Finding NeMo: Localizing Neurons Responsible For Memorization in Diffusion Models

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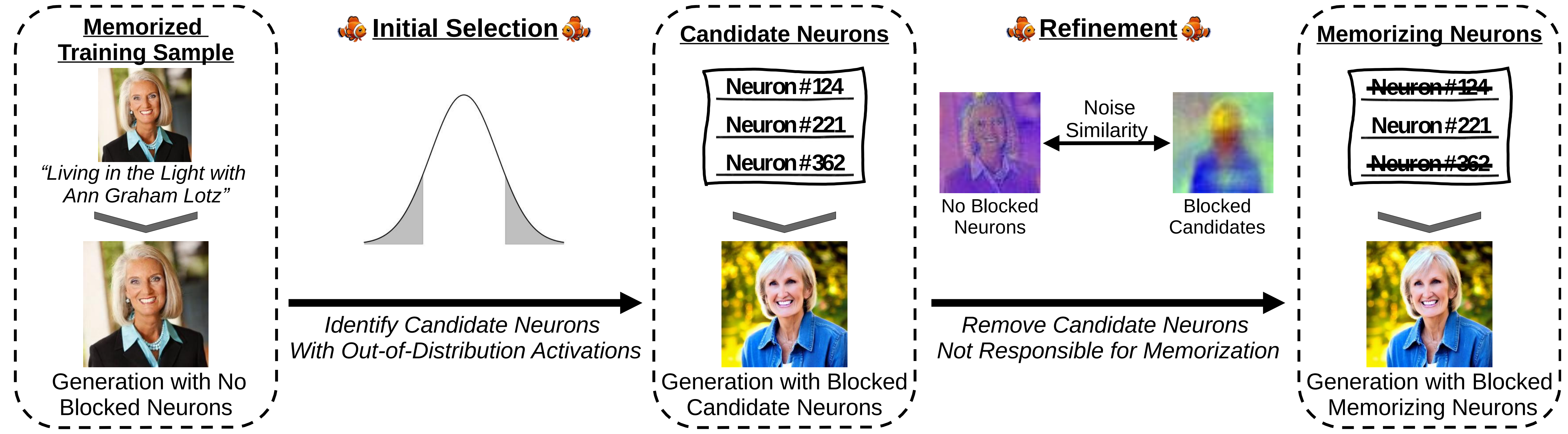
At a Glance

- **Neuron Memorization (NeMo)** localizes the memorization of training samples in diffusion models down to **individual neurons**.
- **Single neurons** within Stable Diffusion are responsible for memorizing multiple training samples.
- All memorization is confined to neurons in the **cross-attention value layers** of the U-Net's down-blocks.
- Deactivating memorization neurons **mitigates memorization and increases output diversity** without compromising image quality.

