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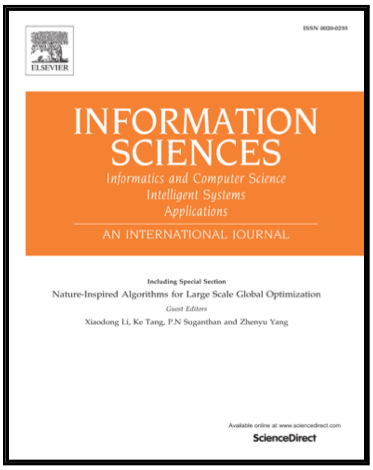

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Generation of Power-law Networks by Employing Various Attachment Schemes: Structural Properties Emulating Real World Networks

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Abstract

In this article we propose a general methodology for constructing complex networks. Popular selection schemes in Genetic algorithms are used for this construction. Mathematically, it has been shown that, under some weak constraints, the degree distribution of the resulting networks follow power-law, as seen in real world networks.

Power-law degree distribution is one of the most significant structural characteristics observed in many real-world complex networks. The main reason behind the emergence of this phenomenon is the mechanism of preferential attachment which states that in a growing network a node with higher degree is more likely to receive new links. However, degree is not the only key factor influencing the network growth leading to power-law degree distribution. Instead, there must be several other factors whose cumulative effect, called fitness of a node, has a significant role in attracting other nodes and thereby producing power law networks. The concept of fitness can be thought of as a generalization of node degree. Heterogeneity in preferential linking also plays an important role in producing power-law networks in this context. The proposed construction methodology, also leading to power law networks, combines the inherent fitness value of a node, drawn from a particular distribution, with various attachment schemes based on the different selection methods commonly used in Genetic algorithms. Six different selection schemes are used in total. Different well known structural measures like average degree of the nearest neighbors, average path length, clustering coefficient, etc. are calculated for each newly generated network to understand their behavior patterns. It has been found that these six schemes can be divided into two distinct groups of three on the basis of their structural properties, where one of these two groups produces proper power-law networks which possess topological properties similar to observed in the real world. Finally, extensive simulations and experiments over scientific collaboration networks validate the effectiveness of the proposed models.

Keywords: Complex networks, Power-law distributions, Genetic algorithm, Preferential attachment, Scale-free networks, Social networks, Pattern recognition.

1. Introduction and related works

During the last decade, there has been growing interest in the study of large scale real world complex networks [3, 39, 1, 36, 33, 6, 37] including its various modelling aspects. Complex networks have been normally modeled using graph theory in which evolving or growing sets of vertices are connected by edges. The vertices are the individuals of the system and the edges symbolize the relations between them. Complex networks display significant statistical and topological resemblances even though the nodes and links may have different interpretations. In the early stages of complex network research, several random graph theory based models had been proposed [7] in order to capture the topology of a complex network. One of the

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