Importing Libraries And Datasets

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

```
df = pd.read_csv("/content/heart.csv")
df.head(10)
```

	age	sex	cp	trestbps	chol	fbs	restecg	thalach	exang	oldpeak	slope	ca
0	52	1	0	125	212	0	1	168	0	1.0	2	2
1	53	1	0	140	203	1	0	155	1	3.1	0	0
2	70	1	0	145	174	0	1	125	1	2.6	0	0
3	61	1	0	148	203	0	1	161	0	0.0	2	1
4	62	0	0	138	294	1	1	106	0	1.9	1	3
5	58	0	0	100	248	0	0	122	0	1.0	1	0
6	58	1	0	114	318	0	2	140	0	4.4	0	3
7	55	1	0	160	289	0	0	145	1	0.8	1	1
8	46	1	0	120	249	0	0	144	0	0.8	2	0
9	54	1	0	122	286	0	0	116	1	3.2	1	2

Next steps: Generate code with df | New interactive sheet

```
df.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 1025 entries, 0 to 1024
Data columns (total 14 columns):
 #   Column    Non-Null Count  Dtype
---  ------    --------------  -----
 0   age       1025 non-null   int64
 1   sex       1025 non-null   int64
 2   cp        1025 non-null   int64
 3   trestbps  1025 non-null   int64
 4   chol      1025 non-null   int64
 5   fbs       1025 non-null   int64
 6   restecg   1025 non-null   int64
 7   thalach   1025 non-null   int64
```

```
 8   exang     1025 non-null   int64
 9   oldpeak   1025 non-null   float64
 10  slope     1025 non-null   int64
 11  ca        1025 non-null   int64
 12  thal      1025 non-null   int64
 13  target    1025 non-null   int64
dtypes: float64(1), int64(13)
memory usage: 112.2 KB
```

```
df.describe()
```

	age	sex	cp	trestbps	chol	fbs
count	1025.000000	1025.000000	1025.000000	1025.000000	1025.00000	1025.000000
mean	54.434146	0.695610	0.942439	131.611707	246.00000	0.149268
std	9.072290	0.460373	1.029641	17.516718	51.59251	0.356527
min	29.000000	0.000000	0.000000	94.000000	126.00000	0.000000
25%	48.000000	0.000000	0.000000	120.000000	211.00000	0.000000
50%	56.000000	1.000000	1.000000	130.000000	240.00000	0.000000
75%	61.000000	1.000000	2.000000	140.000000	275.00000	0.000000
max	77.000000	1.000000	3.000000	200.000000	564.00000	1.000000

```
df.shape
```

```
(1025, 14)
```

```
df.isnull().sum()
```

	0
age	0
sex	0
cp	0
trestbps	0
chol	0
fbs	0
restecg	0
thalach	0
exang	0
oldpeak	0
slope	0
ca	0
thal	0
target	0

dtype: int64

Training A Decision Tree Classifier

```
X = df.drop('target', axis=1)
y = df['target']
```

```
X_train, X_test, y_train, y_test = train_test_split(X, y, test_size=0.3, random_
```

```
print(f"Training Set Size: {X_train.shape[0]}")
print(f"Testing Set Size: {X_test.shape[0]}")
```

