

# Imaging with Diffusion Model Prior

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## Motivation

- Explore the basic abilities of a pre-trained diffusion model as a prior, looking at unconditional generation, deconvolution, and inpainting. Explore different methods for conditional generation.

## Background & Related Work

We base this work off of the three following methods:

- SDEdit
- ScoreALD:  $\mathbf{x}_{t-1} = \mathbf{x}'_{t-1} - \frac{1}{2(\sigma^2 + \gamma_t^2)} \nabla_{\mathbf{x}_t} \|\mathcal{A}(\mathbf{x}_t) - \mathbf{y}\|^2$
- Diffusion Posterior Sampling:  $\mathbf{x}_{t-1} = \mathbf{x}'_{t-1} - \zeta_t \nabla_{\mathbf{x}_t} \|\mathcal{A}(\hat{\mathbf{x}}_0) - \mathbf{y}\|^2$

Quantitative Metrics:

- Peak Signal-to-Noise Ratio (PSNR): measures the strength of the signal relative to the noise (higher is better).
- Learned Perceptual Image Patch Similarity (LPIPS): Uses the activations of a different pre-trained network to estimate the perceptual distance between our result and the ground truth (lower is better).

## References

- [1] C. Meng, Y. He, Y. Song, J. Song, J. Wu, J.Y. Zhu, S. Ermon, "SDEdit: Guided Image Synthesis and Editing with Stochastic Differential Equations", ICLR 2022
- [2] J. Ho, et al, "Denoising Diffusion Probabilistic Models", NeurIPS 2020
- [3] H.Chung, et al, "Diffusion posterior sampling for general noisy inverse problems", ICLR 2023
- [4] Jalal, et al, "Robust compressed sensing mri with deep generative priors", NeurIPS 2021

## Methods



- Several ways to utilize the prior in our conditional term: SDEdit, ScoreALD, Diffusion Posterior Sampling

- Our prior is trained to predict the noise in an image, we can begin with purely random noise (unconditional generation) or a noisy signal (deconvolution)
- Can be "one-shot" or iteratively

Unconditional Generation:



## Results

Qualitative Observations:

- SDEdit does not have a perfect "sweet spot" that can deconvolve or inpaint without introduction significant hallucination artifacts
- Even in deconvolution (where both eyes have some measurement) there is only partial success in accurate eye symmetry
- The shape of the upper lip is particularly difficult to maintain, only DPS partially succeeds.

