In [ ]:

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

from sklearn.model_selection import train_test_split
from sklearn.preprocessing import LabelEncoder
from sklearn.tree import DecisionTreeClassifier
from sklearn.ensemble import RandomForestClassifier
from xgboost import XGBClassifier
from sklearn.metrics import accuracy_score
from sklearn.metrics import classification_report
from sklearn.metrics import confusion_matrix

from sklearn.model_selection import GridSearchCV, RandomizedSearchCV



url = "/content/drive/MyDrive/WA_Fn-UseC_-Telco-Customer-Churn.csv"
data = pd.read_csv(url)
```

In [ ]:

```
def plot_cf_matrix(y_test, y_pred, target_names):
    cf_matrix = confusion_matrix(y_true=y_test, y_pred=y_pred)
    df_matrix_df = pd.DataFrame(cf_matrix,index = target_names, columns = t
    sns.heatmap(df_matrix_df, annot=True, cmap='RdYlBu', linewidth=.5, fmt=
    plt.title('Confusion matrix', y=1.1)
    plt.ylabel('Actual label')
    plt.xlabel('Predicted label')

target_names = ['No Churn', 'Churn']
```

In [ ]:

```
print("特徵類型表格：")
print(data.dtypes)
```

```
特徵類型表格：
customerID           object
gender               object
SeniorCitizen         int64
Partner              object
Dependents           object
tenure                int64
PhoneService         object
MultipleLines        object
InternetService      object
OnlineSecurity       object
OnlineBackup         object
DeviceProtection     object
TechSupport          object
StreamingTV          object
StreamingMovies      object
Contract             object
PaperlessBilling     object
PaymentMethod        object
MonthlyCharges      float64
TotalCharges         object
Churn                object
dtype: object
```

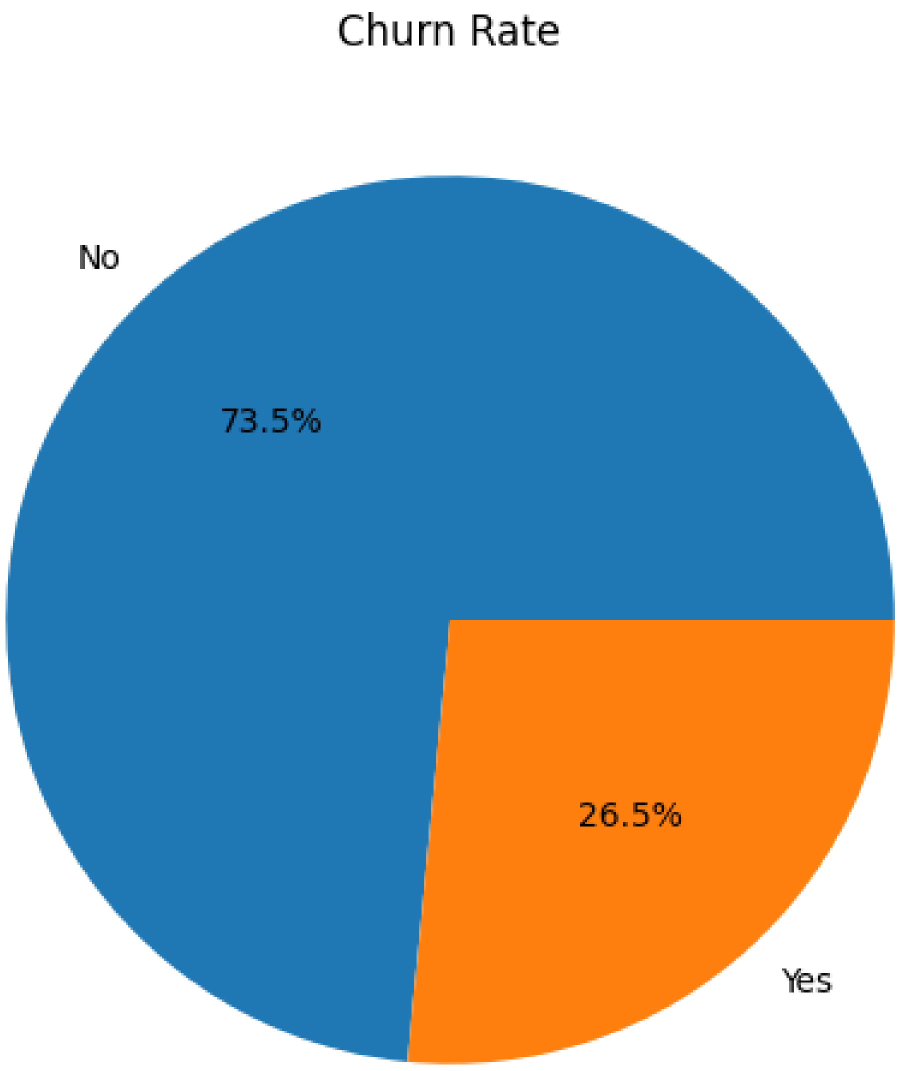
In [ ]:

```python
print("數據的形狀（行數和列數）：", data.shape)


print("\n前五行數據：")
print(data.head())
```

```
數據的形狀（行數和列數）： (7043, 21)

前五行數據：
   customerID  gender  SeniorCitizen Partner Dependents  tenure PhoneServi
ce  \
0  7590-VHVEG  Female              0     Yes         No       1           
No   
1  5575-GNVDE    Male              0      No         No      34           Y
es   
2  3668-QPYBK    Male              0      No         No       2           Y
es   
3  7795-CFOCW    Male              0      No         No      45           
No   
4  9237-HQITU  Female              0      No         No       2           Y
es   

      MultipleLines InternetService OnlineSecurity  ... DeviceProtection  
\
0  No phone service             DSL             No  ...               No   
1                No             DSL            Yes  ...              Yes   
2                No             DSL            Yes  ...               No   
3  No phone service             DSL            Yes  ...              Yes   
4                No     Fiber optic             No  ...               No   

  TechSupport StreamingTV StreamingMovies        Contract PaperlessBilling 
\
0          No          No              No  Month-to-month              Yes   
1          No          No              No        One year               No   
2          No          No              No  Month-to-month              Yes   
3         Yes          No              No        One year               No   
4          No          No              No  Month-to-month              Yes   

              PaymentMethod MonthlyCharges  TotalCharges Churn  
0          Electronic check          29.85         29.85    No  
1              Mailed check          56.95        1889.5    No  
2              Mailed check          53.85        108.15   Yes  
3  Bank transfer (automatic)          42.30       1840.75    No  
4          Electronic check          70.70        151.65   Yes  

