```
import pandas as pd
import numpy as np
from sklearn.model_selection import train_test_split, cross_val_score
from sklearn.tree import DecisionTreeClassifier, plot_tree
from sklearn.ensemble import RandomForestClassifier
from sklearn.metrics import accuracy_score, classification_report
from sklearn.metrics import confusion_matrix, ConfusionMatrixDisplay
import matplotlib.pyplot as plt
import seaborn as sns


df=pd.read_csv('/bin/heart.csv')


df.dropna(inplace=True)
X = df.drop('target', axis=1)
y = df['target']


X_train, X_test, y_train, y_test = train_test_split(X, y, test_size=0.2, random_state=42)


dt_model = DecisionTreeClassifier(random_state=42)
dt_model.fit(X_train, y_train)
```

```
DecisionTreeClassifier
DecisionTreeClassifier(random_state=42)
```

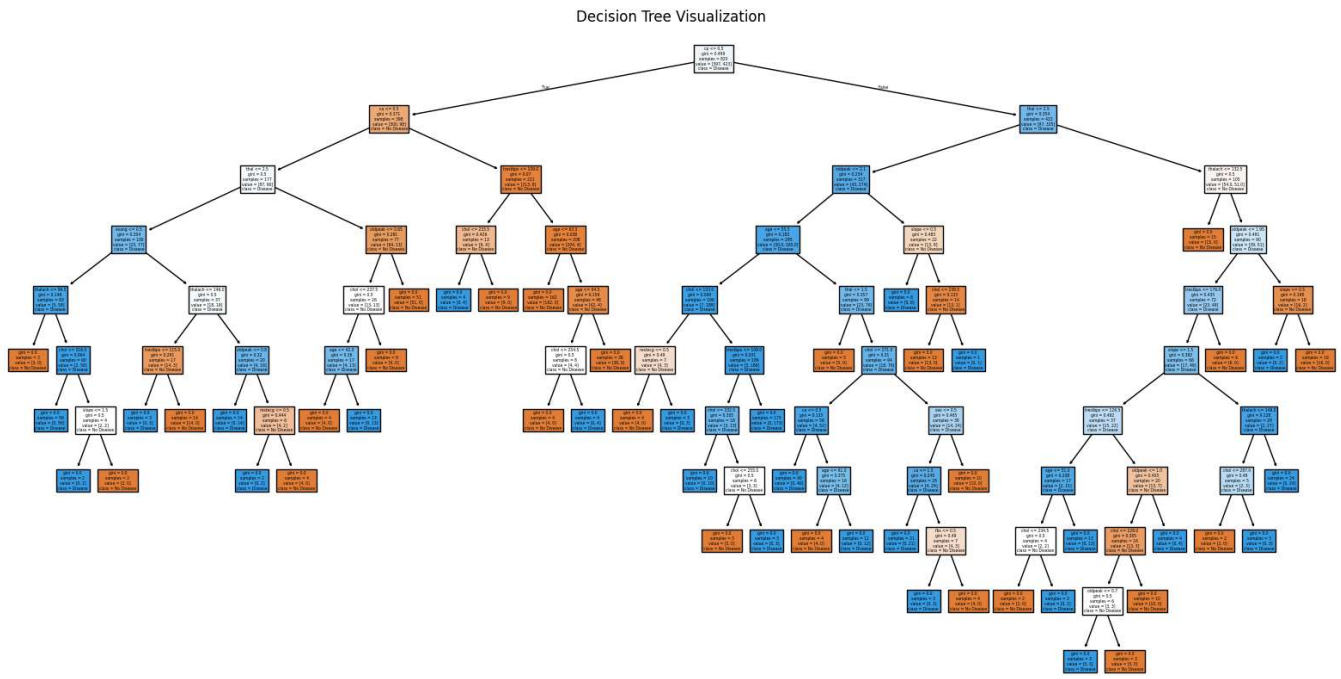
```
y_pred_dt = dt_model.predict(X_test)
