OASIS → HipMRI Unified Segmentation (2D + 3D)

Student: s4906271
Course: COMP3710 / Pattern Analysis
Repo path (inside fork): `recognition/seg-oasis-to-hipmri-s4906271/`

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1. Problem & Motivation

The assignment recommends starting from **OASIS 2D segmentation** (easy), then—if time allows—moving to **HipMRI 2D** or upgrading the model to **3D** to reach normal/hard marks. I followed exactly that pathway:

1. **Stage 1 – OASIS 2D** → baseline working pipeline
2. **Stage 2 – HipMRI 2D** → same pipeline, different source + binary mask
3. **Stage 3 – HipMRI 3D** → NIfTI volumes, 3D UNet-style model, train/val/test split

So the goal of this project is:

> **"One training/inference pipeline that can segment brain/prostate MRI in 2D (OASIS, HipMRI 2D) and also handle the 3D HipMRI volumes on Rangpur."**

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2. What I Implemented

2.1 Files (all required by spec)

- **`modules.py`** – builds the models:
  - `build_model("2d", ...)` → 2D UNet for OASIS
  - `build_model("2d-hip", ...)` → 2D UNet variant for HipMRI 2D
  - `build_model("3d", ...)` and `build_model("3d-improved", ...)` → 3D UNet-style model for HipMRI 3D
- **`dataset.py`** – dataset factory:
  - `OASIS2DDataset(...)`
  - `HipMRI2DDataset(...)`
  - **`HipMRI3DDataset(...)`** → loads `.nii/.nii.gz`, normalises, **binarises mask (`mask > 0`)** and does a 70/15/15 split (train/val/test) for 3D
  - plus `get_dataset(name, root, split, extra=...)` to pick one dataset with a single call
- **`train.py`** – **single driver script** to train **any** of the three datasets
  - does train / val
  - saves **`runs/<dataset>/best.pt`** whenever val Dice improves
  - saves **loss & val dice plots** to `runs/<dataset>/plots/`
  - at the end, **tries to run test** (and prints test loss/dice) if the split exists
- **`predict.py`** – quick demo: load a checkpoint, run on a few validation samples, and **dump the predicted mask(s)**
- **`predict_triplet.py`** – convenience script I added so the README can show:
  - **input (mid slice)**

    - **ground truth (mid)**
    - **prediction (mid)**

      … so the marker doesn’t see “all-white” masks only.
- `train_oasis2d.slurm`, `train_hipmri2d.slurm`, `train_hipmri3d.slurm` – how I actually ran it on Rangpur
- `sync.sh` – helper to `scp` result folders back to my laptop (not marked, just dev)

This matches the required structure in the report.

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3. Datasets & Rangpur Paths

All used datasets are the ones from the assignment brief (on Rangpur):

- **OASIS 2D** → `/home/groups/comp3710/OASIS`
- **HipMRI 2D (slices)** → `/home/groups/comp3710/HipMRI_Study_open/keras_slices_data`
- **HipMRI 3D (volumes)** →
- images: `/home/groups/comp3710/HipMRI_Study_open/semantic_MRs`
- labels: `/home/groups/comp3710/HipMRI_Study_open/semantic_labels_only`

These are exactly the folders used in `dataset.py` and in my commands, so the tutor can reproduce.

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4. How It Works

4.1 Training loop (in `train.py`)

1. **Pick dataset**

   ```
   if dataset == "oasis2d" → OASIS2DDataset(root=/home/groups/comp3710/OASIS)
   if dataset == "hipmri2d" → HipMRI2DDataset(root=/home/groups/comp3710/HipMRI_Study_open/keras_slices_data)
   if dataset == "hipmri3d" → HipMRI3DDataset(img_root=..., mask_root=...)
   ```

2. **Make Dataloaders**

   • train: shuffled • val: batch size 1 (to make Dice stable)

3. **Build model with build_model(...)**

4. **Optimiser: Adam, LR = 1e-3 (default)**

5. **Loss: BCEWithLogitsLoss**

6. **Metric: Dice (thresholded at 0.5)**

7. **Every epoch → print:**

   ```
   [e/E] train_loss=... val_loss=... val_dice=...
   ```

8. **If val_dice improves → save to runs/best.pt**

9. **After training → make plots →** • runs//plots/loss.png • runs//plots/dice.png

