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STUDY ON NETWORK STRUCTURE IN VIRTUAL TRANSACTIONS BASED ON SNA

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ABSTRACT

In virtual transactions, 2-mode network about "user-product" is constructed by e-commerce behavior between users and products. Based on binary matrix of evaluating products by users in virtual transactions, this paper discusses that 2-mode and 1-mode network structure between products and users from the whole network of social network analysis prospect. First, a model about "user-product" is constructed through two representation methods including matrix and graph. Then, this paper introduces main methods such as matrix transformation, bipartite 2-mode graphs, etc. Third, through a case about a B2C transaction website, some quantitative characteristics including network density, clique relationship, and core-periphery structure can be revealed and visually displayed. Furthermore, members' relationships and structure characteristics are acquired based on the analysis of visualization results. Moreover, this paper computes density and the degree centrality, betweenness centrality and closeness centrality demonstrating customer authority. Lastly, a conclusion is reached that the cited network has core-marginalization constitution. Through comparative analysis, we found that there are central nodes and several groups. Furthermore, the proposed methods in this paper can be utilized in the research of members' relation and structure characteristics in the transaction networks, which can be convenient for improving and enhancing user experience.

Keywords: *Virtual Transaction, Social Network Analysis, 2-Mode Network, User Evaluation*

1. INTRODUCTION

With the progress of information technology and network, more and more people are starting to search for information or acquire service. Shopping online is becoming receiving and crazy consumption pattern due to the flourishing Electronic Commerce. In the virtual transaction, users take behavior such as searching, purchasing and evaluating on line to complete shopping-online course. Relevant data coming from the behavior is recorded in background, which can provide powerful support for further management and marketing of the website.

We have segregated the shopping-online course to pre-purchase, in-purchase and post-purchase. Since a great deal of information from the post-purchase behavior can play a vital role in supplying some new thought for some agency service companies, nowadays, many researchers pay more attention to the study of post-purchase behavior. Mitchell has summarized early potential impact of perceived risk which was represented in 3 stages including collecting information, evaluating protocols and post-purchase behavior [1]. Extensive research has concentrated on the interrelations among service quality, customer satisfaction and post-purchase behavior [2-4]. Both positive and negative aspects were considered in the research of influence factor of users' purchase intention public praise by Ye [5]. In summary, researchers have analyzed influence factors of users' purchase intention and decision and constructed concept model which mostly in qualitative methods and rarely in quantitative methods. Post-purchase behavior is divided into various categories such as the use and evaluation of products, legal behavior, repeat-purchase behavior etc. Pre-existing literature has focused on analysis in whole, while lacking anatomy in depth microcosmically. However, as a kind of post-purchase stage, evaluating products is a direct feedback of buying products, which can not only reflect user's degree of satisfaction on the transaction, but directly influence others purchase decisions. Moreover, based on these evaluations, some results can be concluded such as which products users have interest in, which users belong to a same kind. Consequently, if we analyze user's evaluation deeply, relationship among network

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members can be found and hidden structural features can be revealed as well. At present, the researches on network structure concentrate on topology [6], the discovery [7], and evolution tendency and growth pattern [8-9]. From above studies, there is little research on relation structures of virtual transaction community, especially lacking in analysis of network structure and members' relation based on users' evaluation of post-purchase behavior.

In virtual transactions, 2-mode network "users-products" is constructed by the e-commerce behavior between users and products. According to post-purchase evaluation of users, a series of methods are adopted in social network analysis (SNA) such as matrix transformation, bipartite 2-mode graph, Core-periphery analysis, etc. This paper makes a study on the status of network members and the relationships between them. Moreover, multi-dimension rules between users and products are found.

2. MODEL CONSTRUCTION

From the social networks perspective, in virtual transaction, the behavioral agents of 2-mode network about "user-product" are users, namely actor group, and the behavioral objects of it are products, namely event group. As the specific characteristics of virtual transaction, if users give evaluation after they have bought products, it will show that they pay close attention to the products. Therefore, in this paper, we represent the relationships between the two groups on the basis of whether users give evaluation on the purchased products. This paper adopts some methods in SNA [10]. SNA was originated form British anthropology research in the 1920's. For now, SNA has been a research paradigm of both characteristic concept system and measuring tool. Two representations, e.g. matrix and graph, make formal description on this problem.

