# Decision Tree and Random Forest

## Source:

https://www.kaggle.com/ronitf/heart-disease-uci (https://www.kaggle.com/ronitf/heart-disease-uci)

## Defining the Problem Statement

This dataset records the attributes of a group of patients and whether they have heart disease. From this dataset, we would like to be able to predict the presence of heart disease in patients.

## Collecting the Data

In [51]:

```
import pandas as pd
import sklearn
import matplotlib.pyplot as plt
import numpy as np
import seaborn as sns
import time

from sklearn.model_selection import train_test_split
from sklearn.tree import DecisionTreeClassifier
from sklearn.ensemble import RandomForestClassifier
from sklearn.metrics import classification_report, confusion_matrix , accuracy_score

from sklearn.externals.six import StringIO
from IPython.display import display, Image
from sklearn.tree import export_graphviz
import pydotplus
```

Read the file and put it into panda's data frame

In [52]:

```
fname = 'heart.csv'
df = pd.read_csv(fname)
```

In [53]:

```
df.head()
```

Out[53]:

| | age | sex | cp | trestbps | chol | fbs | restecg | thalach | exang | oldpeak | slope | ca | thal | tar |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **0** | 63 | 1 | 3 | 145 | 233 | 1 | 0 | 150 | 0 | 2.3 | 0 | 0 | 1 | |
| **1** | 37 | 1 | 2 | 130 | 250 | 0 | 1 | 187 | 0 | 3.5 | 0 | 0 | 2 | |
| **2** | 41 | 0 | 1 | 130 | 204 | 0 | 0 | 172 | 0 | 1.4 | 2 | 0 | 2 | |
| **3** | 56 | 1 | 1 | 120 | 236 | 0 | 1 | 178 | 0 | 0.8 | 2 | 0 | 2 | |
| **4** | 57 | 0 | 0 | 120 | 354 | 0 | 1 | 163 | 1 | 0.6 | 2 | 0 | 2 | |

Preprocess the data

In [54]:

```
# df_target_infected = df[df["target"]==0]
# df_target_uninfected=df[df["target"]==1]
```

## Exploring the Data

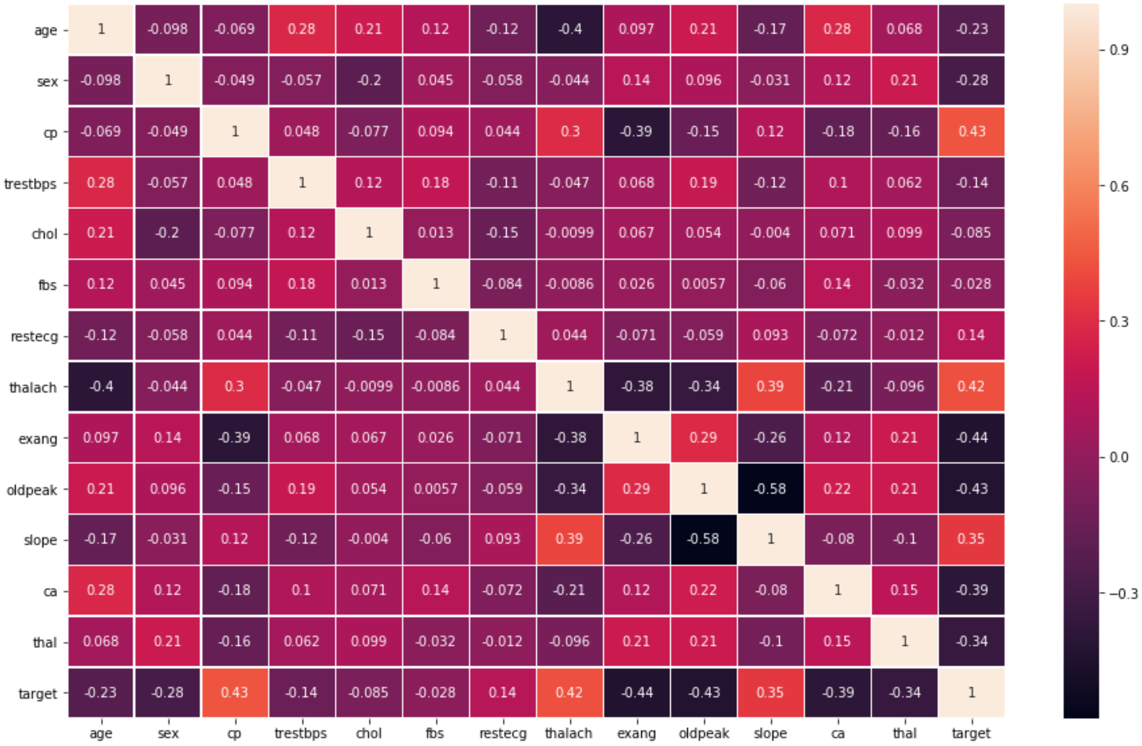
Visualise the **correlation** between the columns

