

Continuous mixture of Gaussians

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if $\mu(t) = Wt + b, \Sigma(t) = \Sigma_0$

get PPCA
(see week 2)

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If $\mu(t) = Wt + b, \Sigma(t) = \Sigma_0$ **get PPCA**
(see week 2)

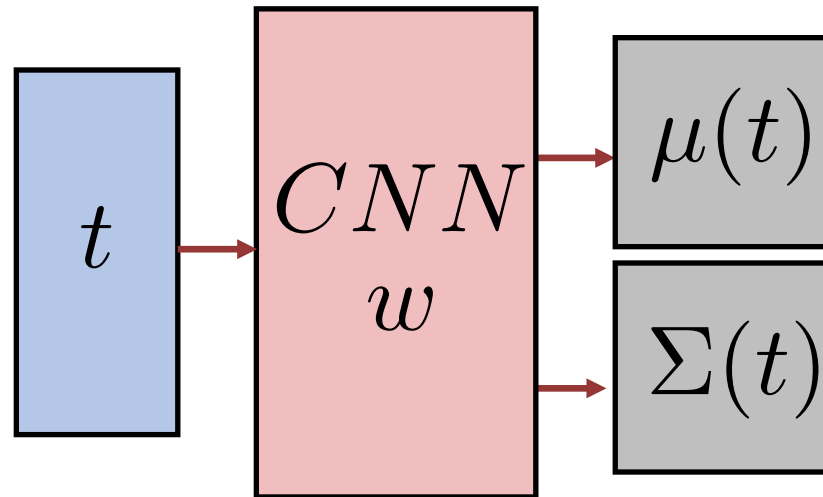
But if x is image, why not $\mu(t) = \text{CNN}_1(t)$
 $\Sigma(t) = \text{CNN}_2(t)$

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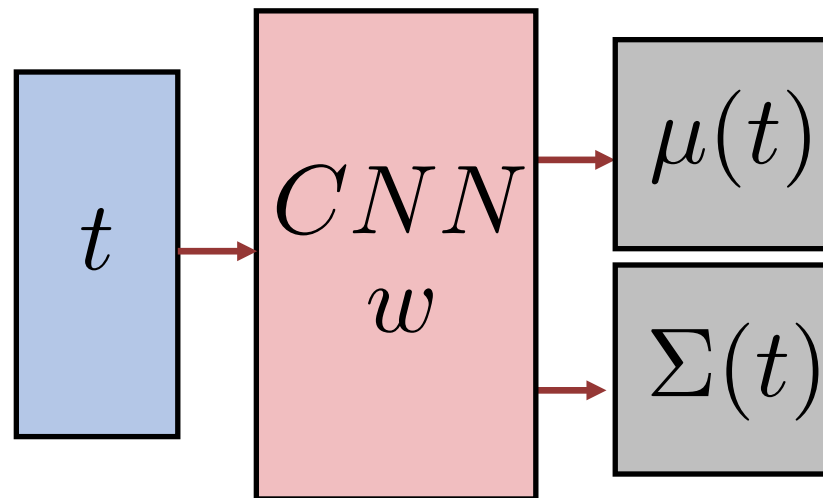


Continuous mixture of Gaussians

$$p(x \mid \textcolor{red}{w}) = \int p(x \mid t, \textcolor{red}{w}) p(t) dt$$

$$p(t) = \mathcal{N}(0, I)$$

$$p(x \mid t, \textcolor{red}{w}) = \mathcal{N}(\mu(t, \textcolor{red}{w}), \Sigma(t, \textcolor{red}{w}))$$

