In [ ]:
```
import lightgbm as lgb
import numpy as np
import pandas as pd
from sklearn.metrics import accuracy_score, confusion_matrix
from sklearn.model_selection import train_test_split
from sklearn.model_selection import cross_validate
from sklearn.preprocessing import LabelEncoder
from sklearn.tree import DecisionTreeClassifier
```

Import Dataset

In [ ]:
```
car_data = pd.read_csv("data/car.data", header=None, names=["buying",
                                                            "maint",
                                                            "doors",
                                                            "persons",
                                                            "lug_boot",
                                                            "safety",
                                                            "class"])

# Remove persons column because it is not required
del car_data['persons']
car_data
```

Out[ ]:

	buying	maint	doors	lug_boot	safety	class
0	vhigh	vhigh	2	small	low	unacc
1	vhigh	vhigh	2	small	med	unacc
2	vhigh	vhigh	2	small	high	unacc
3	vhigh	vhigh	2	med	low	unacc
4	vhigh	vhigh	2	med	med	unacc
...	...	...	...	...	...	...
1723	low	low	5more	med	med	good
1724	low	low	5more	med	high	vgood
1725	low	low	5more	big	low	unacc
1726	low	low	5more	big	med	good
1727	low	low	5more	big	high	vgood

1728 rows × 6 columns

Data Exploration

In [ ]:
```
car_data.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 1728 entries, 0 to 1727
Data columns (total 6 columns):
 #   Column    Non-Null Count  Dtype 
---  ------    --------------  ----- 
 0   buying    1728 non-null   object
 1   maint     1728 non-null   object
 2   doors     1728 non-null   object
 3   lug_boot  1728 non-null   object
 4   safety    1728 non-null   object
 5   class     1728 non-null   object
dtypes: object(6)
memory usage: 81.1+ KB
```

In [ ]:
```
# Check for distribution
car_data["buying"].value_counts()
```

Out[ ]:
```
vhigh    432
high     432
med      432
low      432
Name: buying, dtype: int64
```

In [ ]:
```
# All the columns are categorical
# Apply one-hot encoding
enc_car_data = pd.get_dummies(car_data.drop("buying", axis=1))
enc_car_data.head()
```

Out[ ]:

	maint_high	maint_low	maint_med	maint_vhigh	doors_2	doors_3	doors_4	doors_5more	lu
0	0	0	0	1	1	0	0	0	
1	0	0	0	1	1	0	0	0	
2	0	0	0	1	1	0	0	0	
3	0	0	0	1	1	0	0	0	
4	0	0	0	1	1	0	0	0	

In [ ]:
```
# Encode target variable using Label Encoder
le = LabelEncoder()
le.fit(car_data["buying"])
buying_price = le.transform(car_data["buying"])
```

In [ ]:
```
le.classes_
```

Out[ ]:
```
array(['high', 'low', 'med', 'vhigh'], dtype=object)
```

In [ ]:
```
buying_price
```

Out[ ]:
```
array([3, 3, 3, ..., 1, 1, 1])
```

Splitting dataset

In [ ]:
```
x_train, x_test, y_train, y_test = train_test_split(
    enc_car_data, car_data["buying"], test_size=0.2
)
```

In [ ]:
```
x_train.shape, y_train.shape
```

Out[ ]:
```
((1382, 18), (1382,))
```

In [ ]:
```
x_test.shape, y_test.shape
```

Out[ ]:
```
((346, 18), (346,))
```

Training models

Decision Tree

In [ ]:
```
# Hyperparameter tuning
for depth in [2, 3, 4, 5]:
    dt_model = DecisionTreeClassifier(criterion="gini", max_depth=depth)
    # Cross-validation
    cv_results = cross_validate(dt_model, x_train, y_train, cv=5)
    print(
        f"Max depth: {depth} --- Accuracy results: {round(cv_results['test_score']
    )
```

```
Max depth: 2 --- Accuracy results: 0.3061
Max depth: 3 --- Accuracy results: 0.3162
Max depth: 4 --- Accuracy results: 0.3111
Max depth: 5 --- Accuracy results: 0.296
```

In [ ]:
```
# Best model
dt_model = DecisionTreeClassifier(criterion="gini", max_depth=3)
dt_model.fit(x_train, y_train)
```

