Conditional Generation for Inverse Problems and Class/Text-Based Conditioning

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A. Posterior Samplers for Inverse Problems

for each of the following tasks, I got results for three images from each of the two datastes, for each of the four inverse problems. I will only be including one image from each dataset for each task in the report, but the full results are included in the zip file submission. Please refer to the appendix for the images corresponding to each method and dataset. I will report the PSNR, SSIM, and LPIPS for the images shown in the report, but the full results across all three images are also included in the zip file submission.

I used my lab's server to generate the images for this task, which has an NVIDIA A6000, with 1TB ram and 128 CPU cores.

1) A: Predict $\hat{x_0}$ and sample ddim: I implemened the DDIM from HW3, the results are shown in Figure 1. The images generated look qualitatively similar to those from HW3, and the model for each dataset creates images from that distrobution.

2) B: Implement and compare posterior samplers: I found that an ILVR weight of 0.8 worked well during initial tests, so I used that value for all tasks. For this task I inlcuded the results from CelebA-HQ and ImageNet datasets in Figures 2 and 3.

The CelebA model had an average performance of:

- Time: 50s
- SRx4:
  PSNR: 30.97
  SSIM: 0.880
  LPIPS: 0.0729
- SRx8:
  PSNR: 26.44
  SSIM: 0.7464
  LPIPS: 0.1243
- 80% random inpainting:
  PSNR: 20.86
  SSIM: 0.5541
  LPIPS: 0.4891
- 128x128 box inpainting:
  PSNR: 20.33
  SSIM: 0.8244
  LPIPS: 0.1231

The ImageNet model had an average performance of:

- Time: 176s
- SRx4:
  PSNR: 25.33
  SSIM: 0.735
  LPIPS: 0.2653
- SRx8:
  PSNR: 22.10
  SSIM: 0.5647
  LPIPS: 0.2642
- 80% random inpainting:
  PSNR: 15.95

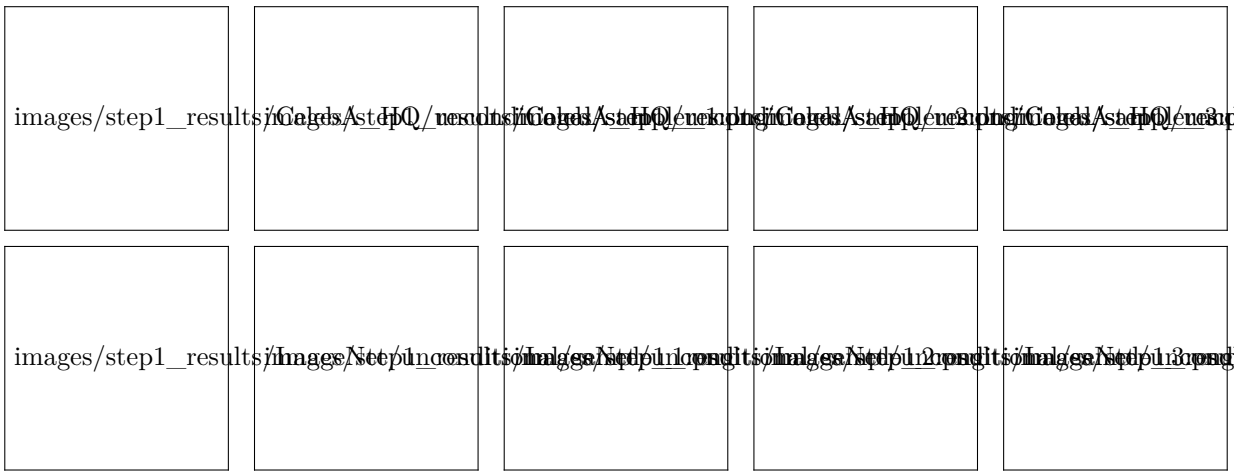

Fig. 1. Unconditional samples from CelebA-HQ (top row) and ImageNet (bottom row) pretrained ADM models using DDIM sampling with 1000 steps.

