```python
# Step 1: Upload CSV in Colab
from google.colab import files
import pandas as pd

uploaded = files.upload()  # Select your kidney_disease.csv

# Load dataset
df = pd.read_csv("kidney_disease.csv")
print("Shape:", df.shape)
df.head()
```

```
<IPython.core.display.HTML object>

Saving kidney_disease.csv to kidney_disease (1).csv
Shape: (400, 26)
```


```
{"type":"dataframe","variable_name":"df"}
```


```python
import numpy as np
from sklearn.model_selection import train_test_split
from sklearn.preprocessing import LabelEncoder, StandardScaler

# Drop ID column if it exists
if 'id' in df.columns:
    df = df.drop('id', axis=1)

# Handle missing values (fill numeric with median, categorical with
mode)
for col in df.columns:
    if df[col].dtype == 'object':
        df[col].fillna(df[col].mode()[0], inplace=True)
    else:
        df[col].fillna(df[col].median(), inplace=True)

# Encode categorical columns
le = LabelEncoder()
for col in df.columns:
    if df[col].dtype == 'object':
        df[col] = le.fit_transform(df[col])

# Define X and y
X = df.drop('classification', axis=1)  # assuming 'classification' is
target
y = df['classification']

# Scale features
scaler = StandardScaler()
X = scaler.fit_transform(X)

# Train-test split
X_train, X_test, y_train, y_test = train_test_split(X, y,
```

```
test_size=0.2, random_state=42, stratify=y)

print("Training shape:", X_train.shape)
print("Testing shape:", X_test.shape)
```

```
Training shape: (320, 24)
Testing shape: (80, 24)
```

```
/tmp/ipython-input-214255797.py:14: FutureWarning: A value is trying
to be set on a copy of a DataFrame or Series through chained
assignment using an inplace method.
The behavior will change in pandas 3.0. This inplace method will never
work because the intermediate object on which we are setting values
always behaves as a copy.

For example, when doing 'df[col].method(value, inplace=True)', try
using 'df.method({col: value}, inplace=True)' or df[col] =
df[col].method(value) instead, to perform the operation inplace on the
original object.


  df[col].fillna(df[col].median(), inplace=True)
/tmp/ipython-input-214255797.py:12: FutureWarning: A value is trying
to be set on a copy of a DataFrame or Series through chained
assignment using an inplace method.
The behavior will change in pandas 3.0. This inplace method will never
work because the intermediate object on which we are setting values
always behaves as a copy.

For example, when doing 'df[col].method(value, inplace=True)', try
using 'df.method({col: value}, inplace=True)' or df[col] =
df[col].method(value) instead, to perform the operation inplace on the
original object.


  df[col].fillna(df[col].mode()[0], inplace=True)
```

```
from xgboost import XGBClassifier
from sklearn.metrics import accuracy_score, classification_report

# Train model
model = XGBClassifier(use_label_encoder=False, eval_metric='logloss',
random_state=42)
model.fit(X_train, y_train)

# Predictions
y_pred = model.predict(X_test)

# Evaluate
acc = accuracy_score(y_test, y_pred)
```

```
print("  XGBoost Accuracy:", acc)
print(classification_report(y_test, y_pred))
```

```
/usr/local/lib/python3.12/dist-packages/xgboost/training.py:183:
UserWarning: [14:05:54] WARNING: /workspace/src/learner.cc:738:
Parameters: { "use_label_encoder" } are not used.

  bst.update(dtrain, iteration=i, fobj=obj)

  XGBoost Accuracy: 0.975
              precision    recall  f1-score   support

           0       0.96      1.00      0.98        50
           2       1.00      0.93      0.97        30

    accuracy                           0.97        80
   macro avg       0.98      0.97      0.97        80
weighted avg       0.98      0.97      0.97        80
```

```
from sklearn.ensemble import RandomForestClassifier
from sklearn.metrics import accuracy_score, classification_report

# Train
rf = RandomForestClassifier(random_state=42)
rf.fit(X_train, y_train)

# Predict
y_pred_rf = rf.predict(X_test)

# Evaluate
acc_rf = accuracy_score(y_test, y_pred_rf)
print(" Random Forest Accuracy:", acc_rf)
print(classification_report(y_test, y_pred_rf))
```

```
 Random Forest Accuracy: 0.9875
              precision    recall  f1-score   support

           0       0.98      1.00      0.99        50
           2       1.00      0.97      0.98        30

    accuracy                           0.99        80
   macro avg       0.99      0.98      0.99        80
weighted avg       0.99      0.99      0.99        80
```

```
from lightgbm import LGBMClassifier
from sklearn.metrics import accuracy_score, classification_report

# Train with regularization + constraints
lgb = LGBMClassifier(
```

```
    random_state=42,
    max_depth=4,          # limit tree depth
    num_leaves=15,        # fewer leaves
    min_child_samples=30,
    subsample=0.8,        # row sampling
    colsample_bytree=0.8,# feature sampling
    reg_alpha=0.3,        # L1 regularization
    reg_lambda=0.3,       # L2 regularization
    n_estimators=100      # fewer trees
)

lgb.fit(X_train, y_train)

# Predict
y_pred_lgb = lgb.predict(X_test)

# Evaluate
acc_lgb = accuracy_score(y_test, y_pred_lgb)
print("□ LightGBM Accuracy:", acc_lgb)
print(classification_report(y_test, y_pred_lgb))
```

```
[LightGBM] [Info] Auto-choosing row-wise multi-threading, the overhead
of testing was 0.000148 seconds.