(i) Matrix Representation: In mathematics, 2-mode networks can be abstracted into matrix. For example, $A_{m\times n}$ is a adjacency matrix about "user-product" in which there are m users and n products. The initial datum in this matrix are from initial survey. For example, if $a_{ij}=1$ (a_{ij} is one of elements in A), it denotes that user i has made evaluation on product j. Otherwise, if $a_{ij}=0$, it denotes user i has made no evaluation on product j.

(ii) Graphic Representation: 2-mode network can be represented with bipartite graph. For example, $G=(V,E)$ is a bipartite graph in which V is a set of users and E is a set of products. There is no subset between them and there is no line in each set. Users and products are regarded as nodes in the graph. The evaluation behavior that users made on products is presented with line between one to another one. We also know that the relationship will be closer if their distance is closer, which denotes they will be more similar.

3. INTRODUCTION OF MAIN METHODS ABOUT 2-MODE NETWORK

2-mode network is a relation network composed of two groups that are actors and events which are used for representing the relationship between them in 2-mode network like "actor-event". Other tension problems, like between "structure and agency", "individual and collective" or "macro and micro", are quantitatively analyzed by means of 2-mode network. The main methods are as follows.

3.1 Network Density Analysis Of 2-Mode Network

Whole network is composed of relations among all the members in an inner-group, in which the density of 2-mode network is that the total of actually existent ties divided by the maximum of possibly existent ones in theory. Supposing that there are n nodes in a two-value undirected relational network, thus the maximum ties total in theory is n(n-1)/2. If the total of actually existent ties is m, the network density is 2m/n(n-1). The larger network density is, the lager the effect that actors and events infect is in the network.

3.2 Matrix Transformation From 2-Mode Network To 1-Mode Network

2-mode data can be shown by rectangular matrix and next can be converted into two 1-mode dada. Namely, "actor-event" matrix can be converted to "actor-actor" matrix and "event-event" matrix, which make it possible to further analyze the ties (link node to node) and ties strength. The transformation from 2-mode network to 1-mode network reflects "duality". Concrete analysis is as follows:

Hypothesis: 2-mode matrix $A_{m\times n}$ is an adjacency matrix of "actor-event", which includes m actors and n events. Datum in $A_{m\times n}$ come from initial investigation. If $a_{ij}=1$ (a_{ij} is a node in A), it means that Actor i participates in Event j; If $a_{ij}=0$, it means Actor i doesn't participate in Event j.

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Conclusion: The amount of overlap between a pair of actors (events) can acquire from the product of correspondence factors from correspondence rows and columns in A. i.e. $P_{i\times j}=\sum_{k=1}^{n}A_{ik}A_{jk}$ (in matrix "actor-actor"); $G_{i\times j}=\sum_{k=1}^{n}A_{ki}A_{kj}$ (in matrix "event-event"). Especially, the elements on diagonal in products matrix show that how many events (actors) an actor (event) participates (is participated) in.

More specifically, we can acquire the amount of events that Actor i and Actor k jointly participate in by multiplying Row i by Row k in A and who they are. Similarly, we can acquire the amount of actors that jointly participate in an event by multiplying Column j by Column l in A and who they are as well.

3.3 Analysis Of Bipartite 2-Mode Graph

Graphic processing is another method from 2-mode network to 1-mode network besides "matrix transformation". First, bipartite matrix should be built by adding some rows and columns based on initial relational matrix. Thus, a square matrix called 2-mode bipartite matrix is established. According to it, bipartite graph can be built. Second, visualize the datum and perform an analysis of bipartite 2-mode graph. Data visualization of bipartite graph refers to divide initial 2-mode graph into two disjoint parts: one is a group of actors, the other is a group of events. Ties between two parts represent participation relations between actors and events. Adopted such method, 2-mode relational structure can be seen clearly and some insights can be acquired as well. When graphs are drawn according to "distance" by multidimensional scaling, the nearer the nodes are, the closer their relations are, namely the bigger similarity is. However, it is a disadvantage that quantitative explain is limited.

4. CASE ANALYSIS

As the virtual properties of virtual transactions, Users will be satisfied or dissatisfied with the products after they have bought them. Thus, it maybe not reflect the true situation if we regard sales of products as the only measurement scale. On the contrary, users are satisfied with the products if they make good evaluations on products. In this paper, we construct 2-mode network about "user-product" in basis on the good evaluation that users made on the products.

