Self-supervised IVIM parameter estimation with a physics based forward model

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Current limitations of IVIM parameter estimation

- Intravoxel incoherent motion model (IVIM) is estimated from DWI signal

\[ S(b) = S_0 \left( fe^{-bD^*} + (1 - f)e^{-bD} \right) \]
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- Voxelwise NNLS based methods are already very sensitive to noise
- No “ground truth” for supervised neural network training
Current remedies to ill-posedness of IVIM estimates

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- Unsupervised (synthetic) voxelwise neural networks [3]

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• 84 pediatric Crohn’s disease patients
• 7 b-values of [0,50,100,200,400,600,800] s/mm²
• Geometrically averaged over 6 diffusion gradients

<table>
<thead>
<tr>
<th>DW-MRI</th>
<th></th>
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<tbody>
<tr>
<td>Type</td>
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<tr>
<td>FOV (mm²)</td>
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<td>Matrix</td>
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<td>Δz (mm)</td>
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<tr>
<td>Acq. Time (mins)</td>
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</table>
Evaluation on high SNR data

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ns = non significant, * / ** = significant at 95% / 99% CI
Evaluation of repeatability on intrasession test-retest

- 6,4,4,3,3 repetitions for 5 healthy volunteers respectively
- 12 voxel ROI
Evaluation on data with decreasing SNR
Conclusions

• A self-supervised 2D CNN for IVIM parameter estimation
• No ground truth NNLS estimates required
• Increased robustness to low SNR signal
• Enables investigation for reduction of diffusion gradients (& scan time)

Questions?
• serge@crl.med.harvard.edu
• Multicomponent models of diffusion, perfusion and relaxation - Wed 19 May, 19:00 UTC

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