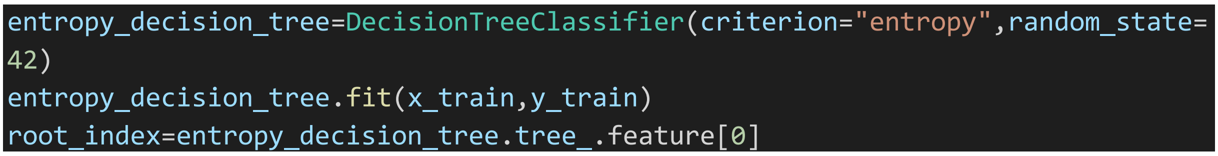


```

The Root of Gini Decision Tree is :  age


The Accuracy of Training Prediction is :  91.53333333333333


The accuracy of Testing Dataset is     :  91.4
```



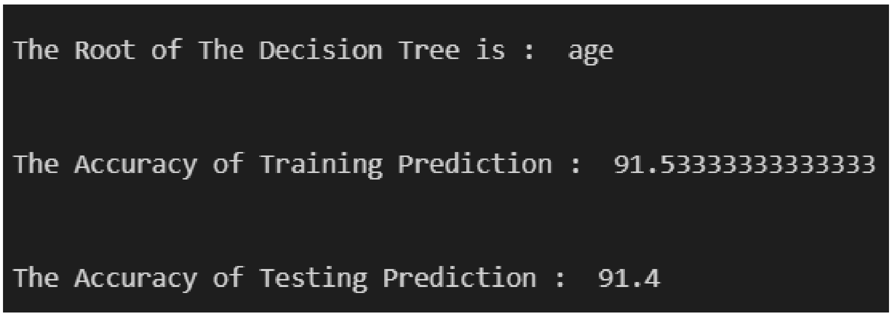
```
plt.figure(figsize=(20,10))
plot_tree(gini_decision_tree, filled=True, feature_names=x.columns,
class_names=["0", "1"])
plt.show()
```





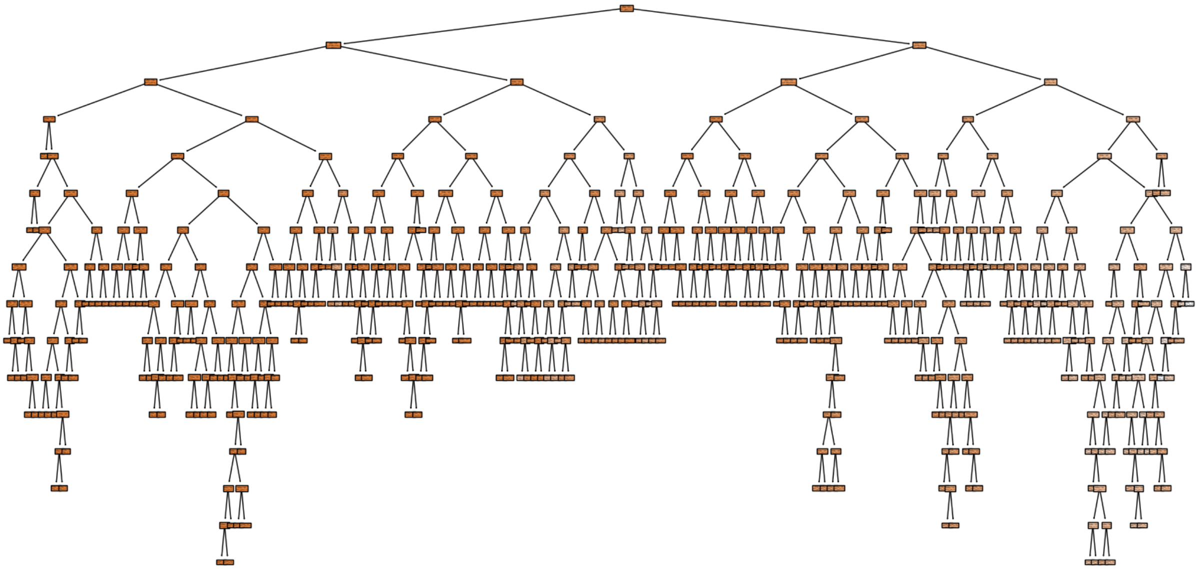
```
entropy_decision_tree=DecisionTreeClassifier(criterion="entropy",random_state=
42)
entropy_decision_tree.fit(x_train,y_train)
root_index=entropy_decision_tree.tree_.feature[0]
```

```
print("\nThe Root of The Decision Tree is : ",x.columns[root_index],"\n")

training_pediction=entropy_decision_tree.predict(x_train)
accuracy7=accuracy_score(y_train,training_prediction)
print("\nThe Accuracy of Training Prediction : ",accuracy7*100,"\n")

test_prediction=entropy_decision_tree.predict(x_test)
accuracy8=accuracy_score(y_test,test_prediction)
print("\nThe Accuracy of Testing Prediction : ",accuracy8*100,"\n")
```



