UNIVERSITY CHILDREN'S HOSPITAL ZURICH

ESPR European Society of Paediatric Radiology

Artificial intelligence segmentation of pediatric MR urography

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F.M. Callaghan[1,2], M. Zellner[3], N. Kocher[3], C.J. Kellenberger[3]

[1]Center for MR Research, University Children's Hospital, University of Zurich, Switzerland.

[2]Children's Research Center, University Children's Hospital, University of Zurich, Switzerland.

[3]Department of Diagnostic Imaging, University Children's Hospital, University of Zurich, Zurich, Switzerland

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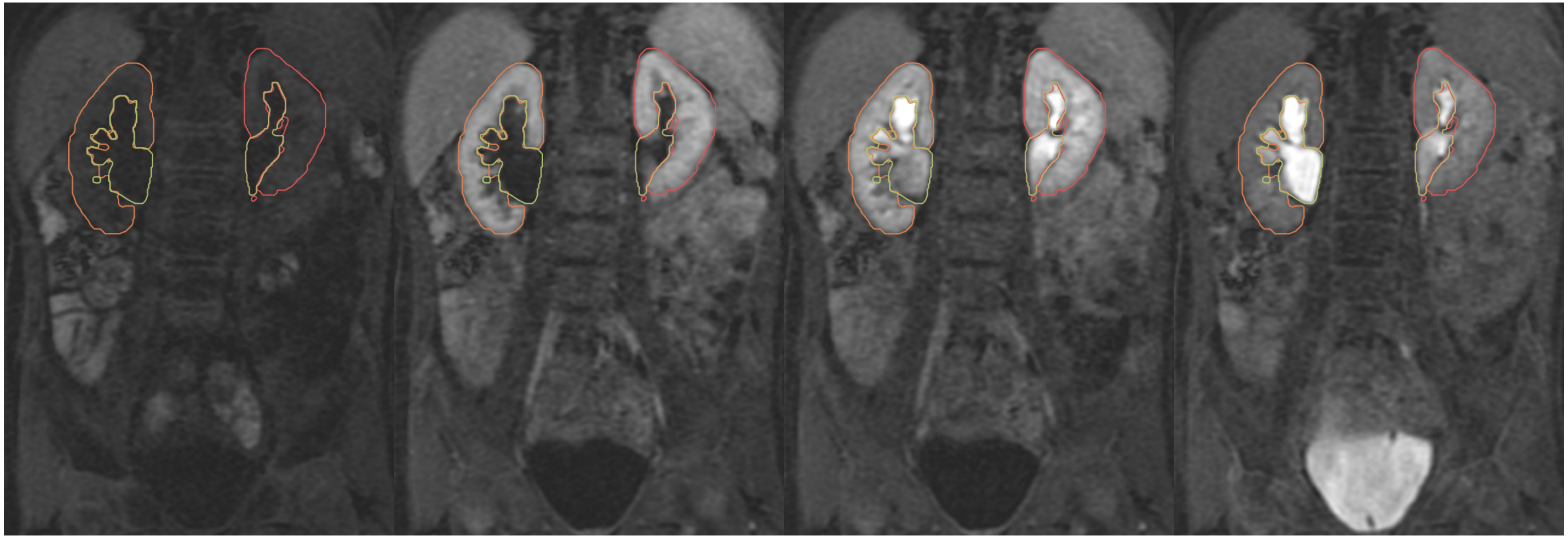
Background

