Importing Libraries

In [1]:
```
import numpy as np
import pandas as pd
from sklearn.metrics import confusion_matrix
from sklearn.model_selection import train_test_split
from sklearn.tree import DecisionTreeClassifier
from sklearn.metrics import accuracy_score
from sklearn.metrics import classification_report
from sklearn import tree
import matplotlib.pyplot as plt
import seaborn as sns
%matplotlib inline
```

Import Data from Excel Sheet

In [2]:
```
file_name =  "Dataset.xls"
sheet =  'Heart Disease 1'

df = pd.read_excel(io=file_name, sheet_name=sheet)
```

Data Processing

Select the given attributes

In [3]:
```
#BMI, Smoking, PhysicalHealth, Race, Age
df = df[['BMI', 'Smoking', 'PhysicalHealth', 'Race', 'AgeCategory', 'SkinCancer']]
```

Remove '0' values from PhysicalHealth

In [4]:
```
df = df[df.PhysicalHealth != 0]
```

Select first 100 rows

In [5]:
```
df=df.head(100)

df
```

Out[5]:

	BMI	Smoking	PhysicalHealth	Race	AgeCategory	SkinCancer
0	16.60	Yes	3	White	55-59	Yes
2	26.58	Yes	20	White	65-69	No
4	23.71	No	28	White	40-44	No
5	28.87	Yes	6	Black	75-79	No
6	21.63	No	15	White	70-74	Yes
...	...	...	...	...	...	...
218	33.01	Yes	14	Black	70-74	No
219	25.84	Yes	20	White	55-59	No
222	21.21	No	7	Black	80 or older	No
224	21.30	No	2	White	60-64	Yes
228	43.27	No	2	Black	50-54	No

100 rows × 6 columns

Change the intervals to midpoint values

In [6]:
```
for i in df['AgeCategory']:
    if i == '18-24':
        df['AgeCategory'] = df['AgeCategory'].replace(['18-24'], 21)
    elif i == '25-29':
        df['AgeCategory'] = df['AgeCategory'].replace(['25-29'], 27)
    elif i == '30-34':
        df['AgeCategory'] = df['AgeCategory'].replace(['30-34'], 32)
    elif i == '35-39':
        df['AgeCategory'] = df['AgeCategory'].replace(['35-39'], 37)
    elif i == '40-44':
        df['AgeCategory'] = df['AgeCategory'].replace(['40-44'], 42)
    elif i == '45-49':
        df['AgeCategory'] = df['AgeCategory'].replace(['45-49'], 47)
    elif i == '50-54':
        df['AgeCategory'] = df['AgeCategory'].replace(['50-54'], 52)
    elif i == '55-59':
        df['AgeCategory'] = df['AgeCategory'].replace(['55-59'], 57)
    elif i == '60-64':
        df['AgeCategory'] = df['AgeCategory'].replace(['60-64'], 62)
    elif i == '65-69':
        df['AgeCategory'] = df['AgeCategory'].replace(['65-69'], 67)
    elif i == '70-74':
        df['AgeCategory'] = df['AgeCategory'].replace(['70-74'], 72)
    elif i == '75-79':
        df['AgeCategory'] = df['AgeCategory'].replace(['75-79'], 77)
    elif i == '80 or older':
        df['AgeCategory'] = df['AgeCategory'].replace(['80 or older'], 87)
```

Change string to Int/Float

In [7]:
```
from sklearn.preprocessing import LabelEncoder
```

In [8]:
```
le_race = LabelEncoder()
```

```
df['Race'] = le_race.fit_transform(df['Race'])
for i in df['Smoking']:
    if i == 'Yes':
        df['Smoking'] = df['Smoking'].replace(['Yes'], int(1))
    elif i == 'No':
        df['Smoking'] = df['Smoking'].replace(['No'], int(0))
for i in df['SkinCancer']:
    if i == 'Yes':
        df['SkinCancer'] = df['SkinCancer'].replace(['Yes'], int(1))
    elif i == 'No':
        df['SkinCancer'] = df['SkinCancer'].replace(['No'], int(0))
df
```

Out[8]:

