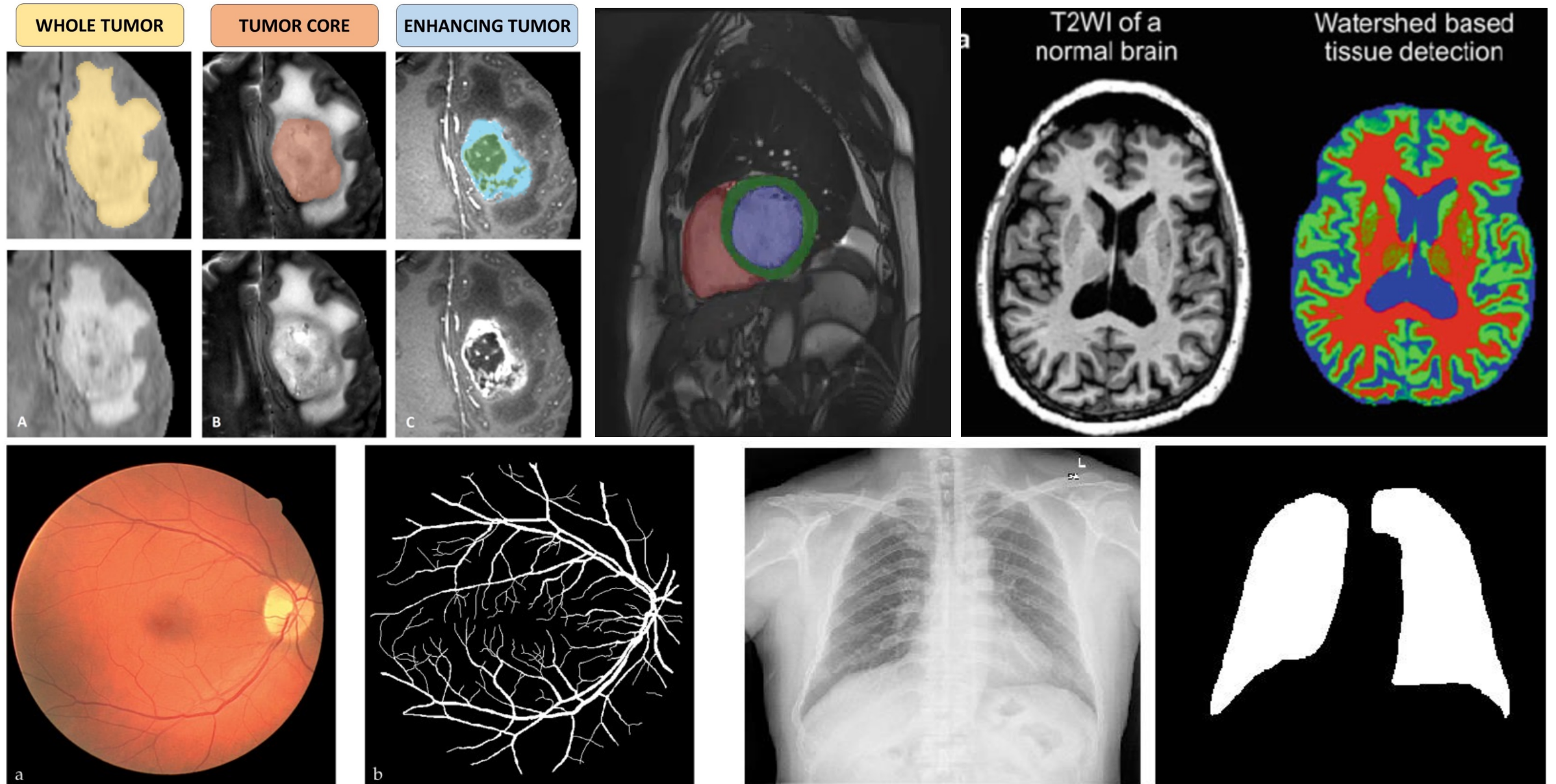# Cross-domain medical image segmentation

Dr Qingjie Meng

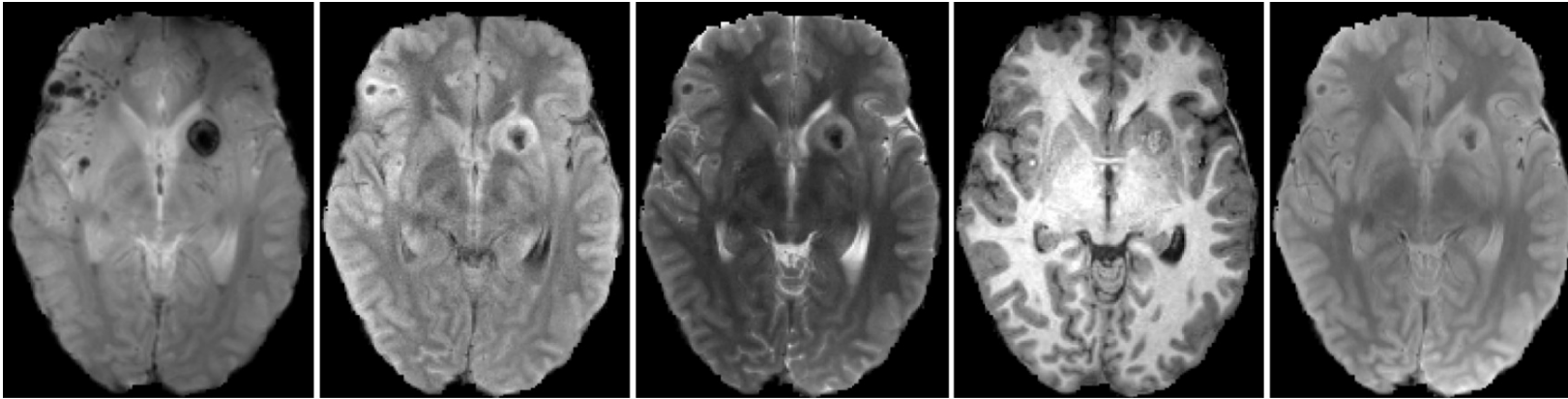School of Computer Science

University of Birmingham

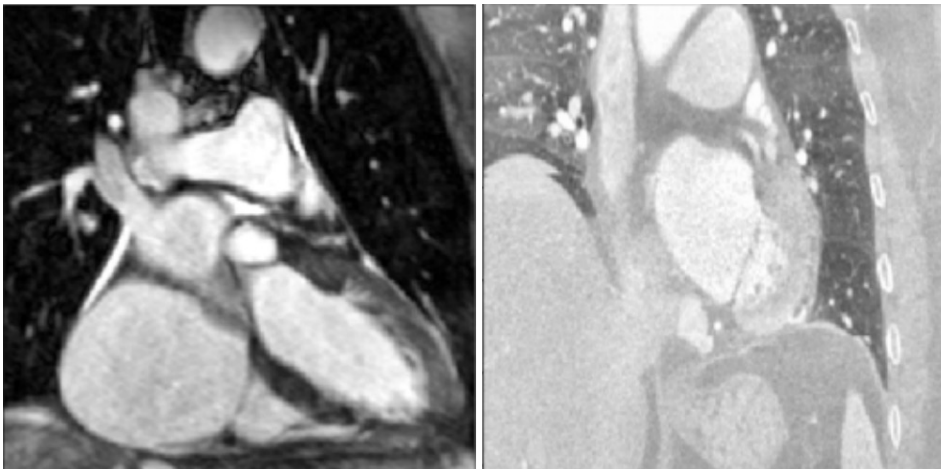# Medical image segmentation

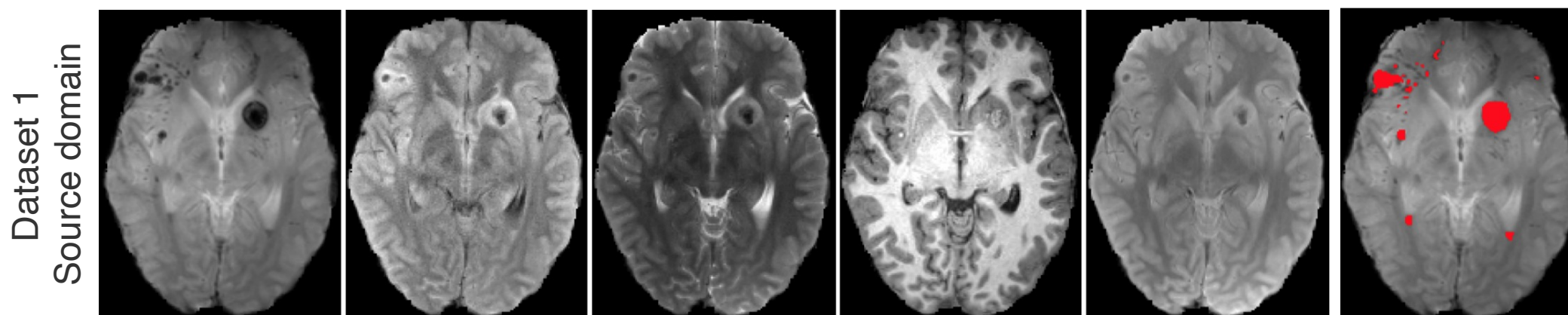# Cross-modality medical image segmentation

- Multi-model brain lesion segmentation

- MRI to CT cardiac segmentation
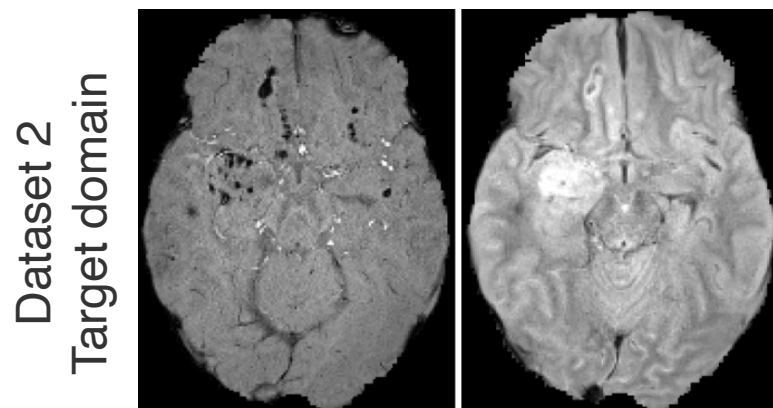
Multi-model brain lesion segmentation

Dataset 1 Source domain

Gradient-Echo | FLAIR   T2   MPRAGE   Proton Density   Annotations

5 modalities

Dataset 2 Target domain

Susceptibility Weighted Image   FLAIR   T2   MPRAGE   Proton Density

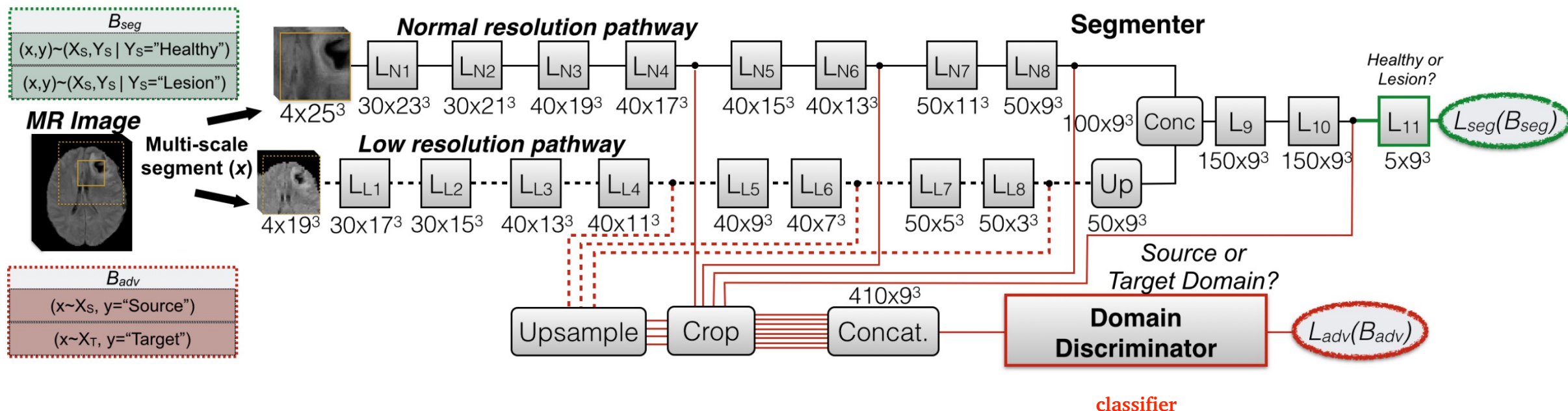Images are used but not presented

Different modalities:
- Gradient-Echo from dataset 1
- Susceptibility weighted Image from dataset 2

Different scanners:
- 3-T Siemens Magnetom TIM Trio for dataset 1
- 3-T Siemens Magnetom Verio for dataset 2
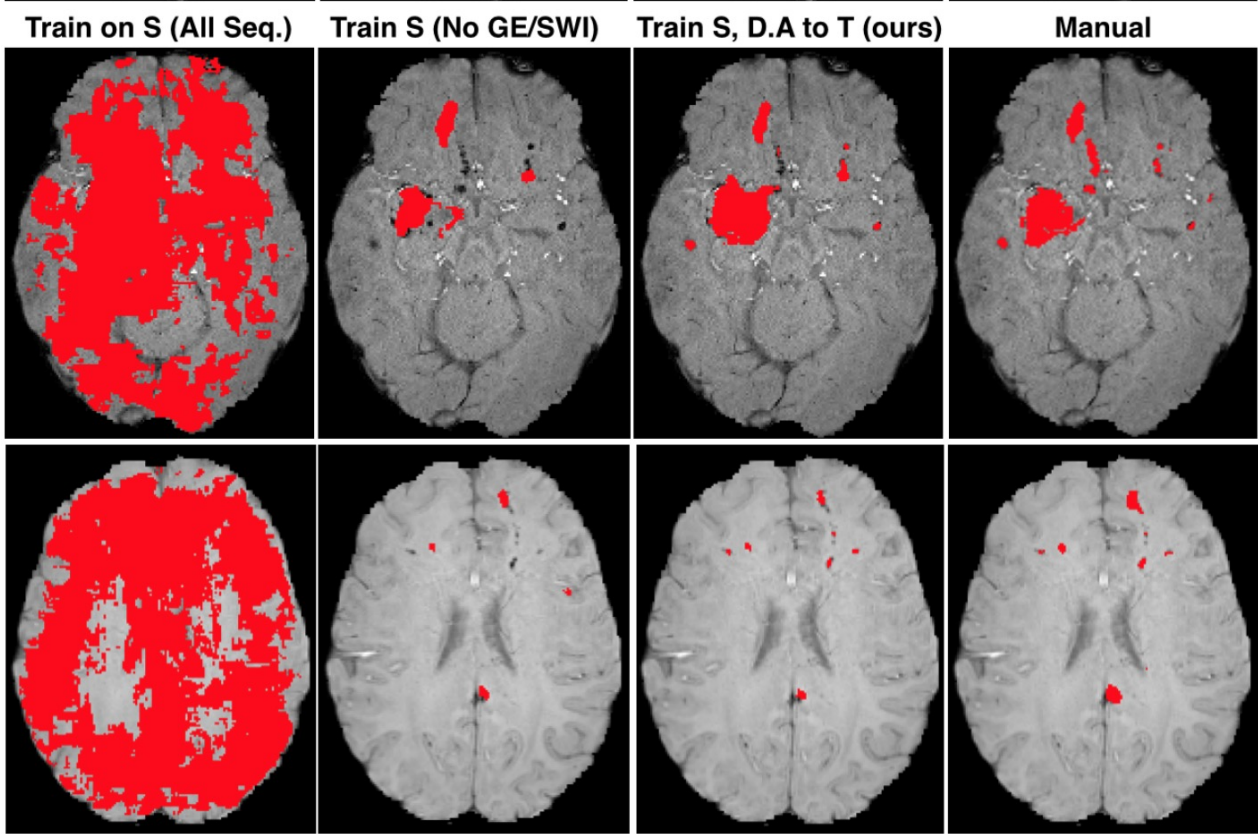
Multi-model brain lesion segmentation

A good example of Adversarial Learning

Minimizing the discriminator's classification loss: $\mathcal{L}_{adv}$

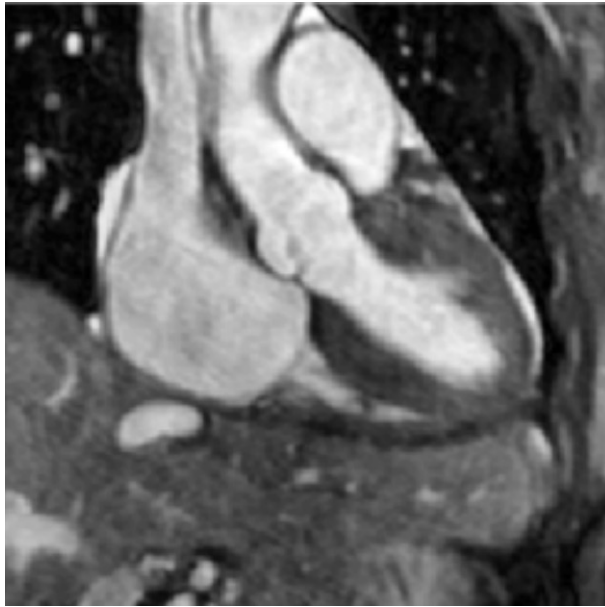Minimizing the segmentation loss and maximize the classification loss:

$$\mathcal{L}_{segAdv}(\theta_{seg}) = \mathcal{L}_{seg}(\theta_{seg}) - \alpha \mathcal{L}_{adv}(\theta_{seg})$$
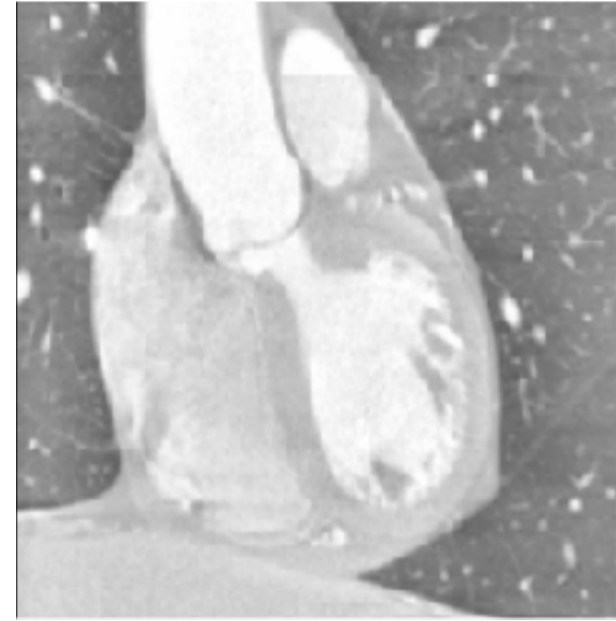
Results

	DSC	Recall	Precision
Train on S	15.7(13.5)	80.4(12.3)	09.5(09.0)
Train on S (No GE/SWI)	59.7(22.1)	55.7(22.6)	69.7(21.5)
Train on S → UDA to T (ours)	62.7(19.8)	58.9(21.2)	71.6(18.4)

MRI-CT cardiac segmentation

Magnetic resonance imaging (MRI)

Computed Tomography (CT)

Benefits:
- High image quality
- Good soft tissue contrast
- No radiation exposure
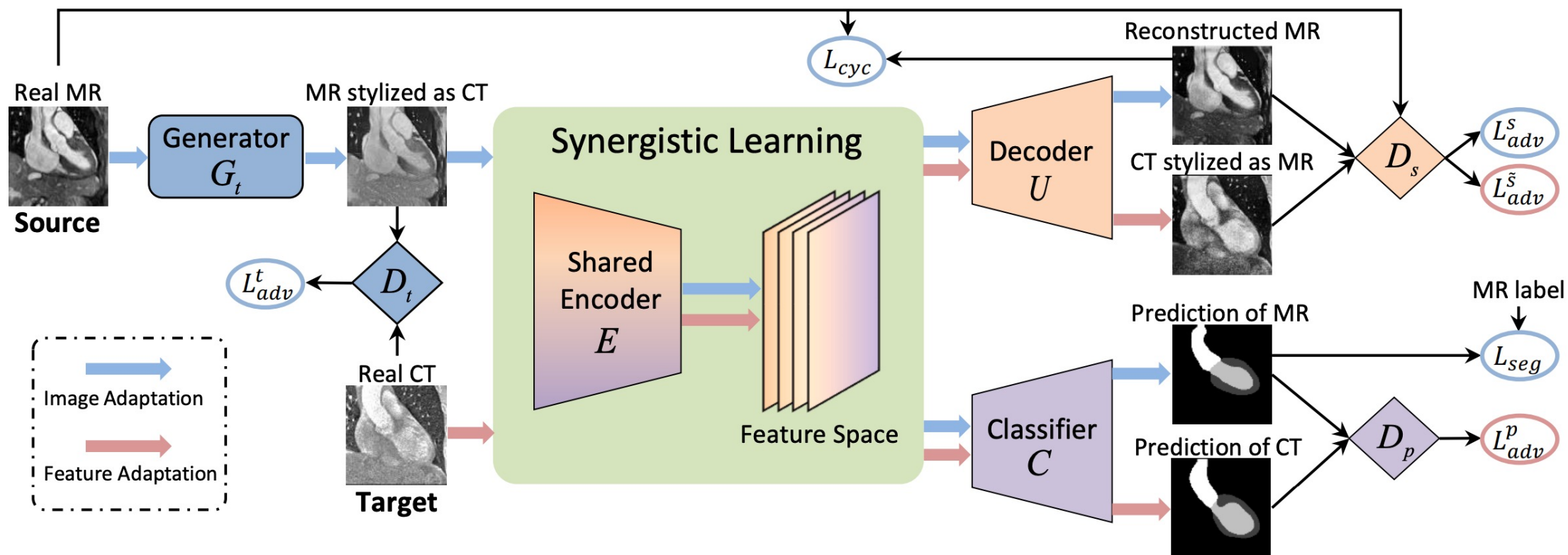- …

Disadvantages:
- Time consuming
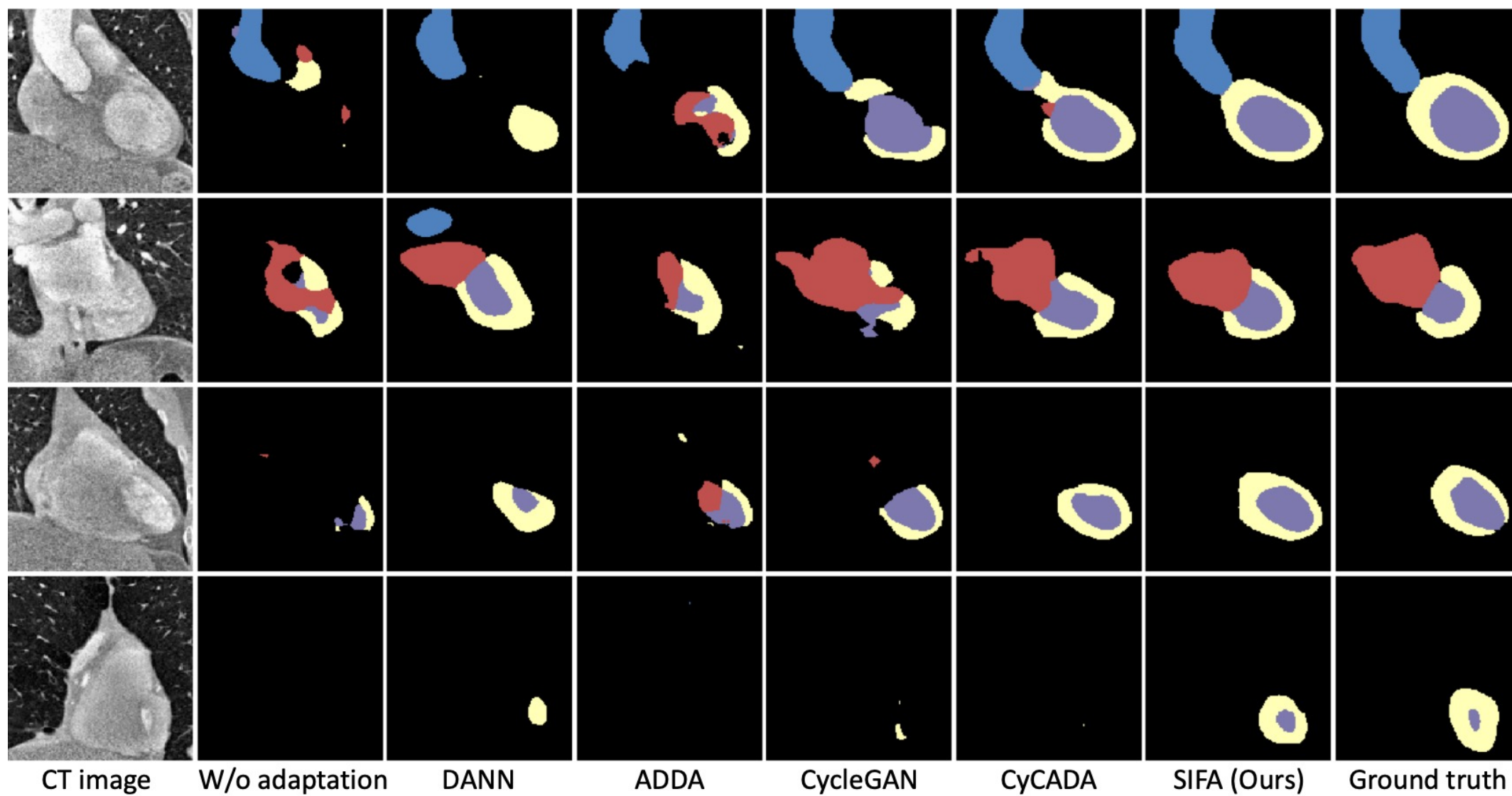- Expensive
- …

Benefits:
- High speed
- Widely available
- …

Disadvantages:
- Radiation exposure
- …

MRI-CT cardiac segmentation

Results

CT image   W/o adaptation   DANN   ADDA   CycleGAN   CyCADA   SIFA (Ours)   Ground truth

Take-away messages

- Domain shift is very common is general computer vision and medical imaging. It results in the **limited generalizability** of the deep learning models.

- Three main ways to address domain shift: **domain adaptation, data augmentation and test-time adaptation**.

- Medical images are complicated and addressing domain shift is still a **challenging** task.