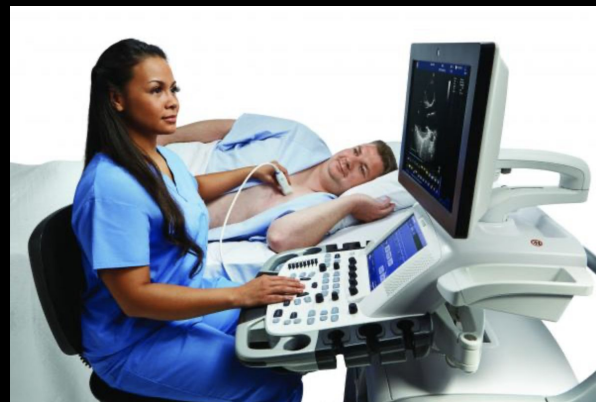


Deep learning takes-on the **heart**: classification of **echocardiogram** images

Maya Remington
October 1st, 2021

The status quo

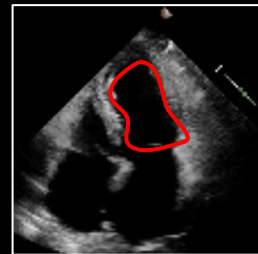
- **Echocardiogram** (aka “echo”) = ultrasound of the heart
 - Widely used to assess heart function and structure
- Certain steps still require significant input by the **human operator** → errors
- Replacing these steps with **machine learning** has the potential to improve reliability and accuracy



Human
selects
frames:



Human
traces
features:



Goals:

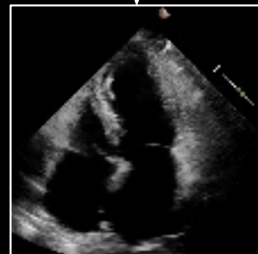
My project:

- 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

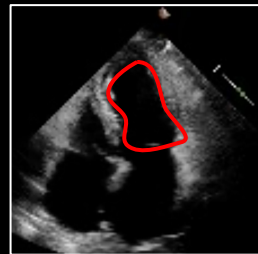


Ultimate goal:

Machine
~~Human~~
selects frames:



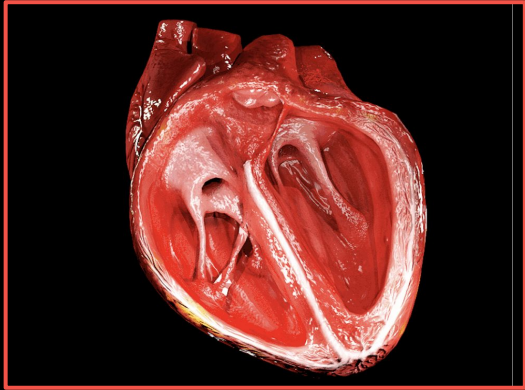
Machine
~~Human~~
traces features:



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

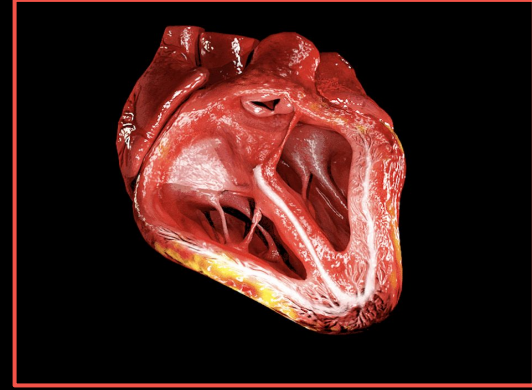
2 phases:

Diastole
(relaxation phase)

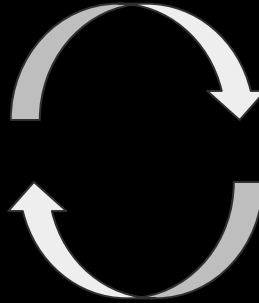


End-diastole: ventricles at
max relaxation → **max size**

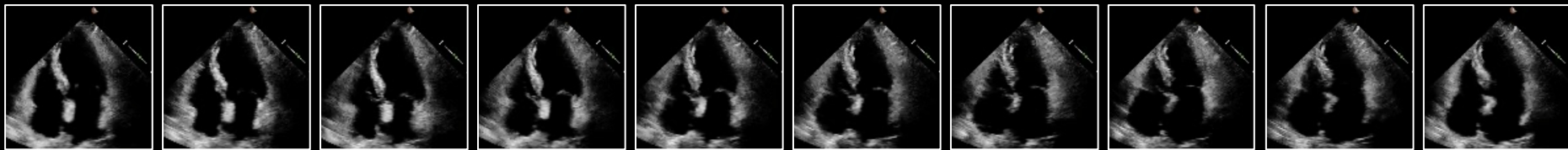
Systole
(contraction phase)



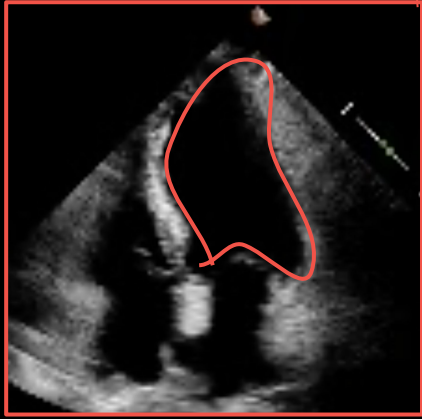
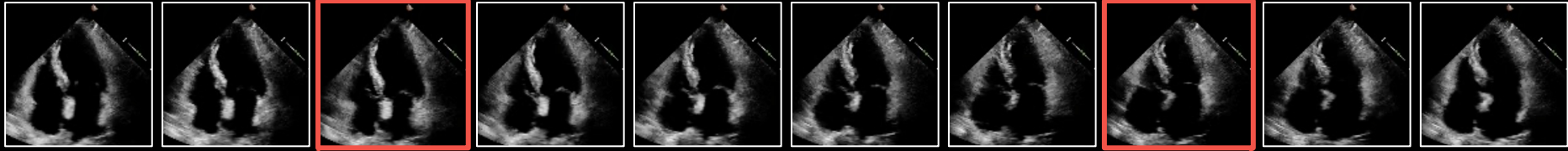
End-systole: ventricles at
max contraction → **min size**



Time →



Time →



End-diastole:
ventricles at max
relaxation → **max size**



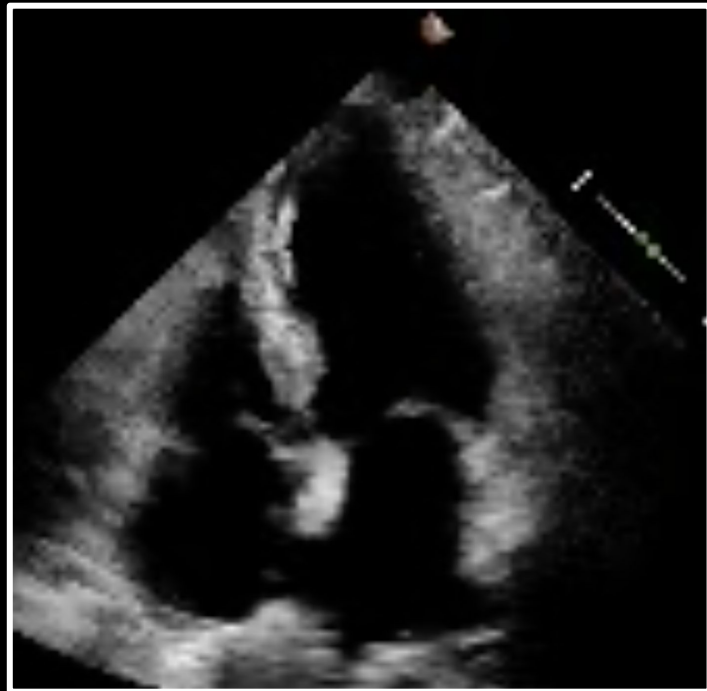
End-systole: ventricles
at max contraction →
min size

Data & Methods

EchoNet-Dynamic*

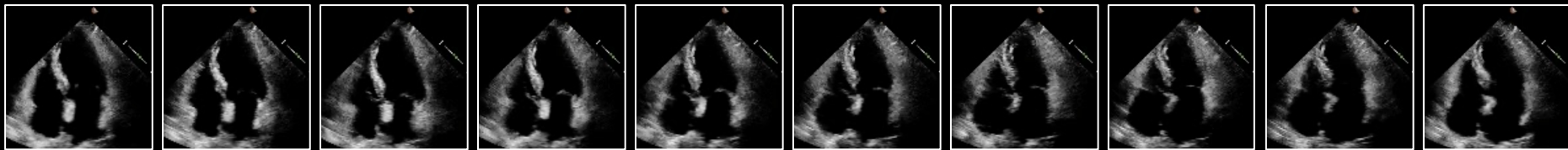
- 10,036 echo video clips
- All the same view: 4-chamber
- Grayscale
- Labeled

4 chamber view:

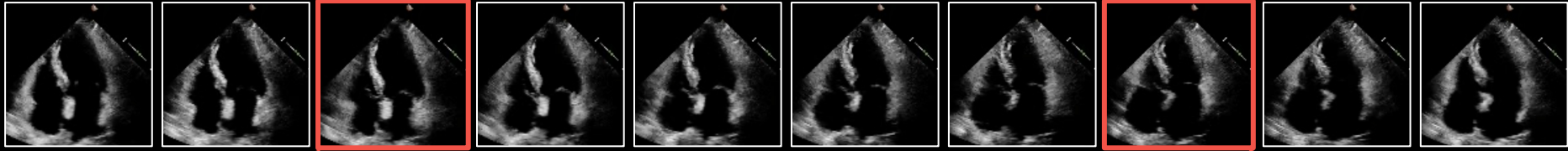


*Ouyang, David et al. "EchoNet-Dynamic: a Large New Cardiac Motion Video Data Resource for Medical Machine Learning."(2019)

Time →



Time →

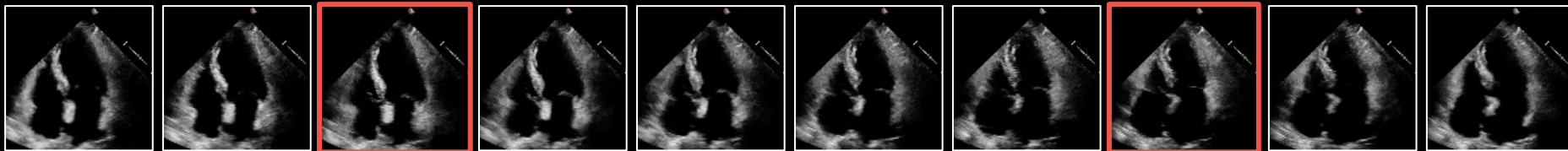


End-diastole:
ventricles at max
relaxation → **max size**

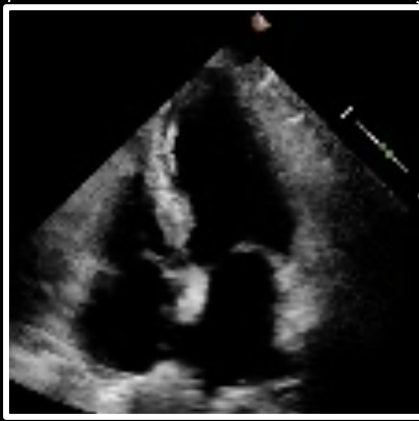


End-systole: ventricles
at max contraction →
min size

Time →



End-diastole:
ventricles at max
relaxation → **max size**



Other

3 images per video

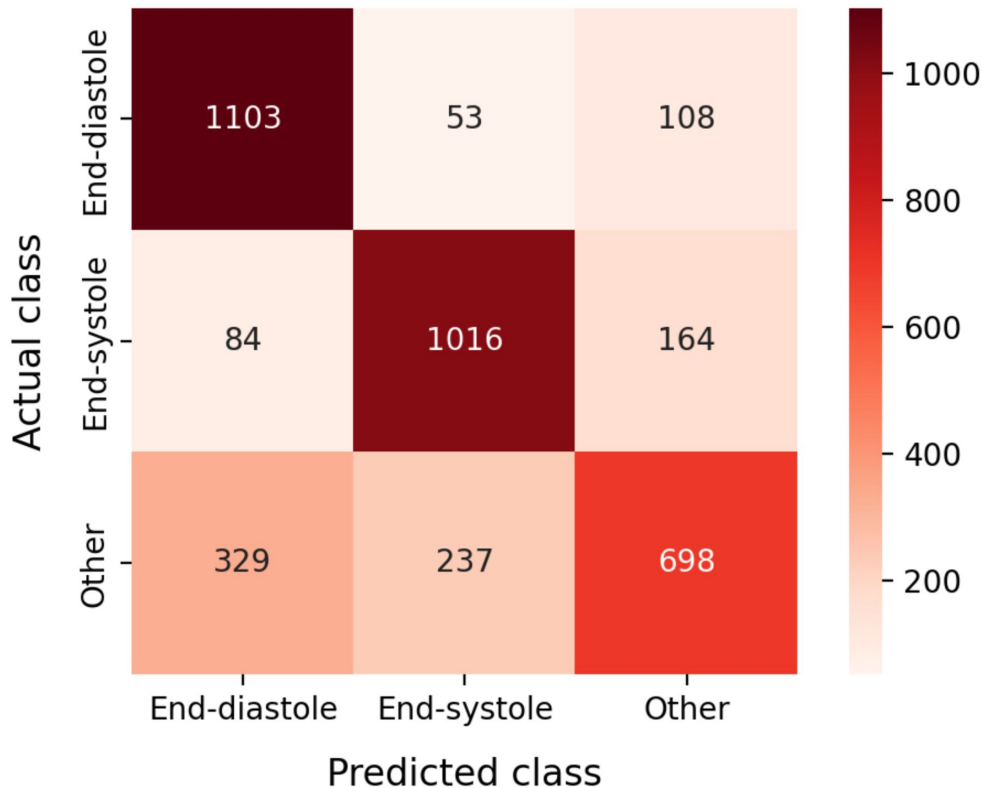


End-systole: ventricles
at max contraction →
min size

Simple CNN (5 layers)