You can set `force_row_wise=true` to remove the overhead.
And if memory is not enough, you can set `force_col_wise=true`.
[LightGBM] [Info] Total Bins 538
[LightGBM] [Info] Number of data points in the train set: 320, number
of used features: 22
[LightGBM] [Info] Start training from score -0.480054
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[LightGBM] [Warning] No further splits with positive gain, best gain:
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[LightGBM] [Warning] No further splits with positive gain, best gain:
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[LightGBM] [Warning] No further splits with positive gain, best gain:
-inf
[LightGBM] [Warning] No further splits with positive gain, best gain:
-inf
[LightGBM] [Warning] No further splits with positive gain, best gain:
-inf
[LightGBM] [Warning] No further splits with positive gain, best gain:
-inf
[LightGBM] [Warning] No further splits with positive gain, best gain:
-inf
[LightGBM] [Warning] No further splits with positive gain, best gain:
-inf
[LightGBM] [Warning] No further splits with positive gain, best gain:
-inf
[LightGBM] [Warning] No further splits with positive gain, best gain:
-inf
[LightGBM] [Warning] No further splits with positive gain, best gain:
-inf
[LightGBM] [Warning] No further splits with positive gain, best gain:
-inf
```

```
[LightGBM] [Warning] No further splits with positive gain, best gain:
-inf
[LightGBM] [Warning] No further splits with positive gain, best gain:
-inf
[LightGBM] [Warning] No further splits with positive gain, best gain:
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[LightGBM] [Warning] No further splits with positive gain, best gain:
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[LightGBM] [Warning] No further splits with positive gain, best gain:
-inf
[LightGBM] [Warning] No further splits with positive gain, best gain:
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[LightGBM] [Warning] No further splits with positive gain, best gain:
-inf
[LightGBM] [Warning] No further splits with positive gain, best gain:
-inf
[LightGBM] [Warning] No further splits with positive gain, best gain:
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[LightGBM] [Warning] No further splits with positive gain, best gain:
-inf
[LightGBM] [Warning] No further splits with positive gain, best gain:
-inf
[LightGBM] [Warning] No further splits with positive gain, best gain:
-inf
[LightGBM] [Warning] No further splits with positive gain, best gain:
-inf
[LightGBM] [Warning] No further splits with positive gain, best gain:
-inf
[LightGBM] [Warning] No further splits with positive gain, best gain:
-inf
[LightGBM] [Warning] No further splits with positive gain, best gain:
-inf
[LightGBM] [Warning] No further splits with positive gain, best gain:
-inf
[LightGBM] [Warning] No further splits with positive gain, best gain:
-inf
[LightGBM] [Warning] No further splits with positive gain, best gain:
-inf
[LightGBM] [Warning] No further splits with positive gain, best gain:
-inf
[LightGBM] [Warning] No further splits with positive gain, best gain:
-inf
□ LightGBM Accuracy: 0.9875
              precision    recall  f1-score   support

           0       0.98      1.00      0.99        50
           2       1.00      0.97      0.98        30

    accuracy                           0.99        80
```
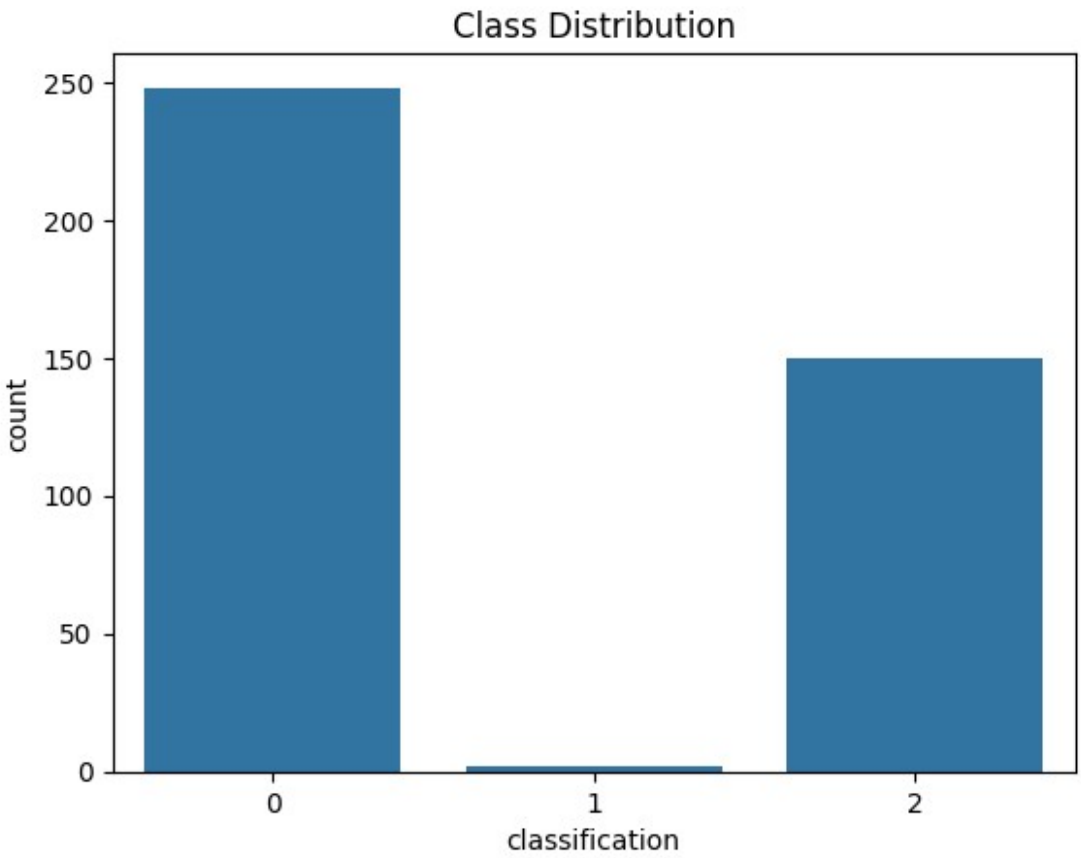
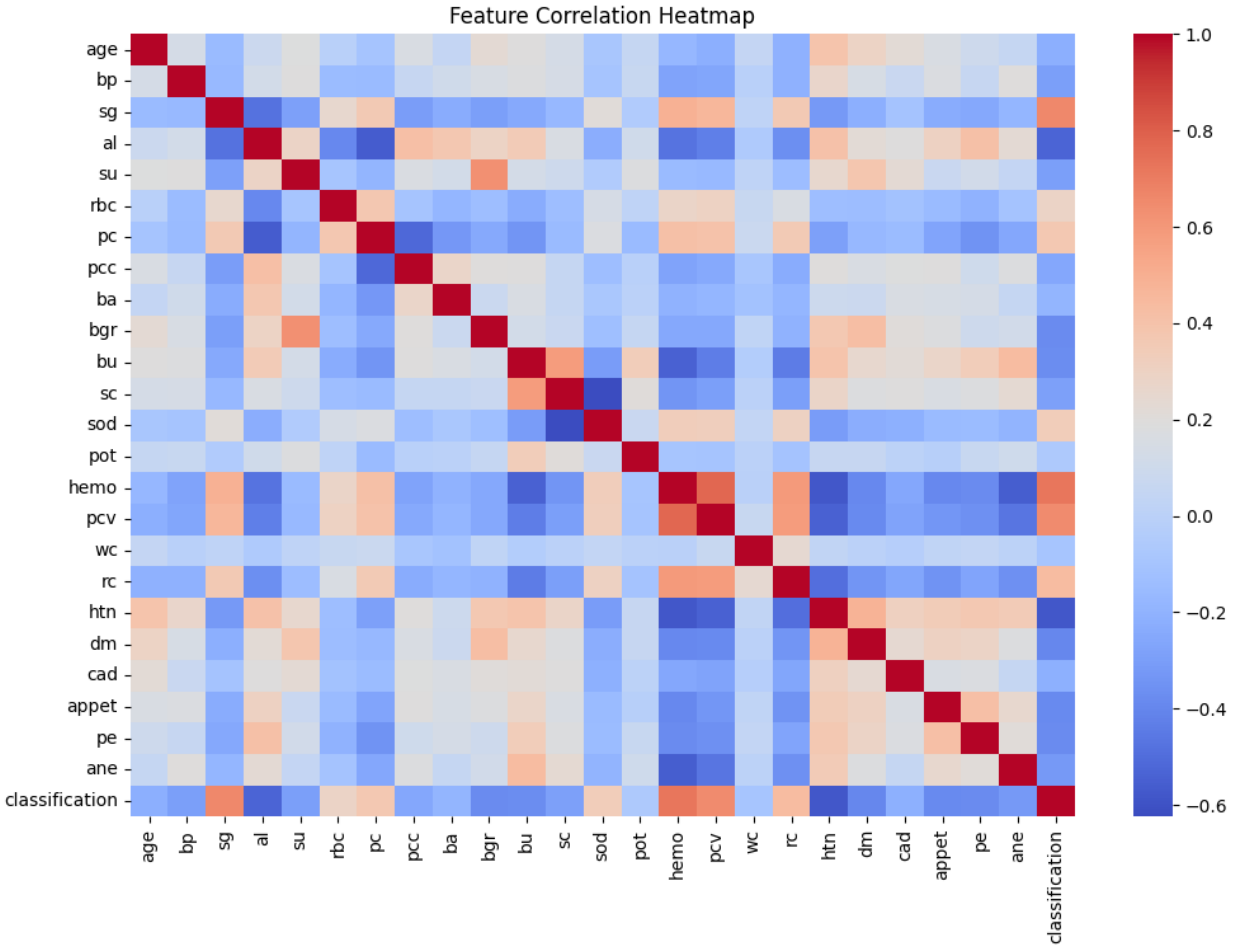
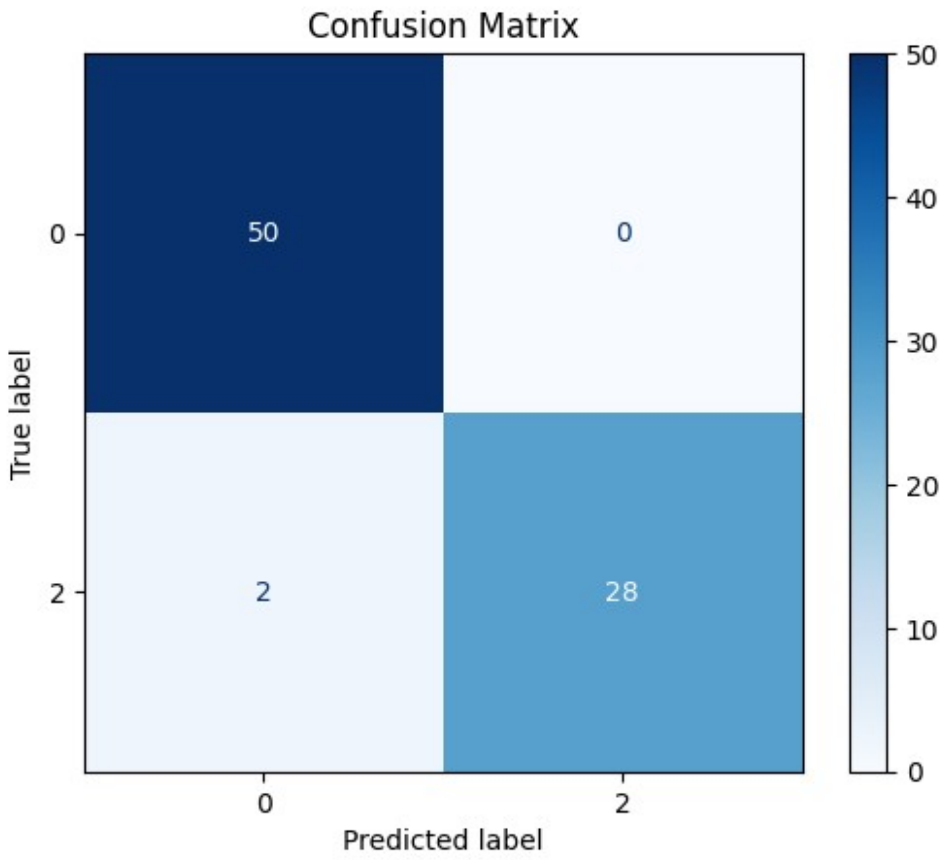
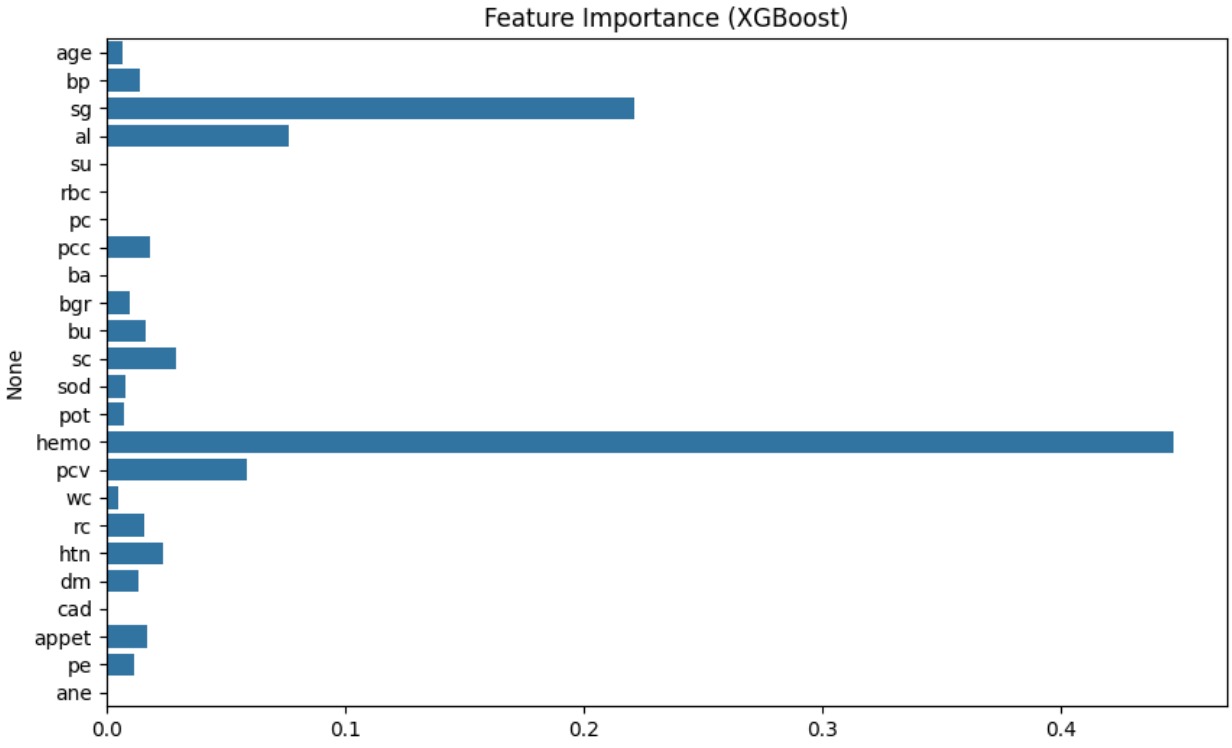

```
   macro avg       0.99      0.98      0.99        80
weighted avg       0.99      0.99      0.99        80


/usr/local/lib/python3.12/dist-packages/sklearn/utils/
validation.py:2739: UserWarning: X does not have valid feature names,
but LGBMClassifier was fitted with feature names
  warnings.warn(
```

```python
import matplotlib.pyplot as plt
import seaborn as sns
from sklearn.metrics import confusion_matrix, ConfusionMatrixDisplay
import numpy as np # Import numpy

# 1. Class distribution
sns.countplot(x='classification', data=df)
plt.title("Class Distribution")
plt.show()

# 2. Correlation heatmap
plt.figure(figsize=(12,8))
sns.heatmap(df.corr(), cmap="coolwarm", annot=False)
plt.title("Feature Correlation Heatmap")