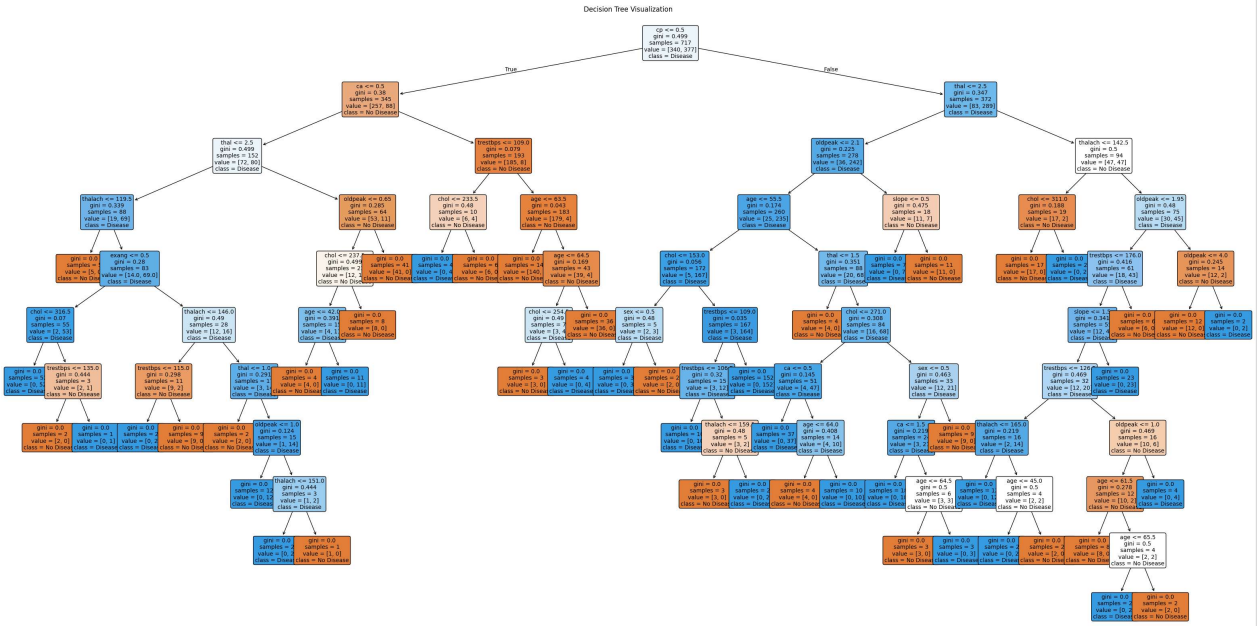
```
Training Set Size: 717
Testing Set Size: 308
```

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

y_train_pred_dt = dt.predict(X_train)
y_test_pred_dt = dt.predict(X_test)

train_acc_dt = accuracy_score(y_train, y_train_pred_dt)
test_acc_dt = accuracy_score(y_test, y_test_pred_dt)
```

```
print(f"Decision Tree (Unconstrained) Training Accuracy: {train_acc_dt:.5f}")
print(f"Decision Tree (Unconstrained) Testing Accuracy: {test_acc_dt:.5f}")
```

```
Decision Tree (Unconstrained) Training Accuracy: 1.00000
Decision Tree (Unconstrained) Testing Accuracy: 0.97078
```

```
plt.figure(figsize=(40, 20))
plot_tree(
    dt,
    feature_names=X.columns.tolist(),
    class_names=['No Disease', 'Disease'],
    filled=True,
    rounded=True,
    fontsize=10
)
plt.title("Decision Tree Visualization")
plt.show()
```

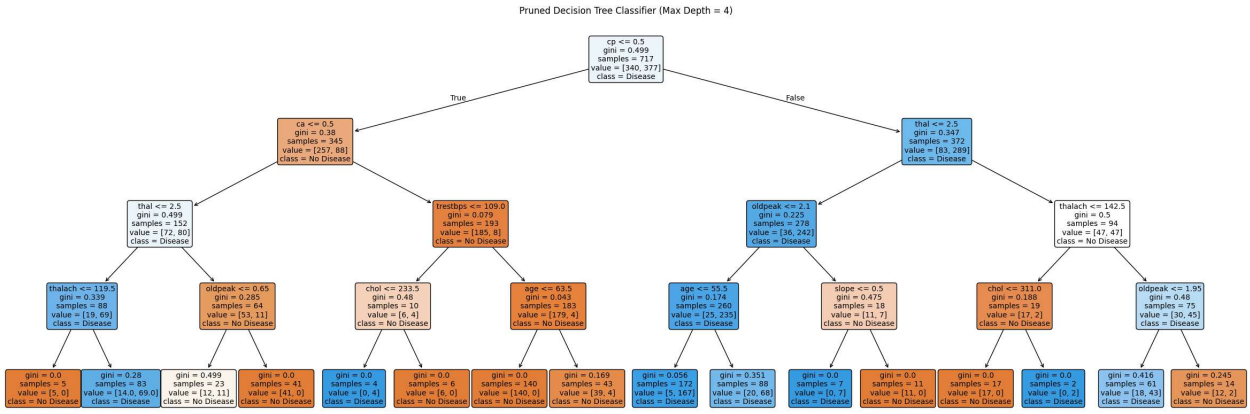


Controlling Tree Depth

