



# ML4CMH2024

AAAI Workshop  
February 26th, 2024  
Vancouver, Canada



Contact



PMC Dataset

## PMC: Paired Multi-Contrast MRI Dataset at 1.5T and 3T for Supervised Image2Image Translation

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# Magnetic resonance imaging (MRI) serves as a widely used modality in brain studies:

- Provides soft tissue contrast
- Generates highly detailed 3D images
- Can be acquired in different contrasts each showing specific tissue characteristics
- Can be acquired at a range of field strengths where the quality increases with field strengths

Many studies focus on supervised learning methods for image-to-image translation within medical imaging and involve MRI:

- From one contrast to another contrast
- From lower to higher field
- From Lower resolution to higher resolution

There is no dataset available which includes paired MR images of the same subjects in multiple contrasts and at both low and high fields



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PMC Dataset

# PMC: Paired Multi-Contrast MRI Dataset at 1.5T and 3T for Supervised Image2Image Translation

In 3D	1.5T	3T
<b>Number of Subjects (F)/ images</b>	181 (94)	181 (94)
<b>Contrasts</b>	T1, T2, PD	T1, T2, PD

Pre-processed and ready to use dataset

In 2D	1.5T	3T
<b>Number of images</b>	6576	6576
<b>Contrasts</b>	T1, T2, PD	T1, T2, PD

- We also, provide a split version:  
The training set, the validation set, and the test set, with an as-close-as-possible ratio of 80% - 10% - 10% (5268, 648, and 660 for the training, validation, and test sets, respectively.)
- No image from the same subject (including its augmentations) is distributed across different subsets.



