Project: Decision Tree Classifier for Bank Marketing Dataset

Purpose: Predict whether a customer will purchase a product or service based on demographic and behavioral data.

Dataset: Bank Marketing Dataset (UCI Machine Learning Repository)

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

```
from google.colab import files
uploaded = files.upload()
```

Choose Files bank-full.csv

- **bank-full.csv**(text/csv) - 4610348 bytes, last modified: 2/14/2012 - 100% done

```
df = pd.read_csv("/content/bank-full.csv", sep=";", quotechar='"')
df.head()
```

	age	job	marital	education	default	balance	housing	loan	contact	day	month	duration	campaign	pdays	previous	poutcc
0	58	management	married	tertiary	no	2143	yes	no	unknown	5	may	261	1	-1	0	unkno
1	44	technician	single	secondary	no	29	yes	no	unknown	5	may	151	1	-1	0	unkno
2	33	entrepreneur	married	secondary	no	2	yes	yes	unknown	5	may	76	1	-1	0	unkno
3	47	blue-collar	married	unknown	no	1506	yes	no	unknown	5	may	92	1	-1	0	unkno
4	33	unknown	single	unknown	no	1	no	no	unknown	5	may	198	1	-1	0	unkno

Next steps: Generate code with df | View recommended plots | New interactive sheet

Understand the Data

```
df.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 45211 entries, 0 to 45210
Data columns (total 17 columns):
 #   Column     Non-Null Count  Dtype
---  ------     --------------  -----
 0   age        45211 non-null  int64
 1   job        45211 non-null  object
 2   marital    45211 non-null  object
 3   education  45211 non-null  object
 4   default    45211 non-null  object
 5   balance    45211 non-null  int64
 6   housing    45211 non-null  object
 7   loan       45211 non-null  object
 8   contact    45211 non-null  object
 9   day        45211 non-null  int64
 10  month      45211 non-null  object
 11  duration   45211 non-null  int64
 12  campaign   45211 non-null  int64
 13  pdays      45211 non-null  int64
 14  previous   45211 non-null  int64
 15  poutcome   45211 non-null  object
 16  y          45211 non-null  object
dtypes: int64(7), object(10)
memory usage: 5.9+ MB
```

```
df.describe()
```

	age	balance	day	duration	campaign	pdays	previous
count	45211.000000	45211.000000	45211.000000	45211.000000	45211.000000	45211.000000	45211.000000
mean	40.936210	1362.272058	15.806419	258.163080	2.763841	40.197828	0.580323
std	10.618762	3044.765829	8.322476	257.527812	3.098021	100.128746	2.303441
min	18.000000	-8019.000000	1.000000	0.000000	1.000000	-1.000000	0.000000
25%	33.000000	72.000000	8.000000	103.000000	1.000000	-1.000000	0.000000
50%	39.000000	448.000000	16.000000	180.000000	2.000000	-1.000000	0.000000
75%	48.000000	1428.000000	21.000000	319.000000	3.000000	-1.000000	0.000000
max	95.000000	102127.000000	31.000000	4918.000000	63.000000	871.000000	275.000000

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

	0
age	0
job	0
marital	0
education	0
default	0
balance	0
housing	0
loan	0
contact	0
day	0
month	0
duration	0
campaign	0
pdays	0
previous	0
poutcome	0
y	0

```
# Identify categorical columns
categorical_cols = ['job', 'marital', 'education', 'default', 'housing', 'loan', 'contact', 'month', 'poutcome']

# Perform one-hot encoding
df = pd.get_dummies(df, columns=categorical_cols, drop_first=True)



#Encode the target variable
df['y'] = df['y'].map({'no': 0, 'yes': 1})


df.head()
```

	age	balance	day	duration	campaign	pdays	previous	y	job_blue-collar	job_entrepreneur	...	month_jul	month_jun	month_mar	month_ma
0	58	2143	5	261	1	-1	0	0	False	False	...	False	False	False	Tru
1	44	29	5	151	1	-1	0	0	False	False	...	False	False	False	Tru
2	33	2	5	76	1	-1	0	0	False	True	...	False	False	False	Tru
3	47	1506	5	92	1	-1	0	0	True	False	...	False	False	False	Tru
4	33	1	5	198	1	-1	0	0	False	False	...	False	False	False	Tru

5 rows × 43 columns

```
from sklearn.model_selection import train_test_split
# Features and target
X = df.drop('y', axis=1)
y = df['y']
```

```
# Split into training and test sets
X_train, X_test, y_train, y_test = train_test_split(X, y, test_size=0.3, random_state=42)

print(f"Training set size: {X_train.shape}")
print(f"Test set size: {X_test.shape}")
```

```
Training set size: (31647, 42)
Test set size: (13564, 42)
```

Decision Tree classifier

```
from sklearn.tree import DecisionTreeClassifier, plot_tree
# Initialize the Decision Tree Classifier
dt = DecisionTreeClassifier(criterion='gini', max_depth=5, random_state=42)

# Train the model
dt.fit(X_train, y_train)
```

```
DecisionTreeClassifier(max_depth=5, random_state=42)
```

```
y_pred = dt.predict(X_test)
```

Measure accuracy and other metrics.

```
from sklearn.metrics import accuracy_score, classification_report, confusion_matrix
```

```
# Accuracy score
print(f"Accuracy: {accuracy_score(y_test, y_pred):.2f}")

# Classification report
print("Classification Report:")
print(classification_report(y_test, y_pred))

# Confusion matrix
print("Confusion Matrix:")
print(confusion_matrix(y_test, y_pred))
```

```
Accuracy: 0.90
Classification Report:
              precision    recall  f1-score   support
```