```
dt_pruned = DecisionTreeClassifier(max_depth=4, min_samples_split=10, random_sta
dt_pruned.fit(X_train, y_train)

y_train_pred_pruned = dt_pruned.predict(X_train)
y_test_pred_pruned = dt_pruned.predict(X_test)

train_acc_pruned = accuracy_score(y_train, y_train_pred_pruned)
test_acc_pruned = accuracy_score(y_test, y_test_pred_pruned)

print(f"Decision Tree (Pruned) Training Accuracy: {train_acc_pruned:.5f}")
print(f"Decision Tree (Pruned) Testing Accuracy: {test_acc_pruned:.5f}")
```

```
Decision Tree (Pruned) Training Accuracy: 0.89679
Decision Tree (Pruned) Testing Accuracy: 0.83442
```

```
plt.figure(figsize=(30, 10))
plot_tree(
    dt_pruned,
    feature_names=X.columns.tolist(),
    class_names=['No Disease', 'Disease'],
    filled=True,
    rounded=True,
    fontsize=10
)
plt.title("Pruned Decision Tree Classifier (Max Depth = 4)")
plt.show()
```



Training A Random Forest

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

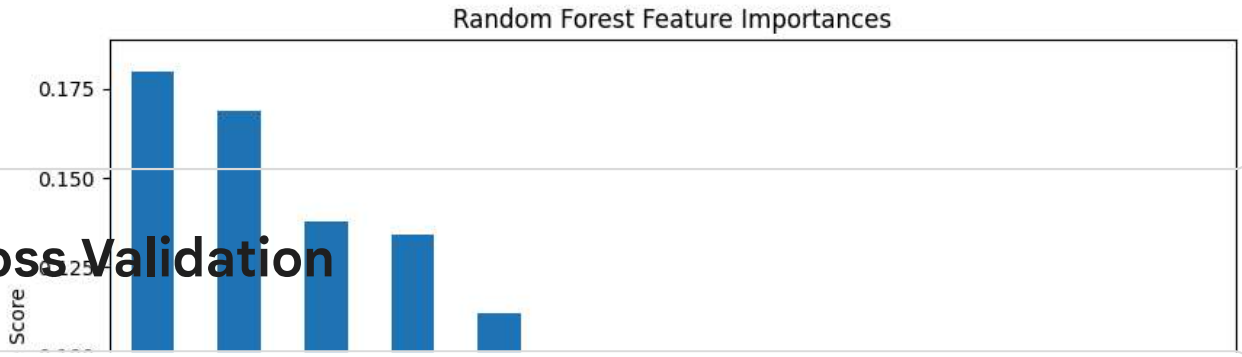
```
y_train_pred_rf = rf_classifier.predict(X_train)
y_test_pred_rf = rf_classifier.predict(X_test)

train_acc_rf = accuracy_score(y_train, y_train_pred_rf)
test_acc_rf = accuracy_score(y_test, y_test_pred_rf)

print(f"Random Forest Training Accuracy: {train_acc_rf:.5f}")
print(f"Random Forest Testing Accuracy: {test_acc_rf:.5f}")
```

```
Random Forest Training Accuracy: 0.93305
Random Forest Testing Accuracy: 0.88636
```

Interpreting Feature Importances

```
feature_importances = pd.Series(rf_classifier.feature_importances_, index=X.colu
sorted_features = feature_importances.sort_values(ascending=False)

print("Feature Importances In Random Forest:")
print(sorted_features.head(20))

plt.figure(figsize=(10, 6))
sorted_features.plot(kind='bar')
plt.title("Random Forest Feature Importances")
plt.ylabel("Importance Score")
plt.show()
```

```
Feature Importances In Random Forest:
cp          0.179715
thal        0.168812
oldpeak     0.137887
ca          0.134040
thalach     0.112034
exang       0.060258
slope       0.057825
age         0.052019
trestbps    0.033680
chol        0.027935
sex         0.025397
restecg     0.006950
fbs         0.003448
dtype: float64
```



Cross Validation

```
cv_scores_dt = cross_val_score(dt_pruned, X, y, cv=5, scoring='accuracy')

cv_scores_rf = cross_val_score(rf_classifier, X, y, cv=5, scoring='accuracy')

print(f"Decision Tree CV Scores: {cv_scores_dt}")
print(f"Decision Tree Mean CV Accuracy: {cv_scores_dt.mean():.5f}")
print(f"Random Forest CV Scores: {cv_scores_rf}")
print(f"Random Forest Mean CV Accuracy: {cv_scores_rf.mean():.5f}")
```


```
Decision Tree CV Scores: [0.84390244 0.83414634 0.87317073 0.80487805 0.81463415]
Decision Tree Mean CV Accuracy: 0.83415
```