CENTRALITY IN BRAIN NODE GROUPS: AN INVERSE INVESTIGATION WITH CLINICAL INSIGHTS

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Abstract: Structural brain networks refer to the representation of the human brain's anatomical connections, which has given rise to various applications in neuroscience. Various network measures have been proposed to analyze the brain network. Recently, network measures for groups of nodes were introduced to analyze the brain network in a group context. The group network measures are defined for global measures such as efficiency and nodal measures such as centrality for a group of nodes. In this study, we focus on a unique inverse query: How can we identify a group of nodes that achieve maximum centrality within a given brain network? This pursuit leads to the concept of a "Group Hub," representing a highly central group of nodes within the brain network. Traditional exhaustive search methods for solving this inverse problem are often infeasible due to their exponential complexity and extensive permutation search spaces. To address this challenge, we introduce a novel algorithm called "Progressive Aggregation for Optimal Node Group Maximization (PANGM) to solve the inverse problem in a large domain of networks. We apply this algorithm extensively to a diverse set of structural connectomes derived from older adults and individuals with Alzheimer's disease. Our results highlight the effectiveness of the PANGM algorithm in revealing group hubs within these populations and uncovering meaningful distinctions among them. This comprehensive analysis provides valuable clinical insights, emphasizing the potential of our methodology in advancing our understanding of group dynamics within brain networks and its relevance in the context of structural brain network analysis.

Keywords: Centrality measures, Group of nodes, Group hub, PANGM, Structural brain network