```
# Importing the required libraries
import pandas as pd, numpy as np
import matplotlib.pyplot as plt, seaborn as sns
%matplotlib inline
```

```
# Reading the csv file and putting it into 'df' object
df = pd.read_csv('/content/drive/MyDrive/Datasets/heart_v2.csv')
df.head()
```

	age	sex	BP	cholestrol	heart disease
0	70	1	130	322	1
1	67	0	115	564	0
2	57	1	124	261	1
3	64	1	128	263	0
4	74	0	120	269	0

```
df.shape
```

```
(270, 5)
```

```
# Putting feature variable to X
X = df.drop('heart disease',axis=1)
# Putting response variable to y
y = df['heart disease']
```

```
# now lets split the data into train and test
from sklearn.model_selection import train_test_split

# Splitting the data into train and test
X_train, X_test, y_train, y_test = train_test_split(X, y, train_size=0.7, random_state=42)
X_train.shape, X_test.shape
```

```
((189, 4), (81, 4))
```

```
from sklearn.ensemble import RandomForestClassifier

classifier_rf = RandomForestClassifier(random_state=42, n_jobs=-1, max_depth=5, n_estimators=100, oob_score=True)
```

```
%%time
classifier_rf.fit(X_train, y_train)
```

```
CPU times: user 251 ms, sys: 19.8 ms, total: 270 ms
Wall time: 261 ms
▾                             RandomForestClassifier
RandomForestClassifier(max_depth=5, n_jobs=-1, oob_score=True, random_state=42)
```

```
# checking the oob score
classifier_rf.oob_score_
```

```
0.656084656084656
```

```
# checking the model score
classifier_rf.score(X_test, y_test)
```

```
0.654320987654321
```

Grid Search for Parameter Finetuning

```
rf = RandomForestClassifier(random_state=42, n_jobs=-1)
```

```
# Creating a dictionary of parameteres with their values being in lists
params = {
    'max_depth': [2,3,5,10,20],
    'min_samples_leaf': [5,10,20,50,100,200],
    'n_estimators': [10,25,30,50,100,200]
}
```

```
# Imporing GridSearch
from sklearn.model_selection import GridSearchCV
```

```
# Instantiating the grid search model
grid_search = GridSearchCV(estimator=rf, param_grid=params, cv = 4, n_jobs=-1, verbose=1, scoring="accuracy")
```

```
%%time
grid_search.fit(X_train, y_train)
```

```
Fitting 4 folds for each of 180 candidates, totalling 720 fits
CPU times: user 2.24 s, sys: 225 ms, total: 2.47 s
Wall time: 1min 31s
```

```
▸          GridSearchCV
▸ estimator: RandomForestClassifier
      ▸ RandomForestClassifier
```