SSIM: 0.1889

LPIPS: 0.9146

- 128x128 box inpainting:

PSNR: 17.23

SSIM: 0.7826

LPIPS: 0.2218

3) C: Manifold Constrained Gradient (MCG): MCG produced

- Time: 55s
- SRx4:

PSNR: 19.68

SSIM: 0.8047

LPIPS: 0.1846

- SRx8:

PSNR: 25.68

SSIM: 0.7404

LPIPS: 0.1335

- 80% random inpainting:

PSNR: 33.40

SSIM: 0.9260

LPIPS: 0.0359

- 128x128 box inpainting:

PSNR: 19.68

SSIM:0.8047

LPIPS: 0.1856

- Time: 178s
- SRx4:

PSNR: 12.75

SSIM: 0.3567

LPIPS: 0.6224

- SRx8:

PSNR: 14.46

SSIM: 0.3693

LPIPS: 0.4716

- 80% random inpainting:

PSNR: 23.98

SSIM: 0.7838

LPIPS: 0.2242

- 128x128 box inpainting:

PSNR: 14.11

SSIM: 0.7472

LPIPS: 0.3034

4) D: Denoising Diffusion Null-Space Model (DDNM):

- Time: 3s
- SRx4:

PSNR: 18.25
SSIM: 0.2746
LPIPS: 0.8742

- SRx8:
  PSNR: 17.02
  SSIM: 0.2033
  LPIPS: 1.0188
- 80% random inpainting:
  PSNR: 10.87
  SSIM: 0.0629
  LPIPS: 14.827
- 128x128 box inpainting:
  PSNR: 15.83
  SSIM: 0.7219
  LPIPS: 0.5116

- Time: 9s
- SRx4:
  PSNR: 13.33
  SSIM: 0.3296
  LPIPS: 0.8221
- SRx8:
  PSNR: 12.76
  SSIM: 0.2855
  LPIPS: 0.9485
- 80% random inpainting:
  PSNR: 8.03
  SSIM: 0.0324
  LPIPS: 1.4114
- 128x128 box inpainting:
  PSNR: 13.24
  SSIM: 0.7202
  LPIPS: 0.5390

5) E: Noisy measurements and Diffusion Posterior Sampling (DPS):

- Time:
- SRx4:
  PSNR:
  SSIM:
  LPIPS:
- SRx8:
  PSNR:
  SSIM:
  LPIPS:
- 80% random inpainting:
  PSNR:
  SSIM:
  LPIPS:
- 128x128 box inpainting:
  PSNR:
  SSIM:
  LPIPS:

- Time:
- SRx4:
  PSNR:
  SSIM:
  LPIPS:
- SRx8:
  PSNR:
  SSIM:
  LPIPS:
- 80% random inpainting:
  PSNR:
  SSIM:
  LPIPS:
- 128x128 box inpainting:
  PSNR:
  SSIM:
  LPIPS:

6) F: Diffusion Posterior Sampling (DPS) for noisy measurements:

- Time: 55s
- SRx4:

PSNR: 22.94

SSIM: 0.7031

LPIPS: 0.2730

- SRx8:

  PSNR: 26.43

  SSIM: 0.7592

  LPIPS: 0.1143

- 80% random inpainting:

  PSNR: 19.02

  SSIM: 0.7389

  LPIPS: 0.3173

- 128x128 box inpainting:

  PSNR: 11.92

  SSIM: 0.3863

  LPIPS: 0.5397

- Time: 177s

- SRx4:

  PSNR: 13.22

  SSIM: 0.3813

  LPIPS: 0.4515

- SRx8:

  PSNR: 16.65

  SSIM: 0.4041

  LPIPS: 0.3862

- 80% random inpainting:

  PSNR: 19.34

  SSIM: 0.5619

  LPIPS: 0.4727

- 128x128 box inpainting:

  PSNR: 13.69

  SSIM: 0.5530

  LPIPS: 0.4243

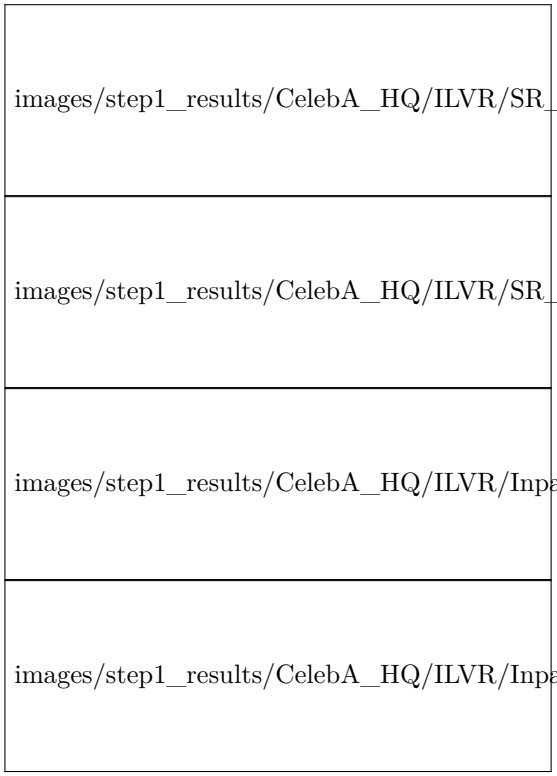

Fig. 2. ILVR Reconstructions on CelebA-HQ for SRx4, SRx8, 80% random inpainting, and 128x128 box inpainting.

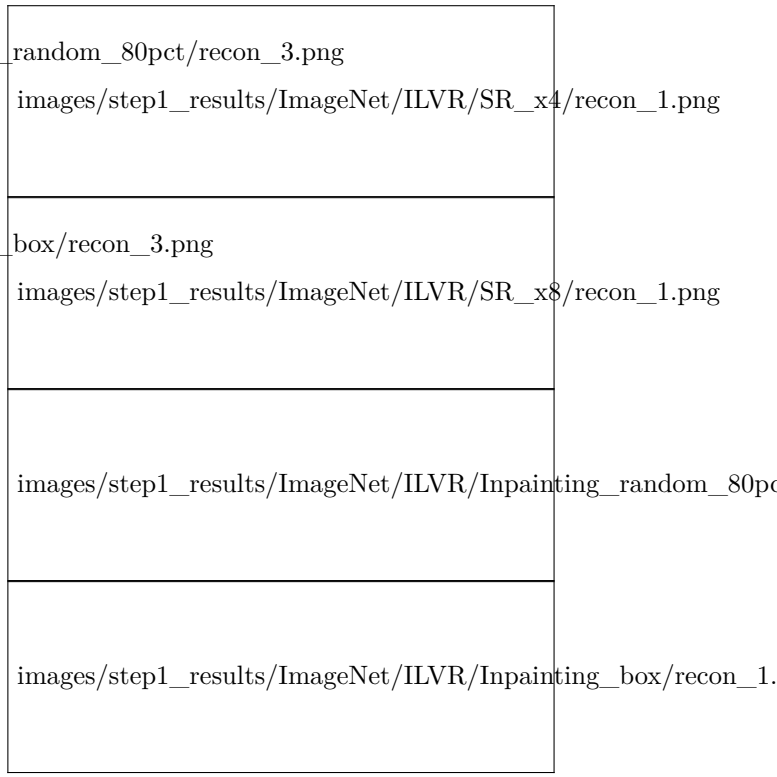

Fig. 3. ILVR Reconstructions on ImageNet for SRx4, SRx8, 80% random inpainting, and 128x128 box inpainting.

