Title: Multimodal Medical Imaging and Pattern Recognition for the Diagnosis of Intellectual Disabilities

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Proposal

Intellectual disabilities (ID) are complex neurodevelopmental conditions often rooted in structural and functional brain abnormalities. Timely and accurate diagnosis is essential for early intervention and effective management. Traditional diagnostic methods which rely heavily on behavioral and cognitive assessments may lack the sensitivity to detect underlying neurobiological markers especially in early developmental stages. In this context, multimodal medical imaging has emerged as a powerful tool offering complementary insights from various imaging modalities such as MRI, fMRI, PET, CT, EEG and MEG. These technologies integrated through sophisticated image fusion and pattern recognition algorithms can provide a more holistic view of brain anatomy, connectivity and function associated with intellectual disabilities. The integration of multimodal imaging data presents significant technical challenges. Differences in spatial and temporal resolution, noise characteristics and data dimensionality complicate effective fusion. Additionally, large-scale annotated datasets specific to ID are scarce, hindering the training of robust machine learning models. Despite these drawbacks, deep learning especially convolutional and transformer-based neural networks has demonstrated remarkable potential in feature extraction, cross-modality data alignment and automated classification of ID-related neuroanatomical patterns. These models can detect subtle abnormalities in brain structure and function that are often imperceptible to the human eye.

This special issue seeks contributions that address both foundational and applied research in the fusion and interpretation of multimodal medical imaging for intellectual disability diagnosis. Topics may include neuroimaging biomarkers, multilevel feature extraction, data harmonization, and AI-driven decision support systems. We are particularly interested in methods that improve clinical interpretability, reduce false positives/negatives and facilitate individualized treatment planning. Future advancements are expected to focus on selfsupervised learning, federated learning across medical institutions and multimodal generative models that simulate or enhance low-quality clinical data. Moreover, integrating imaging data with genomic, behavioral and environmental information will be crucial for developing a systems-level understanding of intellectual disabilities. This special issue provides a platform for researchers, clinicians and engineers to present cutting-edge developments that bridge computational innovation and clinical practice. Submissions should highlight the translational value of the proposed techniques ensuring relevance to both diagnostic accuracy and real-world implementation in pediatric and adult populations affected by intellectual disabilities.

Topics of Interest:

1. Multimodal neuroimaging (MRI, fMRI, PET, EEG) for early detection of intellectual disability
2. Deep learning models for pattern recognition in brain imaging of ID patients
3. Fusion techniques for integrating anatomical and functional brain images
4. Automated classification of genetic intellectual disability syndromes via imaging biomarkers
5. Longitudinal image analysis for developmental tracking in ID diagnosis
6. EEG-fMRI integration for cognitive dysfunction profiling
7. AI-driven segmentation of neuroanatomical structures in ID
8. Transfer learning for small-sample ID imaging datasets
9. Ethical implications of AI-based ID diagnosis
10. Multimodal imaging to differentiate intellectual disability from other neurodevelopmental disorders
11. Brain connectivity analysis using multimodal imaging in ID research
12. Clinical decision support systems leveraging fused neuroimaging data
13. Evaluation and validation of image fusion techniques in real-world ID clinical settings