plt.show()

# 3. Confusion Matrix
cm = confusion_matrix(y_test, y_pred)
# Use unique values from y_test for display labels
disp = ConfusionMatrixDisplay(confusion_matrix=cm,
display_labels=np.unique(y_test))
disp.plot(cmap="Blues")
plt.title("Confusion Matrix")
plt.show()

# 4. Feature Importance
plt.figure(figsize=(10,6))
sns.barplot(x=model.feature_importances_, y=df.drop('classification',
axis=1).columns)
plt.title("Feature Importance (XGBoost)")
plt.show()
```


Class Distribution
250
200
150
100
50
0
count
0
1
2
classification


Feature Correlation Heatmap
age
bp
sg
al
su
rbc
pc
pcc
ba
bgr
bu
sc
sod
pot
hemo
pcv
wc
rc
htn
dm
cad
appet
pe
ane
classification
1.0
0.8
0.6
0.4
0.2
0.0
−0.2
−0.4
−0.6


Confusion Matrix
50
0
2
28
0
2
True label
Predicted label
50
40
30
20
10
0


Feature Importance (XGBoost)
age
bp
sg
al
su
rbc
pc
pcc
ba
bgr
bu
sc
sod
pot
hemo
pcv
wc
rc
htn
dm
cad
appet
pe
ane
None
0.0
0.1
0.2
0.3
0.4

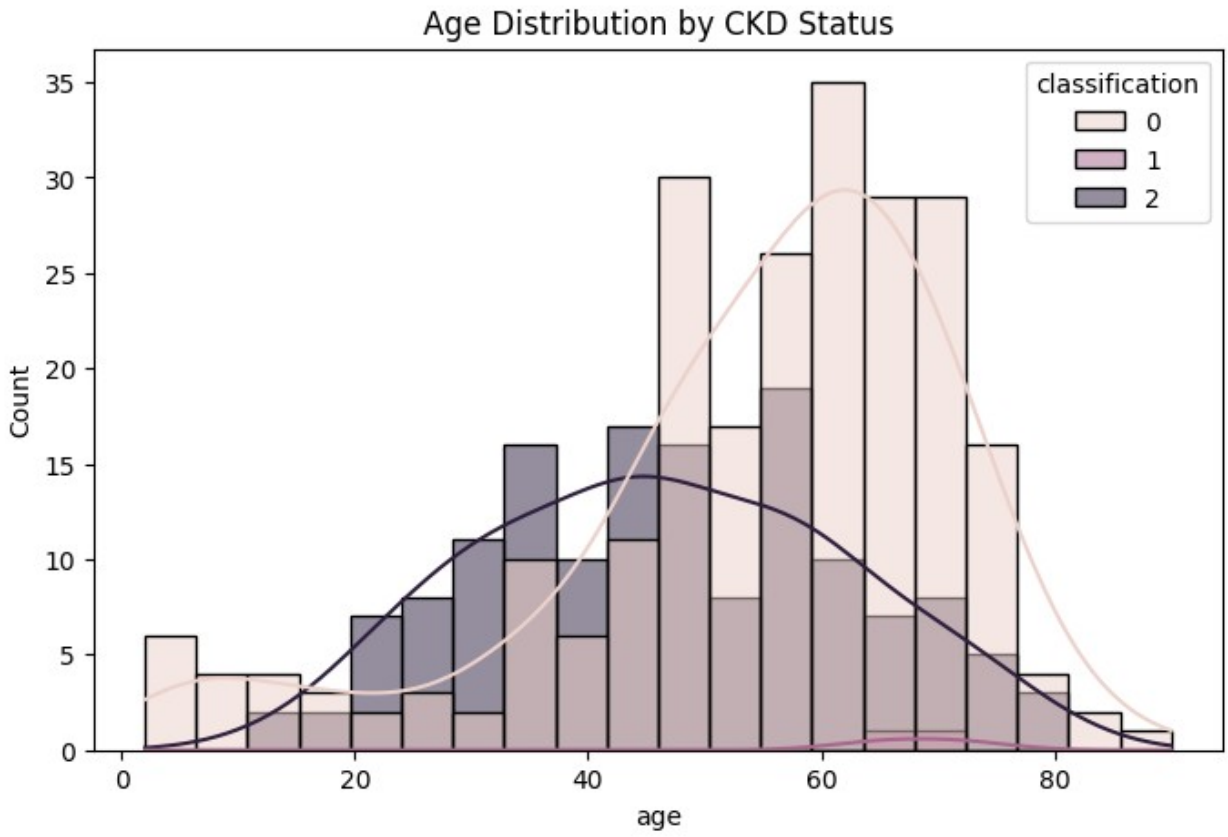
```
from google.colab import files
import pandas as pd
import numpy as np
from sklearn.model_selection import train_test_split
from sklearn.preprocessing import LabelEncoder, StandardScaler
from xgboost import XGBClassifier

try:
    df = pd.read_csv("kidney_disease.csv")
    print("Shape:", df.shape)
except FileNotFoundError:
    print("kidney_disease.csv not found. Please upload the file using
the 'files.upload()' cell.")
