Deep Learning Model Automatically Finds the Aorta in MR Images

Deep learning models are becoming increasingly more used to assist physicians in making diagnoses. For patients with heart disease, it may be useful to calculate the flow in the aorta. Today it is necessary for physicians to manually draw a line around the aorta to make these flow calculations, but the process could be sped up using a deep learning algorithm which automatically finds the aorta in the images.

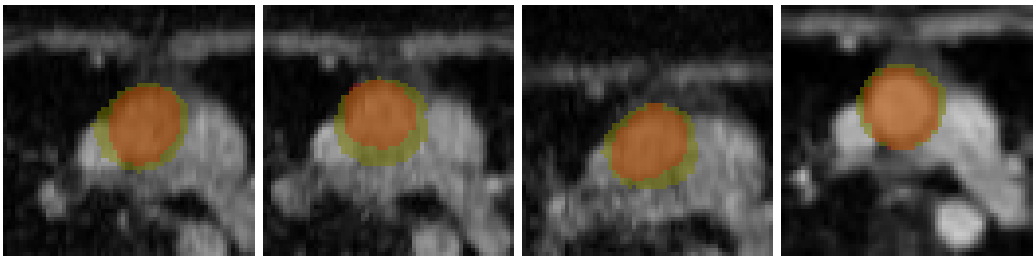
Based on the master thesis "Aortic Segmentation in Real-Time Flow Exercise Cardiac Magnetic Resonance Images using Convolutional Neural Networks" by Mathilda Larsson.

Cardiovascular disease, meaning diseases related to the heart and circulatory system, is the leading cause of death worldwide. In order to diagnose and understand these diseases, it is important for physicians and researchers to be able to understand what happens in the cardiovascular system. This includes imaging both healthy participants (in order to understand how a body without disease functions) and patients with a suspected or confirmed disease. One imaging tool is magnetic resonance (MR) imaging, which uses magnetic fields in a scanner to image the blood flow of the aorta. These flow measurements can be used to evaluate how much blood the heart can pump in terms of volume. Some heart disease is only noticed during exercise, hence it is important to be able to make these measurements as the participant is exercising inside the MR scanner.

To measure the blood flow, it is necessary for a physician to delineate the aorta in the acquired images. This means that the physician has to draw a line around the aorta in every image, using computer software. This is a time-consuming process and could benefit from being assisted by advanced algorithms that automatically delineates the aorta.

One way of implementing such an algorithm is by using a form of deep learning known as a convolutional neural network. Such a network consists of many mathematical operations which are applied to the images containing the aorta with the goal of teaching the network to automatically identify the vessel.

In this project, convolutional neural networks were trained to automatically delineate the aorta in MR images by showing the networks the images and the corresponding reference manual drawing around the vessel. The networks were trained using different settings which modified either the network structure or some part of the training process. Using the settings which gave the best results, a final network was trained and evaluated. In the images below, the network's guess of where the aorta is located is shown in yellow and the manual drawing is shown in orange.



Example images of the delineations by the final network. The orange color overlay is the manual delineation by the physician, the yellow is the delineation made by the network.

As can be seen in the example images above, the final network generally overestimates the area of the aorta. This results in an overestimation of the volumes of blood that the heart pumps during exercise. Before the network trained in this thesis could be used by physicians or researchers, new networks need to be trained using more images. This could be images from other hospitals and other delineators in order to make the network better at delineating new images.