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2014
Mathematical Contest in Modeling (MCM/ICM) Summary Sheet

Who are the 20%?

The famous '80-20' rule states that the 80% influence is caused by the 20% for many events. This principle also applies to the network science: only few nodes have a significant influence and impact to the whole network. In our paper, A Relation Distance Model and an Authority-Popularity Evaluation Model are employed to measure of the 20% and analysis of its influence.

For requirement 1 & 2, we construct the undirected co-author network based on the 511 order relationship matrix. A Relation Distance Model is proposed on the basis of SNA technique. It combines three centrality indexes as a measure vector to calculate the 'distance' with the most influential node. Another measure (Eigenvector centrality) which takes both degree and the influence of co-authors into consideration outputs a new rank. Validation of the model is discussed by comparing the two ranking of the top 15 authors in Erdos1 network, we find ALON, NOGA M. is the most influential person in the Erdos1 network. The degree distribution of the Erdos1 network is proved to approximately be power-law distribution, which indicates it is a scale-free network.

For requirement 3, an Authority-Popularity Evaluation Model is established to analyze the depth and the width of the influence of nodes. An Authority Index is calculated by our Modified PageRank Algorithm (including two steps: initialization and iteration) to measure the depth of impact. A Popularity Index is defined as citation per year to reflect the width of influence. A set of 24 papers citation directed network with weight added to nodes is constructed to implement the algorithm. The final ranking of the papers is obtained by combining Authority-Popularity Indexes. For requirement 4, a set of 15 actors' co-star bidirectional network with co-star movie as links is constructed. The iteration process is refined as the weight added to links instead of nodes.

For requirement 5, we discuss two characteristics of scale-free network: Growth and Preferential attachment. The philosophy of dynamics of scale-free network is revealed as the 'Matthew effect'. The prior method to boost influence is proposed: finding the shortest links to the most influential author. Cooperating with the 80% (more approachable relatively) with low closeness centrality step by step and finally co-author with the key figure in the field.

A sensitivity analysis is conducted to study the robustness of our algorithm to Damp Coefficient and the result shows a good stability. Strength and weakness of our models is also discussed.