    # Provide a placeholder DataFrame or exit if file not found
    df = pd.DataFrame() # Placeholder

if not df.empty:
    # Drop ID column if it exists
    if 'id' in df.columns:
        df = df.drop('id', axis=1)


        if df[col].dtype == 'object':
            df[col] = df[col].fillna(df[col].mode()[0])
        else:
            df[col] = df[col].fillna(df[col].median())


    le = LabelEncoder()
    for col in df.columns:
        if df[col].dtype == 'object':
            df[col] = le.fit_transform(df[col])


    X = df.drop('classification', axis=1)  # assuming 'classification'
is target
    y = df['classification']

    # Scale features
    scaler = StandardScaler()
    X = scaler.fit_transform(X)

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

    print("Training shape:", X_train.shape)
    print("Testing shape:", X_test.shape)


    model = XGBClassifier(use_label_encoder=False,
```

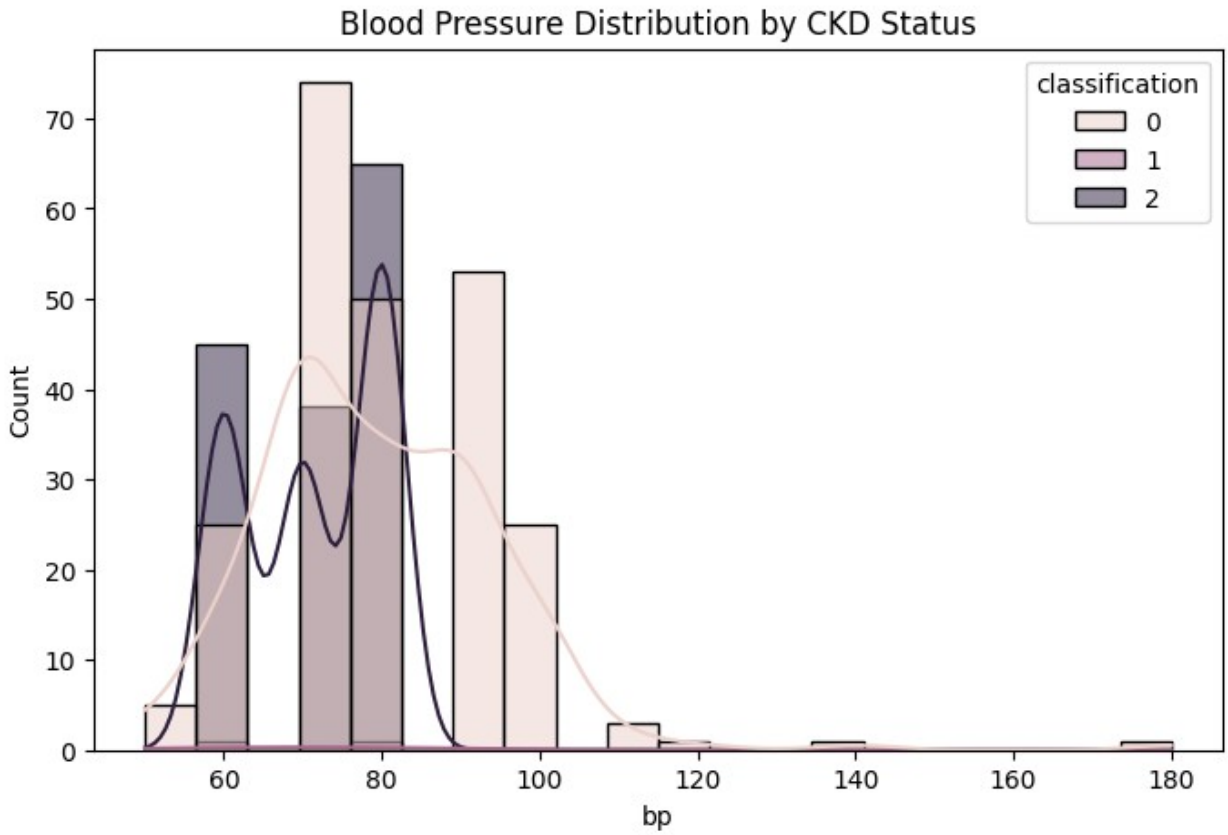
```
eval_metric='logloss', random_state=42)
    model.fit(X_train, y_train)
```

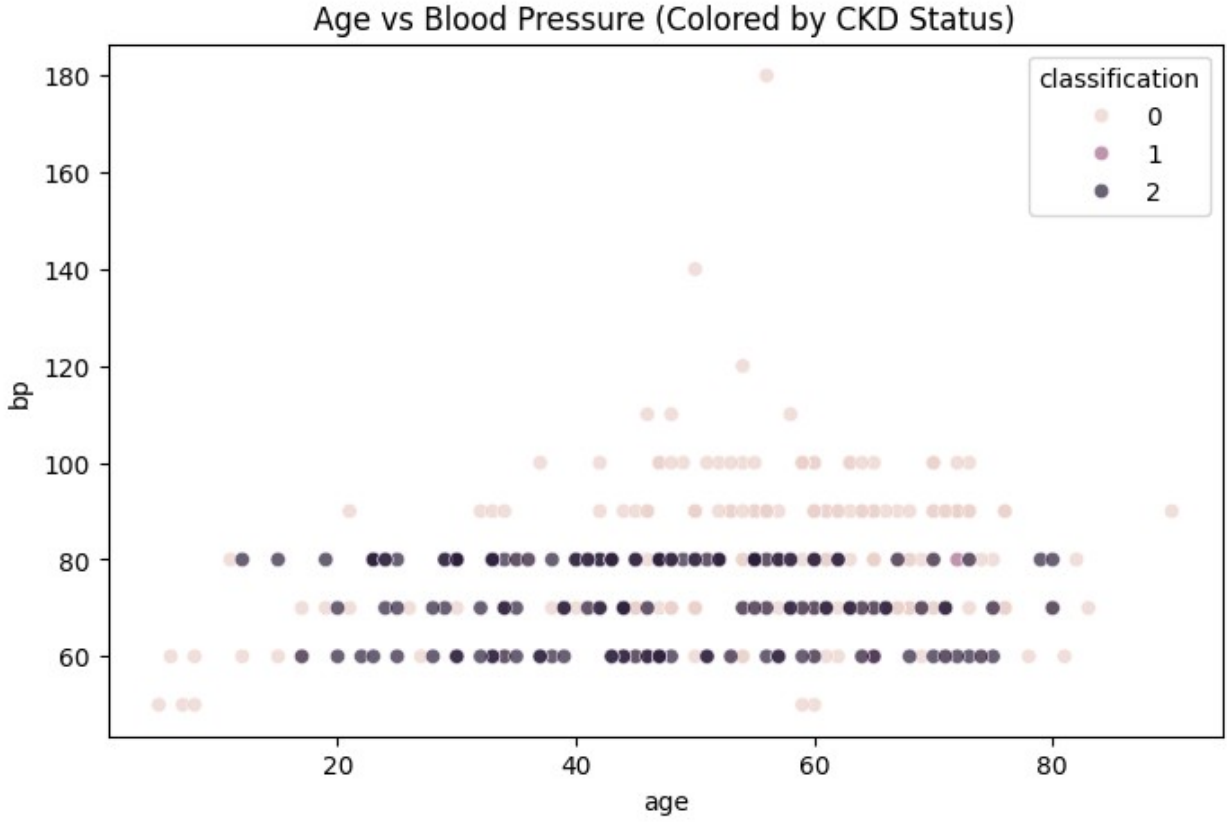
```
Shape: (400, 26)
Training shape: (320, 24)
Testing shape: (80, 24)
```

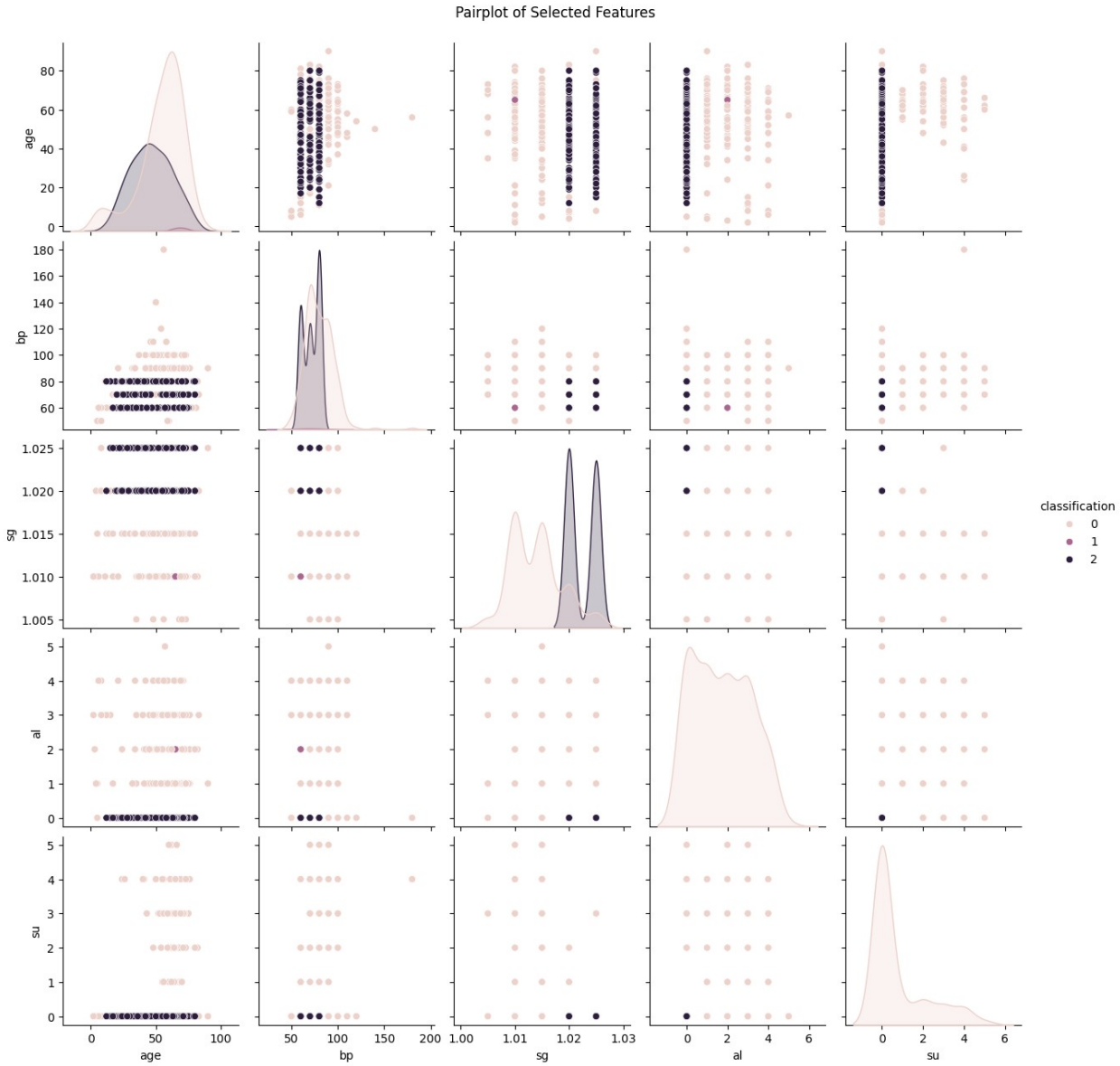
```
/usr/local/lib/python3.12/dist-packages/xgboost/training.py:183:
UserWarning: [14:18:01] WARNING: /workspace/src/learner.cc:738:
Parameters: { "use_label_encoder" } are not used.

