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Thesis title: Mathematical Methods for Computing Centrality Measures Based on Powers of the Adjacency Matrix for Changing Networks

Abstract:
When working with a network it is often of interest to locate the "most important" nodes in the network. A common way to do this is by using some graph centrality measures. Since what constitutes an important node varies from one network to another or even applications on the same network, there is a large number of different centrality measures proposed in the literature.

As such there are numerous equivalent centrality measures in the sense that they give the same ranks. In this research, we focus on centrality measures based on powers of the adjacency matrix and those that use the concept of random walk on directed graphs. In this case, we show how some of these centrality measures are related as well as their lazy variants. We perform some experiments to demonstrate the similarities between the centrality measures.

Alpha and Eigenvetor centralities are some of the highly placed centrality measures applied especially in social networks, disease diffusion networks and mechanical infrastructural developments. We further focus on re-calculating alpha and eigenvector centralities using graph partitioning techniques. We propose an algorithm for partitioning, sorting and efficiently computing these centralities for a graph. Numerical results to demonstrate the algorithm has been performed on a relatively small-size network.
We consider the problem of calculating eigenvector centrality of graph partitioned into components and how this partitioning can be used, in more detail. Two cases are considered; first where a single component in the graph has the dominant eigenvalue, secondly, when there are at least two components with the same dominant eigenvalue for the graph. In the first case we implement and compare the method to the usual approach (power method) for calculating eigenvector centrality while in the second case with shared dominant eigenvalues we show some theoretical and numerical results.

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