```python
import pandas as pd
import numpy as np
import matplotlib.pyplot as plt
from sklearn.model_selection import train_test_split, GridSearchCV
from sklearn.ensemble import RandomForestClassifier
from sklearn.metrics import classification_report,
confusion_matrix,accuracy_score
```

```
C:\Users\user1\AppData\Roaming\Python\Python311\site-packages\pandas\
core\arrays\masked.py:61: UserWarning: Pandas requires version '1.3.6'
or newer of 'bottleneck' (version '1.3.5' currently installed).
  from pandas.core import (
```

```python
df =
pd.read_excel("C:/Users/user1/Downloads/random_forest_dataset.xlsx")
df.head()
```

```
  Unnamed: 0  Unnamed: 1               Unnamed: 2  \
0     Sl No         USN                     Name   
1          1  1RV21MC001               ABHISHEK M   
2          2  1RV21MC002  ABHISHEK RANJANAGOUDA G   
3          3  1RV21MC003           ADARSH V MORYE   
4          4  1RV21MC004       AISHWARYA K KAMBLE   

                                          Unnamed: 3 Unnamed: 4 
Unnamed: 5  \
0                                              Title         P1 
C1   
1                        Generative AI Prompt Pipeline         78 
15.6   
2  Android based Smart Vehicle Parking System usi...         84 
16.8   
3          Sentimental Analysis for product ratings         84 
16.8   
4  Analysis and Deployment of an efficient Deep L...         88 
17.6   

  Unnamed: 6 Unnamed: 7 Unnamed: 8 Unnamed: 9 Unnamed: 10 Unnamed: 11
\
0         P2         C2         P3         C3           R1           T1

1         85         34         93       18.6           13            4

2         82       32.8         77       15.4           15            5