Localizing Memorization

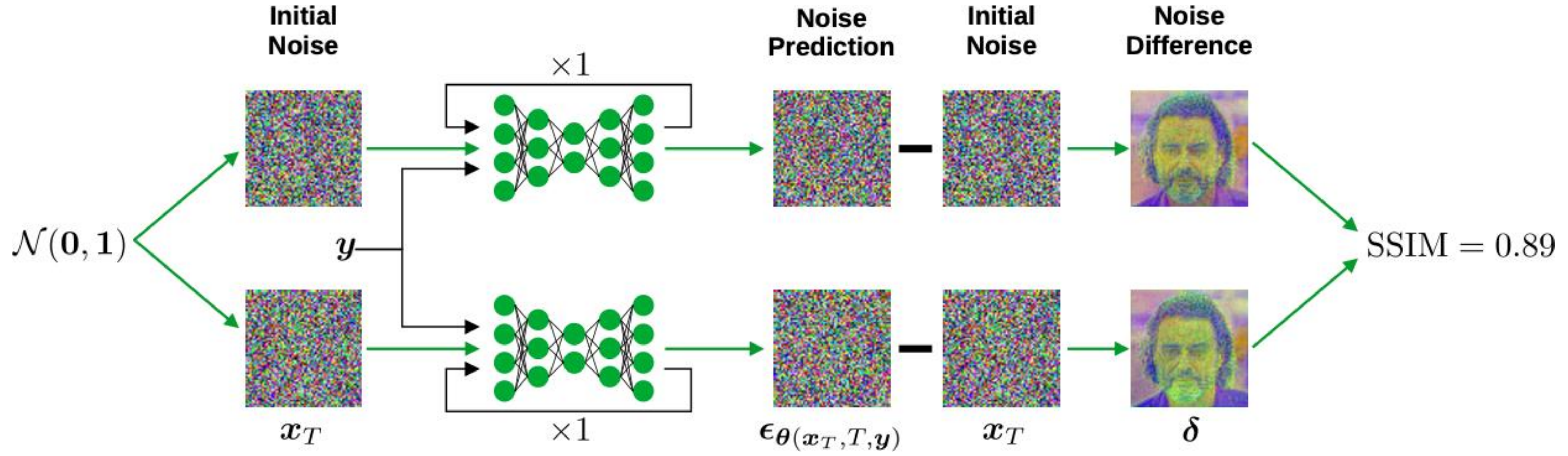
NeMo detects candidate memorization neurons based on their **activation patterns**. The number of initially found neurons is then reduced in a second **refinement step**. This design makes NeMo **very fast and efficient** since no gradient computation is required.



Memorized Training Sample
"Living in the Light with Ann Graham Lotz"
Generation with No Blocked Neurons
Initial Selection
Identify Candidate Neurons With Out-of-Distribution Activations
Candidate Neurons
Neuron#124
Neuron#221
Neuron#362
Generation with Blocked Candidate Neurons
Refinement
Noise Similarity
No Blocked Neurons
Blocked Candidates
Remove Candidate Neurons Not Responsible for Memorization
Memorizing Neurons
~~Neuron#124~~
Neuron#221
~~Neuron#362~~
Generation with Blocked Memorizing Neurons

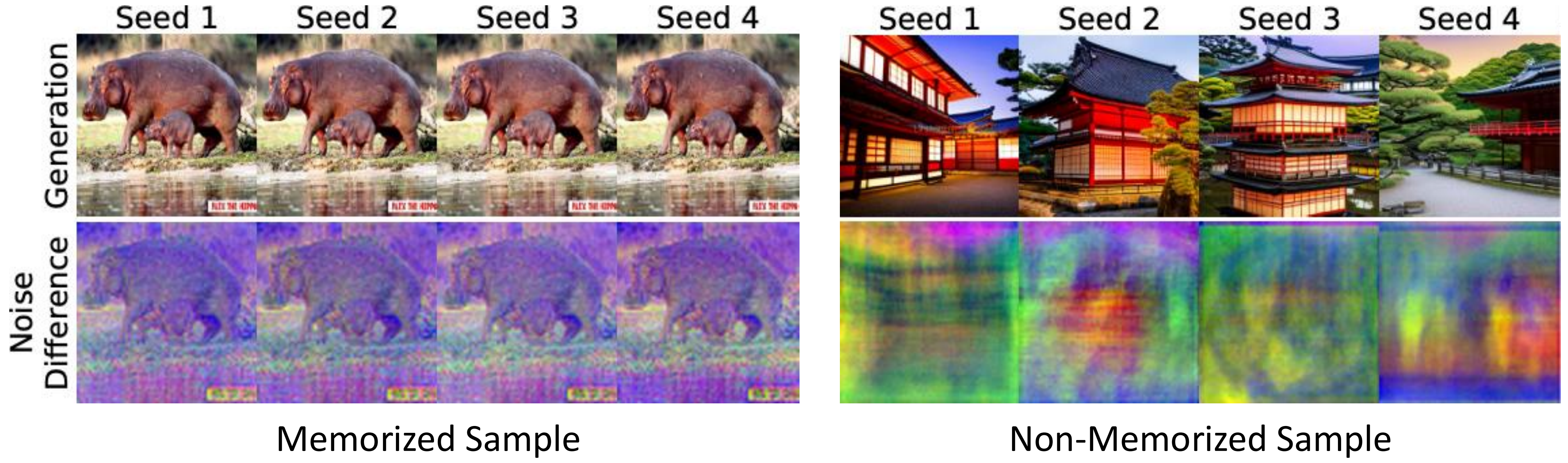
Quantifying Memorization Strength

Memorization strength is quantified by measuring the **similarity between the denoising trajectories** starting from different initial noises.



