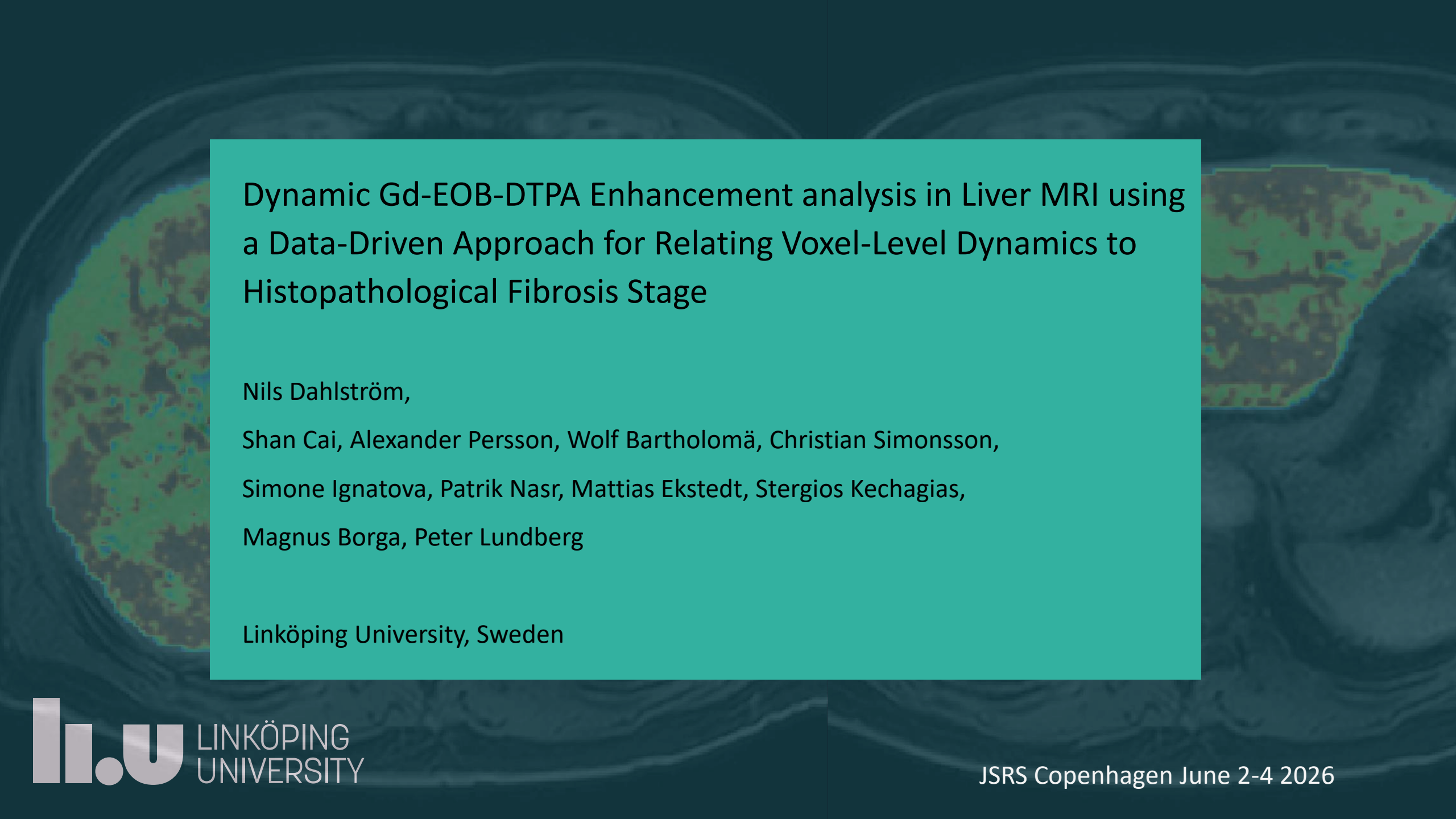




Dynamic Gd-EOB-DTPA Enhancement analysis in Liver MRI using a Data-Driven Approach for Relating Voxel-Level Dynamics to Histopathological Fibrosis Stage

Nils Dahlström,

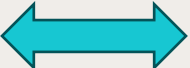
Shan Cai, Alexander Persson, Wolf Bartholomä, Christian Simonsson,
Simone Ignatova, Patrik Nasr, Mattias Ekstedt, Stergios Kechagias,
Magnus Borga, Peter Lundberg

Linköping University, Sweden

Background

- Chronic liver disease is heterogeneous
- Current liver function tests do not deliver regional results

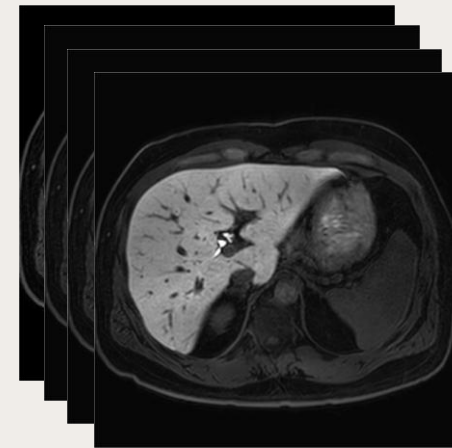
Hepatocyte-specific contrast:

- Impaired enhancement  Impaired liver function

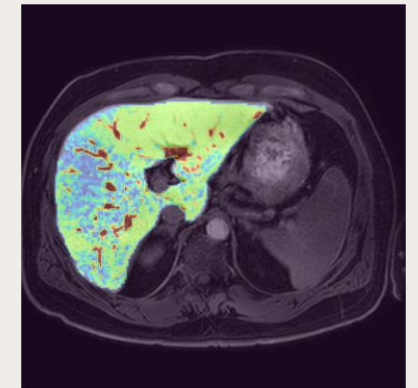
Question: How can enhancement behaviour be assessed on the voxel level?