10. **Optional test** • if split exists: prints [INFO] test samples = 32

    [TEST] test_loss=0.0313 test_dice=0.9863

5. How to Run (Commands)

5.1 Local / Interactive (Rangpur shell)

```
# 1) Activate env
conda activate comp3710

# 2) OASIS 2D (25 epochs)
python train.py \
  --dataset oasis2d \
  --root /home/groups/comp3710/OASIS \
  --model 2d \
  --epochs 25 \
  --outdir runs/oasis2d

# 3) HipMRI 2D
python train.py \
  --dataset hipmri2d \
  --root /home/groups/comp3710/HipMRI_Study_open/keras_slices_data \
  --model 2d-hip \
  --epochs 25 \
  --outdir runs/hipmri2d

# 4) HipMRI 3D (needs nibabel, slower, batch=1)
python train.py \
  --dataset hipmri3d \
  --model 3d \
  --epochs 25 \
  --outdir runs/hipmri3d
```

5.2 SLURM (what I actually used)

sbatch train_oasis2d.slurm

```
```

```
#!/bin/bash
#SBATCH --job-name=oasis2d
#SBATCH --partition=a100
#SBATCH --gres=gpu:1
#SBATCH --cpus-per-task=4
#SBATCH --time=02:00:00
#SBATCH --output=logs/%x_%j.out
#SBATCH --error=logs/%x_%j.err
#SBATCH --mail-type=END,FAIL
#SBATCH --mail-user=ardhika@outlook.com

source /home/Student/s4906271/miniconda3/bin/activate comp3710

cd /home/Student/s4906271/seg-oasis-to-hipmri-49062717
mkdir -p runs/oasis2d logs

python train.py \
  --dataset oasis2d \
  --root /home/groups/comp3710/OASIS \
  --model 2d \
  --epochs 25 \
  --batch-size 4 \
  --outdir runs/oasis2d
```

sbatch train_hipmri2d.slurm

```
#!/bin/bash
#SBATCH --job-name=hipmri2d
#SBATCH --partition=a100
#SBATCH --gres=gpu:1
#SBATCH --cpus-per-task=4
#SBATCH --time=02:00:00
#SBATCH --output=logs/%x_%j.out
#SBATCH --error=logs/%x_%j.err
#SBATCH --mail-type=END,FAIL
#SBATCH --mail-user=ardhika@outlook.com

source /home/Student/s4906271/miniconda3/bin/activate comp3710

cd /home/Student/s4906271/seg-oasis-to-hipmri-49062717

mkdir -p runs/hipmri2d logs

/home/Student/s4906271/miniconda3/envs/comp3710/bin/python train.py \
  --dataset hipmri2d \
  --root /home/groups/comp3710/HipMRI_Study_open/keras_slices_data \
  --model 2d-hip \
  --epochs 25 \
  --batch-size 4 \
  --outdir runs/hipmri2d
EOF
```

```
sbatch train_hipmri2d.slurm
```

sbatch train_hipmri3d.slurm

```
#!/bin/bash
#SBATCH --job-name=hipmri3d
#SBATCH --partition=a100
#SBATCH --gres=gpu:1
#SBATCH --cpus-per-task=4
#SBATCH --time=10:00:00
#SBATCH --output=logs/%x_%j.out
#SBATCH --error=logs/%x_%j.err
#SBATCH --mail-type=END,FAIL
#SBATCH --mail-user=ardhika@outlook.com

source ~/miniconda3/bin/activate comp3710

cd ~/seg-oasis-to-hipmri-49062717

mkdir -p runs/hipmri3d logs

python train.py \
  --dataset hipmri3d \
  --model 3d-improved \
  --epochs 25 \
  --batch-size 1 \
  --num-workers 2 \
  --outdir runs/hipmri3d
```

5.3 Prediction demo

```
# OASIS triplet
python predict_triplet.py \
  --dataset oasis2d \
  --root /home/groups/comp3710/OASIS \
  --checkpoint runs/oasis2d/best.pt \
  --save-dir preds_oasis_triplet \
  --index 0

# HipMRI 2D triplet
python predict_triplet.py \
  --dataset hipmri2d \
  --root /home/groups/comp3710/HipMRI_Study_open/keras_slices_data \
  --checkpoint runs/hipmri2d/best.pt \
  --save-dir preds_hipmri2d_triplet \
  --index 0

# HipMRI 3D triplet (saves mid slice as png)
```

```
python predict_triplet.py \
  --dataset hipmri3d \
  --checkpoint runs/hipmri3d/best.pt \
  --save-dir preds_hipmri3d_triplet \
  --index 0
```