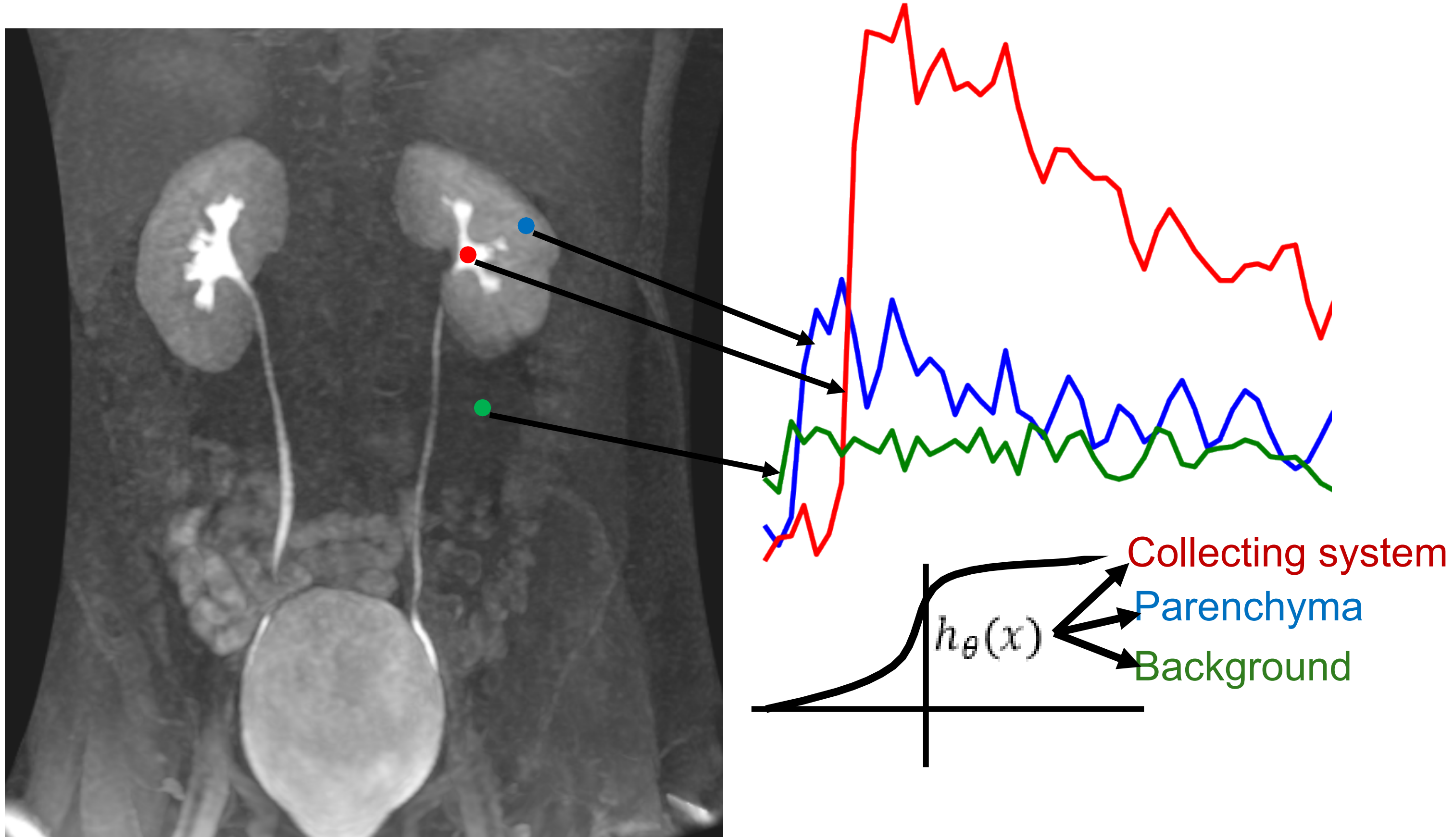
MRI Urography (MRU) is a valuable modality for evaluation of the kidneys and urinary tract in children without exposing the child to ionizing radiation.
Multiple volumes are acquired covering the urinary system at time points during injection and excretion of a contrast agent.
Time dependent signal intensity is assessed within different compartments for evaluation.



Background

The assessment of image data is complex and time consuming.

