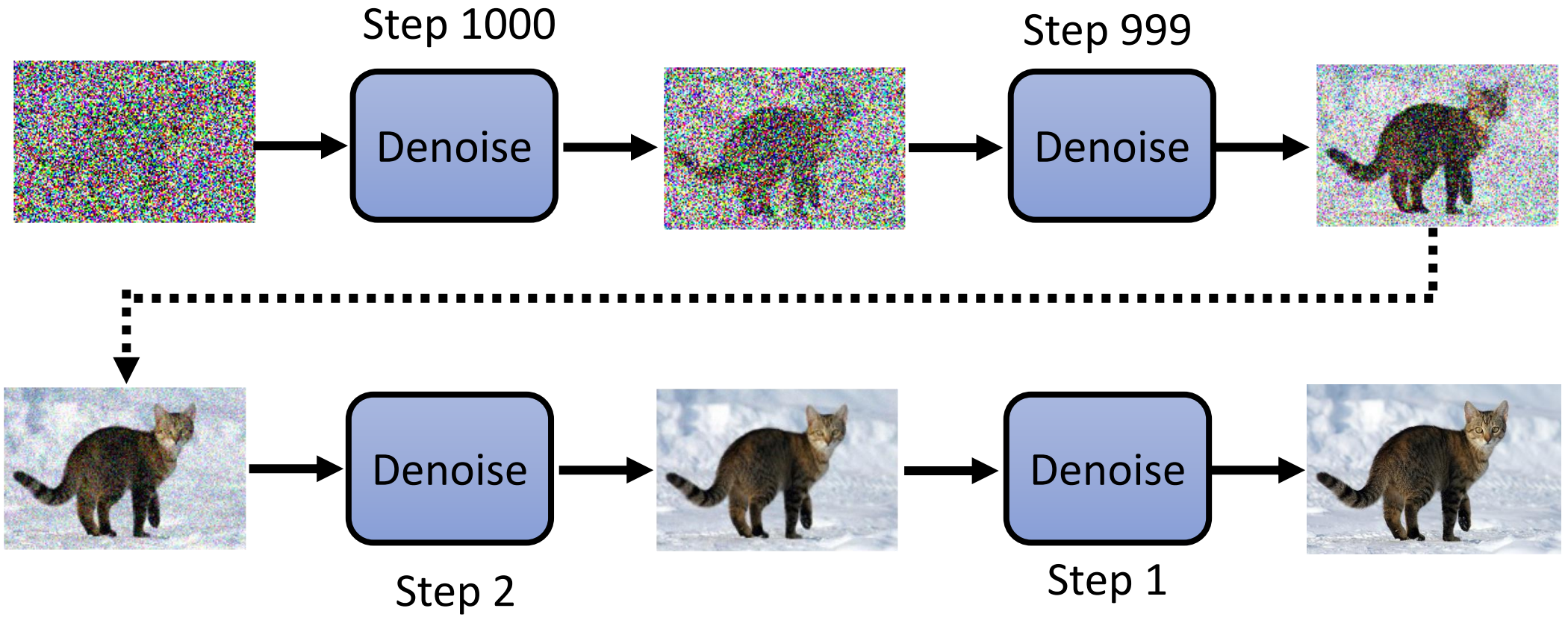
Diffusion Model

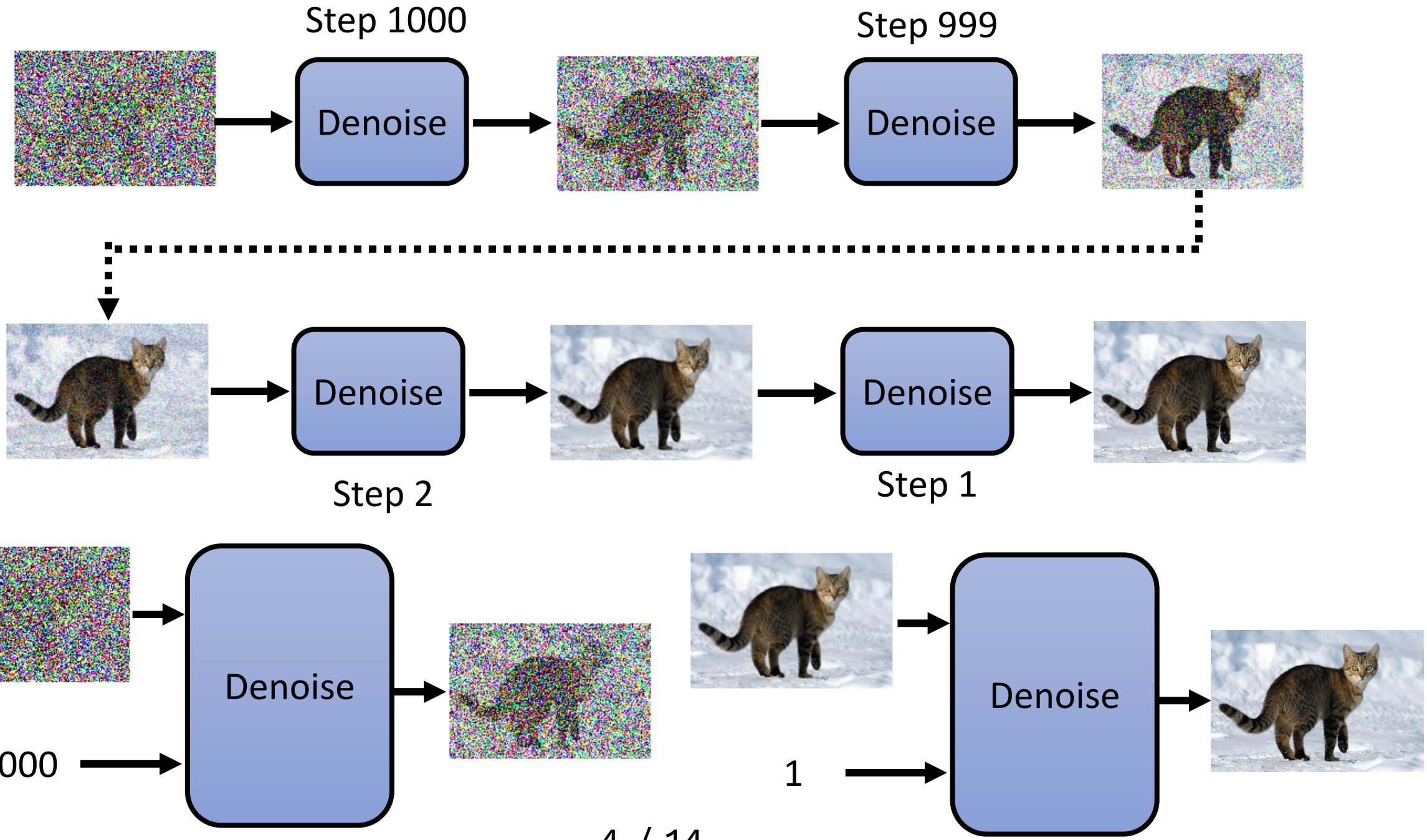
Denoising Diffusion Probabilistic Models (DDPM)
https://arxiv.org/abs/2006.11239