print("Decision Tree Accuracy:", accuracy_score(y_test, y_pred_dt))
print(classification_report(y_test, y_pred_dt))
```

```
Decision Tree Accuracy: 0.9853658536585366
              precision    recall  f1-score   support

           0       0.97      1.00      0.99       102
           1       1.00      0.97      0.99       103

    accuracy                           0.99       205
   macro avg       0.99      0.99      0.99       205
weighted avg       0.99      0.99      0.99       205
```

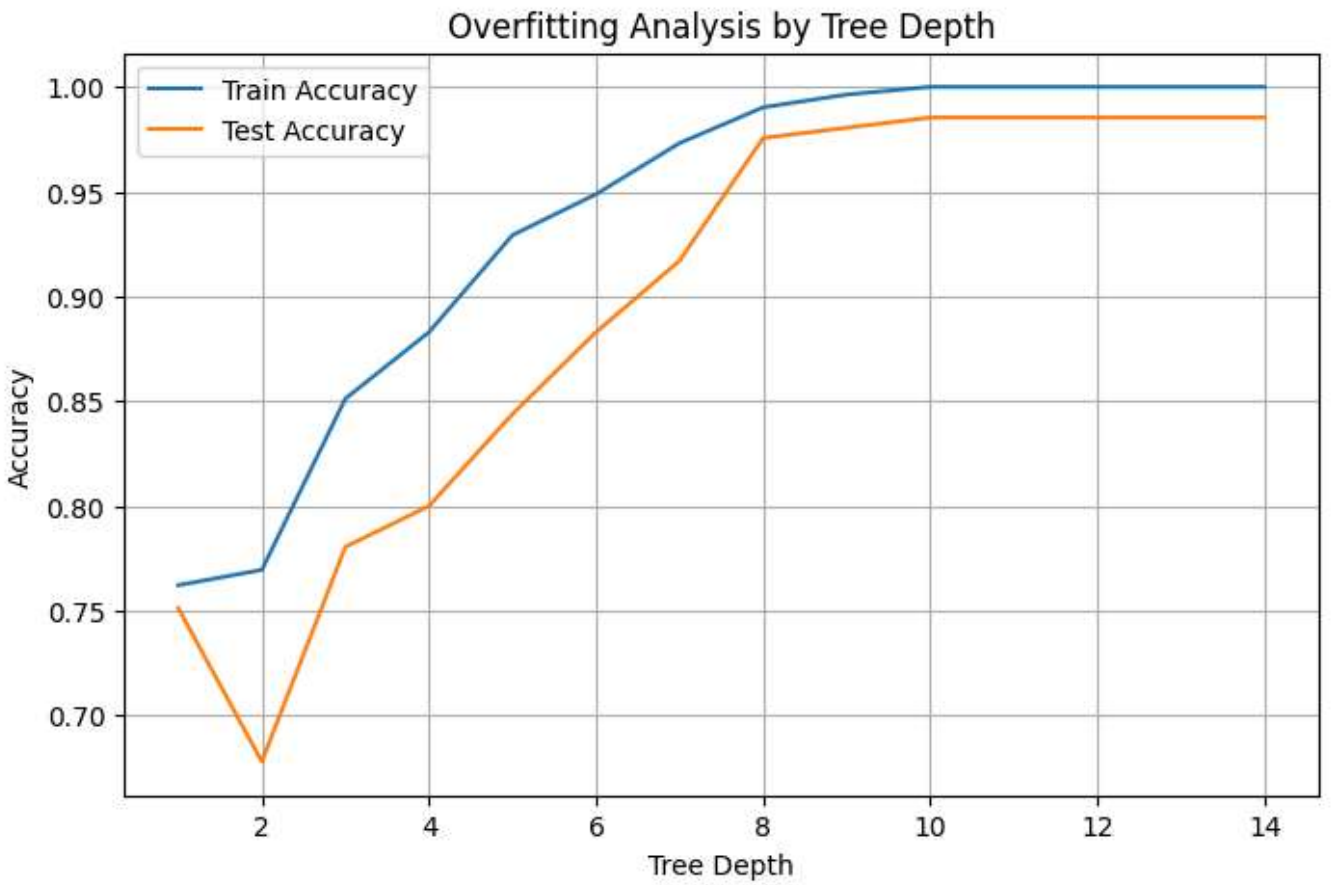
```
plt.figure(figsize=(20,10))
plot_tree(dt_model, filled=True, feature_names=X.columns, class_names=['No Disease', 'Diseas
plt.title("Decision Tree Visualization")
plt.show()
```




```
train_acc = []
test_acc = []
depths = range(1, 15)
for d in depths:
    model = DecisionTreeClassifier(max_depth=d, random_state=42)
