

**Assignment05.ipynb**

파일 수정 보기 삽입 런타임 도구 도움말 모든 변경사항이 저장될

RAM 디스크 설정 가능

**Information**

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Assignment05 : Logistic regression for a binary classification  
Deadline : Apr 23, 2020

**Library**

```
[1] import matplotlib.pyplot as plt; import numpy as np;
```

**Data**

```
[2] path="/content/drive/My Drive/Spring|2020/Machine_Learning/CAU-MachineLearning/Assignment05/data.txt"
data = np.genfromtxt(path, delimiter=',')
x = data[:, 0]
y = data[:, 1]
label = data[:, 2]

x_label0 = x[label == 0]
x_label1 = x[label == 1]

y_label0 = y[label == 0]
y_label1 = y[label == 1]

m = label.size
```

**Logistic regression**

$\hat{h} = \sigma(z)$   
 $z = \theta_0 + \theta_1 x + \theta_2 y$ , where  $\theta_0, \theta_1, \theta_2 \in \mathbb{R}$   
 $\sigma(z) = \frac{1}{1+\exp(-z)}$   
 $\sigma'(z) = \sigma(z)(1 - \sigma(z))$

*Initial State*

$\theta_0 = -18$   
 $\theta_1 = -0.5$   
 $\theta_2 = 0.5$

```
[3] theta0 = -18; theta0_old = 0
thetal = -0.5; thetal_old = 0
theta2 = 0.5; theta2_old = 0
theta0_history = [theta0]
thetal_history = [thetal]
theta2_history = [theta2]

z = theta0 + thetal*x + theta2*y
sigma = 1/(1 + np.exp(-z))
sigma_ = sigma * (1-sigma)
```

**Objective Function**

$J(\theta_0, \theta_1, \theta_2) = \frac{1}{m} \sum_{i=1}^m (-l^{(i)} \log(\sigma(z^{(i)})) - (1 - l^{(i)}) \log(1 - \sigma(z^{(i)})))$

```
[4] j = np.sum(-label*np.log(sigma) - (1-label)*np.log(1-sigma)) / m
j_old = 0
j_history = [j]
```

**Training Process - Gradient Descent**

$\alpha = 0.002$

$\theta_0^{(t+1)} = \theta_0^{(t)} - \alpha \frac{1}{m} \sum_{i=1}^m (\sigma(z^{(i)}) - l^{(i)})$   
 $\theta_1^{(t+1)} = \theta_1^{(t)} - \alpha \frac{1}{m} \sum_{i=1}^m (\sigma(z^{(i)}) - l^{(i)})x^{(i)}$   
 $\theta_2^{(t+1)} = \theta_2^{(t)} - \alpha \frac{1}{m} \sum_{i=1}^m (\sigma(z^{(i)}) - l^{(i)})y^{(i)}$

```
[5] alpha = 0.002

# Check the number of iteration
iteration = 1

# Set the two condition because it spent too much time for converge
while (iteration < 8388608):
    # Calculate the theta
    theta0_old = theta0
    thetal_old = thetal
    theta2_old = theta2
    theta0 = theta0 - alpha*np.sum(sigma-label)/m
    thetal = thetal - alpha*np.sum((sigma-label)*x)/m
    theta2 = theta2 - alpha*np.sum((sigma-label)*y)/m

    # Update the j
    j_old = j
    z = theta0 + thetal*x + theta2*y
    sigma = 1/(1 + np.exp(-z))
    j = np.sum(-label*np.log(sigma) - (1-label)*np.log(1-sigma)) / m

    # Record the history of parameter
    theta0_history.append(theta0)
    thetal_history.append(thetal)
```

```

theta2_history.append(theta2)
j_history.append(j)

iteration = iteration + 1

```

### ▼ Check the Convergence

```

# Iteration
print("# Iteration: " + str(iteration) + '\n')

# Theta 0
print("Updated Theta0: " + str(theta0))
print("Old Theta0: " + str(theta0_old))
print("Diff: " + str(theta0 - theta0_old) + '\n')

# Theta 1
print("Updated Theta1: " + str(theta1))
print("Old Theta1: " + str(theta1_old))
print("Diff: " + str(theta1 - theta1_old) + '\n')

# Theta 2
print("Updated Theta2: " + str(theta2))
print("Old Theta2: " + str(theta2_old))
print("Diff: " + str(theta2 - theta2_old) + '\n')

# J, Energy Value
print("Updated J: " + str(j))
print("Old J: " + str(j_old))
print("Diff: " + str(j - j_old) + '\n')

# Iteration: 8388608
Updated Theta0: -25.127131921679986
Old Theta0: -25.12713190130285
Diff: -2.037713642266681e-08

Updated Theta1: 0.205958132159925
Old Theta1: 0.205958131969281
Diff: 1.6299689375998128e-10

Updated Theta2: 0.20119486478669513
Old Theta2: 0.2011948646218168
Diff: 1.648783332086623e-10

Updated J: 0.20349787574298517
Old J: 0.2034978757431929
Diff: -2.077227279073668e-13

