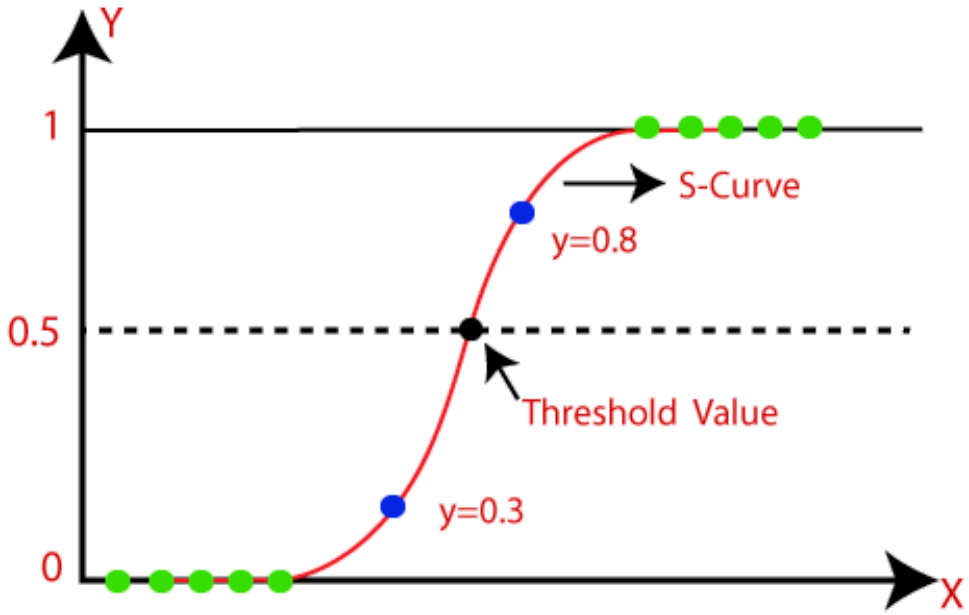
ALBUKHARY INTERNATIONAL UNIVERSITY

Artificial Intelligence ¶

LAB TEN

Logistic Regression (Classification)

- Logistic regression is one of the most popular Machine Learning algorithms, which comes under the Supervised Learning technique. It is used for predicting the categorical dependent variable using a given set of independent variables.
- Logistic regression predicts the output of a categorical dependent variable. Therefore the outcome must be a categorical or discrete value. It can be either Yes or No, 0 or 1, true or False, etc. but instead of giving the exact value as 0 and 1, it gives the probabilistic values which lie between 0 and 1.
- Logistic Regression is much similar to the Linear Regression except that how they are used. Linear Regression is used for solving Regression problems, whereas Logistic regression is used for solving the classification problems.
- In Logistic regression, instead of fitting a regression line, we fit an "S" shaped logistic function, which predicts two maximum values (0 or 1).
- The curve from the logistic function indicates the likelihood of something such as whether the cells are cancerous or not, a mouse is obese or not based on its weight, etc.
- Logistic Regression is a significant machine learning algorithm because it has the ability to provide probabilities and classify new data using continuous and discrete datasets.
- Logistic Regression can be used to classify the observations using different types of data and can easily determine the most effective variables used for the classification. The below image is showing the logistic function:



Type of Logistic Regression:

On the basis of the categories, Logistic Regression can be classified into three types:

- Binomial: In binomial Logistic regression, there can be only two possible types of the dependent variables, such as 0 or 1, Pass or Fail, etc.
- Multinomial: In multinomial Logistic regression, there can be 3 or more possible unordered types of the dependent variable, such as "cat", "dogs", or "sheep".

Problem

There is a dataset given which contains the information of various users obtained from the social networking sites. There is a car making company that has recently launched a new SUV car. So the company wanted to check how many users from the dataset, wants to purchase the car.

For this problem, we will build a Machine Learning model using the Logistic regression algorithm.

Steps in Logistic Regression:

- Data Pre-processing step
- Fitting Logistic Regression to the Training set
- Predicting the test result
- Test accuracy of the result(Creation of Confusion matrix)
- Visualizing the test set result.

1. Data Pre-processing step:

In [ ]:
```
import numpy as np
import matplotlib.pyplot as plt
import pandas as pd

dataset = pd.read_csv('Social_Network_Ads.csv')
```

In [ ]:
```
dataset
```

Extract the Dependent and Independent Variables

In [ ]:
```
X = dataset.iloc[:, [2, 3]].values
y = dataset.iloc[:, -1].values
```

In the above code, we have taken [2, 3] for x because our independent variables are age and salary, which are at index 2, 3. And we have taken 4 for y variable because our dependent variable is at index 4.

In [ ]:
```
X
```

In [ ]:
```
y
```

Splitting the dataset into the Training set and Test set

In [ ]:
```
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)
```

Feature Scaling

Here we will only scale the independent variable because dependent variable have only 0 and 1 values.

In [ ]:
```
from sklearn.preprocessing import StandardScaler
sc = StandardScaler()
X_train = sc.fit_transform(X_train)
X_test = sc.transform(X_test)
```

In [ ]:
```
X_train
```

In [ ]:
```
X_test
```

2. Fitting Logistic Regression to the Training set

In [ ]:
```
#Fitting Logistic Regression to the training set
from sklearn.linear_model import LogisticRegression
classifier = LogisticRegression(random_state = 0)
classifier.fit(X_train, y_train)
```

3. Predicting the Test Result

In [ ]:
```
#Predicting the test set result
y_pred= classifier.predict(X_test)
```

In [ ]:
```
y_pred
```

The above output image shows the corresponding predicted users who want to purchase or not purchase the car.