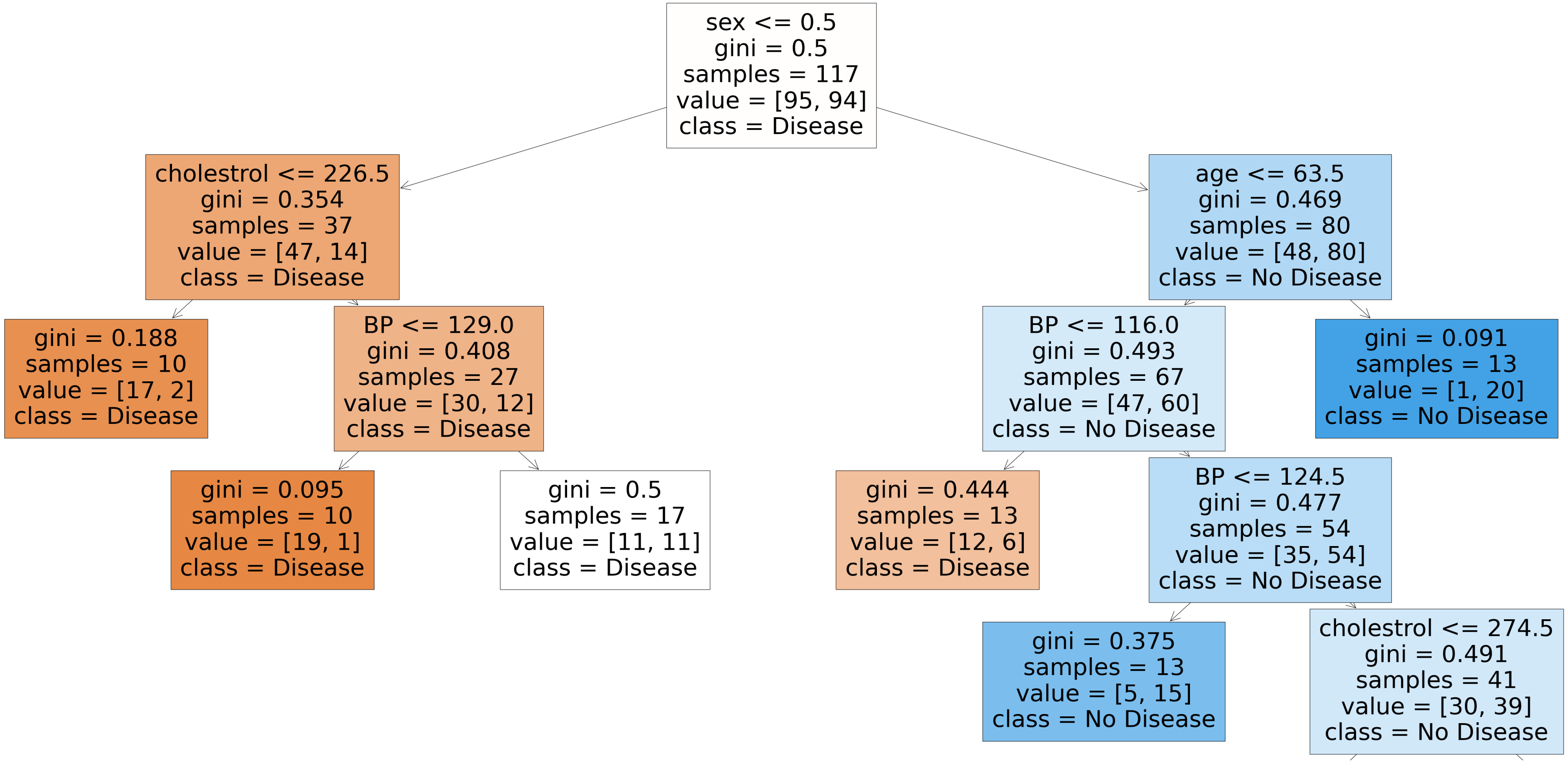
```
grid_search.best_score_
```

```
0.6985815602836879
```