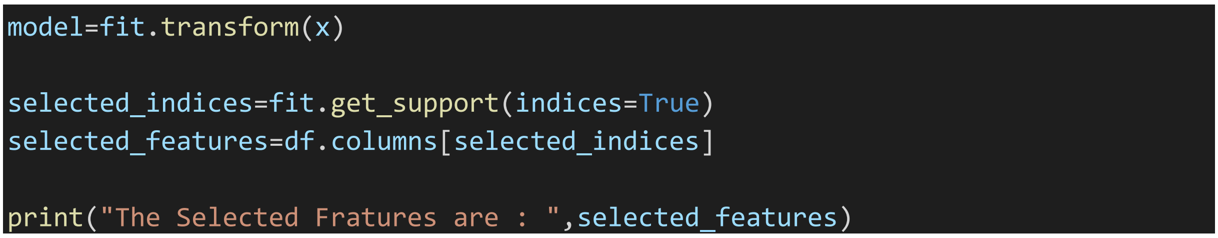
```
The Root of The Decision Tree is :   age


The Accuracy of Training Prediction :   91.53333333333333


The Accuracy of Testing Prediction :   91.4
```

```
plt.figure(figsize=(20,10))
plot_tree(entropy_decision_tree, filled=True, feature_names=x.columns,
class_names=["0", "1"])
plt.show()
```

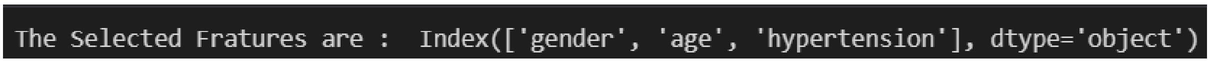


```
Select K Best   K=5
```

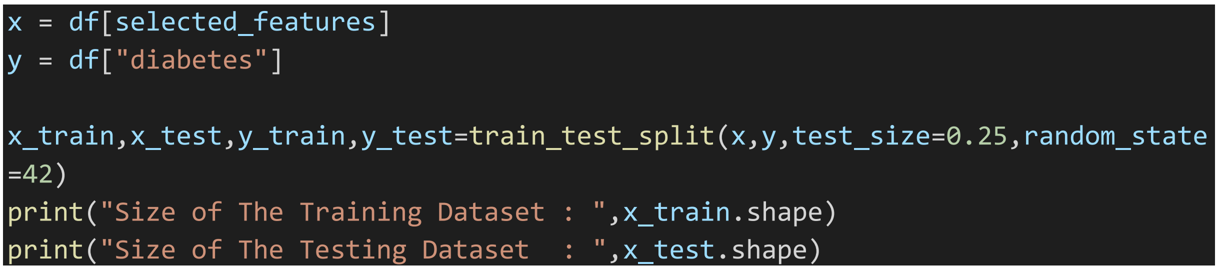
```
test=SelectKBest(score_func=f_classif,k=5)
fit=test.fit(x,y)
np.set_printoptions(precision=10)
```



