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## Batch : C32

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In [17]:

```
# Importing libraries

import pandas as pd
import numpy as np
from sklearn.preprocessing import LabelEncoder
import seaborn as sns
import matplotlib.pyplot as plt
from sklearn.model_selection import train_test_split
from sklearn.tree import DecisionTreeClassifier,plot_tree
from sklearn.metrics import classification_report
import warnings
warnings.filterwarnings('ignore')
```

In [18]:

```
dataset = pd.read_csv('churn.csv')[0:201]
dataset
```

Out[18]:

| | CreditScore | Geography | Gender | Age | Tenure | Balance | NumOfProducts | HasCrCard | IsActiveMember | Estim |
|---|---|---|---|---|---|---|---|---|---|---|
| **0** | 619 | France | Female | 42 | 2 | 0.00 | 1 | 1 | 1 | |
| **1** | 608 | Spain | Female | 41 | 1 | 83807.86 | 1 | 0 | 1 | |
| **2** | 502 | France | Female | 42 | 8 | 159660.80 | 3 | 1 | 0 | |
| **3** | 699 | France | Female | 39 | 1 | 0.00 | 2 | 0 | 0 | |
| **4** | 850 | Spain | Female | 43 | 2 | 125510.82 | 1 | 1 | 1 | |
| **...** | ... | ... | ... | ... | ... | ... | ... | ... | ... | |
| **196** | 616 | Spain | Female | 32 | 6 | 0.00 | 2 | 1 | 1 | |
| **197** | 721 | Germany | Male | 37 | 3 | 107720.64 | 1 | 1 | 1 | |
| **198** | 501 | France | Male | 57 | 10 | 0.00 | 2 | 1 | 1 | |
| **199** | 521 | France | Male | 35 | 6 | 96423.84 | 1 | 1 | 0 | |
| **200** | 850 | Spain | Male | 30 | 2 | 141040.01 | 1 | 1 | 1 | |

201 rows × 11 columns

In [19]:

```
# EDA

print('Columns : ',list(dataset.columns))
print()
print('Number of missing values : ',dataset.isnull().sum().sum())
print()
dataset.describe()
```

```
Columns :  ['CreditScore', 'Geography', 'Gender', 'Age', 'Tenure', 'Balance', 'NumOfProduc
ts', 'HasCrCard', 'IsActiveMember', 'EstimatedSalary', 'Exited']
```

```
Number of missing values :  0
```

Out[19]:

| | CreditScore | Age | Tenure | Balance | NumOfProducts | HasCrCard | IsActiveMember | EstimatedS |
|---|---|---|---|---|---|---|---|---|
| **count** | 201.000000 | 201.000000 | 201.000000 | 201.000000 | 201.000000 | 201.000000 | 201.000000 | 201.0( |
| **mean** | 640.467662 | 37.965174 | 5.174129 | 74504.686269 | 1.542289 | 0.676617 | 0.482587 | 99189.9: |
| **std** | 108.463313 | 9.763902 | 2.987395 | 62726.490142 | 0.591145 | 0.468935 | 0.500944 | 57641.0! |
| **min** | 376.000000 | 19.000000 | 0.000000 | 0.000000 | 1.000000 | 0.000000 | 0.000000 | 600.3( |
| **25%** | 553.000000 | 32.000000 | 2.000000 | 0.000000 | 1.000000 | 0.000000 | 0.000000 | 47125.1' |
| **50%** | 646.000000 | 36.000000 | 5.000000 | 96645.540000 | 2.000000 | 1.000000 | 0.000000 | 99449.8( |
| **75%** | 722.000000 | 43.000000 | 8.000000 | 125851.930000 | 2.000000 | 1.000000 | 1.000000 | 147132.4( |
| **max** | 850.000000 | 75.000000 | 10.000000 | 213146.200000 | 4.000000 | 1.000000 | 1.000000 | 199725.3! |

In [20]:

```
# Data Analysis

print(dataset['Geography'].unique())
print(dataset['Gender'].unique())
```

```
['France' 'Spain' 'Germany']
['Female' 'Male']
```

In [21]:

```
# Data Preprocessing

le = LabelEncoder()
dataset['Gender'] = le.fit_transform(dataset['Gender'])

dataset = pd.get_dummies(dataset,columns = ['Geography'])
dataset
```

