Data augmentation for deep learning based accelerated MRI reconstruction with limited data

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Challenges of DL in medical imaging

- Deep learning models are extremely data-hungry

JFT-300M

- Data collection for medical tasks is challenging:

  1. **Cost**: expensive instruments, time of experts

  2. **Time**: long acquisition time (MRI: 60 mins / scan)

  3. **Health**: ionizing radiation exposure (CT, PET)

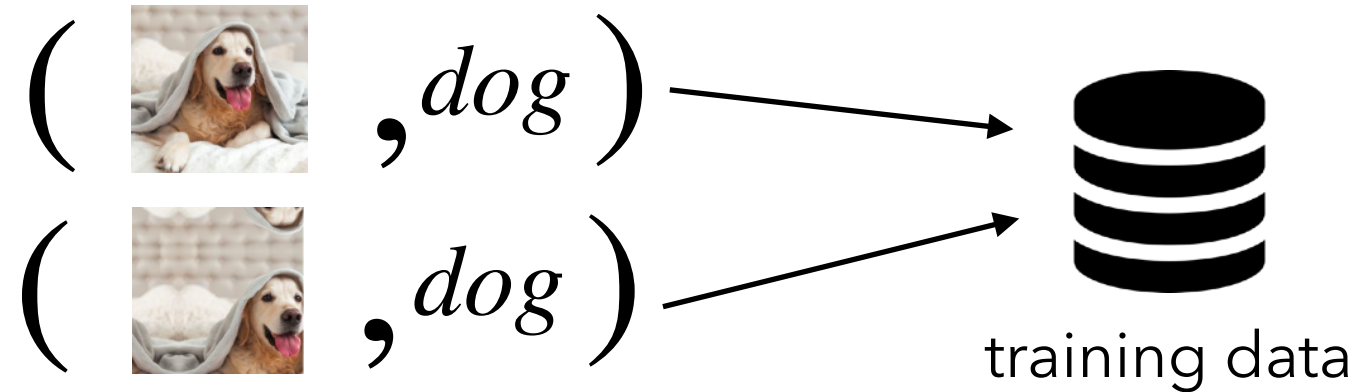 4. **Data curation**: patient confidentiality, data compatibility

How do we train with limited data?
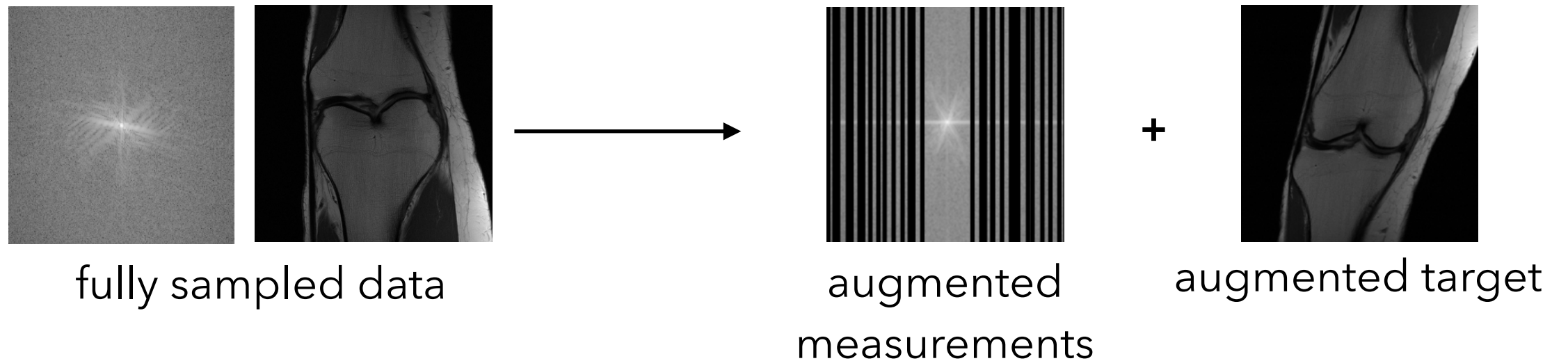
MRI reconstruction

$\mathscr{F}$-transform + undersampling + noise
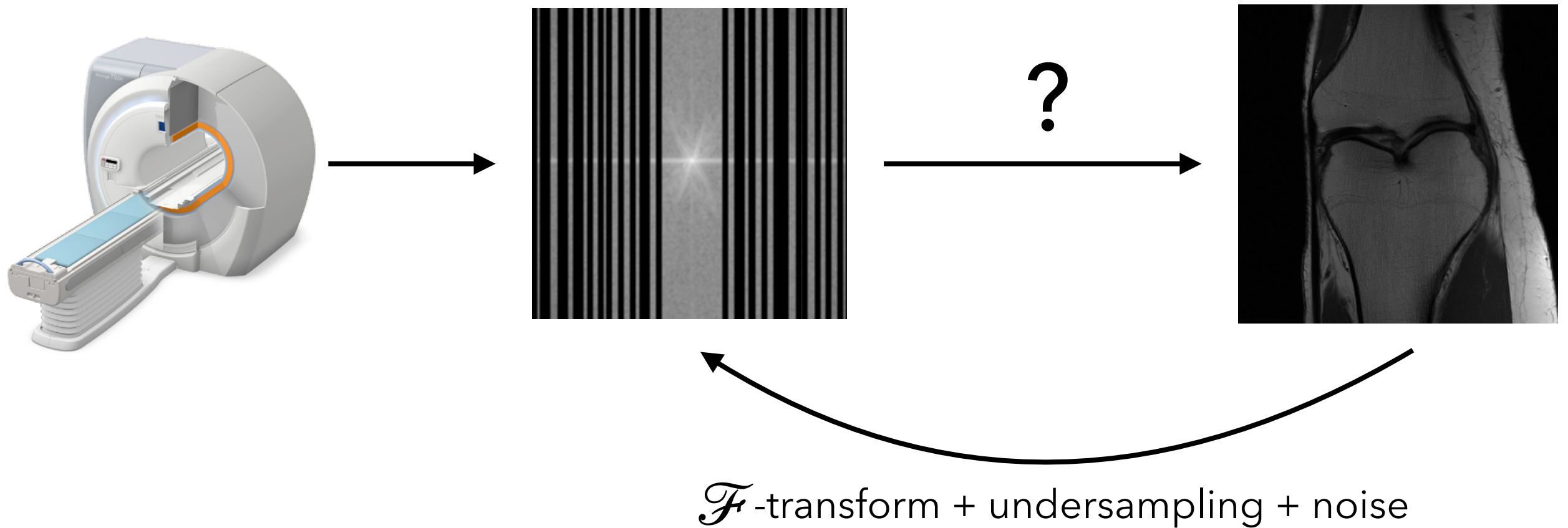
Data augmentation in classification: straightforward

training data

Data augmentation in MRI reconstruction: non-trivial

1. Output is **not** invariant to transformations

fully sampled data

augmented measurements

+

augmented target

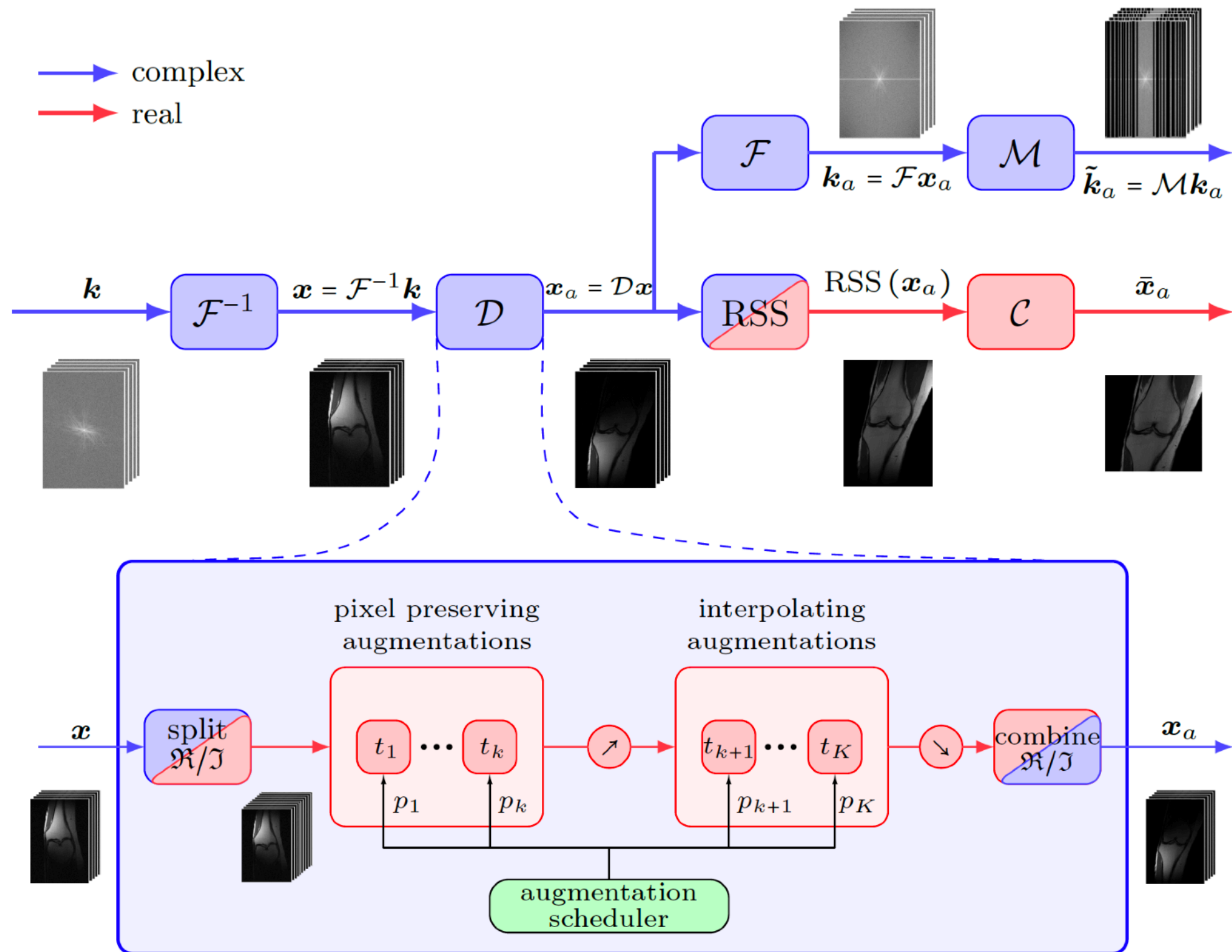2. Distribution shift due to noise

$$x = x^* + n \longrightarrow x_{aug.} = \mathscr{D}x^* + \mathscr{D}n$$
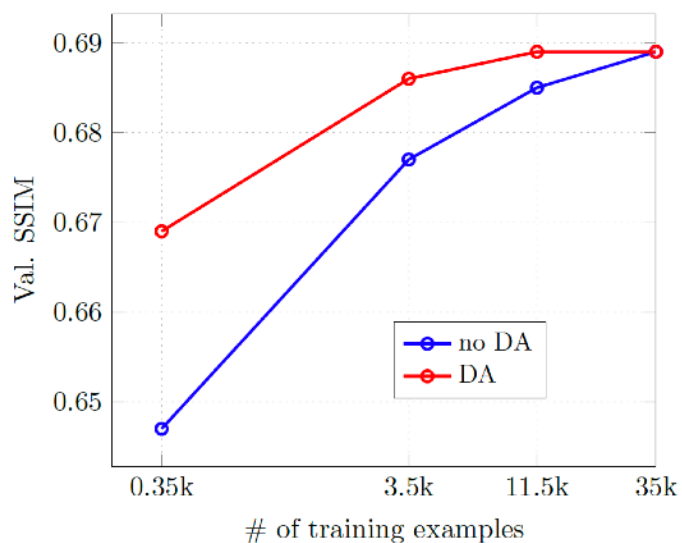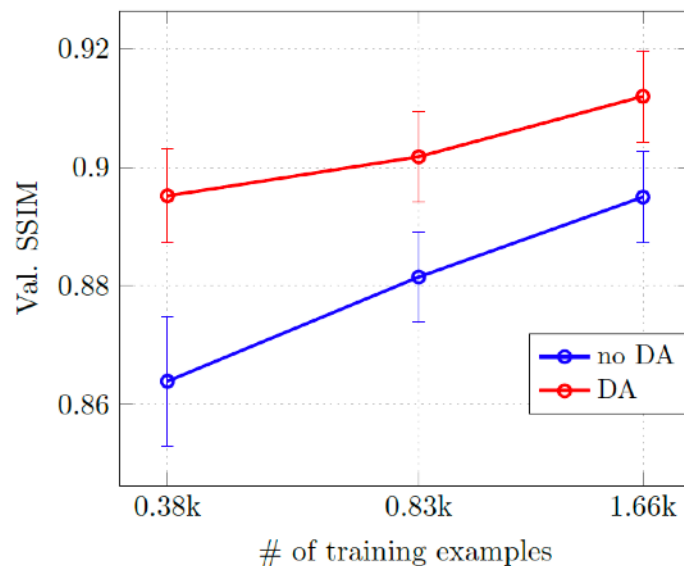
augmented signal

augmented noise!
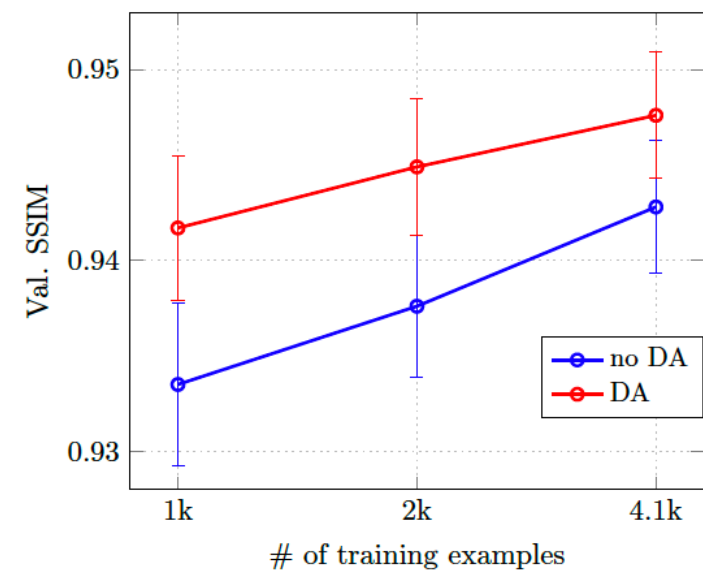
MRAugment pipeline

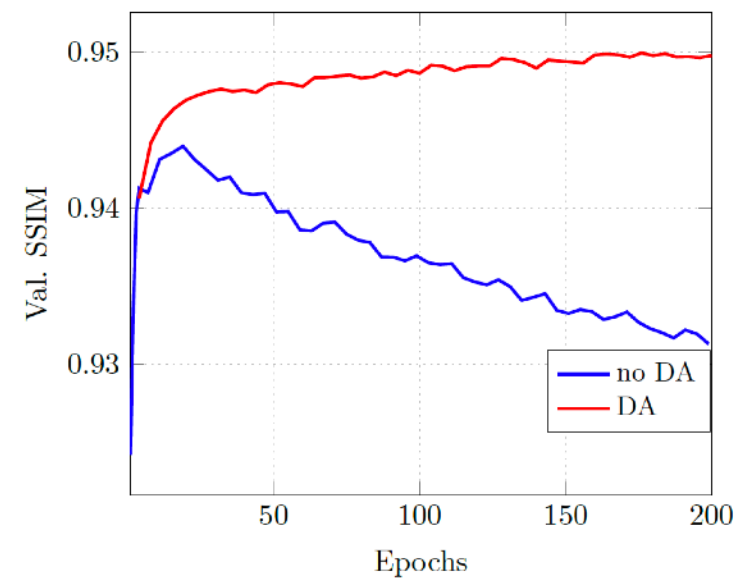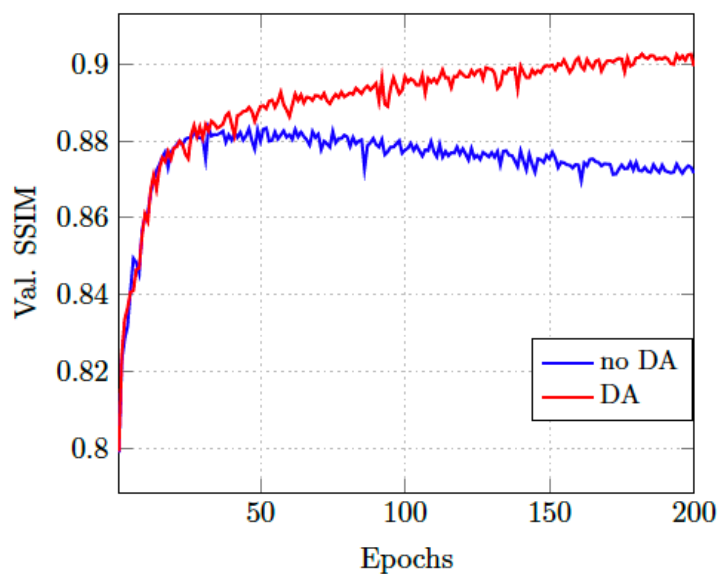# Results on various datasets

fastMRI knees

single-coil

multi-coil

Stanford 2D FSE

Stanford 3D FSE knees
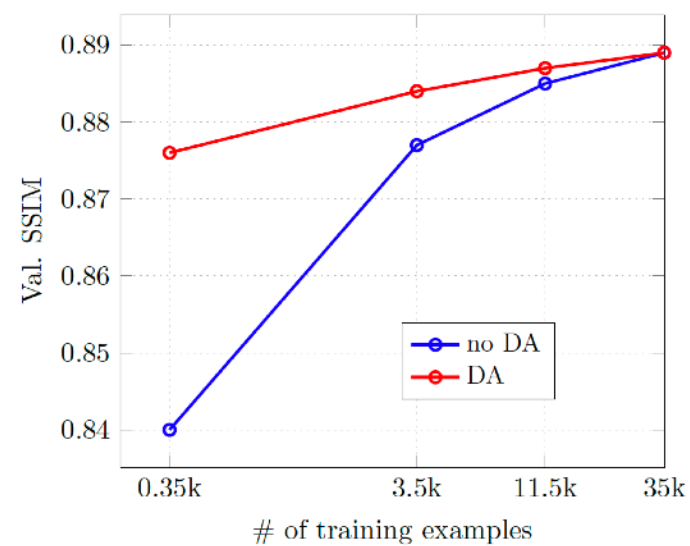
Robustness experiments

Unseen scanners

2% train	no DA	DA
$3T \rightarrow 3T$	0.8646	**0.9049**
$3T \rightarrow 1.5T$	0.8241	**0.8551**
$1.5T \rightarrow 3T$	0.8174	**0.8913**

100% train	no DA	DA
$3T \rightarrow 3T$	0.9177	**0.9185**
$3T \rightarrow 1.5T$	0.8686	**0.8690**
$1.5T \rightarrow 3T$	0.9043	**0.9062**

Unseen anatomies
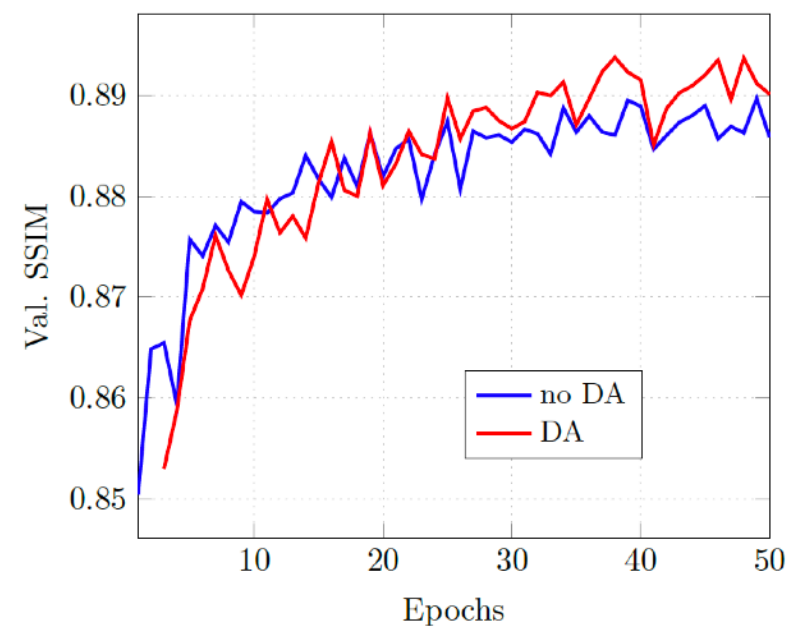
knee ⟶ brain

Hallucinations

MRAugment