[5 rows x 21 columns]
```

In [ ]:

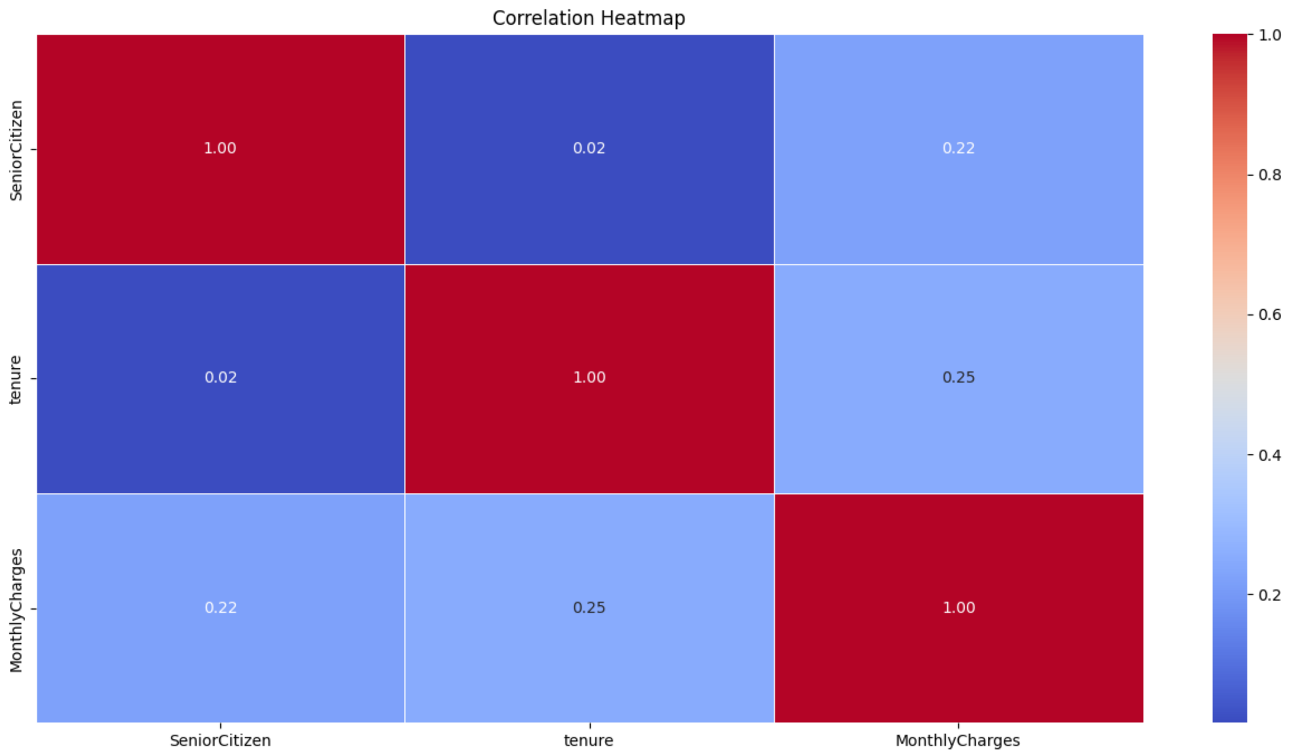
```
# 繪製Churn比例的圓餅圖
churn_counts = data["Churn"].value_counts()
plt.figure(figsize=(6, 6))
plt.pie(churn_counts, labels=churn_counts.index, autopct="%1.1f%%")
plt.title("Churn Rate")
plt.show()
```



In [ ]:

```
# 繪製特徵之間的相關性熱力圖
plt.figure(figsize=(16, 8))
sns.heatmap(data.corr(), annot=True, cmap="coolwarm", linewidths=0.5, fmt='
plt.title("Correlation Heatmap")
plt.show()
```

```
<ipython-input-5-d76f5fd7cc90>:3: FutureWarning: The default value of nume
ric_only in DataFrame.corr is deprecated. In a future version, it will def
ault to False. Select only valid columns or specify the value of numeric_o
nly to silence this warning.
  sns.heatmap(data.corr(), annot=True, cmap="coolwarm", linewidths=0.5, fm
t=".2f")
```



```
In [ ]: for column in data.columns:
            if data[column].dtype == object:
                encoder = LabelEncoder()
                data[column] = encoder.fit_transform(data[column])
```

```
In [ ]: X = data.drop(["Churn",'customerID'], axis=1)
        y = data["Churn"]

        X_train, X_test, y_train, y_test = train_test_split(X, y, test_size=0.2, ra
```

```
In [ ]: from sklearn.feature_selection import chi2
```

```
In [ ]: chi2, p_value = chi2(X_train, y_train)
```

```
In [ ]: chi_df = pd.DataFrame({ 'chi-squares test': chi2, 'p-value':p_value})
        chi_df['p-value'] = chi_df['p-value'].round(4)
        chi_df = chi_df.sort_values('chi-squares test', ascending=False)
        chi_df.style.background_gradient(cmap='Blues')
```

Out[ ]:

	chi-squares test	p-value
4	12349.737573	0.000000
17	2795.912582	0.000000
18	2234.827250	0.000000
14	873.211647	0.000000
8	439.328373	0.000000
11	407.908476	0.000000
9	177.543358	0.000000
10	144.973153	0.000000
3	104.146764	0.000000
1	102.275240	0.000000
15	84.520367	0.000000
2	58.775844	0.000000
16	41.581329	0.000000
7	7.813628	0.005200
6	6.523859	0.010600
12	6.426778	0.011200
13	4.752568	0.029300
0	0.377925	0.538700
5	0.043591	0.834600

In [ ]:

```
from sklearn.feature_selection import SelectKBest, chi2

chi2Filter = SelectKBest(chi2, k=8)
chi2Filter.fit(X_train, y_train)