    model.fit(X_train, y_train)
    train_acc.append(model.score(X_train, y_train))
    test_acc.append(model.score(X_test, y_test))

plt.figure(figsize=(8,5))
plt.plot(depths, train_acc, label="Train Accuracy")
```

```
plt.plot(depths, test_acc, label="Test Accuracy")
plt.xlabel("Tree Depth")
plt.ylabel("Accuracy")
plt.legend()
plt.title("Overfitting Analysis by Tree Depth")
plt.grid(True)
plt.show()
```




```
rf_model = RandomForestClassifier(n_estimators=100, random_state=42)
rf_model.fit(X_train, y_train)
```

```
RandomForestClassifier
RandomForestClassifier(random_state=42)
```

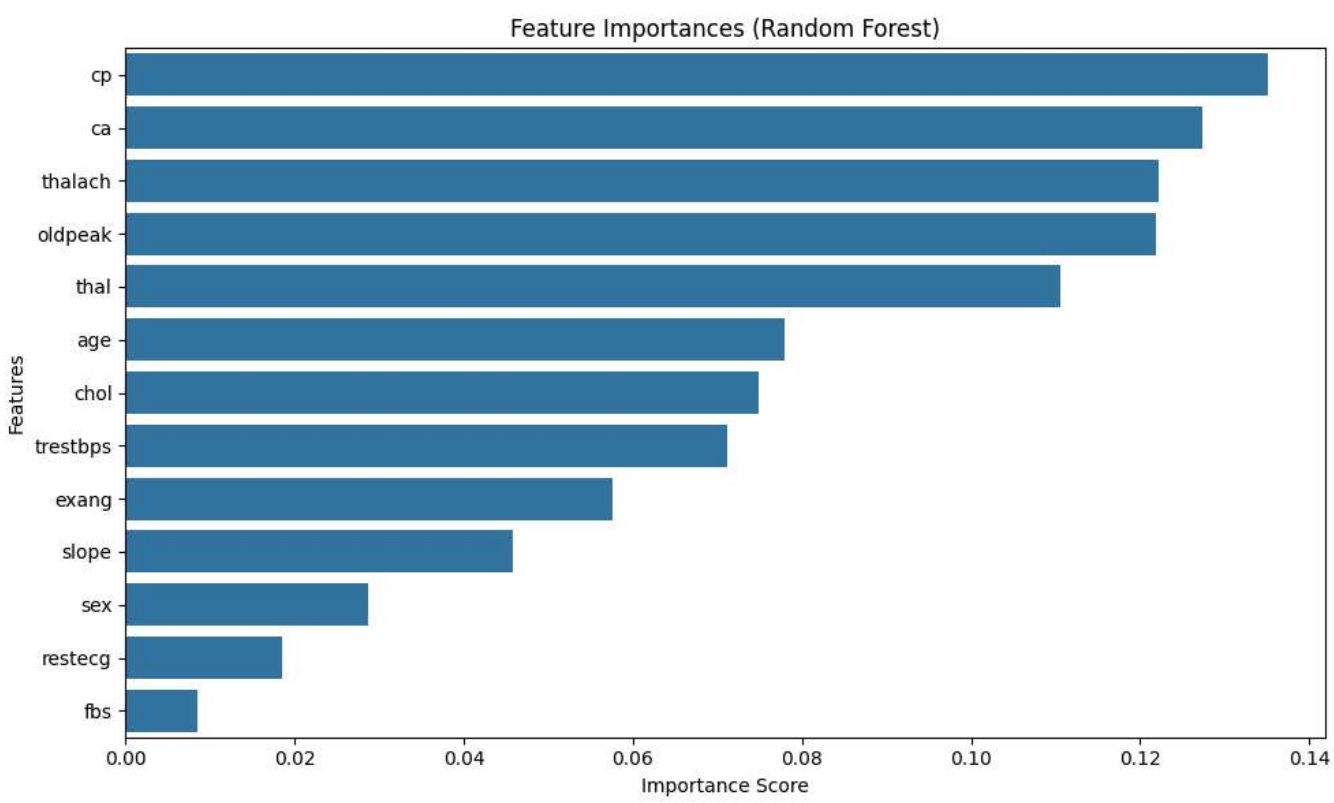
```
y_pred_rf = rf_model.predict(X_test)
print("Random Forest Accuracy:", accuracy_score(y_test, y_pred_rf))
print(classification_report(y_test, y_pred_rf))
```

```
Random Forest Accuracy: 0.9853658536585366
