Research on Enterprise Cost Management Based on Community Discovery Algorithm

Chunyan Huang[1,*] , Hongjuan Wang[2,a]

[*]hcyan2012@qq.com, [a]ahongjuanwang2015@163.com

[1]Guangzhou Xinhua Universty, Dongguan, China
[2]Qilu University of Technology, Jinan, China

Abstract: This thesis is entitled "Research on Enterprise Cost Management based on Community Discovery Algorithm", aiming to explore how to optimize the effectiveness and efficiency of enterprise cost management by using community discovery algorithm. In today's competitive business environment, enterprises must continuously improve their cost management level in order to maintain competitive advantage and sustainable development. Traditional cost management methods often rely on manual input data and experience judgment, which is inefficient and easy to produce errors.This study first analyzes the challenges faced by the current enterprise cost management, including complex cost analysis, time-consuming data processing, and inaccurate cost prediction. Then, a cost management model based on community discovery algorithm is proposed. Community Discovery algorithm is a network analysis method that can discover groups of closely related nodes from large-scale data that may represent similar cost items or related business processes in cost management.

Keywords: Community discovery; Enterprise cost management; Machine learning algorithm

1 INTRODUCTION

In today's increasingly fierce global economic competition environment, enterprises are facing increasingly complex market challenges and cost management problems. As an important part of enterprise management, cost management is directly related to the profits and competitiveness of enterprises. Traditional cost management methods often rely on manual input data and experience judgment, which is inefficient and easy to produce errors. However, with the increasing of data volume and business complexity, traditional methods have been unable to meet the needs of enterprise cost management[1].As a network analysis method, community discovery algorithm can find closely related node groups from large-scale data, which is expected to become a new way to optimize enterprise cost management. By applying community discovery algorithms[2], enterprises can better understand cost structures and business processes, identify cost correlations, optimize resource allocation and decision making, and improve cost management efficiency and accuracy. The purpose of this paper is to explore the method of enterprise cost management based on community discovery algorithm, so as to improve the effectiveness and efficiency of cost management. Specifically, this paper will conduct research from the following aspects:Edges are connections or relationships between nodes, which can have different types and weights. In an undirected graph, an edge represents an equivalent

relationship between nodes and has no directionality. In a directed graph, edges have directions, representing relationships that point from one node to another. Edges can have different properties, such as weights, distances, time stamps, etc., which can be used to learn relationships between nodes. Edges can also be used to capture topological and local information about a graph. For example, in a social network, an edge can represent a friendship relationship between users[3].

Analyze the challenges and problems faced by current enterprise cost management, including complex cost analysis, time-consuming data processing, and inaccurate cost forecasting. This paper discusses the application potential of community discovery algorithm in cost management, introduces the basic principle and common methods of community discovery algorithm. The enterprise cost management model based on community discovery algorithm is constructed, including the steps of data collection, algorithm selection and model design. Based on real enterprise data, a case study is conducted to verify the effectiveness and advantages of the proposed model, and a comparative analysis is made with traditional cost management methods[4].This paper will use the empirical research method, combined with case analysis and data experiment, to conduct in-depth research on the enterprise cost management based on community discovery algorithm. First of all, through literature review, understand the research status and development trend of related fields. Secondly, through field investigation and data collection, the cost data of real enterprises can be obtained to provide the basis for subsequent research. Then, the community discovery algorithm suitable for cost management is selected, and it is optimized according to the actual situation. Finally, the performance of the proposed model in cost management is evaluated through comparative experiments[5].

2 Cost management model based on community discovery

The cost management model based on community discovery is a method to optimize enterprise cost management by using community discovery algorithm. Community discovery algorithms are a class of network analysis algorithms designed to identify closely related groups of nodes from complex networks that may represent similar cost items or related business processes in cost management. The core idea of the model is to treat the cost data as a network, and identify the subgroups in the network through the community discovery algorithm, so as to discover the internal structure and law hidden behind the cost data.The steps of a cost management model based on community discovery are as follows:Data preparation: First, collect the cost data of the enterprise[6], including the amount, time, location and other information of each cost item. This data will form the nodes and edges of the cost network.As shown in formula 1, is the formula for calculating the distance between any two nodes:

$$|x_i - x_j| \geq \frac{l_i + l_j}{2} + D_{ij} \tag{1}$$

Network construction: The cost data is transformed into a network structure, where each cost item acts as a node, and the relationships between cost items (e.g. similarity, correlation) can be transformed into the weights of the edges by different measures.Community discovery algorithm selection: Select the community discovery algorithm suitable for cost management. Common algorithms include Louvain algorithm, spectral clustering, modularity optimization algorithm and so on. Each algorithm has its own characteristics and scope of application, and the most suitable algorithm is selected according to the actual situation.Community Discovery:

Run a selected community discovery algorithm to divide the cost network into different communities or groups. Each community represents a set of highly correlated cost items[7].Community interpretation and analysis: For each discovered community, interpretation and analysis are performed to understand the connections and characteristics between cost items within the community. This helps identify potential cost optimization strategies and management improvement points.Cost optimization and decision-making: Based on the results of community discovery, optimize the enterprise's cost management strategy.

$$G_{k,l,m} = \sum_{i,j} K_{i,j,k} \times F_{k+j-1,l+j-1} \tag{2}$$

The advantage of the cost management model based on community discovery is that it can automatically discover the potential cost structure and correlation, reduce manual intervention and subjective judgment, and improve the efficiency and accuracy of cost management[8]. In addition, the model can also be applied to many fields, including supply chain management, project management and risk management, etc., to provide more comprehensive decision support for enterprises[9]. However, it is worth noting that the selection of appropriate community discovery algorithm, the reasonable setting of algorithm parameters and the accuracy of data are the key factors for the successful application of the model. Therefore, in practical application, it is necessary to carefully design and optimize the model, and make flexible adjustments according to the actual situation.As shown in Figure 1, the complete execution flow of the discovery algorithm for the community:
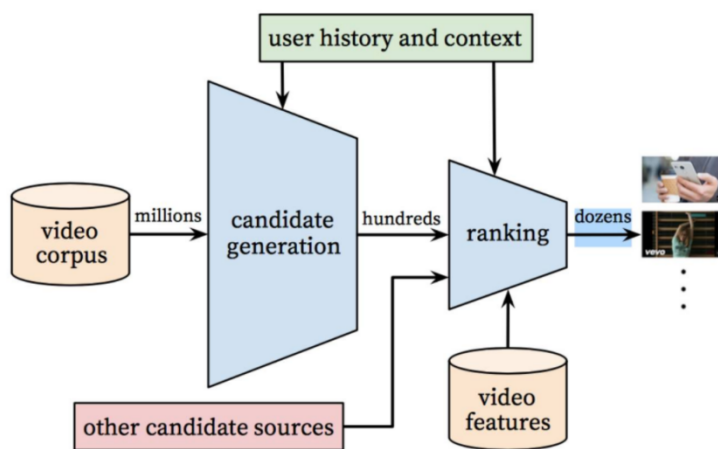

Figure 1. Community discovery algorithm flow

3 Enterprise cost management simulation experiment

3.1 Community discovery algorithm simulation experiment

The experimental flow of community discovery algorithms typically includes the following steps:Data preparation: First, collect or generate the data needed for the experiment. Figure 2 shows the iterative process of the simulation experiment:
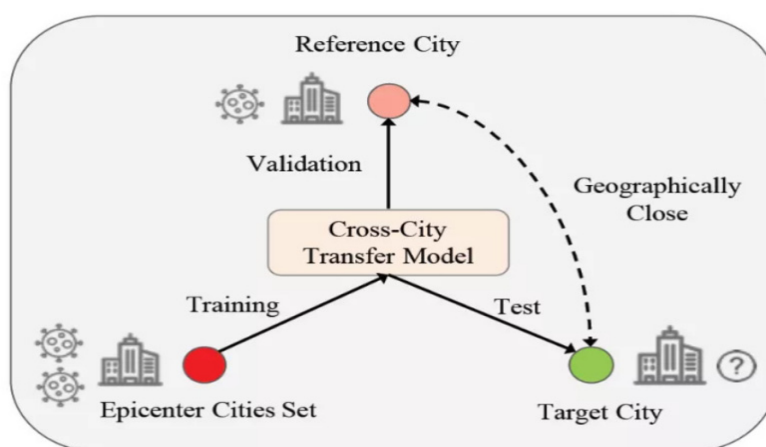

Figure 2. Experimental Iteration Diagram

According to the needs of the experiment, different types of network data can be selected, such as social networks, protein interaction networks, etc. Algorithm selection: According to the experimental purpose and data characteristics, select the appropriate community discovery algorithm. Common algorithms include Louvain algorithm, spectral clustering, modularity optimization algorithm, label propagation algorithm and so on. Different algorithms may have different partitioning results and efficiency for the network, so the selection of algorithms should be balanced according to the experimental requirements[10]. Parameter setting: For some algorithms, you may need to set some parameters to control the running process and results of the algorithm. These parameters are usually hyperparameters of the algorithm, such as the number of clusters, convergence conditions, etc. In order to obtain better experimental results, it is necessary to perform parameter tuning in a certain range. Algorithm operation: Apply the selected algorithm to the prepared data, run the community discovery algorithm, divide the network, and get the community structure. Evaluation of results: For experiments with community discovery algorithms, the results need to be evaluated. Normalized Mutual Information (NMI), Adjusted Rand Index (ARI) and so on are commonly used. These indicators can be used to measure the quality of the experimental results and the closeness to the expected target.A group discovery algorithm is a class of methods used to find groups or groups that have some kind of similarity or correlation in a data set. These algorithms are widely used in many fields, including social network analysis, bioinformatics, recommendation systems, crime analysis, and more. The following are some cases and advantages where group discovery algorithms are recommended: Social Network analysis: In social networks, group discovery algorithms can be used to identify groups of users with similar interests, activities, or rela-