3         82       32.8         88       17.6           13            1

4         85         34         96       19.2           13            4


  Unnamed: 12 Unnamed: 13 Unnamed: 14
```

```
0         P3T      Total        Grade
1        35.6       85.2            A
2        35.4         85            A
3        31.6       81.2            A
4        36.2       87.8            A
```

```
!pip install --upgrade openpyxl
```

```
df = 
pd.read_excel("C:/Users/user1/Downloads/random_forest_dataset.xlsx", 
header=1)
df.head()
```

```
   Sl No         USN                             Name   \
0      1  1RV21MC001                      ABHISHEK M   
1      2  1RV21MC002        ABHISHEK RANJANAGOUDA G   
2      3  1RV21MC003                  ADARSH V MORYE   
3      4  1RV21MC004              AISHWARYA K KAMBLE   
4      5  1RV21MC005  AISHWARYA NAGARAJ BABALESHWAR   

                                               Title   P1    C1    P2  
C2  \
0                      Generative AI Prompt Pipeline   78  15.6  85.0 
34.0   
1  Android based Smart Vehicle Parking System usi...   84  16.8  82.0 
32.8   
2           Sentimental Analysis for product ratings   84  16.8  82.0 
32.8   
3  Analysis and Deployment of an efficient Deep L...   88  17.6  85.0 
34.0   
4  Development of Deep Learning Model for Varied ...   84  16.8  82.0 
32.8   

   P3    C3    R1   T1   P3T  Total  Grade  
0  93  18.6  13.0  4.0  35.6    85.2     A  
1  77  15.4  15.0  5.0  35.4    85.0     A  
2  88  17.6  13.0  1.0  31.6    81.2     A  
3  96  19.2  13.0  4.0  36.2    87.8     A  
4  77  15.4  15.0  5.0  35.4    85.0     A  
```

