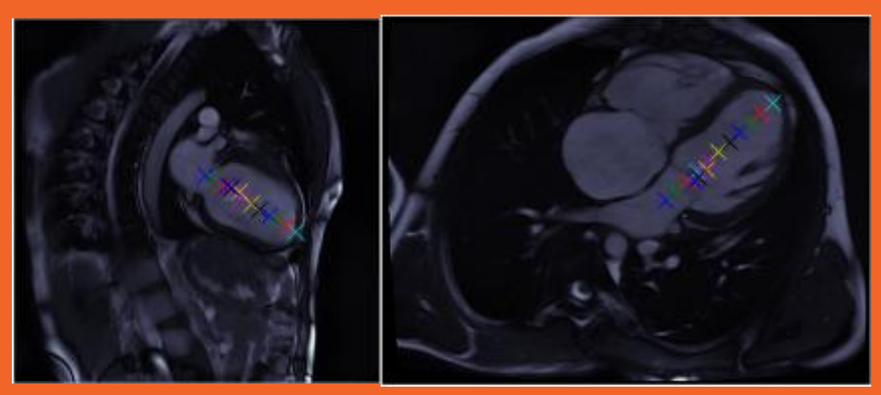
Using Deep Learning to Estimate Systolic and Diastolic volumes from MRI-images

In this paper, we focus on the problem of automatically annotating the volumes of the left ventricle in the heart, based on DICOM MRI-images. This solution came second in an international data mining competition on Kaggle. We show that it is possible to achieve near-human performance using a deep learning approach when using model architectures, designed for this task.

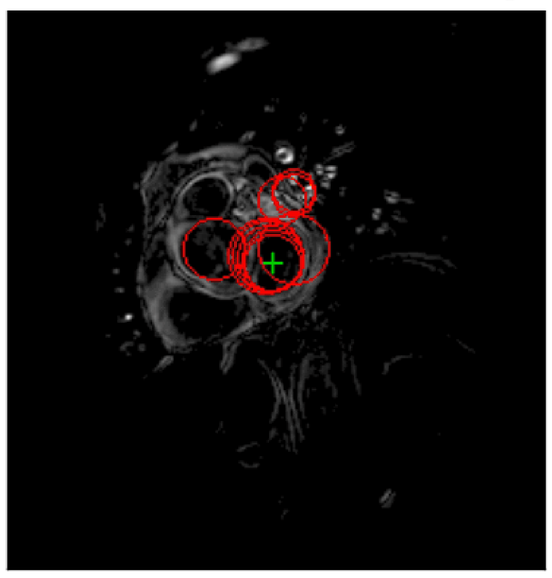
What does it do?

We have multiple slices of the upper body of the patients, each slice showing the evolution of the inside of the body over the period of one heartbeat. Together they form a 4D-dataset of the human body, in which we need to find the minimal and maximal volume in the period of a heartbeat of the left ventricle of the heart.



How does it work?

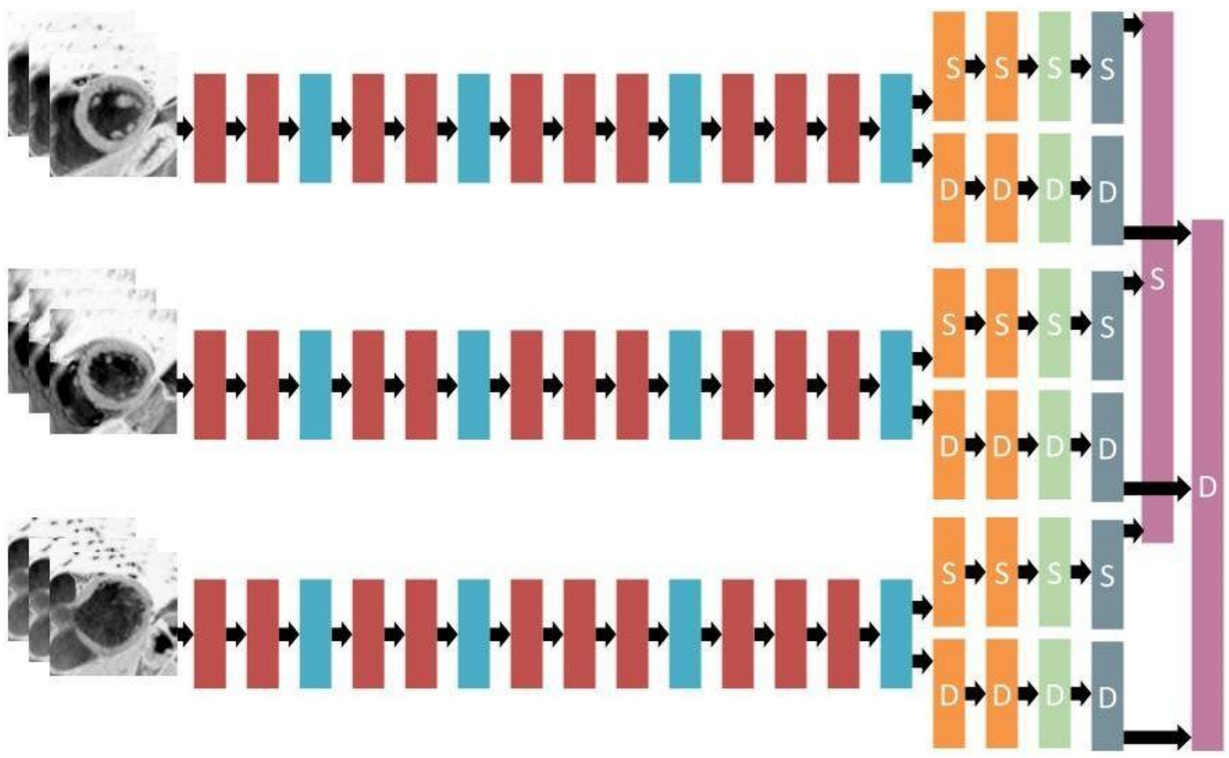
Hough-circle transform on Fourier transform of images



To find the ventricle candidates, we look for circular moving shapes in the slices. The slices are then cut to only include a fixed area around these slices.

The network

A deep neural network then estimates the surface area of this ventricle. These surfaces are combined to find the volume. This entire setup is then trained end-to-end in order to learn how radiologists define the systolic and diastolic surface area.



Result: we achieve near-human performance

	Diastolic Volume	Systolic Volume	Ejection Fraction
CNN	13.65	10.43	6.99%
Human	13	14	6%

#	Δrank	Team Name ‡ model uploaded * in the money	Score	Entries	Last Submission UTC (Best – Last Submission)
1	↑4	Tencia & Woshialex ‡ *	0.009485	5	Sun, 13 Mar 2016 03:14:30 (-3.9d)
2	↑22	**kunsthart ‡ ***	**0.010123**	**4**	**Sun, 13 Mar 2016 19:40:32 (-32.7h)**
3	↑13	Julian de Wit ‡ *	0.010139	3	Mon, 14 Mar 2016 18:17:10
4	↓3	show_me_the_money ‡	0.010666	5	Mon, 14 Mar 2016 15:45:40

Depicted is the final RMS-error of our model. Lower is better. This result shows that our approach is working well enough for medical applications. This will remove the need for highly-trained radiologists for the tedious task of annotating slices of a single patient for over two hours.

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