We researched a webpage in an internal B2C shopping website about the English books of postgraduate exam. Transaction datum from 3 to 6 Mar. 2011 were collected, which recorded basic information including user name, buying time, book title, whether or not giving evaluations, evaluation content, etc.. Making cluster analysis through software SPSS, we selected 20 "active" users who often made evaluations on buying and 9 "hot" books which were given much evaluations from 209 users and 38 books. A 2-mode matrix was built based on users as rows and books as columns, in which the associated element value was 1 if someone has given evaluation on the buying book, else was 0. For simplicity, book titles are represented with b1-b9 and user names are represented with c1-c20. Initial 2-mode matrix is as shown in Figure 1. Moreover, the density (0.3667) of the network can be acquired through UCINET, which indicates closeness is adequate.

	b1	b2	b3	b4	b5	b6	b7	b8	b9
c1	0	0	1	0	1	1	1	0	0
c2	1	1	1	0	0	0	0	1	1
c3	0	0	1	0	0	0	1	1	1
c4	1	1	0	1	0	0	0	0	1
c5	1	1	0	1	1	0	0	1	1
c6	0	0	1	0	0	0	1	0	0
c7	0	0	0	1	1	1	1	1	0
c8	1	1	0	1	0	0	0	0	1
c9	0	0	0	1	0	1	1	0	0
c10	0	0	1	0	1	0	0	1	1
c11	1	1	0	1	0	0	0	1	0
c12	0	0	0	1	0	0	0	0	0
c13	0	0	0	1	0	1	1	1	0
c14	0	0	1	0	0	0	0	0	1
c15	1	1	0	1	0	1	0	0	0
c16	0	0	1	0	0	0	0	0	1
c17	1	0	0	1	0	0	0	0	0
c18	0	0	1	0	0	0	0	0	0
c19	0	0	0	0	0	0	0	0	1
c20	1	0	0	1	1	1	0	0	0

Figure 1: Initial 2-Mode Matrix About "User-Book"

4.1 Matrix Transformation From 2-Mode Network To 1-Mode Network

Step 1: The initial 2-mode matrix is converted into 1-mode matrix through the function of matrix transformation in UCINET. More specifically, 20-order relational matrix about "user-user" is obtained through selecting "row mode" and "Cross-product method", as shown in Figure 2. The element value on diagonal represents the number of products that are evaluated by a single user. For example, the element value of Row 2, Column 2 is 5, which shows User 2 has given evaluation on 5 books. On the other hand, the value of non-diagonal elements represents the number of books that are given common evaluations by corresponding users. For example, the element value of Row 4, Column 2 is 3, which shows there are 3 books commonly evaluated by User 4 and User 2.

Step 2: Based on the 1-mode matrix about "user-user", next we can make clique categories, as we know that users in the same clique possess the features of sharing. The following shows clique relationship of network.

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		1 2 3 4 5 6 7 8 9	1 0 1 2 3 4 5 6 7 8 9 0	1 2
		c c c c c c c c c	c c c c c c c c c c	c c
1	c1	4 1 2 0 1 2 3 0 2	2 0 0 2 1 1 1 0 1 0	2
2	c2	1 4 2 2 3 1 1 2 0	2 3 0 1 1 2 1 1 1 0	1
3	c3	2 2 4 1 1 3 2 1 1	2 2 1 2 2 0 1 0 1 0	0
4	c4	0 2 1 4 3 1 1 4 1	0 4 2 1 1 3 0 2 0 0	2
5	c5	1 3 1 3 5 0 3 3 1	2 4 1 2 0 3 0 2 0 0	3
6	c6	2 1 3 1 0 3 1 1 1	1 1 1 1 2 0 1 0 1 0	0
7	c7	3 1 2 1 3 1 5 1 3	2 2 1 4 0 2 0 1 0 0	3
8	c8	0 2 1 4 3 1 1 4 1	0 4 2 1 1 3 0 2 0 0	2
9	c9	2 0 1 1 1 1 3 1 3	0 1 1 3 0 2 0 1 0 0	2
10	c10	2 2 2 0 2 1 2 0 0	3 1 0 1 1 0 1 0 1 0	1
11	c11	0 3 2 4 4 1 2 4 1	1 5 2 2 1 3 0 2 0 0	2
12	c12	0 0 1 2 1 1 1 2 1	0 2 2 1 1 1 0 1 0 0	1
13	c13	2 1 2 1 2 1 4 1 3	1 2 1 4 0 2 0 1 0 0	2
14	c14	1 1 2 1 0 2 0 1 0	1 1 1 0 2 0 1 0 1 0	0
15	c15	1 2 0 3 3 0 2 3 2	0 3 1 2 0 4 0 2 0 0	3
16	c16	1 1 1 0 0 1 0 0 0	1 0 0 0 1 0 1 0 1 0	0
17	c17	0 1 0 2 2 0 1 2 1	0 2 1 1 0 2 0 2 0 0	2
18	c18	1 1 1 0 0 1 0 0 0	1 0 0 0 1 0 1 0 1 0	0
19	c19	0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0 0	0
20	c20	2 1 0 2 3 0 3 2 2	1 2 1 2 0 3 0 2 0 0	4