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

```
Sl No     0
USN       0
Name      0
Title     1
P1        0
C1        0
P2        0
C2        0
P3        0
```

```
C3       0
R1       8
T1       8
P3T      0
Total    0
Grade    8
dtype: int64
```

```python
# handle outliers
df.dropna(inplace=True)
# there is this extra space after the column names
x = df.drop(['Sl No ',"USN ","Name ","Title ","Grade"],axis=1)
y = df.Grade
```

```python
x.head()
```

```
   P1    C1    P2    C2  P3    C3    R1   T1   P3T  Total
0  78  15.6  85.0  34.0  93  18.6  13.0  4.0  35.6   85.2
1  84  16.8  82.0  32.8  77  15.4  15.0  5.0  35.4   85.0
2  84  16.8  82.0  32.8  88  17.6  13.0  1.0  31.6   81.2
3  88  17.6  85.0  34.0  96  19.2  13.0  4.0  36.2   87.8
4  84  16.8  82.0  32.8  77  15.4  15.0  5.0  35.4   85.0
```

```python
from sklearn.preprocessing import LabelEncoder
```

```python
label_encoder = LabelEncoder()
y = label_encoder.fit_transform(df['Grade'])
```

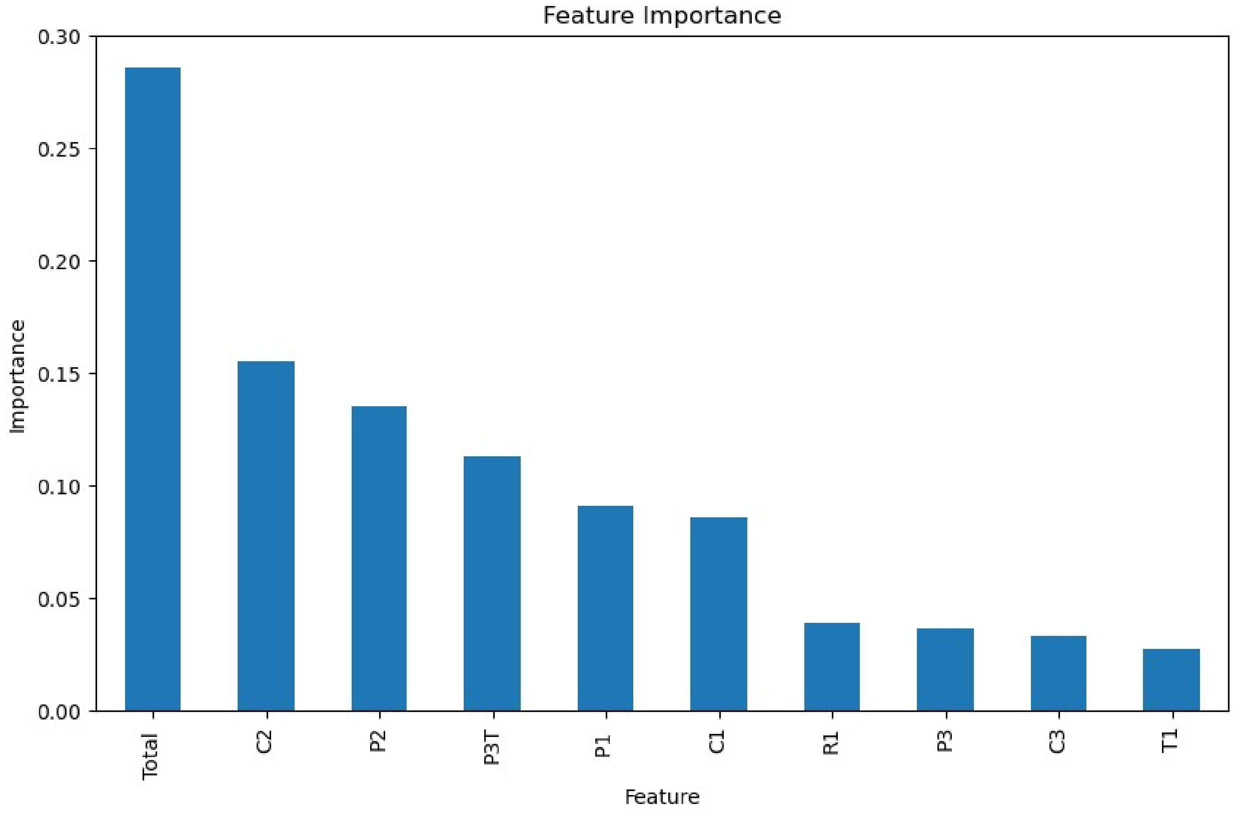
```python
x_train,x_test,y_train,y_test = train_test_split(x,y,test_size=0.3)
rf = RandomForestClassifier(random_state=42)
rf.fit(x_train,y_train)
```

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

```python
feature_importances = pd.Series(rf.feature_importances_,
index=x.columns).sort_values(ascending=False)
print(feature_importances)
plt.figure(figsize=(10, 6))
feature_importances.plot(kind='bar')
plt.xlabel('Feature')
plt.ylabel('Importance')
plt.title('Feature Importance')
plt.show()
```

```
Total    0.285888
C2       0.155264
P2       0.134901
P3T      0.112617
P1       0.090618
C1       0.085522
R1       0.038839