4. Test Accuracy of the result

Confusion Matrix

Now we will create the confusion matrix here to check the accuracy of the classification. To create it, we need to import the *confusion_matrix function* of the *sklearn library*. After importing the function, we will call it using a new variable cm. The function takes two parameters, mainly y_true(the actual values) and *y_pred* (the targeted value return by the classifier).

In [ ]:
```
from sklearn.metrics import confusion_matrix
cm = confusion_matrix(y_test, y_pred)
print(cm)
```

In [ ]:
```
#Import scikit-learn metrics module for accuracy calculation
from sklearn import metrics

# Model Accuracy: how often is the classifier correct?
print("Accuracy:",metrics.accuracy_score(y_test, y_pred))
```

We can find the accuracy of the predicted result by interpreting the confusion matrix. By above output, we can interpret that 65+24= 89 (Correct Output) and 8+3= 11(Incorrect Output).

5. Visualizing the training set result

In [ ]:
```
#Visualizing the training set result
#ListedColormap class help us to colorize the data points.
from matplotlib.colors import ListedColormap

#Create local variables X_set and y_set. Because we use these #variables again in the test set
X_set, y_set = X_train, y_train

#Create the grid. step=0.01 means all the pixels were actually with #a 0.01 resolution. min and max of the
#X_Set use with minus ana plus one to prevent ponits to be squeezed #on the axes.
X1, X2 = np.meshgrid(np.arange(start = X_set[:, 0].min() - 1, stop = X_set[:, 0].max() + 1, step = 0.01),
                     np.arange(start = X_set[:, 1].min() - 1, stop = X_set[:, 1].max() + 1, step = 0.01))

#This is the line applying the classifier on all the pixel #observation points. It colors all the red pixel
#points and the blue pixel points. contour function make the contour #between red and blue regions.
plt.contourf(X1, X2, classifier.predict(np.array([X1.ravel(), X2.ravel()]).T).reshape(X1.shape),
             alpha = 0.75, cmap = ListedColormap(('red', 'green')))

#plot the limits of the age and the estimated salary lines.
plt.xlim(X1.min(), X1.max())
plt.ylim(X2.min(), X2.max())

#This loop here plots all the data points that are the real values.
for i, j in enumerate(np.unique(y_set)):
    plt.scatter(X_set[y_set == j, 0], X_set[y_set == j, 1],
                c = ListedColormap(('red', 'green'))(i), label = j)

#Add the name of the plot and the labels.
plt.title('Logistic Regression (Training set)')
plt.xlabel('Age')
plt.ylabel('Estimated Salary')
plt.legend()
plt.show()
```

In the above code, we have imported the ListedColormap class of Matplotlib library to create the colormap for visualizing the result. We have created two new variables *x_set* and *y_set* to replace *x_train* and *y_train*. After that, we have used the nm.meshgrid command to create a rectangular grid, which has a range of -1(minimum) to 1 (maximum). The pixel points we have taken are of 0.01 resolution.

To create a filled contour, we have used mtp.contourf command, it will create regions of provided colors (red and green). In this function, we have passed the classifier.predict to show the predicted data points predicted by the classifier.

The graph can be explained in the below points:

- In the above graph, we can see that there are some Green points within the green region and Red points within the Red region.
- All these data points are the observation points from the training set, which shows the result for purchased variables.
- This graph is made by using two independent variables i.e., Age on the x-axis and Estimated salary on the y-axis.
- The red point observations are for which purchased (dependent variable) is probably 0, i.e., users who did not purchase the SUV car.
- The green point observations are for which purchased (dependent variable) is probably 1 means user who purchased the SUV car.
- We can also estimate from the graph that the users who are younger with low salary, did not purchase the car, whereas older users with high estimated salary purchased the car.
- But there are some red points in the green region (Buying the car) and some green points in the red region(Not buying the car). So we can say that younger users with a high estimated salary purchased the car, whereas an older user with a low estimated salary did not purchase the car.

Visualizing the test set result

Our model is well trained using the training dataset. Now, we will visualize the result for new observations (Test set). The code for the test set will remain same as above except that here we will use x_test and y_test instead of x_train and y_train.

In [ ]:
```
from matplotlib.colors import ListedColormap
X_set, y_set = X_test, y_test
X1, X2 = np.meshgrid(np.arange(start = X_set[:, 0].min() - 1, stop = X_set[:, 0].max() + 1, step = 0.01),
                     np.arange(start = X_set[:, 1].min() - 1, stop = X_set[:, 1].max() + 1, step = 0.01))
plt.contourf(X1, X2, classifier.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_set)):
    plt.scatter(X_set[y_set == j, 0], X_set[y_set == 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()
```

The above graph shows the test set result. As we can see, the graph is divided into two regions (Red and Green). And Green observations are in the green region, and Red observations are in the red region. So we can say it is a good prediction and model. Some of the green and red data points are in different regions, which can be ignored as we have already calculated this error using the confusion matrix (11 Incorrect output).

In [ ]:
```
```