Diffusion from Scratch

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Link to our Git repo

Overview

1. Diffusion
2. U-Net
3. Training and results
4. Future improvements

Diffusion

Algorithm 1 Training

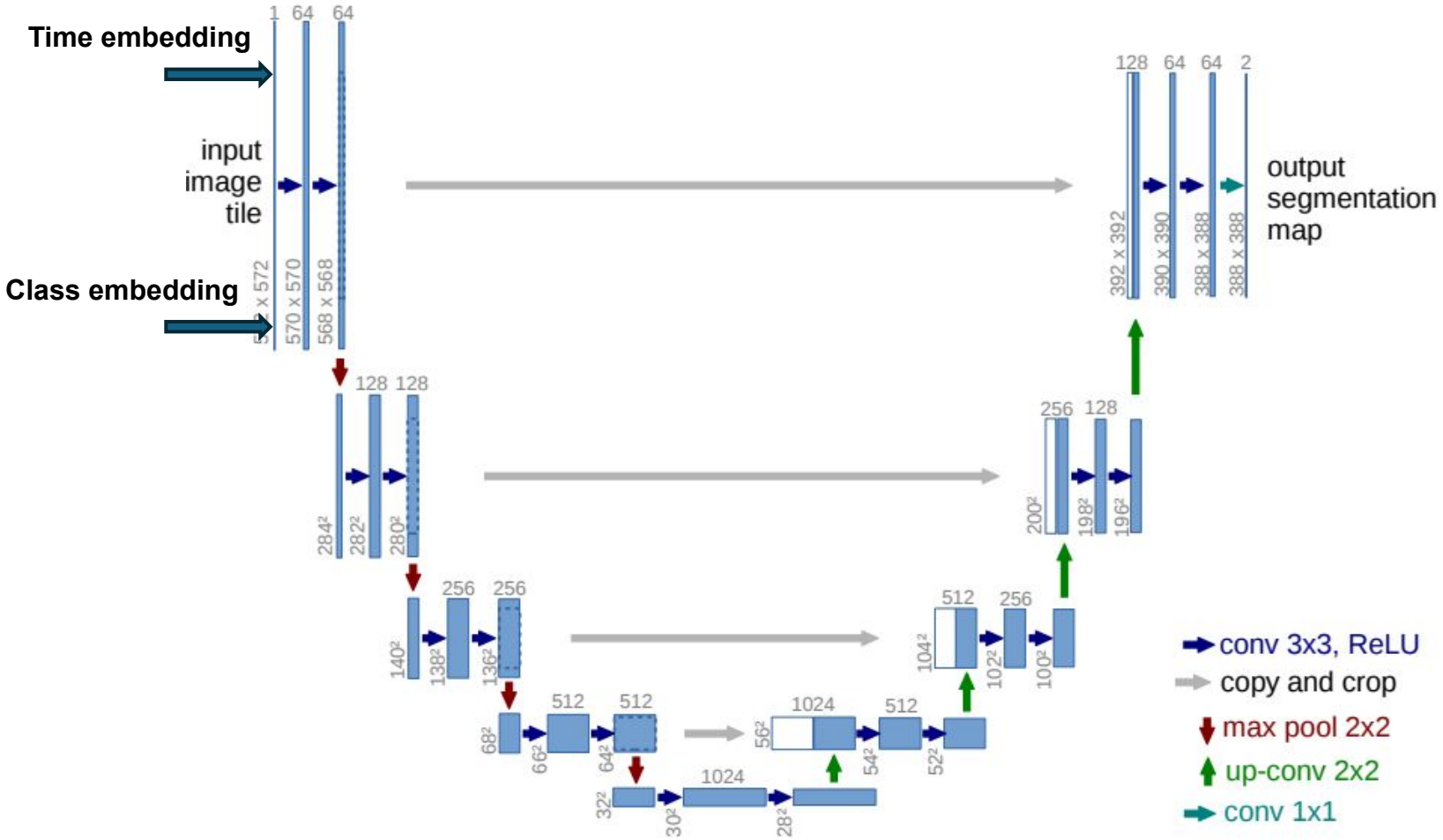
1: **repeat**
2: $\mathbf{x}_0 \sim q(\mathbf{x}_0)$
3: $t \sim \text{Uniform}(\{1, \dots, T\})$
4: $\boldsymbol{\epsilon} \sim \mathcal{N}(\mathbf{0}, \mathbf{I})$
5: Take gradient descent step on
$$\nabla_\theta \left\| \boldsymbol{\epsilon} - \boldsymbol{\epsilon}_\theta(\sqrt{\bar{\alpha}_t}\mathbf{x}_0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