Out[21]:

| | CreditScore | Gender | Age | Tenure | Balance | NumOfProducts | HasCrCard | IsActiveMember | EstimatedSalary | E |
|---|---|---|---|---|---|---|---|---|---|---|
| **0** | 619 | 0 | 42 | 2 | 0.00 | 1 | 1 | 1 | 101348.88 | |
| **1** | 608 | 0 | 41 | 1 | 83807.86 | 1 | 0 | 1 | 112542.58 | |
| **2** | 502 | 0 | 42 | 8 | 159660.80 | 3 | 1 | 0 | 113931.57 | |
| **3** | 699 | 0 | 39 | 1 | 0.00 | 2 | 0 | 0 | 93826.63 | |
| **4** | 850 | 0 | 43 | 2 | 125510.82 | 1 | 1 | 1 | 79084.10 | |
| **...** | ... | ... | ... | ... | ... | ... | ... | ... | ... | |
| **196** | 616 | 0 | 32 | 6 | 0.00 | 2 | 1 | 1 | 43001.46 | |
| **197** | 721 | 1 | 37 | 3 | 107720.64 | 1 | 1 | 1 | 158591.12 | |
| **198** | 501 | 1 | 57 | 10 | 0.00 | 2 | 1 | 1 | 47847.19 | |
| **199** | 521 | 1 | 35 | 6 | 96423.84 | 1 | 1 | 0 | 10488.44 | |
| **200** | 850 | 1 | 30 | 2 | 141040.01 | 1 | 1 | 1 | 5978.20 | |

201 rows × 13 columns

In [23]:

```
dataset[['Geography_France','Geography_Germany','Geography_Spain','EstimatedSalary','Exite
```

Out[23]:

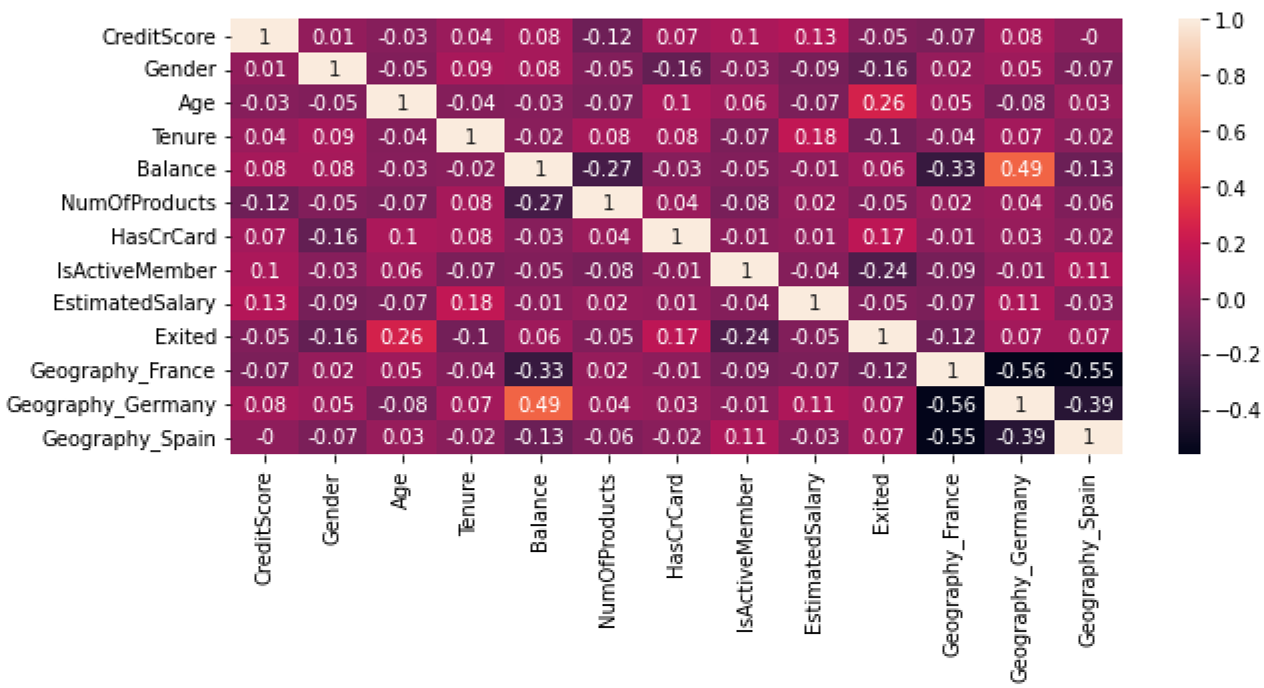
| | Geography_France | Geography_Germany | Geography_Spain | EstimatedSalary | Exited |
|---|---|---|---|---|---|
| **0** | 1 | 0 | 0 | 101348.88 | 1 |
| **1** | 0 | 0 | 1 | 112542.58 | 0 |
| **2** | 1 | 0 | 0 | 113931.57 | 1 |
| **3** | 1 | 0 | 0 | 93826.63 | 0 |
| **4** | 0 | 0 | 1 | 79084.10 | 0 |
| **...** | ... | ... | ... | ... | ... |
| **196** | 0 | 0 | 1 | 43001.46 | 0 |
| **197** | 0 | 1 | 0 | 158591.12 | 0 |
| **198** | 1 | 0 | 0 | 47847.19 | 0 |
| **199** | 1 | 0 | 0 | 10488.44 | 0 |
| **200** | 0 | 0 | 1 | 5978.20 | 0 |

