Visualization of Hierarchical Transaction Network

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ABSTRACT

Our aim was to compare the industrial cluster ' s features and the overall structure of business- to- business networks, primarily on various auto manufacturers; therefore, we have created a higher level Visualization by altering the heights of the nodes which plots out the nodes on every transaction level and by clustering the nodes and the links. This allowed users to grasp the picture of companies ' accumulation degrees per area and of the differences among business-to-business networks per industrial cluster. The method introduced by the authors provided an easier comparison of business-to-business networks and fostered grasping the transaction structure.

1 INTRODUCTION

In business operations, transactions take a significant role and can be divided into two different kinds: B2B (Business to Business) and B2C (Business to Consumer). B2B is performed by companies such as manufacturers-manufacturers, manufacturers-wholesalers, and wholesalers and retailers. B2B is also larger in scale compared to that of B2C. Recently, B2B transactions are considered to be a complexed network, and studies on companies ' assessments have progressed.

Takram Design Engineering (Takram) has introduced its system prototype for analyzing local economies[1]. Japan ' s economy is in dire straits influenced by various factors, namely a shrinking population. Analysis and visualization of business-to-business networks enable companies to contribute to the local economy by providing better support.

2 BUSINESS-TO-BUSINESS NETWORKS

A number of analyses targeting companies have been reported. Many of these result from collecting information from such resources as Securities Reports or Open Data. Companies obliged to submit their Securities Reports are limited, comprising only a part of public listed companies. Furthermore, companies that possess their own website are also limited. So, only some selected companies out of the actual transaction network are subject to such analyses.

Teikoku Data Bank, Inc. (TDB) performs credit investigations for domestic companies. These companies are wide in range: large-small and publically unlisted-listed. Thus, TDB observes companies much closer and, therefore, possesses better information than that simply obtained from Securities Reports or Open Data.

Inter-firm transaction data that shows B2B ' s business relations shall be constructed based on the information collected from our suppliers and clients for this survey. This transaction data is a network constructed in a relation of companies as nodes and transactions as links. By connecting this data, users can build a network, which involves various industries and transactions.

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3 RELATED STUDIES

3.1 Visualizing Inter-firm Transaction Network on Digital Earth

Takram visualized business to business network on Digital Earth. Takram set companies as the nodes and placed them on a map based on each headquarters. Also, inter-firm transactions, which connect nodes, are set as the links. They are described as vertical curves with heights. This helps the user to understand the relationship between companies and regional economy.

3.2 Visualizing Inter-firm Transaction Network whose Heights were Altered Depends on Levels

Arimoto, et al., have visualized business-to-business networks by altering the heights of the nodes that plot business-to-business networks on Digital Earth. Their methods help users to understand the relationship between regional economy and industrial clusters with hierarchy. However, the auto manufacturers that top the industrial cluster produce their products by procuring auto parts from various manufacturers. Thus, one industrial cluster contains nodes and links. This introduces such problems as node complication and lowered visibility.

3.3 Approach of this Study

In this paper, we target auto industries that have second-tier suppliers from auto manufacturers. We will visualize them on Digital Earth by clustering the nodes and links, and distinguishing them by transaction levels.

4 METHODOLOGY

4.1 Constructing Industrial Clusters

In order to describe actual existing companies, we would sample an industrial cluster from business-to-business network which TDB, as explained above, possesses.

This paper uses the 4,869,600 data transactions performed by 735,204 companies in Japan during January 2015. An auto manufacturer headquartered in Aichi prefecture is set as the topping company (tier0), and there are the first-tier supplier (tier1) and the second-tier supplier (tier2). We will construct data of these three-level transactions. Tier 1 should have direct transactions with tier0 and should be the companies that put focus on raw materials or parts for producing autos. Tier2 should have direct transactions and have strong relations to auto manufacturing. Companies that undertake business in foodstuffs, feed, and beverage industries are not included. The companies sampled from more than two levels shall be placed in a level that is closer to the top company in order to construct transaction data in which the same company would not exist in more than two levels.

4.2 Clustering Nodes

The number of the nodes that exist in auto industrial clusters which appear in this paper exceeds 10,000. Plotting all the nodes on the map could cause complications. So, we would accumulate the nodes as a mesh unit (10km as a side) on the second regional partition that was announced by the Ministry of Internal Affairs and Communications. We calculate mesh codes with the longitude and

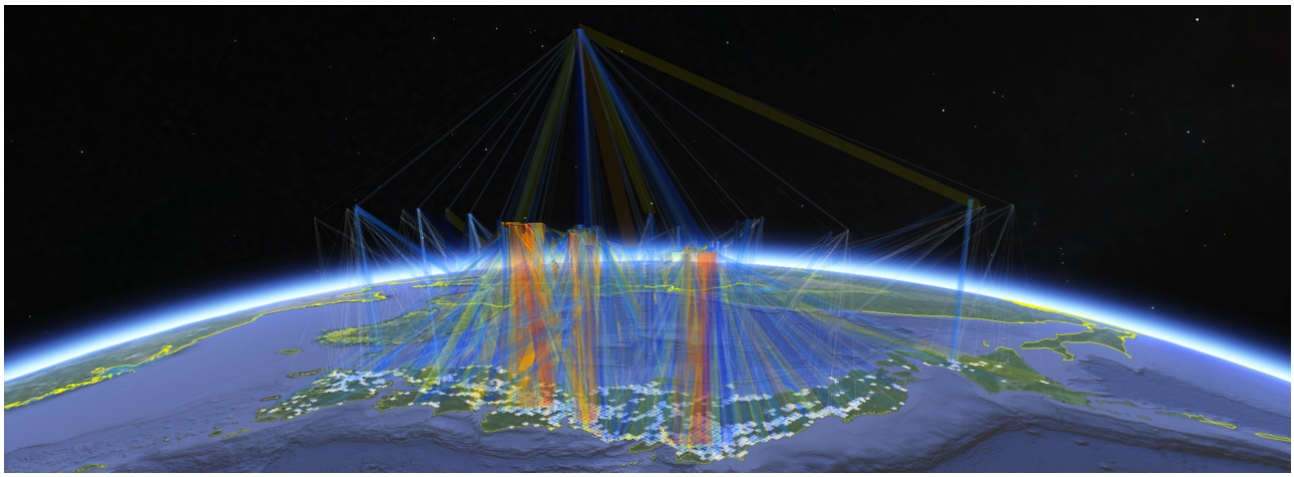

Figure 1: Overall structure of the visualization with the suggested method

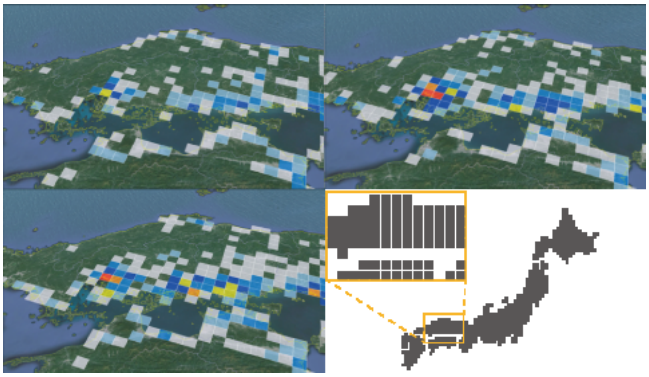

Figure 2: The visualization which focuses on the Chugoku region, after comparing three different transaction clusters

latitude of each headquarters address in the industrial cluster. Then we set the colors depending on the number of the company each mesh contains.

On inter-firm transaction networks, major companies have several clients. So, the number of links is bigger than that of the nodes in an industrial cluster. This applies to this paper as well. It causes complications in the links. This problem could be solved by clustering the links; it could enhance visibility.

We accumulate the links ' starting-ending points per municipality and set them as transactions. Then, we alter the thickness of the clustering links in order to grasp the strengths of the connections. For this process we use a transaction amount estimator by Takayasu, et al. This would enable us to have better understanding on the volume of business that flows among municipalities.

5 Result and Discussion

We have constructed an industrial cluster for each auto manufacturers from business-to-business networks, and visualized auto industrial clusters with transaction hierarchy on Digital Earth.

Figure 1 shows the overall structure of the industrial cluster. Visualizing auto industrial clusters on Digital Earth allows us to see that transactions spread throughout Japan from one company. Also, altering the starting and ending point of the links enables us to understand the features of every transaction level.

Secondly, we compare some auto industrial cluster ' s accumulations. Every cluster has a different topping company. Figure 4 describes the locations of auto manufacturers, A, B, and C in the Chugoku region. From this figure, viewers can observe two remarkable factors; each manufacturer has suppliers located in the Chugoku region, and; in the Chugoku region, a number of companies are located especially in the Seto Inland Sea area. Hence, accumulating the nodes per mesh unit would enhance the visibility of the nodes ' density on the map. Also, comparing the mesh colors would promote a comparison of industrial location on each industrial cluster.

6 Conclusion

Our aim was to compare the industrial cluster ' s features and the overall structure of business-to-business network, primarily on various auto manufacturers; therefore, we have created a higher level visualization by altering the heights of the nodes which plots out the nodes on every transaction level and by clustering the nodes and the links. This allowed users to grasp the picture of companies ' accumulation degrees per area and of the differences among business-to-business networks per industrial cluster. The method introduced by the authors provided an easier comparison of business-to-business network and fostered grasping the transaction structure.

The significance of this paper is to explicitly point out the industrial cluster which centers a specific company. National and local governments now could offer highly accurate support due to this paper, which demonstrates an easier comparison of the different industrial clusters ' features of each centering company. Thus, visualizing industrial clusters by employing out methods would contribute to regional economies in no small measure.

References

[1] takram design engineering：“RESAS Prototype”, http://www.takram.com/ja/projects/resas-prototype/ (Jan, 2016)