Univariate Gaussian:

$$\frac{1}{\sigma\sqrt{2\pi}} e^{-\frac{1}{2}\left(\frac{x-\mu}{\sigma}\right)^2}$$

Multivariate Gaussian:

$$\frac{1}{(2\pi)^{K/2}} \det(\Sigma)^{-\frac{1}{2}} e^{-\frac{1}{2}(x-\mu)^T\Sigma^{-1}(x-\mu)}$$

E-Step:

$$\gamma_j(x_n) \longleftarrow \frac{\pi_j \mathcal{N}(x_n \mid \mu_j, \Sigma_j)}{\sum_{k=1}^{K} \pi_k \mathcal{N}(x_n \mid \mu_k, \Sigma_k)} \quad \begin{array}{l} \forall j = 1, \dots, K \\ \forall n = 1, \dots, N \end{array}$$

M-Step:

$$N_j \longleftarrow \sum_{n=1}^{N} \gamma_j(x_n)$$

$$\hat{\pi}_j^{new} \longleftarrow \frac{\hat{N}_j}{N}$$

$$\hat{\mu}_j^{new} \longleftarrow \frac{1}{\hat{N}_j} \sum_{n=1}^{N} \gamma_j(x_n)\, x_n$$

$$\hat{\Sigma}_j^{new} \longleftarrow \frac{1}{\hat{N}_j} \sum_{n=1}^{N} \gamma_j(x_n)(x_n - \hat{\mu}_j^{new})(x_n - \hat{\mu}_j^{new})^T$$

Least Squares Trick:

Given: $Ay - b = 0$

matrix $\quad$ vectors

Least Squares Problem: $\min\limits_{y} \| b - Ay \|^2$

$A \Longleftrightarrow \Sigma$

$b \Longleftrightarrow x - \mu$

$$\min_{y} \| x - \mu - \Sigma y \|^2$$

$$x - \mu - \Sigma y \overset{!}{=} 0$$

$$\Sigma y = x - \mu$$

$$\boxed{y = \Sigma^{-1}(x - \mu)}$$