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

from sklearn.preprocessing import StandardScaler, LabelEncoder
from sklearn.model_selection import train_test_split
from sklearn.linear_model import LogisticRegression
from sklearn.metrics import accuracy_score, classification_report,
confusion_matrix
from sklearn.naive_bayes import GaussianNB

df = pd.read_csv('breast-cancer.csv')

df.head()
```

```
         id diagnosis  radius_mean  texture_mean  perimeter_mean
area_mean  \
0    842302         M        17.99         10.38          122.80
1001.0
1    842517         M        20.57         17.77          132.90
1326.0
2  84300903         M        19.69         21.25          130.00
1203.0
3  84348301         M        11.42         20.38           77.58
386.1
4  84358402         M        20.29         14.34          135.10
1297.0

   smoothness_mean  compactness_mean  concavity_mean  concave
points_mean  \
0          0.11840           0.27760          0.3001
0.14710
1          0.08474           0.07864          0.0869
0.07017
2          0.10960           0.15990          0.1974
0.12790
3          0.14250           0.28390          0.2414
0.10520
4          0.10030           0.13280          0.1980
0.10430

   ...  radius_worst  texture_worst  perimeter_worst  area_worst  \
0  ...         25.38          17.33           184.60      2019.0
1  ...         24.99          23.41           158.80      1956.0
2  ...         23.57          25.53           152.50      1709.0
3  ...         14.91          26.50            98.87       567.7
4  ...         22.54          16.67           152.20      1575.0

   smoothness_worst  compactness_worst  concavity_worst  concave
```

```
points_worst  \
0            0.1622             0.6656           0.7119
0.2654
1            0.1238             0.1866           0.2416
0.1860
2            0.1444             0.4245           0.4504
0.2430
3            0.2098             0.8663           0.6869
0.2575
4            0.1374             0.2050           0.4000
0.1625

   symmetry_worst  fractal_dimension_worst
0          0.4601                  0.11890
1          0.2750                  0.08902
2          0.3613                  0.08758
3          0.6638                  0.17300
4          0.2364                  0.07678

[5 rows x 32 columns]
```

```
df.dtypes
```

```
id                           int64
diagnosis                   object
radius_mean                float64
texture_mean               float64
perimeter_mean             float64
area_mean                  float64
smoothness_mean            float64
compactness_mean           float64
concavity_mean             float64
concave points_mean        float64
symmetry_mean              float64
fractal_dimension_mean     float64
radius_se                  float64
texture_se                 float64
perimeter_se               float64
area_se                    float64
smoothness_se              float64
compactness_se             float64
concavity_se               float64
concave points_se          float64
symmetry_se                float64
fractal_dimension_se       float64
radius_worst               float64
texture_worst              float64
perimeter_worst            float64
area_worst                 float64
smoothness_worst           float64
```

```
compactness_worst           float64
concavity_worst             float64
concave points_worst        float64
symmetry_worst              float64
fractal_dimension_worst     float64
dtype: object
```

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

```
SampleCodeNumber             0
ClumpThickness               0
UniformityCellSize           0
UniformityCellShape          0
MarginalAdhesion             0
SingleEpithelialCellSize     0
BareNuclei                   0
BlandChromatin               0
NormalNucleoli               0
Mitoses                      0
Class                        0
dtype: int64
```

```
for col in df.columns:
    if df[col].astype(str).str.contains(r"\?").any():
        print(f"Column '{col}' contains '?' values.")
```

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

```
id                         0
diagnosis                  0
radius_mean                0
texture_mean               0
perimeter_mean             0
area_mean                  0
smoothness_mean            0
compactness_mean           0
concavity_mean             0
concave points_mean        0
symmetry_mean              0
fractal_dimension_mean     0
radius_se                  0
texture_se                 0
perimeter_se               0
area_se                    0
smoothness_se              0
compactness_se             0
concavity_se               0
concave points_se          0
symmetry_se                0
fractal_dimension_se       0
```

```
radius_worst               0
texture_worst              0
perimeter_worst            0
area_worst                 0
smoothness_worst           0
compactness_worst          0
concavity_worst            0
concave points_worst       0
symmetry_worst             0
fractal_dimension_worst    0
dtype: int64
```