# 選取完的 top 20 特徵
X_train_new = chi2Filter.transform(X_train)
X_test_new = chi2Filter.transform(X_test)
```

In [ ]:

```
chi2Filter.get_feature_names_out()
```

Out[ ]:

```
array(['tenure', 'OnlineSecurity', 'OnlineBackup', 'DeviceProtection',
       'TechSupport', 'Contract', 'MonthlyCharges', 'TotalCharges'],
      dtype=object)
```

In [ ]:

```
from sklearn.svm import SVC
```

```
rf = RandomForestClassifier(random_state=42)

rf.fit(X_train_new, y_train)

chi2_select_pred_20 = rf.predict(X_test_new)

report = classification_report(y_test, chi2_select_pred_20)
print(report)
```

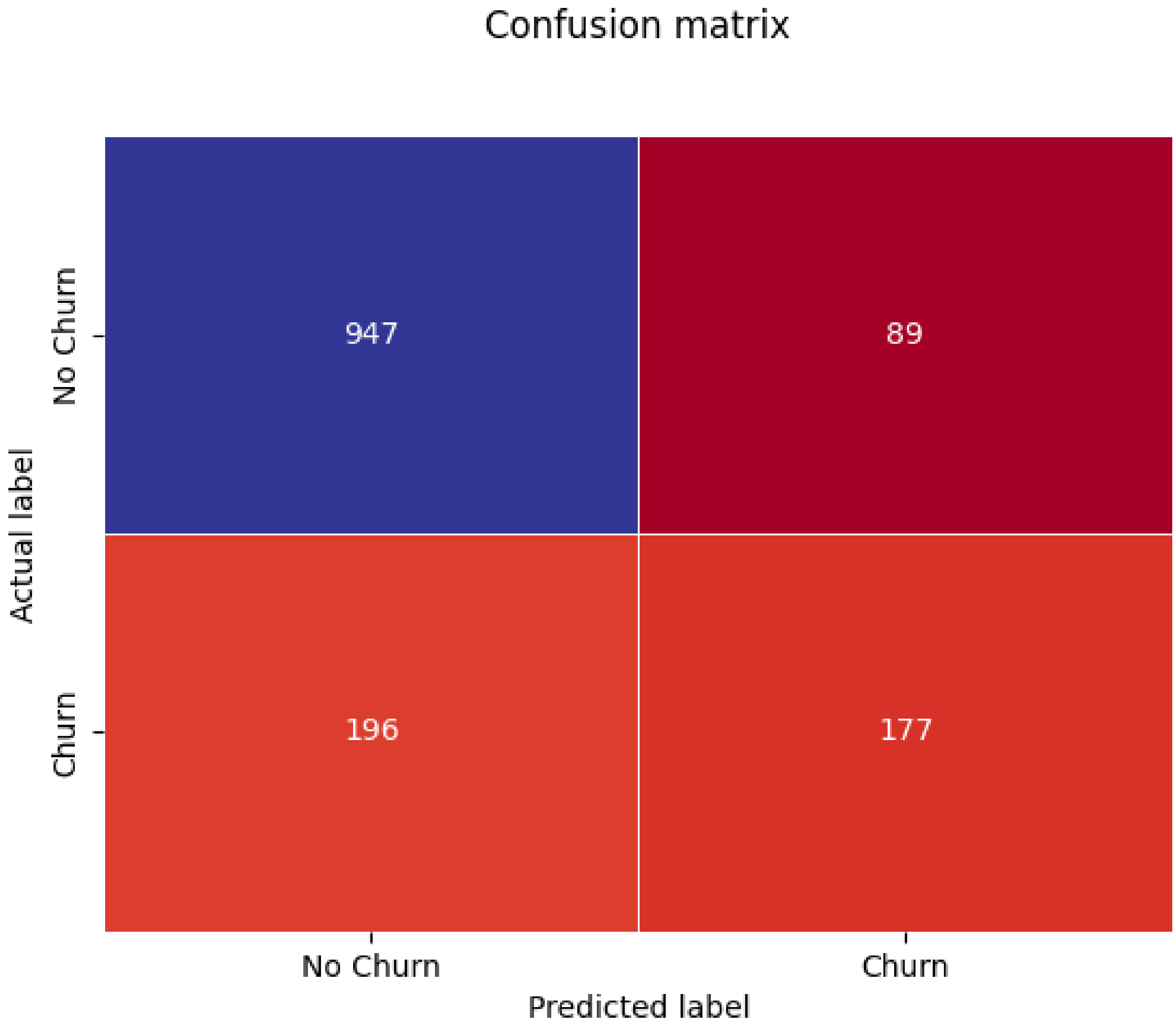
```
              precision    recall  f1-score   support

