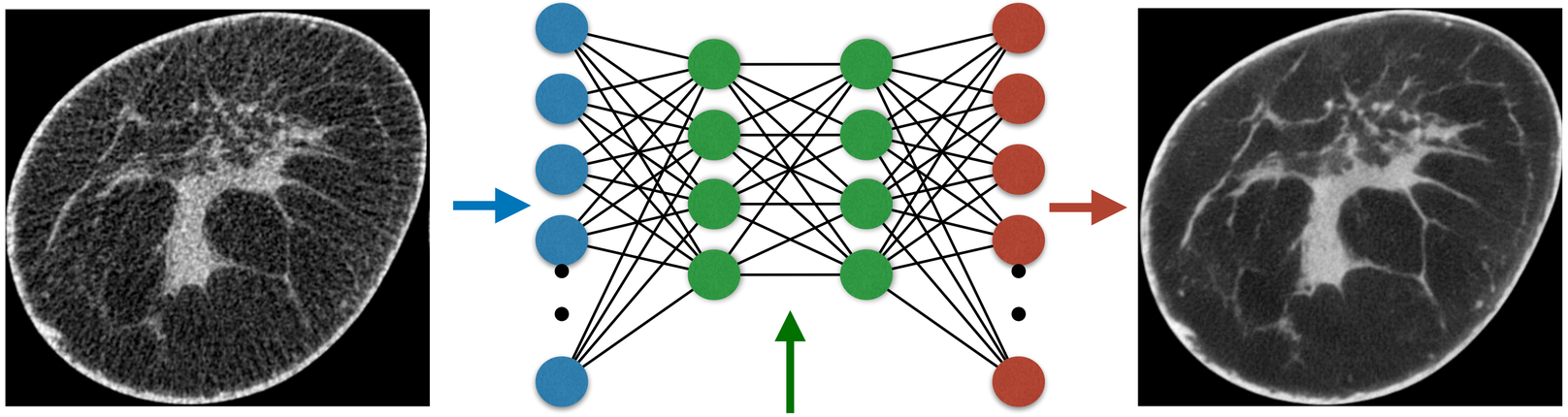
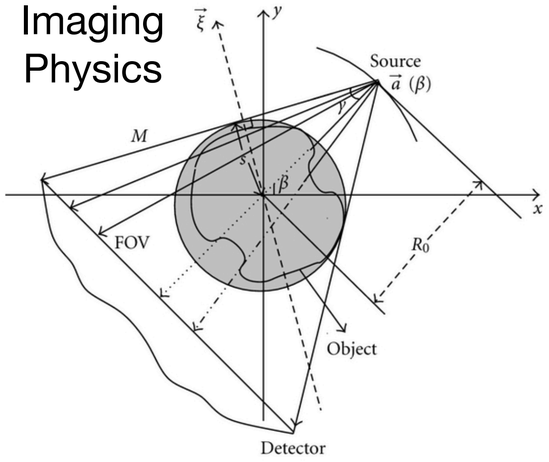
Speed Talk: Learned Reconstruction in Medical Imaging



