# Self-Supervised Learning of Echocardiogram Videos Enables Data-Efficient Diagnosis of Severe Aortic Stenosis

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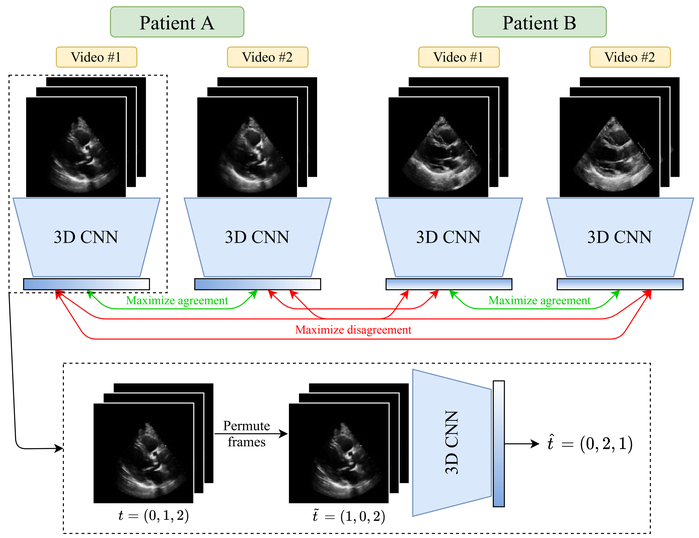
## MOTIVATION

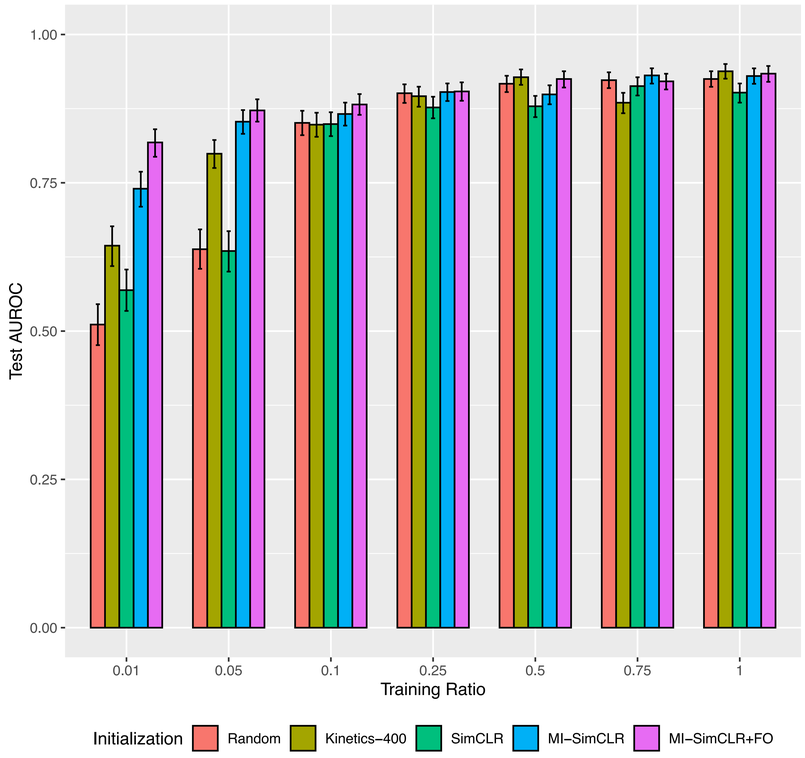
- Problems:
  - Aortic stenosis (AS) is a potentially deadly heart condition
  - Labeling is expensive for medical image recognition tasks
- Goal: Develop a *data-efficient* algorithm for AS diagnosis from 2D echocardiogram videos
  - Solution: self-supervised learning (SSL)
- SSL for echocardiography is difficult because…
  1. Ultrasound images are noisy & brittle to augmentation
  2. Echocardiograms contain rich temporal information

## METHODS



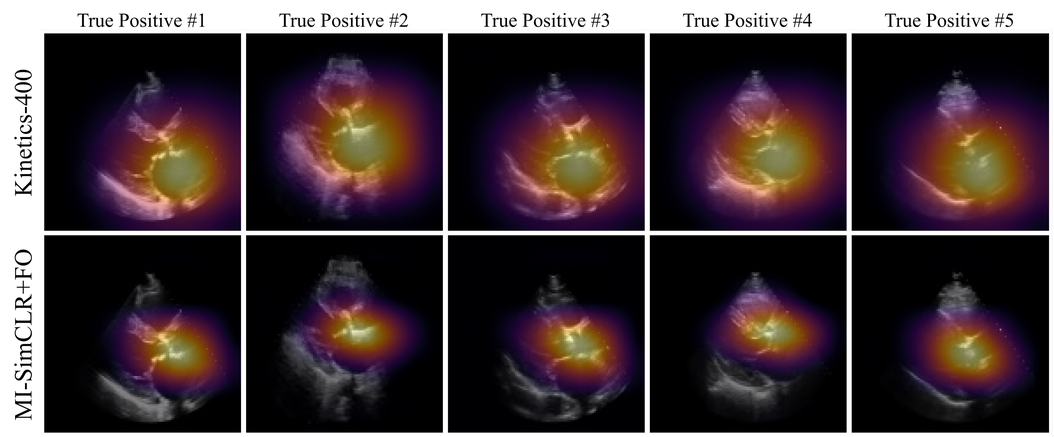

- An SSL method designed for echocardiography:
  1. Use *different* videos from the *same* patient as positive pairs
  2. Use an additional frame re-ordering pretext task
- Evaluated downstream performance of 3 SSL methods:
  - SimCLR
  - Multiple-instance SimCLR (MI-SimCLR)
  - Multiple-instance SimCLR + frame re-ordering (MI-SimCLR+FO)
- Fine-tuned AS model with 5 different inits: ***Random***, ***Kinetics-400***, ***SimCLR***, ***MI-SimCLR***, ***MI-SimCLR+FO***

## RESULTS: Label Efficiency




- Fine-tuned 3D-ResNet18's for severe AS
- On 1% of data (53 studies):
  - **MI-SimCLR+FO**: 0.818 (0.794, 0.840) AUROC
  - **MI-SimCLR**: 0.740 (0.710, 0.769) AUROC
  - **Kinetics-400**: 0.644 (0.610, 0.677) AUROC
- On 5% of data (265 studies):
  - **MI-SimCLR+FO**: 0.872 (0.853, 0.891) AUROC
  - **MI-SimCLR**: 0.853 (0.833, 0.873) AUROC
  - **Kinetics-400**: 0.799 (0.775, 0.822) AUROC
- "Multi-instance" (MI) SSL critical for echos
  - Avoids need for heavy augmentation
- Frame re-ordering helps downstream task
  - Hypothesis: encourages temporal coherence
- Saturation point @ 50% ratio (2.6k studies)

## RESULTS: Interpretability




- For the five most confident severe AS predictions, MI-SimCLR+FO attends more closely to the aortic annulus
  - Critical for building clinician trust in echo-based AI

## PAPER

## CODE