Diffusion Model 是如何運作的？

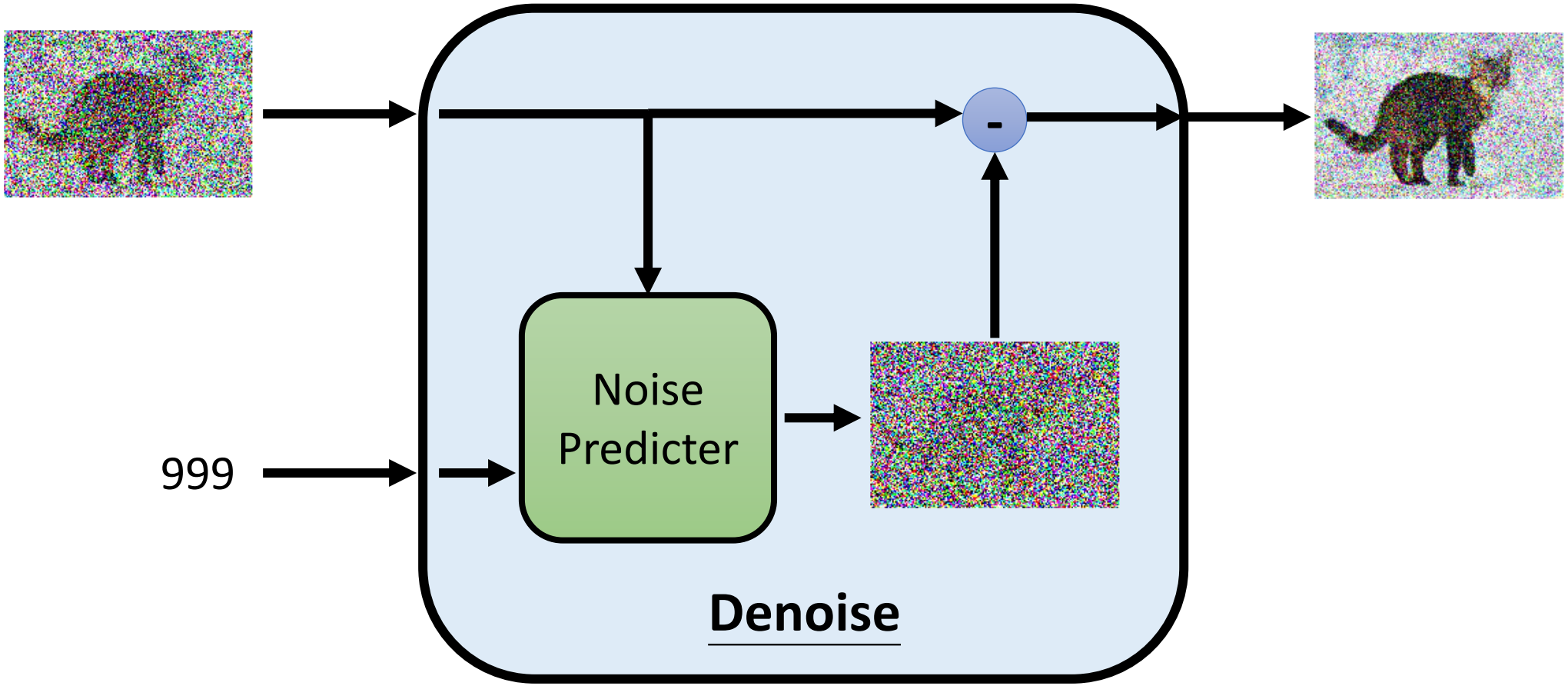


The sculpture is already complete within the marble block, before I start my work. It is already there, I just have to chisel away the superfluous material. **- Michelangelo**