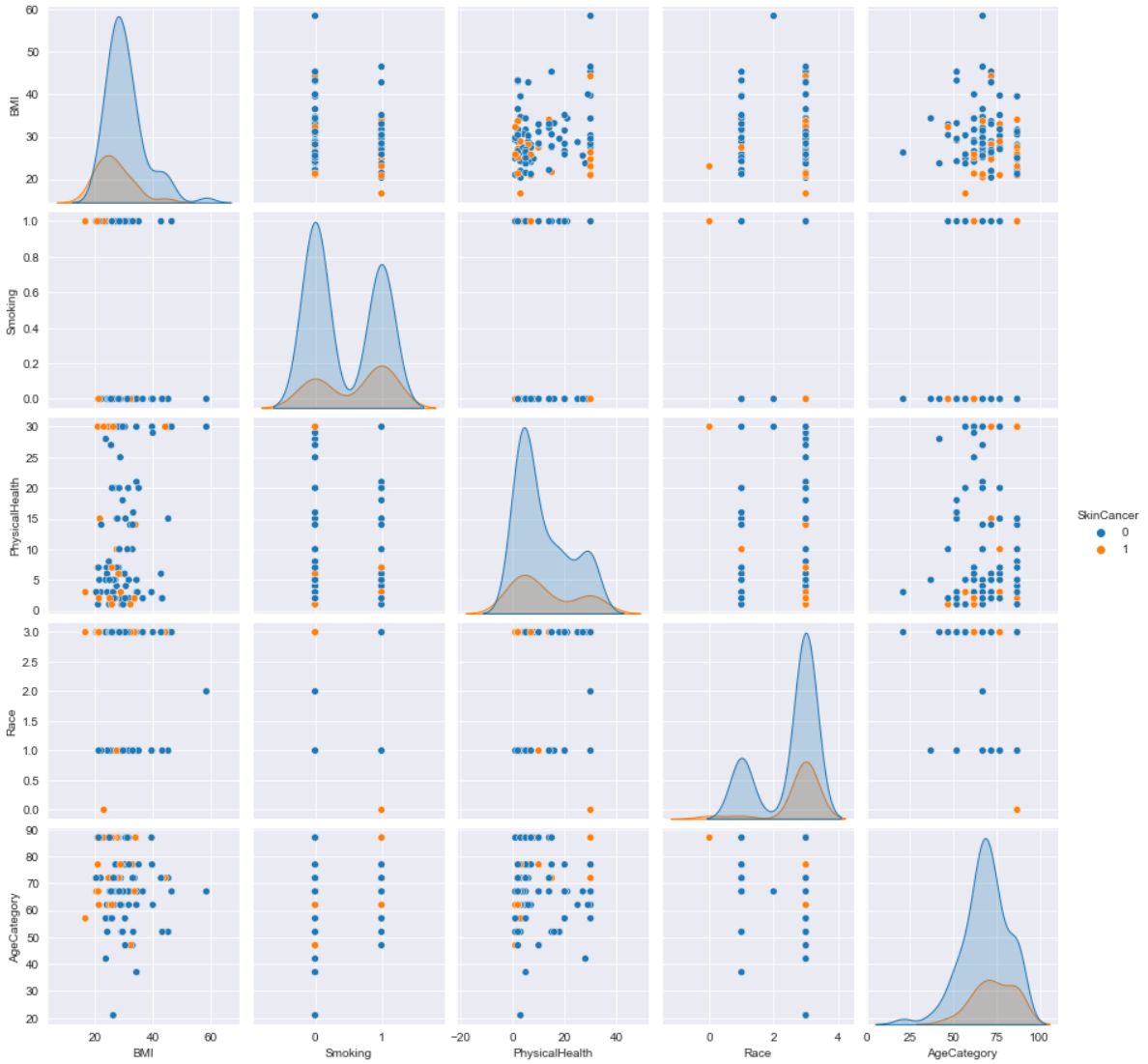
	BMI	Smoking	PhysicalHealth	Race	AgeCategory	SkinCancer
0	16.60	1	3	3	57	1
2	26.58	1	20	3	67	0
4	23.71	0	28	3	42	0
5	28.87	1	6	1	77	0
6	21.63	0	15	3	72	1
...	...	...	...	...	...	...
218	33.01	1	14	1	72	0
219	25.84	1	20	3	57	0
222	21.21	0	7	1	87	0
224	21.30	0	2	3	62	1
228	43.27	0	2	1	52	0

100 rows × 6 columns

Exploratory Data Analysis

In [9]:
```
sns.pairplot(data=df, hue = 'SkinCancer')
```

Out[9]:
```
<seaborn.axisgrid.PairGrid at 0x2242de58d60>
```



Model Fitting & Test

Split Input and Target Columns and Split Train-Test Data

In [10]:
```
target = df['SkinCancer']
inputs = df.drop(['SkinCancer'], axis=1)

x = inputs.values
y = target.values

X_train, X_test, y_train, y_test = train_test_split(x, y, test_size=0.3, random_sta
```

Decision Tree Classifier

In [11]:
```
clf_tree = DecisionTreeClassifier(criterion='entropy', random_state = 100, max_dep
clf_tree.fit(X_train, y_train)
```