In [55]:

```
plt.figure(figsize=(16, 10))
sns.heatmap(df.corr(), annot=True,linewidths=.5)
```

Out[55]:

```
<matplotlib.axes._subplots.AxesSubplot at 0x7f80acfd19b0>
```



| | age | sex | cp | trestbps | chol | fbs | restecg | thalach | exang | oldpeak | slope | ca | thal | target |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| age | 1 | -0.098 | -0.069 | 0.28 | 0.21 | 0.12 | -0.12 | -0.4 | 0.097 | 0.21 | -0.17 | 0.28 | 0.068 | -0.23 |
| sex | -0.098 | 1 | -0.049 | -0.057 | -0.2 | 0.045 | -0.058 | -0.044 | 0.14 | 0.096 | -0.031 | 0.12 | 0.21 | -0.28 |
| cp | -0.069 | -0.049 | 1 | 0.048 | -0.077 | 0.094 | 0.044 | 0.3 | -0.39 | -0.15 | 0.12 | -0.18 | -0.16 | 0.43 |
| trestbps | 0.28 | -0.057 | 0.048 | 1 | 0.12 | 0.18 | -0.11 | -0.047 | 0.068 | 0.19 | -0.12 | 0.1 | 0.062 | -0.14 |
| chol | 0.21 | -0.2 | -0.077 | 0.12 | 1 | 0.013 | -0.15 | -0.0099 | 0.067 | 0.054 | -0.004 | 0.071 | 0.099 | -0.085 |
| fbs | 0.12 | 0.045 | 0.094 | 0.18 | 0.013 | 1 | -0.084 | -0.0086 | 0.026 | 0.0057 | -0.06 | 0.14 | -0.032 | -0.028 |
| restecg | -0.12 | -0.058 | 0.044 | -0.11 | -0.15 | -0.084 | 1 | 0.044 | -0.071 | -0.059 | 0.093 | -0.072 | -0.012 | 0.14 |
| thalach | -0.4 | -0.044 | 0.3 | -0.047 | -0.0099 | -0.0086 | 0.044 | 1 | -0.38 | -0.34 | 0.39 | -0.21 | -0.096 | 0.42 |
| exang | 0.097 | 0.14 | -0.39 | 0.068 | 0.067 | 0.026 | -0.071 | -0.38 | 1 | 0.29 | -0.26 | 0.12 | 0.21 | -0.44 |
| oldpeak | 0.21 | 0.096 | -0.15 | 0.19 | 0.054 | 0.0057 | -0.059 | -0.34 | 0.29 | 1 | -0.58 | 0.22 | 0.21 | -0.43 |
| slope | -0.17 | -0.031 | 0.12 | -0.12 | -0.004 | -0.06 | 0.093 | 0.39 | -0.26 | -0.58 | 1 | -0.08 | -0.1 | 0.35 |
| ca | 0.28 | 0.12 | -0.18 | 0.1 | 0.071 | 0.14 | -0.072 | -0.21 | 0.12 | 0.22 | -0.08 | 1 | 0.15 | -0.39 |
| thal | 0.068 | 0.21 | -0.16 | 0.062 | 0.099 | -0.032 | -0.012 | -0.096 | 0.21 | 0.21 | -0.1 | 0.15 | 1 | -0.34 |
| target | -0.23 | -0.28 | 0.43 | -0.14 | -0.085 | -0.028 | 0.14 | 0.42 | -0.44 | -0.43 | 0.35 | -0.39 | -0.34 | 1 |