Background

- We wanted to apply a quantitative, data-driven approach to describe regional enhancement patterns
- We developed a voxel-wise data-driven framework based on Dynamic Gadoxetate-enhanced Liver MRI
- Fibrosis grade (biopsy) was used as a proxy for impaired function



DCE-MRI
(Gadoxetate =
Gd-EOB-DTPA,
Primovist/Eovist)
 $t = 3\text{--}35\text{ min}$



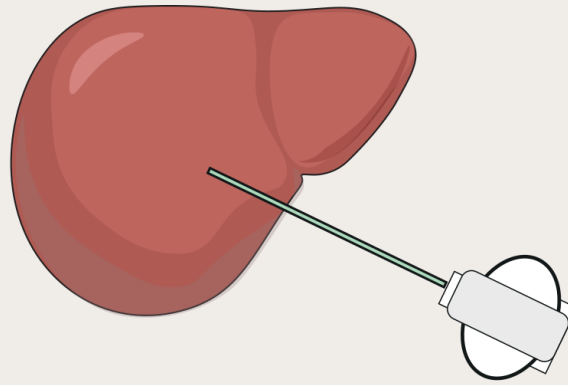
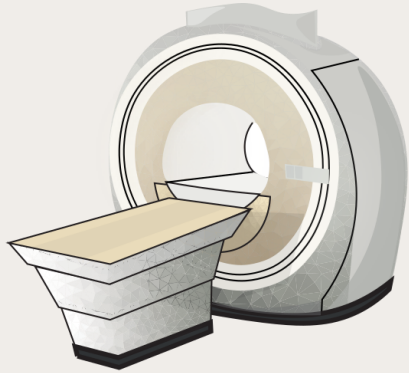
Patterns associated
with fibrosis

Inclusion

- Recruited patients, $n = 85$
- Excluded, $n = 9$
 - Inability to complete MRI examinations, $n = 6$
 - Poor biopsy quality, $n = 1$
 - Image registration failure, $n = 2$
- Final inclusion, $n = 76$

Data collection

- Chronic liver disease (n = 76)



7:30 - 9:00

9:30

Arrival

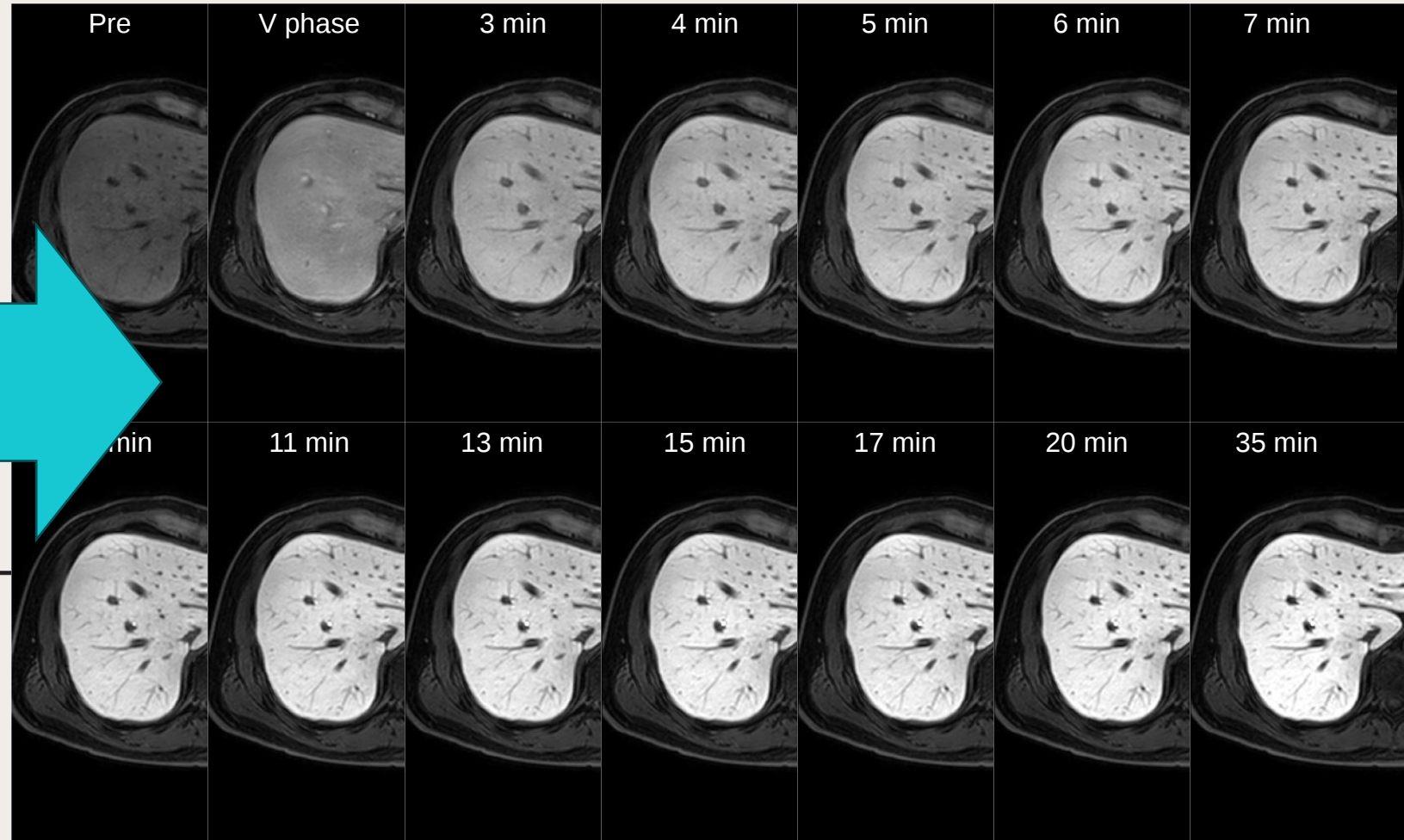
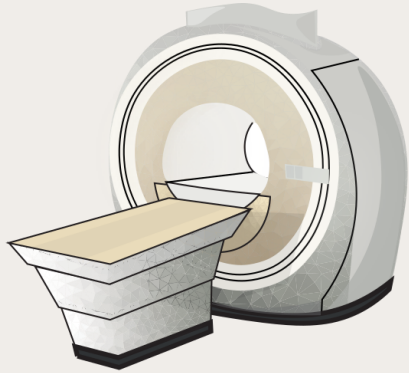
Multi modal MRI

Biopsy

Monitoring

Data collection

- Chronic liver disease (n = 76)