201 rows × 5 columns

In [6]:

```
# Feature Importance

plt.figure(figsize=(10, 4))
correl_matrix = dataset.corr().round(2)
sns.heatmap(data=correl_matrix, annot=True)
plt.show()
```




Hence we can see that most important features for predicting class label 'Exited' are : Age, isActiveMember, HasCrCard, Gender, Geography_France

In [7]:

```
X = dataset[['Age','Geography_France','IsActiveMember','HasCrCard','Gender']]
y = dataset['Exited']

X
```

Out[7]:

| | Age | Geography_France | IsActiveMember | HasCrCard | Gender |
|---|---|---|---|---|---|
| **0** | 42 | 1 | 1 | 1 | 0 |
| **1** | 41 | 0 | 1 | 0 | 0 |
| **2** | 42 | 1 | 0 | 1 | 0 |
| **3** | 39 | 1 | 0 | 0 | 0 |
| **4** | 43 | 0 | 1 | 1 | 0 |
| **...** | ... | ... | ... | ... | ... |
| **196** | 32 | 0 | 1 | 1 | 0 |
| **197** | 37 | 0 | 1 | 1 | 1 |
| **198** | 57 | 1 | 1 | 1 | 1 |
| **199** | 35 | 1 | 0 | 1 | 1 |
| **200** | 30 | 0 | 1 | 1 | 1 |

201 rows × 5 columns

In [8]:

```
y
```

Out[8]:

```
0      1
1      0
2      1
3      0
4      0
      ..
196    0
197    0
198    0
199    0
200    0
Name: Exited, Length: 201, dtype: int64
```

In [9]:

```
# Train test split

X_train1, X_test1, y_train1, y_test1 = train_test_split(X,y,test_size=0.1,
                                                          random_state=13)
X_train2, X_test2, y_train2, y_test2 = train_test_split(X,y,test_size=0.2,
                                                          random_state=13)
X_train3, X_test3, y_train3, y_test3 = train_test_split(X,y,test_size=0.3,
                                                          random_state=13)

X_train1
```

Out[9]:

| | Age | Geography_France | IsActiveMember | HasCrCard | Gender |
|---|---|---|---|---|---|
| **143** | 52 | 0 | 0 | 1 | 1 |
| **68** | 35 | 0 | 1 | 0 | 0 |
| **7** | 29 | 0 | 0 | 1 | 0 |
| **125** | 42 | 1 | 0 | 1 | 1 |
| **175** | 35 | 0 | 1 | 1 | 0 |
| **...** | ... | ... | ... | ... | ... |

| | Age | Geography_France | IsActiveMember | HasCrCard | Gender |
|---|---|---|---|---|---|
| **98** | 22 | 0 | 0 | 0 | 1 |
| **16** | 58 | 0 | 0 | 1 | 1 |
| **74** | 36 | 1 | 1 | 0 | 1 |
| **176** | 30 | 1 | 1 | 1 | 0 |
| **82** | 36 | 1 | 0 | 0 | 0 |

