

**Project title:** Pelvic MRI Segmentation in Endometriosis Using U-Net Variants

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## Purpose

The aim of this project is to apply convolutional neural networks to segment pelvic organs in MRI scans of patients with endometriosis. Accurate segmentation of structures such as the uterus, ovaries, and bladder is important for clinical assessment, and the dataset we selected allows us to work on a well-defined problem with high-quality annotations. Our focus will be to establish a baseline model and then conduct a series of experiments to test how different network variants and training strategies affect performance.

## Dataset

We will use the *Multi-Modal Pelvic MRI Dataset for Deep Learning-Based Pelvic Organ Segmentation in Endometriosis* (Zenodo: <https://zenodo.org/records/15750762>), published in *Nature Scientific Data*. The dataset includes multi-sequence MRI scans with expert annotations and has reported nnU-Net benchmarks. To keep the project manageable, we will start by focusing on a subset of organs rather than the full set, before potentially expanding if time/recourses allow.

## Methods and planned experiments

Our initial step will be to establish a baseline using a standard U-Net on 2D MRI slices. Depending on available resources, we may extend to patch-based 3D experiments. After the baseline, we plan to:

- Compare U-Net with Attention U-Net to test the effect of attention mechanisms.
- Investigate early vs late fusion strategies for handling multiple MRI sequences.
- Apply transfer learning by initializing encoders with ImageNet-pretrained weights.
- Explore alternative loss functions such as Dice+Focal or Tversky loss to address class imbalance and boundary precision.

Evaluation will be based on segmentation metrics reported in the dataset paper, including Dice coefficient and Hausdorff distance.

## References to 1-3 key research papers of related work

Liang, X. et al. *A Multi-Modal Pelvic MRI Dataset for Deep Learning-Based Pelvic Organ Segmentation in Endometriosis*. *Nature Scientific Data* (2025).

Ronneberger, O. et al. *U-Net: Convolutional Networks for Biomedical Image Segmentation*. *MICCAI* (2015).

Oktay, O. et al. *Attention U-Net: Learning Where to Look for the Pancreas*. *arXiv:1804.03999* (2018).