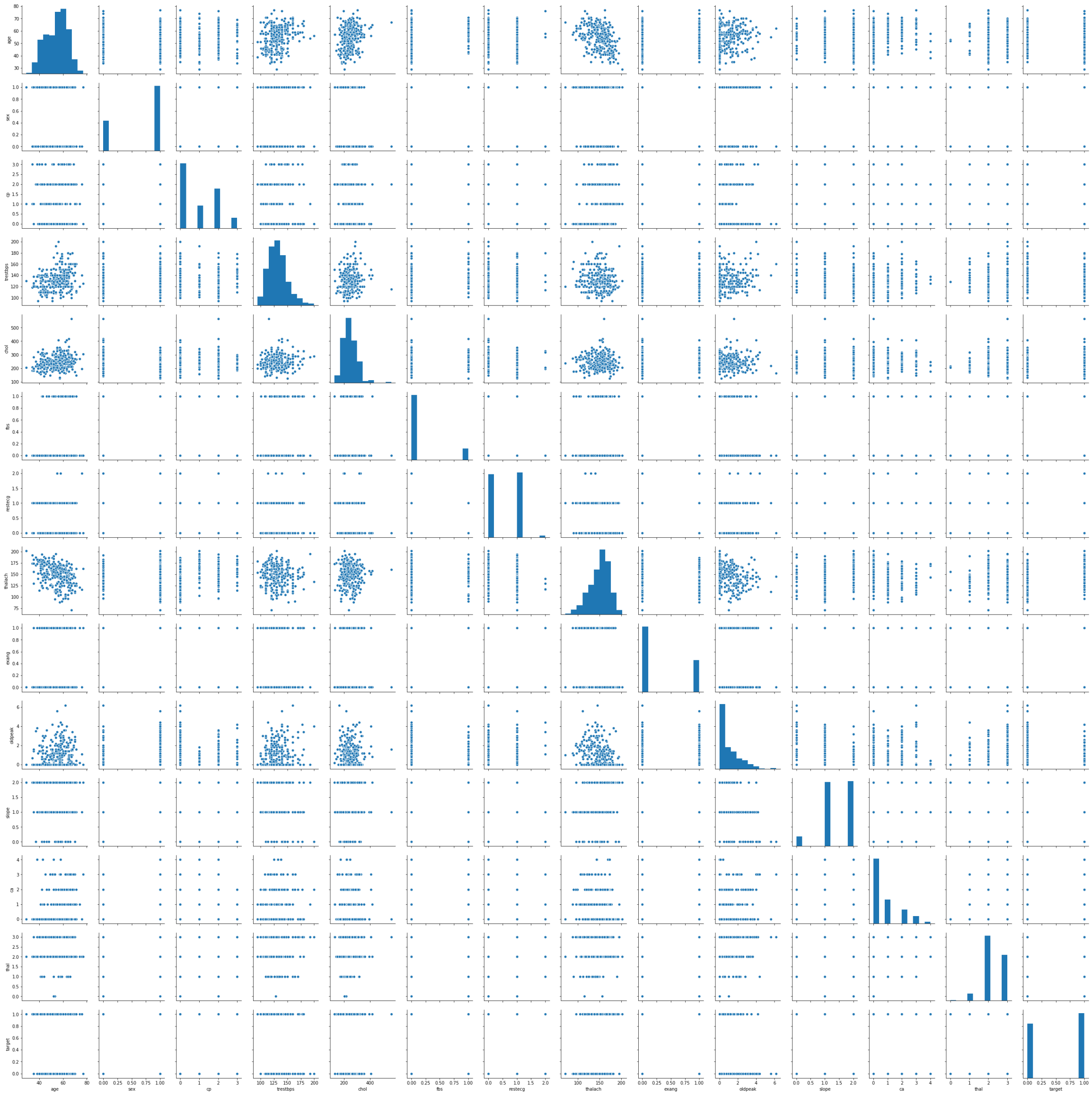
Generate **pair plot diagrams** to figure out the relationship between columns

In [56]:

```
sns.pairplot(df)
```

Out[56]:

```
<seaborn.axisgrid.PairGrid at 0x7f80acab6278>
```



## Defining a Function for the Model

**Self defined function** to return accuracy score , confusion matrix and model

In [70]:

```
def funct(X,y):
    X_train, X_test, y_train, y_test = train_test_split(X,y, test_size=0.2, random_stat
e=42 )
    model = DecisionTreeClassifier(max_leaf_nodes=3)

    import time
    start = time.time()
    model.fit(X_train,y_train)
    end = time.time()
    y_p = model.predict(X_test)
    a_score = accuracy_score(y_test,y_p)
    con_mat = confusion_matrix(y_test, y_p)

    model_rf = RandomForestClassifier(n_estimators = 100)
    start_rf = time.time()
    model_rf.fit(X_train,y_train)
    end_rf = time.time()
    y_p_rf = model_rf.predict(X_test)
    a_score_rf = accuracy_score(y_test,y_p_rf)
    con_mat_rf = confusion_matrix(y_test, y_p_rf)
#     print(end-start,"sec")
    print(a_score_rf)

    return [a_score,con_mat,model,end-start],[a_score_rf,con_mat_rf,model_rf,end_rf-sta
rt_rf]
```

Dictionary of independant columns for training

In [71]:

```
dic={
    1:["chol","trestbps"],
    2:["thalach","oldpeak"],
    3:["thalach","oldpeak","cp"],
    4:["thalach","oldpeak","cp","exang"],
    5:["thalach","oldpeak","cp","exang","slope"]
}
```

Data dictionary

In [72]:

```
dic_new={}
for key,val in dic.items():
    X = df.loc[:,val]
    y = df.iloc[:, -1]
#     acc_score,con_mat,model,time = funct(X,y)
    dt,rf = funct(X,y)
    acc_score,con_mat,model,time = dt
    a_score_rf,con_mat_rf,model_rf,time_rf = rf
    dic_new['_'.join(val)] = [[acc_score,con_mat,model,time],[a_score_rf,con_mat_rf,mod
el_rf,time_rf]]
```

```
0.5737704918032787
0.6557377049180327
0.7704918032786885
0.819672131147541
0.7540983606557377
```