180 rows × 5 columns

In [10]:

```
y_train1
```

Out[10]:

```
143    1
68     0
7      1
125    1
175    0
      ..
98     0
16     1
74     0
176    0
82     0
Name: Exited, Length: 180, dtype: int64
```

# Decision Tree Classifier (90-10 Split)

In [11]:

```
# Decision Tree Classifier for 90-10 Split

dtree = DecisionTreeClassifier(random_state=13)
dtree.fit(X_train1,y_train1)
y_pred_train1 = dtree.predict(X_train1)
y_pred_test1 = dtree.predict(X_test1)

print('90-10 Model performance on Training Set : \n')
print(classification_report(y_train1,y_pred_train1))
print()
print()
print('90-10 Model performance on Test Set : \n')
print(classification_report(y_test1,y_pred_test1))
print()
print()
X_ip = list(map(int,
       input("Enter Age, isActiveMember, HasCrCard, Gender, Geography_France : ")
                .split()))[:5]
print('Predicted class : ',dtree.predict([X_ip])[0])
print()
print()
print('Result : ')
pd.DataFrame({'Actual':y_test1,'Predicted':y_pred_test1})
```

```
90-10 Model performance on Training Set :

              precision    recall  f1-score   support

           0       0.96      0.99      0.98       147
           1       0.96      0.82      0.89        33

    accuracy                           0.96       180
```

```
   macro avg       0.96      0.91      0.93       180
weighted avg       0.96      0.96      0.96       180



90-10 Model performance on Test Set :

              precision    recall  f1-score   support

           0       0.64      0.69      0.67        13
           1       0.43      0.38      0.40         8

    accuracy                           0.57        21
   macro avg       0.54      0.53      0.53        21
weighted avg       0.56      0.57      0.57        21



Enter Age, isActiveMember, HasCrCard, Gender, Geography_France : 40 0 1 1 0
Predicted class :  1


Result :
```

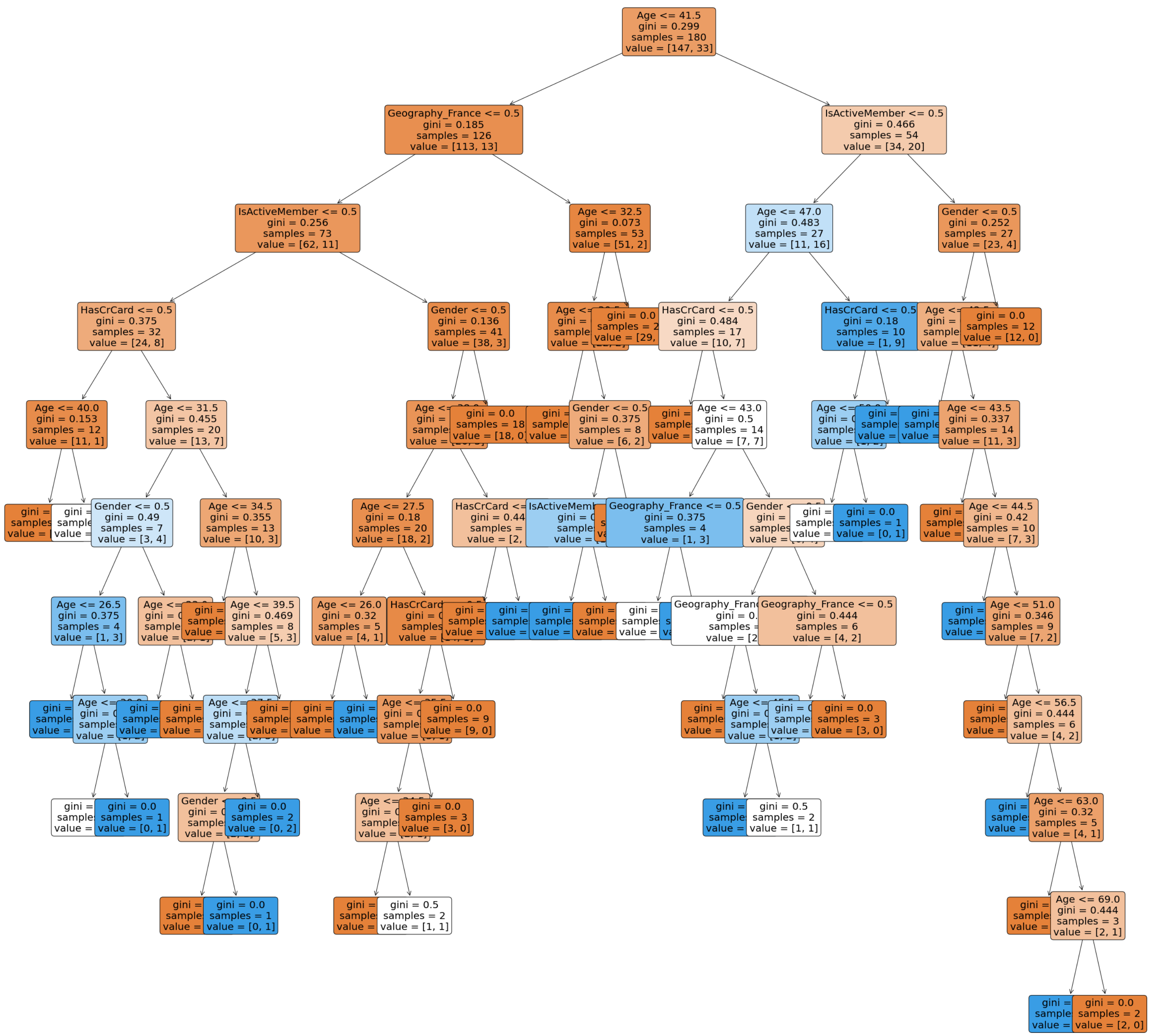
Out[11]:

| | Actual | Predicted |
|---|---|---|
| **101** | 0 | 0 |
| **87** | 0 | 0 |
| **23** | 0 | 0 |
| **140** | 0 | 1 |
| **114** | 1 | 0 |
| **190** | 1 | 0 |
| **65** | 0 | 0 |
| **111** | 0 | 1 |
| **33** | 0 | 1 |
| **196** | 0 | 0 |
| **194** | 0 | 0 |
| **30** | 1 | 1 |
| **70** | 1 | 1 |
| **169** | 0 | 0 |
| **164** | 1 | 0 |
| **132** | 0 | 0 |
| **103** | 0 | 1 |
| **179** | 1 | 1 |
| **105** | 1 | 0 |
| **184** | 1 | 0 |
| **191** | 0 | 0 |

In [12]:

```
# Visualize the Tree
```

```python
plt.figure(figsize=(40,40))
plot_tree(dtree, feature_names = X_train1.columns, filled=True, fontsize=20,
          rounded = True)
plt.show()
```




Training set gave 96% accuracy and test set gave 57% accuracy hence model is overfitted

# Decision Tree Classifier (80-20 Split)

In [13]:

```python
# Decision Tree Classifier for 80-20 Split

dtree = DecisionTreeClassifier(random_state=13)
dtree.fit(X_train2,y_train2)
y_pred_train2 = dtree.predict(X_train2)
y_pred_test2 = dtree.predict(X_test2)

print('80-20 Model performance on Training Set : \n')
print(classification_report(y_train2,y_pred_train2))
print()
print()
print('80-20 Model performance on Test Set : \n')
```

```
print(classification_report(y_test2,y_pred_test2))
print()
print()
X_ip = list(map(int,
       input("Enter Age, isActiveMember, HasCrCard, Gender, Geography_France : ")
              .split()))[:5]
print('Predicted class : ',dtree.predict([X_ip])[0])
print()
print()
print('Result : ')
pd.DataFrame({'Actual':y_test2,'Predicted':y_pred_test2})
```

```
80-20 Model performance on Training Set :

              precision    recall  f1-score   support

           0       0.97      0.99      0.98       133
           1       0.96      0.85      0.90        27

    accuracy                           0.97       160
   macro avg       0.96      0.92      0.94       160
weighted avg       0.97      0.97      0.97       160



80-20 Model performance on Test Set :

              precision    recall  f1-score   support

           0       0.74      0.85      0.79        27
           1       0.60      0.43      0.50        14

    accuracy                           0.71        41
   macro avg       0.67      0.64      0.65        41
weighted avg       0.69      0.71      0.69        41



Enter Age, isActiveMember, HasCrCard, Gender, Geography_France : 40 0 1 1 0
Predicted class :  0


Result :
```