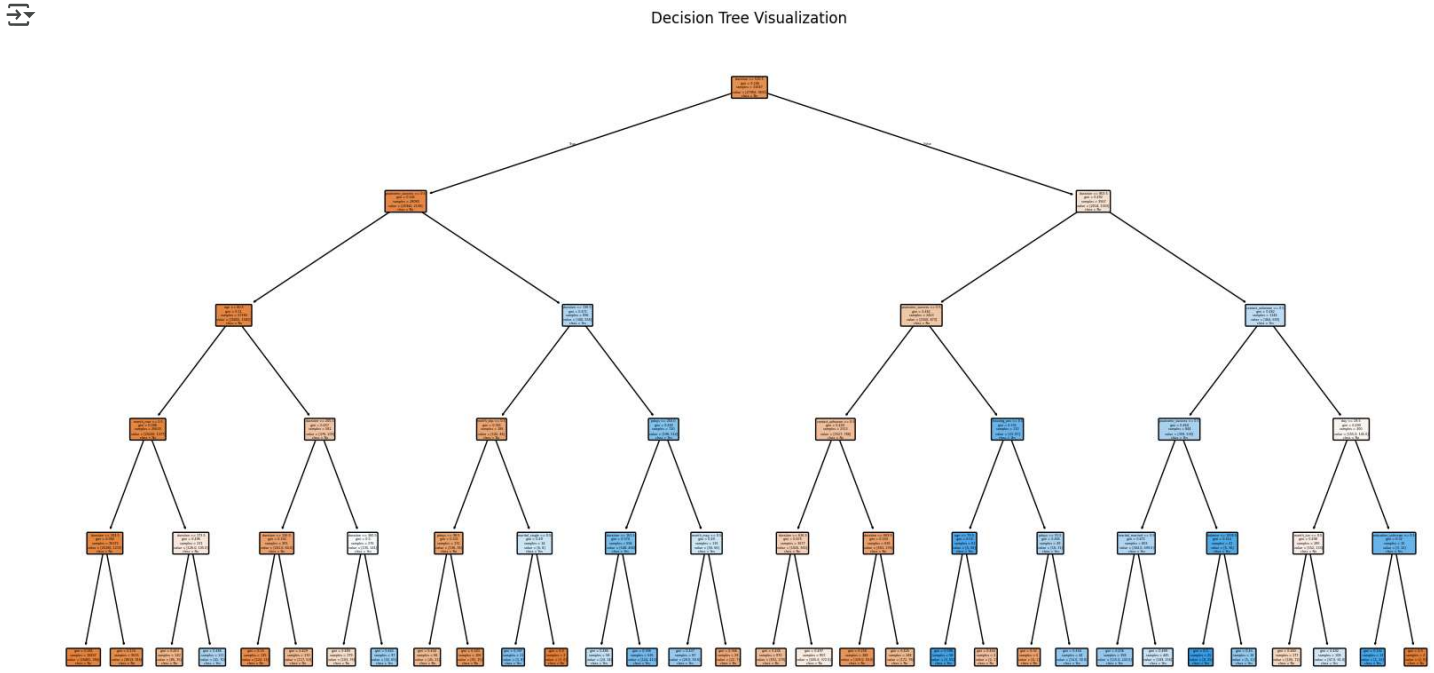
```
              0       0.92      0.97      0.95     11966
              1       0.65      0.35      0.45      1598

       accuracy                           0.90     13564
      macro avg       0.78      0.66      0.70     13564
   weighted avg       0.89      0.90      0.89     13564

   Confusion Matrix:
   [[11666   300]
    [ 1043   555]]
```

Visualize the decision tree

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



Hyperparameter Tuning

Hyperparameter Tuning

```
from sklearn.model_selection import GridSearchCV

# Define parameter grid
param_grid = {
    'max_depth': [3, 5, 7, 10],
    'min_samples_split': [2, 5, 10],
    'criterion': ['gini', 'entropy']
}

# Perform grid search
grid_search = GridSearchCV(DecisionTreeClassifier(random_state=42), param_grid, cv=5, scoring='accuracy')
```

```
grid_search.fit(X_train, y_train)

# Best parameters
print("Best Parameters:", grid_search.best_params_)

# Train the best model
best_dt = grid_search.best_estimator_
```

```
Best Parameters: {'criterion': 'entropy', 'max_depth': 5, 'min_samples_split': 2}
```

+ Code + Text

```
# Example new customer data
new_customer_data = {
    'age': [35],
    'balance': [5000],
    'duration': [120],
    'campaign': [2],
    'pdays': [-1],
    'previous': [0],
    'job_technician': [1],
    'job_unknown': [0],
    'marital_married': [1],
    'marital_single': [0],
    'education_secondary': [1],
    'education_tertiary': [0],
    'default_yes': [0],
    'housing_yes': [1],
    'loan_yes': [0],
    'contact_cellular': [1],
    'contact_unknown': [0],
    'month_jun': [0],
    'month_may': [1],
    'month_nov': [0],
    'poutcome_success': [0]
}

# Convert to DataFrame
new_customer = pd.DataFrame(new_customer_data)


# Ensure all columns match
for col in X.columns:
    if col not in new_customer:
        new_customer[col] = 0  # Add missing columns with default value 0
new_customer = new_customer[X.columns]  # Reorder columns to match training data

# Predict for the new customer
prediction = best_dt.predict(new_customer)
print("Prediction:", "Yes" if prediction[0] == 1 else "No")
```

```
Prediction: No
```