$$P(y=k \mid \mathbf{x}_j) \propto \frac{1}{(2\pi)^{m/2} \|\Sigma_k\|^{1/2}} \exp\left[-\frac{1}{2}\left(\mathbf{x}_j - \mu_k\right)^T \Sigma_k^{-1}\left(\mathbf{x}_j - \mu_k\right)\right] P(y=k)$$

- Marginal likelihood:

$$\prod_{j=1}^{m} P(\mathbf{x}_j) = \prod_{j=1}^{m} \sum_{k=1}^{K} P(\mathbf{x}_j, y=k)$$

$$= \prod_{j=1}^{m} \sum_{k=1}^{K} \frac{1}{(2\pi)^{m/2} \|\Sigma_k\|^{1/2}} \exp\left[-\frac{1}{2}\left(\mathbf{x}_j - \mu_k\right)^T \Sigma_k^{-1}\left(\mathbf{x}_j - \mu_k\right)\right] P(y=k)$$