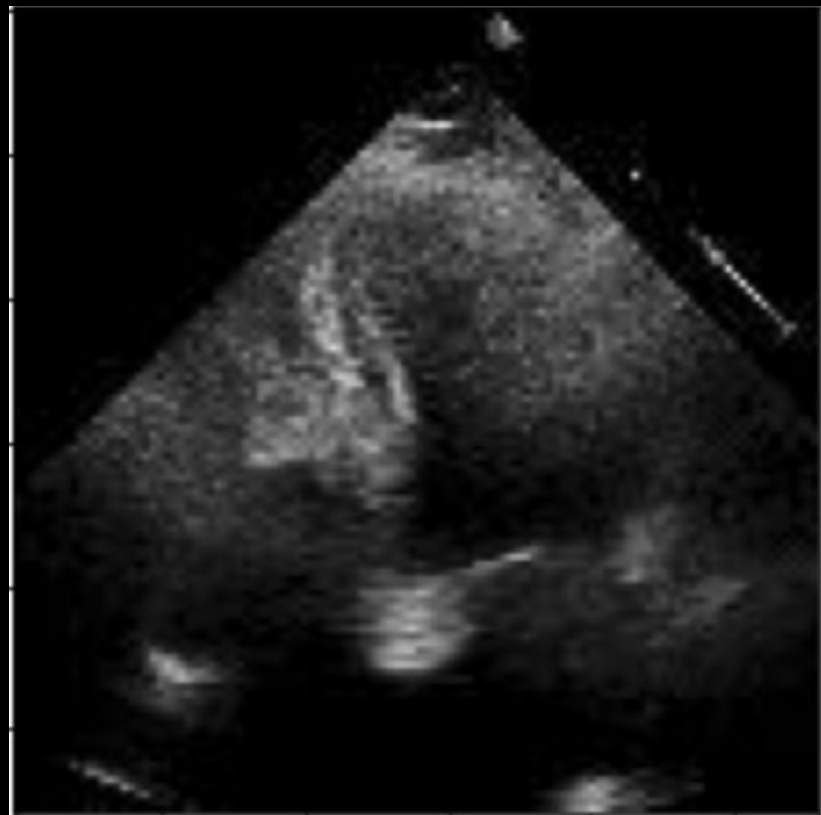
Accuracy = 0.743

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



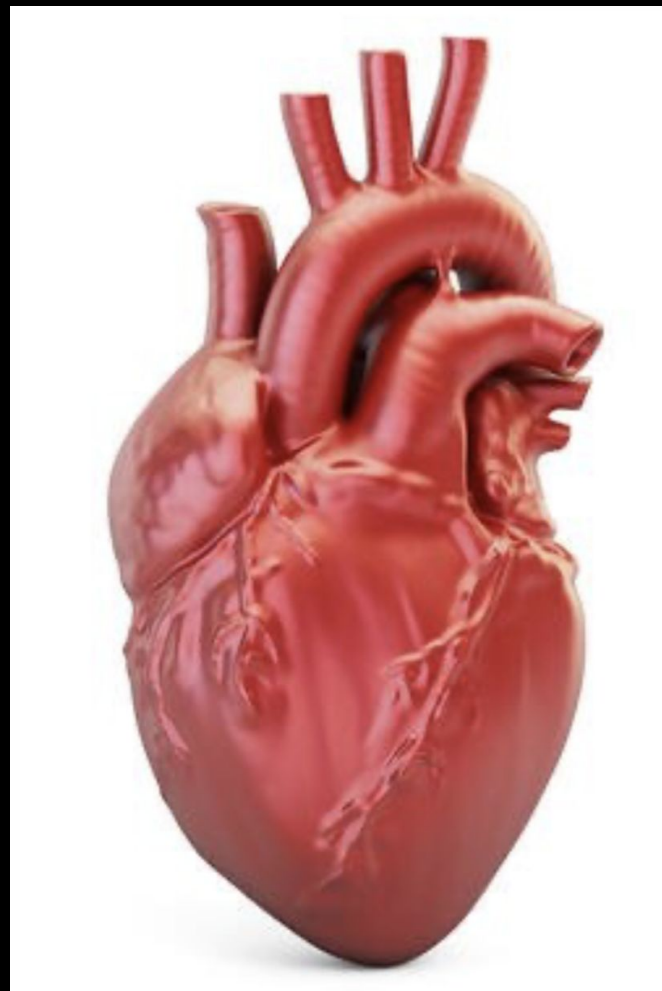
Poor image quality

Likely contributing to incorrect classification!



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
- In order to 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!