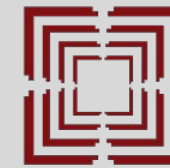


Breast Cancer Segmentation using nnU-net

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Introduction

Breast cancer is highly prevalent, and DCE-MRI provides detailed imaging for diagnosis. However, manual tumor segmentation is slow and inconsistent.

This project leverages **3D nnU-Net** on the **BreastDM dataset** to automate tumor segmentation, aiming to improve accuracy, speed, and clinical utility.



Methodology

Data Preparation: Reformatted files and structure for nnU-Net compatibility.

Preprocessing: Removed blank slices, cropped to non-zero regions, resampled spacing, and applied patch-wise z-score standardization.

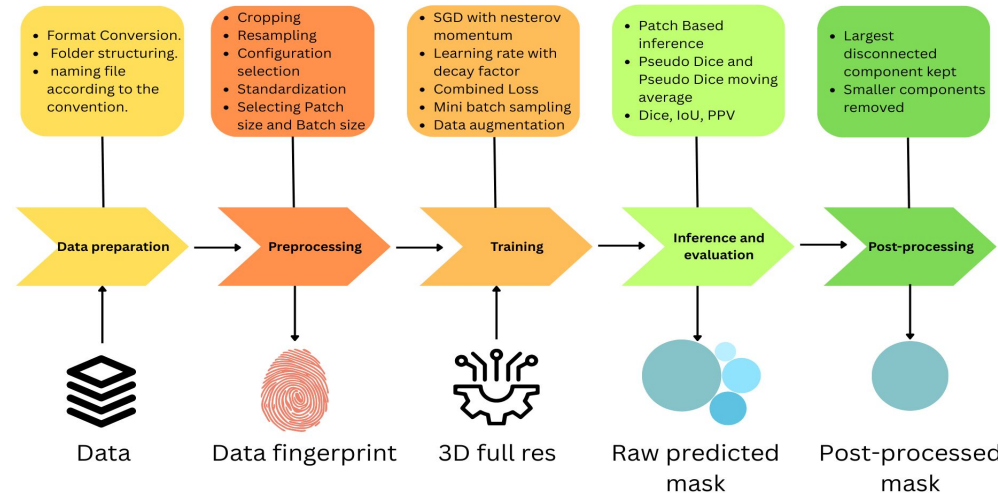
Model: Auto-selected 3D full-resolution U-Net based on data characteristics.

Training: Trained for 53 epochs with SGD (Nesterov momentum), Dice + Cross-Entropy loss, oversampling, and on-the-fly augmentation.

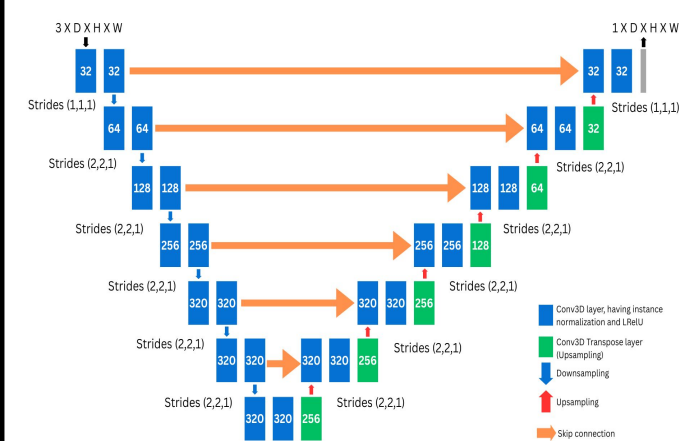
Inference & Post-processing: Patch-wise prediction with Gaussian averaging; retained largest connected component to remove false positives.

Evaluation: Assessed with Dice, IoU, PPV, and qualitative visualizations.

Training Pipeline



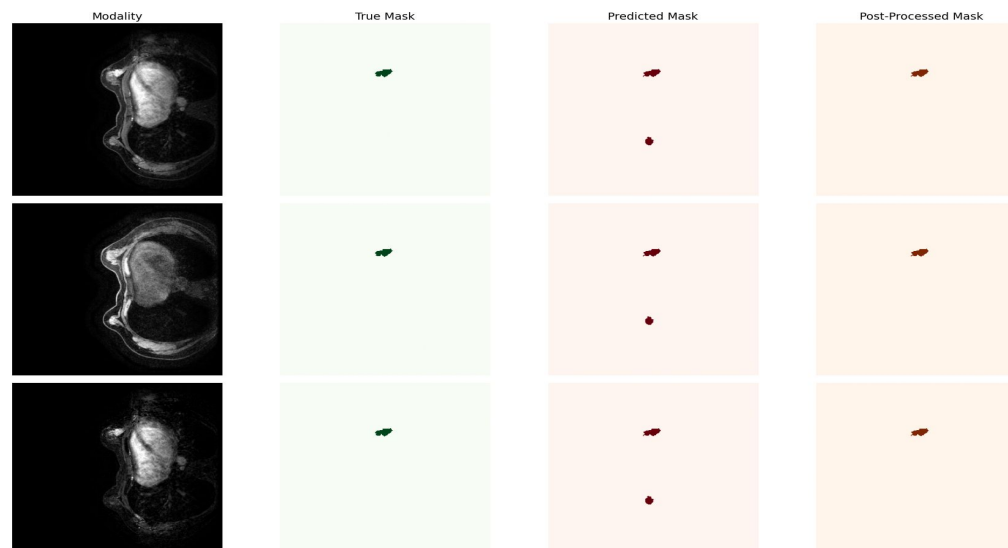
Model Architecture



Results

| Model | DSC (%) | IoU (%) | PPV (%) |
|---------------------|-------------|-------------|-------------|
| 3D U-Net (Paper) | 66.5 | 75.1 | 83.3 |
| 3D V-Net (Paper) | 65.6 | 74.2 | 77.1 |
| 3D DenseSeg (Paper) | 67.0 | 74.9 | 84.1 |
| 3D nnU-Net | 86.9 | 80.5 | 87.6 |

Slice 2 (axis 0) across 3 modalities



Conclusion

Used a high-accuracy 3D segmentation model, nnU-Net on breast MRI data, surpassing existing baselines. Progressed from no prior AI/ML experience to implementing advanced 2D and 3D models.

Future Work:

Integrate with clinical PACS systems, optimize inference speed, expand to tumor classification, and train on diverse datasets for broader generalizability.

Contributions

- Reformatted dataset for nnU-Net
- explored 2D & 3D models (Swin U-Net, MedSAM) before finalizing nnU-net
- implemented nnU-Net pipeline with manual post-processing
- Evaluated performance using Dice, IoU, and PPV metrics
- visualized segmentation results for insights.