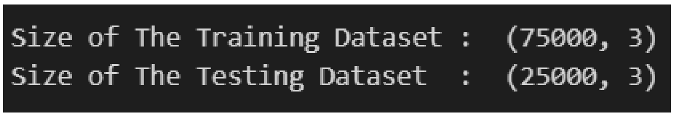
```
model=fit.transform(x)

selected_indices=fit.get_support(indices=True)
selected_features=df.columns[selected_indices]

print("The Selected Fratures are : ",selected_features)
```



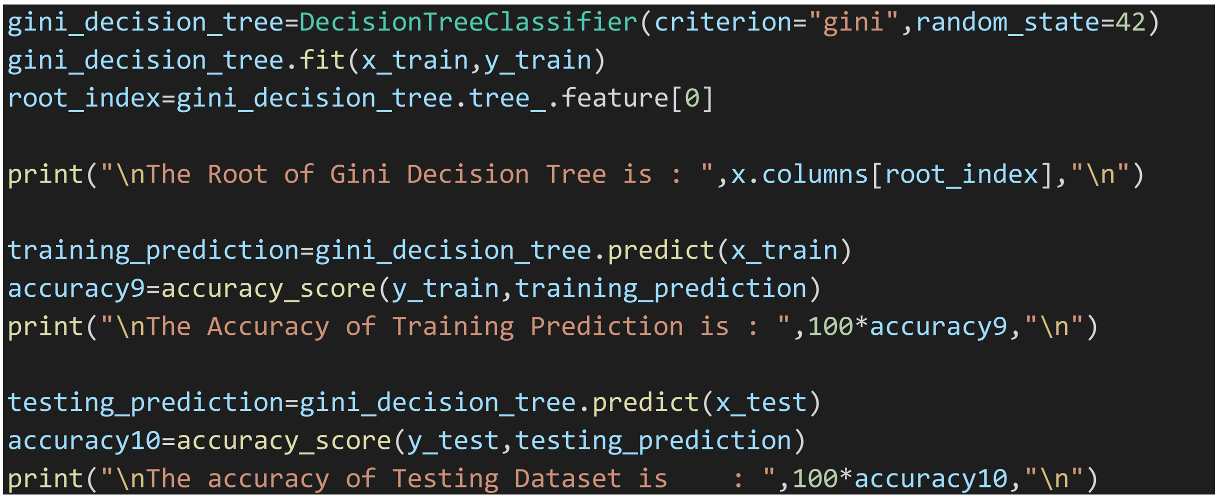
```
The Selected Fratures are :  Index(['gender', 'age', 'hypertension'], dtype='object')
```



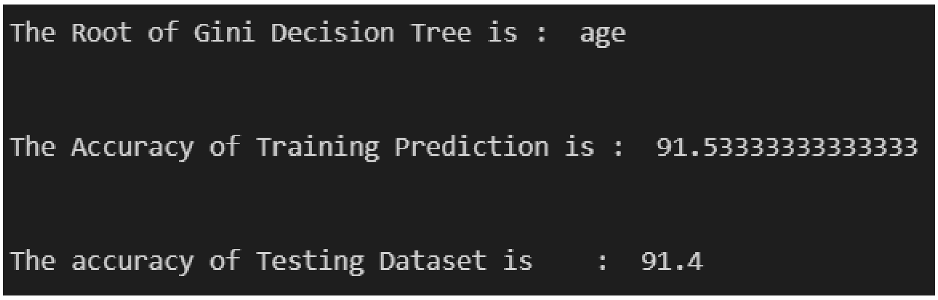
```
x = df[selected_features]
y = df["diabetes"]

x_train,x_test,y_train,y_test=train_test_split(x,y,test_size=0.25,random_state
=42)
print("Size of The Training Dataset : ",x_train.shape)
print("Size of The Testing Dataset  : ",x_test.shape)
```