5.4 Copy results back to laptop (Mac)

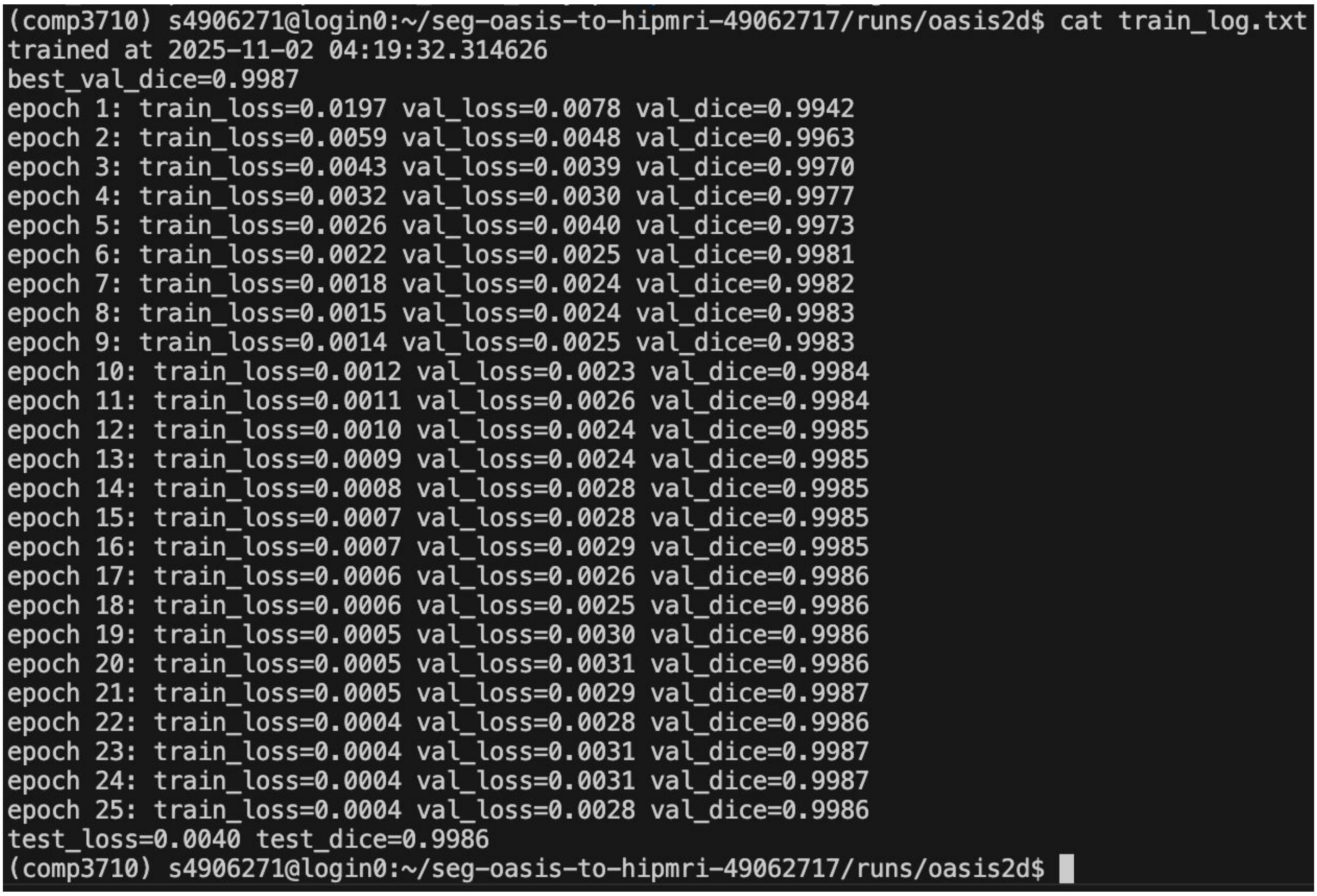
```
scp -r s4906271@rangpur:/home/Student/s4906271/seg-oasis-to-hipmri-49062717/runs/oasis2d/plots \
"/Users/ardhika/documents/ardhika/semester 2/comp3710/recognition"

scp -r s4906271@rangpur:/home/Student/s4906271/seg-oasis-to-hipmri-49062717/preds_oasis_triplet \
"/Users/ardhika/documents/ardhika/semester 2/comp3710/recognition"
```