```

### ▼ Generate the grid

```

x = [30 : 0.5 : 100]
y = [30 : 0.5 : 100]

[7] x_range = np.arange(30, 100.5, 0.5)
     y_range = np.arange(30, 100.5, 0.5)
     x_grid, y_grid = np.meshgrid(x_range, y_range)
     classifier_colormap = 1 / (1 + np.exp(-theta0 * x_grid - theta2 * y_grid))

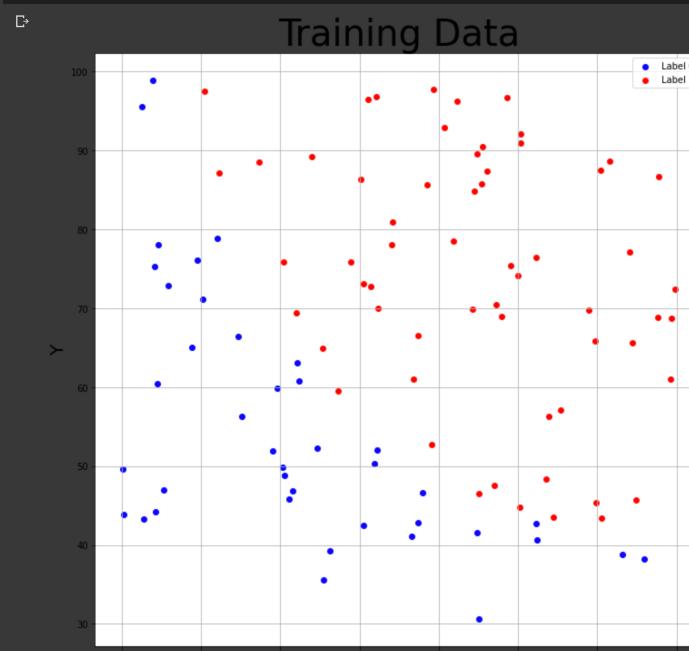
```

### ▼ 1. Training Data

```

[8] plt.figure(figsize=(12,12))
    plt.scatter(x_label0, y_label0, c='b', label='Label 0')
    plt.scatter(x_label1, y_label1, c='r', label='Label 1')
    plt.grid()
    plt.title('Training Data', fontsize=40)
    plt.xlabel('X', fontsize=20)
    plt.ylabel('Y', fontsize=20)
    plt.show()

