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Intravoxel Incoherent Motion Optimization of b-values Acquisition for Different Fitting Algorithms

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Introduction: This study proposed to compare different fitting algorithms for IntraVoxel Incoherent Motion (IVIM) in b-value sampling reduction. Choosing the best distribution of b-values is an essential objective of the studies in IVIM imaging [1]. The optimization of the b-value sample has been studied since the optimal sampling can reduce the number of b-values to estimate the IVIM maps better and turn the acquisition protocol faster.

Materials and Methods: We simulated an IVIM signal with 15 b-values (0, 4, 8, 16, 30, 60, 120, 250, 500, 1000, 1200, 1400, 1600, 1800, 2000 s/mm²) consisting of a N = 10000 signal (Figure A). As ground truth, we used the values of D, D*, and f as 0.00081 mm²/s, 0.022 mm²/s, and 0.2 [2]. We added a normal deviation of 0.25 in the signal to create noise. For analysis, we used the mean of the three RRMSE, selecting the best b-value subset to continue the reduction process. The codes were written in Python using the libraries Dipy and Numpy (https://github.com/inbrainlab/IVIMReduction).

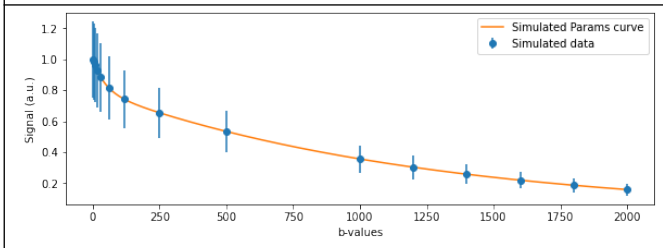
Results: We found that the mean value of pseudo-diffusion D* is privileged by reducing the number of b-values. Fitting the original data with Dipy non-linear least-squares algorithm, the average values for D, D* and f were $(0.8\pm0.2)\times10^{-3}$ mm²/s, $(30\pm120)\times10^{-3}$ mm²/s, and 0.15±0.30. Applying the algorithm for reduction of 5 b-values, we got the reduced b-value scheme of 10 b-values (0, 4, 8, 16, 120, 500, 1000, 1200, 1800, 2000 s/mm²) and D, D* and f of $(0.8\pm0.2)\times10^{-3}$ mm²/s, $(24\pm140)\times10^{-3}$ mm²/s and 0.15±0.30.

Discussion/Conclusion: The Dipy fitting algorithm better estimates the mean value of pseudo-diffusion, which is privileged by reducing the number of b-values but with a great standard deviation. Our next steps are to analyze other fitting methods to compare the consistency and deeply study the impacts of a b-value reduction for multiple fittings methods.

References: [1] Malagi, A. V. et al., doi:10.1007/s10334-019-00764-0; [2] Chabert, S et al., doi:10.2463/mrms.mp.2019-0061.

Legend: A - The distribution of simulated data. B - Fitting results from different b-value samples.

A



B