# SYNOPSIS


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**Project Title:** Cardiac Ultrasound: Self-supervised Learning in LV Segmentation

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## Abstract:

Echocardiography is vital for cardiovascular diagnosis, but left ventricular (LV) segmentation is challenging due to sparse annotations, with clinicians labeling only end-diastole and end-systole frames. This project implements **SimLVSeg**, a novel video-based framework for consistent LV segmentation from sparsely annotated echocardiogram videos. SimLVSeg employs a two-stage training strategy: **(i)** self-supervised pre-training with temporal masking to learn cyclic cardiac patterns from unannotated frames, and **(ii)** weakly supervised learning for segmentation using limited labels. Evaluated on the **EchoNet-Dynamic** dataset, SimLVSeg achieves a **93.32% Dice score (95% CI: 93.21–93.43%)**, outperforming 2D and complex video-based methods while being **4× faster** than nnU-Net and **3.8× more efficient** than SepXception. Validation on the **CAMUS** dataset further confirms its generalizability, establishing video-based networks as a promising solution for reliable, temporally consistent LV segmentation in echocardiography.


**Specific Contribution:** Implemented weakly supervised fine-tuning for 85 epochs on sparse ED/ES labels, developed a combined Dice + BCE loss for accurate segmentation, built an evaluation pipeline for 1,277 videos, and added post-processing logic to compute Ejection Fraction from raw mask outputs.

**Specific Learning:** Mastered transfer learning, understood weakly supervised 3D training with single-frame labels, applied advanced segmentation losses (Dice + BCE), learned EF-based post-processing, and handled complex 5D tensors for 3D video processing in PyTorch.

**Technical & Ethical Challenges:** Encountered EF sensitivity to small pixel errors, GPU memory limits restricting batch size, and the black-box nature of 3D U-Net affecting interpretability; ethically, faced risks of misdiagnosis from model errors and bias due to under-represented patient groups.

Name & Signature of the Student

Signature of Guide

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Date: 30 / 10 / 2025