  bst.update(dtrain, iteration=i, fobj=obj)
```

```
# 📊 Histogram of Age
plt.figure(figsize=(8,5))
sns.histplot(data=df, x='age', bins=20, kde=True,
hue='classification')
plt.title("Age Distribution by CKD Status")
plt.show()

# 📊 Histogram of Blood Pressure
plt.figure(figsize=(8,5))
sns.histplot(data=df, x='bp', bins=20, kde=True, hue='classification')
plt.title("Blood Pressure Distribution by CKD Status")
plt.show()

# 📊 Scatter Plot: Age vs Blood Pressure
plt.figure(figsize=(8,5))
sns.scatterplot(x=df['age'], y=df['bp'], hue=df['classification'],
alpha=0.7)
plt.title("Age vs Blood Pressure (Colored by CKD Status)")
plt.show()

# 📊 Pairplot for selected features
selected_features = ['age', 'bp', 'sg', 'al', 'su', 'classification']
sns.pairplot(df[selected_features], hue='classification')
plt.suptitle("Pairplot of Selected Features", y=1.02)
plt.show()
```

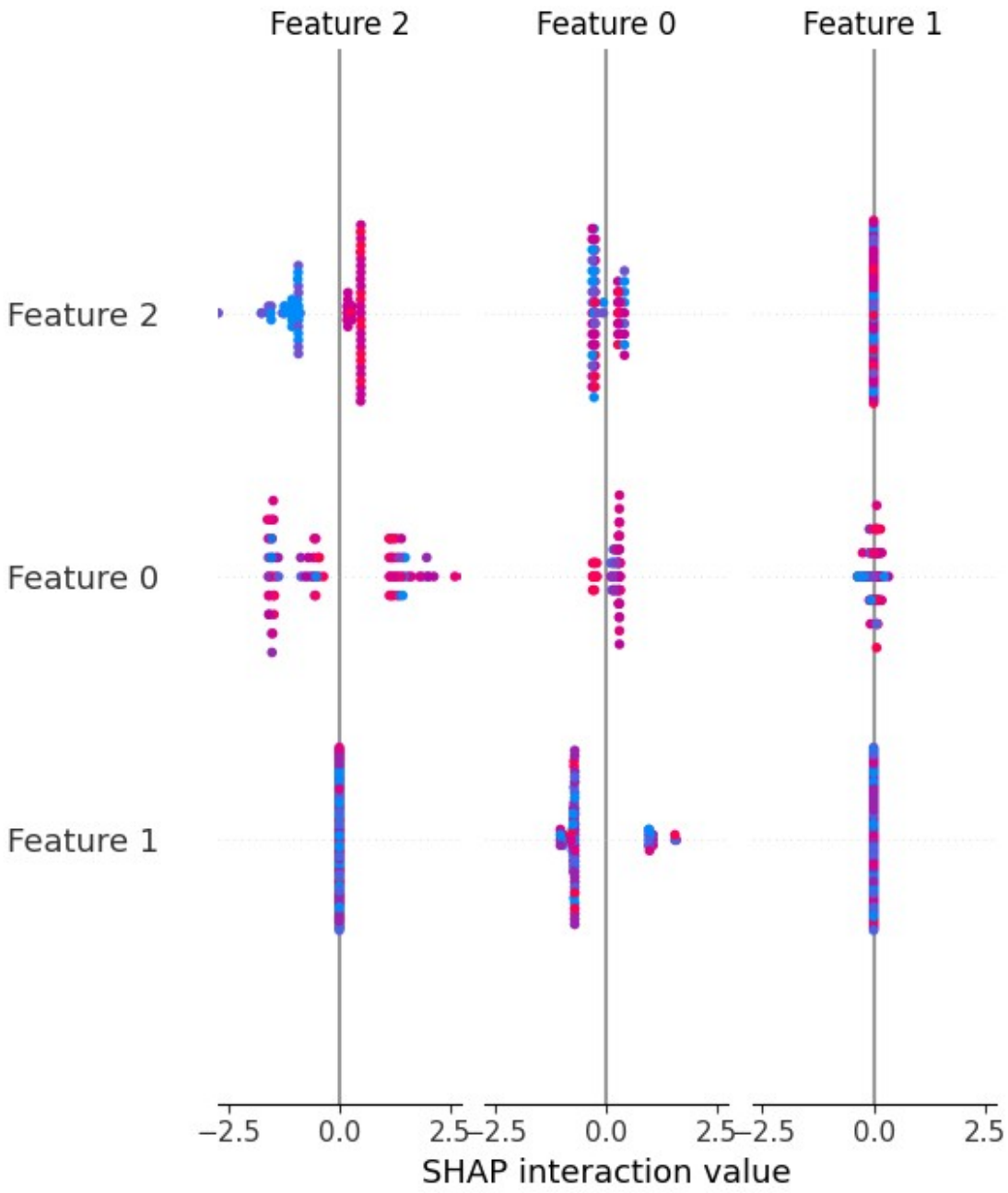

Age Distribution by CKD Status
classification
0
1
2
Count
age
0
5
10
15
20
25
30
35
0
20
40
60
80


Blood Pressure Distribution by CKD Status
classification
0
1
2
Count
bp
0
10
20
30
40
50
60
70
60
80
100
120
140
160
180


Age vs Blood Pressure (Colored by CKD Status)
classification
0
1
2
bp
age
60
80
100
120
140
160
180
20
40
60
80




```
import shap
explainer = shap.TreeExplainer(model)
shap_values = explainer.shap_values(X_test)
shap.summary_plot(shap_values, X_test)
```


Feature 2
Feature 0
Feature 1
Feature 2
Feature 0
Feature 1
−2.5
0.0
2.5
−2.5
0.0
2.5
−2.5
0.0
2.5
SHAP interaction value