2440016804 - Rio Pramana - LA01 - Assignment 5

Import libraries and load dataset

In [1]:
```
import numpy as np
import pandas as pd
from matplotlib import pyplot as plt
import seaborn as sns
```

In [2]:
```
# Importing the dataset, downloaded file is in the same folder
csv_path = "Social_Network_Ads.csv"
SNA_df = pd.read_csv(csv_path)
```

Check dataset (Shape, Info)

In [3]:
```
SNA_df.shape
```

Out[3]:
```
(400, 3)
```

In [4]:
```
SNA_df.head(10)
```

Out[4]:

	Age	EstimatedSalary	Purchased
0	19	19000	0
1	35	20000	0
2	26	43000	0
3	27	57000	0
4	19	76000	0
5	27	58000	0
6	27	84000	0

	Age	EstimatedSalary	Purchased
7	32	150000	1
8	25	33000	0
9	35	65000	0

In [5]:
```
SNA_df.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 400 entries, 0 to 399
Data columns (total 3 columns):
 #   Column           Non-Null Count  Dtype
---  ------           --------------  -----
 0   Age              400 non-null    int64
 1   EstimatedSalary  400 non-null    int64
 2   Purchased        400 non-null    int64
dtypes: int64(3)
memory usage: 9.5 KB
```

No missing data and anomaly of the data type found

Data Summarization

In [6]:
```
SNA_df.describe()
```

Out[6]:

	Age	EstimatedSalary	Purchased
count	400.000000	400.000000	400.000000
mean	37.655000	69742.500000	0.357500
std	10.482877	34096.960282	0.479864
min	18.000000	15000.000000	0.000000
25%	29.750000	43000.000000	0.000000
50%	37.000000	70000.000000	0.000000
75%	46.000000	88000.000000	1.000000

	Age	EstimatedSalary	Purchased
max	60.000000	150000.000000	1.000000

Extracting independent and dependent variables

In [7]:
```
#Extracting independent variables:
x = SNA_df.iloc[:, :-1].values #Extract semua kolom kecuali kolom terakhir
print(x)
```

```
[[    19  19000]
 [    35  20000]
 [    26  43000]
 [    27  57000]
 [    19  76000]
 [    27  58000]
 [    27  84000]
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[    49  36000]]
```

In [8]:

```
#Extracting dependent variable:
y = SNA_df.iloc[:, 2].values #Extract kolom terakhir
print(y)
```

```
[0 0 0 0 0 0 0 1 0 0 0 0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 1 0 0 0 1 0 0 0 0 0
 0 0 0 0 0 0 0 0 0 0 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1 0 0 0 0 0 0 0 0 0
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 1 1 0 1 0 1 0 0 1 1 0 1 1 1 1 1 1 0 1 1 1 1 1 1 0 1 1 1 0 1]
```

Feature Scaling

In [9]:

```
from sklearn.preprocessing import StandardScaler
sc = StandardScaler()
X = sc.fit_transform(x)
X
```

Out[9]:

```
array([[-1.78179743, -1.49004624],
       [-0.25358736, -1.46068138],
```

```
       [-1.11320552, -0.78528968],
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```

```
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       [ 0.41500455,  1.123426  ],
```

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```
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       [ 1.17910958, -1.46068138],
```

```
[-0.15807423, -1.07893824],
[ 1.08359645, -0.99084367]])
```

Splitting dataset into Training set and Test set

With 400 data, I decided to split the dataset into 3:1 ratio (Training set contains 300 data, Test set contains 100 data)

In [10]:
```
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('Train set: ', X_train.shape, y_train.shape)
print('Test set: ', X_test.shape, y_test.shape)
```

```
Train set:  (300, 2) (300,)
Test set:  (100, 2) (100,)
```

Create classifier using Logistic Regression

In [11]:
```
from sklearn.linear_model import LogisticRegression
from sklearn.metrics import confusion_matrix
LR = LogisticRegression(C=0.01, solver = 'liblinear').fit(X_train, y_train)
LR
```