Ho, J., Jain, A., & Abbeel, P. (2020). Denoising Diffusion Probabilistic Models (Version 2). arXiv. https://doi.org/10.48550/ARXIV.2006.11239

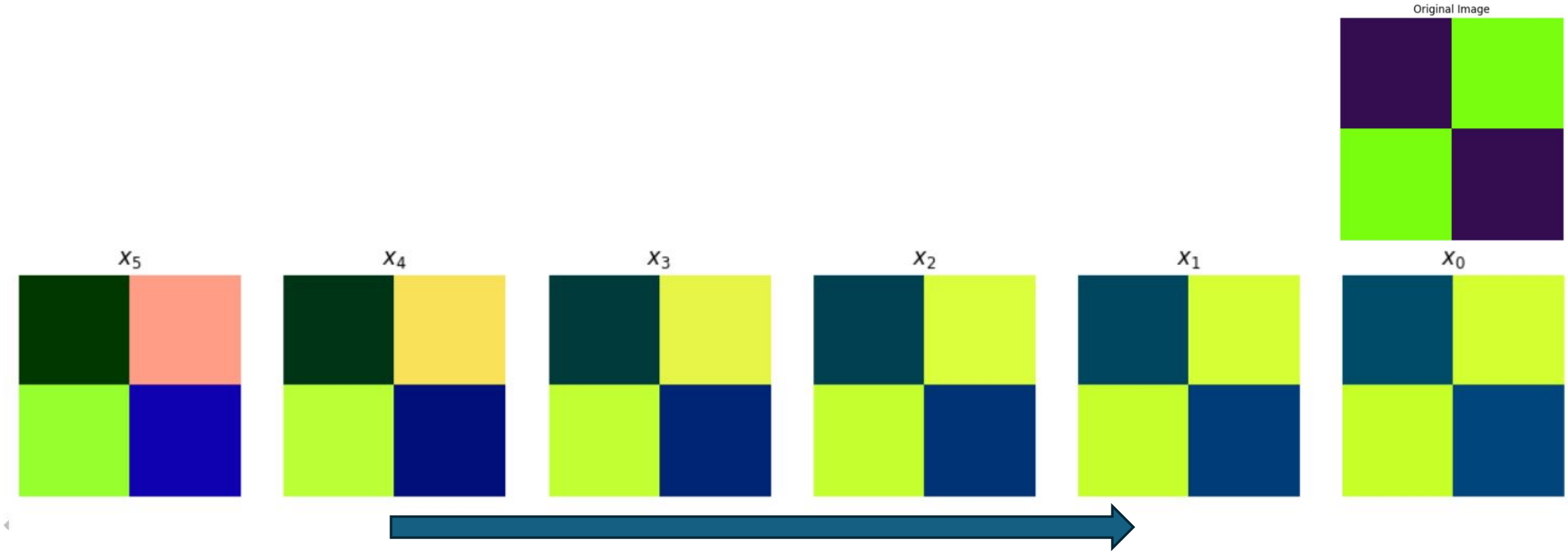
U-Net + Attention



Ho, J., Jain, A., & Abbeel, P. (2020). Denoising Diffusion Probabilistic Models (Version 2). arXiv. https://doi.org/10.48550/ARXIV.2006.11239