              precision    recall  f1-score   support

           0       0.97      1.00      0.99       102
           1       1.00      0.97      0.99       103
```

```
              accuracy                           0.99       205
             macro avg       0.99      0.99      0.99       205
          weighted avg       0.99      0.99      0.99       205
```

```
importances = rf_model.feature_importances_
features = pd.Series(importances, index=X.columns).sort_values(ascending=False)
plt.figure(figsize=(10,6))
sns.barplot(x=features, y=features.index)
plt.title("Feature Importances (Random Forest)")
plt.xlabel("Importance Score")
plt.ylabel("Features")
plt.tight_layout()
plt.show()
```

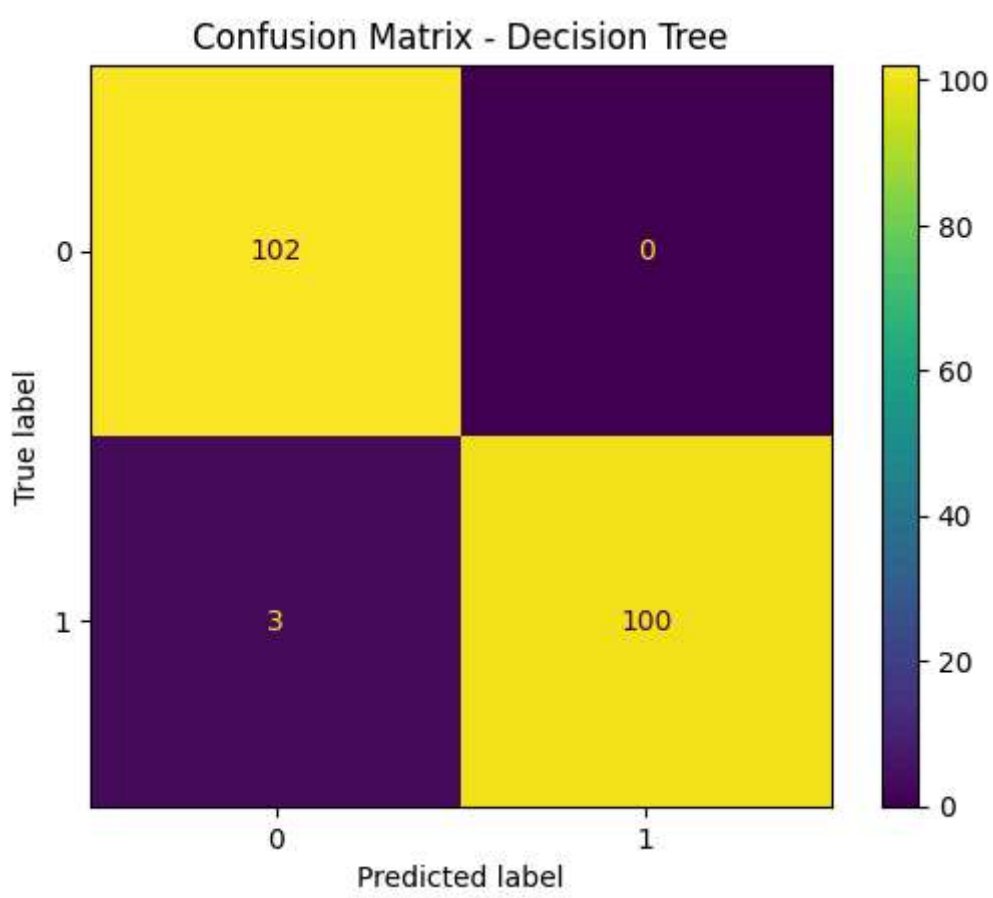



```
dt_cv_scores = cross_val_score(dt_model, X, y, cv=5)
rf_cv_scores = cross_val_score(rf_model, X, y, cv=5)
```