Out[11]:
```
LogisticRegression(C=0.01, solver='liblinear')
```

Predict Purchased (1) or Not Purchased (0)

In [12]:
```
#Predict using test set
yhat = LR.predict(X_test)
yhat
```

Out[12]:
```
array([0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 1,
       0, 1, 0, 1, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0,
       1, 0, 0, 1, 0, 1, 1, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 1,
       0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 1, 0, 1, 1, 1, 1, 0, 0, 1, 1, 0, 1,
       0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 1, 1], dtype=int64)
```

In [13]:
```
#Predict probability for each class
yhat_prob = LR.predict_proba(X_test)
yhat_prob
```

Out[13]:
```
array([[0.61071527, 0.38928473],
       [0.59481337, 0.40518663],
       [0.57875015, 0.42124985],
       [0.62618269, 0.37381731],
       [0.62773323, 0.37226677],
       [0.75730282, 0.24269718],
       [0.72989984, 0.27010016],
       [0.42703227, 0.57296773],
       [0.76141118, 0.23858882],
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       [0.68172416, 0.31827584],
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       [0.55899908, 0.44100092],
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       [0.77854369, 0.22145631],
       [0.29525288, 0.70474712],
       [0.63244561, 0.36755439],
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       [0.35988265, 0.64011735],
       [0.60001276, 0.39998724],
       [0.72415503, 0.27584497],
       [0.7844081 , 0.2155919 ],
       [0.7045581 , 0.2954419 ],
       [0.6515971 , 0.3484029 ],
       [0.69813256, 0.30186744],
       [0.4976011 , 0.5023989 ],
       [0.64123538, 0.35876462],
       [0.55697804, 0.44302196],
       [0.64874053, 0.35125947],
       [0.68316089, 0.31683911],
```

```
       [0.41213166, 0.58786834],
       [0.69562746, 0.30437254],
       [0.54593751, 0.45406249],
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       [0.61423372, 0.38576628],
       [0.50901668, 0.49098332],
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       [0.62931958, 0.37068042],
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       [0.74292637, 0.25707363],
       [0.39131252, 0.60868748],
       [0.48831761, 0.51168239],
       [0.52164571, 0.47835429],
       [0.22410821, 0.77589179],
```

```
       [0.52199505, 0.47800495],
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       [0.52108055, 0.47891945],
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       [0.67963878, 0.32036122],
       [0.62601882, 0.37398118],
       [0.72519844, 0.27480156],
       [0.51529249, 0.48470751],
       [0.39989772, 0.60010228],
       [0.43944779, 0.56055221]])
```

Visualising the Training and Test set results

In [14]:

```
from matplotlib.colors import ListedColormap

x1, x2 = np.meshgrid(np.arange(start = X_train[:, 0].min()-1, stop = X_train[:, 0].max()+1, step = 0.01),
                     np.arange(start = X_train[:, 1].min()-1, stop = X_train[:, 1].max()+1, step = 0.01))

plt.contourf(x1, x2, LR.predict(np.array([x1.ravel(), x2.ravel()]).T).reshape(x1.shape),
                                alpha = 0.75, cmap = ListedColormap(('red', 'green')))

plt.xlim(x1.min(), x1.max())
plt.ylim(x2.min(), x2.max())

for i, j in enumerate(np.unique(y_train)):
    plt.scatter(X_train[y_train == j, 0], X_train[y_train == j, 1],
    c = ListedColormap(('red', 'green'))(i), label = j)

plt.title('Logistic Regression (Training Set)')
plt.xlabel('Age')
plt.ylabel('Estimated Salary')

plt.legend()
plt.show()
```

```
*c* argument looks like a single numeric RGB or RGBA sequence, which should be avoided as value-mapping will have precedence in ca
se its length matches with *x* & *y*.  Please use the *color* keyword-argument or provide a 2D array with a single row if you inte
nd to specify the same RGB or RGBA value for all points.
*c* argument looks like a single numeric RGB or RGBA sequence, which should be avoided as value-mapping will have precedence in ca
```

```
se its length matches with *x* & *y*.  Please use the *color* keyword-argument or provide a 2D array with a single row if you inte
nd to specify the same RGB or RGBA value for all points.
```

