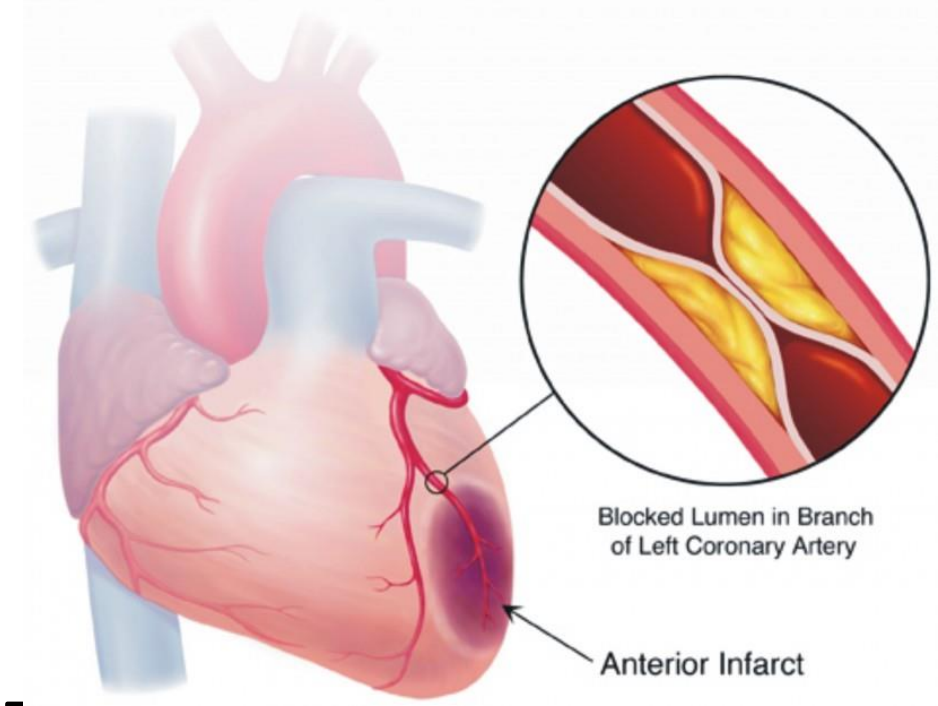
AI in Heart Diseases

Cardiovascular diseases

- Cardiovascular diseases are the number one cause of death globally, according to the World Health Organization.
- Taking an estimated 17.9 million lives each year.
- one third of these deaths occur prematurely in people under 70 years of age.

How is deep learning helps in cardiac imaging analysis

- Deep learning can help to analyze coronary angiography



- echocardiography and electrocardiogram (ECG).
- identify coronary atherosclerotic plaques more accurately than clinicians.

Cardiac intervention has been the main treatment for cardiovascular disease in recent decades.

- AI can also be used to analyze echocardiographic images.
- automatic measurement of the size of each chamber and assessment of left ventricular function.

- it can be used to assess structural diseases, such as valvular disease, to help determine the classification and staging of the disease.

A group of experiments use artificial intelligence

- Rima Arnaout, an assistant professor at the University of California, San Francisco, built convolutional neural networks by using the echocardiographies of 267 randomized patients (age range: 20–96 years) between 2000 and 2017 from the university medical center.

- From the perspective, 223,000 images were divided into fifteen categories. Furthermore, this classification algorithm has outperformed the human cardiovascular physicians in the classification competition of cardiac ultrasound images.

A group of experiments use artificial intelligence

- Another study from Samad, et al.

- demonstrated that deep learning can predict survival with higher accuracy after analyzing echocardiography of multiple cases.
- Other applications of AI in cardiac imaging analysis include intravascular ultrasound (for the detection of the border of the lumen and the media-adventitia)
- optical coherence tomography (for the classification of the three layers of the coronary artery)

A group of experiments use artificial intelligence

- cardiac single-photon emission computed tomography (for the diagnosis of myocardial ischemia.
- the improvement of the diagnostic accuracy of myocardial perfusion imaging)
- MRI (for the efficient and fast visualization of the cardiac segmentation in short-axis MRI).