Out[ ]:
```
DecisionTreeClassifier(max_depth=3)
```

In [ ]:
```
# Check accuracy on test set
y_pred = dt_model.predict(x_test)
accuracy = accuracy_score(y_pred, y_test)
print("Model accuracy score: {0:0.4f}".format(accuracy_score(y_test, y_pred)))
```

```
Model accuracy score: 0.3092
```

In [ ]:
```
columns = y_test.unique()
pd.DataFrame(
    confusion_matrix(y_test, y_pred, labels=columns),
    columns=columns + "_pred",
    index=columns + "_true",
)
```

Out[ ]:

	low_pred	vhigh_pred	high_pred	med_pred
low_true	16	52	0	23
vhigh_true	0	62	0	18
high_true	0	57	0	25
med_true	10	54	0	29

Gradient-boosted decision tree

In [ ]:

```
# Hyperparameter tuning
best_model = {"accuracy": 0}
for leaves in [2, 3, 4, 6, 8]:
    for lr in [0.5, 0.1, 0.5, 0.01]:
        for n_est in [100, 200, 500]:
            lgb_model = lgb.LGBMClassifier(
                objective="multiclass",
                num_leaves=leaves,
                boosting_type="dart",
                learning_rate=lr,
                n_estimators=n_est,
                num_threads=4,
            )
            cv_results = cross_validate(lgb_model, x_train, y_train, cv=5)
            if cv_results["test_score"].mean() > best_model["accuracy"]:
                best_model["accuracy"] = cv_results["test_score"].mean()
                best_model["leaves"] = leaves
                best_model["lr"] = lr
                best_model["n_est"] = n_est
                print(
                    f"Leaves: {leaves}, lr: {lr}, n_est: {n_est} --- Accuracy resu
                )
```

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Leaves: 2, lr: 0.5, n_est: 100 --- Accuracy results: 0.335
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Leaves: 2, lr: 0.5, n_est: 200 --- Accuracy results: 0.3401
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Leaves: 2, lr: 0.5, n_est: 500 --- Accuracy results: 0.3416
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In [ ]:

```
# Best model
lgb_model = lgb.LGBMClassifier(
    objective="multiclass",
    num_leaves=best_model["leaves"],
    boosting_type="dart",
    learning_rate=best_model["lr"],
    n_estimators=best_model["n_est"],
    num_threads=4,
)
lgb_model.fit(x_train, y_train)
```

```
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e: num_threads=4
```

Out[ ]:

```
LGBMClassifier(boosting_type='dart', learning_rate=0.01, n_estimators=500,
               num_leaves=3, num_threads=4, objective='multiclass')
```

In [ ]:

```
# Check accuracy on test set
y_pred = lgb_model.predict(x_test)
accuracy = accuracy_score(y_pred, y_test)
print("Model accuracy score: {0:0.4f}".format(accuracy_score(y_test, y_pred)))
```

```
Model accuracy score: 0.3295
```

In [ ]:

```
pd.DataFrame(
    confusion_matrix(y_test, y_pred, labels=columns),
    columns=columns + "_pred",
    index=columns + "_true",
)
```

Out[ ]:

	low_pred	vhigh_pred	high_pred	med_pred
low_true	19	52	2	18
vhigh_true	0	62	15	3
high_true	0	57	21	4
med_true	12	54	15	12

Prediction (Answering question)

- Maintenance = High
- Number of doors = 4
- Lug Boot Size = Big
- Safety = High
- Class Value = Good

In [ ]:

```
sample = {
    "maint_high": 1,
    "maint_low": 0,
    "maint_med": 0,
    "maint_vhigh": 0,
    "doors_2": 0,
    "doors_3": 0,
    "doors_4": 1,
    "doors_5more": 0,
    "lug_boot_big": 1,
    "lug_boot_med": 0,
    "lug_boot_small": 0,
    "safety_high": 1,
    "safety_low": 0,
    "safety_med": 0,
    "class_acc": 0,
    "class_good": 1,
    "class_unacc": 0,
    "class_vgood": 0,
}
prediction = lgb_model.predict([list(sample.values())])
print(f"Predicted buying price: {prediction[0]}")
```

```
Predicted buying price: low
```