```
import pandas as pd

df = pd.read_csv("/content/Commercial Doc Classification data.csv")
df.head()
```

	X	Y
0	United Arab Emirates Saatall Aas yal) alley \u...	0
1	\u2018DELIVERY ORDER\n\nGenerated using Dubai ...	0
2	Wee\n\ni , DK09025040118\nBILL- OF LADING (NOT...	0
3	FH WTeAeKBReARAT\n| Re ZHEJIANG SUPER POWER FI...	1
4	A Wile AwBKR SARA A\n\nCHAO\n\nZHEJIANG SUPER ...	0

```
# Step 1: Prepare data
X = df["X"].str.lower().str.replace(r"\\n", " ", regex=True).str.replace(r"\\u[\dA-Fa-f]+", " ", regex=True)
y = df["Y"]


X[0]
```

```
'united arab emirates saatall aas yal) alley  ih page 1-of 41 uae customs i key) blea  dubai customs est alem cah lad eh lam uae customs  porttype esi 4| [dec type owes 3| [dec date cea 2|[decno owls 1 sea \\"02/08/2026 101-27076169-25 | customs declaration import to local from row 141115692858 (se olen net weight geile c5 ll importer / exporter shaddifo,sueat] 6 | [delivery order no. atu on 8 | 5 | 44670 (kg) ae-3002412 - emirates fire fighting equiriment factory llc (i - e0812) gross weight eta cist [10] [intercessor co. abwasit 4st] 9 | [ carrier\'s \\\\ captain \\\\ driver sts/uaaiacun| 8 | 46520 (kg) ae-1054554 - emirates shipping line llc measurement wt |13] [ commercial reg. no. aoi deat! 34/12] [ carrier\'s name amu au} | 71] 1796 esl wasl no.of packages ashi se [16] | tin no. gai 98/124] [
```

```
# Step 2: Split data (even though it's small, to simulate real-world pipeline)
X_train, X_test, y_train, y_test = train_test_split(X, y, test_size=0.2, random_state=42)

# Step 3: Create pipeline
pipeline = Pipeline([
    ("tfidf", TfidfVectorizer(max_features=20, stop_words="english")),
    ("clf", DecisionTreeClassifier(max_depth=3, random_state=42))
])
```