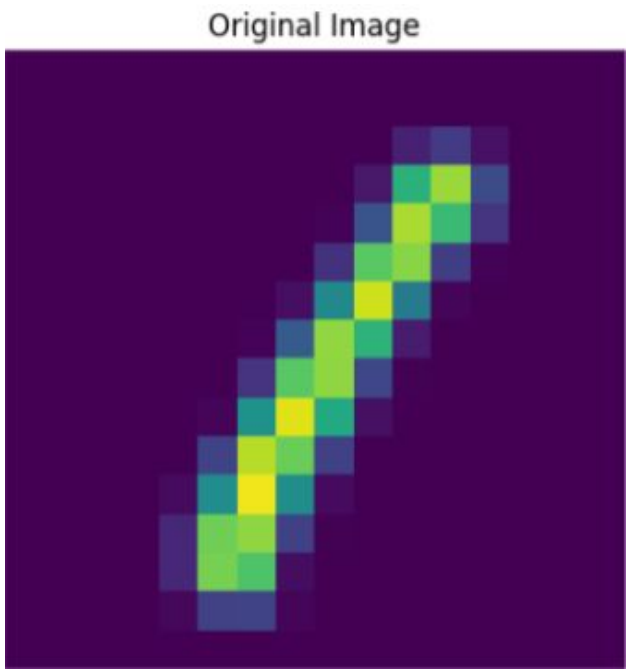
Training and results

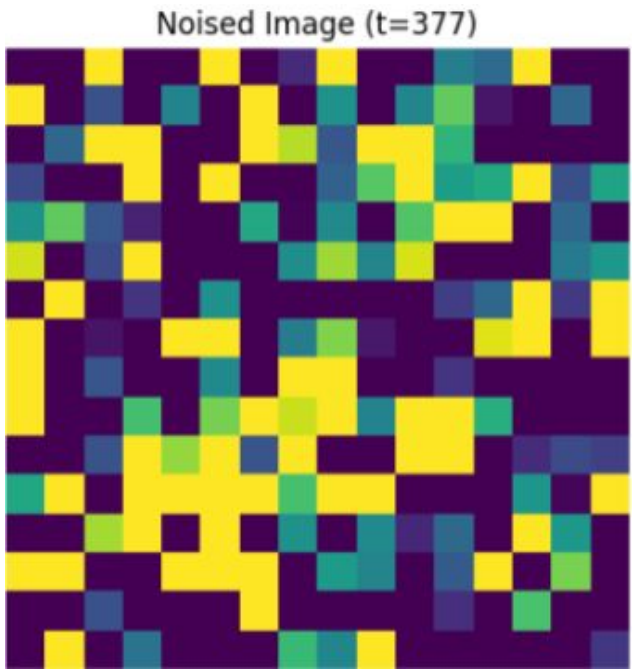
- Grid prototype – using one hidden layer