In [15]:

```
x1, x2 = np.meshgrid(np.arange(start = X_test[:, 0].min()-1, stop = X_test[:, 0].max()+1, step = 0.01),
                     np.arange(start = X_test[:, 1].min()-1, stop = X_test[:, 1].max()+1, step = 0.01))

plt.contourf(x1, x2, LR.predict(np.array([x1.ravel(), x2.ravel()]).T).reshape(x1.shape),
                                alpha = 0.75, cmap = ListedColormap(('red', 'green')))

plt.xlim(x1.min(), x1.max())
plt.ylim(x2.min(), x2.max())

for i, j in enumerate(np.unique(y_test)):
    plt.scatter(X_test[y_test == j, 0], X_test[y_test == j, 1],
    c = ListedColormap(('red', 'green'))(i), label = j)

plt.title('Logistic Regression (Test Set)')
plt.xlabel('Age')
plt.ylabel('Estimated Salary')

plt.legend()
plt.show()
```

```
*c* argument looks like a single numeric RGB or RGBA sequence, which should be avoided as value-mapping will have precedence in ca
se its length matches with *x* & *y*.  Please use the *color* keyword-argument or provide a 2D array with a single row if you inte
```

```
nd to specify the same RGB or RGBA value for all points.
*c* argument looks like a single numeric RGB or RGBA sequence, which should be avoided as value-mapping will have precedence in ca
se its length matches with *x* & *y*.  Please use the *color* keyword-argument or provide a 2D array with a single row if you inte
nd to specify the same RGB or RGBA value for all points.
```

Evaluation

Jaccard Index

In [16]:
```
from sklearn.metrics import jaccard_score
jaccard_score(y_test, yhat)
```

Out[16]:
```
0.7058823529411765
```

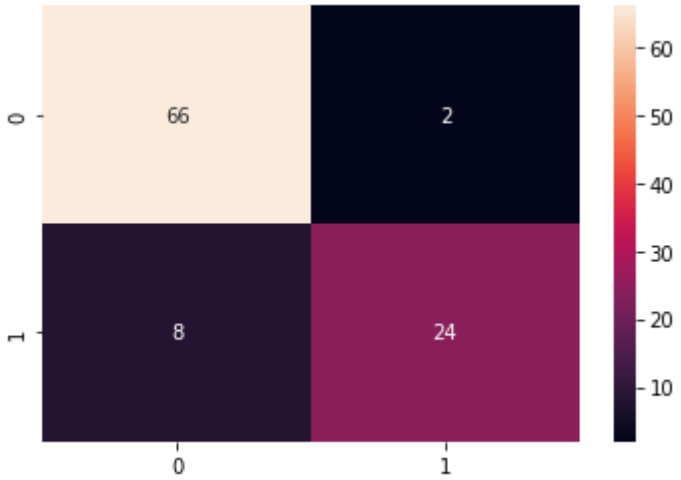
Confusion Matrix

In [17]:
```
from sklearn.metrics import classification_report, confusion_matrix
conf_matrix = confusion_matrix(y_test, yhat)
conf_matrix
```

Out[17]:
```
array([[66,  2],
       [ 8, 24]], dtype=int64)
```

In [18]:
```
sns.heatmap(conf_matrix, annot=True)
```

Out[18]:
```
<AxesSubplot:>
```



Classification Report

In [19]:
```
print(classification_report(y_test, yhat))
```

```
              precision    recall  f1-score   support

           0       0.89      0.97      0.93        68
           1       0.92      0.75      0.83        32

    accuracy                           0.90       100
   macro avg       0.91      0.86      0.88       100
weighted avg       0.90      0.90      0.90       100
```

Average accuracy = average of f1-score = **0.90**

Log Loss

In [20]:
```
from sklearn.metrics import log_loss
log_loss(y_test, yhat_prob)
```

```
0.479816705064194
```

Out[20]: