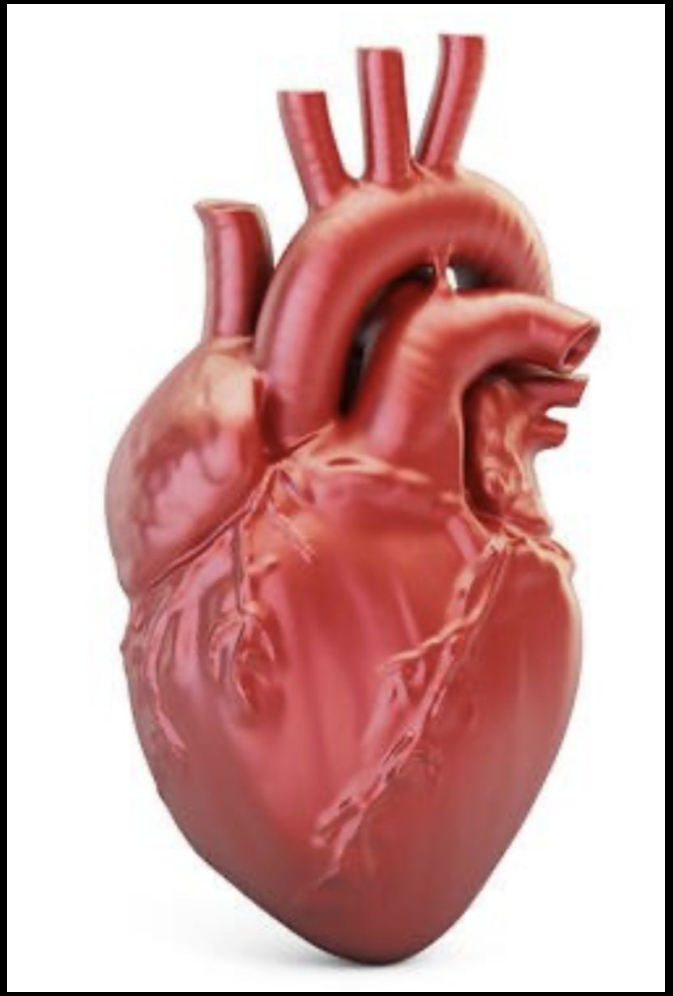


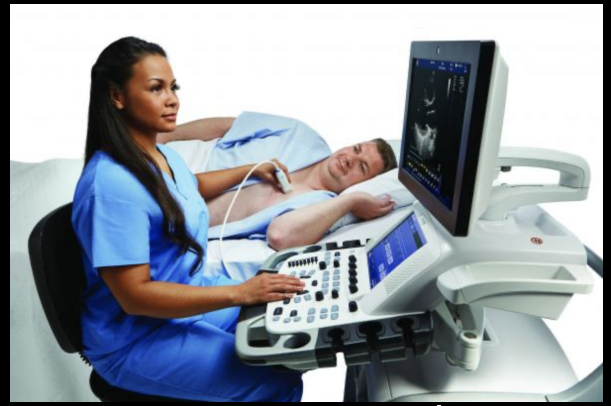
Deep learning takes-on the heart: classification of echocardiogram images

Maya Remington

October 1st, 2021

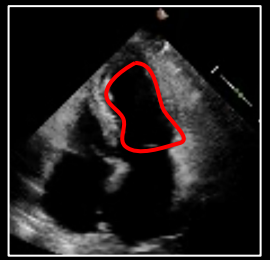
The status quo

- Echocardiogram (aka “echo”) = ultrasound of the heart
    - Widely used to assess heart function and structure
- Certain steps still require significant input by the human operator → errors
- Replacing these steps with machine learning has the potential to improve reliability and accuracy



Human selects frames:

Human traces features:



Goals:

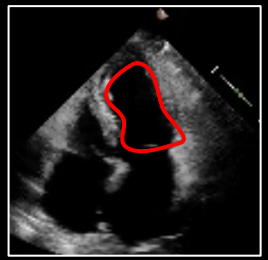
My project:

- Use deep learning to take a small step towards automating one part of the echocardiogram
- In particular I'm going to classify phases of the cardiac cycle

Ultimate goal:

Machine ~~Human~~ selects frames:

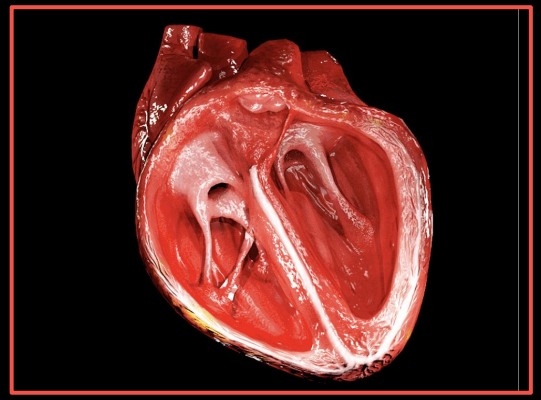
Machine ~~Human~~ traces features:



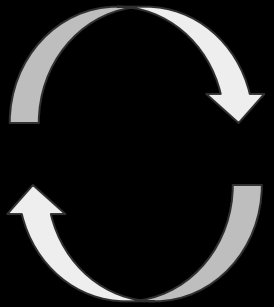
The cardiac cycle = Series of events occurring within a single heartbeat

2 phases:

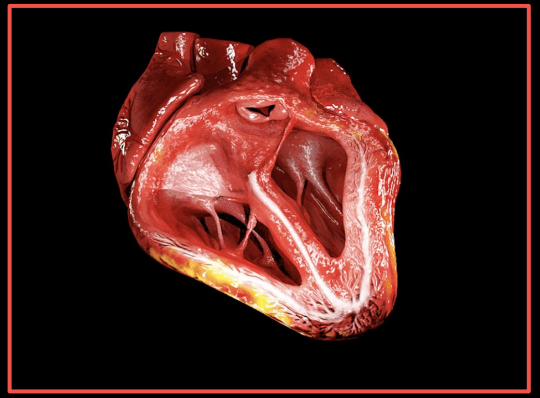
Diastole
(relaxation phase)



End-diastole: ventricles at max relaxation → max size

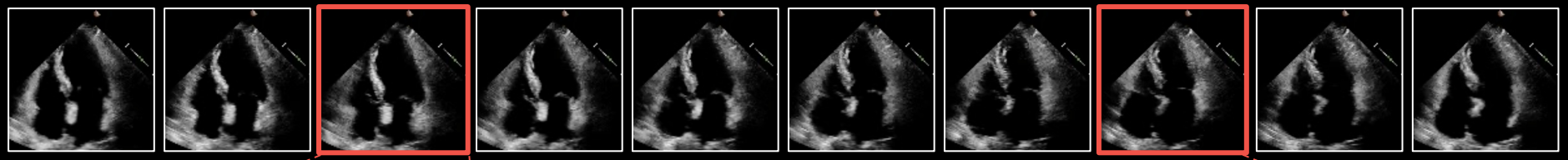


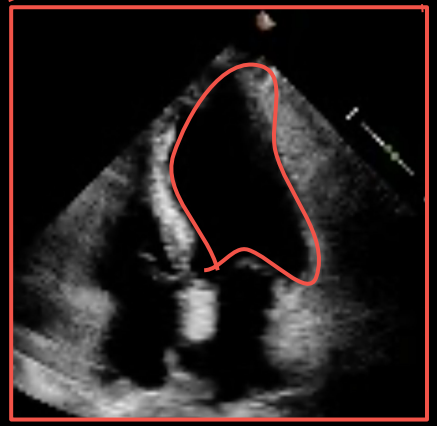
Systole
(contraction phase)



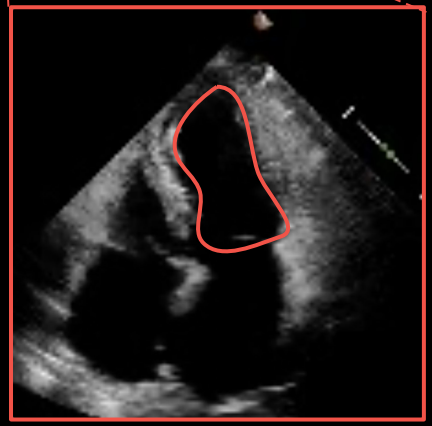
End-systole: ventricles at max contraction → min size

Time →





End-diastole:
ventricles at max relaxation → max size



End-systole:
ventricles at max contraction → min size

Data & Methods

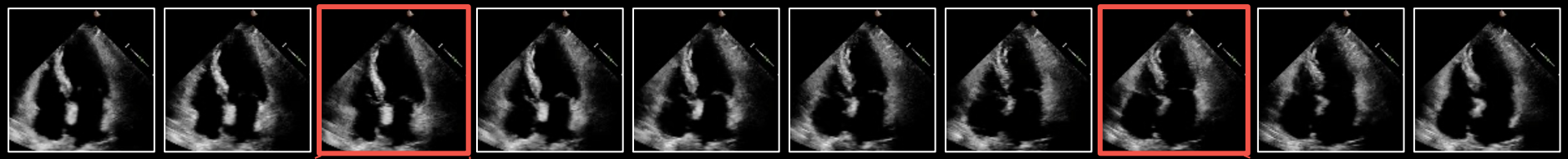
4 chamber view:

EchoNet-Dynamic*

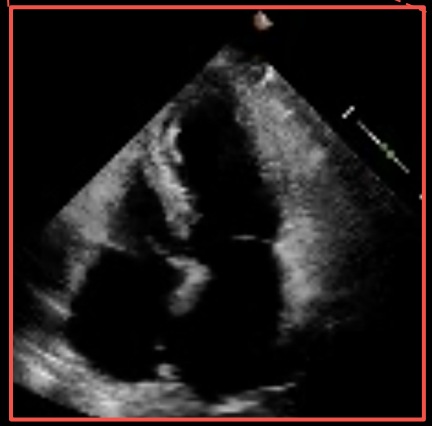
- 10,036 echo video clips
- All the same view: 4-chamber
- Grayscale
- Labeled

*Ouyang, David et al. “EchoNet-Dynamic: a Large New Cardiac Motion Video Data Resource for Medical Machine Learning.”(2019)

Time →

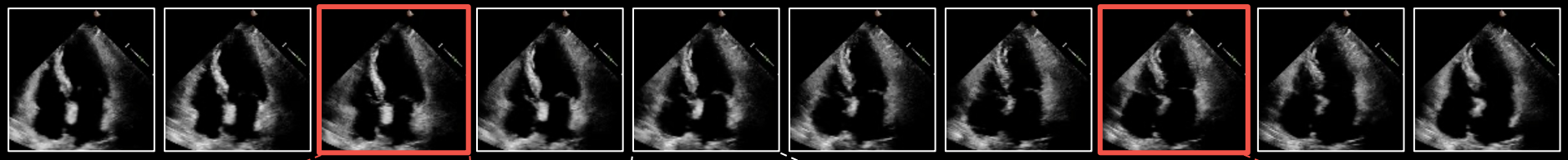


End-diastole:
ventricles at max relaxation → max size



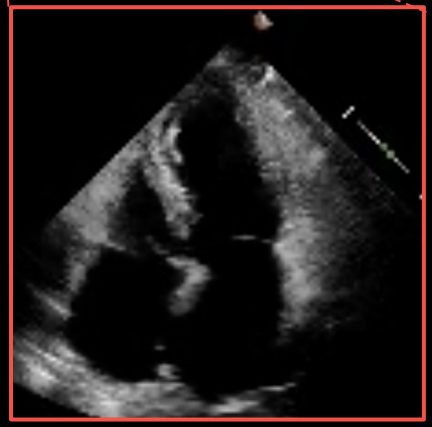
End-systole:
ventricles at max contraction → min size

