PAPER IMPLEMENTATION:

ZERO-SHOT IMAGE RESTORATION USING DENOISING DIFFUSION NULL-SPACE MODEL

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Yinhuai Wang, Jiwen Yu, and Jian Zhang.
Zero-Shot Image Restoration Using Denoising Diffusion Null-Space Model.
2022. arXiv: 2212.00490.

Background

- State-of-the-art diffusion model presented in Denoising Diffusion Probabilistic Model (DDPM)

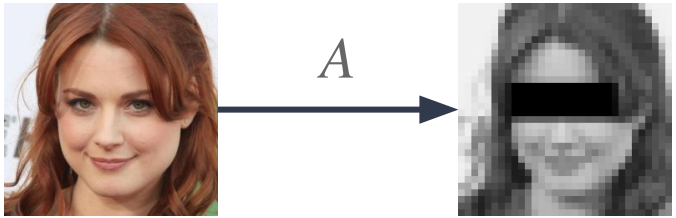
- Range-Null Space Decomposition: any sample x can be decomposed into its range-space and null-space as follows:

$$x \equiv A^{\dagger}Ax + (I - A^{\dagger}A)x$$

Problem and Constraints

$$Ax = y$$

- A: degradation operator
- x: ground-truth image
- y = degraded image



x y

Produce $\hat{x}$ that satisfies

- Consistency: $A\hat{x} \equiv y$
- Realness: $\hat{x} \sim q(x)$

$\hat{x}$

Proposed Solution

Algorithms:

1. DDNM
2. DDNM+ (noise and time-travel)

« the time-travel trick produces a better ‘past’, which in turn produces a better ‘future’ »

Zero Shot: no need for a model explicitly trained for the IR task

Roadmap of our approach

1. DDPM sampling algorithm
2. DDNM
3. DDNM+ with no time travel
4. DDNM+ with time travel
5. Mask-Shift trick
6. Final evaluation

Algorithm Iteration

1. Compute estimation using pre-trained model
2. Compute rectified estimation using range-space and null-space decomposition
3. Sample new value for the next iteration

At each iteration we reduce the disharmony between range-space and null-space resulting in a final output which yields better realness.

Now let’s dive into the code!