Figure 2: 1-Mode Matrix About "User-User"

(i) When we set the parameter value "9", namely the scope of clique is 9, the clique isn't divided too thin. The 1-mode matrix is divided into 5 cliques, as shown in Figure 3. We can reach a conclusion that users in a same clique focus on the same kind of books and have the same feature of sharing. Moreover, members from different cliques can be overlapped with each other, as shown in Figure 4. For example, a user like c4, c5 or c8 belongs to 4 cliques, but user like c1, c6 or c18 doesn't belong to any cliques. At the same time, we can also know that "Actor-by-Actor Clique Co-Membership Matrix" and "Clique-by-Clique Actor Co-membership matrix". The former gives us the number of cliques that every pair of users belongs to, and the latter gives us the number of common members from different cliques and the figure of clustering. Space lacks for a detailed description of it.

```
5 cliques found.

   1:  c2 c3 c4 c5 c7 c8 c10 c11 c13
   2:  c2 c3 c4 c5 c8 c10 c14 c16 c19
   3:  c2 c4 c5 c7 c8 c10 c11 c13 c20
   4:  c2 c4 c5 c7 c8 c11 c13 c15 c17 c20
   5:  c4 c5 c7 c8 c9 c11 c12 c13 c15 c17 c20
```

Figure 3: Result Of Clique Categories

HIERARCHICAL CLUSTERING OF OVERLAP MATRIX

	c c c c c c c c c c c c c c c c c c c c
	c 1 1 1 1 c 1 c 1 1 1 c c c c c 1 1 2
	1 6 8 4 6 9 9 2 3 0 5 7 2 8 5 4 7 1 3 0
Level	1 6 8 4 6 9 9 2 3 0 5 7 2 8 5 4 7 1 3 0
5.000	. . . . . XXXXX . . . .
4.000	. . . . . XXXXXXX XXXXX .
3.800	. . . . . XXXXXXXXXXXX .
2.927	 XXXXXXXXXXXXXX
2.000	. . . . . XXX XXX XXXXXXXXXXXXX
1.966	. . . . . XXX XXXXXXXXXXXXXXXXX
1.086	 XXXXXXXXXXXXXXXXXXX
1.000	. . . XXXXX XXX XXXXXXXXXXXXXXXXXXX
0.833	. . . XXXXX XXXXXXXXXXXXXXXXXXXXXXX
0.231	. . . XXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
0.000	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX

Figure 4: Hierarchical Clustering Of Overlap Matrix

(ii) Figure 5 shows user by user clique co-membership matrix. That is the number of cliques of each pair of users participating in a common, e.g. the value of line 4 column 3 is 2, which denotes c4 and c3 belong to the same two cliques. According to the analysis from Figure 3, we know that they are clique 1 and clique 2. Its value on the diagonal line shows the number of cliques about the corresponding user.