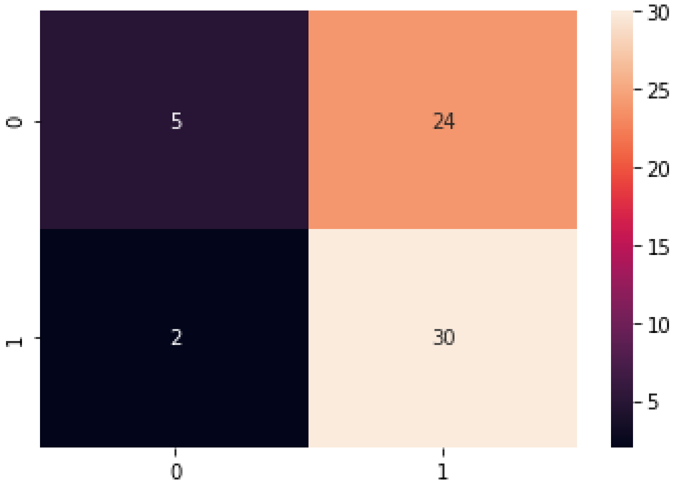
## Modelling: Decision Tree

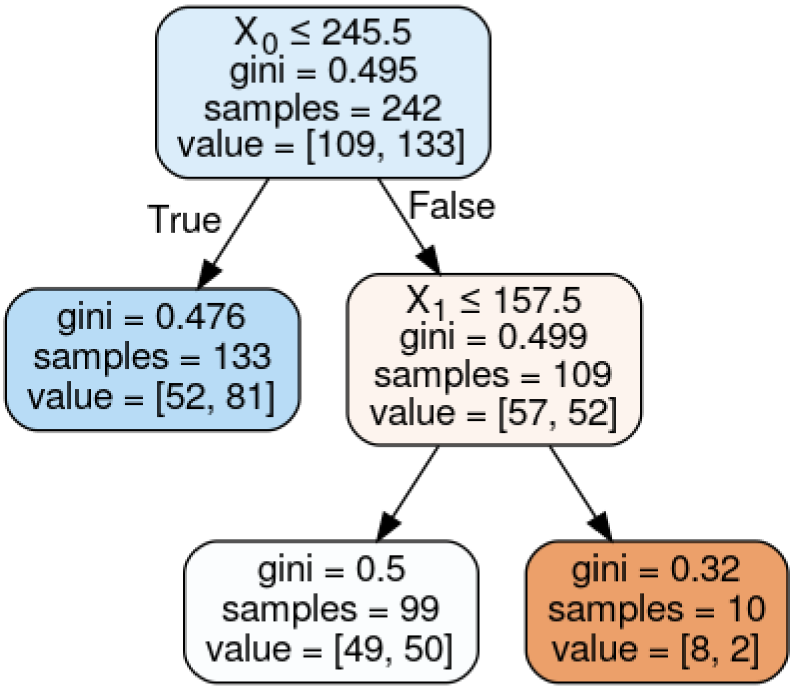
Finding the accuracy score and confusion matrix and the DECISION TREE

In [74]:

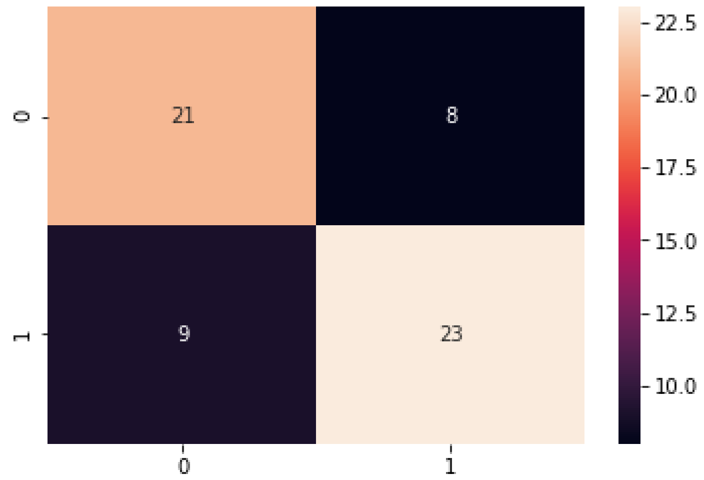
```
for k,v in dic_new.items():
    print("**********"+k+"**********")
    print()
    print("accuracy_core :",v[0][0] )
    print("time elapsed : ",v[0][3],"sec")
    print("confucion_matrix :")
    sns.heatmap(v[0][1],annot=True, fmt="d" )
    plt.show()

    dot_data = StringIO()
    export_graphviz(v[0][2], out_file=dot_data,
                    filled=True, rounded=True,
                    special_characters=True)
    graph = pydotplus.graph_from_dot_data(dot_data.getvalue())
    display(Image(graph.create_png()))
```