```
numeric_cols = df.select_dtypes(include=[np.number]).columns
df_cleaned = df[(df[numeric_cols] >= 0).all(axis=1)]

def remove_outliers_iqr(df, columns):
    for col in columns:
        Q1 = df[col].quantile(0.25)
        Q3 = df[col].quantile(0.75)
        IQR = Q3 - Q1
        lower = Q1 - 1.5 * IQR
        upper = Q3 + 1.5 * IQR
        df = df[(df[col] >= lower) & (df[col] <= upper)]
    return df

# Apply outlier removal to relevant columns (all numeric columns
except 'id' and 'diagnosis')
df_no_outliers = remove_outliers_iqr(df_cleaned,
df_cleaned.columns[2:])

df_no_outliers.shape
```

```
(277, 32)
```

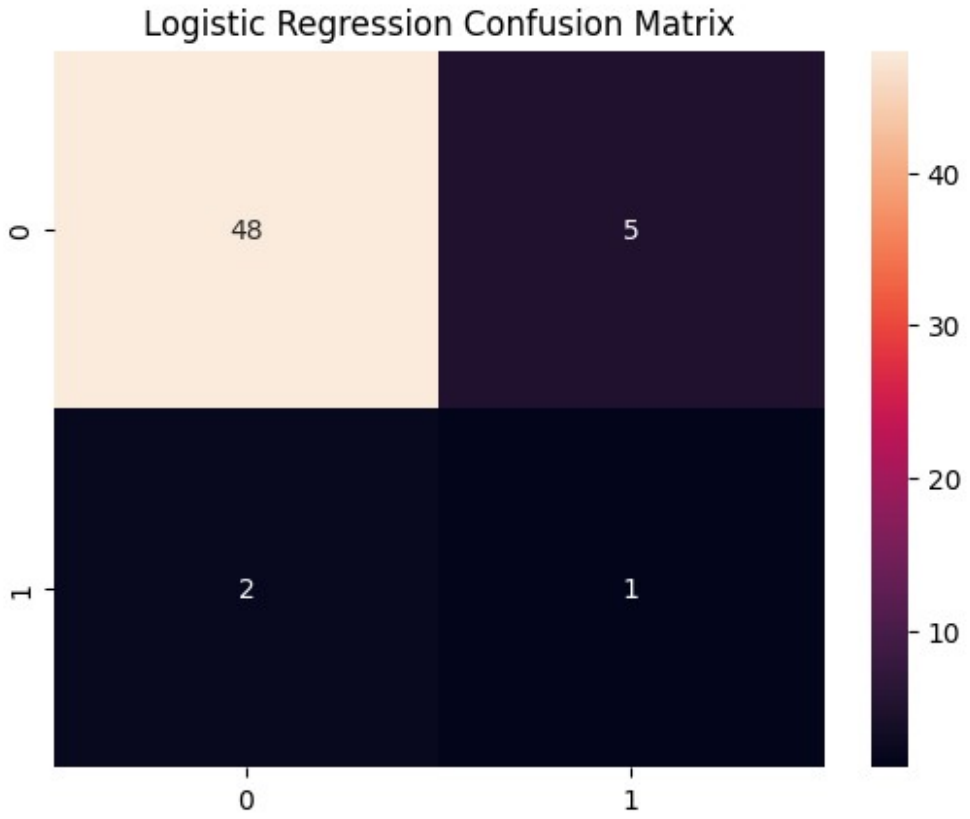
```
# Encode the diagnosis column ('M' -> 1, 'B' -> 0)
df_transformed = df_no_outliers.copy()
df_transformed['diagnosis'] = df_transformed['diagnosis'].map({'M': 1,
'B': 0})

from sklearn.model_selection import train_test_split
from sklearn.linear_model import LogisticRegression
from sklearn.naive_bayes import GaussianNB
from sklearn.metrics import accuracy_score, classification_report
from sklearn.utils import resample

# Features and target
X = df_transformed.drop(['id', 'diagnosis'], axis=1)  # Drop 'id' and
'diagnosis' as they're not features
y = df_transformed['diagnosis']  # Target is 'diagnosis' (0: Benign,
1: Malignant)
```

```python
# Split the data into training and testing sets (80% train, 20% test)
X_train, X_test, y_train, y_test = train_test_split(X, y,
test_size=0.2, random_state=42)

X_resampled, y_resampled = resample(X_train, y_train,
                                    replace=True,
                                    n_samples=len(X_train),
                                    random_state=42)

# Logistic Regression Model
logreg = LogisticRegression(max_iter=3000,class_weight='balanced')
logreg.fit(X_train, y_train)
y_pred_logreg = logreg.predict(X_test)
logreg_acc = accuracy_score(y_test, y_pred_logreg)

