Practical No. : 05

1. Implement logistic regression using Python/R to perform classification on Social_Network_Ads.csv dataset.
2. Compute Confusion matrix to find TP, FP, TN, FN, Accuracy, Error rate, Precision, Recall on the given datast.

Import all the required Python Libraries.

In [18]:
```
import numpy as np
import pandas as pd
```

1) Implement logistic regression using Python/R to perform classification on Social_Network_Ads.csv dataset.

In [19]:
```
df = pd.read_csv('Social_Network_Ads.csv')
```

In [20]:
```
df.head()
```

Out[20]:

	User ID	Gender	Age	EstimatedSalary	Purchased
0	15624510	Male	19.0	19000.0	0
1	15810944	Male	35.0	20000.0	0
2	15668575	Female	26.0	43000.0	0
3	15603246	Female	27.0	57000.0	0
4	15804002	Male	19.0	76000.0	0

In [21]:
```
df.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 400 entries, 0 to 399
Data columns (total 5 columns):
 #   Column           Non-Null Count  Dtype  
---  ------           --------------  -----  
 0   User ID          400 non-null    int64  
 1   Gender           400 non-null    object 
 2   Age              400 non-null    float64
 3   EstimatedSalary  400 non-null    float64
 4   Purchased        400 non-null    int64  
dtypes: float64(2), int64(2), object(1)
memory usage: 15.8+ KB
```

In [22]:
```
df.describe()
```

Out[22]:

	User ID	Age	EstimatedSalary	Purchased
count	4.000000e+02	400.000000	400.000000	400.000000
mean	1.569154e+07	37.655000	69742.500000	0.357500
std	7.165832e+04	10.482877	34096.960282	0.479864
min	1.556669e+07	18.000000	15000.000000	0.000000
25%	1.562676e+07	29.750000	43000.000000	0.000000
50%	1.569434e+07	37.000000	70000.000000	0.000000
75%	1.575036e+07	46.000000	88000.000000	1.000000
max	1.581524e+07	60.000000	150000.000000	1.000000

In [23]:
```
X = df[['Age', 'EstimatedSalary']]
Y = df['Purchased']
```

In [24]:
```
from sklearn.model_selection import train_test_split
X_train, X_test, Y_train, Y_test = train_test_split(X, Y, test_size = 0.25, random_state = 0)
print(f'Train Dataset Size - X: {X_train.shape}, Y: {Y_train.shape}')
print(f'Test  Dataset Size - X: {X_test.shape}, Y: {Y_test.shape}')
```

```
Train Dataset Size - X: (300, 2), Y: (300,)
Test  Dataset Size - X: (100, 2), Y: (100,)
```

In [25]:
```
import matplotlib.pyplot as plt
import seaborn as sns
```

In [26]:
```
from sklearn.linear_model import LogisticRegression

lm = LogisticRegression(random_state = 0, solver='lbfgs' )
lm.fit(X_train, Y_train)
predictions = lm.predict(X_test)
```

2) Compute Confusion matrix to find TP, FP, TN, FN, Accuracy, Error rate, Precision, Recall on the given datast.

