detection_testing

April 10, 2024

[30]:
```
pip install matplotlib seaborn scikit-learn shap
```

```
Requirement already satisfied: matplotlib in ./venv/lib/python3.11/site-packages
(3.8.4)
Requirement already satisfied: seaborn in ./venv/lib/python3.11/site-packages
(0.13.2)
Requirement already satisfied: scikit-learn in ./venv/lib/python3.11/site-
packages (1.4.2)
Collecting shap
  Downloading shap-0.45.0-cp311-cp311-
manylinux_2_12_x86_64.manylinux2010_x86_64.manylinux_2_17_x86_64.manylinux2014_x
86_64.whl (538 kB)
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Requirement already satisfied: contourpy>=1.0.1 in
./venv/lib/python3.11/site-packages (from matplotlib) (1.2.1)
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Requirement already satisfied: fonttools>=4.22.0 in ./venv/lib/python3.11/site-
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Requirement already satisfied: numpy>=1.21 in ./venv/lib/python3.11/site-
packages (from matplotlib) (1.26.4)
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packages (from matplotlib) (24.0)
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(from matplotlib) (10.2.0)
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packages (from matplotlib) (3.1.2)
Requirement already satisfied: python-dateutil>=2.7 in
./venv/lib/python3.11/site-packages (from matplotlib) (2.9.0.post0)
Requirement already satisfied: pandas>=1.2 in ./venv/lib/python3.11/site-
packages (from seaborn) (2.2.1)
Requirement already satisfied: scipy>=1.6.0 in ./venv/lib/python3.11/site-
packages (from scikit-learn) (1.13.0)
Requirement already satisfied: joblib>=1.2.0 in ./venv/lib/python3.11/site-
packages (from scikit-learn) (1.4.0)
```

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Requirement already satisfied: threadpoolctl>=2.0.0 in
./venv/lib/python3.11/site-packages (from scikit-learn) (3.4.0)
Collecting tqdm>=4.27.0
  Downloading tqdm-4.66.2-py3-none-any.whl (78 kB)
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15.1 MB/s eta 0:00:00
Collecting slicer==0.0.7
  Downloading slicer-0.0.7-py3-none-any.whl (14 kB)
Collecting numba
  Downloading
numba-0.59.1-cp311-cp311-manylinux2014_x86_64.manylinux_2_17_x86_64.whl (3.7 MB)
                           3.7/3.7 MB
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Collecting cloudpickle
  Downloading cloudpickle-3.0.0-py3-none-any.whl (20 kB)
Requirement already satisfied: pytz>=2020.1 in ./venv/lib/python3.11/site-
packages (from pandas>=1.2->seaborn) (2024.1)
Requirement already satisfied: tzdata>=2022.7 in ./venv/lib/python3.11/site-
packages (from pandas>=1.2->seaborn) (2024.1)
Requirement already satisfied: six>=1.5 in ./venv/lib/python3.11/site-packages
(from python-dateutil>=2.7->matplotlib) (1.16.0)
Collecting llvmlite<0.43,>=0.42.0dev0
  Downloading
llvmlite-0.42.0-cp311-cp311-manylinux_2_17_x86_64.manylinux2014_x86_64.whl (43.8
MB)
                           43.8/43.8 MB
10.6 MB/s eta 0:00:0000:0100:01
Installing collected packages: tqdm, slicer, llvmlite, cloudpickle, numba,
shap
Successfully installed cloudpickle-3.0.0 llvmlite-0.42.0 numba-0.59.1
shap-0.45.0 slicer-0.0.7 tqdm-4.66.2
Note: you may need to restart the kernel to use updated packages.
```

[3]:

```
import pandas as pd
import requests

url = "http://192.168.0.222:3000/csv/
 ↪detecting_testing_applied_rules_93e874d3-a01e-4467-ac61-958e5ff22b85.csv"

response = requests.get(url)
with open("network_data.csv", "wb") as file:
    file.write(response.content)

df = pd.read_csv("network_data.csv")
```

[4]:

```
# Check for missing values
print(df.isnull().sum())
```

```
# Check data types
print(df.dtypes)
```

```
timestamp          0
source_ip          0
destination_ip     0
protocol           0
length             0
http_scan          0
ping_scan          0
nmap_scan          0
unmalicious        0
maybemalicious     0
malicious          0
dtype: int64
timestamp          object
source_ip          object
destination_ip     object
protocol           object
length              int64
http_scan           int64
ping_scan           int64
nmap_scan           int64
unmalicious         int64
maybemalicious      int64
malicious           int64
dtype: object
```

[11]:
```
import numpy as np  # Importing NumPy

# Statistical summary
print(df.describe())

# For visualizations, you can use libraries like matplotlib or seaborn
import matplotlib.pyplot as plt
import seaborn as sns

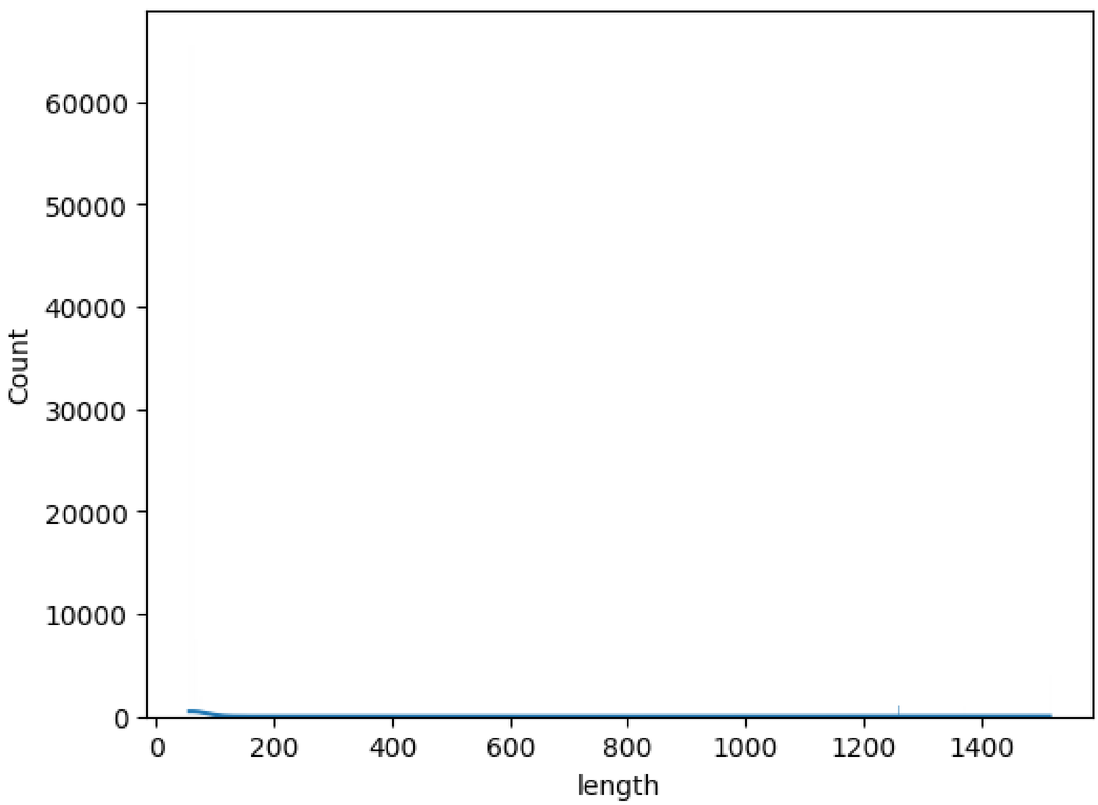
# Example: Distribution of 'length'
sns.histplot(df['length'], kde=True)
plt.show()