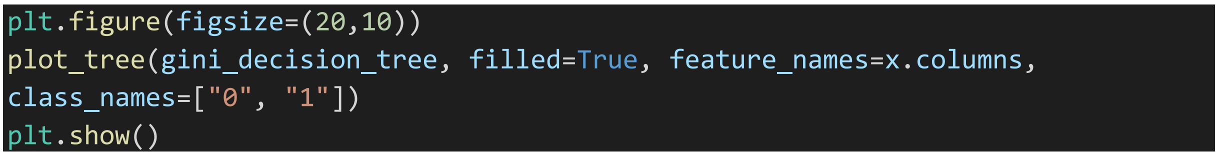
```
Size of The Training Dataset :  (75000, 3)
Size of The Testing Dataset  :  (25000, 3)
```



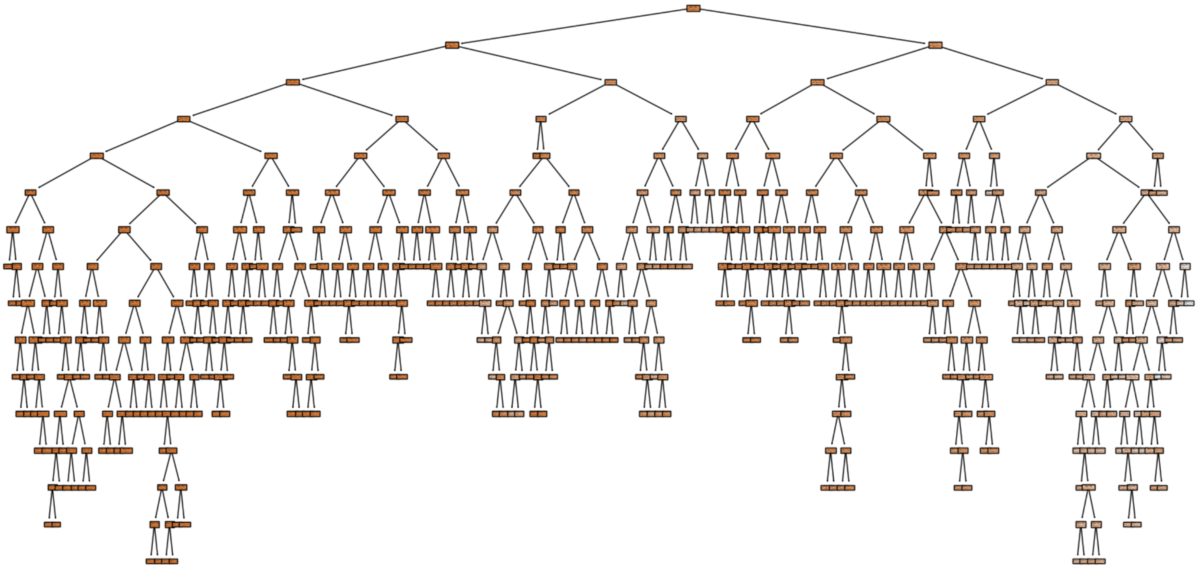
```
gini_decision_tree=DecisionTreeClassifier(criterion="gini",random_state=42)
gini_decision_tree.fit(x_train,y_train)
root_index=gini_decision_tree.tree_.feature[0]

print("\nThe Root of Gini Decision Tree is : ",x.columns[root_index],"\n")

training_prediction=gini_decision_tree.predict(x_train)
accuracy9=accuracy_score(y_train,training_prediction)
print("\nThe Accuracy of Training Prediction is : ",100*accuracy9,"\n")

testing_prediction=gini_decision_tree.predict(x_test)
accuracy10=accuracy_score(y_test,testing_prediction)
print("\nThe accuracy of Testing Dataset is     : ",100*accuracy10,"\n")
```

