10-701 Introduction to Machine Learning

The EM Algorithm

Spring 2019

Ameet Talwalkar (slide credit: Virginia Smith)

What is the E-step in GMM?

$$\gamma_{nk} = p(z = k | \mathbf{x}_n; \boldsymbol{\theta}^{(t)})$$

What is the E-step in GMM?

$$\gamma_{nk} = p(z = k | \mathbf{x}_n; \boldsymbol{\theta}^{(t)})$$

What is the M-step in GMM? The Q-function is

$$Q(\theta, \theta^{(t)}) = \sum_{n} \sum_{k} p(z = k | \mathbf{x}_n; \theta^{(t)}) \log p(\mathbf{x}_n, z = k | \theta)$$

What is the E-step in GMM?

$$\gamma_{nk} = p(z = k | \mathbf{x}_n; \boldsymbol{\theta}^{(t)})$$

What is the M-step in GMM? The Q-function is

$$Q(\theta, \theta^{(t)}) = \sum_{n} \sum_{k} p(z = k | \mathbf{x}_{n}; \theta^{(t)}) \log p(\mathbf{x}_{n}, z = k | \theta)$$
$$= \sum_{n} \sum_{k} \gamma_{nk} \log p(\mathbf{x}_{n}, z = k | \theta)$$

What is the E-step in GMM?

$$\gamma_{nk} = p(z = k|\mathbf{x}_n; \boldsymbol{\theta}^{(t)})$$

What is the M-step in GMM? The Q-function is

$$Q(\theta, \theta^{(t)}) = \sum_{n} \sum_{k} p(z = k | \mathbf{x}_{n}; \theta^{(t)}) \log p(\mathbf{x}_{n}, z = k | \theta)$$

$$= \sum_{n} \sum_{k} \gamma_{nk} \log p(\mathbf{x}_{n}, z = k | \theta)$$

$$= \sum_{k} \sum_{n} \gamma_{nk} \log p(z = k) p(\mathbf{x}_{n} | z = k)$$

What is the E-step in GMM?

$$\gamma_{nk} = p(z = k|\mathbf{x}_n; \boldsymbol{\theta}^{(t)})$$

What is the M-step in GMM? The Q-function is

$$Q(\theta, \theta^{(t)}) = \sum_{n} \sum_{k} p(z = k | \mathbf{x}_{n}; \theta^{(t)}) \log p(\mathbf{x}_{n}, z = k | \theta)$$

$$= \sum_{n} \sum_{k} \gamma_{nk} \log p(\mathbf{x}_{n}, z = k | \theta)$$

$$= \sum_{k} \sum_{n} \gamma_{nk} \log p(z = k) p(\mathbf{x}_{n} | z = k)$$

$$= \sum_{k} \sum_{n} \gamma_{nk} [\log \omega_{k} + \log N(\mathbf{x}_{n} | \mu_{k}, \mathbf{\Sigma}_{k})]$$

We have recovered the parameter estimation algorithm for GMMs that we previously discussed