# Exclude non-numeric columns for correlation calculation
numeric_df = df.select_dtypes(include=[np.number])

# Now, you can safely compute the correlation matrix and plot the heatmap
plt.figure(figsize=(10, 8))
```

```python
sns.heatmap(numeric_df.corr(), annot=True, fmt=".2f")
plt.show()
```

```
             length      http_scan  ping_scan      nmap_scan    unmalicious  \
count  147019.000000  147019.000000   147019.0  147019.000000  147019.000000
mean      117.825852       0.006965        0.0       0.452799       0.006965
std       278.897565       0.083166        0.0       0.497769       0.083166
min        56.000000       0.000000        0.0       0.000000       0.000000
25%        56.000000       0.000000        0.0       0.000000       0.000000
50%        62.000000       0.000000        0.0       0.000000       0.000000
75%        62.000000       0.000000        0.0       1.000000       0.000000
max      1516.000000       1.000000        0.0       1.000000       1.000000

       maybemalicious      malicious
count        147019.0  147019.000000
mean              0.0       0.452799
std               0.0       0.497769
min               0.0       0.000000
25%               0.0       0.000000
50%               0.0       0.000000
75%               0.0       1.000000
max               0.0       1.000000
```



[12]:
```
# Example: Selecting features based on correlation analysis
# This is a simplified approach, you might need more sophisticated methods like␣
↪Feature Importance from RandomForest

features = df[['length', 'http_scan', 'ping_scan', 'nmap_scan']]  # Example␣
↪feature set
target = df['malicious']  # Assuming 'malicious' is the target variable
```

[17]:
```
from sklearn.model_selection import train_test_split
from sklearn.tree import DecisionTreeClassifier

# Split the data into train and test sets
X_train, X_test, y_train, y_test = train_test_split(features, target,␣
↪test_size=0.2, random_state=42)
```

```
# Initialize the Decision Tree Classifier
model = DecisionTreeClassifier()

# Fit the model
model.fit(X_train, y_train)
```

[17]: DecisionTreeClassifier()

[18]:
```
from sklearn.metrics import classification_report, confusion_matrix

# Predictions
y_pred = model.predict(X_test)

# Evaluation
print(confusion_matrix(y_test, y_pred))
print(classification_report(y_test, y_pred))
```

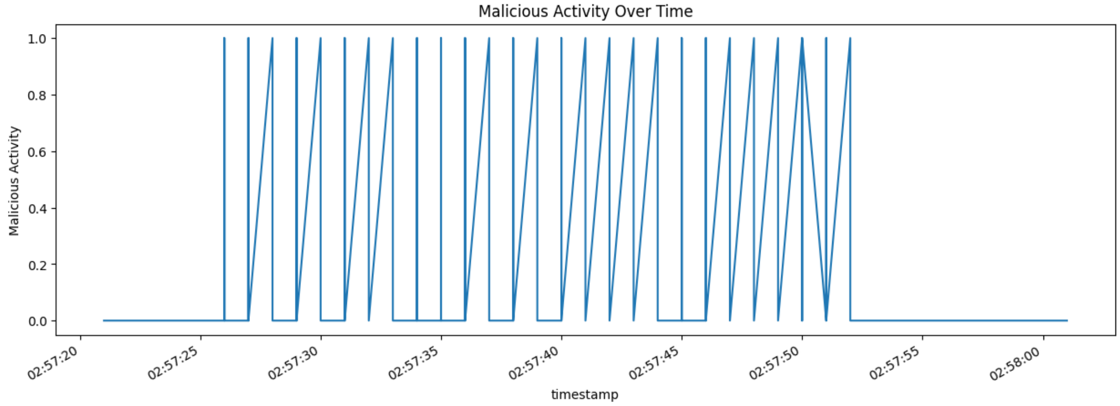
```
[[16064     0]
 [    0 13340]]
              precision    recall  f1-score   support