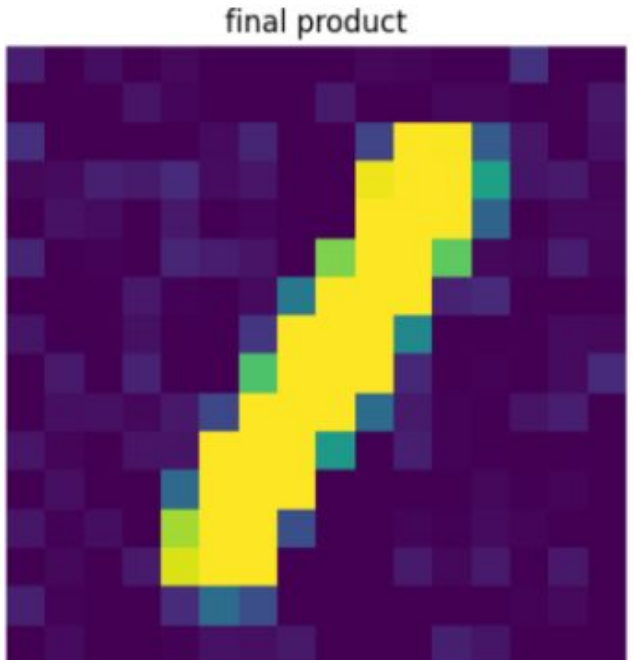


Training and results

- First MNIST results – introducing U-Net







Training and results

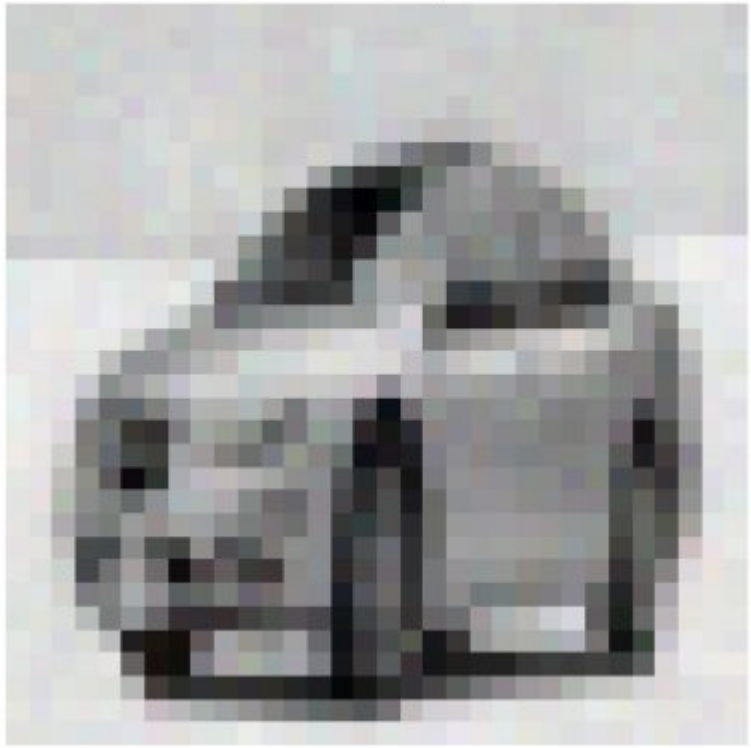
- First CIFAR10 results

Training and results

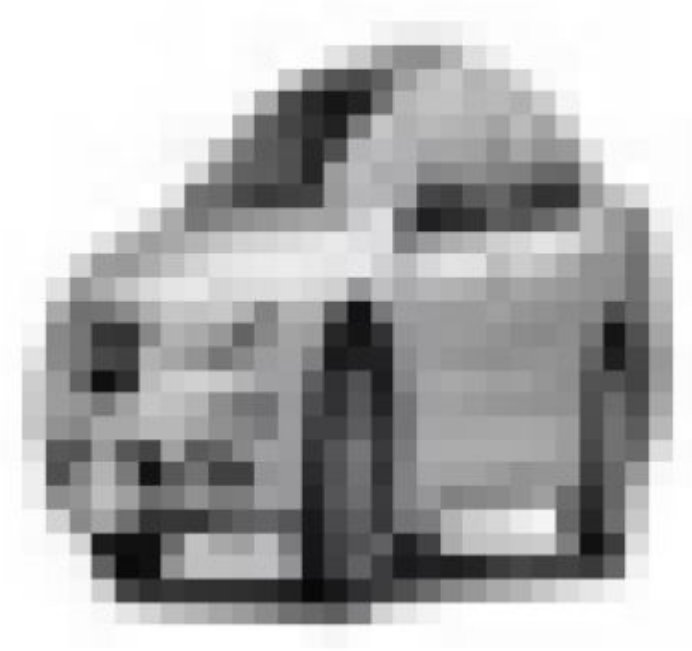
- Better CIFAR10 results

Training and results

model output

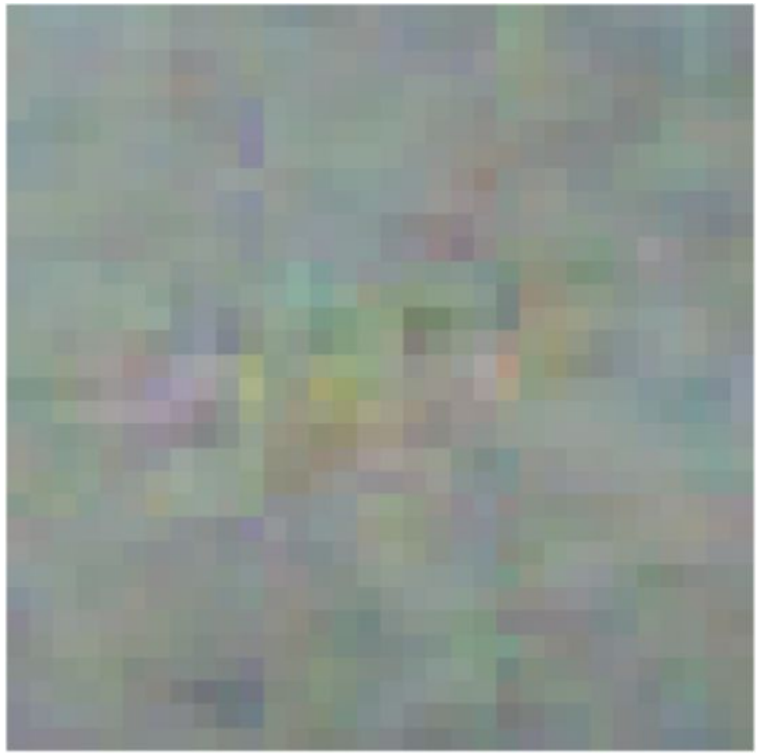


closest image in dataset



Training and results

- Grid-like noise when training on full dataset



Training and results

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Future improvements

- Improve the architecture
- Adjust hyperparameters
- More training
- Use FID & IS score

References

[1] Ho, J., Jain, A., & Abbeel, P. (2020). Denoising Diffusion Probabilistic Models (Version 2). arXiv. https://doi.org/10.48550/ARXIV.2006.11239

[2] Nichol, A., & Dhariwal, P. (2021). Improved Denoising Diffusion Probabilistic Models (Version 1). arXiv. https://doi.org/10.48550/ARXIV.2102.09672

[3] Ho, J., & Salimans, T. (2022). Classifier-Free Diffusion Guidance (Version 1). arXiv. https://doi.org/10.48550/ARXIV.2207.12598

ANY QUESTIONS?