Project Proposal Bowen Song - Compressed Sensing with Neural Representation Learning

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Abstract. Neural representation learning has gained popularity rapidly among the machine learning community in recent years. However, the application of neural representation learning on compressed sensing has not been studied extensively yet. In this proposal, we propose to fully investigate the application of neural representation based methods on compressed sensing. We plan to further improve the performance of the neural representation methods on patient-specific CT reconstruction, combine it with other supervised or unsupervised methods and analyze its theoretical properties.

1 Introduction

Implicit neural representation gains a lot of popularity recently and demonstrates superior performance in represent images in the functional space 5. Shen et.al proposed a framework called NeRP for sparse view CT reconstruction 1. Sun et.al proposed a framework called CoIL to solve image inverse problems 2. However, 1 needs a prior image to get high-quality reconstructions. In this proposal there are 3 projects that can studied, based on the ideas of neural representation

2 Project 1 CoIL+NeRP

For sparse view CT reconstruction, 3 demonstrates good performance of a two-step algorithm that inpaints the sinogram first using a GAN, and then use FBP and a super-resolution GAN to reconstruct the final image. This approach can be extended to our case. We can first use CoIL based methods[1] to inpaints a sinogram and then apply NeRP based methods for reconstruction. Experiments will be carried with this approach

3 Project 2 NeRP as a postprocessing tool

Many supervised and unsupervised compressed sensing algorithms utilize the geometry or back-projection algorithm to obtain high-quality reconstructions. 3, 6. In this project, we will investigate whether using NeRP to replace those geometry algorithms will give us a better performance in compressed sensing tasks. On the other hand, since some unsupervised or supervised approaches fail to get the reconstruction close to the ground-true image close in the projection domain, NeRP can also be used as a powerful tool to learn on the residual signal to correct the bias introduced by those algorithms.

4 Project 3 Theoretical study of NeRP

NeRP places some internal regularization on the functional space. The reason that it gives reconstructions with much better quality than other traditional methods is still unclear. It is helpful to analyze the smoothness or constraint of NeRP internally to get a deeper insight. This can be extended to place more constraint in NeRP, such as a sparsity constraint.

References

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