           0       0.83      0.90      0.86      1036
           1       0.64      0.49      0.55       373

    accuracy                           0.79      1409
   macro avg       0.73      0.70      0.71      1409
weighted avg       0.78      0.79      0.78      1409
```

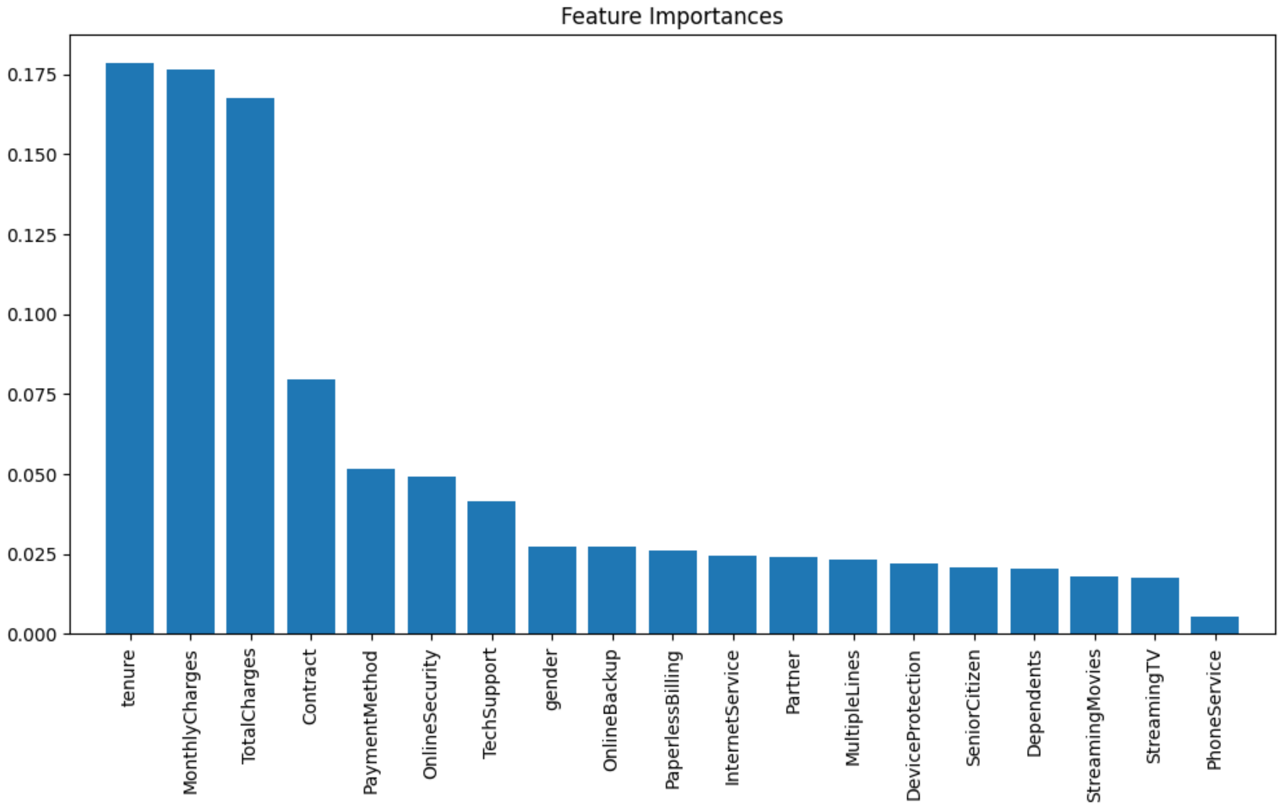
In [ ]:

```
rf_classifier = RandomForestClassifier(random_state=42)


param_grid = {
    "n_estimators": [50, 100, 200, 300],
    #"max_depth": [3, 5, 7, 9, None],
    #"min_samples_split": [2, 5, 10, 20],
    #"min_samples_leaf": [1, 5, 10, 20],
    #"max_features": ["auto", "sqrt", "log2", None]
}


random_search = RandomizedSearchCV(rf_classifier, param_grid, n_iter=20, cv
random_search.fit(X_train, y_train)


best_model = random_search.best_estimator_


y_pred = best_model.predict(X_test)


report = classification_report(y_test, y_pred)
print(report)

plot_cf_matrix(y_test, y_pred, target_names)

importances = best_model.feature_importances_
indices = np.argsort(importances)[::-1]
feature_names = X.columns

plt.figure(figsize=(12, 6))
plt.title("Feature Importances")
plt.bar(range(X.shape[1]), importances[indices], align="center")
plt.xticks(range(X.shape[1]), feature_names[indices], rotation=90)
plt.xlim([-1, X.shape[1]])
plt.show()
```

```
/usr/local/lib/python3.10/dist-packages/sklearn/model_selection/_search.p
y:305: UserWarning: The total space of parameters 4 is smaller than n_iter
=20. Running 4 iterations. For exhaustive searches, use GridSearchCV.
  warnings.warn(
```

```
              precision    recall  f1-score   support

           0       0.83      0.91      0.87      1036
           1       0.67      0.47      0.55       373

    accuracy                           0.80      1409
   macro avg       0.75      0.69      0.71      1409
weighted avg       0.79      0.80      0.79      1409
```





In [ ]:

```
dt_classifier = DecisionTreeClassifier(random_state=42)


param_grid = {
    "max_depth": [3, 5, 7, 9, None],
    "min_samples_split": [2, 5, 10, 20],
    "min_samples_leaf": [1, 5, 10, 20],
    "max_features": ["auto", "sqrt", "log2", None]
}


random_search = RandomizedSearchCV(dt_classifier, param_grid, n_iter=20, cv
random_search.fit(X_train, y_train)


best_model = random_search.best_estimator_


y_pred = best_model.predict(X_test)


report = classification_report(y_test, y_pred)
print(report)