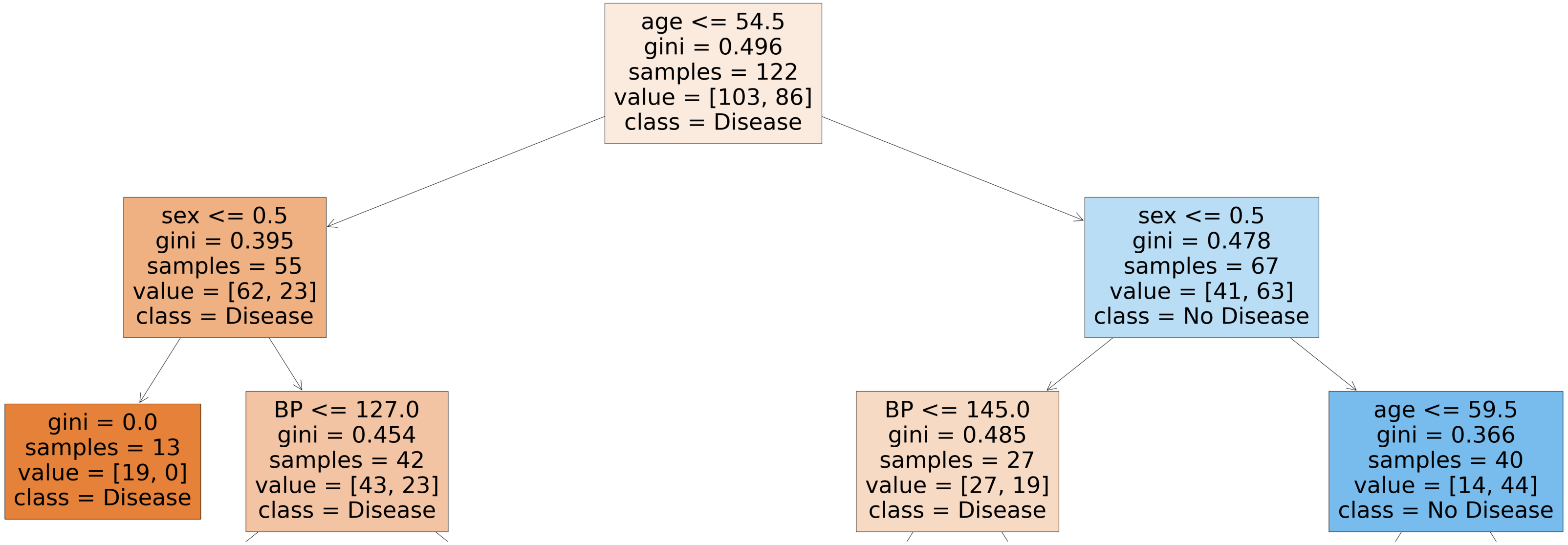
```
rf_best = grid_search.best_estimator_
rf_best
```

```
▾                          RandomForestClassifier
RandomForestClassifier(max_depth=5, min_samples_leaf=10, n_estimators=10,
                       n_jobs=-1, random_state=42)
```

```
# Visualizing the decision tree with index 5 in the given random foresr

from sklearn.tree import plot_tree
plt.figure(figsize=(80,40))
plot_tree(rf_best.estimators_[9], feature_names = X.columns,class_names=['Disease', "No Disease"],filled=True);
```



```
# Visualizing the decision tree with index 7 in the given random foresr

from sklearn.tree import plot_tree
plt.figure(figsize=(80,40))
plot_tree(rf_best.estimators_[7], feature_names = X.columns,class_names=['Disease', "No Disease"],filled=True);
```



```
# Finding the feature importance

rf_best.feature_importances_
```

```
     array([0.46128487, 0.2180848 , 0.13174619, 0.18888413])
```

```
imp_df = pd.DataFrame({
    "Varname": X_train.columns,
    "Imp": rf_best.feature_importances_
})
```

```
imp_df.sort_values(by="Imp", ascending=False)
```

	Varname	Imp
0	age	0.461285
1	sex	0.218085
3	cholestrol	0.188884
2	BP	0.131746

Random Search for Hyperparameter Finetuning

```
from scipy.stats import randint

rs_space={'max_depth':list(np.arange(10, 100, step=10)) + [None],
              'n_estimators':np.arange(10, 500, step=50),
              'max_features':randint(1,7),
              'criterion':['gini','entropy'],
              'min_samples_leaf':randint(1,4),
              'min_samples_split':np.arange(2, 10, step=2)
         }
```

```
from sklearn.model_selection import RandomizedSearchCV

rf = RandomForestClassifier(random_state=42, n_jobs=-1)

rf_random = RandomizedSearchCV(rf, rs_space, n_iter=50, scoring='accuracy', n_jobs=-1, cv=4)
```

```
%%time
model_random = rf_random.fit(X_train, y_train)
```

```
     CPU times: user 2.14 s, sys: 294 ms, total: 2.43 s
     Wall time: 1min 40s
```

```
model_random.best_params_
```

```
     {'criterion': 'entropy',
      'max_depth': 30,
      'max_features': 3,
      'min_samples_leaf': 3,
      'min_samples_split': 6,
      'n_estimators': 460}
```