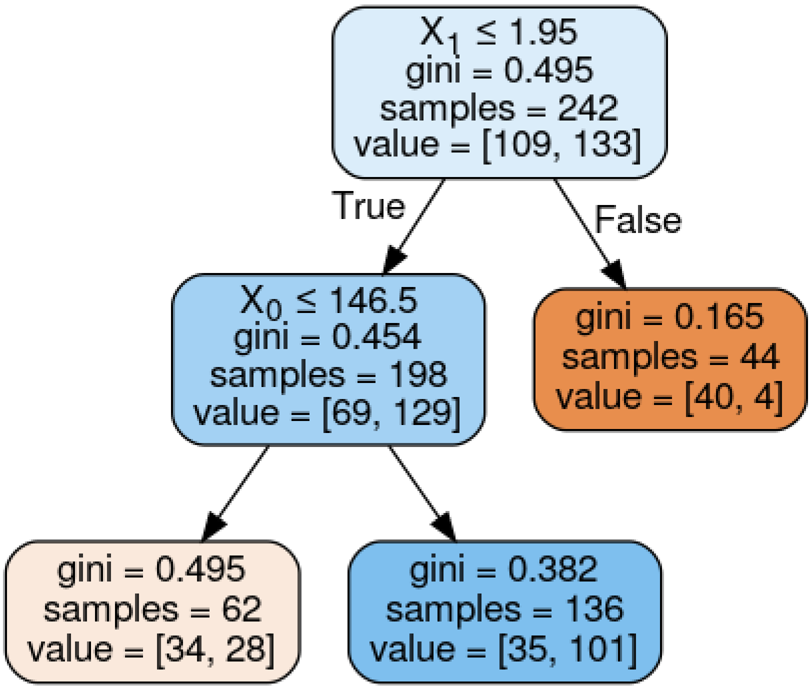
```
**********chol_trestbps**********

accuracy_core : 0.5737704918032787
time elapsed :  0.0019404888153076172 sec
confucion_matrix :
```



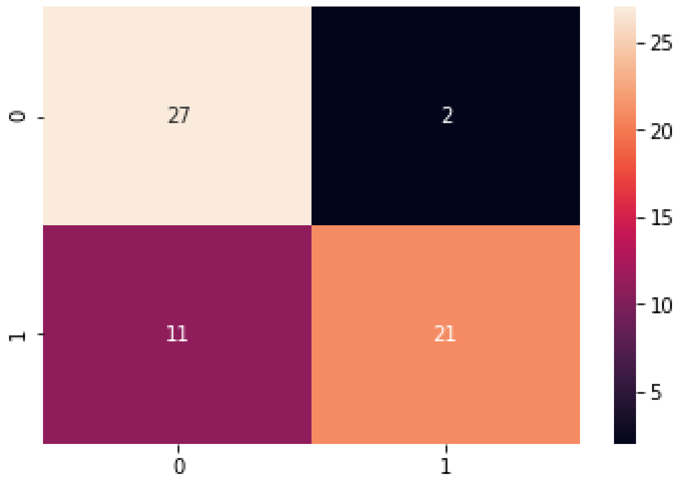


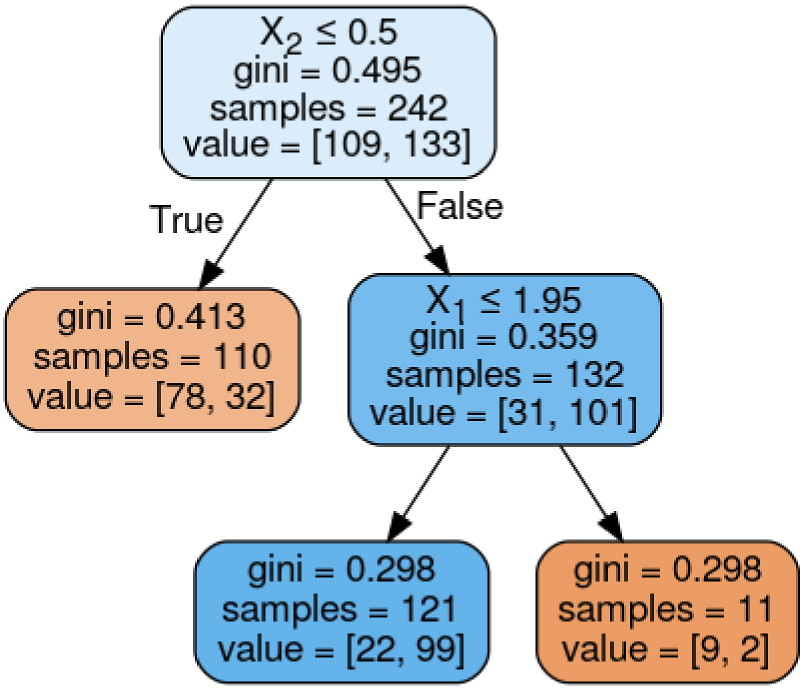
```
**********thalach_oldpeak**********

accuracy_core : 0.7213114754098361
time elapsed :  0.0013625621795654297 sec
confucion_matrix :
```