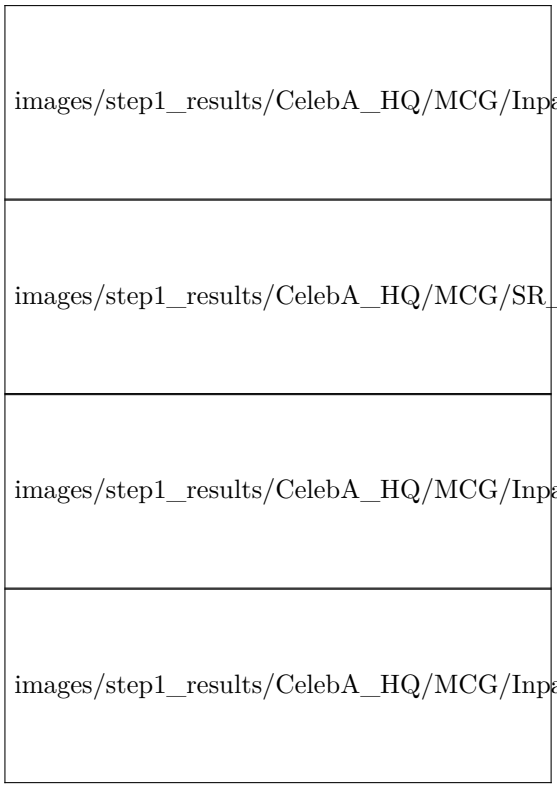

Fig. 4. MCG Reconstructions on CelebA-HQ for SRx4, SRx8, 80% random inpainting, and 128x128 box inpainting.

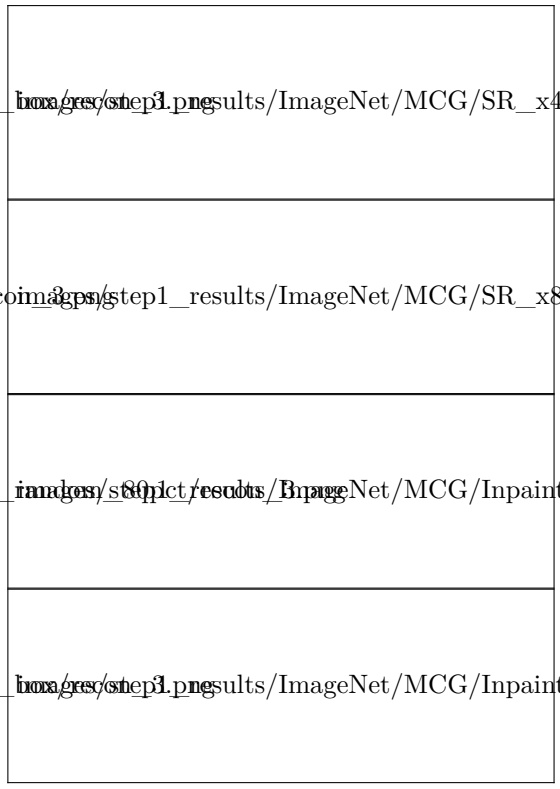

Fig. 5. MCG Reconstructions on ImageNet for SRx4, SRx8, 80% random inpainting, and 128x128 box inpainting.

Fig. 6. DDNM Reconstructions on CelebA-HQ for SRx4, SRx8, 80% random inpainting, and 128x128 box inpainting.