Time →



End-diastole:
ventricles at max relaxation → max size

Other



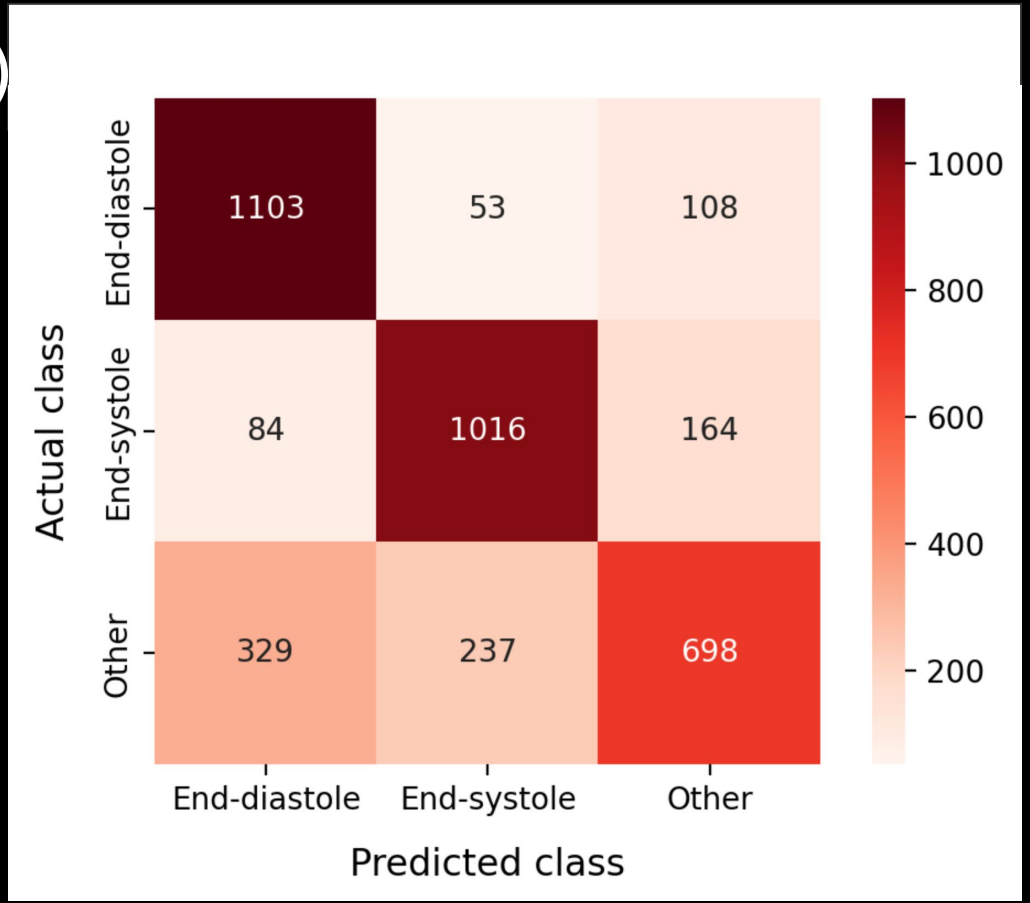
End-systole:
ventricles at max contraction → min size

3 images per video

Simple CNN (5 layers)

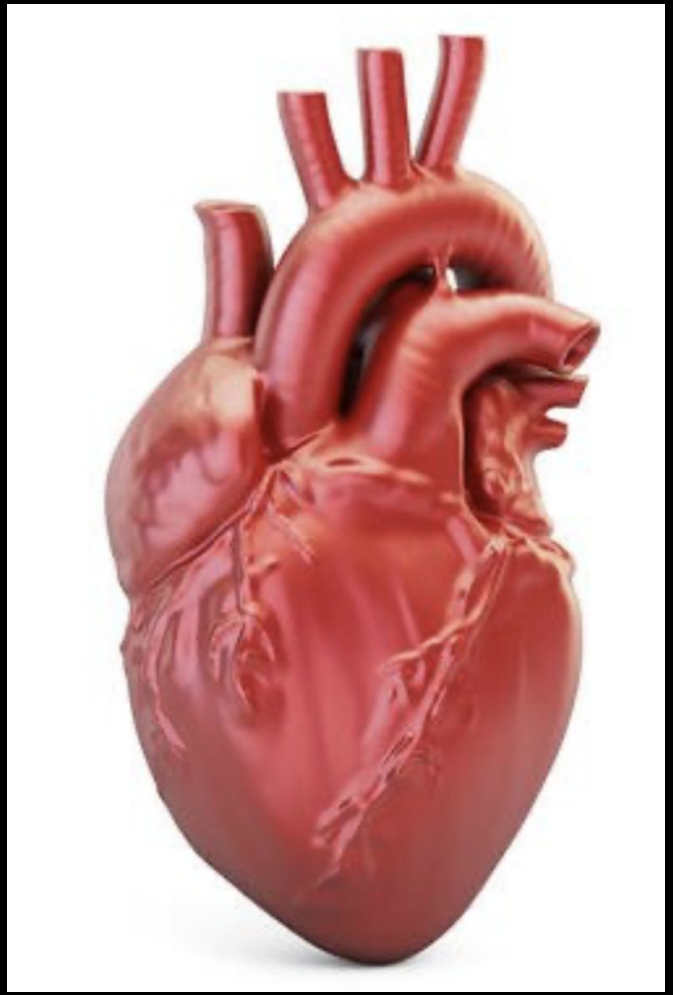
Accuracy = 0.743

- Model excels at distinguishing end-systole from end-diastole
- But struggles to classify the “Other” class
  - Likely due to greater heterogeneity



Conclusion

- A relatively simple CNN (plus a large data set!) classifies echocardiogram images fairly well
- This is one step towards replacing human input - and human error - with machine learning
    - Goal: improve reliability and accuracy



Future Directions

- Generate more “Other” images - representing the entire cardiac cycle
- Build a more advanced model:
  - Segmentation
  - CNN-RNN

Thank you!