```

```
P3         0.036235
C3         0.033041
T1         0.027075
dtype: float64
```



```python
from sklearn.model_selection import GridSearchCV, RandomizedSearchCV
from sklearn.ensemble import RandomForestClassifier

# Define the parameter grid correctly
param_grid = {
    'n_estimators': [100, 200, 300],  # Fixed key name
    'max_depth': [10, 20, 30],
    'min_samples_split': [2, 5, 10],
    'min_samples_leaf': [1, 2, 4]  # Fixed "min_samples_lear" typo
}

grid_search = GridSearchCV(estimator=rf, param_grid = param_grid,
cv=5, n_jobs=-1,verbose=1)

grid_search.fit(x_train,y_train)
```

```
Fitting 5 folds for each of 81 candidates, totalling 405 fits
```

```
C:\ProgramData\anaconda3\Lib\site-packages\sklearn\model_selection\
_split.py:700: UserWarning: The least populated class in y has only 4
members, which is less than n_splits=5.
  warnings.warn(
```

```
GridSearchCV(cv=5, estimator=RandomForestClassifier(random_state=42),
n_jobs=-1,
             param_grid={'max_depth': [10, 20, 30],
                         'min_samples_leaf': [1, 2, 4],
                         'min_samples_split': [2, 5, 10],
                         'n_estimators': [100, 200, 300]},
             verbose=1)
```

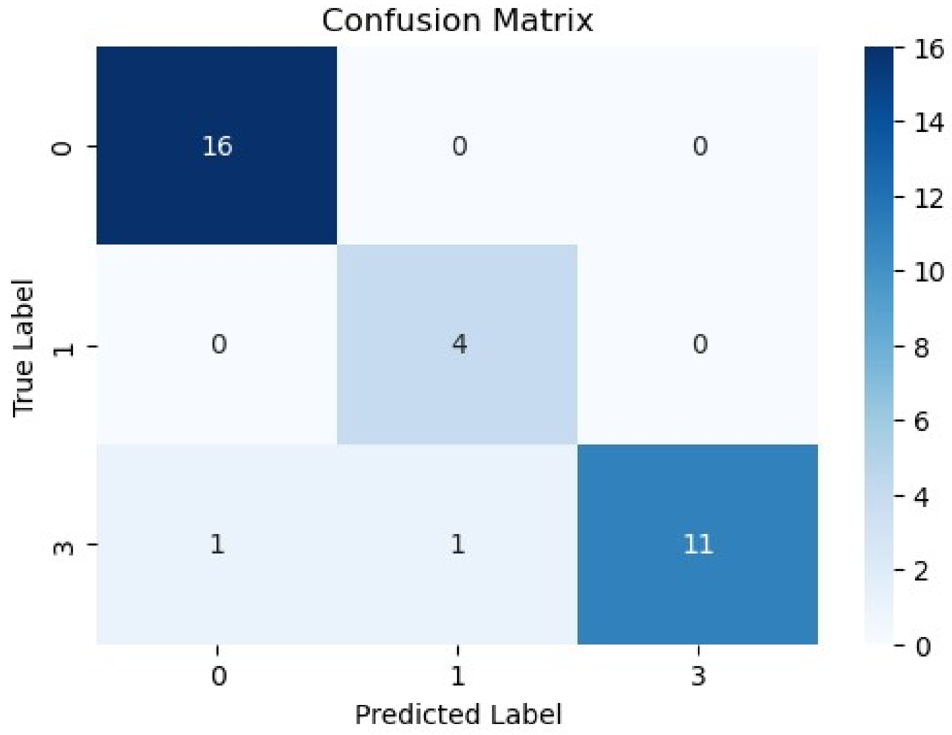
```
best_params = grid_search.best_params_
best_params
```

```
{'max_depth': 10,
 'min_samples_leaf': 1,
 'min_samples_split': 2,
 'n_estimators': 100}
```

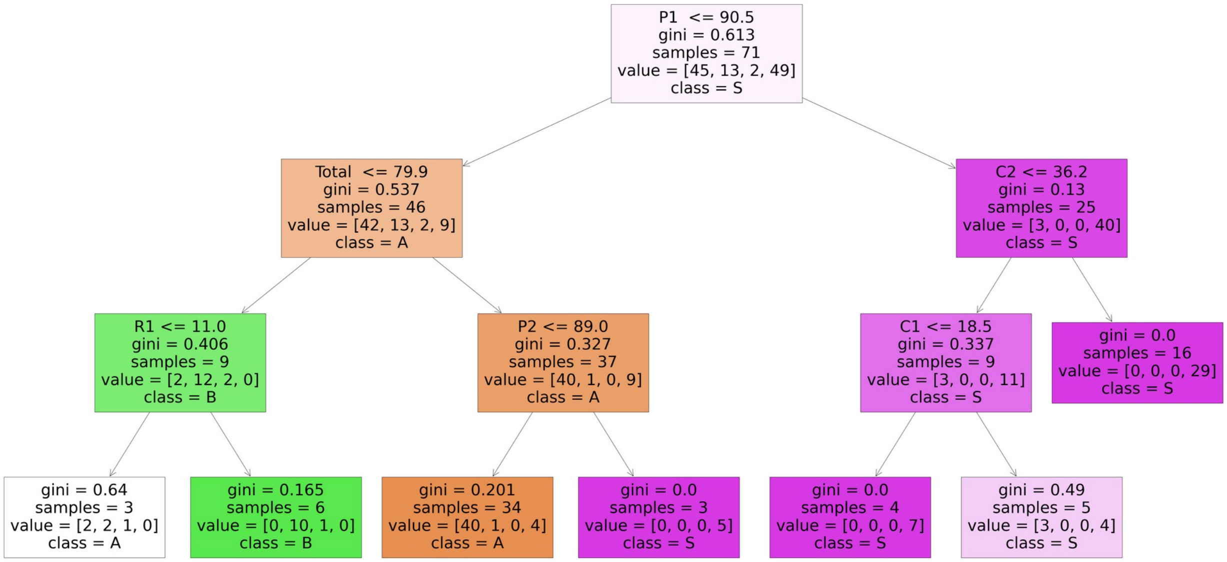
```
best_rf = RandomForestClassifier(random_state=42,**best_params)
best_rf.fit(x_train,y_train)
y_pred = best_rf.predict(x_test)
```

```
import matplotlib.pyplot as plt
import seaborn as sns