```

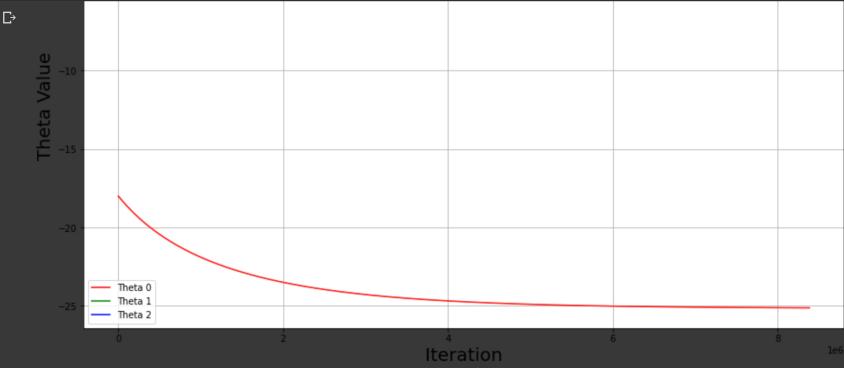


X

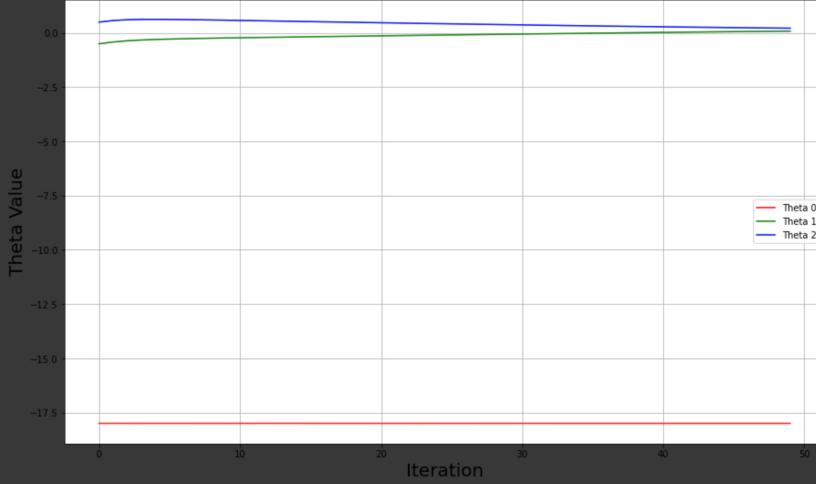
## ▼ 2. Estimated Parameters

```
[9] plt.figure(figsize=(15,9))
    plt.plot(theta0_history, color='red', label='Theta 0')
    plt.plot(theta1_history, color='green', label='Theta 1')
    plt.plot(theta2_history, color='blue', label='Theta 2')
    plt.grid()
    plt.legend()
    plt.title('Estimated Parameters', fontsize=40)
    plt.xlabel('Iteration', fontsize=20)
    plt.ylabel('Theta Value', fontsize=20)

plt.figure(figsize=(15,9))
plt.plot(theta0_history[0:50], color='red', label='Theta 0')
plt.plot(theta1_history[0:50], color='green', label='Theta 1')
plt.plot(theta2_history[0:50], color='blue', label='Theta 2')
plt.grid()
plt.legend()
plt.title('Detail: Estimated Parameters[0~50]', fontsize=40)
plt.xlabel('Iteration', fontsize=20)
plt.ylabel('Theta Value', fontsize=20)
```



Detail: Estimated Parameters[0~50]

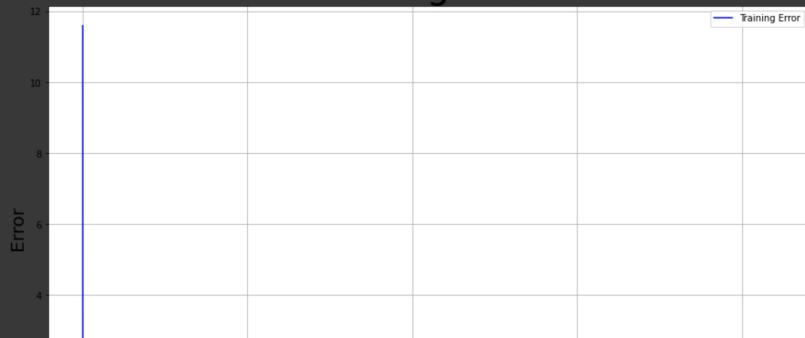


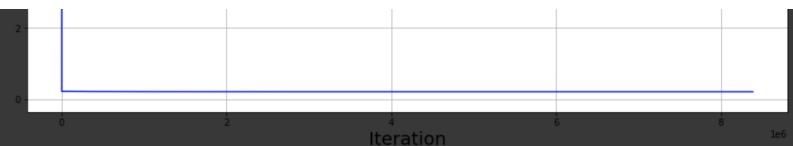
## ▼ 3. Training Error

```
[10] plt.figure(figsize=(15,9))
    plt.plot(j_history, color='blue', label='Training Error')
    plt.grid()
    plt.legend()
    plt.title('Training Error', fontsize=40)
    plt.xlabel('Iteration', fontsize=20)
    plt.ylabel('Error', fontsize=20)
```

Text(0, 0.5, 'Error')

Training Error





#### ▼ 4. Obtained Classifier

```
[11] plt.figure(figsize=(12,12))
    plt.pcolor(x_range, y_range, classifier_colormap, cmap='coolwarm')
    plt.scatter(x_label0, y_label0, c='b', label='Label 0', edgecolors='black')
    plt.scatter(x_label1, y_label1, c='r', label='Label 1', edgecolors='black')
    plt.xlabel('X', fontsize=20)
    plt.ylabel('Y', fontsize=20)
    plt.grid()
    plt.show()
```