Confusion matrix

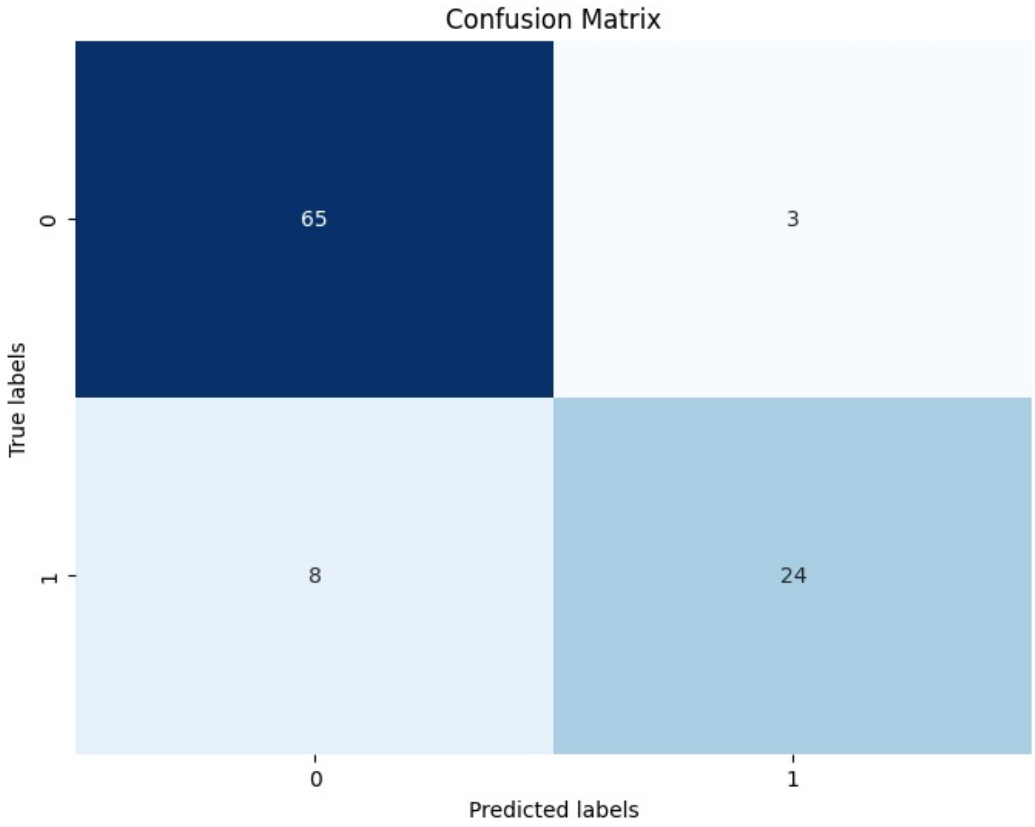
In [27]:
```
from sklearn.metrics import classification_report
cm = classification_report(Y_test, predictions)
print('Classification report : \n', cm)
```

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

           0       0.89      0.96      0.92        68
           1       0.89      0.75      0.81        32

    accuracy                           0.89       100
   macro avg       0.89      0.85      0.87       100
weighted avg       0.89      0.89      0.89       100
```

In [28]:
```
from sklearn.metrics import classification_report, confusion_matrix
conf_matrix = confusion_matrix(Y_test, predictions)
plt.figure(figsize=(8, 6))
sns.heatmap(conf_matrix, annot=True, fmt='d', cmap='Blues', cbar=False)
plt.xlabel('Predicted labels')
plt.ylabel('True labels')
plt.title('Confusion Matrix')
plt.show()
```



In [29]:
```
y_pred = lm.predict(X_test)
cm = confusion_matrix(Y_test, y_pred)

TN = cm[0, 0]
FP = cm[0, 1]
FN = cm[1, 0]
TP = cm[1, 1]

accuracy = (TP + TN) / float(TP + TN + FP + FN)
error_rate = (FP + FN) / float(TP + TN + FP + FN)
precision = TP / float(TP + FP)
recall = TP / float(TP + FN)
```

```
print("\nPerformance Metrics:")
print("True Positives (TP):", TP)
print("False Positives (FP):", FP)
print("True Negatives (TN):", TN)
print("False Negatives (FN):", FN)
print("Accuracy:", accuracy)
print("Error Rate:", error_rate)
print("Precision:", precision)
print("Recall:", recall)
```

```
Performance Metrics:
True Positives (TP): 24
False Positives (FP): 3
True Negatives (TN): 65
False Negatives (FN): 8
Accuracy: 0.89
Error Rate: 0.11
Precision: 0.8888888888888888
Recall: 0.75
```