Out[13]:

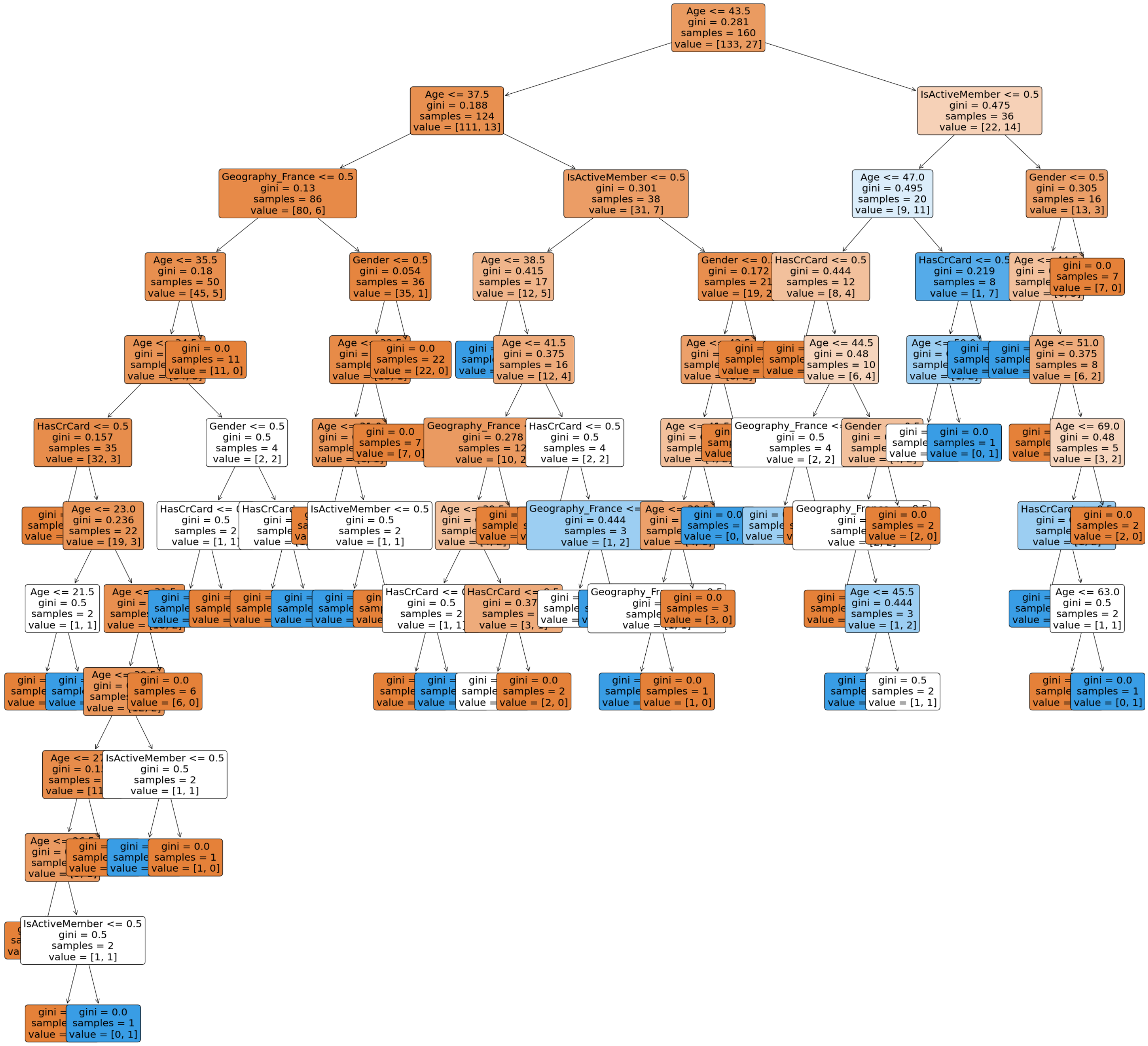
| | Actual | Predicted |
|---|---|---|
| **101** | 0 | 0 |
| **87** | 0 | 0 |
| **23** | 0 | 0 |
| **140** | 0 | 1 |
| **114** | 1 | 0 |
| **190** | 1 | 0 |
| **65** | 0 | 0 |
| **111** | 0 | 1 |
| **33** | 0 | 1 |
| **196** | 0 | 0 |
| **194** | 0 | 0 |
| **30** | 1 | 1 |