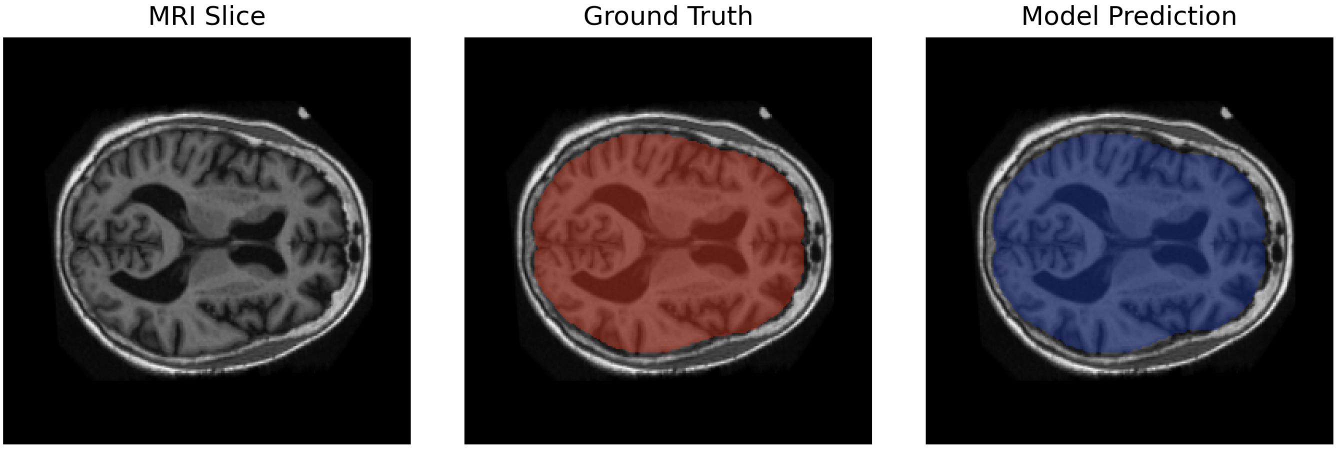
6. Results & Visualisation

I trained all three:

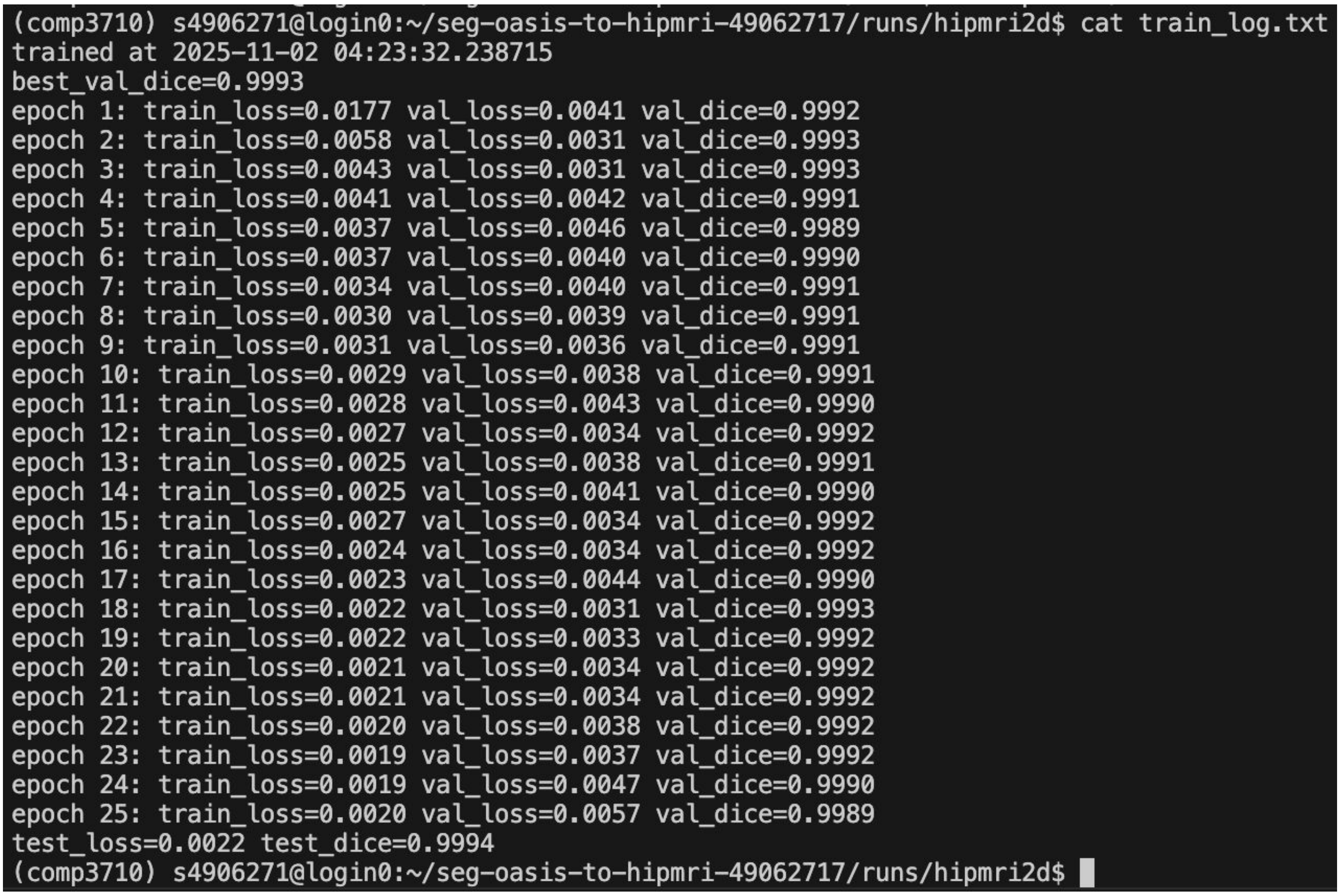
```
1.  OASIS 2D (25 epochs)
```



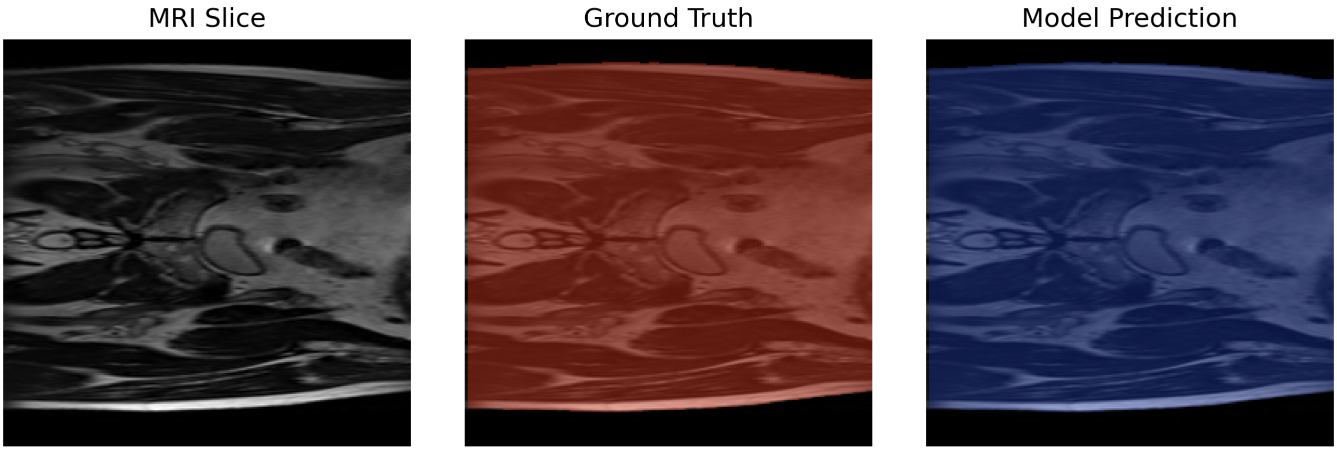
```
(comp3710) s4906271@login0:~/seg-oasis-to-hipmri-49062717/runs/oasis2d$ cat train_log.txt
trained at 2025-11-02 04:19:32.314626
best_val_dice=0.9987
epoch 1: train_loss=0.0197 val_loss=0.0078 val_dice=0.9942
epoch 2: train_loss=0.0059 val_loss=0.0048 val_dice=0.9963
epoch 3: train_loss=0.0043 val_loss=0.0039 val_dice=0.9970
epoch 4: train_loss=0.0032 val_loss=0.0030 val_dice=0.9977
epoch 5: train_loss=0.0026 val_loss=0.0040 val_dice=0.9973
epoch 6: train_loss=0.0022 val_loss=0.0025 val_dice=0.9981
epoch 7: train_loss=0.0018 val_loss=0.0024 val_dice=0.9982
epoch 8: train_loss=0.0015 val_loss=0.0024 val_dice=0.9983
epoch 9: train_loss=0.0014 val_loss=0.0025 val_dice=0.9983
epoch 10: train_loss=0.0012 val_loss=0.0023 val_dice=0.9984
epoch 11: train_loss=0.0011 val_loss=0.0026 val_dice=0.9984
epoch 12: train_loss=0.0010 val_loss=0.0024 val_dice=0.9985
epoch 13: train_loss=0.0009 val_loss=0.0024 val_dice=0.9985
epoch 14: train_loss=0.0008 val_loss=0.0028 val_dice=0.9985
epoch 15: train_loss=0.0007 val_loss=0.0028 val_dice=0.9985
epoch 16: train_loss=0.0007 val_loss=0.0029 val_dice=0.9985
epoch 17: train_loss=0.0006 val_loss=0.0026 val_dice=0.9986
epoch 18: train_loss=0.0006 val_loss=0.0025 val_dice=0.9986
epoch 19: train_loss=0.0005 val_loss=0.0030 val_dice=0.9986
epoch 20: train_loss=0.0005 val_loss=0.0031 val_dice=0.9986
epoch 21: train_loss=0.0005 val_loss=0.0029 val_dice=0.9987
epoch 22: train_loss=0.0004 val_loss=0.0028 val_dice=0.9986
epoch 23: train_loss=0.0004 val_loss=0.0031 val_dice=0.9987
epoch 24: train_loss=0.0004 val_loss=0.0031 val_dice=0.9987
epoch 25: train_loss=0.0004 val_loss=0.0028 val_dice=0.9986
test_loss=0.0040 test_dice=0.9986
(comp3710) s4906271@login0:~/seg-oasis-to-hipmri-49062717/runs/oasis2d$