# Naive Bayes Model
nb = GaussianNB()
nb.fit(X_resampled, y_resampled)
y_pred_nb = nb.predict(X_test)
nb_acc = accuracy_score(y_test, y_pred_nb)

# Print the results
print(f"Logistic Regression Accuracy: {logreg_acc:.4f}")
print(f"Naive Bayes Accuracy: {nb_acc:.4f}")

# Classification reports
print("\nClassification Report (Logistic Regression):")
print(classification_report(y_test, y_pred_logreg))

print("\nClassification Report (Naive Bayes):")
print(classification_report(y_test, y_pred_nb))
```

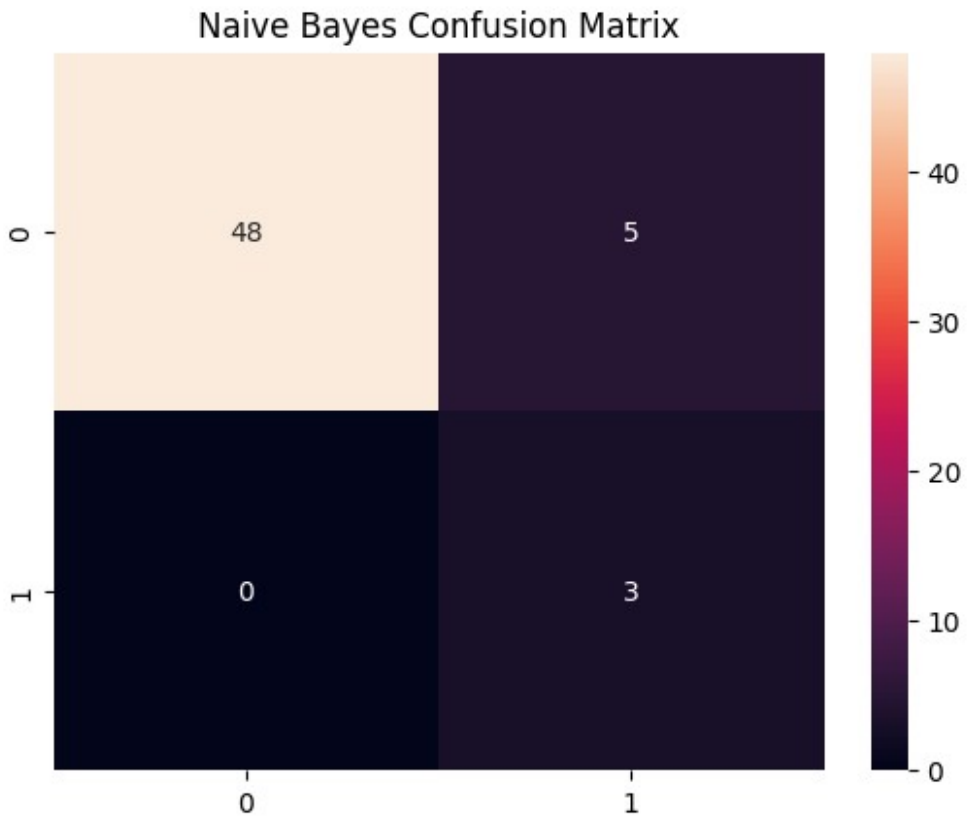
```
Logistic Regression Accuracy: 0.8750
Naive Bayes Accuracy: 0.9107

Classification Report (Logistic Regression):
              precision    recall  f1-score   support

           0       0.96      0.91      0.93        53
           1       0.17      0.33      0.22         3

    accuracy                           0.88        56
   macro avg       0.56      0.62      0.58        56
weighted avg       0.92      0.88      0.89        56


Classification Report (Naive Bayes):
              precision    recall  f1-score   support

           0       1.00      0.91      0.95        53
           1       0.38      1.00      0.55         3
```

```
    accuracy                           0.91        56
   macro avg       0.69      0.95      0.75        56
weighted avg       0.97      0.91      0.93        56
```

```
sns.heatmap(confusion_matrix(y_test, y_pred_logreg), annot=True,
fmt='d')
plt.title("Logistic Regression Confusion Matrix")
plt.show()
```




```
sns.heatmap(confusion_matrix(y_test, y_pred_nb), annot=True, fmt='d')
plt.title("Naive Bayes Confusion Matrix")
plt.show()
```


Naive Bayes Confusion Matrix
48
5
0
3
0
1
0
1
40
30
20
10
0