Actor-by-Actor Clique Co-Membership Matrix

		1 2 3 4 5 6 7 8 9	1 0 1 2 3 4 5 6 7 8 9 0	1 2
		c c c c c c c c c	c c c c c c c c c c	c c
1	c1	0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0 0	0
2	c2	0 4 2 4 4 0 3 4 0	3 3 0 3 1 1 1 1 0 1	2
3	c3	0 2 2 2 2 0 1 2 0	2 1 0 1 1 0 1 0 0 1	0
4	c4	0 4 2 5 5 0 4 5 1	3 4 1 4 1 2 1 2 0 1	3
5	c5	0 4 2 5 5 0 4 5 1	3 4 1 4 1 2 1 2 0 1	3
6	c6	0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0 0	0
7	c7	0 3 1 4 4 0 4 4 1	2 4 1 4 0 2 0 2 0 0	3
8	c8	0 4 2 5 5 0 4 5 1	3 4 1 4 1 2 1 2 0 1	3
9	c9	0 0 0 1 1 0 1 1 1	0 1 1 1 0 1 0 1 0 0	1
10	c10	0 3 2 3 3 0 2 3 0	3 2 0 2 1 0 1 0 0 1	1
11	c11	0 3 1 4 4 0 4 4 1	2 4 1 4 0 2 0 2 0 0	3
12	c12	0 0 0 1 1 0 1 1 1	0 1 1 1 0 1 0 1 0 0	1
13	c13	0 3 1 4 4 0 4 4 1	2 4 1 4 0 2 0 2 0 0	3
14	c14	0 1 1 1 1 0 0 1 0	1 0 0 0 1 0 1 0 0 1	0
15	c15	0 1 0 2 2 0 2 2 1	0 2 1 2 0 2 0 2 0 0	2
16	c16	0 1 1 1 1 0 0 1 0	1 0 0 0 1 0 1 0 0 1	0
17	c17	0 1 0 2 2 0 2 2 1	0 2 1 2 0 2 0 2 0 0	2
18	c18	0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0 0	0
19	c19	0 1 1 1 1 0 0 1 0	1 0 0 0 1 0 1 0 0 1	0
20	c20	0 2 0 3 3 0 3 3 1	1 3 1 3 0 2 0 2 0 0	3

Figure 5: User By User Clique Co-Membership Matrix

(iii) Clique-by-clique user co-membership matrix provides the user co-membership between one clique and the other clique, as shown in Figure 6, e.g. the value of line 2 column 4 is 4, which denotes clique 2 and clique 4 coown 4 users. Its value on the diagonal line shows the number of users about the corresponding clique. Figure 7 shows hierarchical clustering of overlap matrix. From the result, we can find that clique 4 and clique 5 overlap 9 users.

Clique-by-Clique Actor Co-membership matrix

	1	2	3	4	5
1	9	6	8	7	6
2	6	9	5	4	3
3	8	5	9	8	7
4	7	4	8	10	9
5	6	3	7	9	11

Figure 6: Clique-by-clique user co-membership matrix

HIERARCHICAL CLUSTERING OF OVERLAP MATRIX

Level	2 1 3 4 5
9.000	. . . XXX
8.000	. XXX XXX
7.000	. XXXXXXX
4.500	XXXXXXXXX

Figure 7: Hierarchical Clustering Of Overlap Matrix

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(iv) Figure 8 shows clique user cluster graph. Such graph can describe the situation of clique assignment, e.g. c8, c5 and c4 belong together to 5 cliques. Furthermore, c3 and c10, as well as c15 and c17 belong together to 2 cliques. Otherwise, c1, c6 and c18 belong to none clique.

According to above analysis, we can acquire the relations about "user-user" in basis on the user gives the evaluation to their buying. Thus, the corresponding relationship among small groups can be obtained. Deeply study can be made based on user relations, clique categories and the concrete content of evaluation, which will provide support to the right marketing strategies.

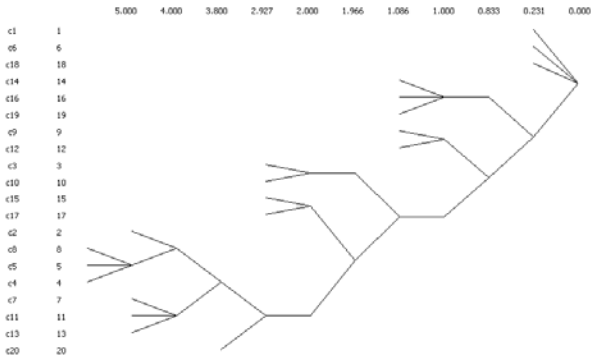

Figure 8: Clique User Cluster Graph

Similarly, based on the transformation from 2-mode network to 1-mode network, the matrix about "book-book" can be acquired. We can also know that the relations and cliques of product dimension through similar analysis.