plot_cf_matrix(y_test, y_pred, target_names)
```

```
/usr/local/lib/python3.10/dist-packages/sklearn/tree/_classes.py:269: Futu
reWarning: `max_features='auto'` has been deprecated in 1.1 and will be re
moved in 1.3. To keep the past behaviour, explicitly set `max_features='sq
rt'`.
  warnings.warn(
/usr/local/lib/python3.10/dist-packages/sklearn/tree/_classes.py:269: Futu
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```

```
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moved in 1.3. To keep the past behaviour, explicitly set `max_features='sq
rt'`.
  warnings.warn(
```
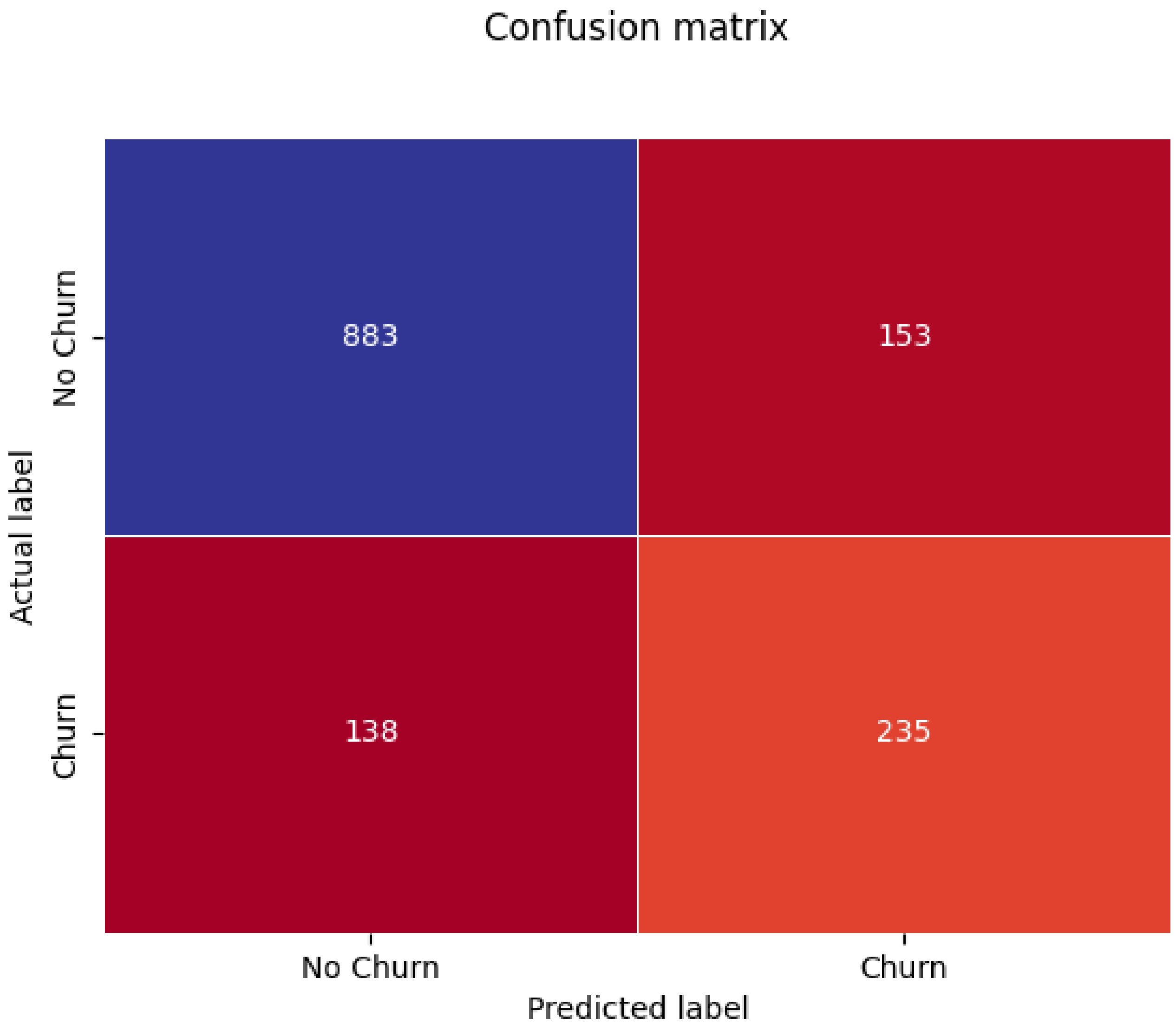

```
              precision    recall  f1-score   support

           0       0.86      0.85      0.86      1036
           1       0.61      0.63      0.62       373

    accuracy                           0.79      1409
   macro avg       0.74      0.74      0.74      1409
weighted avg       0.80      0.79      0.79      1409
```

