

DWIQC: A Python package for preprocessing and quality assurance of diffusion weighted images

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Summary

Diffusion weighted neuroimaging is an MR modality that maps white-matter microstructure in the human brain. DWIQC serves as a robust quality assurance preprocessing tool for diffusion weighted images as well as a means to facilitate data management and sharing via the XNAT platform. DWIQC utilizes analysis tools developed by FSL (Smith et al., 2004), Prequal (Cai et al., 2021), Qsiprep (Cieslak et al., 2021) and MRtrix (Tournier et al., 2012) to perform first level preprocessing of diffusion weighted images and to assess data quality through quantitative metrics. DWIQC utilizes containerized versions of the aforementioned software to ensure reproducibility of results and portability. DWIQC generates an aggregated report of summary metrics and images from the output of analysis software, including parametric maps and connectivity matrices from Prequal and Qsiprep, which can be uploaded to the XNAT (Marcus et al., 2007) data management platform, though uploading to XNAT is not necessary. All outputs from software used are stored in the user specified output directory.

Statement of need

Diffusion neuroimaging is a burgeoning field with huge potential to deepen our understanding of the brain. While exciting, it also means that acquisition parameters, study designs, and theoretical analysis frameworks vary greatly. DWIQC is an effort to make diffusion imaging analysis and quality assurance accessible to researchers with diverse experimental designs. By leveraging the respective strengths of various diffusion imaging analysis tools, DWIQC appeals to a broad range of users who employ different data acquisition approaches. Additionally, large, multi-site studies can use the standardized preprocessing to ensure uniformity in data preprocessing, data quality metrics and downstream analysis. DWIQC serves as a one stop destination for users who want a seamless integration of Prequal, Qsiprep and FSL Eddy Quad with the flexibility of catering to diverse acquisition protocols. Users can configure settings in DWIQC that will be applied across all the software that is used, abstracting away the sometimes convoluted task of doing so for each software pipeline individually.

Furthermore, DWIQC's integration with the XNAT data management platform facilitates ease of adoption due to XNAT's widespread use at neuroimaging centers. Sites that use DWIQC and upload its results to an XNAT instance provide transparency in analysis practices for collaborating sites. Multi-site studies benefit by seeing diffusion analysis reports in the same format across sites and subjects.

DWIQC benefits researchers by catching problems in data quality in real-time. The robustness DWIQC's pipelines allows even minor data quality issues to be caught. By running the diffusion

weighted data through large-scale preprocessing pipelines, researchers are privy to data quality problems that would not be caught otherwise. As such, adjustments can be made mid-study to data collection protocols as necessary, rather than waiting until data collection has stopped only to discover data quality issues.

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