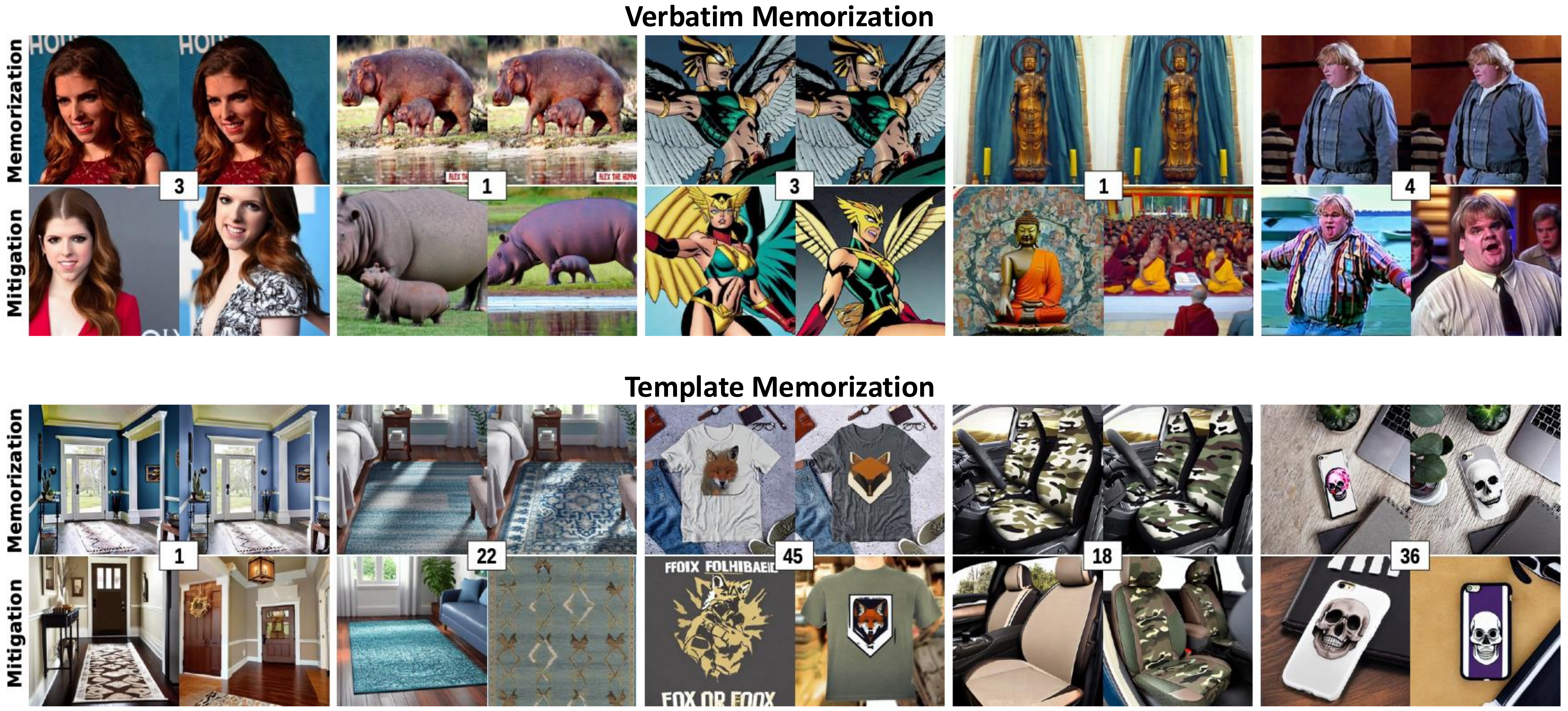
Noise Differences

The denoising **trajectories are consistent** for memorized samples but vary substantially for non-memorized content.