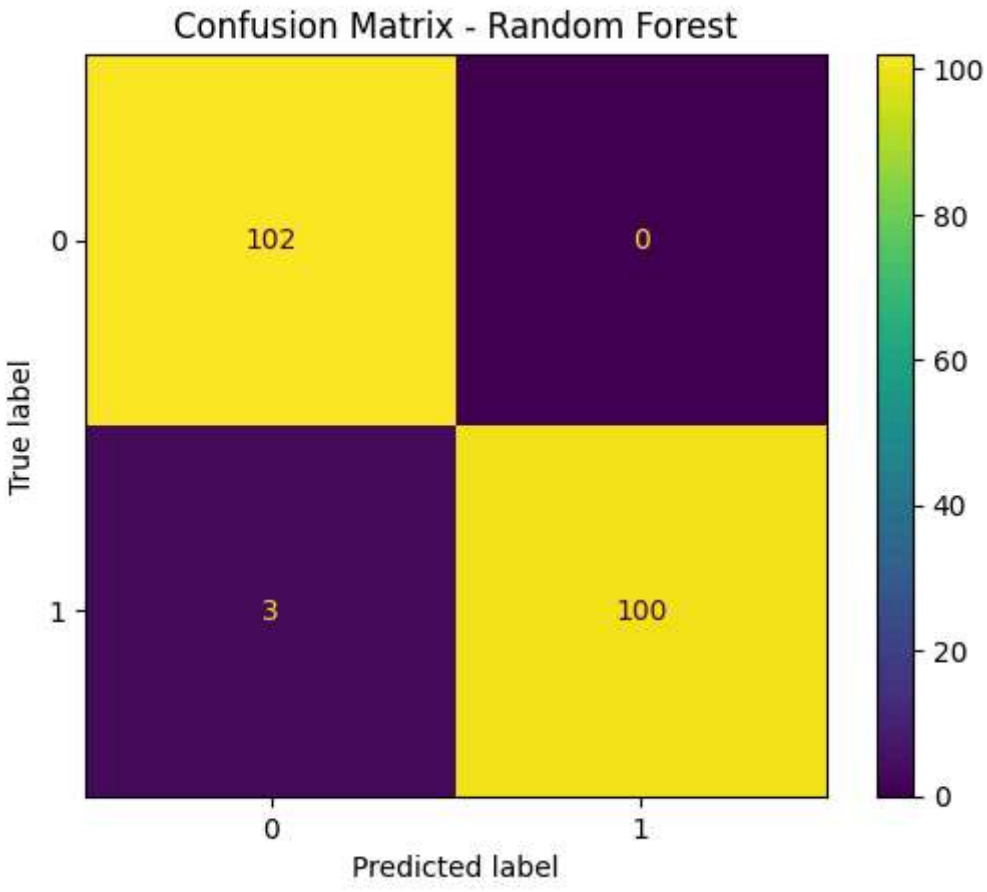
```
print("Decision Tree Cross-Validation Accuracy:", np.mean(dt_cv_scores))
print("Random Forest Cross-Validation Accuracy:", np.mean(rf_cv_scores))
```

```
Decision Tree Cross-Validation Accuracy: 1.0
Random Forest Cross-Validation Accuracy: 0.9970731707317073
```

```
cm_dt = confusion_matrix(y_test, y_pred_dt)
disp_dt = ConfusionMatrixDisplay(confusion_matrix=cm_dt, display_labels=dt_model.classes_)
disp_dt.plot()
plt.title("Confusion Matrix - Decision Tree")
plt.show()
```




```
plt.show()
cm_rf = confusion_matrix(y_test, y_pred_rf)
disp_rf = ConfusionMatrixDisplay(confusion_matrix=cm_rf, display_labels=rf_model.classes_)
disp_rf.plot()
plt.title("Confusion Matrix - Random Forest")
plt.show()
```


Confusion Matrix - Random Forest
102
0
3
100
0
1
True label
0
1
Predicted label
100
80
60
40
20
0