Start coding or generate with AI.

```
from sklearn.feature_extraction.text import TfidfVectorizer
from sklearn.tree import DecisionTreeClassifier, export_text
from sklearn.pipeline import Pipeline
from sklearn.model_selection import train_test_split

# # Step 1: Prepare data
# X = df["X"].str.lower().str.replace(r"\\n", " ", regex=True).str.replace(r"\\u[\dA-Fa-f]+", " ", regex=True)
# y = df["Y"]

# Step 2: Split data (even though it's small, to simulate real-world pipeline)
X_train, X_test, y_train, y_test = train_test_split(X, y, test_size=0.2, random_state=42)

# Step 3: Create pipeline
pipeline = Pipeline([
    ("tfidf", TfidfVectorizer(max_features=20, stop_words="english")),
    ("clf", DecisionTreeClassifier(max_depth=3, random_state=42))
])

# Step 4: Train model
pipeline.fit(X_train, y_train)

# Step 5: Extract rules
vectorizer = pipeline.named_steps["tfidf"]
classifier = pipeline.named_steps["clf"]
feature_names = vectorizer.get_feature_names_out()
rules = export_text(classifier, feature_names=list(feature_names))

rules
```

```
'|--- 2025 <= 0.15\n|   |--- class: 1\n|--- 2025 >  0.15\n|   |--- class: 0\n'
```

```
# Re-import necessary packages after code execution state reset
import pandas as pd
import re
from sklearn.feature_extraction.text import TfidfVectorizer
from sklearn.tree import DecisionTreeClassifier, export_text
from sklearn.pipeline import Pipeline
from sklearn.model_selection import train_test_split

# # Reload the dataset
# file_path = "/mnt/data/Commercial Doc Classification data.csv"
# df = pd.read_csv(file_path)

# Define the cleaning function again
def clean_text(text):
    text = text.lower()
    text = re.sub(r"\\n", " ", text)
    text = re.sub(r"\\u[\dA-Fa-f]+", " ", text)
    text = re.sub(r"[^\w\s]", " ", text)
    text = re.sub(r"\d+", " ", text)
    text = re.sub(r"\s+", " ", text).strip()
    return text

# Apply cleaning
X_cleaned = df["X"].apply(clean_text)
y = df["Y"]

# Split data
X_train, X_test, y_train, y_test = train_test_split(X_cleaned, y, test_size=0.2, random_state=42)

# Create and train pipeline
pipeline_cleaned = Pipeline([
    ("tfidf", TfidfVectorizer(max_features=20, stop_words="english")),
    ("clf", DecisionTreeClassifier(max_depth=3, random_state=42))
])

pipeline_cleaned.fit(X_train, y_train)

# Extract rules
vectorizer_cleaned = pipeline_cleaned.named_steps["tfidf"]
classifier_cleaned = pipeline_cleaned.named_steps["clf"]
feature_names_cleaned = vectorizer_cleaned.get_feature_names_out()
rules_cleaned = export_text(classifier_cleaned, feature_names=list(feature_names_cleaned))

rules_cleaned
```

```
'|--- fighting <= 0.24\n|   |--- class: 1\n|--- fighting >  0.24\n|   |--- class: 0\n'
```

```
X_cleaned[0]
```

```
'united arab emirates saatall aas yal alley ih page of uae customs i key blea dubai customs est alem cah lad eh lam uae customs porttyp
e esi dec type owes dec date cea decno owls sea customs declaration import to local from row se olen net weight geile c ll importer exp
orter shaddifo sueat delivery order no atu on kg ae emirates fire fighting equiriment factory llc i e gross weight eta cist intercessor
co abwasit st carrier s captain driver sts uaaiacun kg ae emirates shipping line llc measurement wt commercial reg no aoi deat carrier
