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Scaling for Big Data: An Enhanced Surface Reconstruction of the Hippocampus Leveraging Delaunay Triangulation for High-Resolution Mapping from Unfolded to Native Spaces

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The ability to process and analyze large and complex neuroimaging datasets is crucial to develop computer simulations of the brain. A focus of significant interest is to model the hippocampus, a brain structure integral to memory formation and emotional regulation. This study introduces a state-of-the-art algorithmic pipeline for big data scaling and enhanced surface reconstruction of the hippocampus, utilizing Delaunay Triangulation for high-resolution surface generation.

Initially, the pipeline addresses the challenge of upscaling low-resolution surface models by leveraging Delaunay Triangulation. This algorithmic approach not only maintains but enhances anatomical detail, allowing for a high-resolution representation of the hippocampus' complex topology. This process is particularly advantageous for large datasets, making it scalable and big data-compatible.

Following the surface enhancement, the pipeline employs a specialized warp field algorithm to transform the high-resolution surface from an unfolded space to a native space. This ensures compatibility with existing volumetric datasets and enhances the granularity and precision of subsequent analyses. An extensive set of validation checks ensures the warp field's fidelity, safeguarding the integrity of the transformed model.

Finally, the warped high-resolution surface is integrated with BigBrain hippocampal volumetric data through a robust volume-to-surface mapping algorithm. This step harmonizes the dual approaches of surface-based and volume-based analyses, allowing for comprehensive, nuanced exploration of hippocampal structure and function.

The pipeline is implemented in widely-accepted neuroimaging formats like NIFTI and GIFTI, ensuring seamless integration with existing analytical tools and datasets. Preliminary results indicate a significant advancement in the accuracy and depth of hippocampal analyses. This scalable approach is versatile and holds promise for a myriad of applications, from basic neuroscience research to advanced investigations into neurodegenerative diseases and cognitive disorders. Overall, the pipeline sets a new precedent for high-resolution, big data-compatible computational analysis of complex brain structures.

Primary authors: SALINAS-MEDINA, Alejandro (McGill University, Montreal); DEKRAKER, Jordan (McGill University, Montreal)

Co-authors: OBERSTRASS, Alexander (Institute of Neuroscience and Medicine (INM-1), Forschungszentrum Jülich); BERNHARDT, Boris (McGill University, Montreal); Dr TOUSSAINT, Paule Joanne (McGill University); LIU, Xue S (McGill University, Montreal); Prof. EVANS, Alan C (McGill University, Montreal)

Presenter: SALINAS-MEDINA, Alejandro (McGill University, Montreal)

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