7:30 - 9:00

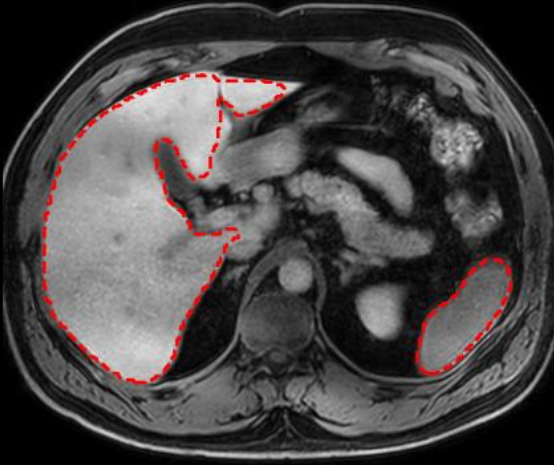
Multi modal MRI

Arrival

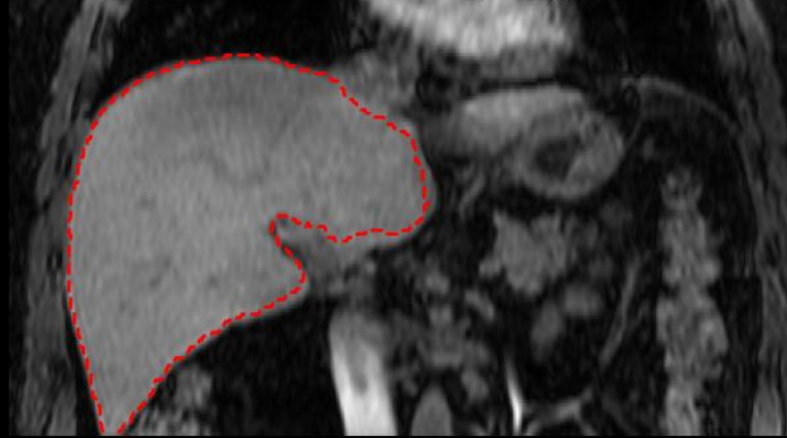
Gd-EOB-DTPA (Primovist®)

Preprocessing – Registration

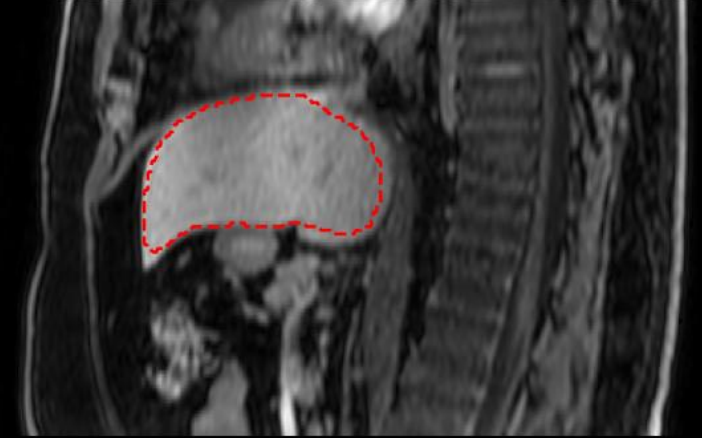
Fixed axial [52]



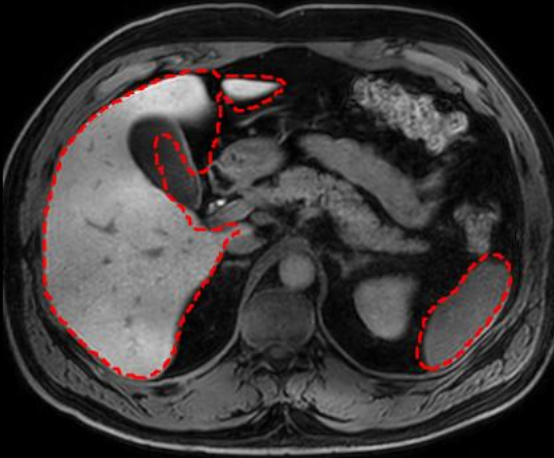
Fixed coronal [230]



Fixed sagittal [212]



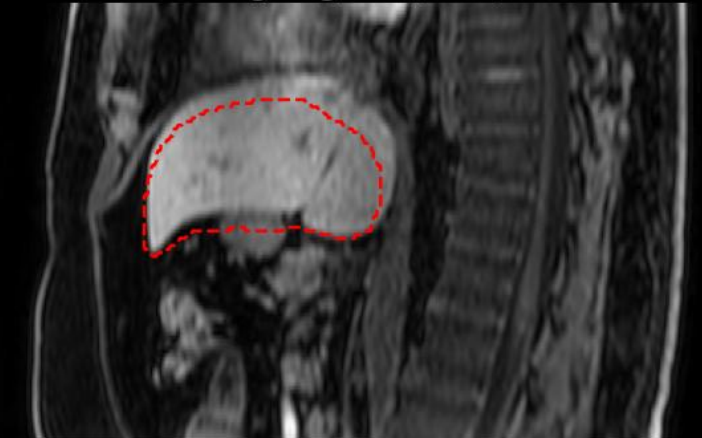
Moving axial [52]



Moving coronal [230]

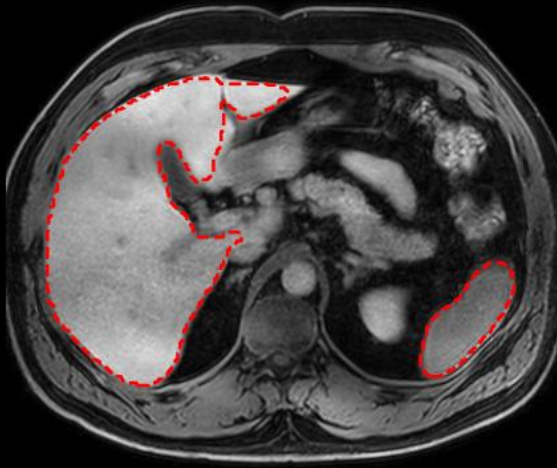


Moving sagittal [212]