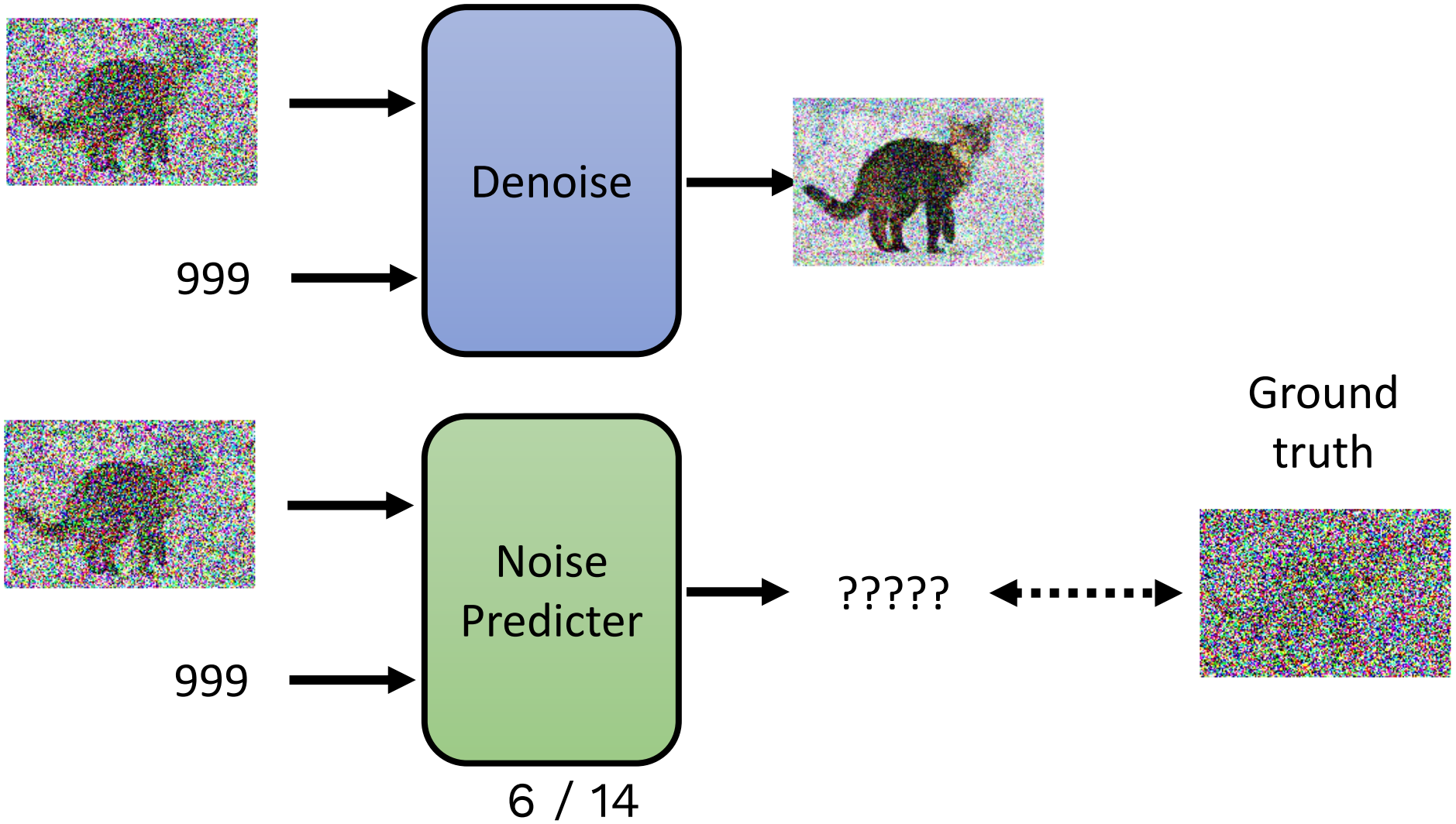
Powered by Midjourney

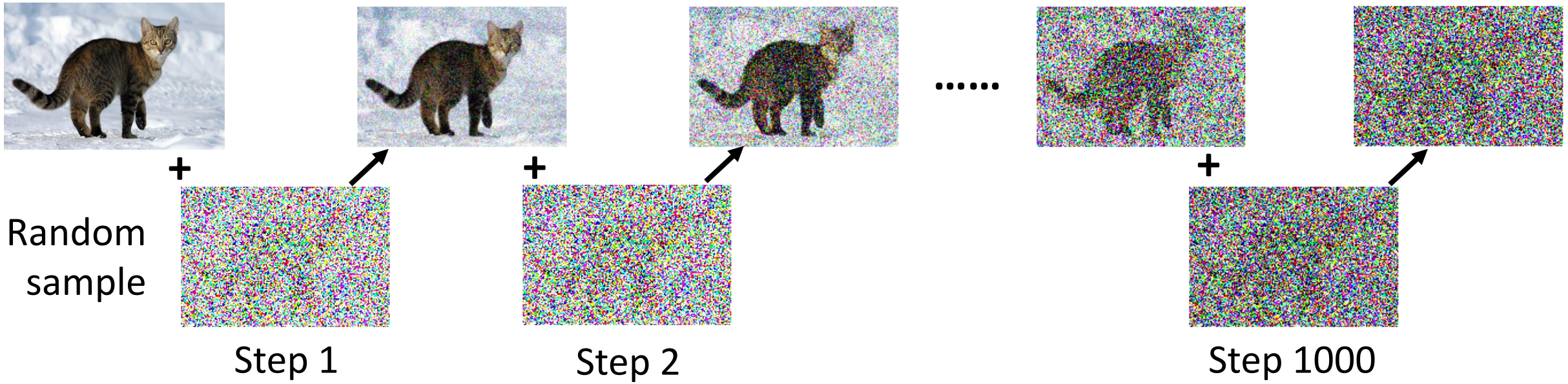

Step 1000
Step 999
Denoise
Denoise
Denoise
Denoise
Step 2
Step 1
1000
Denoise
1
Denoise