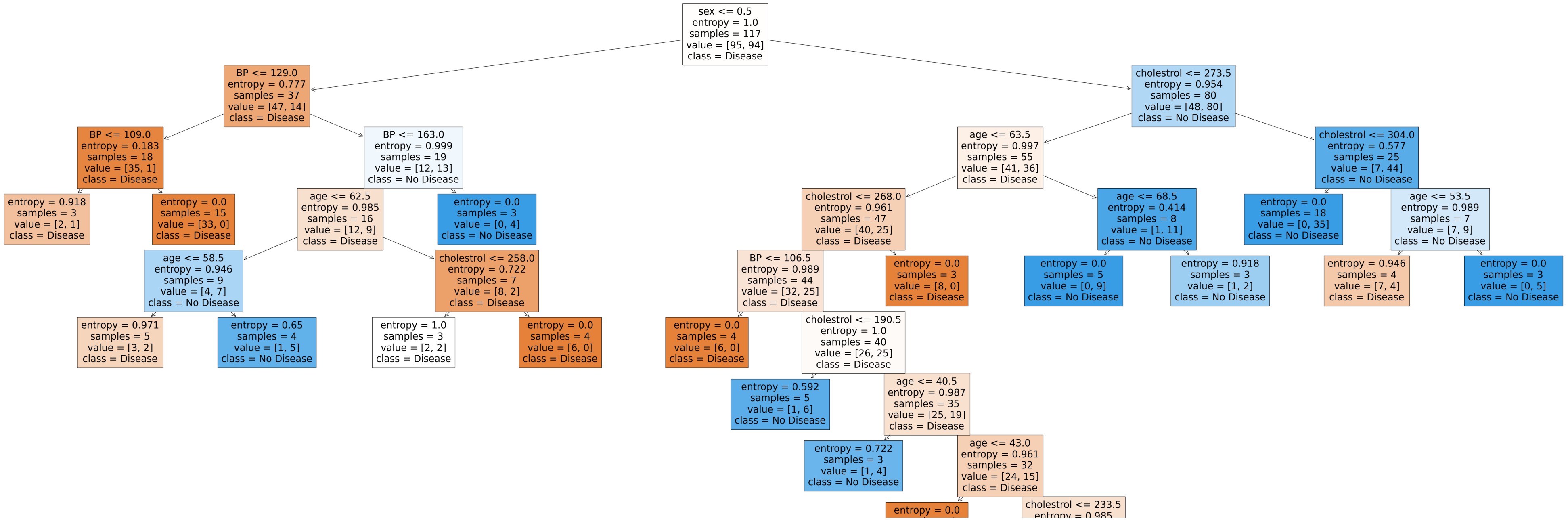
```
model_random.best_score_
```

```
     0.6880540780141844
```

```
rf_best1 = model_random.best_estimator_
rf_best1
```

```
▾                          RandomForestClassifier
RandomForestClassifier(criterion='entropy', max_depth=30, max_features=3,
                       min_samples_leaf=3, min_samples_split=6,
                       n_estimators=460, n_jobs=-1, random_state=42)
```

```
# Visualizing the decision tree with index 5 in the given random foresr

from sklearn.tree import plot_tree
plt.figure(figsize=(80,40))
plot_tree(rf_best1.estimators_[9], feature_names = X.columns,class_names=['Disease', "No Disease"],filled=True);
```