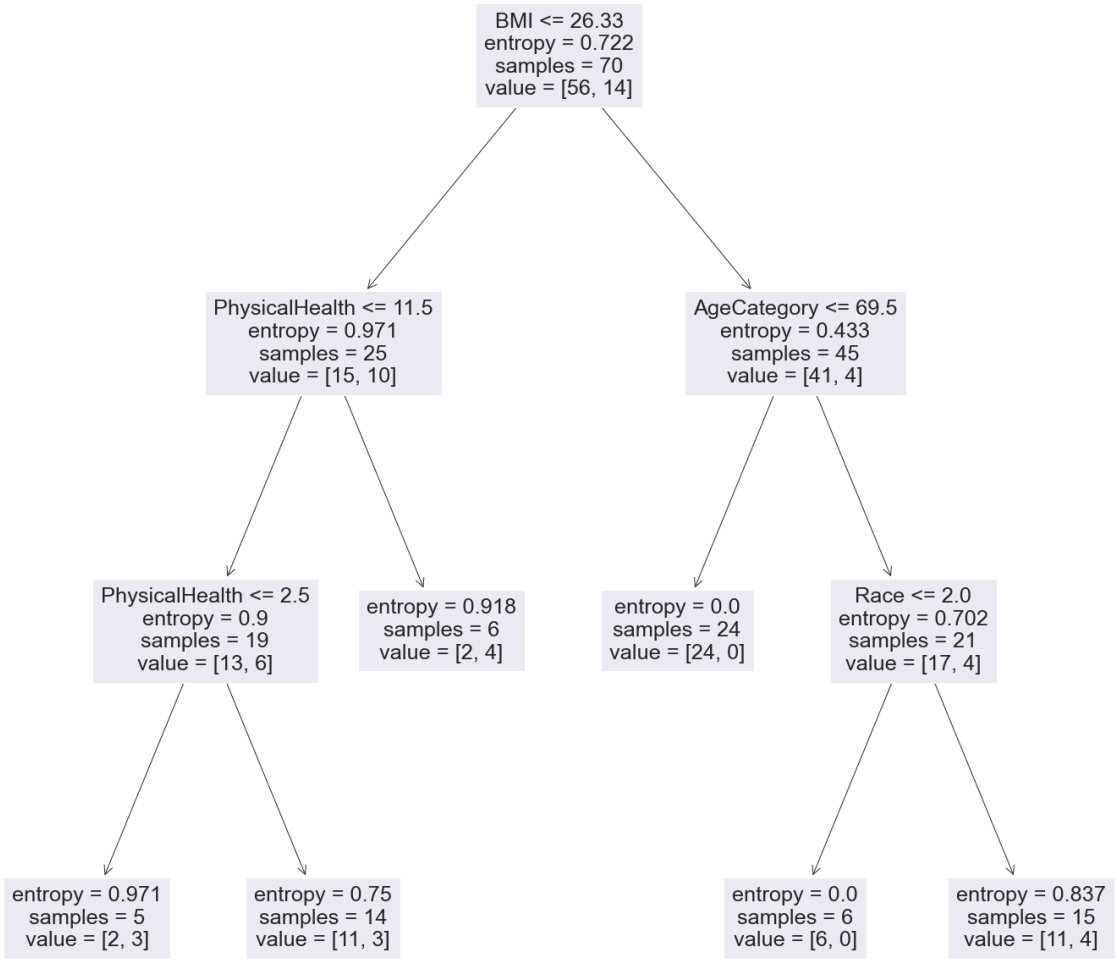
Out[11]:

```
DecisionTreeClassifier(criterion='entropy', max_depth=3, min_samples_leaf
=5,
                       random_state=100)
```

Plot Tree

In [12]:

```
fig, ax = plt.subplots(figsize=(25,25))
tree.plot_tree(clf_tree, ax=ax, feature_names=['BMI', 'Smoking', 'PhysicalHealth',
plt.show()
```



Show Predicted Values

In [13]:

```
y_pred = clf_tree.predict(X_test)
print("Predicted values:")
print(y_pred)
```

```
Predicted values:
[0 0 0 0 0 0 0 0 0 0 0 0 0 1 1 0 1 0 1 0 0 0 0 0 0 0 0 0 0 0]
```