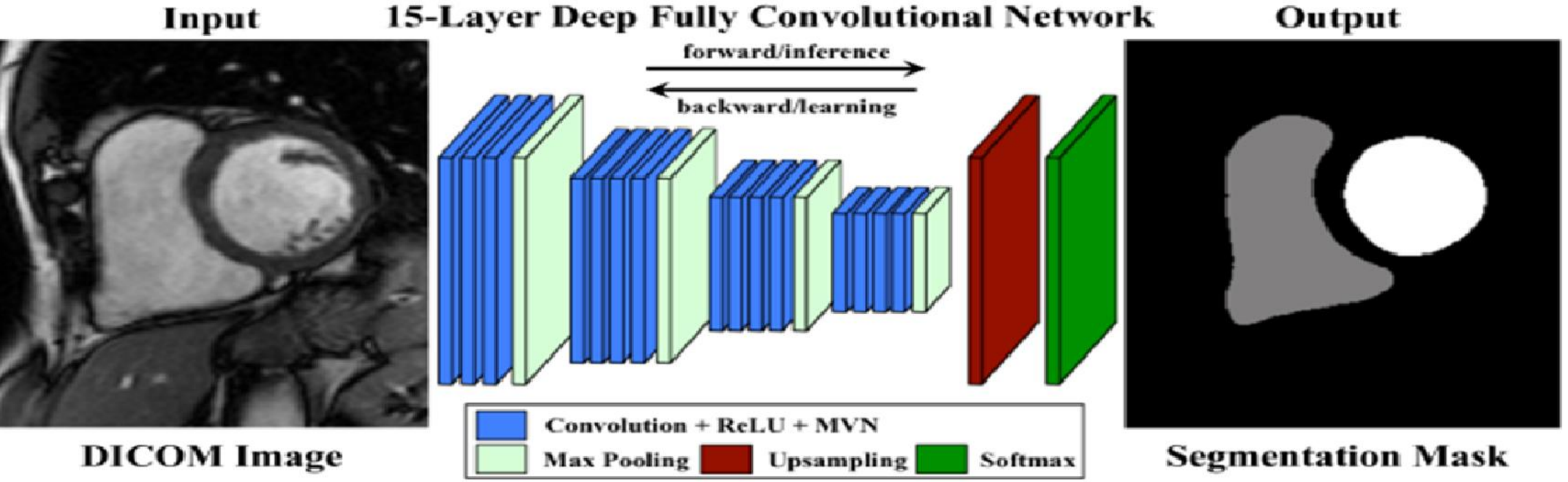
A Fully Convolutional Neural Network for Cardiac Segmentation in Short-Axis MRI.

- We propose to tackle the problem of automated left and right ventricle segmentation through the application of a deep fully convolutional neural network architecture.
- Our model is efficiently trained end-to-end in a single learning stage from whole-image inputs and ground truths to make inference at every pixel.
- this is the first application of a fully convolutional neural network architecture for pixel-wise labeling in cardiac magnetic resonance imaging.
- The models and code are available at https://github.com/vuptran/cardiac-segmentation.

