



# Patched Diffusion Models for Unsupervised Anomaly Detection in Brain MRI

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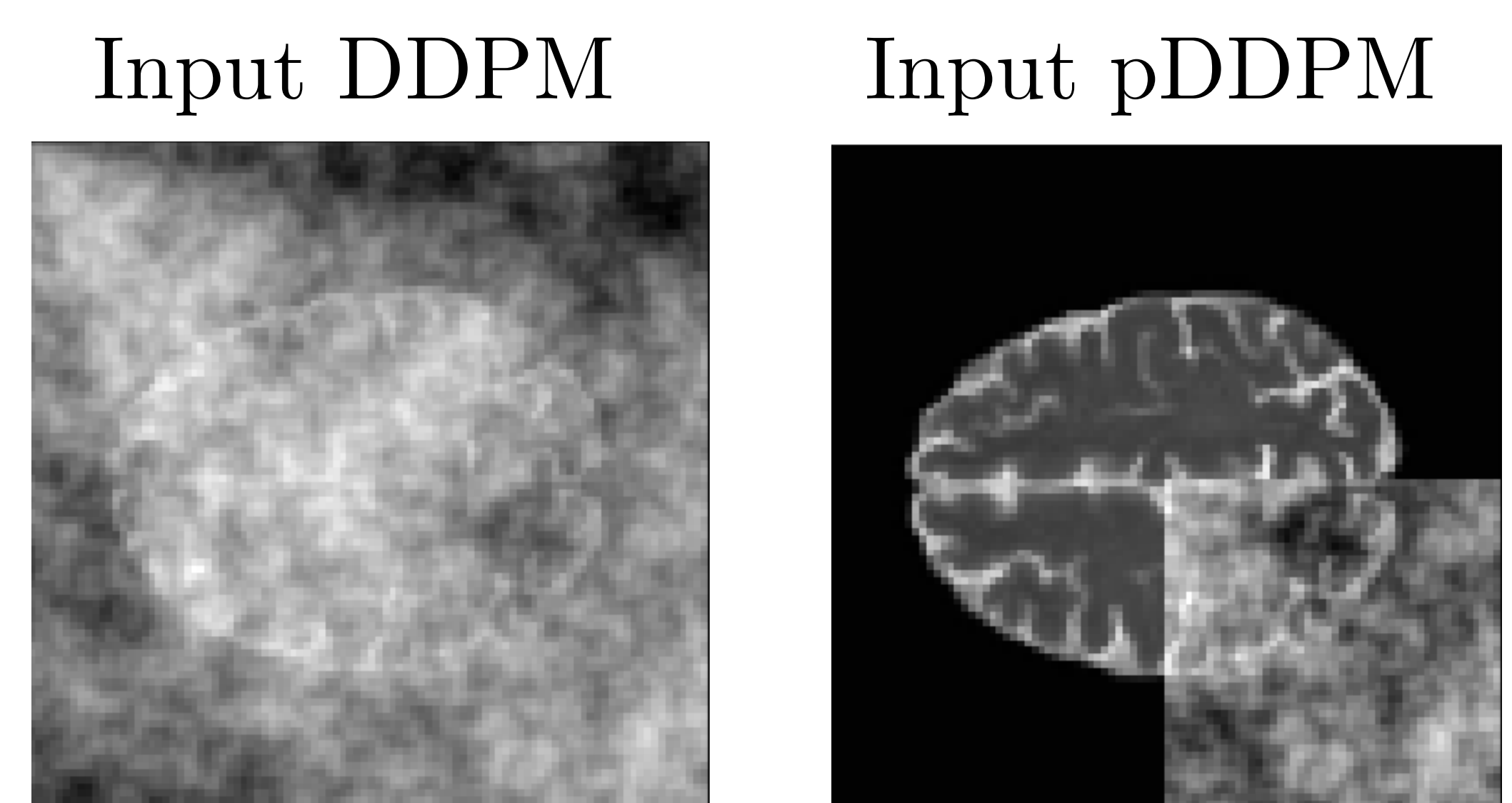
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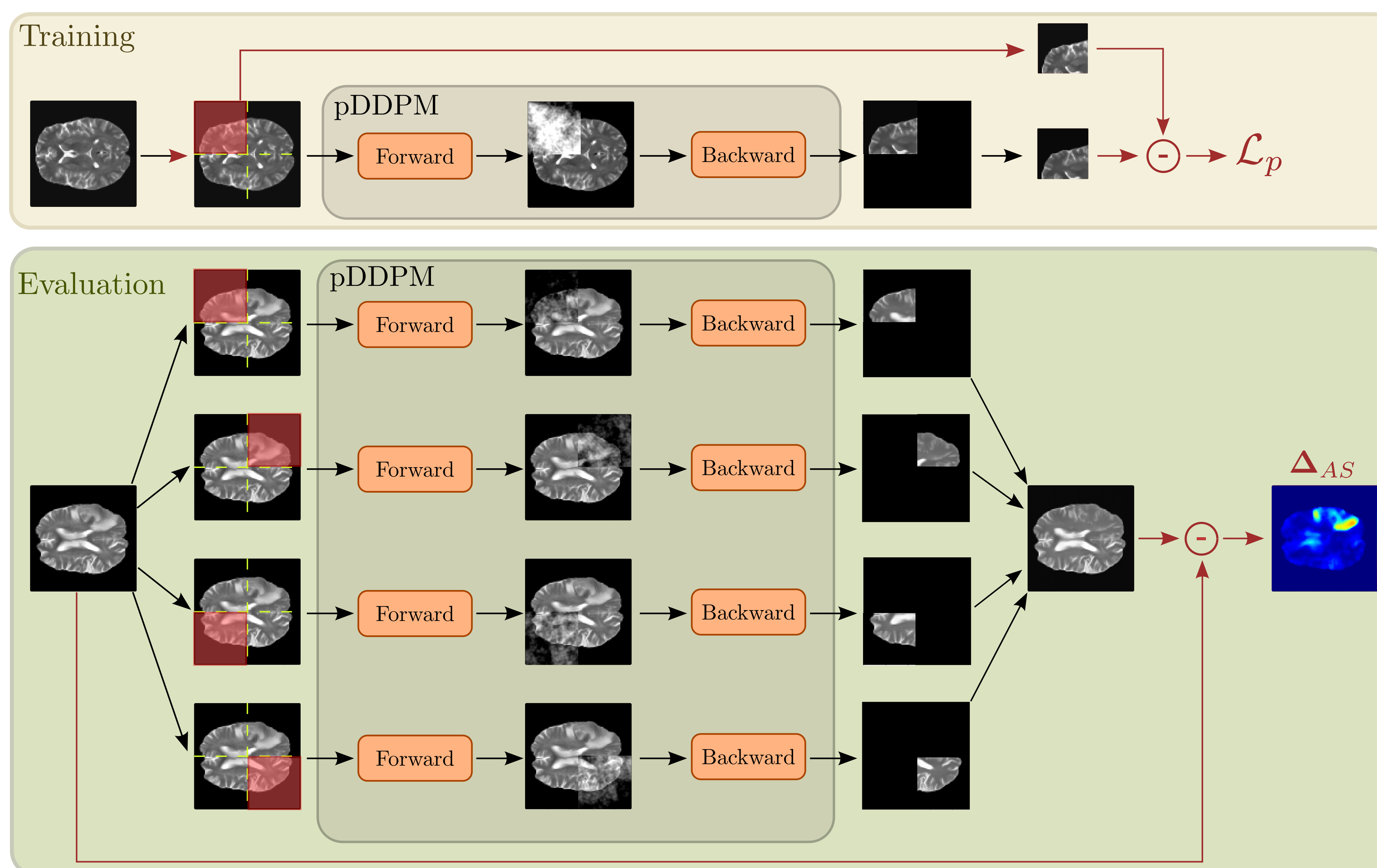
## Introduction