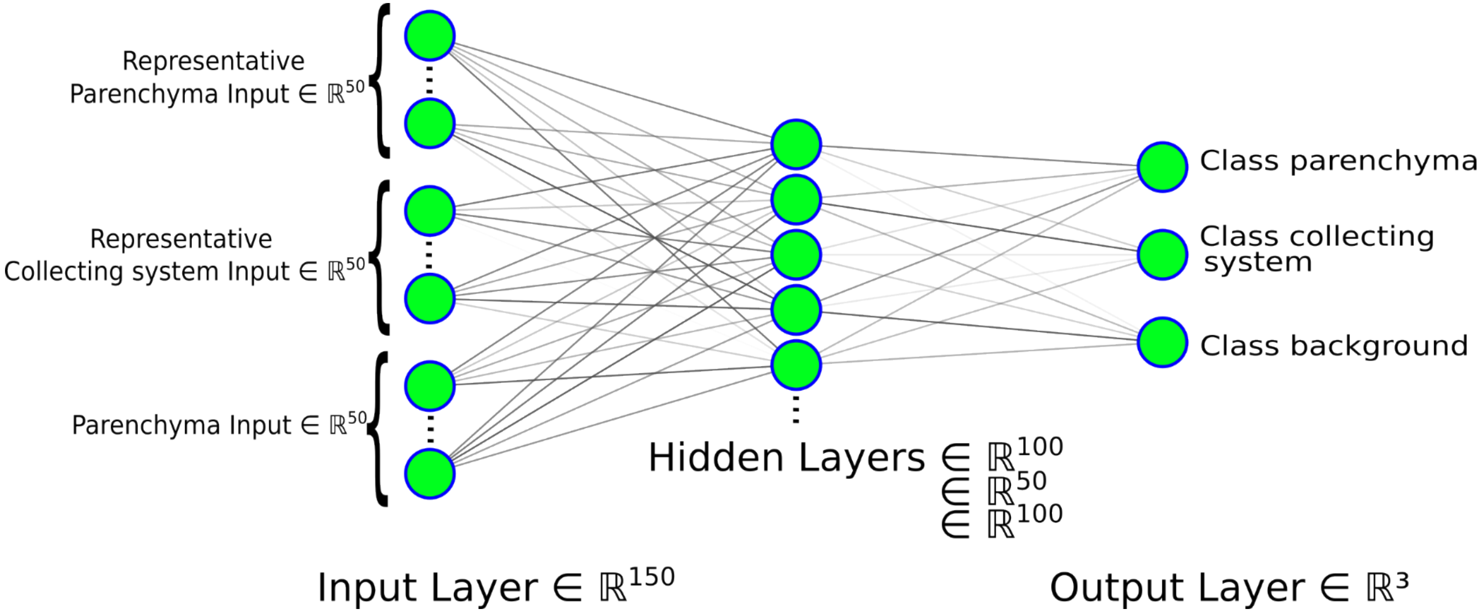
We developed an artificial intelligence algorithm for automated kidney compartment segmentation.



Typical MRU data and enhancement curves from parenchyma, collecting system and background voxels.

Methods

Neural network



Training data

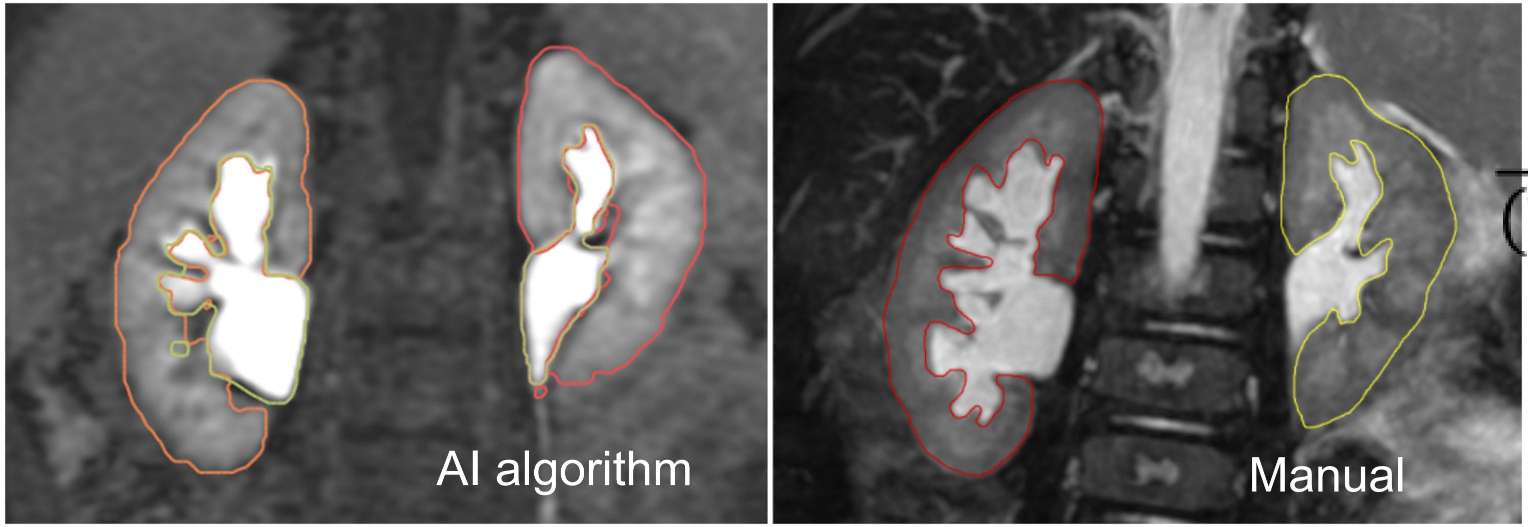
- > 100,000 time curve samples
- 10 subjects
- Left and right kidneys

