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Analysis of Associtivity and Community Structure in Mobile Social Networks

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Abstract

Community structure detection is crucial attracted in field of study complex network. People have find vast detection algorithmic of community structure of network. However, most of methods mainly used in single static state network. And less community partition method apply to multi-slice network. In this paper, we first according to the time sequence of mobile social networks construct multi-slice network model, then investigate assortativity of MSNs by analyzing the assortativity coefficient over time. In the next instalment, we detect community partition in mobile social networks(MSNs) by optimizing multi-slice modularity function, since The advantages of modularity optimizing is that without prior knowledge of the communities. By optimizing multi-slice modularity and succedent method of diagnostics on the result of network partition. It is thereby maybe to find topology information about community structure of time-dependent MSNs.

Keywords: mobile social networks, disassortative, community structure, multi-slice networks, modularity;

1. Introduction

As the development of wireless connection device and sensor network technology. Human interactions can more convenient connect and communicate with each other in circumstance of mobile, temporal and space transform. It also generated a large amount of available mobile social network of time series[1,5]. For the research field of complex network, one find that using a single static state network model has far from fully depict MSNs, also can't discuss the inner details of MSNs. Hence, we use the multi-slice network model to describe MSNs possess characteristic of time-ordered. The principle is that cutting a time series of network into many section equally. Thus formed some time snapshot of fixed time domain. They compose the time-dependent multi-slice network model. We attempt to use the model framework to explore the assortativity and community structure characteristics of MSNs[2].

The current study of MSNs mainly concentrated in the analysis of static structure and the mechanism of dynamic evolution process. About static structure research is focused on the combination of mathematics statistic and

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analysis to discussing the network topology and nodes connection. Such as the node degree and degree distribution, hierarchical structure, the nature of cluster and community[3,4,5]. The research emphasis of dynamic evolution process has two aspects: one is utilize the feature of node distribution about the whole network to rebuild a dynamic network model, analysis the information spreading and mobile of nodes[6]. Among than, we analysis the assortativity and modularity of MSNs, that is vastly significance to reveal the network architecture and the dynamic evolution mechanism.

MSNs can be regarded as many changing graph composed by single static status graph, therein edges between a couple nodes indicate the interaction of two people in the MSNs during a given time interval. The MSNs is divided into a number of time slice that equal time length interval according to the duration of each network. Edge mean the connection about two nodes exist communication within the scope of own time interval. Each edge is reckoned have a weight and the weight values assigned each edge be dependent on the come across time intervals of a pair of associated nodes. In order to clearly define the multi-slice network model. We use $G\{V, E_{intra}\}$ to represent each single slice network. $V = \{v_{11}, v_{12}, ..., v_{si}\}$ is the nodes set of entire network, v_{si} represent the i node in s slice. $E_{intra} = \{e_{112}, e_{113}, ..., e_{sij}\}$ is the edges on each slice. The e_{sij} is the edge of i node and j node on slice s. The edge between the slices are represented $E_{inter} = \{e_{112}, e_{113}, ..., e_{srj}\}$, the e_{srj} represent the edge joint the same node on two adjoining slice. So, for the multi-slice network model, we use $N = \{V, E_{intra}, E_{inter}\}$ to represent. This paper, we selects four typical weighted MSNs. Following is the specific introduction: Cambridge lab dataset, MIT reality dataset, Info 05 dataset and Rollernet dataset be applied to the follow research method. The numbers of nodes and slices sum be partitioned of four MSNs are listed in Table 1. The Cambridge lab dataset collected encounter data from a number of traces of Bluetooth sighting by 19 graduate students carrying small devices for a several days. The MIT reality dataset contains the students/faculty in the MIT Media Laboratory with their personal mobile phones and resulted in personal behavior and interpersonal interactions for one month[7]. Info 05 dataset was got from Infocom 2005 experiment with 268 nodes, and Roller dataset contains the trace sets of Bluetooth devices by groups of people carrying iMotes in a rollerblading tour in Paris, France[8].

Table1. Common characteristics of network model about four realistic MSNs

Dataset	The number of Nodes	Duration time	Preestablish of slices
CambLab	223	6says	12
MIT	97	29days	29
Info05	268	3days	6
Roller	1112	3hours	6

2. Analysis of assortative mixing

The main characteristics of the nodes is node degree, a network has the properties of assortativity if value of node degree high tend to connected to other nodes with high value of node degree. Whereas, if high node degree have a tendency to link other nodes with low degree, we said it show disassortative[9]. That can depict by calculated the assortativity coefficient. The coefficient defined as follow:

$$r = \frac{M^{-1}\sum_i j_i k_i - \left(M^{-1}\sum_i \frac{1}{2}(j_i + k_i)\right)^2}{M^{-1}\sum_i \frac{1}{2}(j_i^2 + k_i^2) - \left(M^{-1}\sum_i \frac{1}{2}(j_i + k_i)\right)^2} \quad (1)$$

Where j_i and k_i denote the degrees of the two vertices linked by the ith edge, with i = 1,2 ... ... M. In Fig. 1, we show r of every piece of time slice for the selected four MSNs. As the figure show, the assortativity coefficient is negative in each time slice of the network, and the average assortativity coefficient of the whole slice network is equally negative. It means the four MSNs in the process of the time series are all disassortative. This proves that the