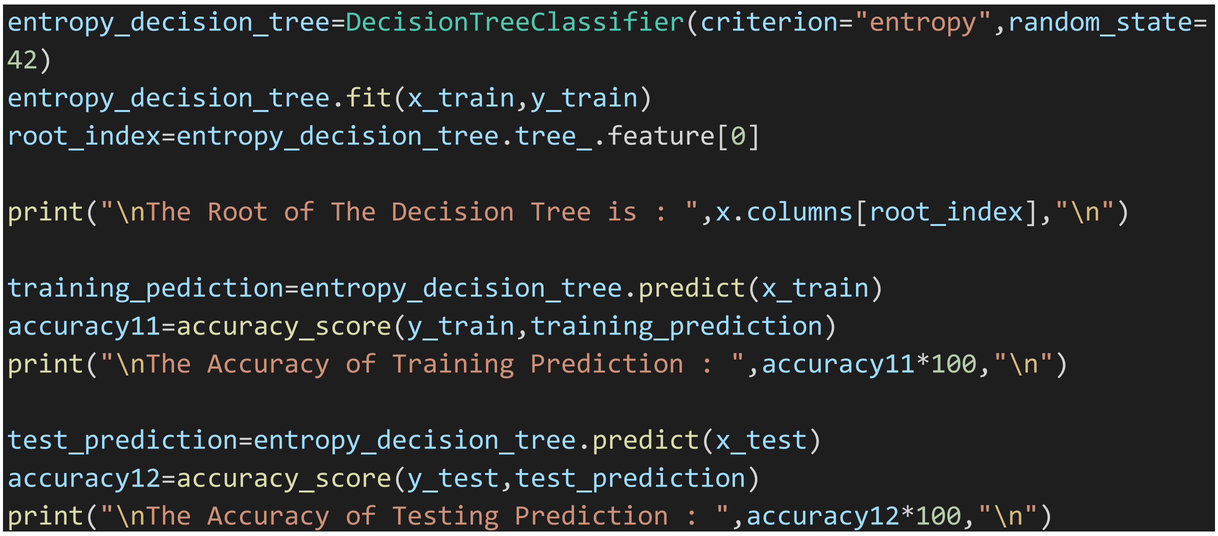


```
The Root of Gini Decision Tree is :  age


The Accuracy of Training Prediction is :  91.53333333333333


The accuracy of Testing Dataset is     :  91.4
```

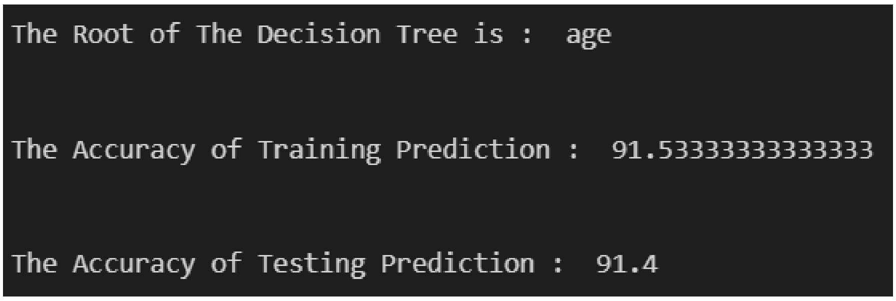


```
plt.figure(figsize=(20,10))
plot_tree(gini_decision_tree, filled=True, feature_names=x.columns,
class_names=["0", "1"])
plt.show()
```