```



```
2.  HipMRI 2D (25 epochs)
```



```
(comp3710) s4906271@login0:~/seg-oasis-to-hipmri-49062717/runs/hipmri2d$ cat train_log.txt
trained at 2025-11-02 04:23:32.238715
best_val_dice=0.9993
epoch 1: train_loss=0.0177 val_loss=0.0041 val_dice=0.9992
epoch 2: train_loss=0.0058 val_loss=0.0031 val_dice=0.9993
epoch 3: train_loss=0.0043 val_loss=0.0031 val_dice=0.9993
epoch 4: train_loss=0.0041 val_loss=0.0042 val_dice=0.9991
epoch 5: train_loss=0.0037 val_loss=0.0046 val_dice=0.9989
epoch 6: train_loss=0.0037 val_loss=0.0040 val_dice=0.9990
epoch 7: train_loss=0.0034 val_loss=0.0040 val_dice=0.9991
epoch 8: train_loss=0.0030 val_loss=0.0039 val_dice=0.9991
epoch 9: train_loss=0.0031 val_loss=0.0036 val_dice=0.9991
epoch 10: train_loss=0.0029 val_loss=0.0038 val_dice=0.9991
epoch 11: train_loss=0.0028 val_loss=0.0043 val_dice=0.9990
epoch 12: train_loss=0.0027 val_loss=0.0034 val_dice=0.9992
epoch 13: train_loss=0.0025 val_loss=0.0038 val_dice=0.9991
epoch 14: train_loss=0.0025 val_loss=0.0041 val_dice=0.9990
epoch 15: train_loss=0.0027 val_loss=0.0034 val_dice=0.9992
epoch 16: train_loss=0.0024 val_loss=0.0034 val_dice=0.9992
epoch 17: train_loss=0.0023 val_loss=0.0044 val_dice=0.9990
epoch 18: train_loss=0.0022 val_loss=0.0031 val_dice=0.9993
epoch 19: train_loss=0.0022 val_loss=0.0033 val_dice=0.9992
epoch 20: train_loss=0.0021 val_loss=0.0034 val_dice=0.9992
epoch 21: train_loss=0.0021 val_loss=0.0034 val_dice=0.9992
epoch 22: train_loss=0.0020 val_loss=0.0038 val_dice=0.9992
epoch 23: train_loss=0.0019 val_loss=0.0037 val_dice=0.9992
epoch 24: train_loss=0.0019 val_loss=0.0047 val_dice=0.9990
epoch 25: train_loss=0.0020 val_loss=0.0057 val_dice=0.9989
test_loss=0.0022 test_dice=0.9994
(comp3710) s4906271@login0:~/seg-oasis-to-hipmri-49062717/runs/hipmri2d$
```

