Diffusion Model

一. Encoder

$$q(x_t \mid x_0) = \mathcal{N}(x_t; \sqrt{\bar{\alpha}_t}\, x_0, (1-\bar{\alpha}_t) I)$$

$$x_0 = \frac{x_t - \sqrt{1-\bar{\alpha}_t}\,\varepsilon}{\sqrt{\bar{\alpha}_t}}$$

二. Decoder

$$\frac{1}{\sqrt{\alpha_t}}\left(x_t - \frac{1-\alpha_t}{\sqrt{1-\bar{\alpha}_t}}\varepsilon\right)$$

$$\Uparrow$$

$$\frac{\sqrt{\alpha_t}(1-\bar{\alpha}_{t-1})x_t + \sqrt{\bar{\alpha}_{t-1}}(1-\alpha_t)x_0}{1-\bar{\alpha}_t}$$

$$\Uparrow$$

$$q(x_{t-1} \mid x_t, x_0) = \mathcal{N}(x_{t-1}; \mu(x_t, x_0), \boxed{\Sigma(t)\ I})$$

$$p_\theta(x_{t-1} \mid x_t) = \mathcal{N}(x_{t-1}; \mu_\theta(x_t, t), \quad)$$

$$\Downarrow$$

$$\frac{\sqrt{\alpha_t}(1-\bar{\alpha}_{t-1})x_t + \sqrt{\bar{\alpha}_{t-1}}(1-\alpha_t)\hat{x}_\theta(x_t, t)}{1-\bar{\alpha}_t}$$

$$\Downarrow$$

$$\frac{1}{\sqrt{\alpha_t}}\left(x_t - \frac{1-\alpha_t}{\sqrt{1-\bar{\alpha}_t}}\hat{\varepsilon}_\theta(x_t, t)\right)$$

$$\arg\min_\theta \| \hat{x}_\theta(x_t, t) - x_0 \|_2^2$$

$$\arg\min_\theta \| \varepsilon - \hat{\varepsilon}_\theta(x_t, t) \|_2^2$$

三. Train.

$t \sim U(1, T)$

$t, x_0 \rightarrow \varepsilon \sim \mathcal{N}(0, 1) \rightarrow x_t$

$t, x_t \rightarrow \hat{\varepsilon}_t = P_\theta(x_t, t) \rightarrow x_{t-1}$

$\vdots \qquad\qquad\qquad\qquad \vdots$

$x_1 \rightarrow \quad \cdots\cdots \quad \rightarrow x_0$

LOSS