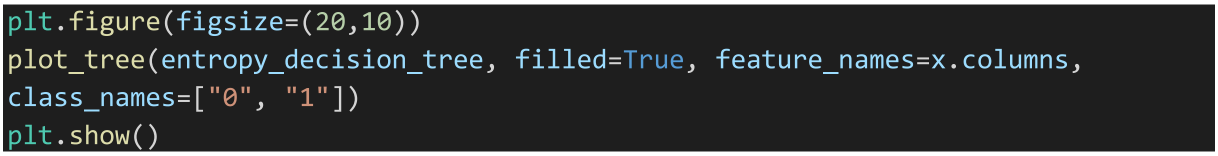




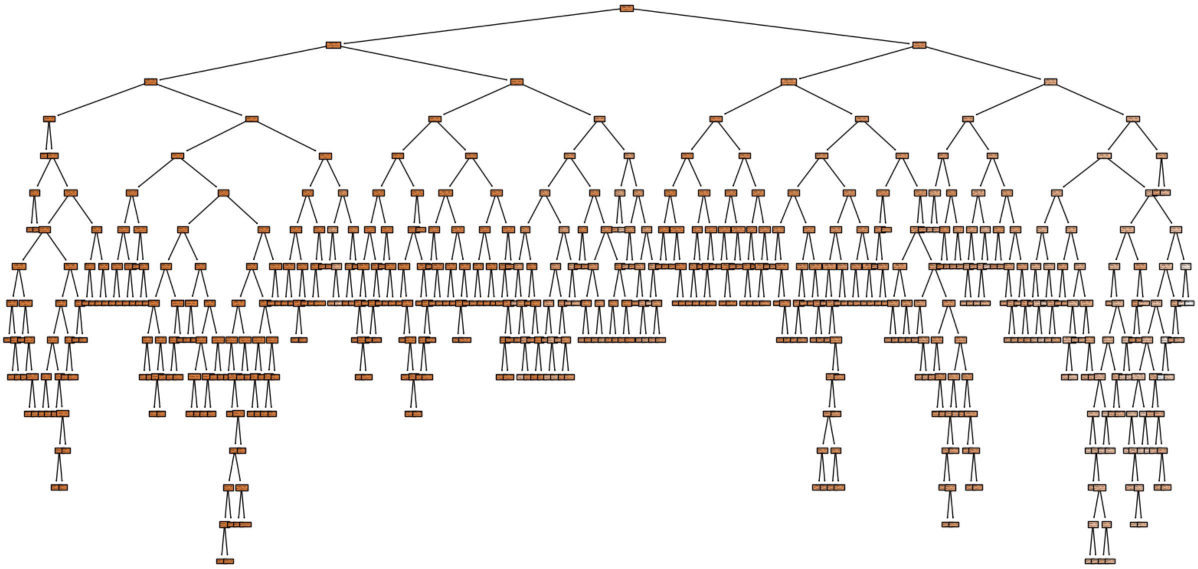
```
entropy_decision_tree=DecisionTreeClassifier(criterion="entropy",random_state=
42)
entropy_decision_tree.fit(x_train,y_train)
root_index=entropy_decision_tree.tree_.feature[0]

print("\nThe Root of The Decision Tree is : ",x.columns[root_index],"\n")

training_pediction=entropy_decision_tree.predict(x_train)
accuracy11=accuracy_score(y_train,training_prediction)
print("\nThe Accuracy of Training Prediction : ",accuracy11*100,"\n")

test_prediction=entropy_decision_tree.predict(x_test)
accuracy12=accuracy_score(y_test,test_prediction)
print("\nThe Accuracy of Testing Prediction : ",accuracy12*100,"\n")
```



```
The Root of The Decision Tree is :  age


The Accuracy of Training Prediction :  91.53333333333333


The Accuracy of Testing Prediction :  91.4
```