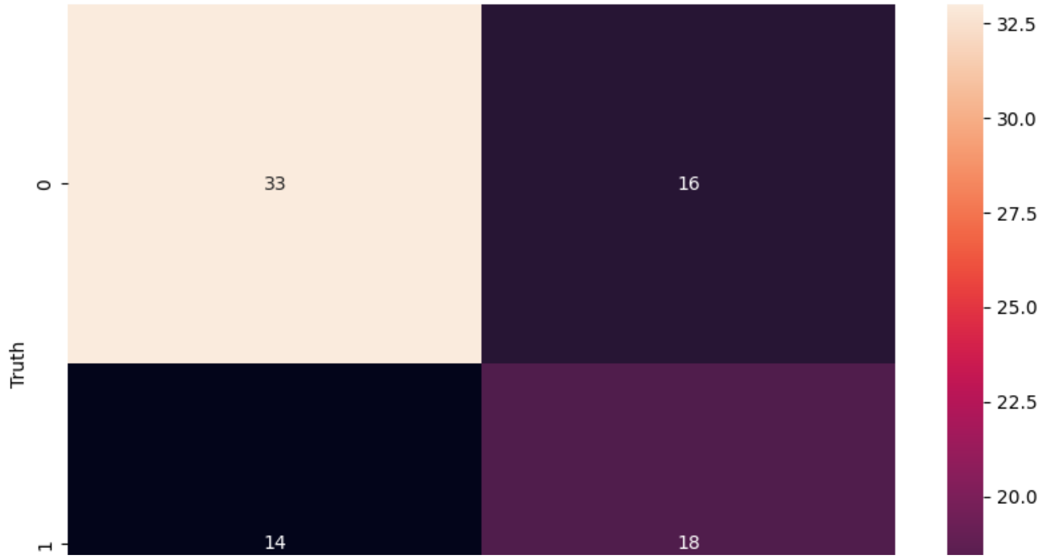
Normal RF Vs. GridSearch RF Vs. RandomSearch RF

```
# Model (Model Picked through GridSearch) Validation

from sklearn.metrics import confusion_matrix

y_pred = rf_best.predict(X_test)

cm = confusion_matrix(y_test, y_pred)
cm
```

```
     array([[33, 16],
            [14, 18]])
```

```
plt.figure(figsize=(10,7))
sns.heatmap(cm, annot=True)
plt.xlabel('Predicted')
plt.ylabel('Truth')
```

```
Text(95.72222222222221, 0.5, 'Truth')
```

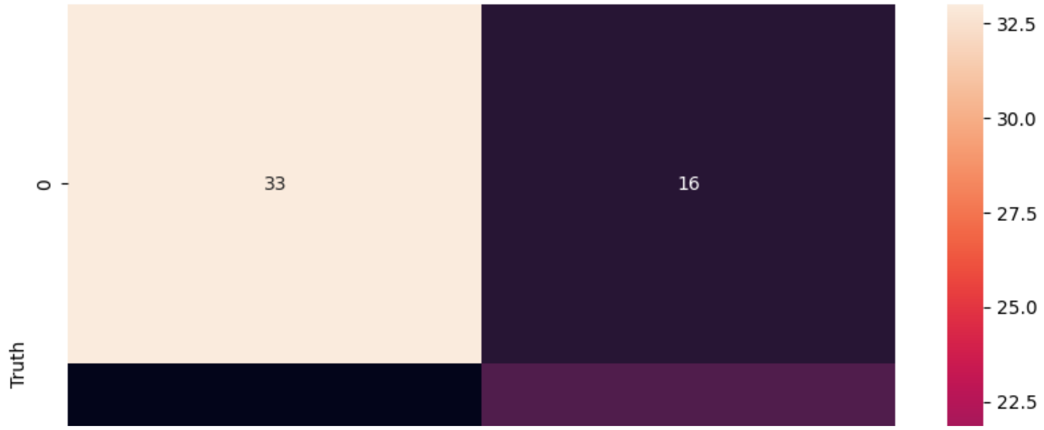


```
# Model (Model Picked through RandomSearch) Validation

from sklearn.metrics import confusion_matrix

y_pred1 = rf_best1.predict(X_test)

cm1 = confusion_matrix(y_test, y_pred)
cm1
```

```
array([[33, 16],
       [14, 18]])
```

```
plt.figure(figsize=(10,7))
sns.heatmap(cm1, annot=True)
plt.xlabel('Predicted')
plt.ylabel('Truth')
```

```
Text(95.72222222222221, 0.5, 'Truth')
```



```
# Classification Report (Model Picked through GridSearch)

from sklearn.metrics import classification_report
print(classification_report(y_test, y_pred))
```

```
              precision    recall  f1-score   support

           0       0.70      0.67      0.69        49
           1       0.53      0.56      0.55        32

    accuracy                           0.63        81
   macro avg       0.62      0.62      0.62        81
weighted avg       0.63      0.63      0.63        81
```

```
# Classification Report (Model Picked through RandomSearch)

from sklearn.metrics import classification_report
print(classification_report(y_test, y_pred1))
```