from sklearn.metrics import (
    accuracy_score, precision_score, recall_score, f1_score,
confusion_matrix,
    classification_report
)
# Print metrics
accuracy = accuracy_score(y_test, y_pred)
precision = precision_score(y_test, y_pred, average='weighted')
recall = recall_score(y_test, y_pred, average='weighted')
f1 = f1_score(y_test, y_pred, average='weighted')

print(f"□ Accuracy: {accuracy:.4f}")
print(f"□ Precision: {precision:.4f}")
print(f"□ Recall: {recall:.4f}")
print(f"□ F1 Score: {f1:.4f}")

# Print classification report
print("\n□ Classification Report:\n", classification_report(y_test,
y_pred))
```

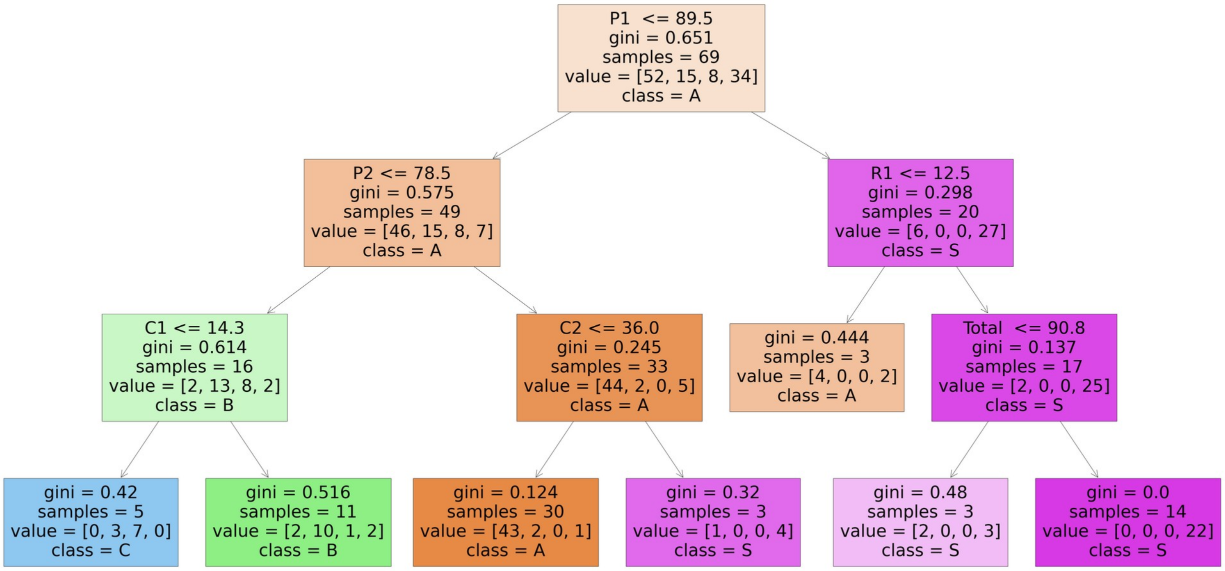
```
□ Accuracy: 0.9394
□ Precision: 0.9472
□ Recall: 0.9394
□ F1 Score: 0.9390

□ Classification Report:
              precision    recall  f1-score   support

           0       0.94      1.00      0.97        16
           1       0.80      1.00      0.89         4
           3       1.00      0.85      0.92        13

    accuracy                           0.94        33
   macro avg       0.91      0.95      0.93        33
weighted avg       0.95      0.94      0.94        33


# Confusion matrix
cm = confusion_matrix(y_test, y_pred)

plt.figure(figsize=(6,4))
sns.heatmap(cm, annot=True, fmt="d", cmap="Blues",
xticklabels=np.unique(y_test), yticklabels=np.unique(y_test))
plt.xlabel("Predicted Label")
plt.ylabel("True Label")
plt.title("Confusion Matrix")
plt.show()
```



```
from sklearn.tree import plot_tree
plt.figure(figsize=(80,40))
plot_tree(best_rf.estimators_[5], feature_names =
x.columns,class_names=['A', 'B', 'C', 'S'],filled=True);
```



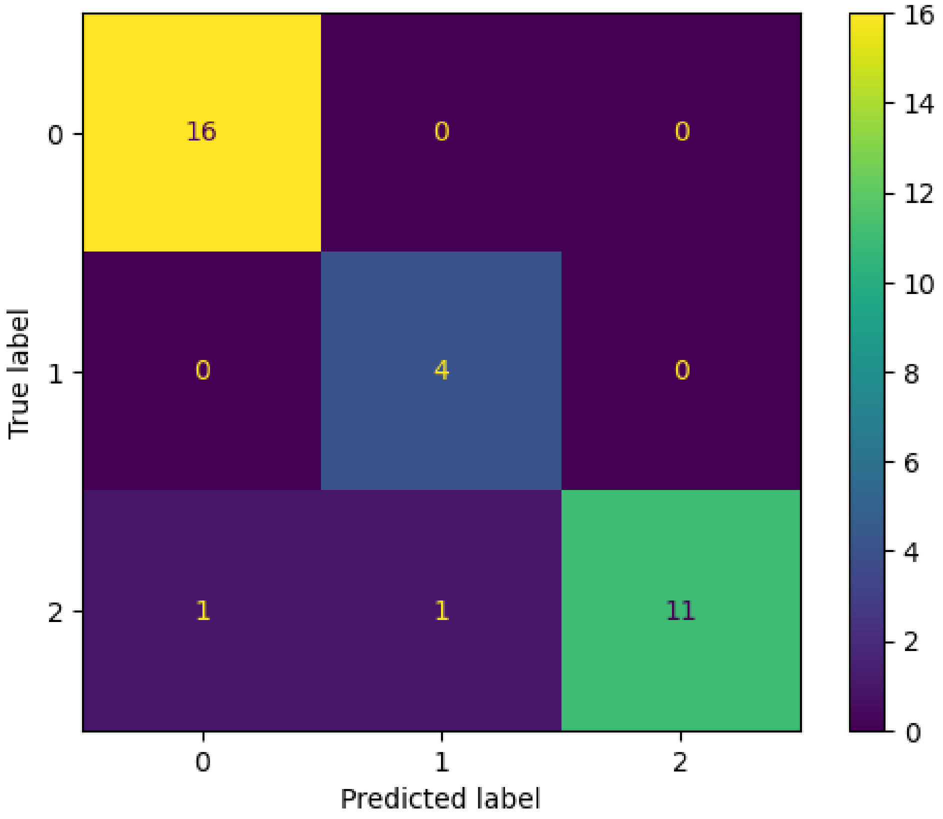