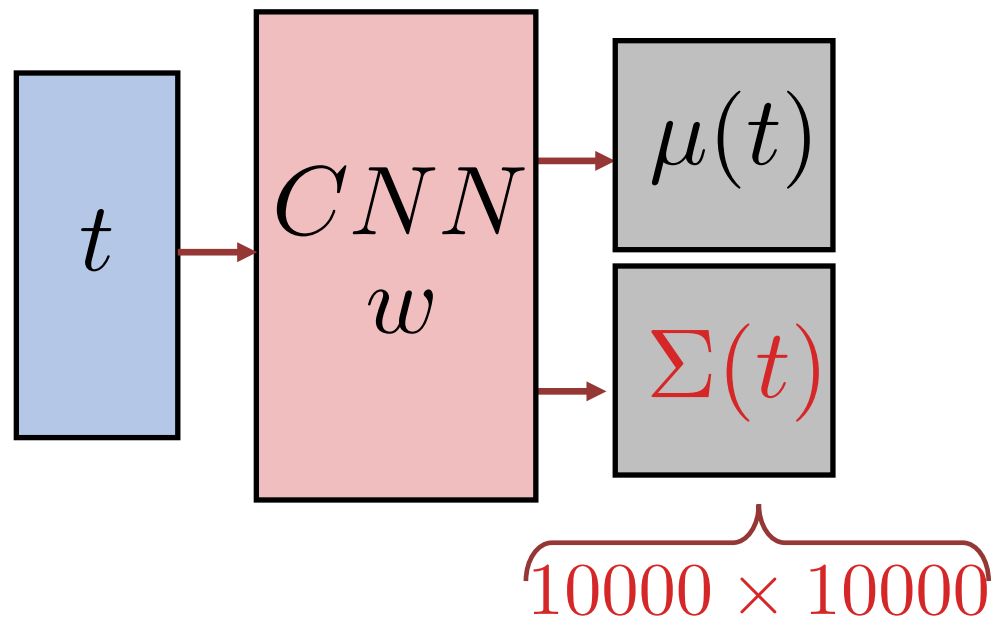


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$$p(x \mid w) = \int p(x \mid t, w) p(t) dt$$

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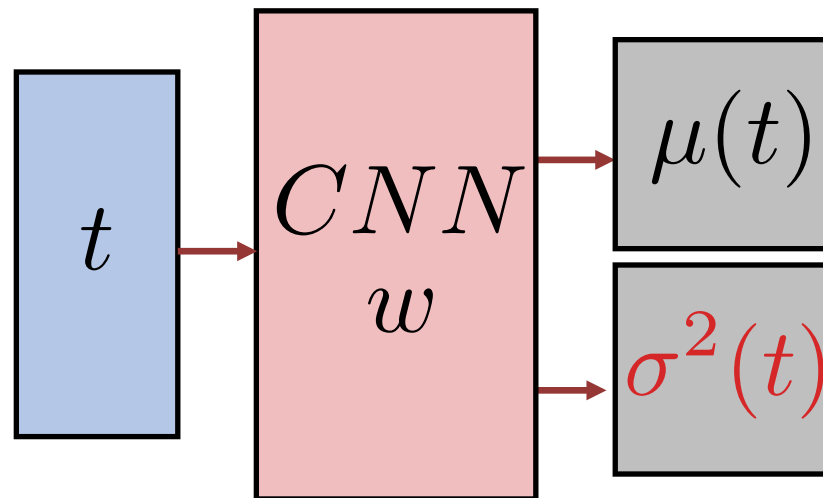


Continuous mixture of Gaussians

$$p(x \mid w) = \int p(x \mid t, w) p(t) dt$$

$$p(t) = \mathcal{N}(0, I)$$

$$p(x \mid t, w) = \mathcal{N}(\mu(t, w), \text{diag}(\sigma^2(t, w)))$$



Scaling up Expectation Maximization

$$\max_w p(X \mid w) = \int p(X \mid T, w) p(T) dt$$

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Latent Variable model — use EM!

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$$\max_w p(X \mid w) = \int p(X \mid T, w) p(T) dt$$

Latent Variable model — use EM!

$$\log p(X \mid w) \geq \mathcal{L}(w, q)$$

$$\underset{w, q}{\text{maximize}} \quad \mathcal{L}(w, q)$$

Scaling up Expectation Maximization

$$\max_w p(X \mid w) = \int p(X \mid T, w) p(T) dt$$

Latent Variable model — use EM! But E-step is intractable

Need to compute $p(T \mid X, w)$

$$\log p(X \mid w) \geq \mathcal{L}(w, q)$$

$$\underset{w, q}{\text{maximize}} \quad \mathcal{L}(w, q)$$

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MCMC?

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MCMC?

$$\mathbb{E}_q \log p(X, T \mid w) \approx \frac{1}{M} \sum_{s=1}^M \log p(X, T_s \mid w)$$

$$T_s \sim q(T)$$

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$$\max_w p(X \mid w) = \int p(X \mid T, w) p(T) dt$$

Latent Variable model — use EM! But E-step is intractable

MCMC? An option, but we can do better

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Then Variational EM!

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$$\underset{w, q}{\text{maximize}} \quad \mathcal{L}(w, q)$$

$$\text{subject to} \quad q_i(t_i) = \tilde{q}(t_{i1}) \dots \tilde{q}(t_{im})$$

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$$\max_w p(X \mid w) = \int p(X \mid T, w) p(T) dt$$

Latent Variable model — use EM! But E-step is intractable

MCMC? An option, but we can do better

Then Variational EM! **But again intractable.**

$$\log p(X \mid w) \geq \mathcal{L}(w, q)$$

$$\underset{w, q}{\text{maximize}} \quad \mathcal{L}(w, q)$$

$$\text{subject to} \quad q_i(t_i) = \tilde{q}(t_{i1}) \dots \tilde{q}(t_{im})$$