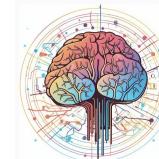
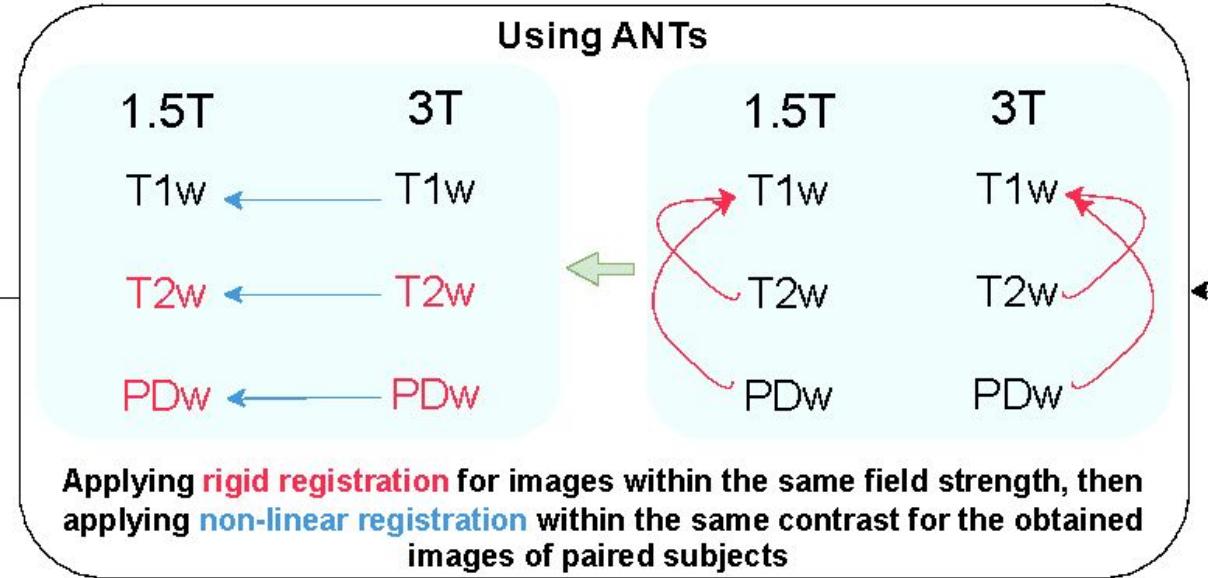
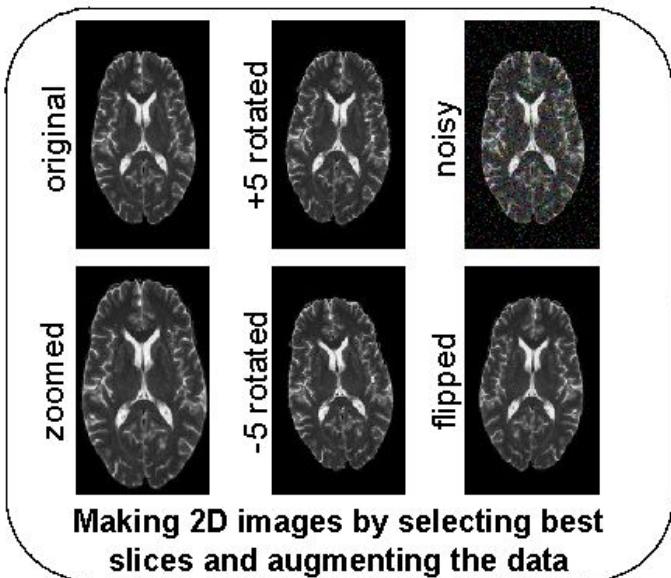
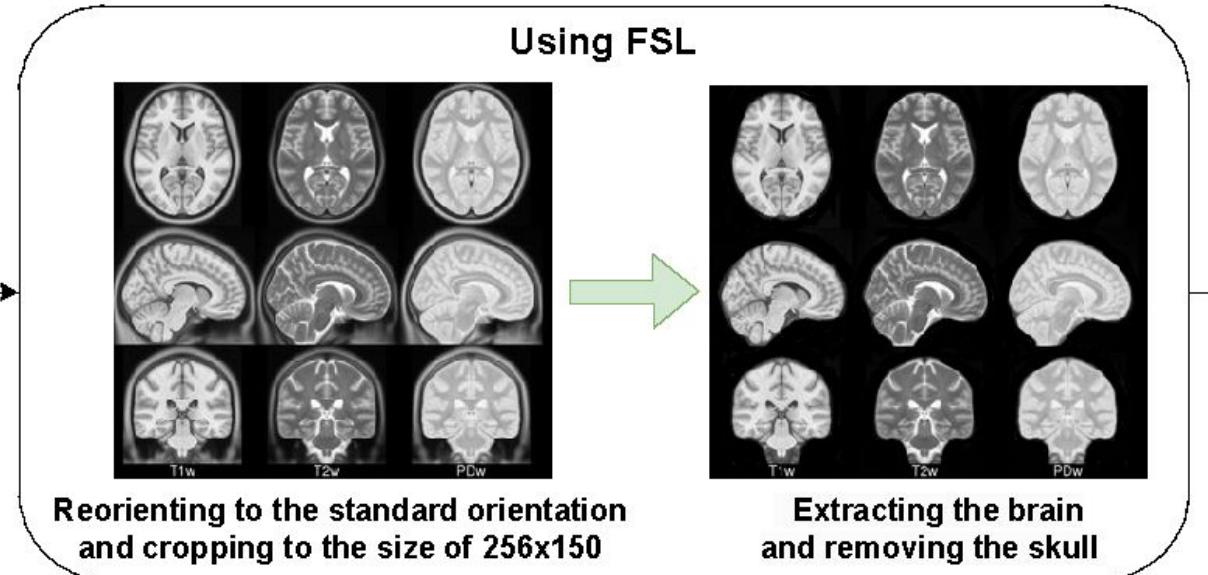
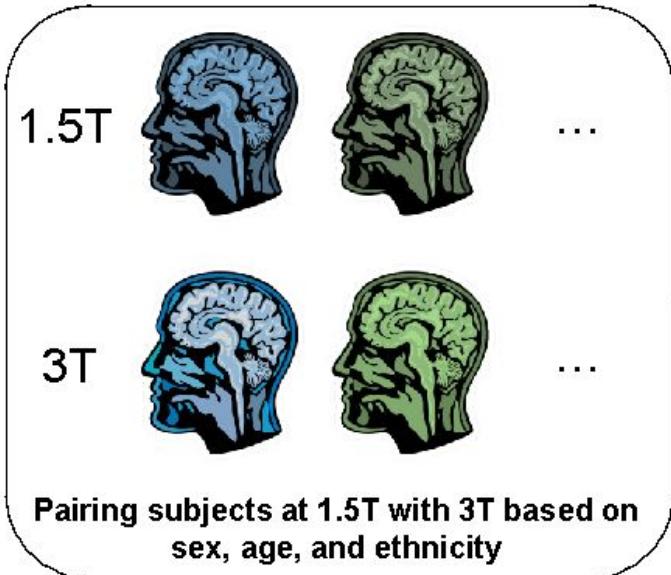
# Data Synthesis Pipeline

- **IXI Dataset** (<https://brain-development.org/ixi-dataset/>)

<b>3 contrasts for each subject at 1.5T</b>
<b>3 contrasts for each subject at 3T</b>
<b>Subjects at 1.5T and 3T are not the same</b>

<b>Number of Subjects (F)</b>	1.5T 181 (94)	3T 181 (94)
<b>Contrasts</b>	T1, T2, PD	T1, T2, PD

- **FMRIB Software Library (FSL) software**  
(<https://fsl.fmrib.ox.ac.uk/fsl/fslwiki/FSL>)
- **Advanced Normalization Tools (ANTs)**  
(<https://github.com/ANTsX/ANTs>)

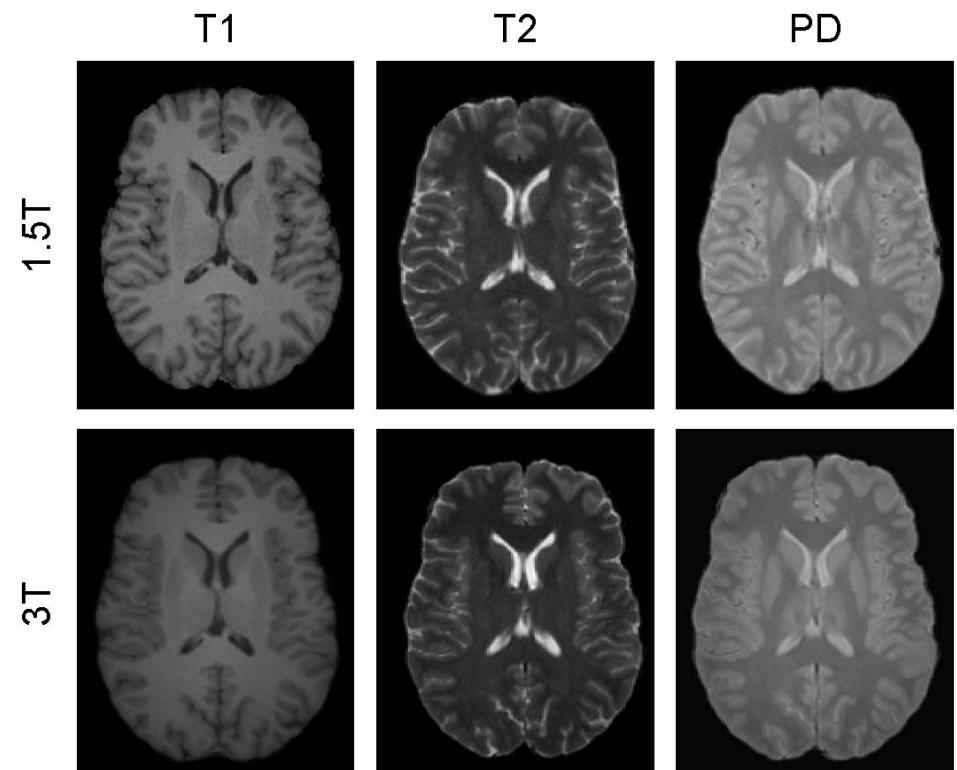


# Data Evaluation

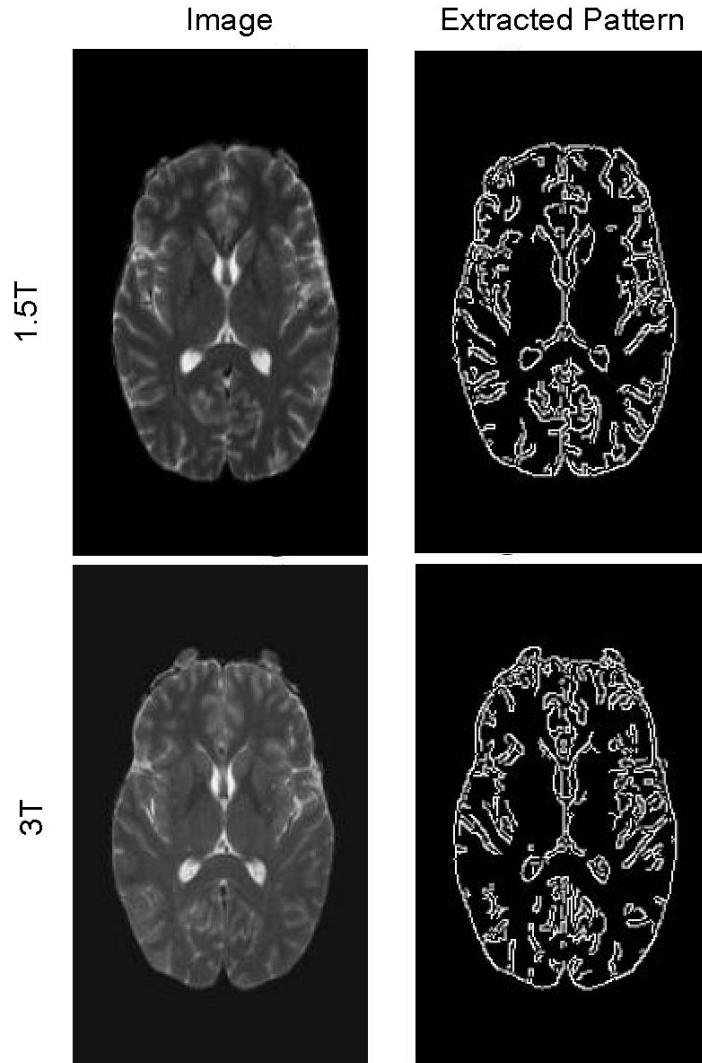
**Table 1**

Synthesized MR images at 3T compared with the reference images at 1.5T evaluated using MSE, PSNR, CORR, and MI metrics (The directions of vertical arrows indicate higher image quality. Results are reported as the mean $\pm$ standard deviation).

Contrast	MSE $\downarrow$	PSNR $\uparrow$	CORR $\uparrow$	MI $\uparrow$
T1	0.014 $\pm$ 0.006	20.3 $\pm$ 1.02	0.97 $\pm$ 0.005	0.88 $\pm$ 0.035
T2	0.015 $\pm$ 0.006	21.3 $\pm$ 1.77	0.90 $\pm$ 0.020	0.77 $\pm$ 0.032
PD	0.012 $\pm$ 0.004	20.5 $\pm$ 1.57	0.96 $\pm$ 0.008	0.80 $\pm$ 0.034



# Data Evaluation



**Table 2**

Patterns extracted from synthesized MR images at 3T compared with the ones extracted from reference images at 1.5T evaluated using MSE and SSIM metrics (The directions of vertical arrows indicate higher image qualities. Results are reported as the mean $\pm$ standard deviation).

Contrast	MSE $\downarrow$	SSIM $\uparrow$
T1	0.12 $\pm$ 0.012	0.62 $\pm$ 0.033
T2	0.11 $\pm$ 0.033	0.60 $\pm$ 0.037
PD	0.12 $\pm$ 0.013	0.60 $\pm$ 0.036



# Data Evaluation

**Table 3**

Subbands of synthesized MR images at 3T compared with the reference images at 1.5T evaluated using MSE and SSIM metrics (The directions of vertical arrows indicate higher image qualities. Results are reported as the mean±standard deviation).

Contrast	Metric	Subband 1	Subband 2	Subband 3
T1	MSE↓	0.005±0.004	0.01±0.010	0.009±0.010
	SSIM↑	0.74±0.028	0.70±0.032	0.62±0.033
T2	MSE↓	0.005±0.003	0.007±0.006	0.007±0.007
	SSIM↑	0.70±0.034	0.66±0.034	0.62±0.037
PD	MSE↓	0.004±0.004	0.008±0.009	0.008±0.009
	SSIM↑	0.74±0.035	0.70±0.037	0.65±0.037

Image Subband1 Subband2 Subband3

1.5T

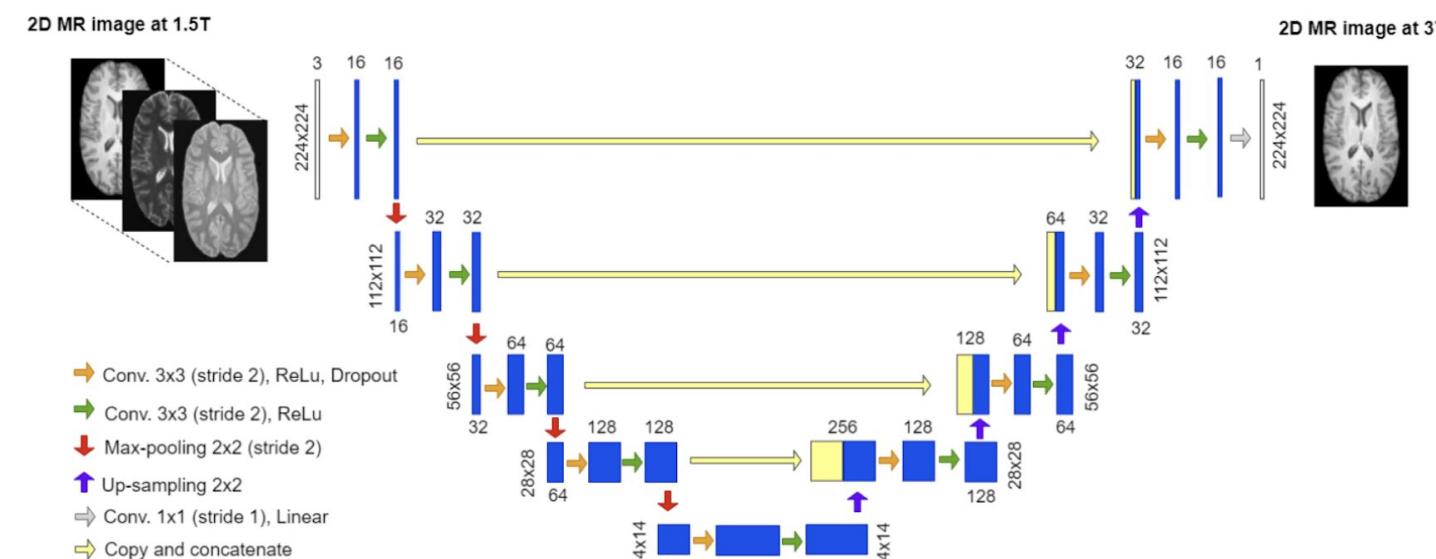
3T



# Data Application

We implemented a U-Net based architecture and applied the data on it, this model was previously proposed in [1] and has shown high performance in the following tasks:

1. Cross-modality MR image translation
2. 3T MR image prediction from the same contrast at 1.5T
3. 3T MR image prediction using 1.5T multi-contrast MR

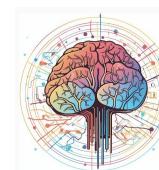


1. F. Bagheri, K. Uludag, MR image prediction at high field strength from mr images taken at low field strength using multi-to-one translation, CMBES Proceedings 45 (2023)

**Table 4**

Quantitative results of generated MR images using U-Net compared with the ground truth images, using PMC dataset (The directions of vertical arrows indicate higher image qualities. Results are reported as the mean $\pm$ standard deviation).

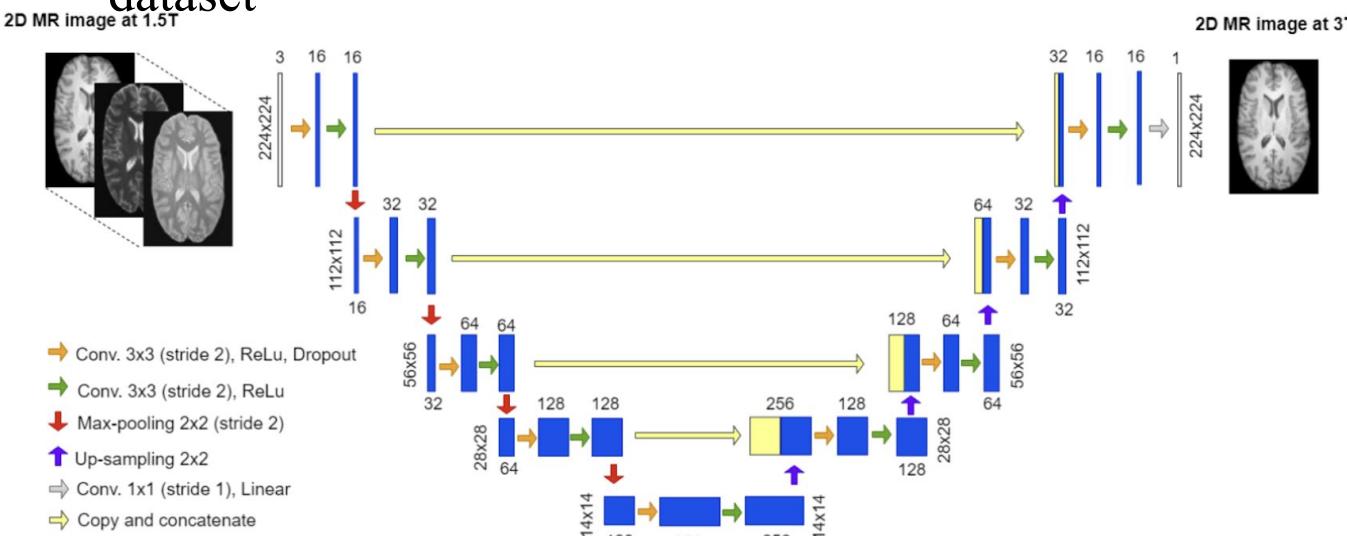
Task	Translation	MSE $\downarrow$	PSNR $\uparrow$
1	1.5T T2 $\rightarrow$ 1.5T T1	0.0022 $\pm$ 0.001	26.97 $\pm$ 1.89
	1.5T T1 $\rightarrow$ 1.5T T2	0.0019 $\pm$ 0.001	27.93 $\pm$ 2.38
2	1.5T T1 $\rightarrow$ 3T T1	0.0028 $\pm$ 0.002	25.83 $\pm$ 1.71
	1.5T T2 $\rightarrow$ 3T T2	0.0046 $\pm$ 0.002	23.78 $\pm$ 1.95
	1.5T PD $\rightarrow$ 3T PD	0.0047 $\pm$ 0.002	23.55 $\pm$ 1.76
3	1.5T T1, T2, PD $\rightarrow$ 3T T1	0.0033 $\pm$ 0.002	25.16 $\pm$ 1.87
	1.5T T1, T2, PD $\rightarrow$ 3T T2	0.0043 $\pm$ 0.002	23.97 $\pm$ 1.72
	1.5T T1, T2, PD $\rightarrow$ 3T PD	0.0047 $\pm$ 0.002	23.49 $\pm$ 1.73



# Data Application

We utilized the latest release of the Open Access Series of Imaging Studies (OASIS), known as OASIS3 dataset (<https://www.oasis-brains.org/#data>)

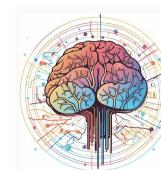
- Trained and tested the model on OASIS3 Dataset
- Pre-trained on PMC dataset and tested on OASIS3 dataset



**Table 5**

Quantitative results on OASIS3 dataset, using U-Net model trained by OASIS3 vs. PMC dataset (The directions of vertical arrows indicate higher image qualities. Results are reported as the mean $\pm$ standard deviation).

Trained on	Translation	MSE $\downarrow$	PSNR $\uparrow$
OASIS3	1.5T T1 $\rightarrow$ 3T T1	0.007 $\pm$ 0.002	21.73 $\pm$ 1.47
	1.5T T2 $\rightarrow$ 3T T2	0.009 $\pm$ 0.003	20.93 $\pm$ 1.33
PMC	1.5T T1 $\rightarrow$ 3T T1	0.011 $\pm$ 0.004	19.73 $\pm$ 1.31
	1.5T T2 $\rightarrow$ 3T T2	0.007 $\pm$ 0.002	21.3 $\pm$ 1.44



# Conclusion

- We proposed a dataset including paired MR images for the same pseudo-subjects at 1.5T and 3T in T1, T2, and PD contrasts
- The dataset is ready-to-use and fully pre-processed, and available in both 2D and 3D
- Can be used in cross-modality, cross-field strength, and super-resolution tasks
- Future studies can extend the dataset to real-world scenarios (including patients' data), more contrasts, and other sets of field strengths (e.g., 3T-7T)





# Questions?