| | Actual | Predicted |
|---|---|---|
| **70** | 1 | 1 |
| **169** | 0 | 0 |
| **164** | 1 | 0 |
| **132** | 0 | 0 |
| **103** | 0 | 0 |
| **179** | 1 | 1 |
| **105** | 1 | 0 |
| **184** | 1 | 0 |
| **191** | 0 | 0 |
| **143** | 1 | 1 |
| **68** | 0 | 1 |
| **7** | 1 | 0 |
| **125** | 1 | 1 |
| **175** | 0 | 0 |
| **124** | 0 | 0 |
| **144** | 1 | 0 |
| **127** | 1 | 1 |
| **166** | 1 | 0 |
| **79** | 0 | 0 |
| **97** | 0 | 0 |
| **102** | 0 | 0 |
| **106** | 0 | 0 |
| **10** | 0 | 0 |
| **92** | 0 | 0 |
| **13** | 0 | 0 |
| **42** | 0 | 0 |
| **15** | 0 | 0 |
| **131** | 0 | 0 |
| **95** | 0 | 0 |

In [14]:

```
# Visualize the Tree

plt.figure(figsize=(40,40))
plot_tree(dtree, feature_names = X_train2.columns, filled=True, fontsize=20,
          rounded = True)
plt.show()
```




Training set gave 97% accuracy and test set gave 71% accuracy hence model is slightly overfitted

# Decision Tree Classifier (70-30 Split)

In [15]:

```
# Decision Tree Classifier for 70-30 Split

dtree = DecisionTreeClassifier(random_state=13)
dtree.fit(X_train3,y_train3)
y_pred_train3 = dtree.predict(X_train3)
y_pred_test3 = dtree.predict(X_test3)

print('70-30 Model performance on Training Set : \n')
print(classification_report(y_train3,y_pred_train3))
print()
print()
print('70-30 Model performance on Test Set : \n')
print(classification_report(y_test3,y_pred_test3))
print()
print()
X_ip = list(map(int,
       input("Enter Age, isActiveMember, HasCrCard, Gender, Geography_France : ")
```

```
                    .split()))[:5]
print('Predicted class : ',dtree.predict([X_ip])[0])
print()
print()
print('Result : ')
pd.DataFrame({'Actual':y_test3,'Predicted':y_pred_test3})
```

```
70-30 Model performance on Training Set :

              precision    recall  f1-score   support

           0       0.97      0.99      0.98       114
           1       0.96      0.88      0.92        26

    accuracy                           0.97       140
   macro avg       0.97      0.94      0.95       140
weighted avg       0.97      0.97      0.97       140



70-30 Model performance on Test Set :

              precision    recall  f1-score   support

           0       0.83      0.83      0.83        46
           1       0.47      0.47      0.47        15

    accuracy                           0.74        61
   macro avg       0.65      0.65      0.65        61
weighted avg       0.74      0.74      0.74        61



Enter Age, isActiveMember, HasCrCard, Gender, Geography_France : 40 0 1 1 0
Predicted class :  0


Result : 
```

Out[15]:

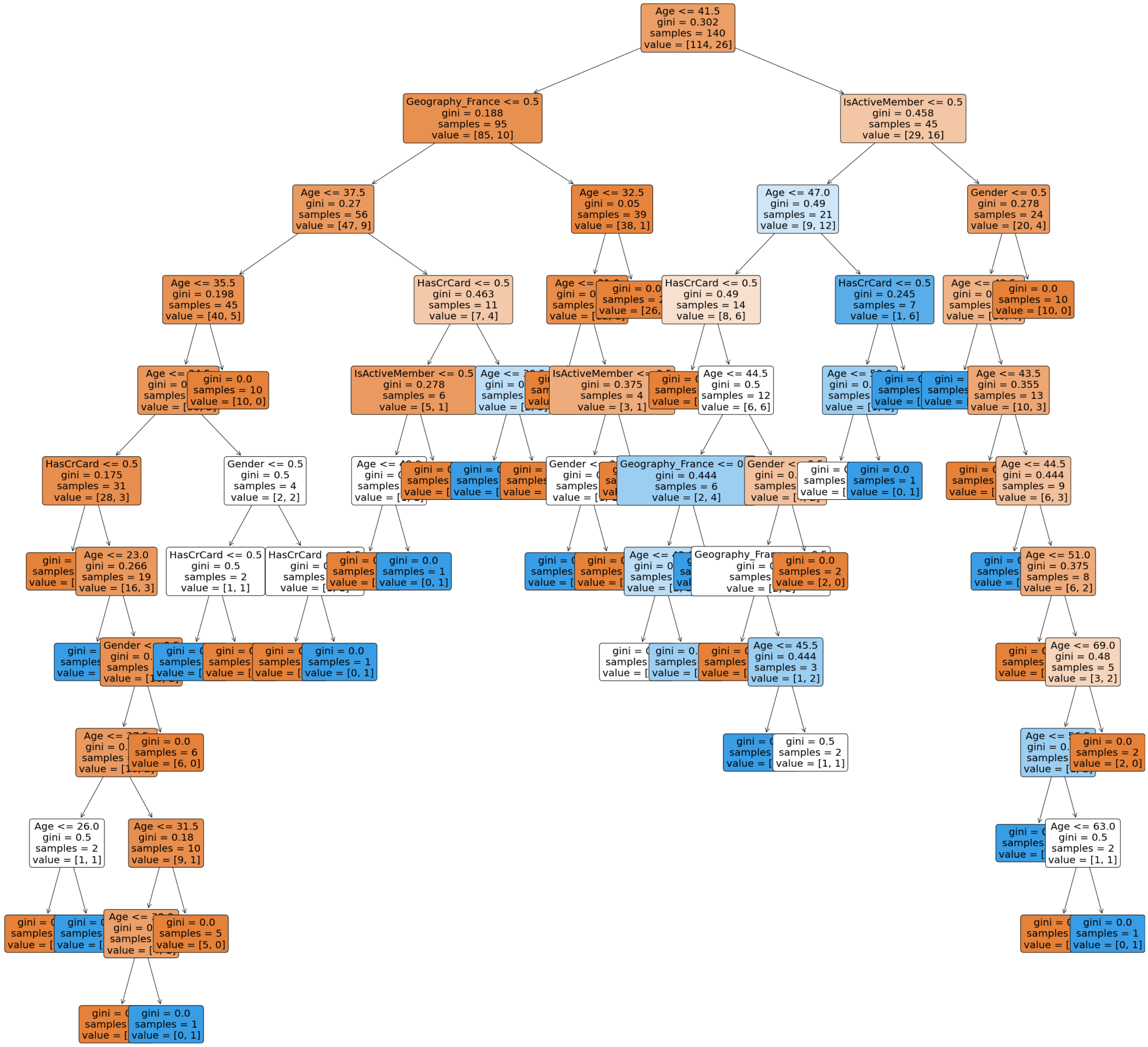
| | Actual | Predicted |
|---|---|---|
| **101** | 0 | 0 |
| **87** | 0 | 0 |
| **23** | 0 | 0 |
| **140** | 0 | 1 |
| **114** | 1 | 0 |
| **...** | ... | ... |
| **32** | 0 | 1 |
| **19** | 0 | 0 |
| **17** | 0 | 0 |
| **173** | 0 | 0 |
| **193** | 0 | 0 |

61 rows × 2 columns

In [16]:

```
# Visualize the Tree
```

```
plt.figure(figsize=(40,40))
plot_tree(dtree, feature_names = X_train3.columns, filled=True, fontsize=20,
          rounded = True)
plt.show()
```




Training set gave 97% accuracy and test set gave 74% accuracy hence model is slightly overfitted

## Conclusion : Best model obtained using 70% data for training and 30% data for testing with accuracy of 97% on training set and 74% on test set. Also, it has been observed that as we decrease the training set size, the test set accuracy increases and hence overfitting reduces.