- Diffusion models are well suited for unsupervised anomaly detection [3].
- However, with increasing noise during the forward process, detailed reconstructions become challenging.
- We propose a patch-based DDPM (pDDPM), where only a part of the input is noised and the patch surroundings provide context during reconstruction.

## Which is easier to denoise?



## Methods



- In our approach, we apply the forward and backward process of DDPMs in a patched fashion.
- During the forward process, i.e., the noising step we add noise to the input image only at a given patch position.
- In the backward process, the partly noised image is fed to the denoising network to estimate the patch reconstruction.
- During evaluation, we slide the noise patch over the image, subsequently perform the diffusion process and stitch the individual patch reconstructions to obtain the full image.

## Results

Table 1: Anomaly segmentation performance. DICE scores are reported in percent.

Model	BraTS21	MSLUB
AE [1]	32.87±1.25	7.10±0.68
VAE [1]	31.11±1.50	6.89±0.09
DAE [2]	37.05±1.42	3.56±0.91
DDPM [3]	40.67±1.21	6.42±1.60
<b>pDDPM</b>	<b>49.00±0.84</b>	<b>10.35±0.69</b>

## Conclusion

- pDDPMs allow to incorporate context information about individual brain structure and appearance when estimating brain anatomy.
- Thereby, pDDPMs outperform both their non-patched counterparts and various baseline methods considering the UAD performance.

## References

- [1] Baur, Christoph et al.: *Autoencoders for unsupervised anomaly segmentation in brain mr images: a comparative study*. Medical Image Analysis, pp. 101952, 2021.
- [2] Kascenas, Antanas et al.: *Denoising autoencoders for unsupervised anomaly detection in brain mri*. MIDL/PMLR, 2022.
- [3] Wyatt, Julian et al.: *Anoddpm: Anomaly detection with denoising diffusion probabilistic models using simplex noise*. CVPR, pp. 650-656, 2022.