Effect of Deactivating Memorization Neurons

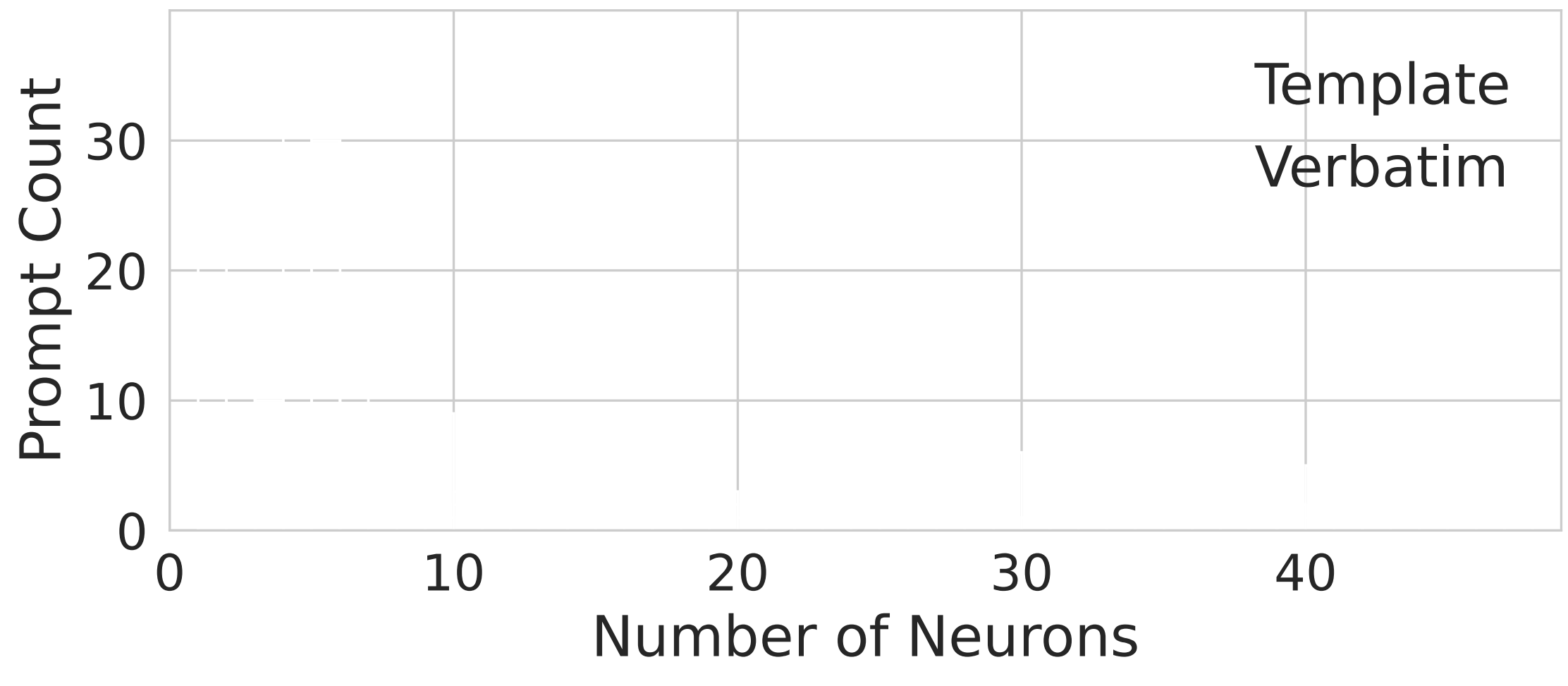
Deactivating memorization neurons **increases diversity** and **mitigates memorization**. Only a **few neurons** are responsible for memorization.



