

Question 1

Logistic Regression for multiclass classification

In [16]:

```
import numpy as np
import pandas as pd
from sklearn.model_selection import train_test_split
```

In [17]:

```
dataset = pd.read_csv('Iris.csv', header=0)
dataset.sample(n=5)
```

Out[17]:

	Id	SepalLengthCm	SepalWidthCm	PetalLengthCm	PetalWidthCm	Species
37	38	4.9	3.1	1.5	0.1	Iris-setosa
53	54	5.5	2.3	4.0	1.3	Iris-versicolor
15	16	5.7	4.4	1.5	0.4	Iris-setosa
21	22	5.1	3.7	1.5	0.4	Iris-setosa
112	113	6.8	3.0	5.5	2.1	Iris-virginica

In [18]:

```
x = dataset.iloc[:, :-1]
y = dataset.iloc[:, -1]
x = np.hstack((np.ones((x.shape[0], 1)), x)) #[1 x]
print(x.shape)
```

(150, 6)

In [19]:

```
y_class = y.unique()
y_class
```

Out[19]:

array(['Iris-setosa', 'Iris-versicolor', 'Iris-virginica'], dtype=object)

In [20]:

```
#in the given dataset, replace the Species column with the numerical value that refers to the class
Y = np.zeros((y.shape[0], len(y_class)))
print(Y.shape)
for i in range(len(Y)):
    for j in range(len(y_class)):
        if y_class[j] == y[i]:
            Y[i][j] = 1
```

(150, 3)

In [21]:

```
train_x, test_x, train_y, test_y = train_test_split(x, Y, train_size=0.8, shuffle=True)
```

In [22]:

```
print(train_x.shape)
print(test_x.shape)
print(train_y.shape)
print(test_y.shape)
```

(120, 6)

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```
(120, 3)
(30, 3)
```

In [23]:

```
theta = np.zeros((x.shape[1], len(y_class)))
theta.shape
```

Out[23]:

```
(6, 3)
```

In [24]:

```
def sigmoid(x, theta):
    return 1/(1+np.exp(-np.dot(x, theta)))

def multiclass_logistic_regression(x, y, theta, alpha, iterations):
    m = x.shape[0]
    for _ in range(iterations):
        prec_y = sigmoid(x, theta)
        theta = theta - (alpha/m)*np.dot(x.T, prec_y - y)
    return theta
```

In [43]:

```
theta = multiclass_logistic_regression(train_x, train_y, theta, 0.0002, 70000)
```

In [44]:

```
prediction = sigmoid(test_x, theta)
for i in prediction:
    ind = np.where(i == np.amax(i))
    for j in range(len(i)):
        i[j] = 1 if ind[0][0] == j else 0
```

In [45]:

```
error = (prediction == test_y)
```

In [46]:

```
s = len(y_class)
error_prec = 0
for i in error:
    if np.sum(i) != s:
        error_prec += 1
print(error_prec)
```

0

In [47]:

```
percentage_error = (error_prec/len(prediction))*100
percentage_error
```

Out[47]:

```
0.0
```

In [48]:

```
print(f"Accuracy: {100-percentage_error}%")
```

Accuracy: 100.0

In [49]:

```
theta #theta values for 100 percent accuracy
```

Out[49]:

```
array([[ 0.42223406,  0.45399512, -0.95066014],
       [-0.10240462, -0.04805176,  0.0881562 ],
       [ 0.93390198,  0.39392457, -1.85590212],
       [ 1.56725751, -1.49237918, -1.65695853],
```

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[-0.75270099, -0.10552299, 1.04105788]])

In [50]:

```
print(train_x)
```

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In [51]:

print(+est_v)

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In [52]:

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print(train_y)
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In [53]:

```
print(test_y)
```

In []:

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