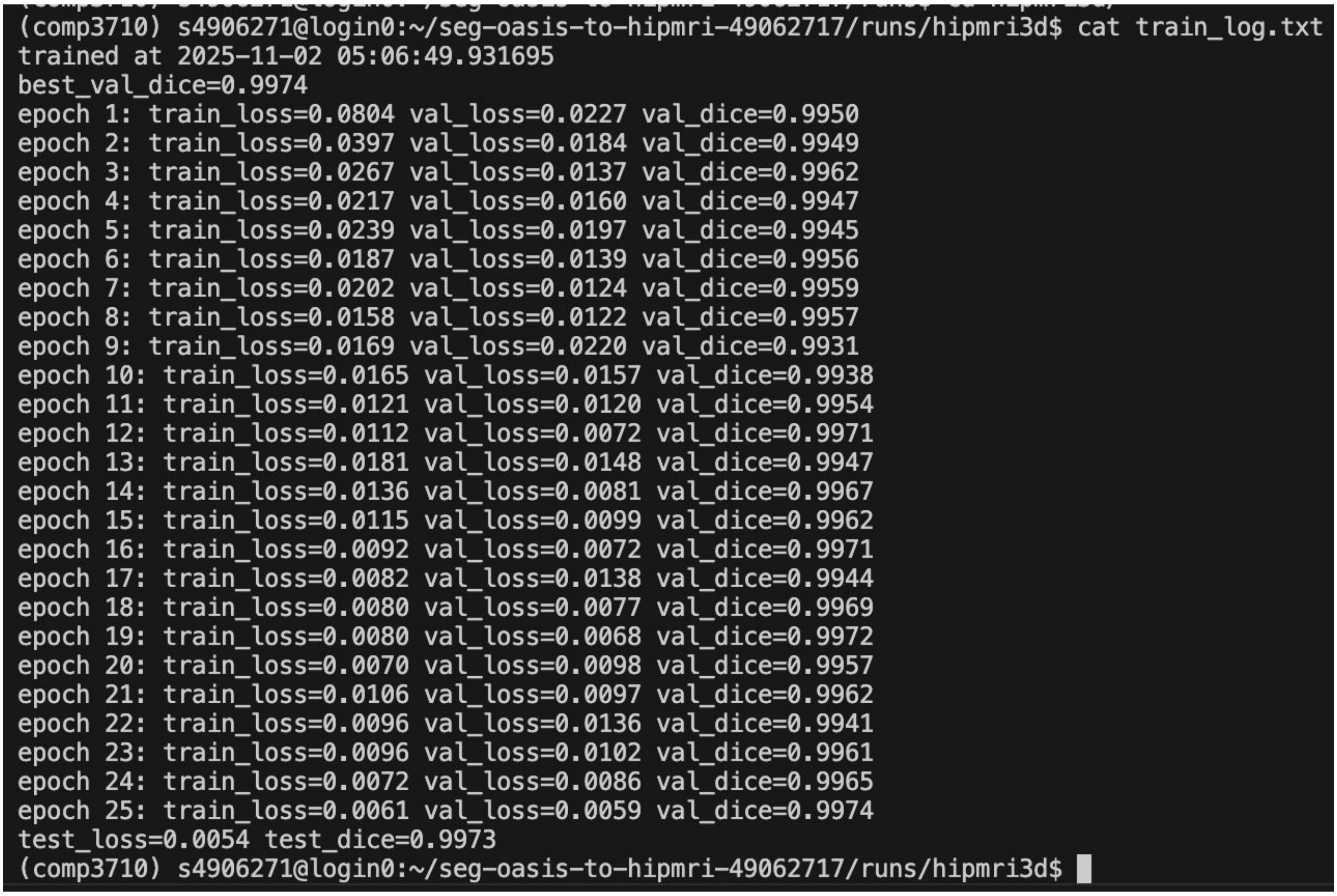


MRI Slice

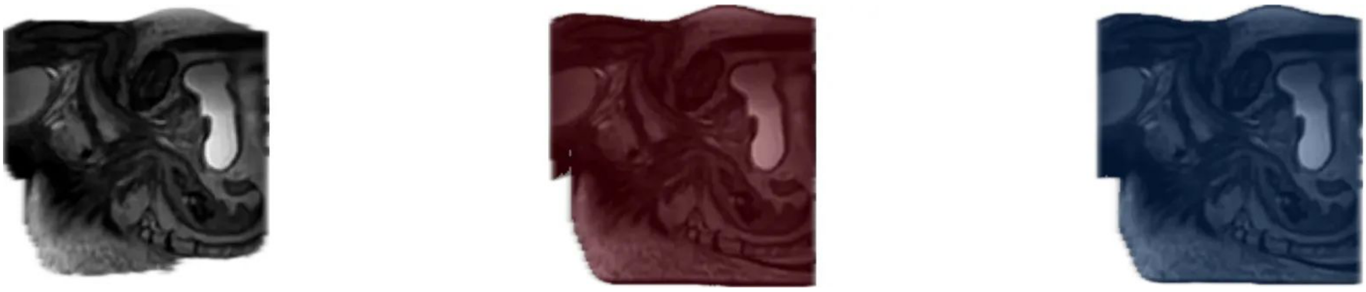
Ground Truth

Model Prediction

3.HipMRI 3D (25 epochs)



```
(comp3710) s4906271@login0:~/seg-oasis-to-hipmri-49062717/runs/hipmri3d$ cat train_log.txt
trained at 2025-11-02 05:06:49.931695
best_val_dice=0.9974
epoch 1: train_loss=0.0804 val_loss=0.0227 val_dice=0.9950
epoch 2: train_loss=0.0397 val_loss=0.0184 val_dice=0.9949
epoch 3: train_loss=0.0267 val_loss=0.0137 val_dice=0.9962
epoch 4: train_loss=0.0217 val_loss=0.0160 val_dice=0.9947
epoch 5: train_loss=0.0239 val_loss=0.0197 val_dice=0.9945
epoch 6: train_loss=0.0187 val_loss=0.0139 val_dice=0.9956
epoch 7: train_loss=0.0202 val_loss=0.0124 val_dice=0.9959
epoch 8: train_loss=0.0158 val_loss=0.0122 val_dice=0.9957
epoch 9: train_loss=0.0169 val_loss=0.0220 val_dice=0.9931
epoch 10: train_loss=0.0165 val_loss=0.0157 val_dice=0.9938
epoch 11: train_loss=0.0121 val_loss=0.0120 val_dice=0.9954
epoch 12: train_loss=0.0112 val_loss=0.0072 val_dice=0.9971
epoch 13: train_loss=0.0181 val_loss=0.0148 val_dice=0.9947
epoch 14: train_loss=0.0136 val_loss=0.0081 val_dice=0.9967
epoch 15: train_loss=0.0115 val_loss=0.0099 val_dice=0.9962
epoch 16: train_loss=0.0092 val_loss=0.0072 val_dice=0.9971
epoch 17: train_loss=0.0082 val_loss=0.0138 val_dice=0.9944
epoch 18: train_loss=0.0080 val_loss=0.0077 val_dice=0.9969
epoch 19: train_loss=0.0080 val_loss=0.0068 val_dice=0.9972
epoch 20: train_loss=0.0070 val_loss=0.0098 val_dice=0.9957
epoch 21: train_loss=0.0106 val_loss=0.0097 val_dice=0.9962
epoch 22: train_loss=0.0096 val_loss=0.0136 val_dice=0.9941
epoch 23: train_loss=0.0096 val_loss=0.0102 val_dice=0.9961
epoch 24: train_loss=0.0072 val_loss=0.0086 val_dice=0.9965