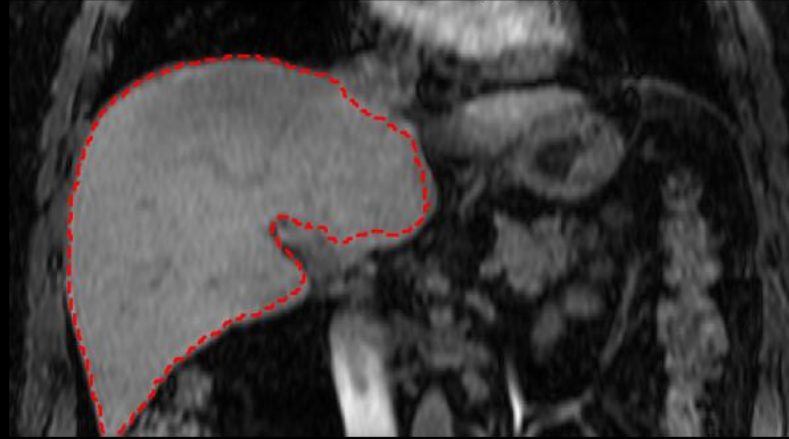


Preprocessing – Registration

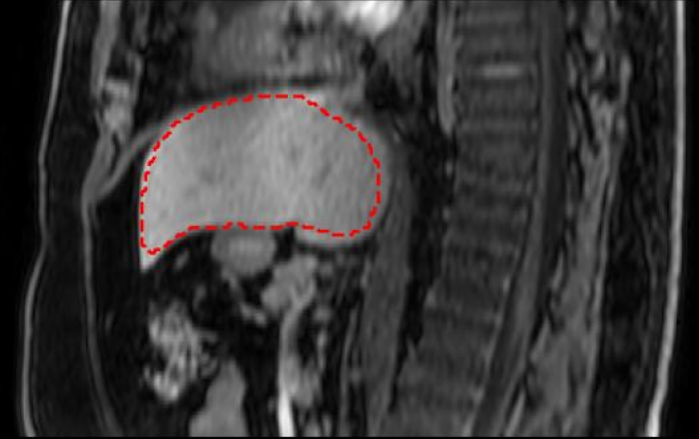
Fixed axial [52]



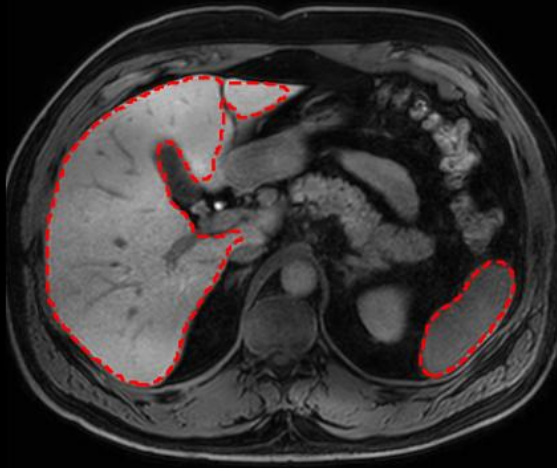
Fixed coronal [230]



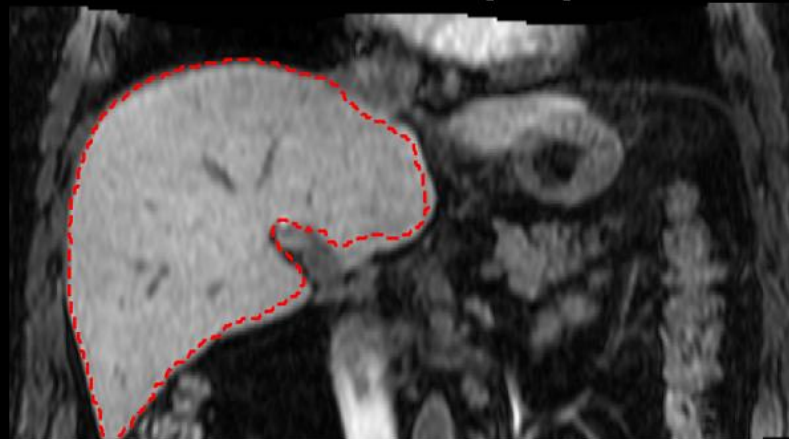
Fixed sagittal [212]



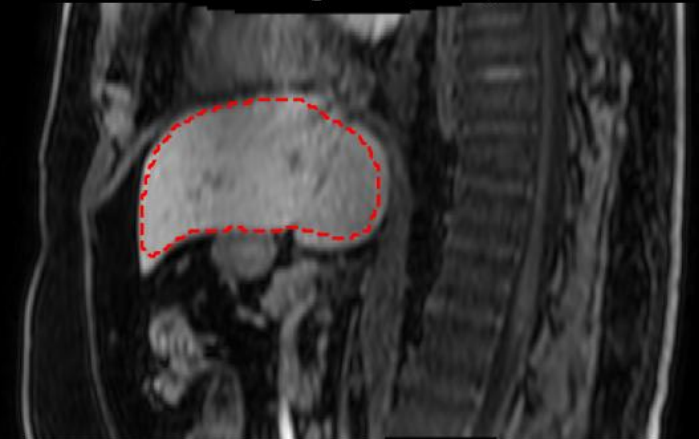
Result axial [52]



Result coronal [230]