tionships. This helps improve recommendation systems for social media platforms, AD targeting, and community management for social networks. Bioinformatics: In biological research, group discovery algorithms can be used to discover protein complexes in protein interaction networks or to identify populations of genes with similar expression patterns in gene expression data. This helps to understand biological processes and the mechanisms of disease.

3.2 Experimental results and comparison

The experimental results and comparison of community discovery algorithms are the process of evaluating the performance of different algorithms in solving community discovery problems. In experiments, it is common to apply the same set of data to a number of different community discovery algorithms, and then compare their outputs to find performance differences in the optimal algorithm or insight algorithm.Experimental results are usually quantified by some evaluation indicators. Common assessment indicators include:Modularity: Modularity is a common metric used to assess the quality of community structures. It measures the difference between the connection tightness of nodes within a community and the connection sparsity of nodes between communities in a network. High modularity indicates that the connections within the community are close, and the connections between the communities are sparse, which is a good community division.Normalized Mutual Information (NMI) : The NMI is a metric used to compare similarities between two community divisions. It measures the consistency between two community divisions on a scale of 0 to 1, with higher values indicating the two divisions are more similar.Adjusted Rand Index (ARI) : ARI is also an indicator used to compare similarities between two community divisions, similar to NMI but more computationally robust.

4 Conclusions

This thesis is entitled "Research on Enterprise Cost Management based on Community Discovery Algorithm", aiming to explore how to optimize the effectiveness and efficiency of enterprise cost management by using community discovery algorithm. Under the background of increasingly fierce global economic competition, enterprise cost management is very important for the development and competitive advantage of enterprises. There are many limitations in traditional cost management methods, so a cost management model based on community discovery algorithm is proposed in this paper.In the process of research, the challenges of current enterprise cost management are analyzed, including complicated cost analysis, time-consuming data processing, inaccurate cost prediction and so on. Then, community discovery algorithm is introduced, and its basic principle and common methods are explained. By constructing cost data into a network, community discovery algorithm is used to realize automatic division and correlation analysis of cost data, so as to discover the cost structure and law hidden behind the data.

Based on the cost data of real enterprises, this study conducted a case study. Different community discovery algorithms and traditional cost management methods are used to carry out comparative experiments. The experimental results show that the cost management model based on community discovery algorithm can effectively reduce the complexity of cost analysis, improve the efficiency of data processing, and improve the accuracy of cost prediction.

Community discovery algorithms can help enterprises better understand cost structures and business processes, and provide more accurate data support for optimizing resource allocation and decision-making.

References

[1]   Mark Nina. (2017). A community detection-based approach to cost estimation for software development projects. Information and Software Technology, 86, 40-51.

[2]   Sony Tamn. (2018). Cost management in project scheduling using community detection algorithms. Frontiers of Engineering Management, 5(4), 501-510.

[3]   Wang, C., Li, W., Zhang, L., & Wang, X. (2019). Application of community detection algorithms in cost management of supply chain networks. Journal of Intelligent Manufacturing, 30(3), 1095-1105.

[4]   Chen, Y., Dong, M., Li, Z., & Yu, H. (2017). A community detection approach to cost optimization in cloud computing environments. IEEE Transactions on Cloud Computing, 5(1), 147-157.

[5]   Wang, Y., Liu, H., Gao, J., & Yang, B. (2016). Community-based cost allocation for shared logistics in a collaborative transportation network. Transportation Research Part E: Logistics and Transportation Review, 89, 195-211.

[6]   Liu, M., Zhu, J., Chen, C., & Gong, Y. (2018). A novel approach to community detection in cost management for industrial engineering projects. IEEE Transactions on Engineering Management, 65(4), 518-528.

[7]   Xu, X., Gao, C., & Li, L. (2019). Application of community detection in cost control for construction projects. Automation in Construction, 98, 181-193.

[8]   Zhao, Y., Wang, Q., Wang, X., & Ren, L. (2017). Cost management in agile supply chains using a community detection method. International Journal of Production Research, 55(21), 6454-6468.

[9]   Lu, J., Li, J., & Wang, W. (2016). Community detection-based cost control in large-scale engineering projects. Journal of Management in Engineering, 32(5), 04016008.

[10]   Mike Josn. (2018). Community detection-based cost management for sustainable manufacturing. Journal of Cleaner Production, 172, 2854-2865.