s name amu au esl wasl no of packages ashi se tin no gai voyage flight no ala marks numbers exported to a jaa b l awb no manif cobliadt
ancosd galt a firex firex emivchnnino port of loading daal pga ningbo port of discharge e kl elie jebel ali destination chal aga loc ie
```

the data quality improved!!!

```
# Step 1: Get TF-IDF feature importance (top 20 features)
import numpy as np

# Get TF-IDF matrix for training data
tfidf_vectorizer = pipeline_cleaned.named_steps["tfidf"]
X_train_tfidf = tfidf_vectorizer.transform(X_train)
feature_names = tfidf_vectorizer.get_feature_names_out()

# Get feature importances from the decision tree
importances = pipeline_cleaned.named_steps["clf"].feature_importances_
top_indices = np.argsort(importances)[::-1]

# Pair features with their importance scores
top_features = [(feature_names[i], importances[i]) for i in top_indices if importances[i] > 0]

# Step 2: Run prediction on the full dataset to identify misclassifications
```

```
df["cleaned_text"] = X_cleaned
df["predicted"] = pipeline_cleaned.predict(X_cleaned)
df["correct"] = df["predicted"] == df["Y"]

(top_features, df[["X", "Y", "predicted", "correct"]])
```

```
([('fighting', np.float64(1.0))],
                                                   X  Y  predicted  correct
 0  United Arab Emirates Saatall Aas yal) alley \u...  0          0     True
 1  \u2018DELIVERY ORDER\n\nGenerated using Dubai ...  0          0     True
 2  Wee\n\ni , DK09025040118\nBILL- OF LADING (NOT...  0          0     True
 3  FH WTeAeKBReARAT\n| Re ZHEJIANG SUPER POWER FI...  1          1     True
 4  A Wile AwBKR SARA A\n\nCHAO\n\nZHEJIANG SUPER ...  0          0     True
 5  ORIGINAL\n: aa \u201cSerial No. \u2014 CCPIT34...  0          0     True)
```

```
import pandas as pd
import re
from sklearn.feature_extraction.text import TfidfVectorizer
from sklearn.tree import DecisionTreeClassifier, export_text
from sklearn.pipeline import Pipeline
from sklearn.model_selection import train_test_split

# Load your CSV
df = pd.read_csv("Commercial Doc Classification data.csv")  # Adjust path if needed

# Text cleaning function
def clean_text(text):
    text = text.lower()
    text = re.sub(r"\\n", " ", text)
    text = re.sub(r"\\u[\dA-Fa-f]+", " ", text)
    text = re.sub(r"[^\w\s]", " ", text)  # Remove punctuation
    text = re.sub(r"\d+", " ", text)  # Optional: remove numbers
    text = re.sub(r"\s+", " ", text).strip()
    return text

# Apply cleaning
df["cleaned_text"] = df["X"].apply(clean_text)
X = df["cleaned_text"]
y = df["Y"]

# Train/test split
X_train, X_test, y_train, y_test = train_test_split(X, y, test_size=0.2, random_state=42)

# Create pipeline with more features and deeper tree
pipeline = Pipeline([
    ("tfidf", TfidfVectorizer(max_features=50, stop_words="english")),
    ("clf", DecisionTreeClassifier(max_depth=5, random_state=42))
])

# Train model
pipeline.fit(X_train, y_train)

# Extract decision tree rules
vectorizer = pipeline.named_steps["tfidf"]
classifier = pipeline.named_steps["clf"]
feature_names = vectorizer.get_feature_names_out()

# Print the tree as readable text
rules = export_text(classifier, feature_names=list(feature_names))
print(rules)
```

```
|--- port <= 0.13
|   |--- class: 0
|--- port >  0.13
|   |--- class: 1
```