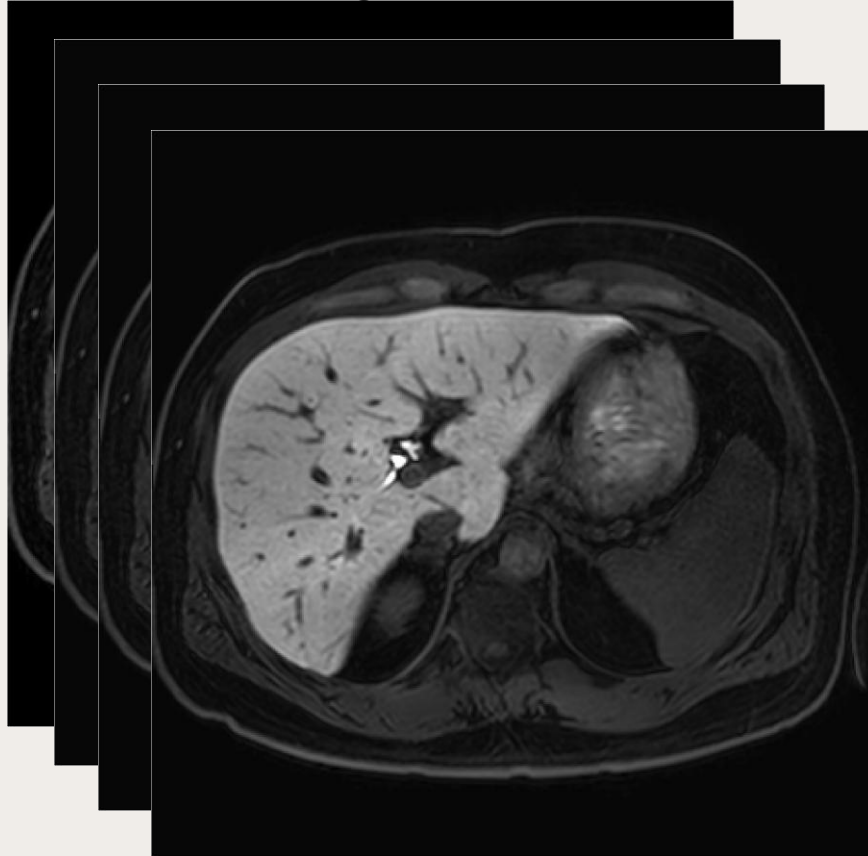


Result sagittal [212]

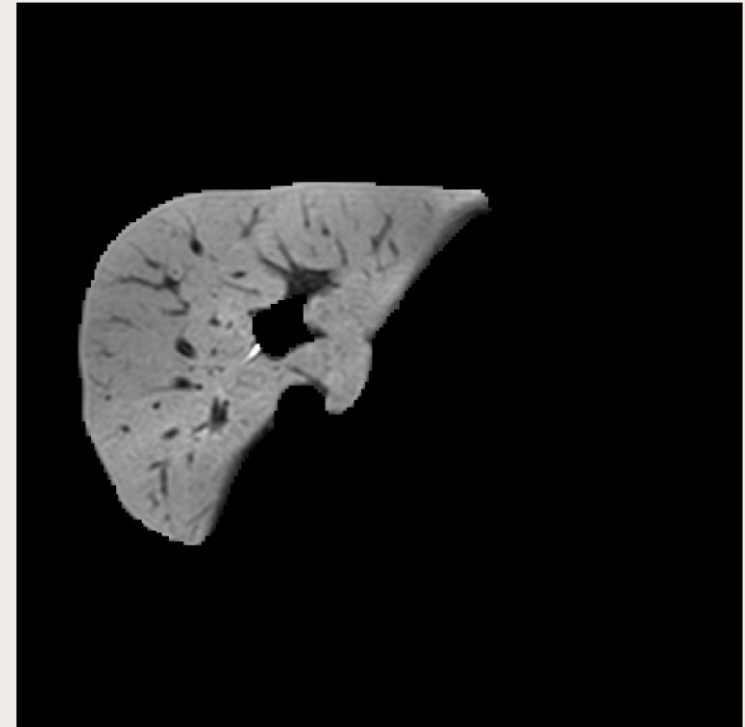
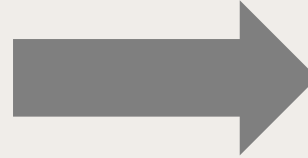