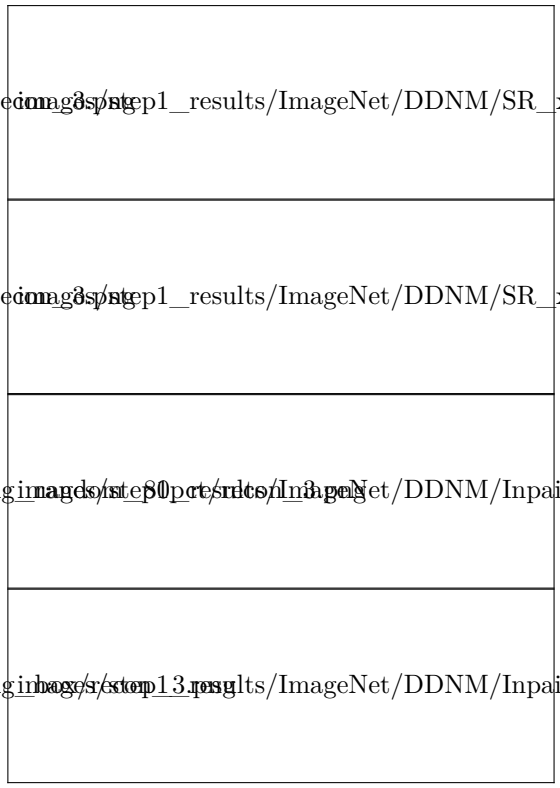

Fig. 7. DDNM Reconstructions on ImageNet for SRx4, SRx8, 80% random inpainting, and 128x128 box inpainting.

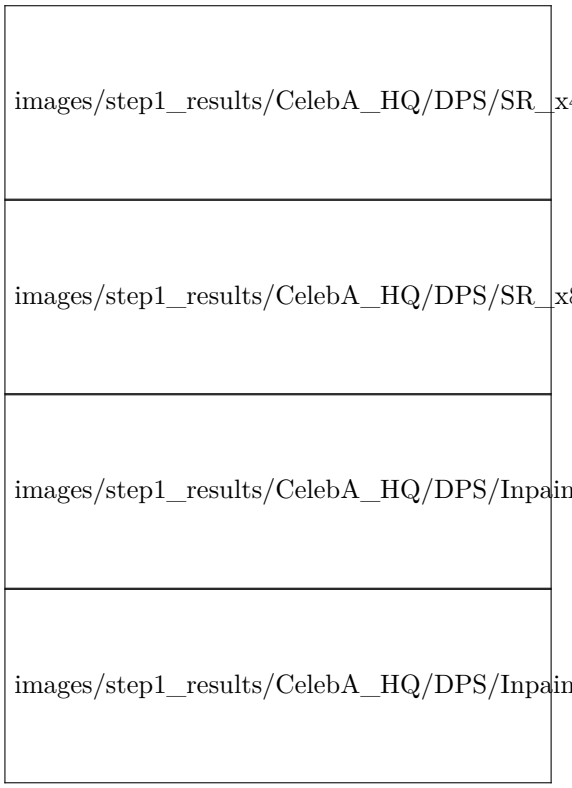

Fig. 8. DPS Reconstructions on CelebA-HQ for SRx4, SRx8, 80% random inpainting, and 128x128 box inpainting with noisy measurements.

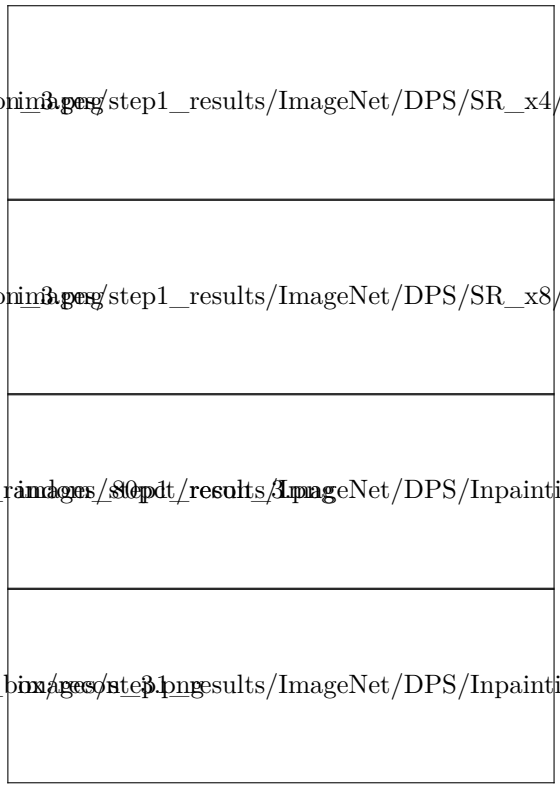

Fig. 9. DPS Reconstructions on ImageNet for SRx4, SRx8, 80% random inpainting, and 128x128 box inpainting with noisy measurements.