決策樹混淆矩陣：



In [ ]:

```
xgb_classifier = XGBClassifier(use_label_encoder=False, eval_metric="loglos


param_grid = {
    "n_estimators": [50, 100, 200, 300],
    #"max_depth": [3, 5, 7, 9],
    #"learning_rate": [0.01, 0.05, 0.1, 0.2],
    #"subsample": [0.5, 0.75, 1],
    #"colsample_bytree": [0.5, 0.75, 1]
}


random_search = RandomizedSearchCV(xgb_classifier, param_grid, n_iter=20, c
random_search.fit(X_train, y_train)


best_random_model = random_search.best_estimator_


y_pred = best_random_model.predict(X_test)


report = classification_report(y_test, y_pred)
print("Classification Report:\n", report)
```

```
plot_cf_matrix(y_test, y_pred, target_names)
```

```
/usr/local/lib/python3.10/dist-packages/xgboost/sklearn.py:1395: UserWarni
ng: `use_label_encoder` is deprecated in 1.7.0.
  warnings.warn("`use_label_encoder` is deprecated in 1.7.0.")
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ng: `use_label_encoder` is deprecated in 1.7.0.
  warnings.warn("`use_label_encoder` is deprecated in 1.7.0.")
```
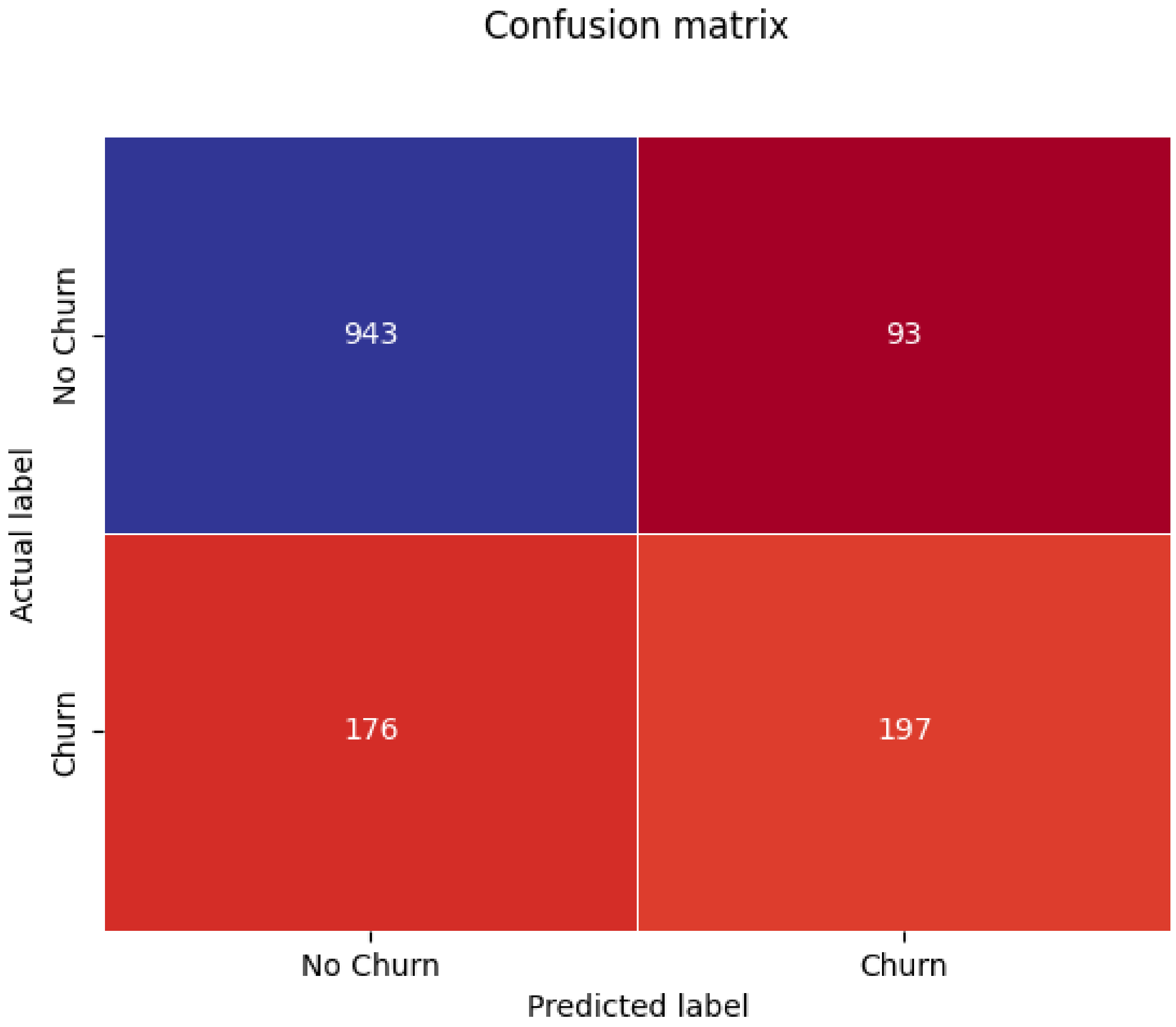

```
Classification Report:
              precision    recall  f1-score   support

           0       0.84      0.91      0.88      1036
           1       0.68      0.53      0.59       373

    accuracy                           0.81      1409
   macro avg       0.76      0.72      0.73      1409
weighted avg       0.80      0.81      0.80      1409
```


Confusion matrix
No Churn
Churn
Actual label
No Churn
Churn
Predicted label