4.2 Building Bipartite 2-Mode Graph

Step 1: Building bipartite matrix. Adding some rows and columns to the initial 2-mode matrix about "user-book", it will be composed of 29 rows (20 users add 9 books) and 29 columns (9 books add 20 users). In the formed bipartite matrix, the block of "user-book" is the same as the initial matrix, the two blocks of new matrix ("user-user" matrix and "book-book" matrix) are encoded "0".

Step 2: Building bipartite 2-mode graphs on the basis of the constructed bipartite matrix. Selecting NetDraw, redrawing on MDS (MultiDimensional Scaling), we can get that their distances are nearer among b1, b2 and b3, which reveals their relations are closer and their relevancies are stronger, as shown in Figure 9. In fact, these 3 books are about vocabulary, grammar and real topics, which are 3 different types of English books of postgraduate exam. The result represents that users often select different book types rather than the same ones when they want to buy such exam books in order to cover as much knowledge as possible. The result of visualization coincides well with the fact. Otherwise, the nearer distance between c4 and c8 indicates they have the similar focuses and preferences. Correspondingly, similar online marketing strategy can be adopted in such products or users that have high commonness and strong relevancies.

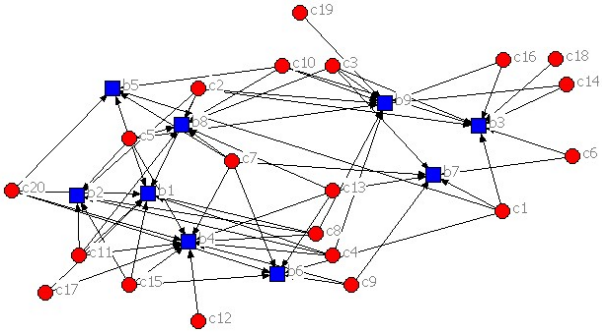

Figure 9: Bipartite 2-Mode Graph About "User-Book"

Step 3: Making an analysis of centrality. Some quantitative results can be gotten based on the above bipartite 2-mode graphs. For example, we select "Analysis\Centrality Measures\ Betweenness". As shown in Figure 10, we find that centrality of b4 is the biggest, b9 is bigger and b2 is the smallest, which indicates b4 is core of the network as its evaluations are the most. The Centrality of c2 is the biggest, likewise, he can be regarded as "opinion leader" due to his high activeness.

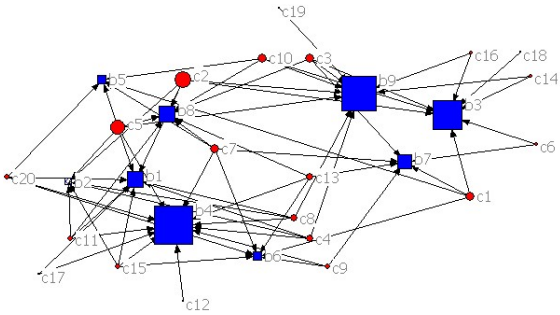

Figure 10: Centrality Analysis On Bipartite 2-Mode Graph About "User-Book"

Step 4: Above analysis shows network structure relationship visually. But it can't give more quantitative explain. Performing analysis on 2-mode data about "user-product", we will get the result of centrality analysis, as shown Table I and Table II. Table I shows the centrality analysis result about 20 users. From this, degree centrality value about c5 (0.667) is the highest. Otherwise, degree centrality value about c12, c18 and c19 (0.111) is the lowest. We also find that the value of

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closeness centrality about c5 (0.825) is the highest, and betweenness centrality value about it (0.090) is a little lower than c2 (0.094) whose value is highest. That shows that c5 maybe be a core user. Among c12, c18 and c19, closeness centrality value (0.516) and betweenness centrality value (0.000) about c18 are the lowest. The next one is c19, and the third one is c12. That shows that they are all the periphery users.

Table 1: Centrality Analysis Result With 20 Users

2-Mode Centrality Measures for ROWS of Book1

	Degree	Closeness	Betweenne
c1	0.444	0.681	0.055
c2	0.556	0.797	0.094
c3	0.444	0.723	0.054
c4	0.444	0.746	0.040
c5	0.667	0.825	0.090
c6	0.222	0.595	0.009
c7	0.556	0.746	0.054
c8	0.444	0.746	0.040
c9	0.333	0.662	0.021
c10	0.444	0.723	0.044
c11	0.444	0.681	0.020
c12	0.111	0.553	0.000
c13	0.444	0.723	0.037
c14	0.222	0.610	0.008
c15	0.444	0.662	0.025
c16	0.222	0.610	0.008
c17	0.222	0.610	0.002
c18	0.111	0.516	0.000
c19	0.111	0.540	0.000
c20	0.444	0.681	0.028

Table II provides centrality results about 9 products. From this, we can find that b4 is the core product since its values of degree centrality, closeness centrality and betweenness centrality are the highest, which are 0.550, 0.621 and 0.231. On the contrary, b5 is the periphery product, whose three values are 0.250, 0.545 and 0.047.