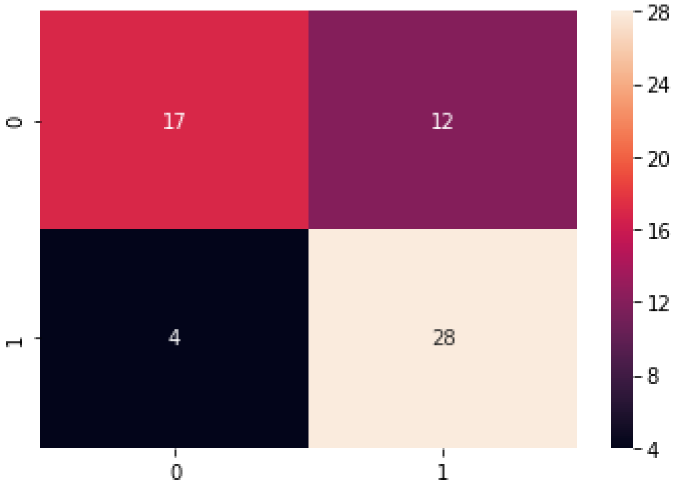


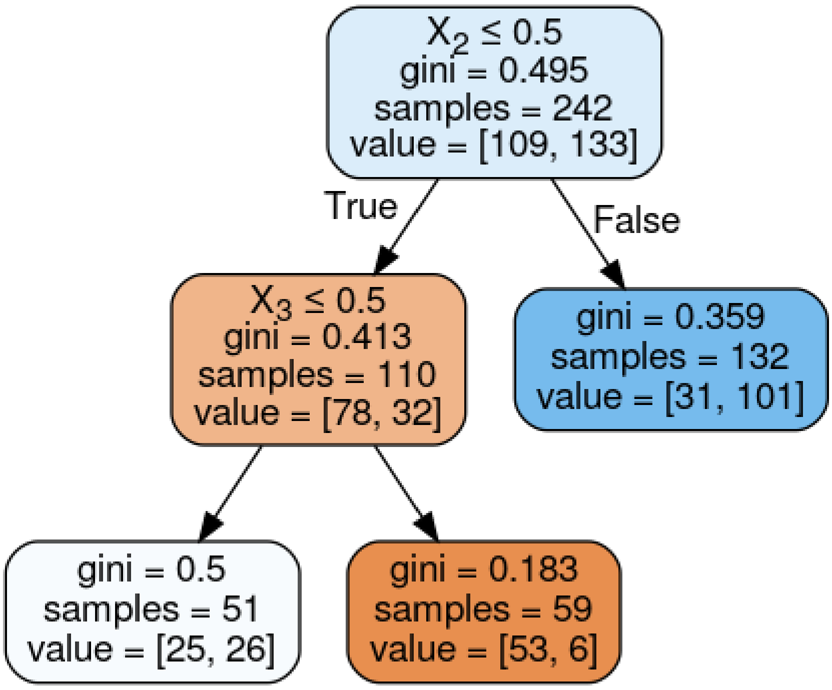
```
**********thalach_oldpeak_cp**********

accuracy_core : 0.7868852459016393
time elapsed :  0.0014171600341796875 sec
confucion_matrix :
```