           0       1.00      1.00      1.00     16064
           1       1.00      1.00      1.00     13340

    accuracy                           1.00     29404
   macro avg       1.00      1.00      1.00     29404
weighted avg       1.00      1.00      1.00     29404
```

[19]:
```
# Feature importance
importance = pd.DataFrame({'feature': features.columns, 'importance': model.
 ↪feature_importances_}).sort_values('importance', ascending=False)
print(importance)
```

```
     feature  importance
3  nmap_scan         1.0
0     length         0.0
1  http_scan         0.0
2  ping_scan         0.0
```

[20]:
```
df['timestamp'] = pd.to_datetime(df['timestamp'])
```

[21]:
```
df.set_index('timestamp')['malicious'].plot(figsize=(15, 5))
plt.ylabel('Malicious Activity')
plt.title('Malicious Activity Over Time')
plt.show()
```



[22]:
```
df['hour'] = df['timestamp'].dt.hour
df['day_of_week'] = df['timestamp'].dt.dayofweek
```

[23]:
```
from sklearn.ensemble import RandomForestClassifier
rf_model = RandomForestClassifier()
rf_model.fit(X_train, y_train)
```

[23]:
```
RandomForestClassifier()
```

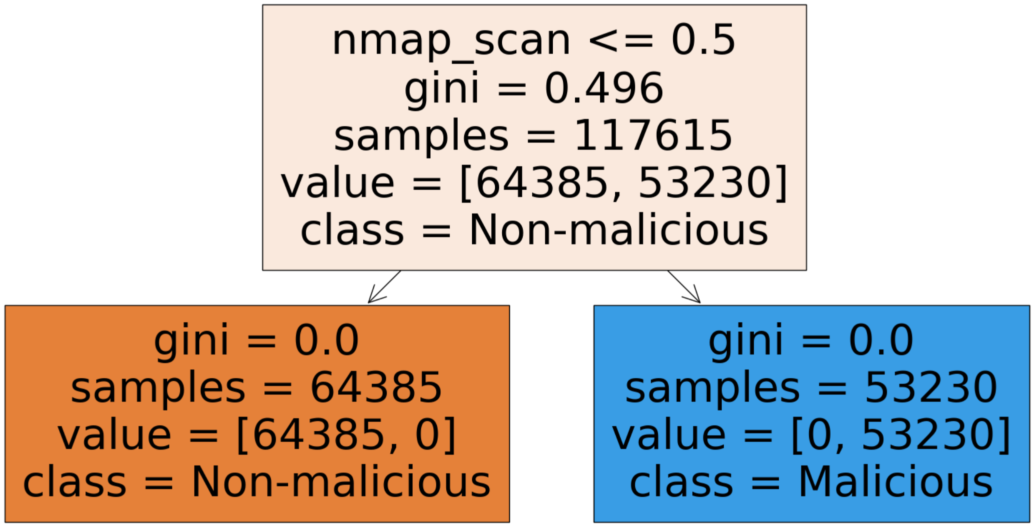
[24]:
```
from sklearn.model_selection import GridSearchCV
param_grid = {'max_depth': [3, 5, 10], 'min_samples_split': [2, 5, 10]}
grid_search = GridSearchCV(DecisionTreeClassifier(), param_grid, cv=5)
grid_search.fit(X_train, y_train)
```

[24]:
```
GridSearchCV(cv=5, estimator=DecisionTreeClassifier(),
             param_grid={'max_depth': [3, 5, 10],
                         'min_samples_split': [2, 5, 10]})
```

[25]:
```
from sklearn.model_selection import cross_val_score
scores = cross_val_score(model, features, target, cv=5, scoring='roc_auc')
print("ROC-AUC scores:", scores)
```