Distribution of Memorization Neurons

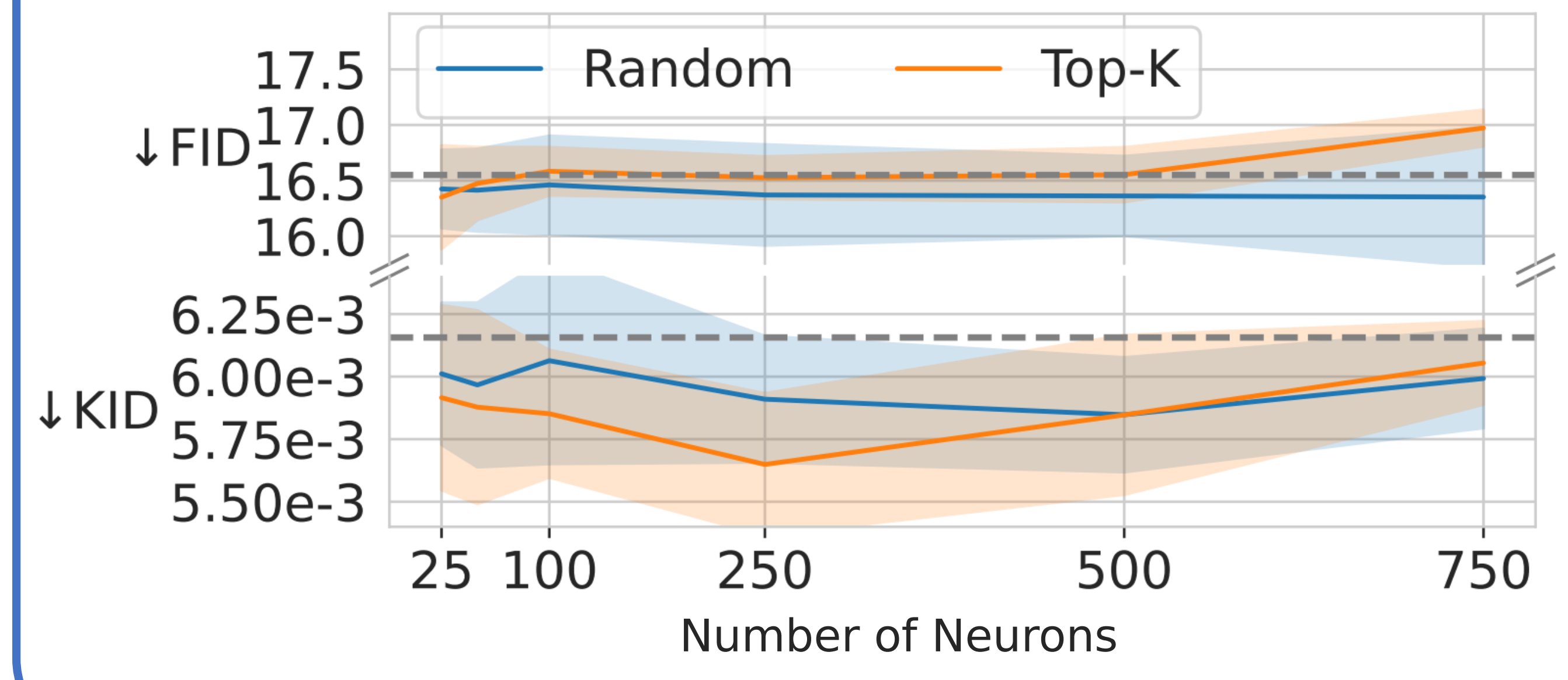
A **small set of neurons** is responsible for memorization.

Number of prompts memorized by a fixed number of neurons



Quality Retention

Deactivating memorization neurons **does not degrade image quality**.



Code & Paper

Contact

Please feel free to reach out to us!

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