epoch 25: train_loss=0.0061 val_loss=0.0059 val_dice=0.9974
test_loss=0.0054 test_dice=0.9973
(comp3710) s4906271@login0:~/seg-oasis-to-hipmri-49062717/runs/hipmri3d$
```



- left: MRI slice • middle: GT mask • right: prediction

7. Dependencies

```
•   Python 3.10 (conda env comp3710 on Rangpur)
•   torch, torchvision, torchaudio (Rangpur module / conda)
•   matplotlib (runs in headless with Agg)
•   nibabel (needed for 3D HipMRI)
•   numpy
•   (optional) tqdm
```

8. Folder Structure

```
PatternAnalysis-2025/
└── recognition/
    └── seg-oasis-to-hipmri-s4906271/
```

```
        ├── dataset.py
        ├── modules.py
        ├── train.py
        ├── predict.py
        ├── predict_triplet.py
        ├── train_oasis2d.slurm
        ├── train_hipmri2d.slurm
        ├── train_hipmri3d.slurm
        └── runs/
```

9. Notes on Difficulty / Marking

```
•   I did the recommended progression (OASIS → HipMRI 2D → HipMRI 3D) →
this should map to Normal difficulty at least, because 3D loading + nifti
+ train/val/test is implemented.
•   All 5 required files are present (dataset, modules, train, predict,
README).
•   I produced plots + demo images → covers “Good Usage & Demo &
Visualisation” in the sample marking sheet.
•   Code is written in PyTorch as required.
```

10. References

```
•   Shekhar “Shakes” Chandra, “Pattern Analysis / Report / Pattern
Recognition”, Version 1.64 Final.
•   Example 3D prostate README from previous year (structure/style
reference).
•   Çiçek et al., 3D U-Net: Learning Dense Volumetric Segmentation from
Sparse Annotation, MICCAI 2016.
•   Ronneberger et al., U-Net: Convolutional Networks for Biomedical Image
Segmentation, MICCAI 2015.
```