```
ROC-AUC scores: [1. 1. 1. 1. 1.]
```

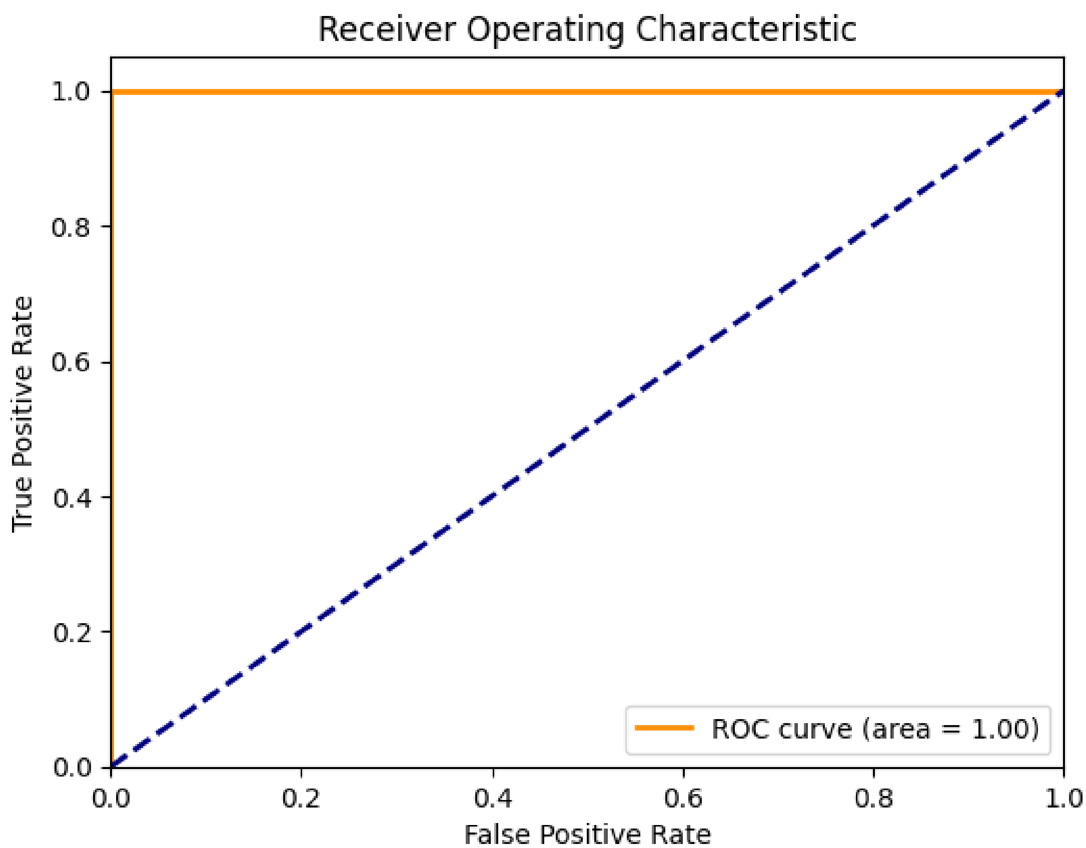
[26]:
```
from sklearn.tree import plot_tree
plt.figure(figsize=(20, 10))
plot_tree(model, filled=True, feature_names=features.columns,␣
  ↪class_names=['Non-malicious', 'Malicious'], max_depth=3)
plt.show()
```