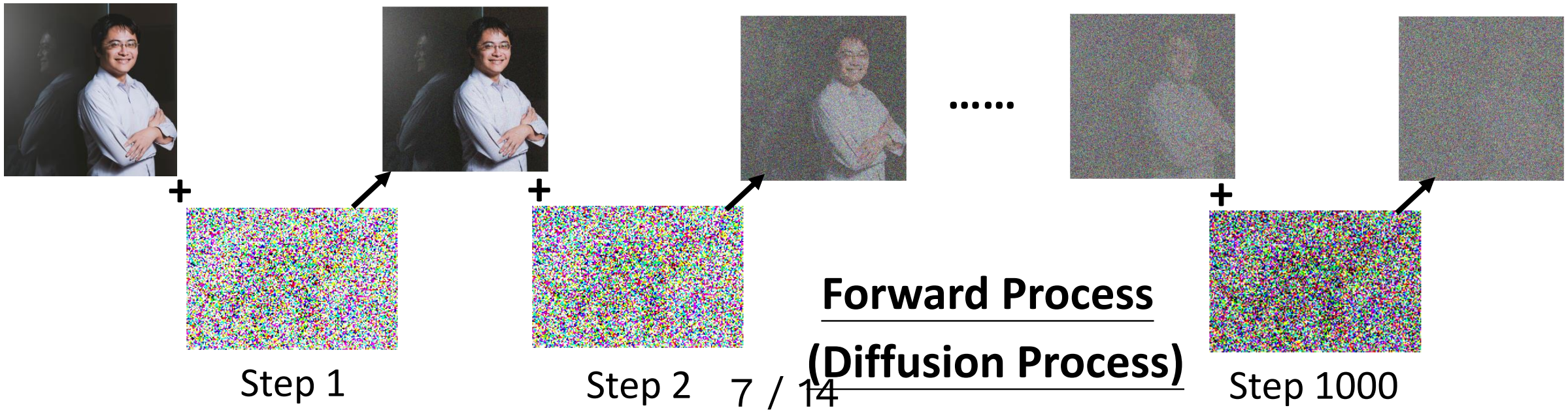
Denoise 模組內部實際做的事情



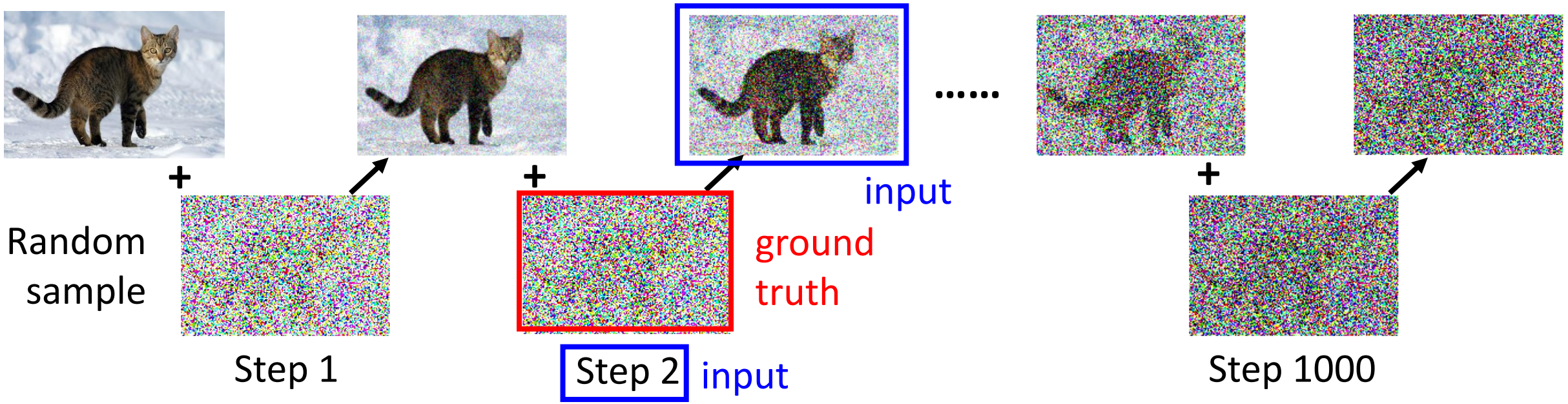
如何訓練 Noise Predictor

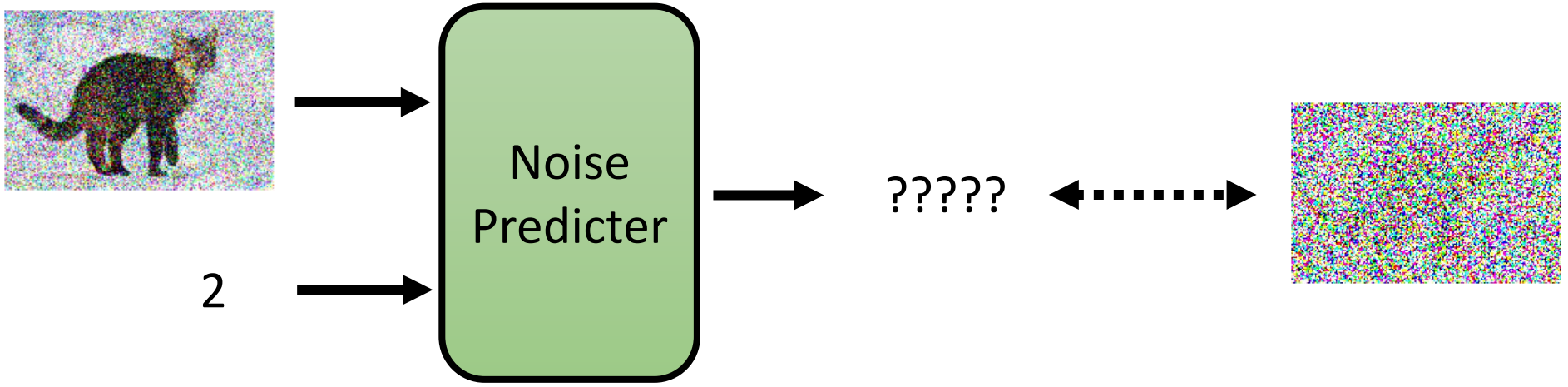






Forward Process (Diffusion Process)