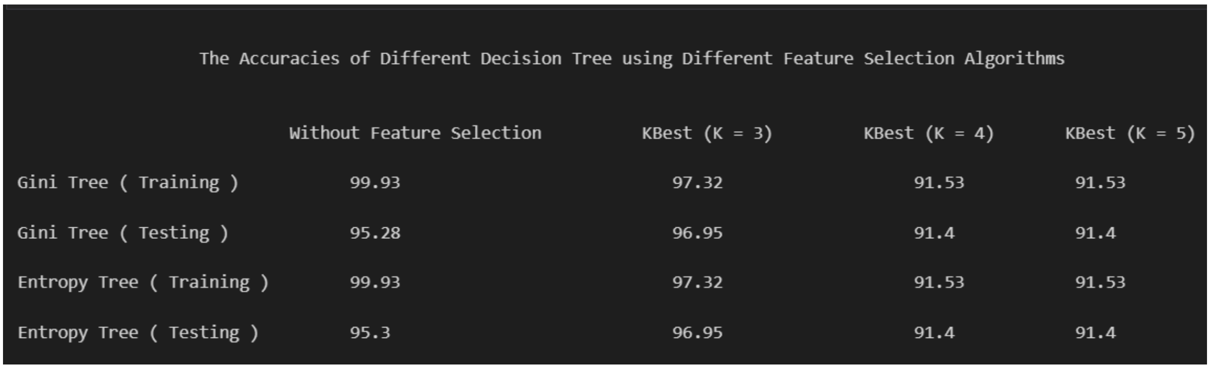


```
plt.figure(figsize=(20,10))
plot_tree(entropy_decision_tree, filled=True, feature_names=x.columns,
class_names=["0", "1"])
plt.show()
```

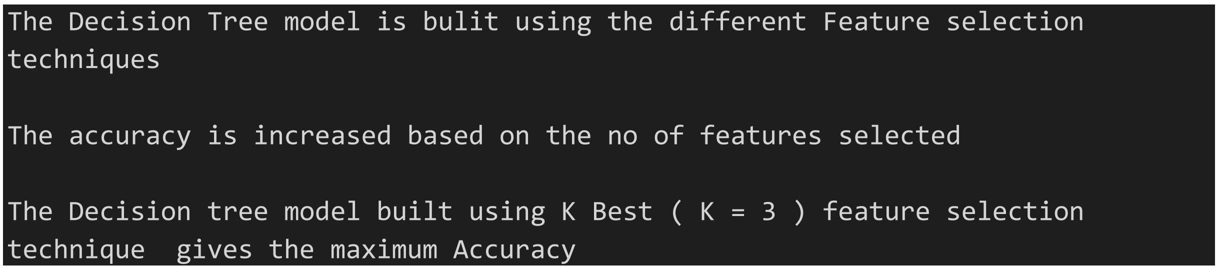


Conclusion and Results

```
print()
print("                  The Accuracies of Different Decision Tree using
Different Feature Selection Algorithms")
print("\t\t\t   Without Feature Selection          KBest (K = 3)         KBest
(K = 4)       KBest (K = 5)")
print()
print("Gini Tree ( Training
)   \t",round(accuracy13*100,2),"\t\t\t\t",round(accuracy1*100,2),"\t\t\t",rou
nd(accuracy5*100,2),"\t\t",round(accuracy9*100,2))
print()
print("Gini Tree ( Testing
)   \t",round(accuracy14*100,2),"\t\t\t\t",round(accuracy2*100,2),"\t\t\t",rou
nd(accuracy6*100,2),"\t\t",round(accuracy10*100,2))
print()
print("Entropy Tree ( Training
)   \t",round(accuracy15*100,2),"\t\t\t\t",round(accuracy3*100,2),"\t\t\t",rou
nd(accuracy7*100,2),"\t\t",round(accuracy11*100,2))
print()
print("Entropy Tree ( Testing
)   \t",round(accuracy16*100,2),"\t\t\t\t",round(accuracy4*100,2),"\t\t\t",rou
nd(accuracy8*100,2),"\t\t",round(accuracy12*100,2))
```



```
            The Accuracies of Different Decision Tree using Different Feature Selection Algorithms

                              Without Feature Selection       KBest (K = 3)      KBest (K = 4)     KBest (K = 5)
Gini Tree ( Training )              99.93                          97.32              91.53             91.53
Gini Tree ( Testing )               95.28                          96.95              91.4              91.4
Entropy Tree ( Training )           99.93                          97.32              91.53             91.53
Entropy Tree ( Testing )            95.3                           96.95              91.4              91.4
```



The Decision Tree model is bulit using the different Feature selection techniques

The accuracy is increased based on the no of features selected

The Decision tree model built using K Best (K = 3) feature selection technique gives the maximum Accuracy