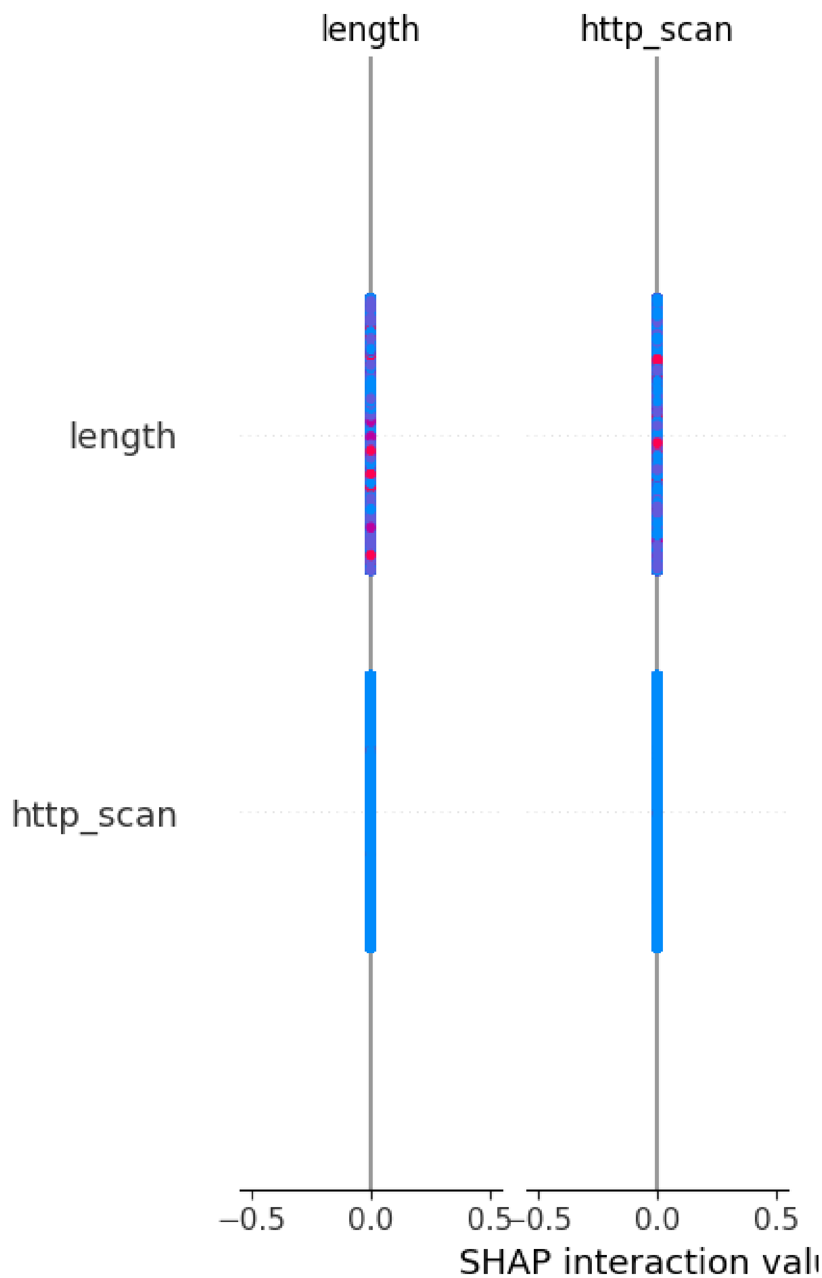
[27]:
```
from sklearn.model_selection import cross_val_score
rf_cross_val_scores = cross_val_score(rf_model, X_train, y_train, cv=5)
print(f"Random Forest Cross-Validation Scores: {rf_cross_val_scores.mean():.2f}
 ± {rf_cross_val_scores.std():.2f}")
```

