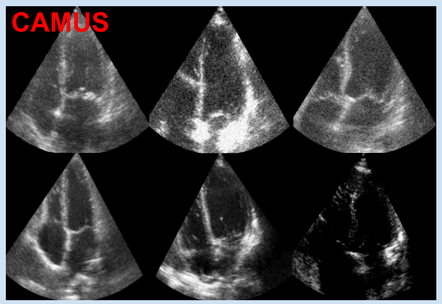
Domain Adaptation on Segmentation of Echocardiography

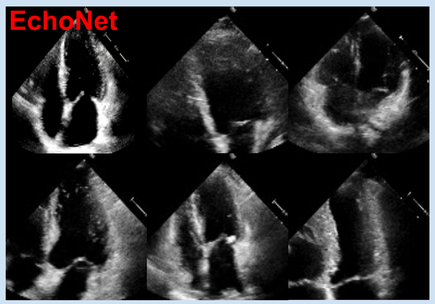
Junyang Cai
Advisors: Dr. Joshua Stough[1], Dr. Christopher Haggerty[2]
[1]Department of Computer Science Bucknell University, Lewisburg, PA
[2]Translational Data Science and Informatics, Geisinger Health Group

Motivation

- Echocardiography segmentation using convolutional neural network (CNN) is a promising solution for diagnosis of cardiovascular disease.
- The performance of such machine learning models trained from a particular source domain, when transferred to a different target domain can drop unhelpfully[1].
- We want to integrate and analyze domain adaptation techniques to build a CNN for echocardiography segmentation that generalizes well across datasets and outperforms other models that do not use domain adaptation.

Datasets and Experiment Setup

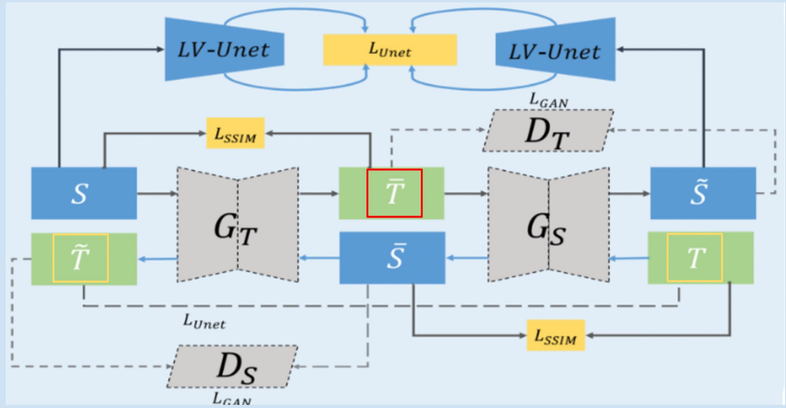




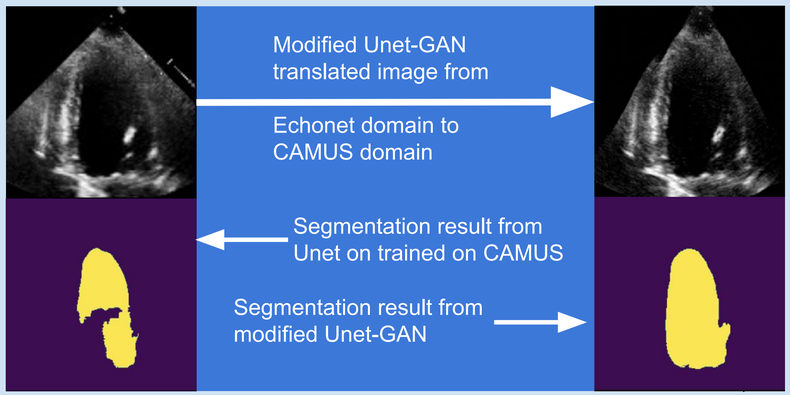
- We have two datasets of echocardiogram images: CAMUS[2] and EchoNet[3]. The experimental setup for this research is:
- 1. Train on CAMUS dataset, Test on EchoNet dataset (current standard, baseline)
- 2. Train on EchoNet dataset, Test on EchoNet dataset (best possible performance, only possible when you have enough annotated data in target domain)
- 3. Domain adaptation train on CAMUS and EchoNet dataset, Test on EchoNet dataset (expect to perform better than 1 and hopefully close to 2)

Modified Unet-GAN

- Yan et al. [1] proposed a generic framework called Unet-GAN which can translate an image from a source domain to a target domain in the absence of paired examples while keeping the anatomical structure the same.
- We modified the Unet-GAN by including training the Unet model through the training process of the GAN to ensure our Unet model become more generalized on both domains.

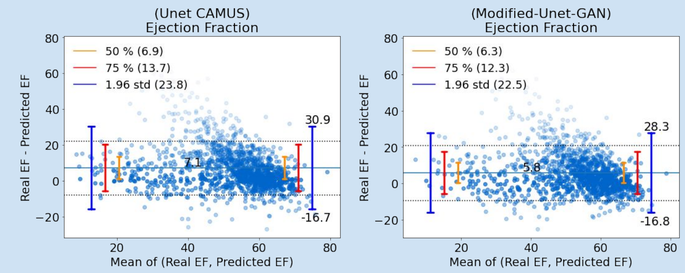


Example of one case



Results

- Mean absolute error of EF from 1264 patients:
- 11.47% on Unet CAMUS (experiment 1)
- 11.29% on original Unet-GAN
- 9.84% on Modified Unet-GAN (experiment 3)
- 6.91% on Unet EchoNet (experiment 2)



Conclusions

- Domain adaptation can help overcome domain shift problems.
- Our modified Unet-GAN with colearning image translation and segmentation is better than original Unet-GAN.

References

- [1] Yan, W.; Wang, Y.; Gu, S.; Huang, L.; Yan, F.; Xia, L.; Tao, Q. The domain shift problem of medical image segmentation and vendor-adaptation by Unet-GAN. arXiv 2019, arXiv:1910.13681.
- [2] J.V. Stough, S. Raghunath, X. Zhang, J. M. Pfeifer, B. K. Fornwalt, and C. M. Haggerty, “Left ventricular and atrial segmentation of 2D echocardiography with convolutional neural networks” https://doi.org/10.1117/12.2547375
- [3] Ouyang, D., et al.: Video-based ai for beat-to-beat assessment of cardiac function. Nature 580(7802), 252–256 (2020)

Acknowledgement

- Bucknell University Department of Computer Science
- Bucknell Geisinger Research Initiative.
- Ciffolillo Healthcare Technology Inventors Program