Imaging Physics



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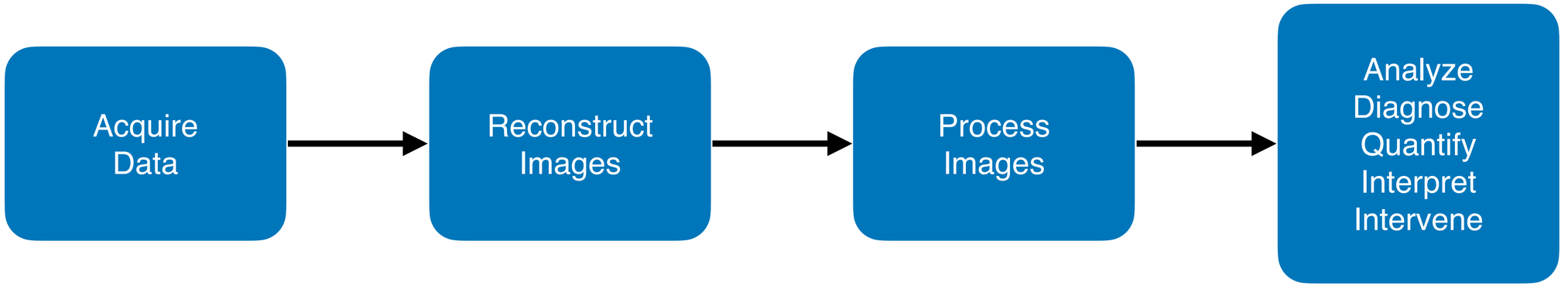
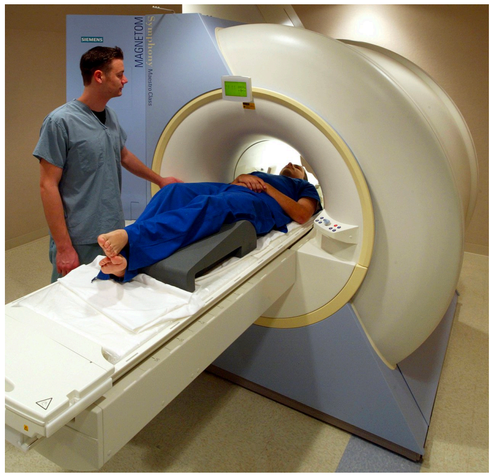
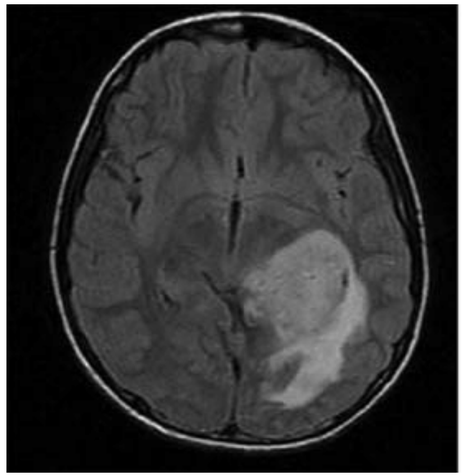
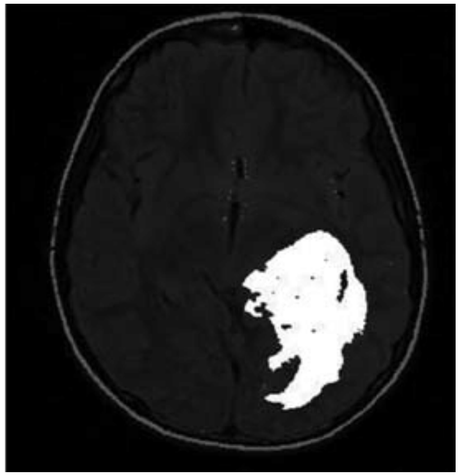
Opportunities for AI/ML in the Medical Imaging Pipeline