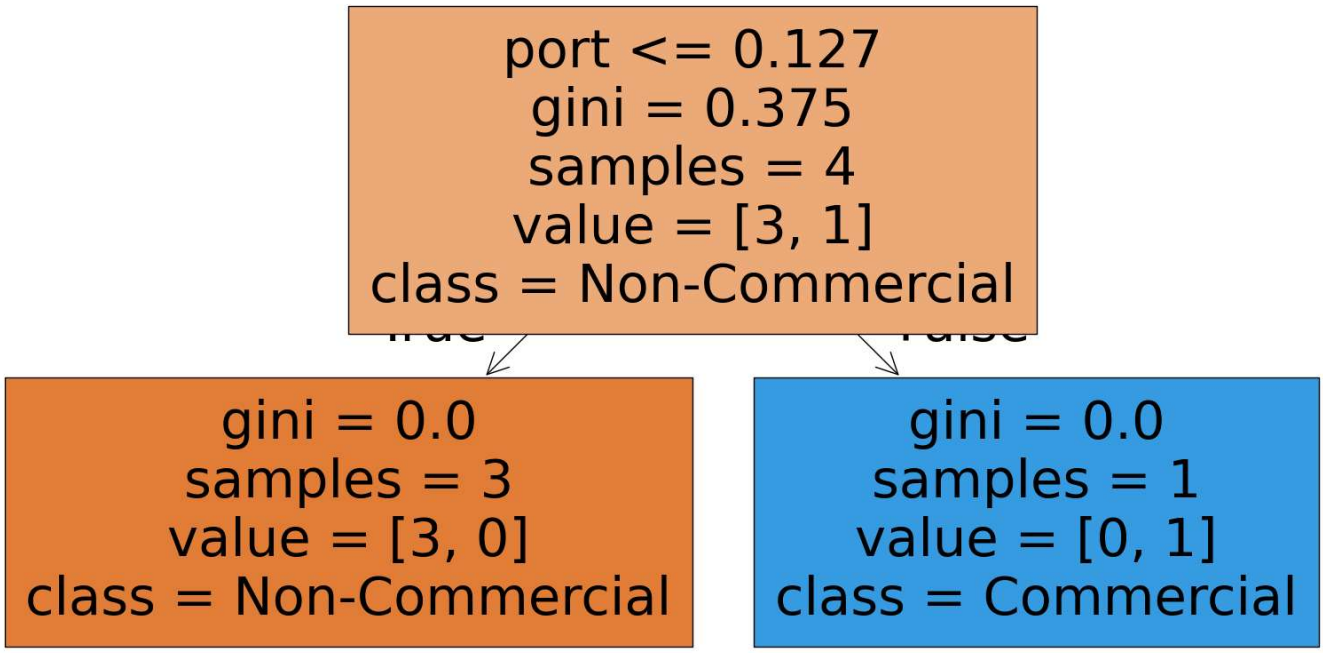
```
df["predicted"] = pipeline.predict(X)
df["correct"] = df["predicted"] == df["Y"]

# View misclassified rows
print(df[df["correct"] == False][["X", "Y", "predicted"]])
```

```
                                                   X  Y  predicted
0  United Arab Emirates Saatall Aas yal) alley \u...  0          1
1  \u2018DELIVERY ORDER\n\nGenerated using Dubai ...  0          1
```

```
import pandas as pd
import re
from sklearn.feature_extraction.text import TfidfVectorizer
from sklearn.tree import DecisionTreeClassifier, export_text, plot_tree
from sklearn.pipeline import Pipeline
from sklearn.model_selection import train_test_split
import matplotlib.pyplot as plt

# Load your data
df = pd.read_csv("Commercial Doc Classification data.csv")

# Clean text function
def clean_text(text):
    text = text.lower()
    text = re.sub(r"\\n", " ", text)
    text = re.sub(r"\\u[\dA-Fa-f]+", " ", text)
    text = re.sub(r"[^\w\s]", " ", text)
    text = re.sub(r"\d+", " ", text)
    text = re.sub(r"\s+", " ", text).strip()
    return text

# Apply cleaning
df["cleaned_text"] = df["X"].apply(clean_text)
X = df["cleaned_text"]
y = df["Y"]

# Train/test split
X_train, X_test, y_train, y_test = train_test_split(X, y, test_size=0.2, random_state=42)

# TF-IDF + Decision Tree pipeline
pipeline = Pipeline([
    ("tfidf", TfidfVectorizer(max_features=50, stop_words="english")),
    ("clf", DecisionTreeClassifier(max_depth=5, random_state=42))
])

# Train
pipeline.fit(X_train, y_train)

# Export rules
vectorizer = pipeline.named_steps["tfidf"]
classifier = pipeline.named_steps["clf"]
feature_names = vectorizer.get_feature_names_out()
rules_text = export_text(classifier, feature_names=list(feature_names))
print(rules_text)
```

```
|--- port <= 0.13
|   |--- class: 0
|--- port >  0.13
|   |--- class: 1
```

```
plt.figure(figsize=(20, 10))
plot_tree(classifier, feature_names=feature_names, class_names=["Non-Commercial", "Commercial"], filled=True)
plt.savefig("decision_tree_rules.png", dpi=300)
plt.show()
```




```
def convert_export_text_to_if_else(tree_text):
    lines = tree_text.strip().split("\n")
    indent_unit = "    "
    code_lines = ["def is_commercial_doc(features):"]

    for line in lines:
        indent_level = line.count("|   ")
        line = line.replace("|   ", "").replace("|--- ", "")
        spacing = indent_unit * (indent_level + 1)

        if "<=" in line or ">" in line:
            feature, condition = line.split(" <= " if "<=" in line else " > ")
            op = "<=" if "<=" in line else ">"
            code_lines.append(f"{spacing}if features['{feature.strip()}'] {op} {condition.strip()}:")
        elif "class:" in line:
            label = line.split("class:")[1].strip()
            code_lines.append(f"{spacing}return {label}  # {'Commercial' if label == '1' else 'Non-Commercial'}")

    return "\n".join(code_lines)


tree_as_text = export_text(classifier, feature_names=list(feature_names))
print(convert_export_text_to_if_else(tree_as_text))
```

```
def is_commercial_doc(features):
    if features['port'] <= 0.13:
        return 0  # Non-Commercial
    if features['port'] > 0.13:
        return 1  # Commercial
```

```
Start coding or generate with AI.
```