Show Results

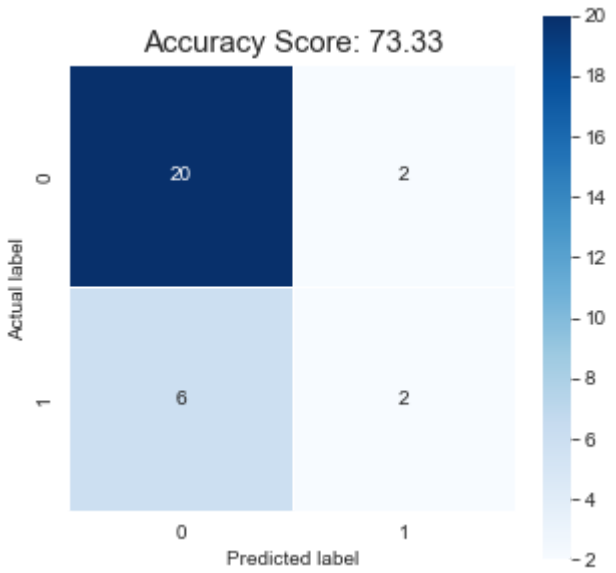
In [14]:
```
print("Confusion Matrix:\n",confusion_matrix(y_test, y_pred))

print ("Accuracy : ",accuracy_score(y_test,y_pred)*100)

print("Report :\n",classification_report(y_test, y_pred))
```

```
Confusion Matrix:
 [[20  2]
 [ 6  2]]
Accuracy :  73.33333333333333
Report :
              precision    recall  f1-score   support

           0       0.77      0.91      0.83        22
           1       0.50      0.25      0.33         8

    accuracy                           0.73        30
   macro avg       0.63      0.58      0.58        30
weighted avg       0.70      0.73      0.70        30
```

Confusion Matrix - Using Seaborn

In [15]:
```
cm = confusion_matrix(y_test, y_pred)
plt.figure(figsize=(5,5))
sns.heatmap(data=cm, linewidths=.5, annot=True, square = True,  cmap = 'Blues')
plt.ylabel('Actual label')
plt.xlabel('Predicted label')
all_sample_title = 'Accuracy Score: {:.2f}'.format(accuracy_score(y_test,y_pred)*1
plt.title(all_sample_title, size = 15)
```

Out[15]:
```
Text(0.5, 1.0, 'Accuracy Score: 73.33')
```



CSE 438

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Types of Data:

BMI → Numerical ~~(Interval)~~

Smoking → Categorical ~~(Nominal)~~

PhysicalHealth → Numerical

Race → Categorical

AgeCategory → Numerical

SkinCancer → Categorical

Calculating Entropy

For BMI, we can make data intervals:

$x < 20 \rightarrow 1$

$20 < x < 25 \rightarrow 22$

$25 < x < 30 \rightarrow 39$

$30 < x < 35 \rightarrow 25$

$35 < x < 40 \rightarrow 5$

$x > 40 \rightarrow 8$

$$\therefore \text{Entropy (BMI)} = -\frac{1}{100}\log_2\left(\frac{1}{100}\right) - \frac{22}{100}\log_2\left(\frac{22}{100}\right) - \frac{39}{100}\log_2\left(\frac{39}{100}\right) - \frac{25}{100}\log_2\left(\frac{25}{100}\right) - \frac{5}{100}\log_2\left(\frac{5}{100}\right) - \frac{8}{100}\log_2\left(\frac{8}{100}\right)$$

$$= 2.08441$$

Smoking:

$0 \rightarrow 53$

$1 \rightarrow 47$

$\therefore$ Entropy (Smoking) $= -\frac{53}{100}\log_2\left(\frac{53}{100}\right) - \frac{47}{100}\log_2\left(\frac{47}{100}\right)$

$= 0.9974$

Physical Health:

$x < 5 \rightarrow 31$

$5 < x < 10 \rightarrow 31$

$10 < x < 20 \rightarrow 11$

$x > 20 \rightarrow 27$

$\therefore$ Entropy (Physical Health) $= -\frac{31}{106}\log_2\left(\frac{31}{100}\right) - \frac{31}{100}\log_2\left(\frac{31}{100}\right)$

$- \frac{11}{100}\log_2\left(\frac{11}{100}\right) - \frac{27}{100}\log_2\left(\frac{27}{100}\right)$

$= 1.90789$

Race:

0 → 1

1 → 20

2 → 1

3 → 78

$$\text{Entropy(Race)} = -\frac{1}{100}\log_2\left(\frac{1}{100}\right) - \frac{20}{100}\log_2\left(\frac{20}{100}\right) - \frac{1}{100}\log_2\left(\frac{1}{100}\right) - \frac{78}{100}\log_2\left(\frac{78}{100}\right)$$

$$= 0.87685$$

Age Category:

$x < 30 \rightarrow 1$

$31 < x < 50 \rightarrow 5$

$51 < x < 70 \rightarrow 44$

$71 < x < 90 \rightarrow 50$

Entropy (Age Category) =

$$-\frac{1}{100}\log_2\left(\frac{1}{100}\right) - \frac{5}{100}\log_2\left(\frac{5}{100}\right)$$

$$-\frac{44}{100}\log_2\left(\frac{44}{100}\right) - \frac{50}{100}\left(\frac{50}{100}\right)$$

$$= 1.30368$$

Skin Cancer :

0 → 78

1 → 22

Entropy (skin Cancer) $= -\frac{78}{100}\log_2\left(\frac{78}{100}\right) - \frac{22}{100}\log_2\left(\frac{22}{100}\right)$

$= 0.76016$