Table 2: Centrality Analysis Result With 9 Products

2-Mode Centrality Measures for COLUMNS of Book1

	Degree	Closeness	Betweenne
b1	0.400	0.581	0.090
b2	0.300	0.545	0.036
b3	0.400	0.563	0.177
b4	0.550	0.621	0.231
b5	0.250	0.545	0.047
b6	0.300	0.529	0.052
b7	0.300	0.529	0.077
b8	0.350	0.581	0.089
b9	0.450	0.600	0.210

4.3 Core-Periphery Analysis Of 2-Mode Data

The result of partition, as shown in Figure 11, is gotten from making core-periphery analysis on "user-book". The final fitness between partitioned datum and ideal-model datum is 0.701, which shows their relations are tight. As seen from partitioned matrix, 6 users including c8 etc. and 9 books including b9 etc. are the cores of the network, whose relational density is 0.519. Others in the figure are the periphery, whose relational density is 0.192. It well represents Core-periphery structure of "user-book" network.

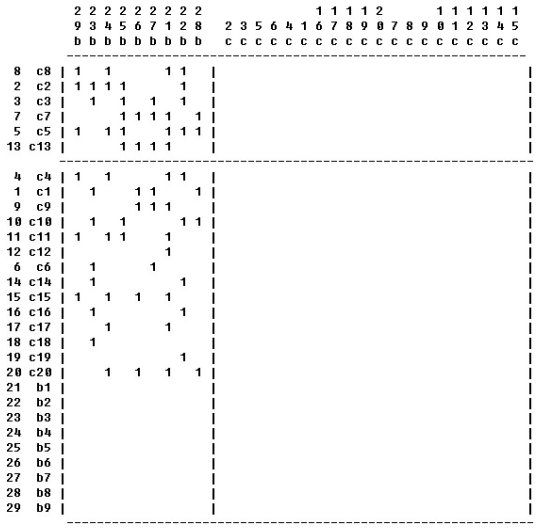

Figure 11: Core-Periphery Analysis On 2-Mode Datum About "User-Book"

5. CONCLUSION AND DISCUSSION

Above research result indicates that there are some relations between actors and events through users purchase and evaluate products. We can measure the network structure as well as the position where nodes in it in basis on SNA. The method is operative and with high value on the production.

On one hand, based on SNA nodes (e.g. users or products) in the network can be sorted. For example, the whole network structure can be measured by the density index. The nodes' positions can be measured by the centrality index. Core nodes and periphery nodes can be distinguished by the core-periphery analysis. Thus we can not only know the whole network structure, but also recognize the node position in networks. But even more important, core nodes or key nodes can be recognized. It will be help for taking some corresponding marketing management measures on these nodes.

On the other hand, based on SNA the correlation on immanent logic between users and users or products and products can be revealed. For example, cliques can be parted by cohesive subgroups analysis and then similarity users and relevance products can be got. The user cluster can be caused by products and the product cluster can be caused by users through the multidimensional scale

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analysis. Thus the deep connection between users and products can be acquired, which will provide a basis for carrying out individual information service. We know that the purpose that analyzing network structure is to provide users with better commodity information services, e.g. the better recommendation will be acquired to users on the sorted commodities. Furthermore, it will provide reference for formulating and carrying out marketing policies. Considered from this point, it will be significant and great perspective to analyze network structure in virtual transactions based on SNA.

This paper introduces the features of relationship among network members based on shopping evaluations, which is visualized according to some methods like 2-mode networks of SNA. "Duality" between group relationships and personal relationships is fully embodied. From the view of user post-purchase evaluations, the hidden network structure can be revealed. Moreover, the methods like SVD and PCA are also adopted in the case, but corresponding results are unmeaning, which may be related with the limited number and degree of density of the collected datum. We will select more webpages to collect multi-products and multi-users in the later. Thus, the network structure in virtual transaction can be researched more broadly.

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