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```
Start coding or generate with AI.
```

1. Training & Saving (train_and_export.py)

```
import pandas as pd
import re
from sklearn.feature_extraction.text import TfidfVectorizer
from sklearn.tree import DecisionTreeClassifier, export_text
from sklearn.model_selection import train_test_split
import joblib

# Text cleanup function
def clean_text(text):
    text = text.lower()
    text = re.sub(r"[^\w\s]", " ", text)
    text = re.sub(r"\d+", " ", text)
    text = re.sub(r"\s+", " ", text).strip()
    return text

# Load data
df = pd.read_csv("Commercial Doc Classification data.csv")
df["cleaned_text"] = df["X"].apply(clean_text)

X = df["cleaned_text"]
y = df["Y"]

# Train/test split with stratification
# ValueError: The least populated class in y has only 1 member, which is too few. The minimum number of groups for any class cannot be less
# X_train, _, y_train, _ = train_test_split(X, y, test_size=0.2, random_state=42, stratify=y)
X_train, _, y_train, _ = train_test_split(X, y, test_size=0.2, random_state=42)

# TF-IDF + vectorization
vectorizer = TfidfVectorizer(max_features=50, stop_words="english")
X_train_vec = vectorizer.fit_transform(X_train)

# Decision tree with class balancing
clf = DecisionTreeClassifier(max_depth=3, class_weight="balanced", random_state=42)
clf.fit(X_train_vec, y_train)

# Save vectorizer and model
joblib.dump(vectorizer, "tfidf_vectorizer.joblib")
joblib.dump(clf, "decision_tree_model.joblib")

# Extract feature names
feature_names = vectorizer.get_feature_names_out()

# Function to auto-generate if-else rules
def convert_export_text_to_if_else(tree_text):
    lines = tree_text.strip().split("\n")
    indent_unit = "    "
    code_lines = ["def is_commercial_doc(features):"]

    for line in lines:
        indent_level = line.count("|   ")
        line = line.replace("|   ", "").replace("|--- ", "")
        spacing = indent_unit * (indent_level + 1)

        if "<=" in line or ">" in line:
            feature, condition = line.split(" <= " if "<=" in line else " > ")
            op = "<=" if "<=" in line else ">"
            code_lines.append(f"{spacing}if features['{feature.strip()}'] {op} {condition.strip()}:")
        elif "class:" in line:
            label = line.split("class:")[1].strip()
            code_lines.append(f"{spacing}return {label}  # {'Commercial' if label == '1' else 'Non-Commercial'}")

    return "\n".join(code_lines)

# Extract rule as Python function
tree_code = export_text(clf, feature_names=list(feature_names))
if_else_code = convert_export_text_to_if_else(tree_code)
```

```
# Save rule
with open("commercial_rule.py", "w") as f:
    f.write(if_else_code)

print("✅ Model trained with class balancing and rule saved to 'commercial_rule.py'")
```

```
✅ Model trained with class balancing and rule saved to 'commercial_rule.py'
```

2. Production Inference (predict_from_ocr.py)

```
# predict_from_ocr.py

import joblib
import re
from commercial_rule import is_commercial_doc  # auto-generated

# Load saved vectorizer
vectorizer = joblib.load("tfidf_vectorizer.joblib")

def clean_text(text):
    text = text.lower()
    text = re.sub(r"[^\w\s]", " ", text)
    text = re.sub(r"\d+", " ", text)
    text = re.sub(r"\s+", " ", text).strip()
    return text

def get_feature_vector(text):
    cleaned = clean_text(text)
    vector = vectorizer.transform([cleaned])
    feature_names = vectorizer.get_feature_names_out()
    return {name: vector[0, idx] for idx, name in enumerate(feature_names)}

# Example usage
ocr_text = "Port of Hamburg and shipment note inside."
features = get_feature_vector(ocr_text)
prediction = is_commercial_doc(features)

print("Prediction:", "Commercial" if prediction == 1 else "Non-Commercial")
```

```
Prediction: Non-Commercial
```

✅ Benefits of This Setup

- 🔁 Fully automatic: No manual threshold writing
- 🔒 Consistent: Uses your trained model's actual logic
- 🪶 Lightweight: Doesn't require model loading at runtime, just the if-else file
- 🏭 Production-ready: No dependency on scikit-learn in real-time if you just use the rule