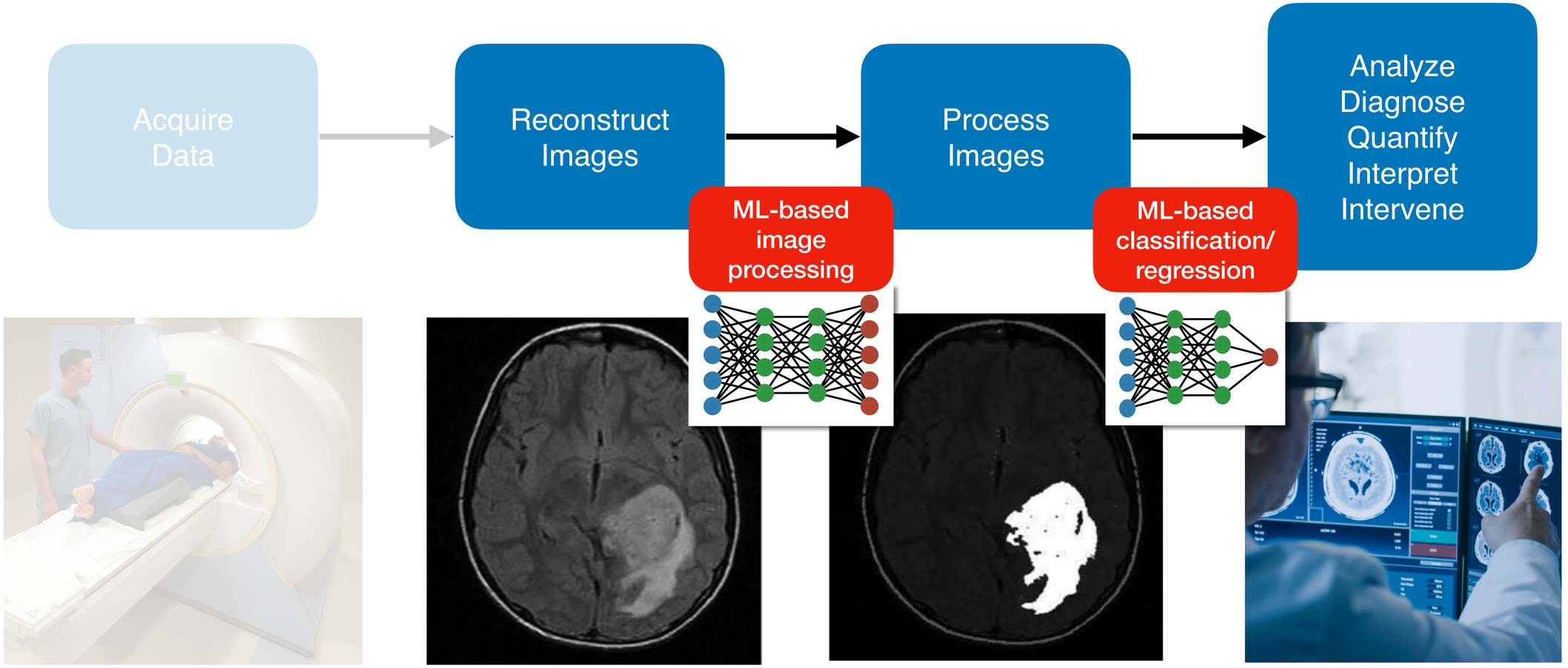




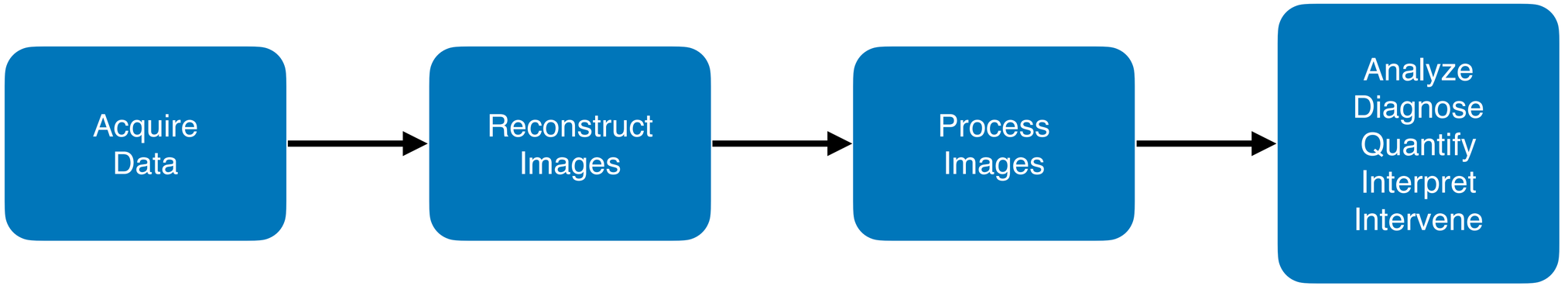


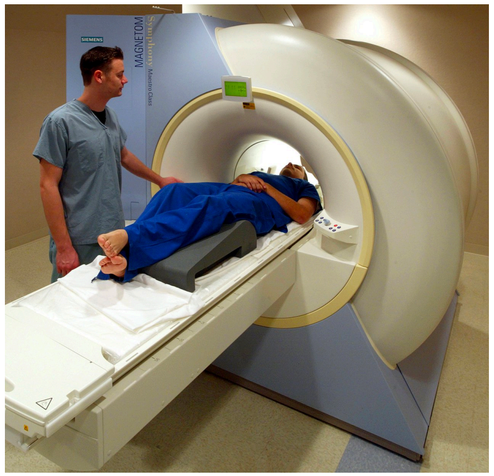
Opportunities for AI/ML in the Medical Imaging Pipeline

