$$P(x|y=i) = N(x|u_i, \Sigma)$$

$$N(x|u_i, \Sigma) = \frac{1}{(2\pi)^{\Sigma/2}} e^{-\frac{(x-u_i)^2}{2}}$$

if $a_i = \ln\left|P(x|y=i)P(Y=i)\right|$

then $ai = -\frac{1}{2}x^T x + (w^i)^T x + b^i$

$$\boxed{ai = -\frac{1}{2}x^T x + u_i^T x - \frac{1}{2}u^T u + \ln\left|P(Y=i)\right| + \ln\left|\frac{1}{(2\pi)^{\Sigma/2}}\right|}$$

In this case, ai is not linear as it contains a logarithm

If the covariance is different the function does not change:

$$a_i = (\ldots) + \ln\left[\frac{1}{(2\pi)^{\Sigma/2}}\right]_{\Sigma \forall R}$$

For all covariance Σ the function is still not linear.

$$\tilde{L}(\alpha) = \sum_{i=1}^{n} \alpha - \frac{1}{2}\sum_{i=1}^{n}\sum_{j=1}^{n} \alpha_i \alpha_j y_i y_j x_i^T x_j$$

if $\alpha \geq 0 \ (\forall i)$ and $\sum_{i=1}^{n} \alpha_i y_i = 0$

and $\alpha^* = (\alpha_1^* + \dots + \alpha_n^*)$

then:

$$\frac{1}{\gamma^2} = \sum_{i=1}^{n} \alpha_i^*$$

So:

$$\min_{w,b} \frac{1}{2}\|w\|^2 \to \mathcal{L}(w,b,\alpha) = \sum_i^n a_i - \frac{1}{2}\sum_i \alpha_i[(z)-1]$$

if: $\sum_i \alpha_i \alpha_j y_i y_j \boxed{\cancel{x_i^T x_j}}$ and $\sum \alpha_i y_i = 0$
$\sum \alpha_j y_j = 0$

then:

$$\boxed{\gamma = \left(\frac{1}{\sum \alpha_i}\right)^{1/2} \to \gamma = \frac{1}{\|w\|^2}}$$