Preprocessing – Segmentation

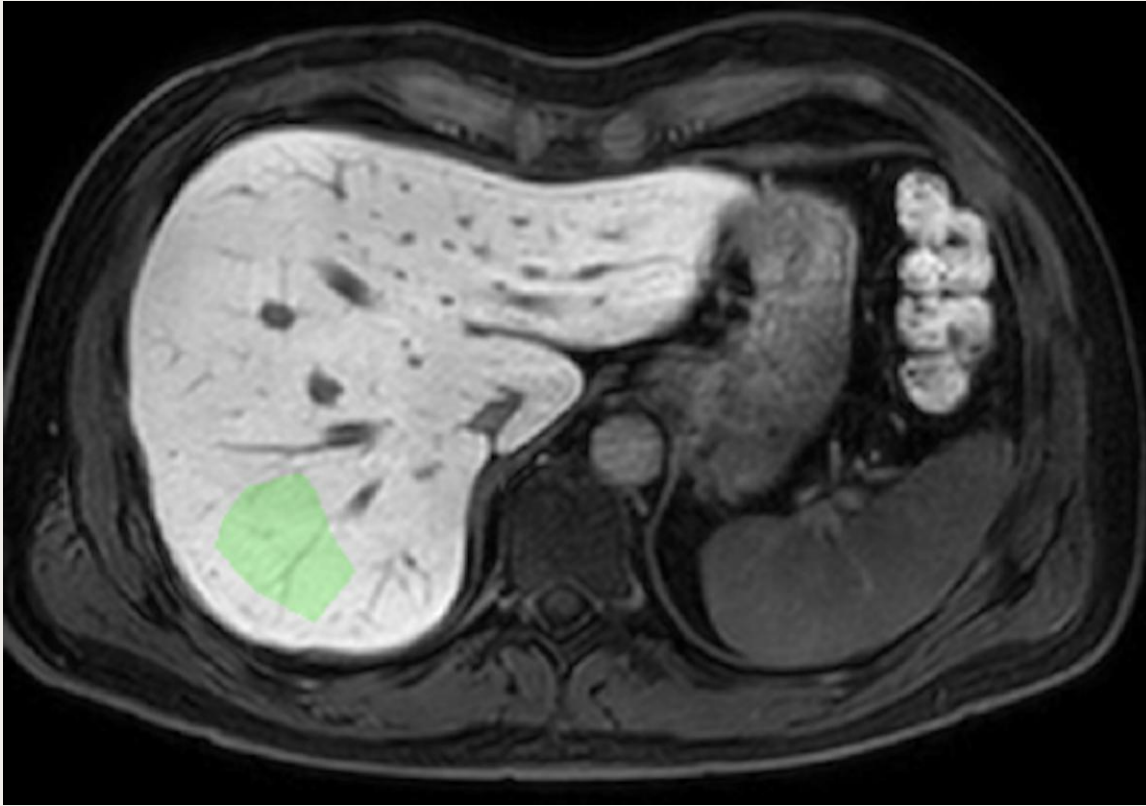
Registration



Segmentation



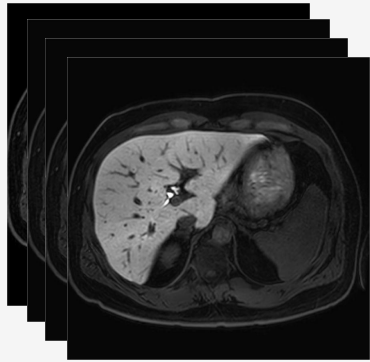
ROI - normal vs abnormal/impaired



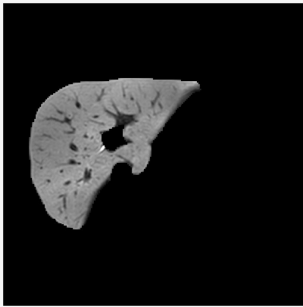
Framework

Preprocessing

Image registration

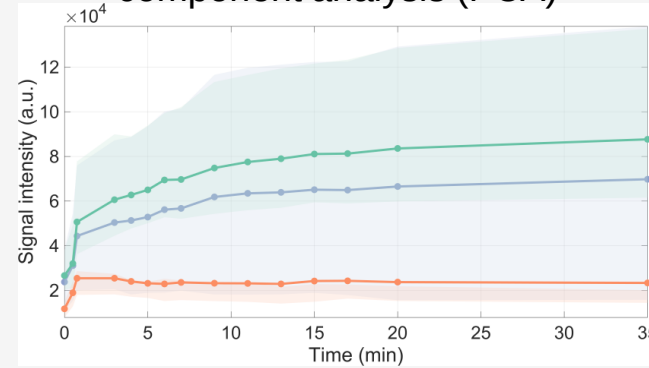


Segmentation

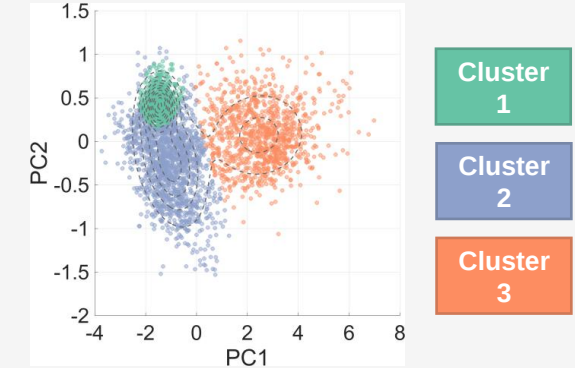


Feature extraction and cluster

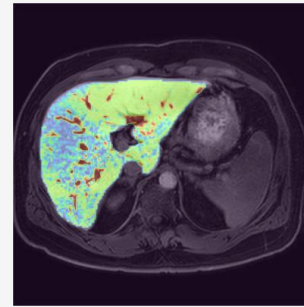
Curve fitting and principal component analysis (PCA)



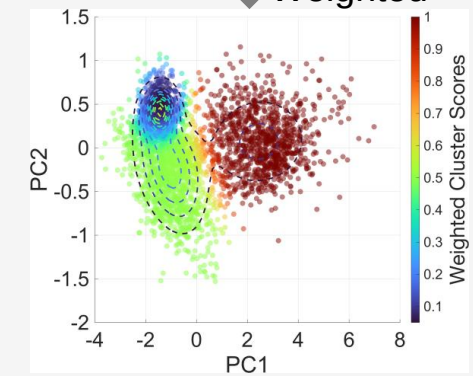
Gaussian mixture modeling of PCA features



Visualization

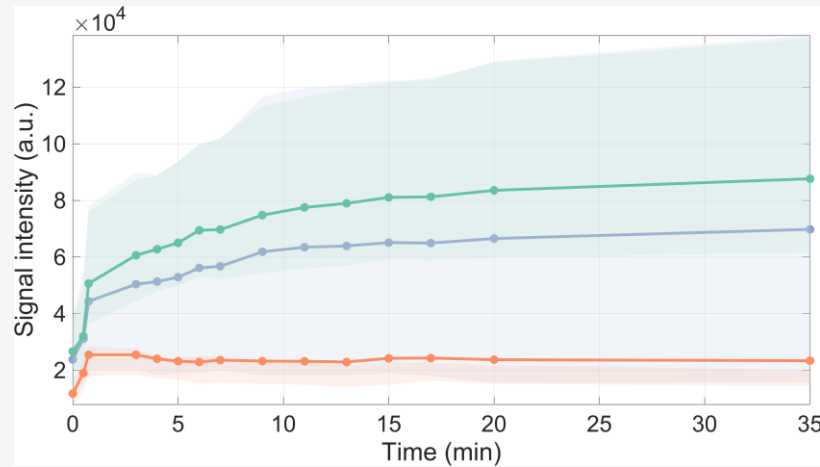


Weighted

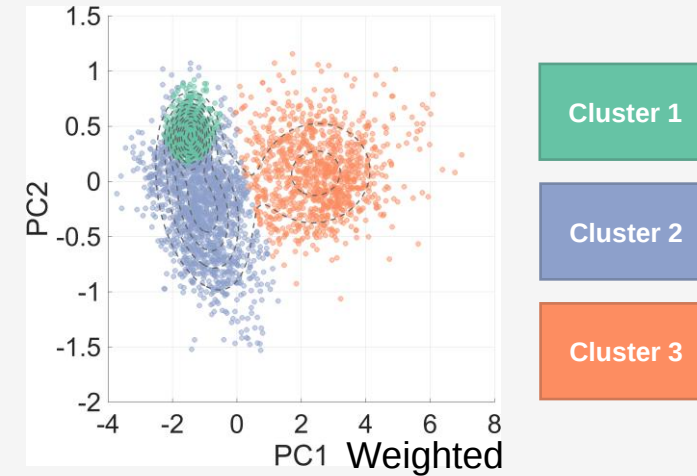


Feature extraction and cluster

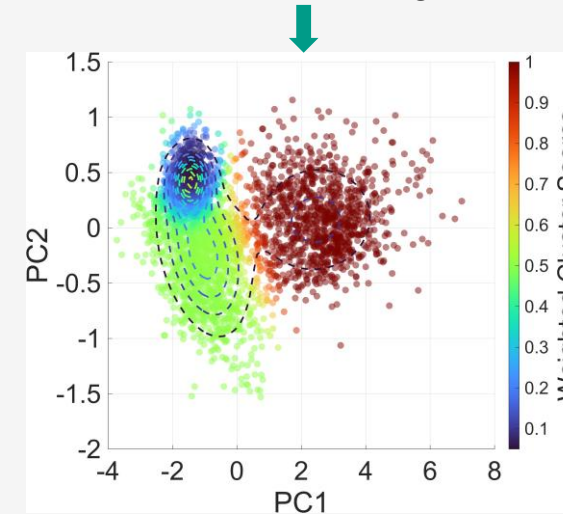
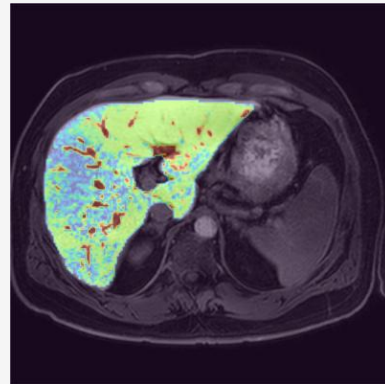
Curve fitting and principal component analysis (PCA)