Random sample
Step 1
Step 2
input
ground truth
input
.....
Step 1000


2
Noise Predicter
?????

Text-to-Image

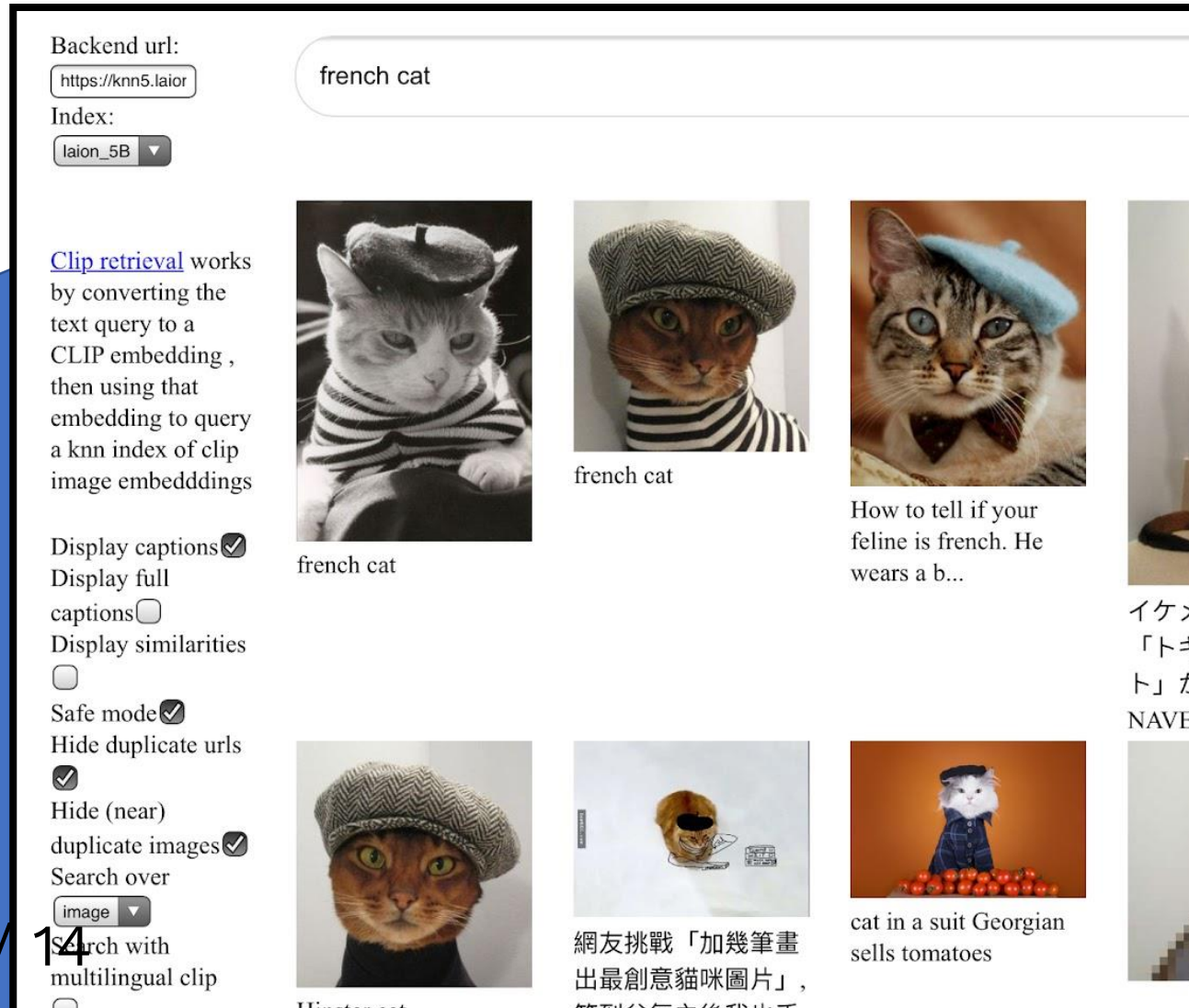
https://laion.ai/blog/laion-5b/

A cat in the snow → Text-to-image Generator →

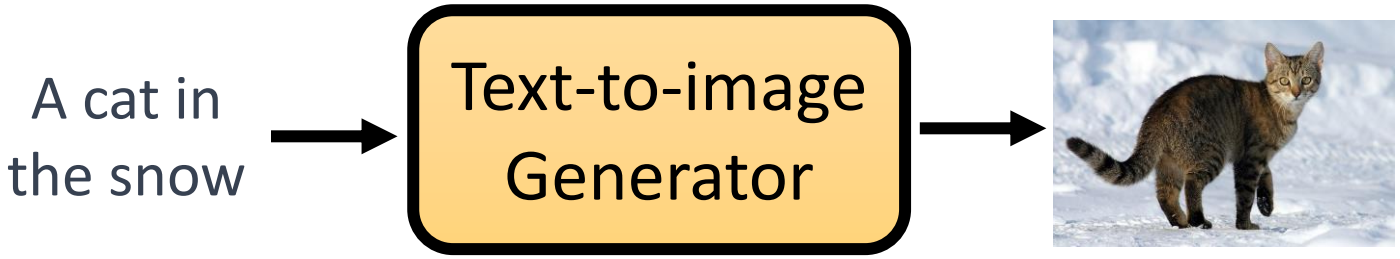
HW6 70k

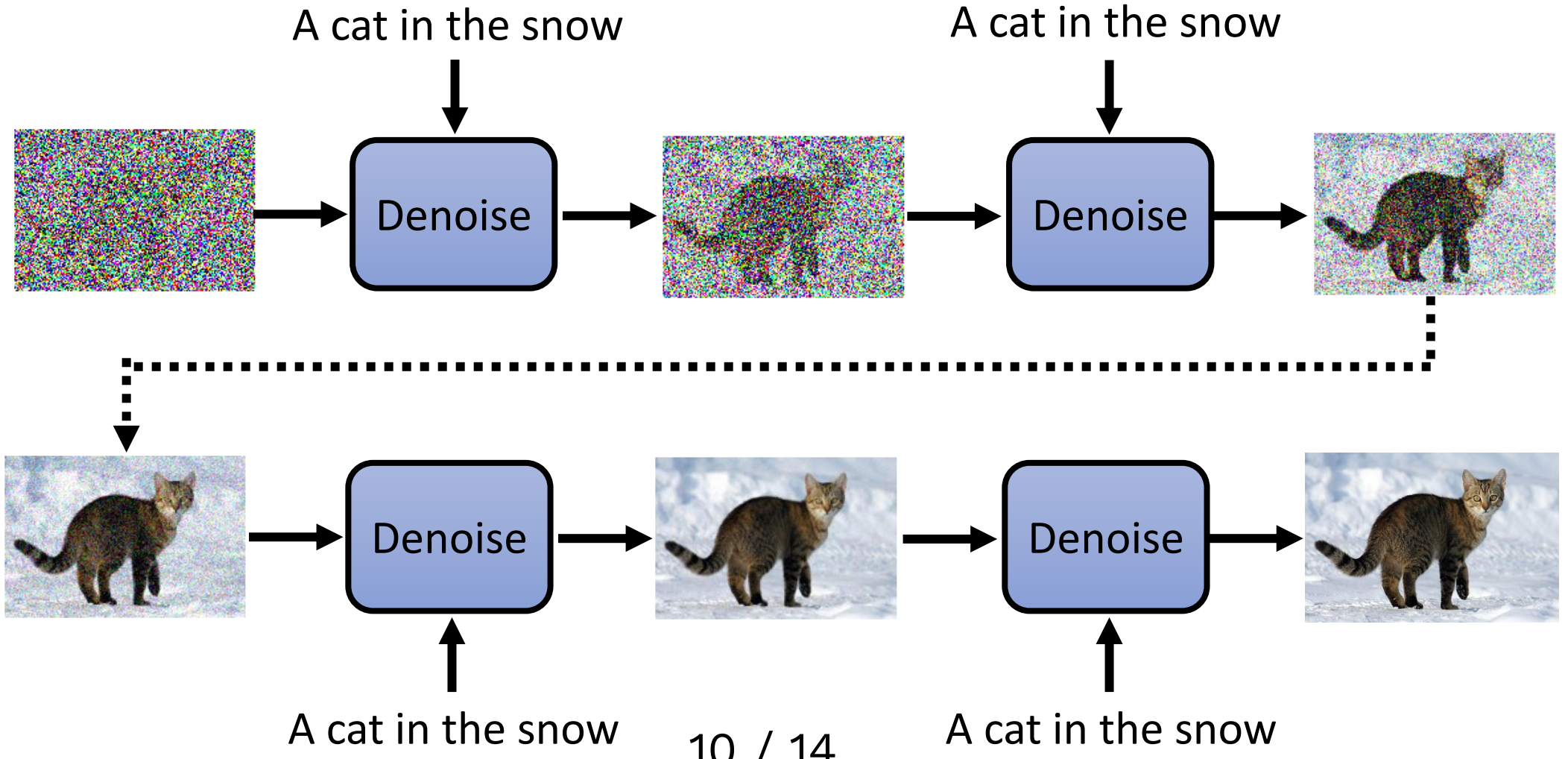
ImageNet 1M

LAION 5.85B

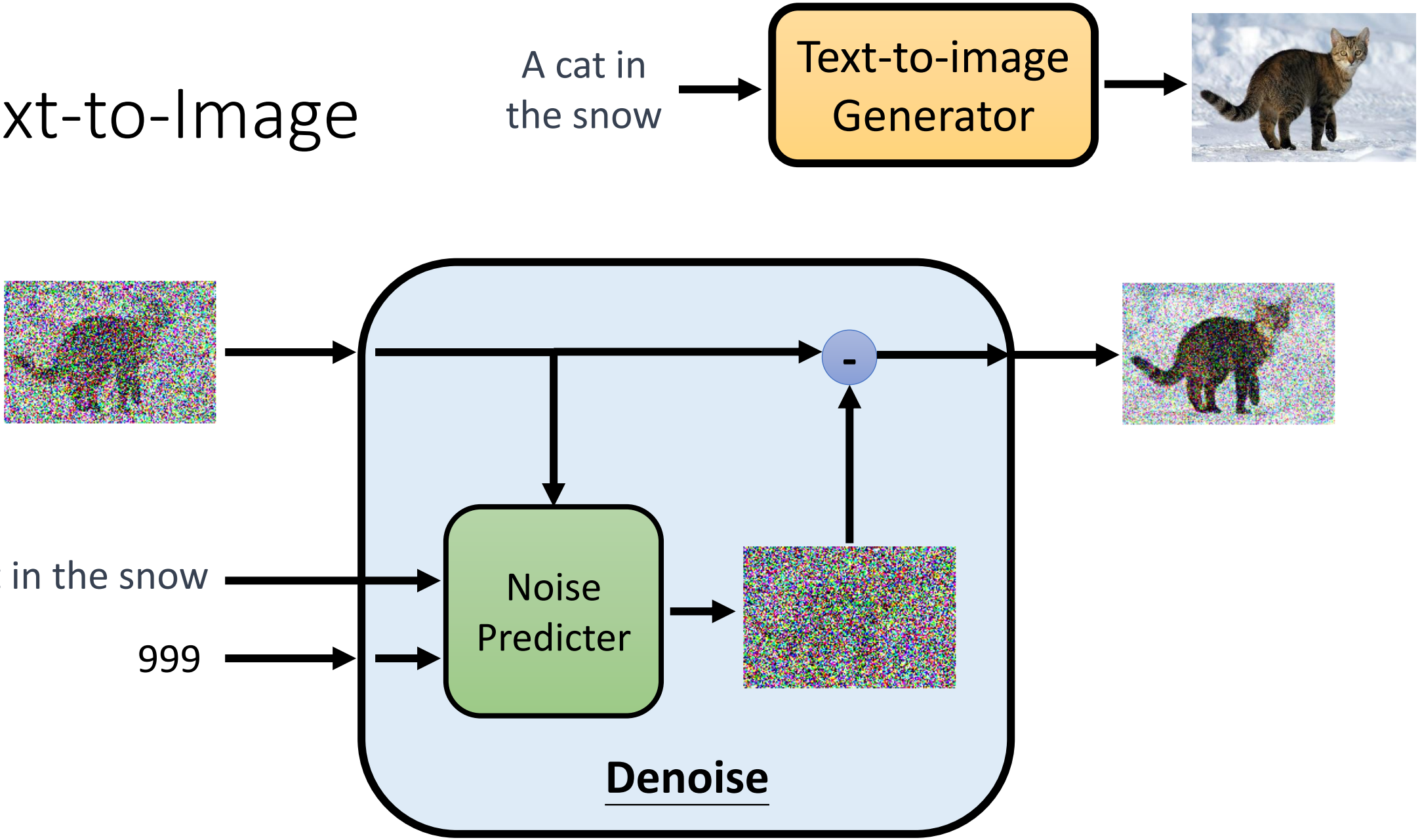