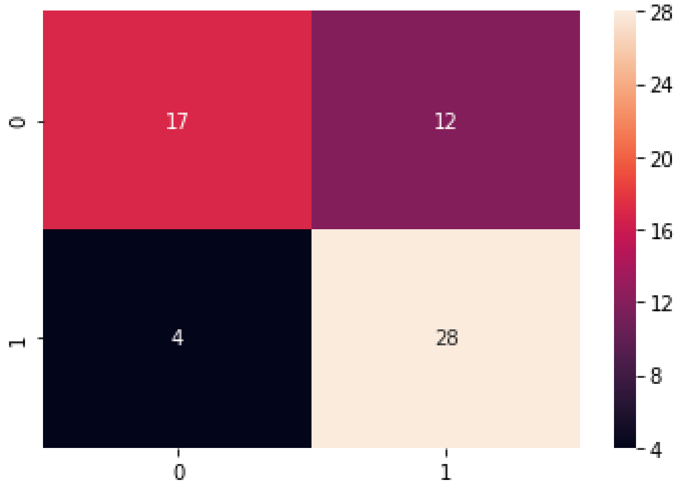


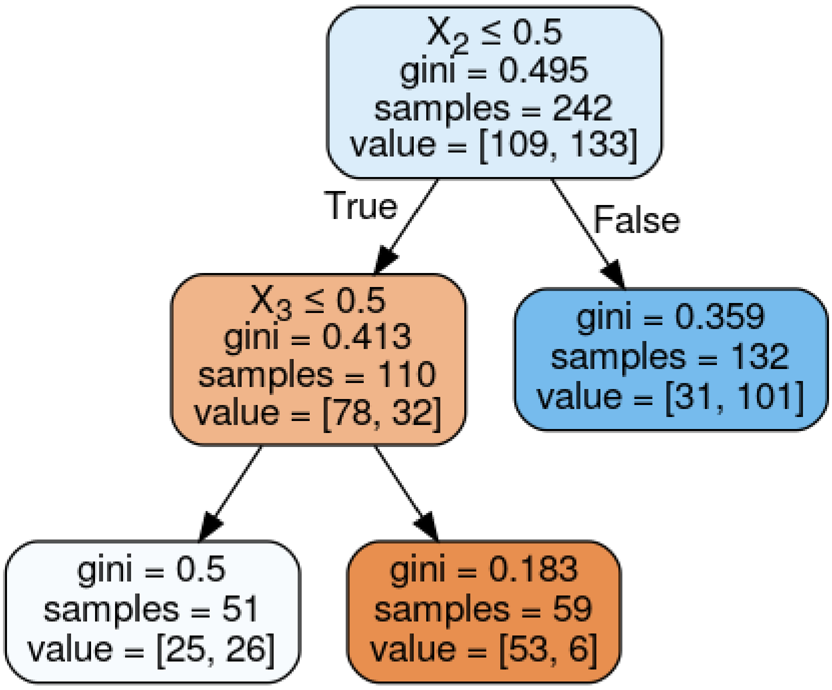
```
**********thalach_oldpeak_cp_exang**********

accuracy_core : 0.7377049180327869
time elapsed :  0.0012917518615722656 sec
confucion_matrix :
```





```
**********thalach_oldpeak_cp_exang_slope**********

accuracy_core : 0.7377049180327869
time elapsed :  0.0012478828430175781 sec
confucion_matrix :
```





## Conclusion: Decision Tree

A score of **0.7377049180327869** is obtained when **thalach , oldpeak , cp , exang and slope** are the inputs.

The max score of **0.7868852459016393** is obtained when **thalach,** oldpeak **and** cp__ are the inputs

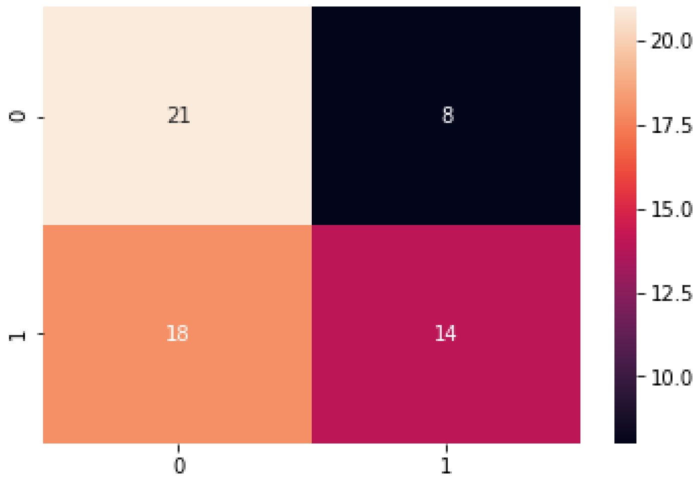
## Modelling: Random Forest

Finding the accuracy score and confusion matrix and the RANDOM FOREST

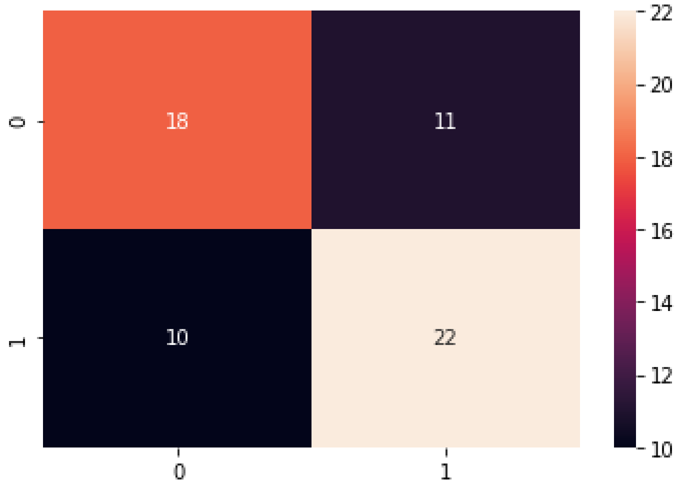
In [75]:

```
for k,v in dic_new.items():
    print("**********"+k+"**********")
    print()
    print("accuracy_core :",v[1][0] )
    print("time elapsed : ",v[1][3],"sec")
    print("confucion_matrix :")
    sns.heatmap(v[1][1],annot=True, fmt="d" )
    plt.show()
```