```
from sklearn.tree import plot_tree
plt.figure(figsize=(80,40))
plot_tree(best_rf.estimators_[7], feature_names =
x.columns,class_names=['A', 'B', 'C', 'S'],filled=True);
```



```
from sklearn.model_selection import RandomizedSearchCV
from sklearn.metrics import  ConfusionMatrixDisplay
from sklearn.model_selection import RandomizedSearchCV,
train_test_split
from scipy.stats import randint
param_dist = {
  'n_estimators': randint(100, 500),
  'max_depth': randint(3, 15),
  'min_samples_split': randint(2, 10),
  'min_samples_leaf': randint(1, 5)
}


# Create a random forest classifier
rf = RandomForestClassifier(random_state=42, n_jobs=-1)

# Use random search to find the best hyperparameters
rand_search = RandomizedSearchCV(
  rf, param_distributions=param_dist,
  n_iter=10, cv=5, scoring='accuracy',
  n_jobs=-1, random_state=42)
rand_search.fit(x, y)

# Create a variable for the best model
best_rf = rand_search.best_estimator_

# Print the best hyperparameters
print('Best hyperparameters:',  rand_search.best_params_)
    # Generate predictions with the best model
y_pred = best_rf.predict(x_test)

# Create the confusion matrix
cm = confusion_matrix(y_test, y_pred)

ConfusionMatrixDisplay(confusion_matrix=cm).plot();
```

```
C:\ProgramData\anaconda3\Lib\site-packages\sklearn\model_selection\
_split.py:700: UserWarning: The least populated class in y has only 4
members, which is less than n_splits=5.
  warnings.warn(
```

```
Best hyperparameters: {'max_depth': 3, 'min_samples_leaf': 3,
'min_samples_split': 4, 'n_estimators': 269}
```


16
0
0
0
4
0
1
1
11
True label
0
1
2
Predicted label
0
1
2
16
14
12
10
8
6
4
2
0