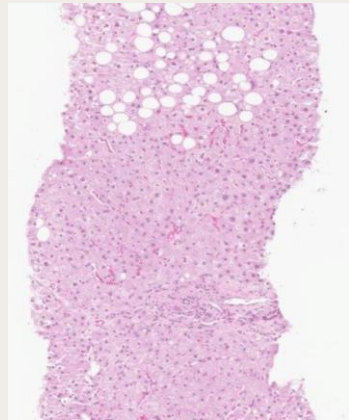
Gaussian mixture modeling of PCA features



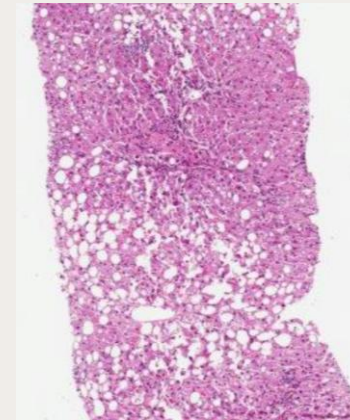
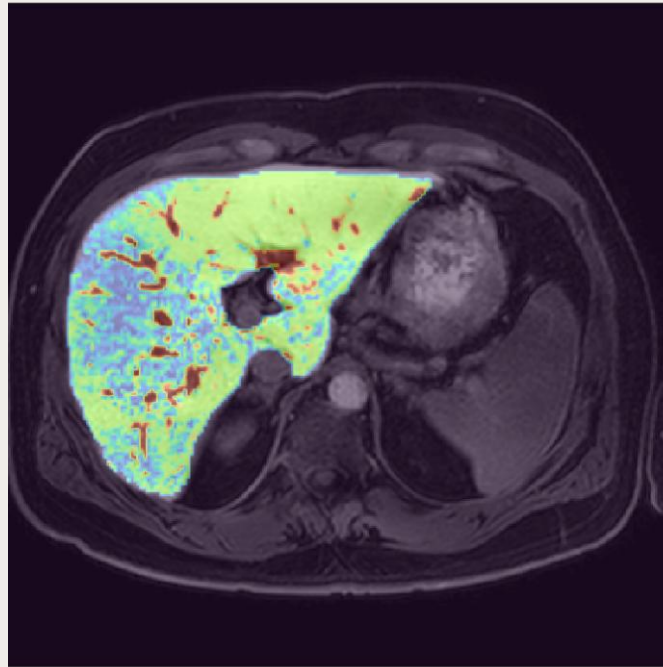
Visualization



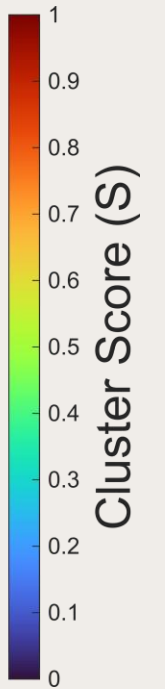
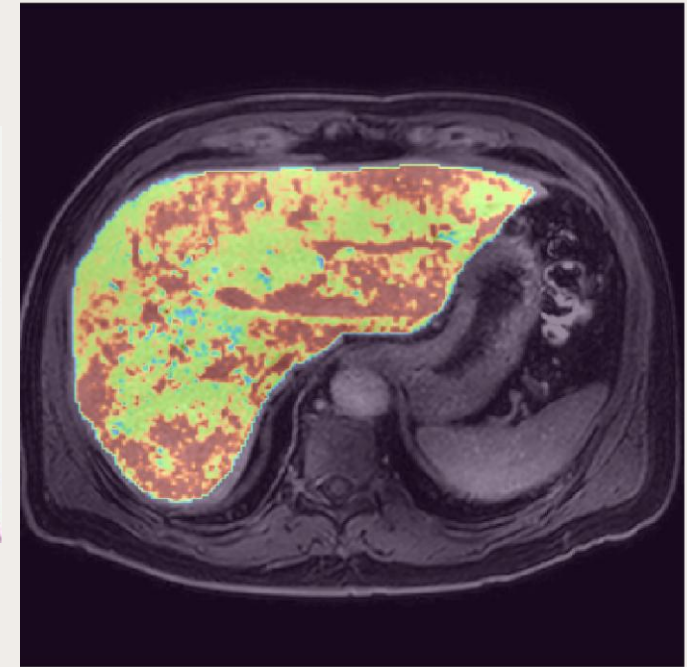
Associated with Fibrosis