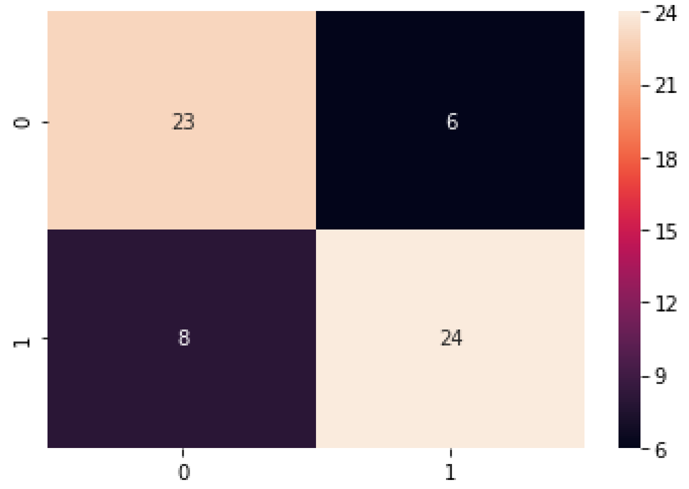
```
**********chol_trestbps**********

accuracy_core : 0.5737704918032787
time elapsed :  0.08995819091796875 sec
confucion_matrix :
```



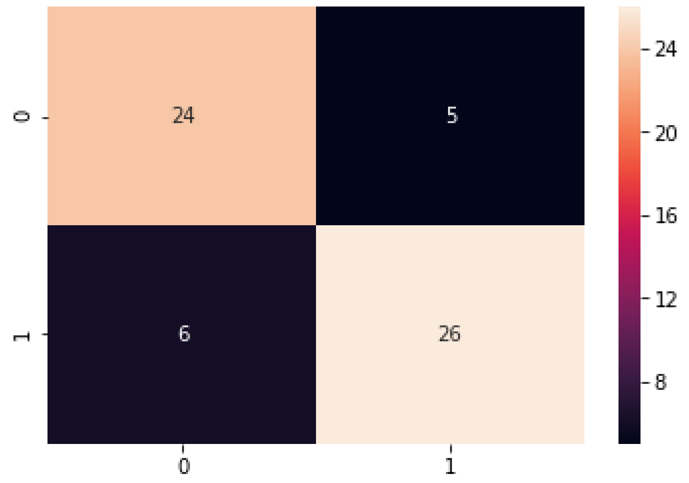
```
**********thalach_oldpeak**********

accuracy_core : 0.6557377049180327
time elapsed :  0.060263633728027344 sec
confucion_matrix :
```



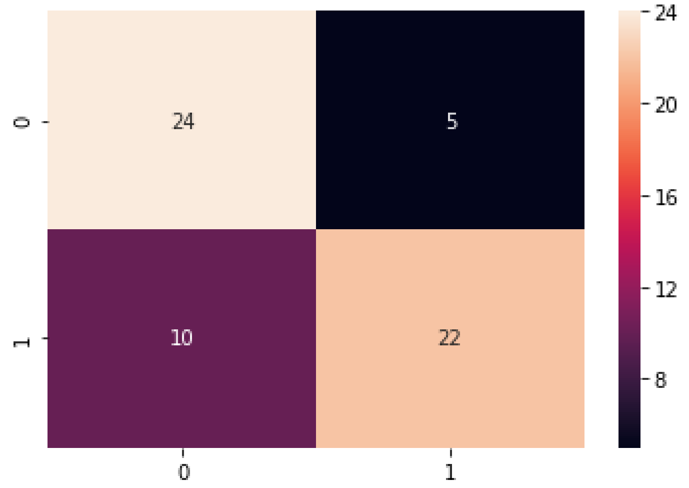
```
**********thalach_oldpeak_cp**********

accuracy_core : 0.7704918032786885
time elapsed :  0.06828618049621582 sec
confucion_matrix :
```



```
**********thalach_oldpeak_cp_exang**********

accuracy_core : 0.819672131147541
time elapsed :  0.07621526718139648 sec
confucion_matrix :
```



```
**********thalach_oldpeak_cp_exang_slope**********

accuracy_core : 0.7540983606557377
time elapsed :  0.06003427505493164 sec
confucion_matrix :
```



## Conclusion: Random Forest

A score of **0.7540983606557377** is obtained when **thalach , oldpeak , cp , exang and slope** are the inputs

The max score of **0.819672131147541** is obtained when **thalach, oldpeak, cp and exang** are given the inputs