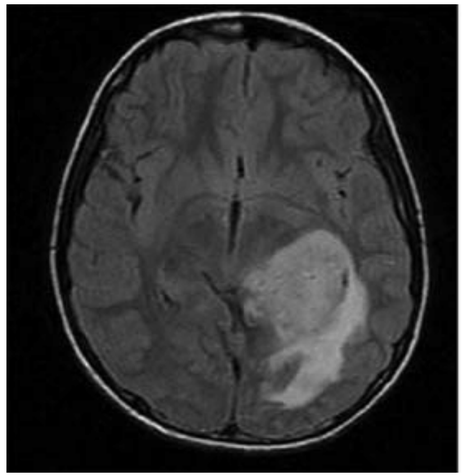
Most obvious place for machine learning is in post-processing

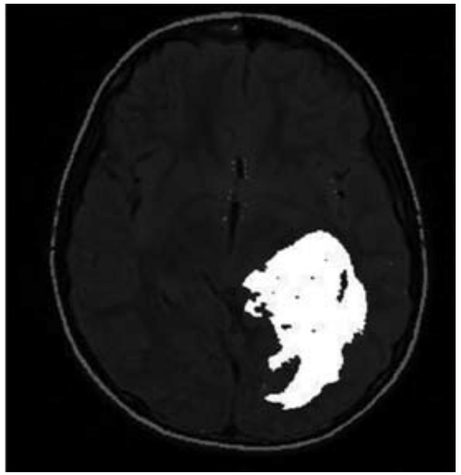


Opportunities for AI/ML in the Medical Imaging Pipeline



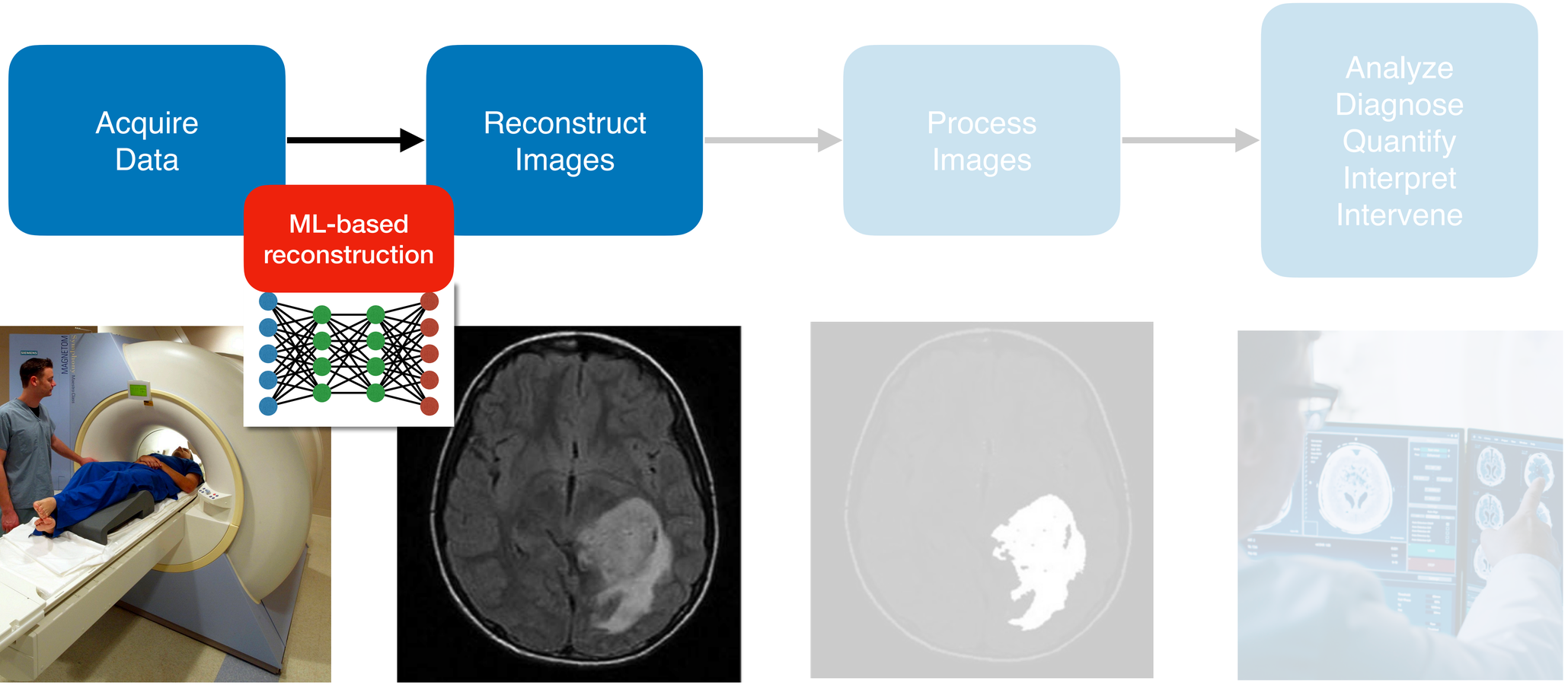






Opportunities for AI/ML in the Medical Imaging Pipeline

(initially) less obvious place: image reconstruction



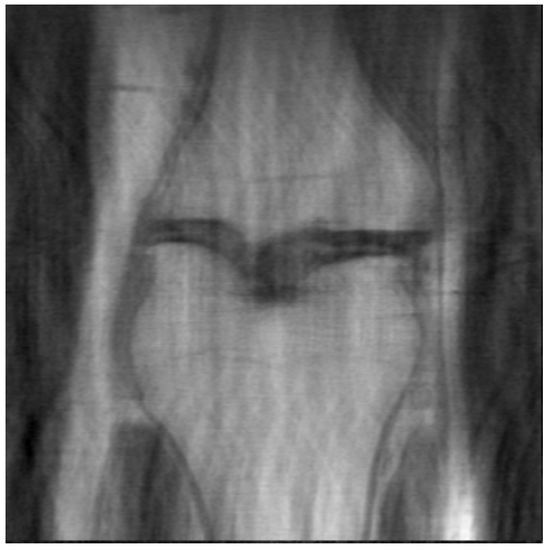
Why bother with AI/ML in recon?