A fully connected neural network was developed to classify voxels based on signal intensity time series curves.
Model inputs are representative times series from the parenchyma and collecting system of the compartment of interest. This permits <u>compartment specific segmentation</u> of left and right, and even upper and lower poles of duplex kidney systems.

Methods

Validation of segmentation against ground truths

- Manual segmentations performed on 3D fast spin echo data (typical clinical practice)
- 12 subjects not in training data set
- Two blinded readers
- Sorensen-Dice used for similarity metric



Automated DL segmentation (left) compared against same slice manual segmentation (right).

$$\frac{2\times TP}{(TP+FP)+(TP+FN)}$$

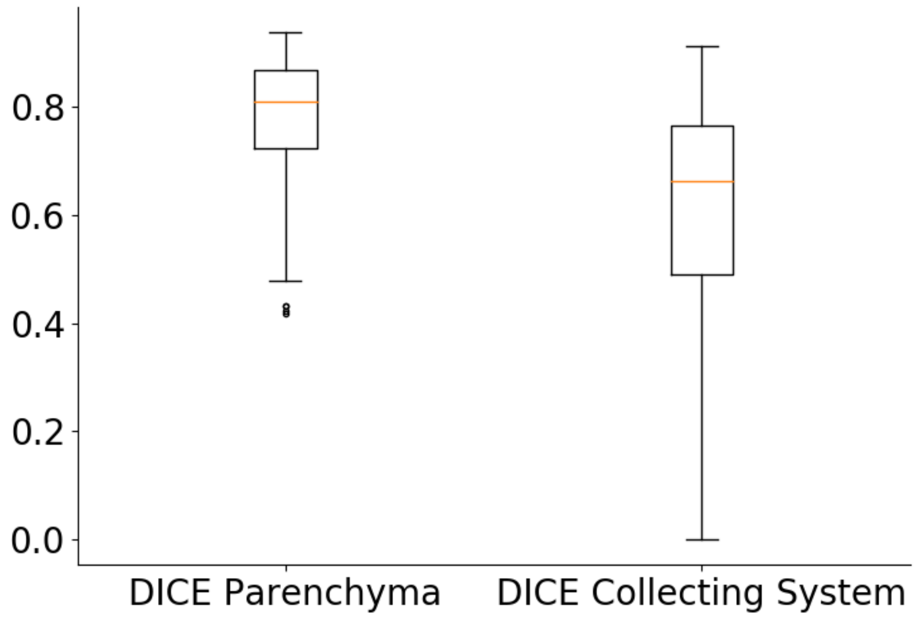
$$=1 : Perfect\ match$$

$$=0 : No\ matching\ voxels$$

Sorensen-Dice similarity metric.

