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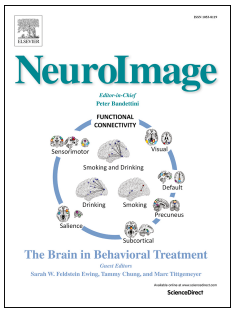

Analytic tractography: A closed-form solution for estimating local white matter connectivity with diffusion MRI

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Analytic tractography: A closed-form solution for estimating local white matter connectivity with diffusion MRI

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Abstract

White matter structures composed of myelinated axons in the living human brain are primarily studied by diffusion-weighted MRI (dMRI). These long-range projections are typically characterized in a two-step process: dMRI signal is used to estimate the orientation of axon segments within each voxel, then these local orientations are linked together to estimate the spatial extent of putative white matter bundles. Tractography, the process of tracing bundles across voxels, either requires computationally expensive (probabilistic) simulations to model uncertainty in fiber orientation or ignores it completely (deterministic). Furthermore, simulation necessarily generates a finite number of trajectories, introducing "simulation error" to trajectory estimates. Here we introduce a method to analytically (via a closed-form solution) take an orientation distribution function (ODF) from each voxel and calculate the probabilities that a trajectory projects from a voxel into each directly adjacent voxels. We validate our method by demonstrating experimentally that probabilistic simulations

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