Status Meeting - Application of Graph Learning to inverse problems

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Problem and Goal

> Denoise observations
> Motivation from imaging (computed tomography, cryo-EM)

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Input

$\mathcal{I}$: class of images (where $i \in \mathbb{R}^M$ with M as image dimension.)

Output

$$denoiser : (i + \eta) \mapsto i^* \approx i$$

Where $i \in \mathcal{I}$ and $\eta \sim \mathcal{N}(0, \sigma^2) \in \mathbb{R}$.

Sinogram Denoiser

forward : radon transform

backward : filter back projection

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Sinogram Denoiser

$denoiser_{sino} : forward(i) + \eta \mapsto forward(i)^* \approx forward(i)$

$denoiser = backward(denoiser_{sino}(forward(i) + \eta))$

Where $i \in \mathcal{I}$ and $\eta \sim \mathcal{N}(0, \sigma^2) \in \mathbb{R}$.

GAT Denoiser

GAT - Graph Attention Network

$GAT(A, \text{GAT args}) :\rightarrow$ fixed angles $\rightarrow$ k-nn circle graph

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$$GAT(A, \text{GAT args}) :\rightarrow \text{fixed angles} \rightarrow \text{k-nn circle graph}$$

GAT Loss

$$\mathcal{L}_1 = ||forward(i) - denoiser_{sino}(forward(i) + \eta)||_2$$

$$\mathcal{L}_2 = ||i - backward(denoiser_{sino}(forward(i) + \eta))||_2$$

Where $i \in \mathcal{I}$ and $\eta \sim \mathcal{N}(0, \sigma^2) \in \mathbb{R}$.

GAT Denoiser - 2

GAT - Graph Attention Network

$$GAT(A, \text{GAT args}) :\rightarrow \text{fixed angles} \rightarrow \text{k-nn circle graph}$$

Input Graph

> Learning does work with circle graph
> Learning does not work with random (Erdős–Rényi) graph
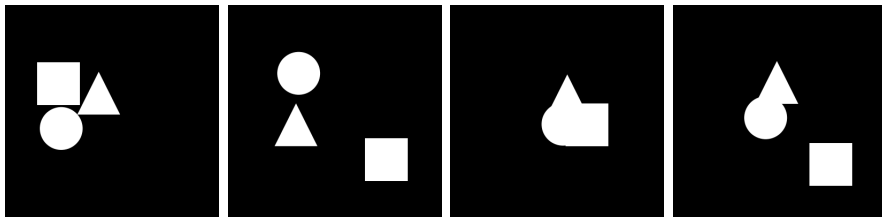
Toy images

> Uniformly places shapes on image

Figure: Example Toy images

Current Results

- Results with $\mathcal{L}_1$ available.
- Results with $\mathcal{L}_2$ calculating.
- If time, add some comparison with BM3d
- Currently, network trained with fixed SNR.
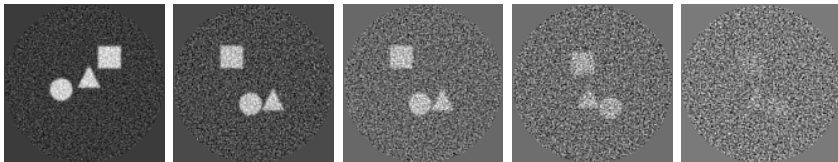
Current Results - 2

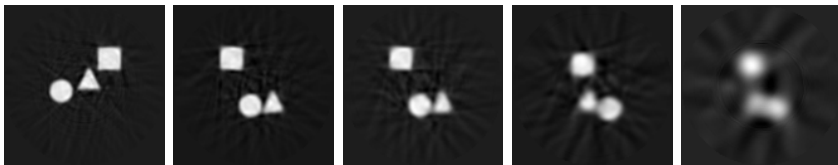Figure: Noisy fbp with snr [5, 0, -5, -10 ,-20]

Figure: Denoised fbp with snr [5, 0, -5, -10 ,-20]

Some wandb reports

> K-nn:
  https://wandb.ai/cedric-mendelin/autogeneratedtoyimagesscicoreknn/
  reports/Auto-toyimages-knn--VmlldzoxOTA4MjM2

> 3d-Model: https://wandb.ai/cedric-mendelin/bunniesscicore?
  workspace=user-cedric-mendelin

> GAT parameters:
  https://wandb.ai/cedric-mendelin/toy-images-input-size/reports/
  Toy-Images-Overview-Advanced-GAT--VmlldzoxNzczNDc0

> Denoiser can adopt to slight changes

Final steps

> Gather final results
> Write report
> Comparing with BM3D