In Magnetic Resonance Imaging (MRI)…

- Physical limits to how fast data can be acquired
- Acquiring “fully sampled” data time-consuming
- Taking fewer measurements gives noise/artifacts

“fully-sampled” knee MRI

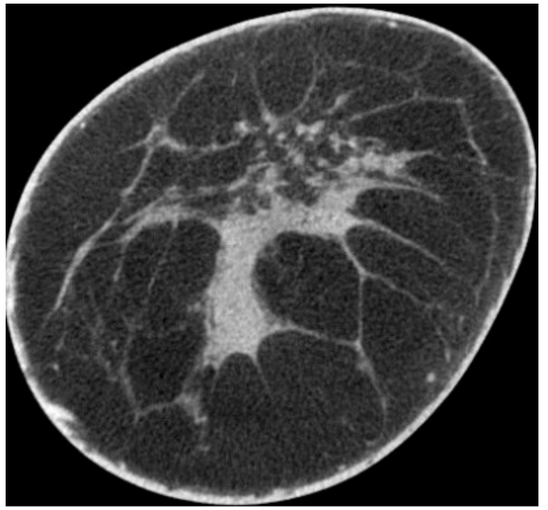
accelerated knee MRI



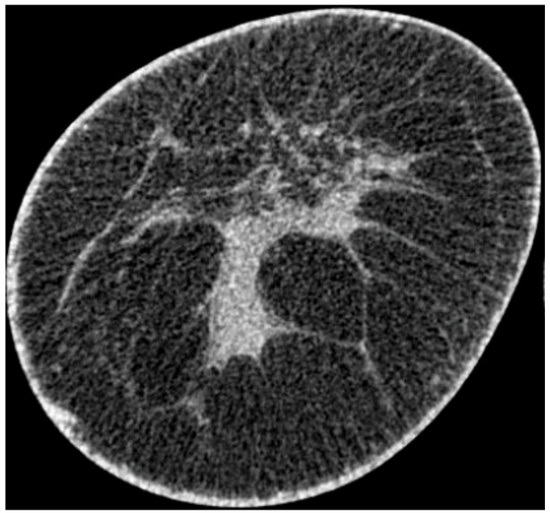
In X-ray Computed Tomography (CT)…

- Uses ionizing radiation — potentially harmful to patient
- Can reduce dose but at the expense of noise/artifacts