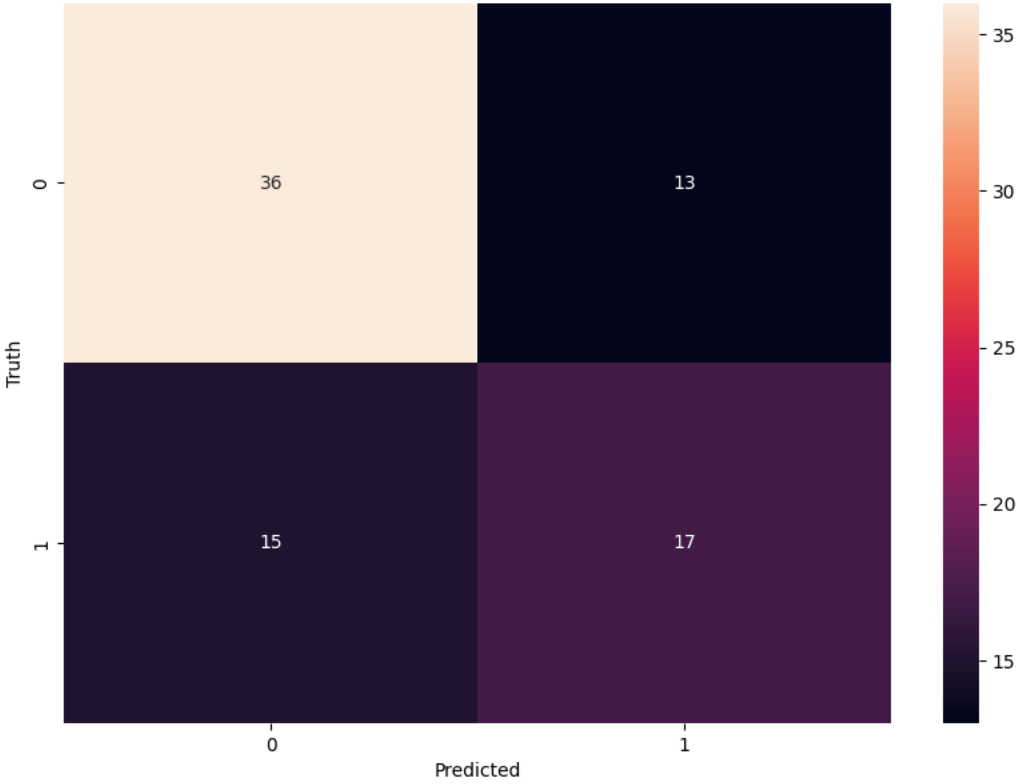
```
              precision    recall  f1-score   support

           0       0.69      0.73      0.71        49
           1       0.55      0.50      0.52        32

    accuracy                           0.64        81
   macro avg       0.62      0.62      0.62        81
weighted avg       0.64      0.64      0.64        81
```

```
# Model (Original Model) Validation

y_pred2 = classifier_rf.predict(X_test)

cm2 = confusion_matrix(y_test, y_pred2)
cm2
```

```
    array([[36, 13],
           [15, 17]])
```

```
plt.figure(figsize=(10,7))
sns.heatmap(cm2, annot=True)
plt.xlabel('Predicted')
plt.ylabel('Truth')
```

```
    Text(95.72222222222221, 0.5, 'Truth')
```



Exercise: Solve the classification problem for the Titanic toy dataset with Random Forest ensemble in the following fashion and report the best possible result.

1. Train and test a baseline model with values for parameters to be default or something filled by you as standard ones.
2. Perform grid search to understand and find the best model.
3. Perform randome search to understand and find the best model.
4. Compare - Baseline Vs. GridSearch Model Vs. RandomSearch Model