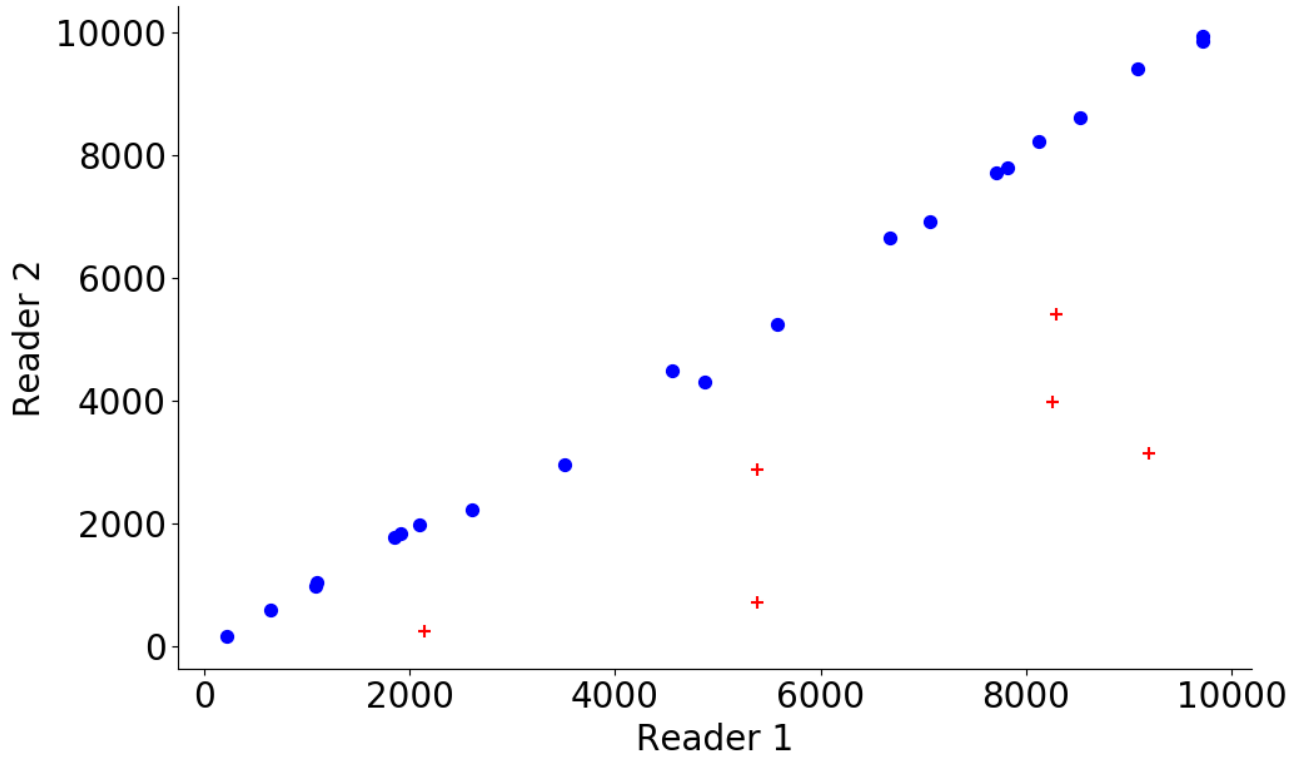
Results

DICE Score



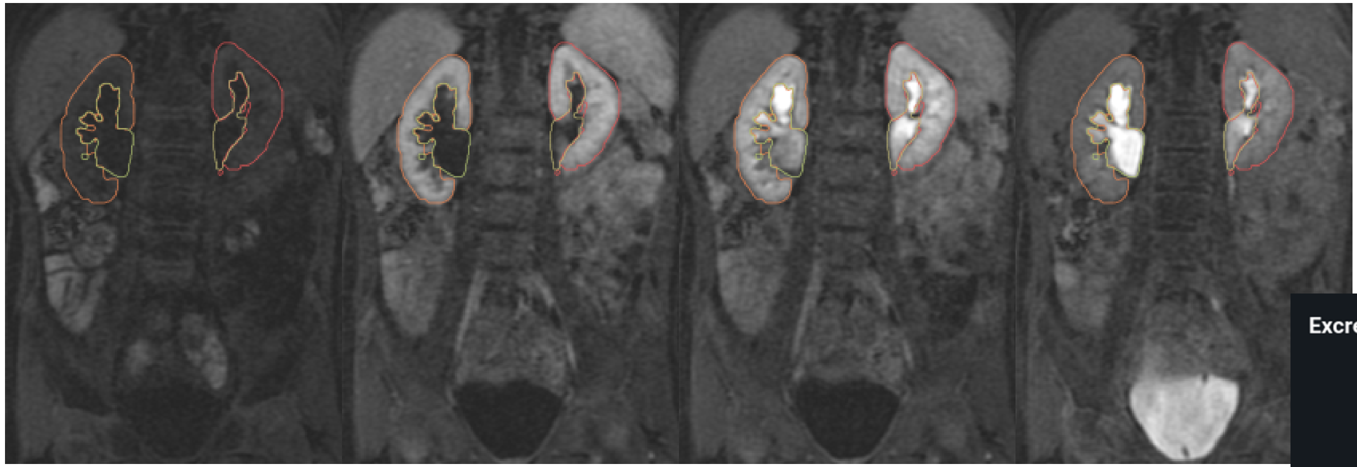
DICE score distribution for parenchyma and collecting system segmentations.

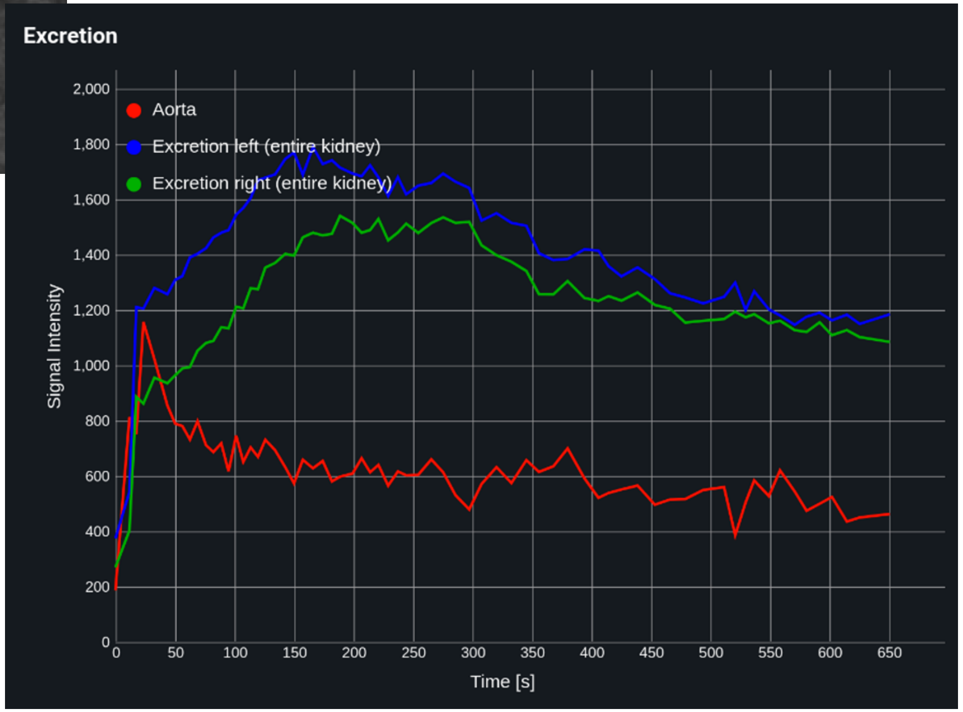
Inter-reader variability



Inter-reader agreement (outliers marked in red). Outliers due to technical limitations in image registration

Discussion





- Small user input achieves very good automatic segmentations
- Full compartment segmentation improves volume and enhancement curve measures
- Automation represents a large time saving for clinicians
- Segmentation and analysis algorithms included in OHIF based web app: https://ohif.org