Available online at www.sciencedirect.com
ScienceDirect
ELSEVIER
April 2014, 21(2): 15–20
www.sciencedirect.com/science/journal/10058885
The Journal of China Universities of Posts and Telecommunications
http://jcupt.xsw.bupt.cn

Evolution model for scientific collaboration network with local-world information

TIAN Sheng-wen[1,2] (✉), LIAO Jian-xin[1], WANG Jing-yu[1], QI Qi[1]

1. State Key Laboratory of Networking and Switching Technology, Beijing University of Posts and Telecommunications, Beijing 100876, China
2. School of Information and Electrical Engineering, Ludong University, Yantai 264025, China

Abstract

In order to reveal the intrinsic properties of scientific collaboration networks, a new local-world evolution model on a scientific collaboration network is proposed by analysing the network growth mechanism. The act degree as the measurement of preferential attachment is taken, and the local-world information of nodes is taken into account. Analysis and simulation show that the node degree and the node strength obey the power-law distribution. Low average path length and high clustering coefficient are approved. Experiment indicates that the model can depict efficiently the topological structure and statistical characteristics of real-life scientific collaboration networks.

Keywords scientific collaboration network, evolution model, local-world information, scale-free, act degree

1 Introduction

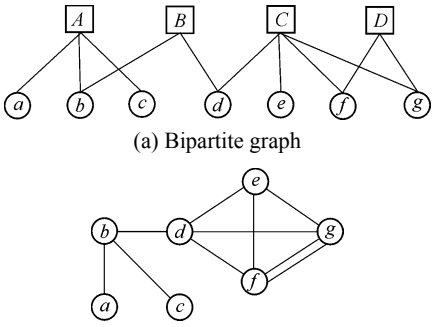
A complex network is the common abstraction and description of a complex system, which is a large scale network with a complex topology structure and some dynamic characteristics. Recently, Complex networks are extensively studied in various areas, such as social networks, biological networks, Internet and WWW. Especially, since small world (SW) model [1] and scale-free network (BA) model [2] are proposed, much progress is achieved. Through some demonstration researches and statistical analysis, it has been found that many networks have the characteristics of small world: high clustering coefficient and low average path length. At the same time, these networks are scale-free networks, in which the node degree distribution follows a power law.

A scientific collaboration network consisted of researchers and articles [3–4], is a special complex network that represents the collaboration relationship among scientific researchers. Note that the authors also use ‘scientist’ to represent ‘researcher’ in this article. A scientific collaboration network can be modelled as a bipartite graph. In the bipartite graph, nodes fall into two obvious categories: scientists and scientific articles. Fig. 1(a) shows an example, in which boxes represent articles, and circles denote scientists. In Fig. 1(a), the scientist *a*, *b* and *c* publish the article *A* together. The scientist *b* completes the article *B* with the scientist *d*. The authors of the article *C* consist of *d*, *e*, *f* and *g*, while the authors of the article *D* are *f* and *g*. In order to conveniently study, the bipartite graph is usually converted into a single-mode graph, an undirected graph containing only one type of nodes. Fig. 1(b) shows the single-mode graph of the bipartite network described in Fig. 1(a), in which each node is denoted as a scientist, and the link between two nodes is created if two scientists have published an article together. The weight of link denotes the number of collaboration of two scientists (two ends of the links). For the example shown in Fig. 1(b), the weight W_{gf} of link (g, f) is 2.

To some extent, the network structure has effect on its performance. So, the network modelling is always a hot research area in complex networks. In a scientific collaboration network, the growth mechanism and the structure characteristics of network can be uncovered by

Received date: 26-09-2013
Corresponding author: TIAN Sheng-wen, E-mail: gltsw@163.com
DOI: 10.1016/S1005-8885(14)60281-8

studying the evolution model, which is beneficial for researching the intrinsic characteristics of network.



(a) Bipartite graph

(b) Single-mode grapah

Fig. 1 Scientific collaboration network

So, the authors study the evolution model of a weighted scientific collaboration network by taking advantage of the local-world information of nodes. The concept of local-world information was first proposed in Ref. [5] based on the group of social network and the family phenomenon in protein-protein interaction network. Local-world information varies in different networks. In scientific collaboration network, the local-world information of a node refers to the local connection information of this node in the network, which reflects the local properties of the network.

The rest of the article is organized is as follows. In Sect. 2, the related work is introduced. The proposed evolution model is presented in Sect. 3. Analysis and simulation are described in Sect. 4. Finally, conclusions are given in Sect. 5.

2 Related work

In previous literatures, some of scientific collaboration networks were regarded as unweighted networks [3], in which the closeness relationship between two co-authors cannot be represented. In Ref. [6], Xiao et al. took a scientific collaboration network as a weighted network and constructs the model by the preferential attachment based on the node degree and the weight of edge, but they ignore the local-world information. The effect of link weight on the collaboration mechanism of scientific collaboration network was taken into account in Ref. [5], in which though the authors have considered the node degree, the node strength and the local-world information in the process of constructing the preferential attachment, the sequential relationship among them is ignored. The preferential attachment often occurs within the local scope of network was shown in Ref. [7]. a scientific collaboration network evolution model was studied using motif emerging technology in Ref. [8], in which the weight of edge is ignored.

In addition, other problems are also studied in scientific collaboration networks. For example, the identification of vital researchers in a scientific research group was researched in Ref. [9–10]. The problem of community evolution was expressed in Ref. [11]. And in Ref. [12–13], staudt et al. gave a study on the community detection in scientific collaboration networks with modularity-based clustering and compares the results based on topical similarity. The evolutionary dynamic of scientific collaboration networks was also studied as well in Ref. [14] by comparing and analysing the properties of the networks: density, centrality measures, and clustering coefficient. In Ref. [15], Pan et al. gave local neighbourhood relationships in co-authorship networks, and find that in co-authorship networks dense local neighbourhoods mainly consist of weak links, whereas strong links are more important for overall connectivity, which is different from ordinary social networks.

3 Evolution model for weighted scientific collaboration network

3.1 Act degree

According to SW model [1] and BA model [2], the preferential attachment is a key step for the evolution model in complex networks. In the evolution model about a scientific collaboration network, the authors take the act degree as the measurement of preferential attachment. The concept of act degree, and the relationship between node degree and node strength are described in detail.

The degree k_i of node i is defined as the number of adjacent edges of this node, which can be expressed as follows:

$$k_i = \sum_{j \in \tau(i)} a_{ij} \tag{1}$$

where $\tau(i)$ represents the set of neighbour nodes of node i, and $a_{ij} \in \{0,1\}$ denotes the element of the unweighted adjacency matrix. The single-mode graph that represents a scientific collaboration network is a weighted graph, in which the weight w_{ij} of link (i, j) is greater than or equal to 1. w_{ij} referring the number of articles published by two co-authors i and j together, the strength s_i of node

Download English Version:

https://daneshyari.com/en/article/720215

Download Persian Version:

https://daneshyari.com/article/720215

Daneshyari.com