standard dose
breast CT scan

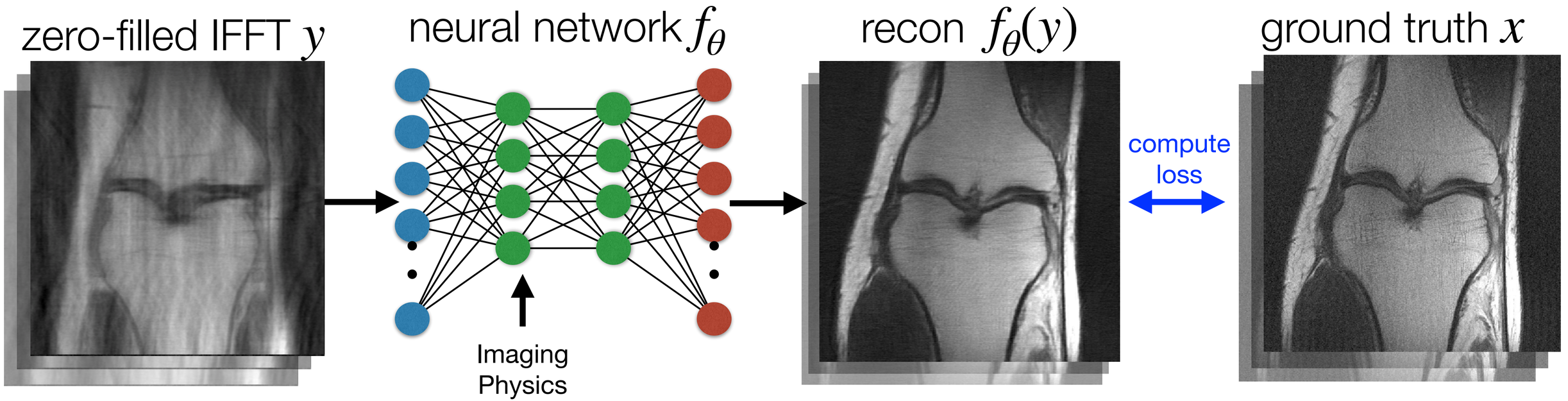


reduced dose
breast CT scan



Example: Learned recon of accelerated MRI acquisitions

- Ex: Train neural network to de-artifact accelerated MRI acquisitions



- Minimize loss over training image/measurement pairs:

$$\min_{\theta} \frac{1}{n} \sum_{i=1}^{n} \text{loss}(f_\theta(y_i), x_i)$$

network parameters

zero-filled IFFT images

"ground truth" images

Issue: Hallucination of clinically relevant details

ground truth

neural network recon

4-fold undersampled MRI

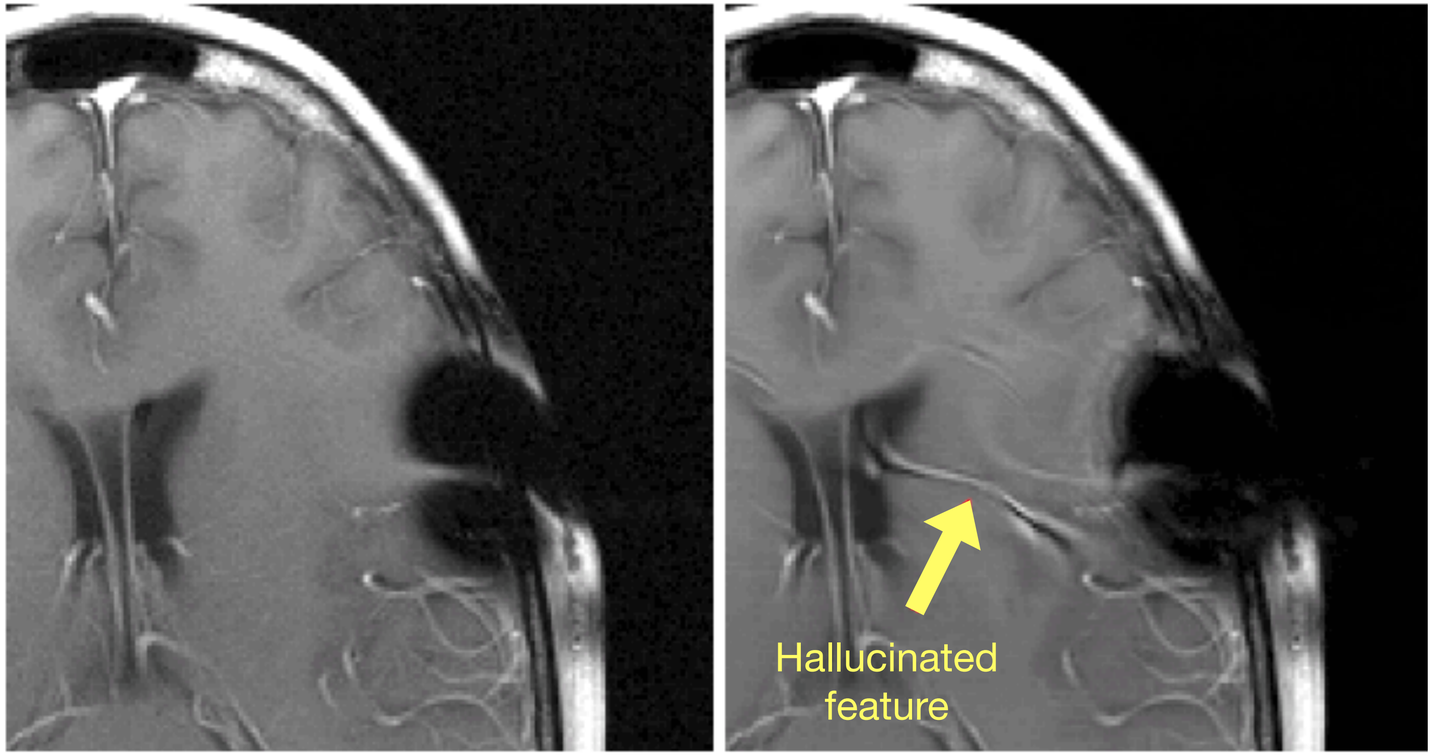


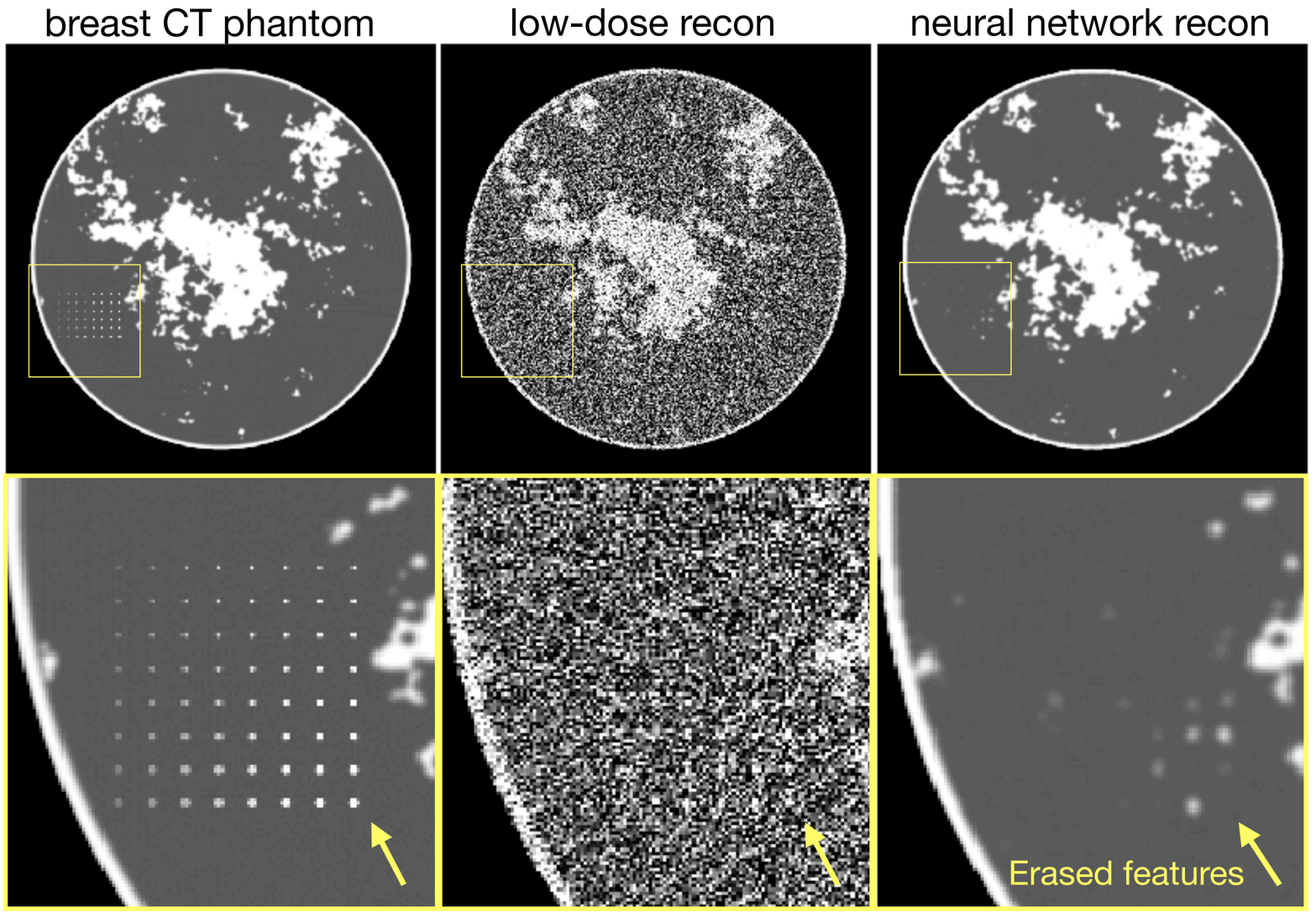
figure from:

2306 IEEE TRANSACTIONS ON MEDICAL IMAGING, VOL. 40, NO. 9, SEPTEMBER 2021

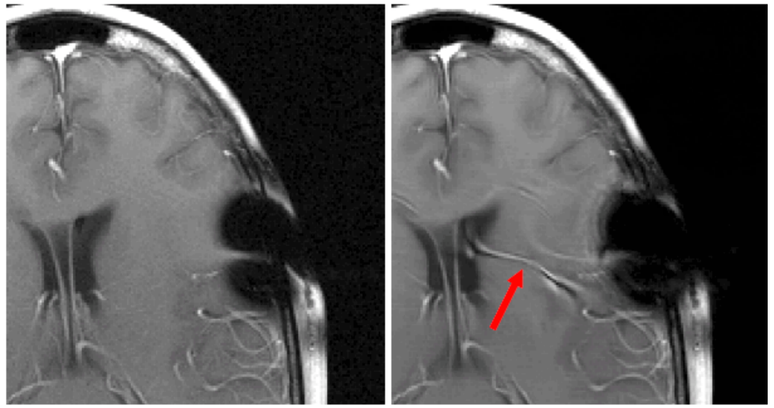
Results of the 2020 fastMRI Challenge for Machine Learning MR Image Reconstruction

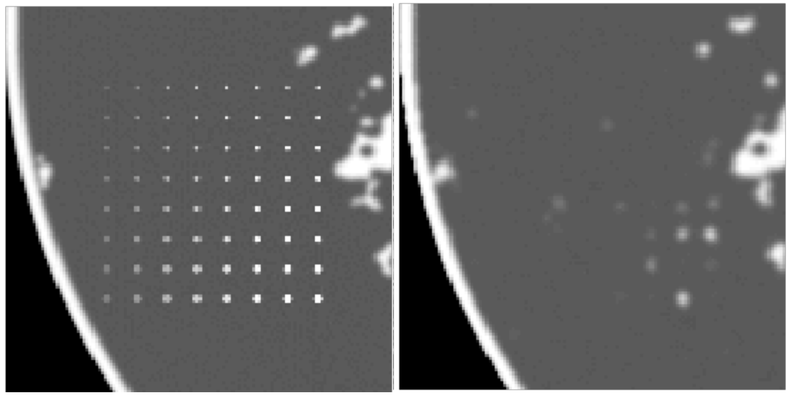
Issue: Erasure of clinically relevant details

breast CT
simulation study



O., Sidky, Resier, & Pan, SPIE Med Img 2021





Key Problem: How do we ensure learning approaches to image reconstruction yield faithful, reliable results, with task-specific improvements?

My focus:

1. NN architecture design
2. Loss function design
3. Deep learning theory

Thanks!
Questions?

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