Mild
Fibrosis

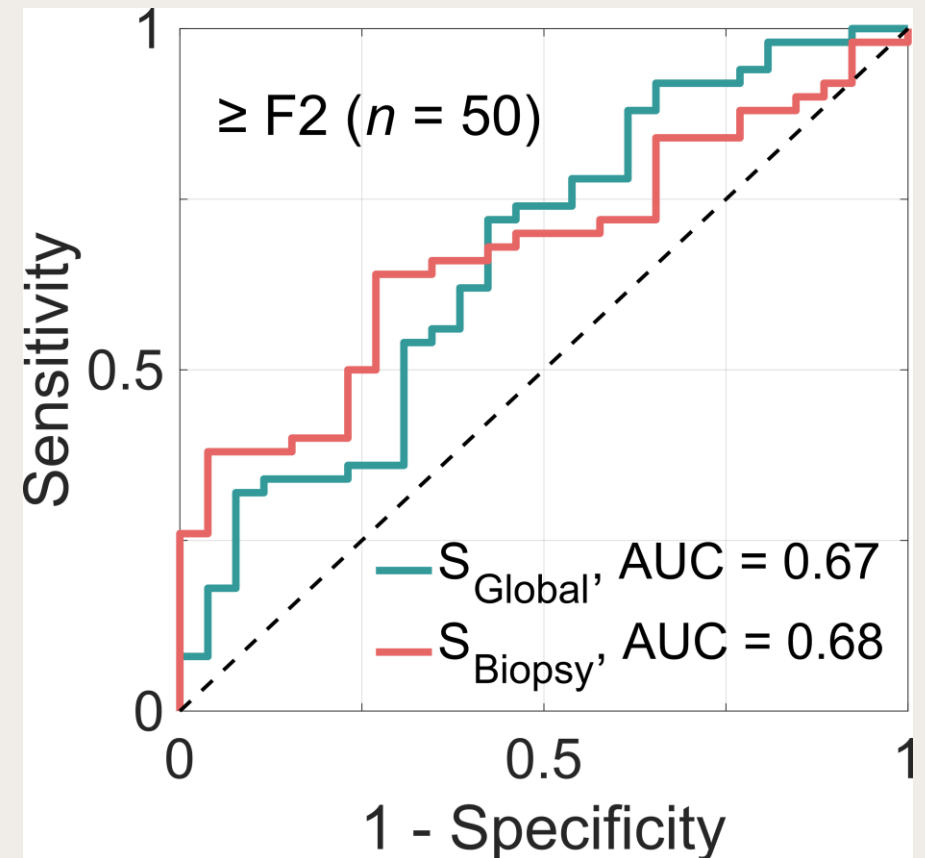
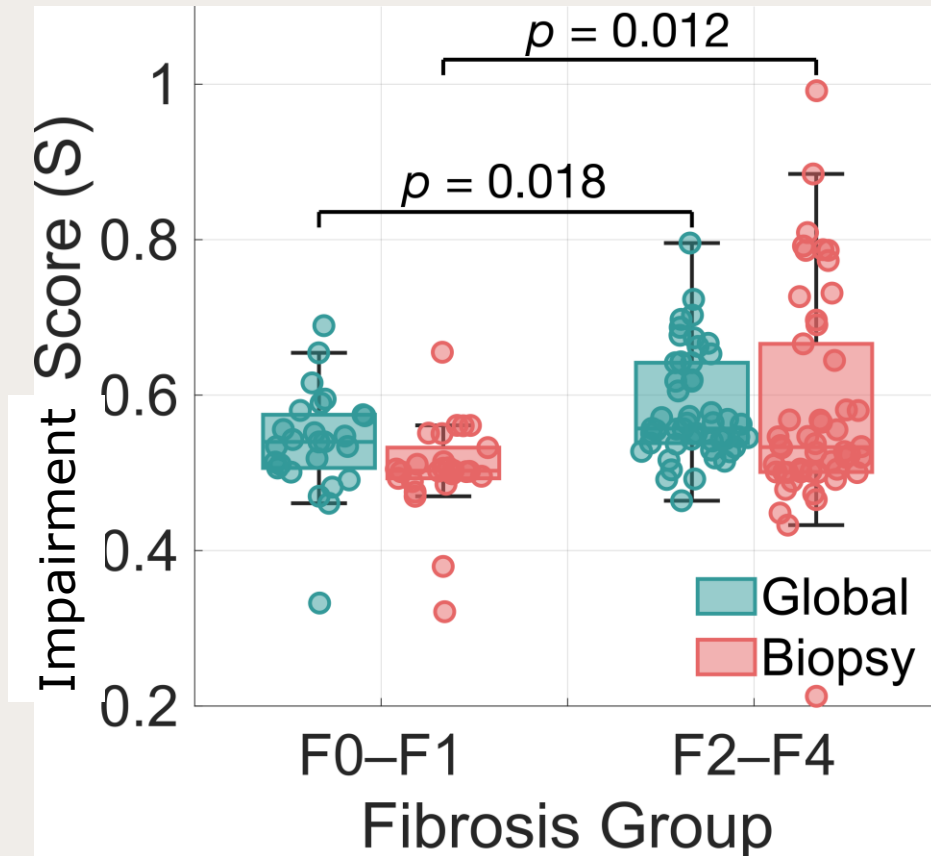


Severe
Fibrosis



$\rho = 0.33$, $p = 0.004$ (Spearman)

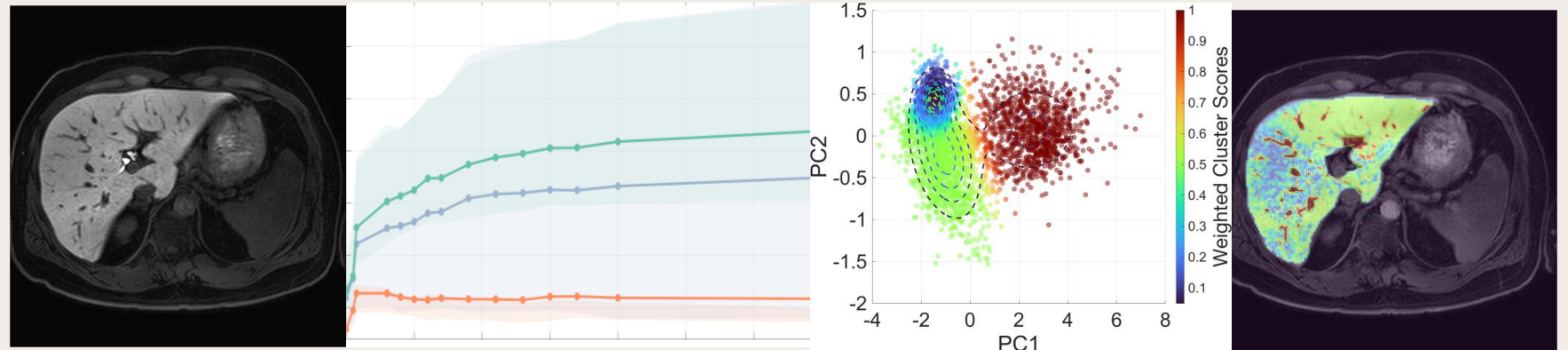
Impaired Function vs Fibrosis



Conclusions

- The score map showed regional liver enhancement patterns
- Patients with more severe fibrosis showed higher abnormal enhancement scores.
- Our framework provides a global and also a regional assessment of Gadoxetate enhancement.

Linköping
University



Thank you for your attention!

Contact: nils.dahlstrom@liu.se