$$\text{Loss}(\beta) = (Y-\hat{Y})^T(Y-\hat{Y}) \qquad \hat{Y} = \hat{\beta}^T X$$

$$= (Y-\hat{\beta}^T X)^T (Y-\hat{\beta}^T X)$$

$$= Y^T Y + X^T \hat{\beta}\hat{\beta}^T X - 2X^T\hat{\beta} Y$$

$$\frac{\partial \text{Loss}(\beta)}{\partial \beta} = 2X^T X\hat{\beta} - 2X^T Y = 0$$

$$\Rightarrow X^T X \hat{\beta} = X^T Y$$

$$\Rightarrow \hat{\beta} = (X^T X)^{-1} X^T Y$$

```
import numpy as np
data=np.genfromtxt("RegressionExample.txt", delimiter=' ',dtype =float)
x=data[:,1:]
y=data[:,0]

def closed_form_solution(y,x):
	y = y.reshape(y.shape[0],1)
	xtxi = np.linalg.inv((x.T@x))
	return xtxi@(x.T)@y

B_head = closed_form_solution(y,x)
print(B_head)
```

3 $C_{MP}^{GC} = \arg\max\{P(c|X)\} = \arg\max\{P(c)\, f(X|c)\}$

$$= \arg\min\{-2\ln(P(c)) + \ln(|\Sigma_c|) - (X-\mu_c)^T\Sigma^{-1}(X-\mu_c)\}$$

$$- \arg\max\{(-\ln P(c)) + (-\ln f(X|c))$$

$= C$

$$= \arg\min[-\ln(P(c)) + (-\ln[(2\pi)^{-\frac{d}{2}}\, |\Sigma_c|^{-0.5} \exp[-0.5\,(X-\mu_c)^T\Sigma^{-1}(X-\mu_c)]]]\}$$

$$= \arg\min[-\ln(P(c)) + 0.5\ln|\Sigma_c| + 0.5\,(X-\mu_c)^T\Sigma^{-1}(X-\mu_c)]$$

$(\times 2$

$$= \arg\min\{-2\ln(P(c)) + \ln(|\Sigma_c|) + (X-\mu_c)^T\Sigma^{-1}(X-\mu_c)\}$$

$$J = \frac{1}{2} w^T w - \sum_{i=1}^{n} \alpha_i \left(y_i (w^T x_i + b) - 1 + \xi_i \right) + C \sum_{i=1}^{n} \xi_i - \sum_{i=1}^{n} \beta_i \xi_i$$

$$\frac{\partial J}{\partial w} = w - \sum_{i=1}^{n} \alpha_i y_i x_i = 0 \qquad \sum_{i=1}^{n} \alpha_i y_i = 0$$

$$w = \sum_{i=1}^{n} \alpha_i y_i x_i$$

$$J = \frac{1}{2} \sum_{i=1}^{n} \sum_{j=1}^{n} \alpha_j \alpha_i y_i y_j x_j^T x_i - \sum_{i=1}^{n} \alpha_i y_i \sum_{j=1}^{n} \alpha_j y_j x_j^T x_i - \cancel{b \sum_{i=1}^{n} \alpha_i y_i}^{\,0} + \sum_{i=1}^{n} \alpha_i$$

$$\cancel{- \sum_{i=1}^{n} \alpha_i \xi_i} \quad \cancel{+ C \sum_{i=1}^{n} \xi_i} \quad 0 \quad \cancel{- \sum_{i=1}^{n} \beta_i \xi_i}$$

$$- \sum_{i=1}^{n} (\alpha_i + \beta_i) \xi_i$$

$$C = \alpha_i + \beta_i$$

$$\Rightarrow J = -\frac{1}{2} \sum_{i=1}^{n} \sum_{j=1}^{n} \alpha_j \alpha_i y_i y_j x_j^T x_i + \sum_{i=1}^{n} \alpha_i \quad \#$$