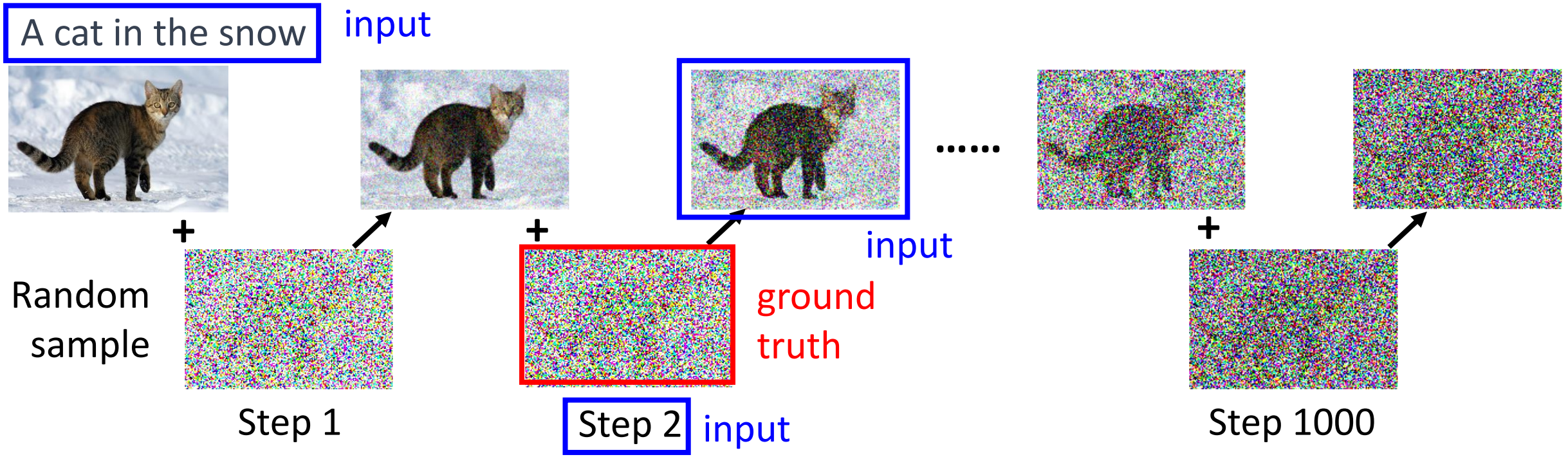
Text-to-Image

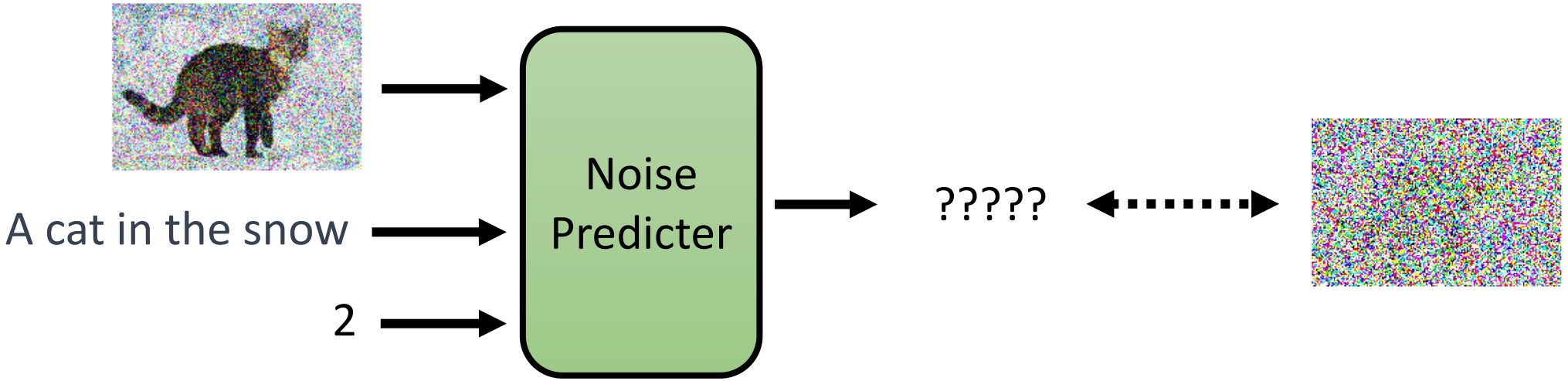




Text-to-Image




A cat in the snow
input
Random sample
Step 1
Step 2
input
ground truth
input
.....
Step 1000


A cat in the snow
2
Noise Predicter
?????

Denoising Diffusion Probabilistic Models

Algorithm 1 Training

1: **repeat**
2: $\mathbf{x}_0 \sim q(\mathbf{x}_0)$
3: $t \sim \text{Uniform}(\{1, \dots, T\})$
4: $\boldsymbol{\epsilon} \sim \mathcal{N}(\mathbf{0}, \mathbf{I})$
5: Take gradient descent step on
$$\nabla_\theta \left\| \boldsymbol{\epsilon} - \boldsymbol{\epsilon}_\theta(\sqrt{\bar{\alpha}_t}\mathbf{x}_0 + \sqrt{1-\bar{\alpha}_t}\boldsymbol{\epsilon}, t) \right\|^2$$
6: **until** converged

Algorithm 2 Sampling

1: $\mathbf{x}_T \sim \mathcal{N}(\mathbf{0}, \mathbf{I})$
2: **for** $t = T, \dots, 1$ **do**
3: $\mathbf{z} \sim \mathcal{N}(\mathbf{0}, \mathbf{I})$ if $t > 1$, else $\mathbf{z} = \mathbf{0}$
4: $\mathbf{x}_{t-1} = \frac{1}{\sqrt{\alpha_t}} \left(\mathbf{x}_t - \frac{1-\alpha_t}{\sqrt{1-\bar{\alpha}_t}} \boldsymbol{\epsilon}_\theta(\mathbf{x}_t, t) \right) + \sigma_t \mathbf{z}$
5: **end for**
6: **return** $\mathbf{x}_0$

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