```
Random Forest Cross-Validation Scores: 1.00 ± 0.00
```

[28]:
```
from sklearn.metrics import roc_curve, auc
fpr, tpr, thresholds = roc_curve(y_test, model.predict_proba(X_test)[:,1])
roc_auc = auc(fpr, tpr)

plt.figure()
plt.plot(fpr, tpr, color='darkorange', lw=2, label='ROC curve (area = %0.2f)' %
 roc_auc)
plt.plot([0, 1], [0, 1], color='navy', lw=2, linestyle='--')
plt.xlim([0.0, 1.0])
plt.ylim([0.0, 1.05])
plt.xlabel('False Positive Rate')
plt.ylabel('True Positive Rate')
plt.title('Receiver Operating Characteristic')
plt.legend(loc="lower right")
plt.show()
```

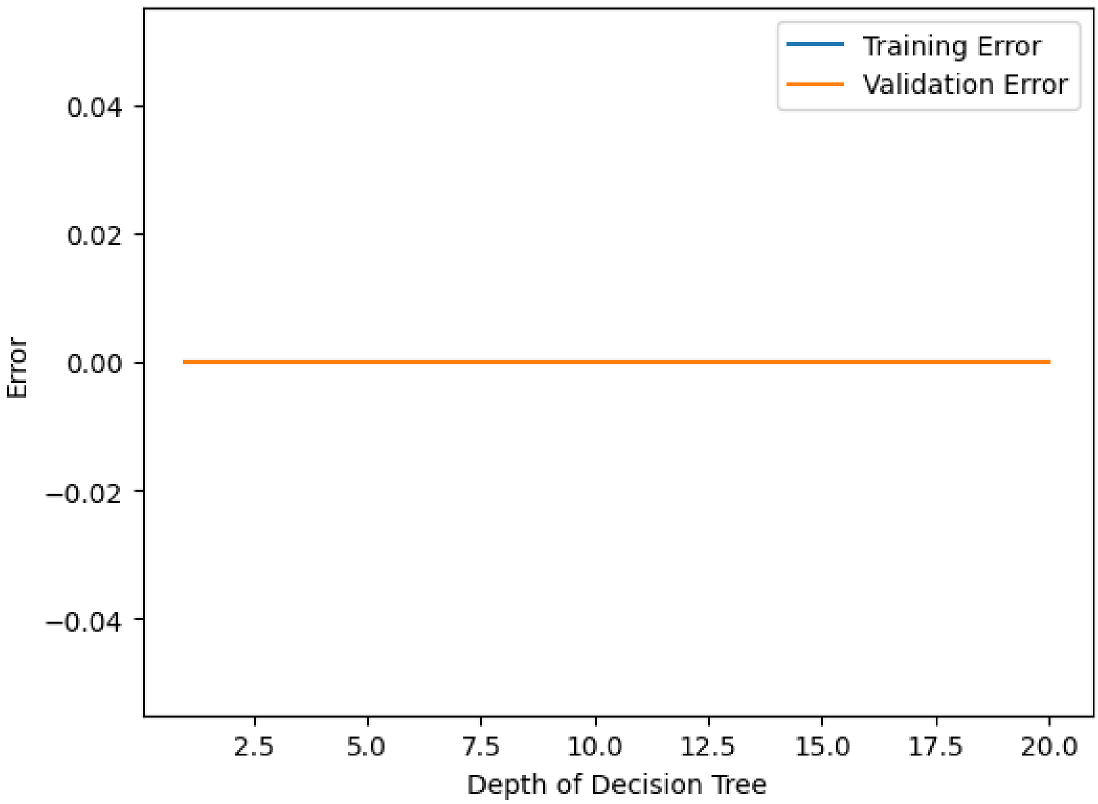


[31]:
```
import shap
# Calculate SHAP values
explainer = shap.TreeExplainer(model)
shap_values = explainer.shap_values(X_train)

# Plot summary plot
shap.summary_plot(shap_values, X_train, feature_names=features.columns)
```



[32]:
```
depths = range(1, 21)
training_error = []
validation_error = []

for depth in depths:
    model = DecisionTreeClassifier(max_depth=depth)
    model.fit(X_train, y_train)
```

```
    training_error.append(1 - model.score(X_train, y_train))
    validation_error.append(1 - model.score(X_test, y_test))

plt.plot(depths, training_error, label='Training Error')
plt.plot(depths, validation_error, label='Validation Error')
plt.xlabel('Depth of Decision Tree')
plt.ylabel('Error')
plt.legend()
plt.show()
```



[ ]: