

## Introduction

- WHO** : Degradation of joints in knee causing **loss of cartilage, joint space narrowing, osteophytes**, and sometimes **joint inflammation**, resulting in **pain and decreased function**<sup>[1]</sup>. Prevalence [2024]: **364.58 M** <sup>[2]</sup>

### Classification of KOA

- Key diagnostic modalities: **X-ray and MRI**
- Grading systems: X-rays: K-L <sup>[4]</sup>, Ahlbäck<sup>[5]</sup>,
- MRI: WORMS<sup>[6]</sup>, MOAKS<sup>[7]</sup>,
- Challenges: **Overlap between KOA stages, and progression heterogeneity**

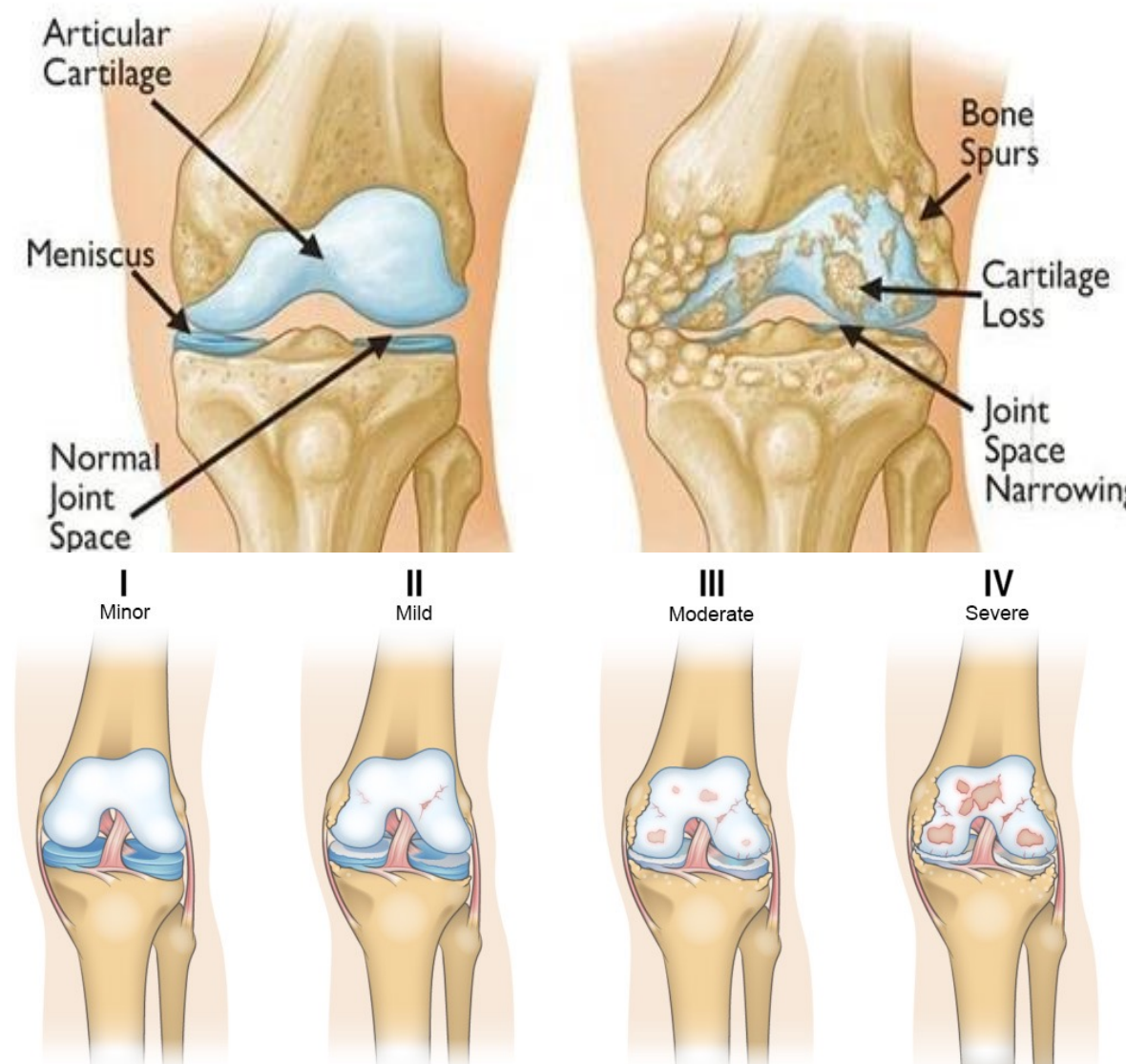
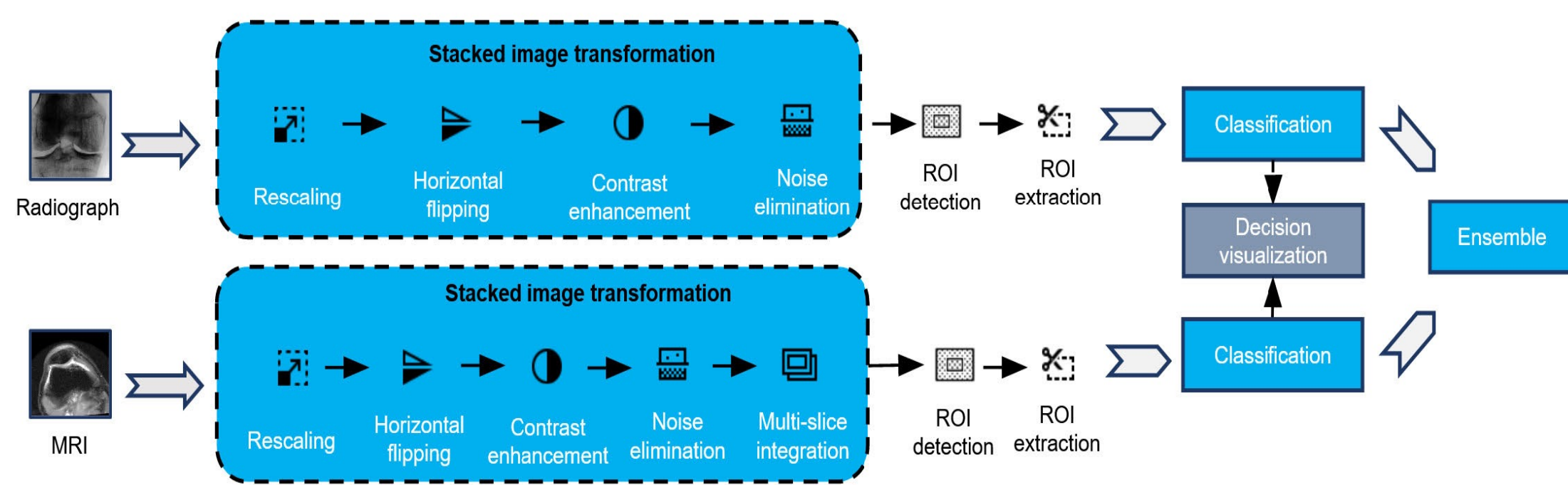
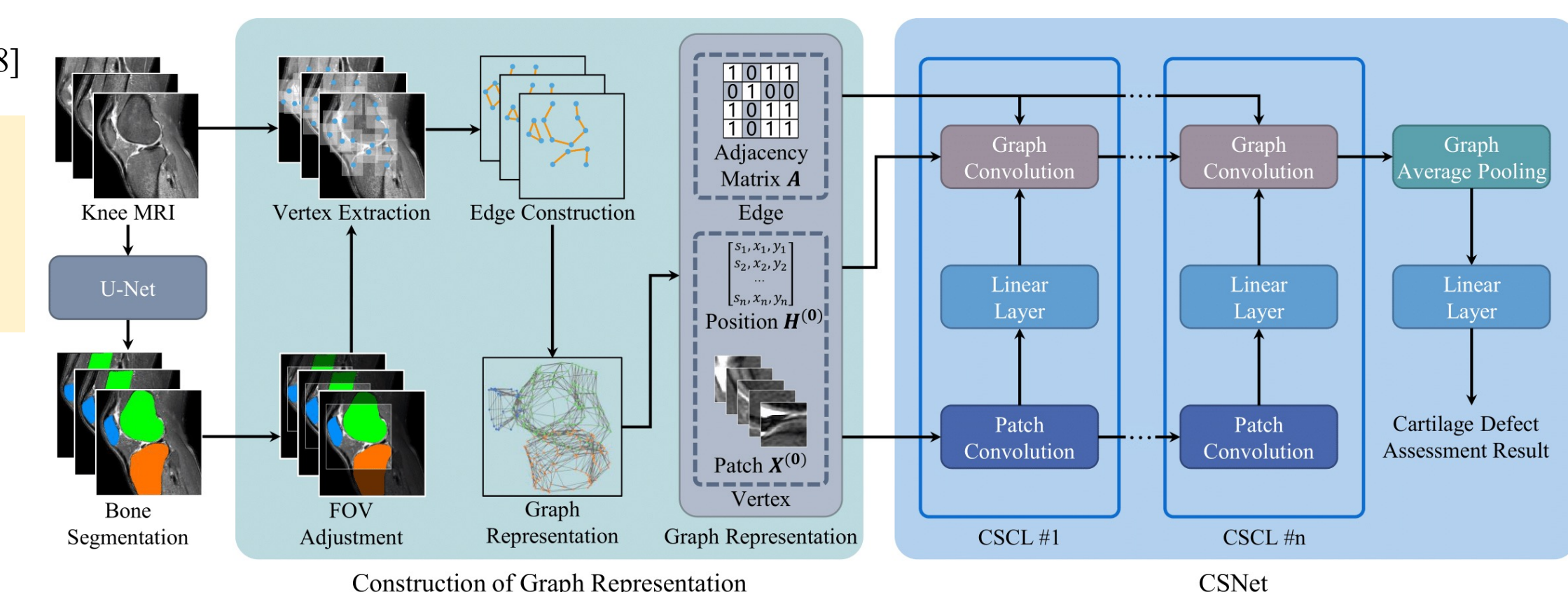


Figure: Schematic of Knee Anatomy and KOA stages<sup>[8]</sup>

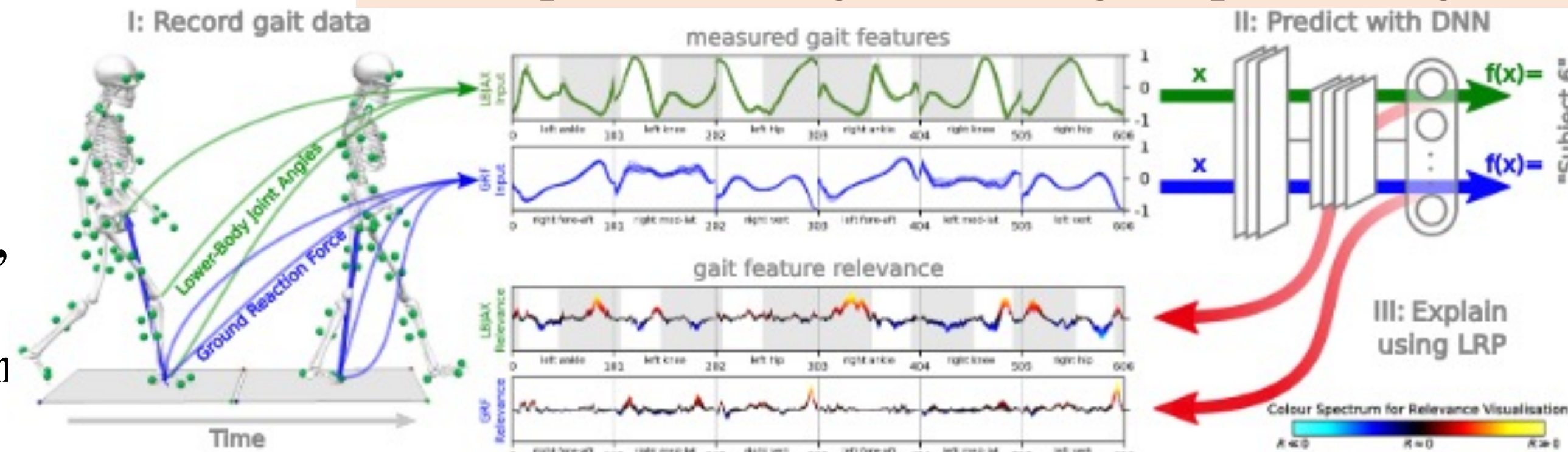
### DeepKneeExplainer<sup>[3]</sup>



### Graph Representation and Surface Convolution<sup>[9]</sup>



### Gait pattern Recognition using Deep Learning<sup>[14]</sup>



### Segmentation of Knee Tissues

- Key modality: **MRI**
- Key tissues assessed: Bones, cartilages, meniscus, ligaments,
- Challenges: **High variability in knee tissues, information dilution, heterogeneous scanning parameters, low signal-to-noise ratio (SNR), and motion artifacts.**

Openly Available Datasets: **OAI**<sup>[10]</sup>, **MOST**<sup>[11]</sup>, **SKM-TEA**<sup>[12]</sup>, **fastMRI**<sup>[13]</sup>

### Detection of Knee Defects

### Reconstruction of Knee MRI

### Advance Research in KOA

- KOA affects gait pattern**: For e.g. altered stride length, gait velocity, step time, joint loading, and joint moments.
- Deep learning applications: **Pose estimation, action recognition, object detection and tracking, musculoskeletal modelling**

## Our Approach: Semantic Segmentation of Knee Tissues

### Proposed MtRA-Unet Model

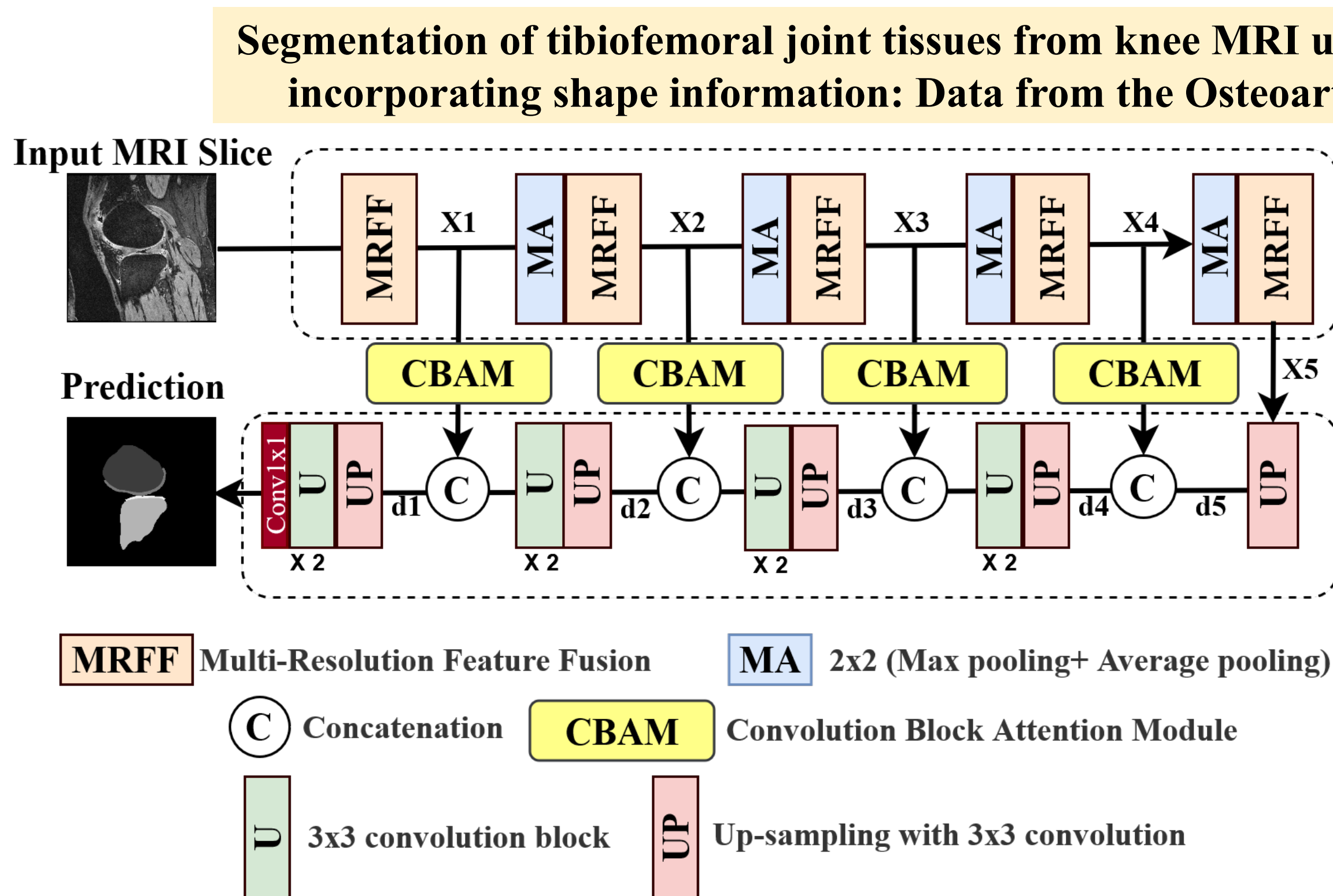


Figure: Schematic of proposed MtRA-Unet model

### Quantitative Results

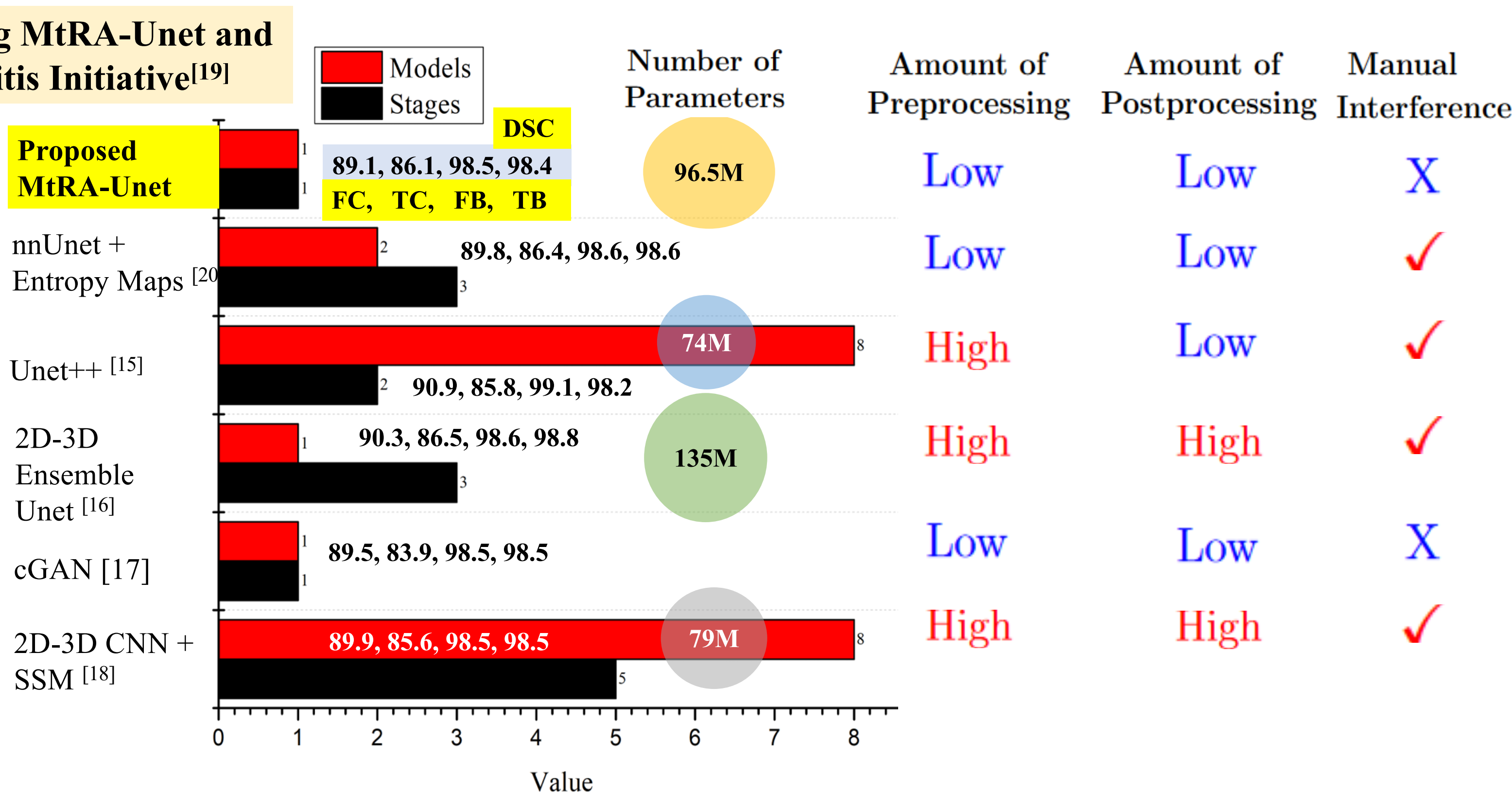


Figure: Quantitative comparison of proposed MtRA-Unet with state-of-the-arts

### Qualitative Results

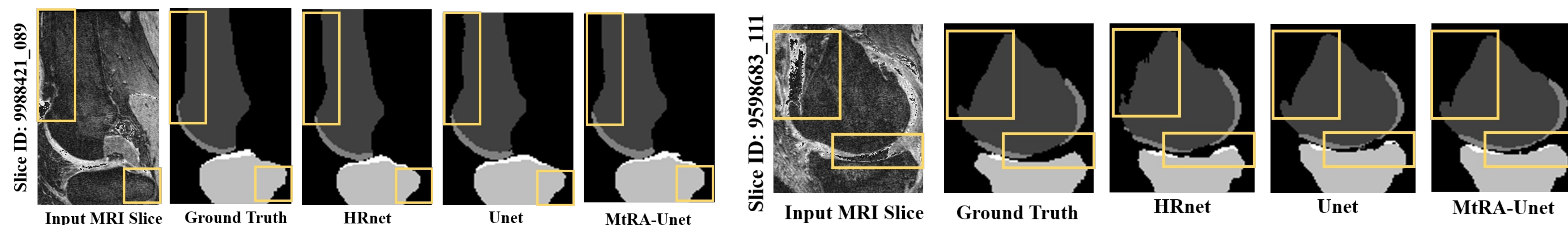


Figure: Qualitative comparison of proposed MtRA-Unet with state-of-the-arts

### Selected References

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- [2] M. R. Karim *et al.*, "DeepKneeExplainer: Explainable knee osteoarthritis diagnosis from radiographs and magnetic resonance imaging," *IEEE Access*, vol. 9, pp. 39757–39780, 2021.
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- [4] Z. Zhuang *et al.*, "Knee cartilage defect assessment by graph representation and surface convolution," *arXiv [eess.IV]*, 2022.
- [5] "NDA," *Nih.gov*. [Online]. Available: <https://nda.nih.gov/oai>. [Accessed: 14-Sep-2024]
- [6] F. Horst, S. Lapuschkin, W. Samek, K.-R. Müller, and W. I. Schöllhorn, "Explaining the unique nature of individual gait patterns with deep learning," *Sci. Rep.*, vol. 9, no. 1, p. 2391, 2019.
- [7] F. Ambellan, A. Tack, M. Ehlke, and S. Zachow, "Automated segmentation of knee bone and cartilage combining statistical shape knowledge and convolutional neural networks: Data from the Osteoarthritis Initiative," *Med. Image Anal.*, vol. 52, pp. 109–118, 2019.
- [8] A. Daydar, A. Pramanick, A. Sur, and S. Kanagaraj, "Segmentation of tibiofemoral joint tissues from knee MRI using MtRA-Unet and incorporating shape information: Data from the Osteoarthritis Initiative," *arXiv [eess.IV]*, 2024.