Deep learning segmentation of major vessels in X-ray coronary angiography

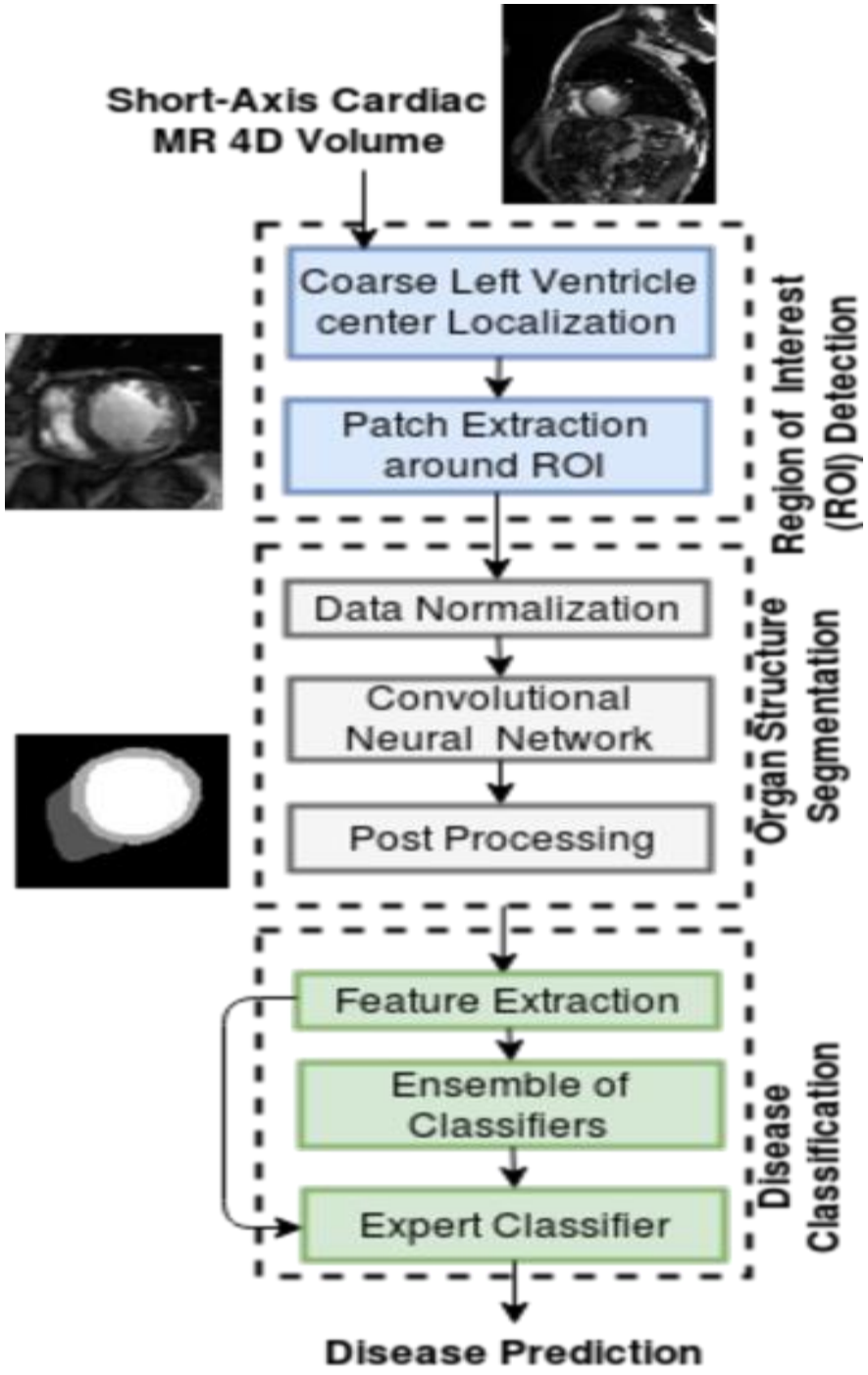
There are a number of open technical challenges in automated left ventricle (LV) and right ventricle (RV) segmentation

- The overlap of pixel intensity distributions between cardiac objects and surrounding background structures.
- The shape variability of the endocardial and epicardial contours across slices and phases;
- Extreme imbalance in the number of pixels belonging to object class versus background;
- Fuzzy boundary and edge information, especially in basal and apical slices;
- Variability in cine MRI from different institutions, scanners, and populations;
- Inherent noise associated with cine MRI.


Input
15-Layer Deep Fully Convolutional Network
Output
forward/inference
backward/learning
Convolution + ReLU + MVN
Max Pooling
Upsampling
Softmax
DICOM Image
Segmentation Mask

Results of comparison study for analyzing the effectiveness

- Illustrates our automated cardiac segmentation and disease diagnosis framework. The pipeline involves:
- Fourier analysis and Circular Hough-Transform for Region of Interest (ROI) cropping.
- Proposed network for cardiac structures segmentation.
- An ensemble of classifiers for disease diagnosis based on features extracted from the segmentation.



References

- https://www.who.int/health-topics/cardiovascular-diseases/#tab=tab_1
- https://github.com/vuptran/cardiac-segmentation
- https://www.groundai.com/project/a-fully-convolutional-neural-network-for-cardiac-segmentation-in-short-axis-mri/3
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