Research on visualisation transmission method for business innovation strategy data based on structural characteristics

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Abstract: In order to overcome the problems of low transfer accuracy and user satisfaction existing in the existing data visualisation transfer methods, this paper proposes a data visualisation transfer method of business innovation strategy based on structural features. The similarity calculation method of structure feature tree is used to realise the data structure feature processing. The sub-trees of all non-isomorphic patterns of K nodes are constructed. The number of isomorphic sub-trees is calculated in the tree, and the transfer data division is completed. Based on the basic program of business intelligence, the original data of business innovation strategy is processed, converted into various types of visualisation structure data, and transmitted to relevant personnel in online form to complete the visualisation transmission of business innovation strategy data. The experimental results show that the proposed method is more accurate, up to 99.3%, and users are more satisfied.

Keywords: structural characteristics; business innovation; strategic data; visualisation transmission.

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1 Introduction

In the enterprise business development and support system, the data volume of business innovation strategy continues to grow. How to use these data to improve enterprise's decision-making performance and market response efficiency, and how to transform large-scale data into reliable information and available knowledge, and then help enterprises increase profits and market share in a unified and easy-to-access mode to transfer to relevant personnel, have become the hot issues in this field (Peng et al., 2019; Xie et al., 2017; Chen and Wu, 2016).

At present, with the rapid development of information technology, the total amount of data of global enterprises is rising gradually. Various types of strategic data have become the difficulty and the focus of survival and development that enterprises must deal with in real-time. Efficient mining of valuable information from business data and intelligent management and utilisation are the core to promote the rapid development of enterprises and achieve scientific management.

The front-end display of business innovation strategy data management platform is responsible for direct interaction with all relevant personnel. It is a visual application of data transmission and utilisation. It is very important for decision-makers to get decision-making basis and to give scientific and reasonable data analysis conclusions (Dai et al., 2016; Wang et al., 2016; Cui et al., 2017). Therefore, for enterprise data analysts and IT personnel, the research on visualisation transmission of innovation strategy data in business intelligence has significant theoretical and practical significance in improving the judgment ability of enterprise decision-making, dispatching enterprise information resources and improving the efficiency of decision-makers.

In Zhang and Xu (2019), the business online review data is regarded as the information source, and the business data visualisation analysis model based on online review is constructed. According to the feature word detection and extraction, keyword co-occurrence and social network analysis, the purpose of visual transmission of common data of feature dictionary and user's view is realised. However, the accuracy of this method needs to be further improved. Jin et al. (2018) takes the business literature as the data source. Through analysis, it can be seen that the main hot spots of business model in the innovation process include value creation and model challenges, etc., which have developed to the current cloud computing and cloud manufacturing, etc., and the hot spots gradually develop to virtual reality and artificial intelligence, so as to realise the visualisation of business data, but the user satisfaction of this method is poor. In Nie et al. (2018), the online comments of public comments are regarded as data. According to word2vec and dependency syntax, the feature dictionary of business field is designed and constructed, and the selection of user's views is realised, so as to realise the visualisation of business data feature topic aggregation and the calculation of user's views and feelings, and complete the visualisation of data transmission. However, the data transmission effect of this method is poor.

The above research results of business data visualisation analysis still need to be improved in terms of data visualisation accuracy and user satisfaction. Therefore, a method of data visualisation transmission of business innovation strategy based on structural features is proposed. The overall scheme of this method is as follows:

1 Using similarity calculation method, using the features of extraction tree to achieve tree similarity calculation, and then get the data division results of business innovation strategy based on structural features.

2 Based on the above data results, business intelligence is combined with data warehouse, online technology and data information mining technology, which is processed based on the structural features, converted into various types of visual structural data, and visualised transfer of business innovation strategy data.

3 Experimental verification. Taking the accuracy of data division and user satisfaction as the experimental comparison index, the proposed method was compared with Zhang and Xu (2019), Jin et al. (2018) and Nie et al. (2018).

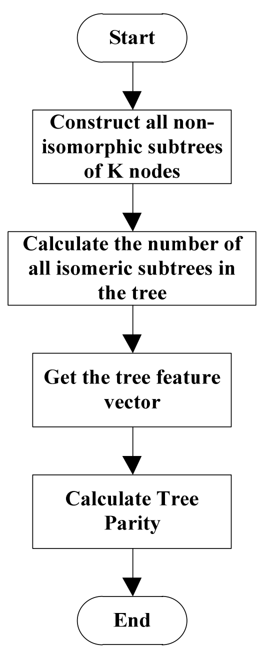
According to the above scheme, the accurate transmission of business innovation strategy data is realised, which provides reliable support for solving the existing problems of current relevant research methods.

2 Visual data transmission of business innovation strategy

2.1 Partition of business innovation strategy data based on structural characteristics

Each kind of data has its own unique structural characteristics. Extracting the structural characteristics of business innovation strategy data can accurately divide the business innovation strategy data to achieve the visual transmission of data. Data partitioning is a key point in the visual transmission of business innovation strategy data under the whole human-machine interaction. In the process of business innovation strategy data partition based on structural characteristics, a tree similarity calculation method is proposed, and tree similarity calculation is realised by extracting tree features. In order to get the tree similarity efficiently, the tree similarity is calculated by using the tree's structural characteristics, and the sub-tree of all non-isomorphic modes of K nodes is constructed. The number of isomorphic sub-trees is calculated in the tree, and the tree similarity is calculated as a feature vector to get the result of data partition of business innovation strategy based on structural characteristics. Figure 1 is a sketch of the steps for calculating tree similarity.

Figure 1 A sketch of the steps for calculating tree similarity



In the process of constructing non-isomorphic pattern subtrees, a recursive method is used (Zhang et al., 2016; Li, 2016a). Firstly, a subtree with two nodes is constructed. In this form, the subtree pattern is only one, as shown in Figure 2.

Then, non-isomorphic subtrees of three nodes are derived from non-isomorphic subtrees of two nodes. The non-isomorphic subtrees can be constructed as non-isomorphic subtrees of two node. In the subtree of Figure 5, a node with a number of 3 is added in node 2 and 1, and then a non-isomorphic subtree under three nodes is constructed, as shown in Figure 3.

In order to further describe the construction process, the non-isomorphic subtree pattern under three nodes is constructed according to the non-isomorphic subtree pattern under four nodes. Firstly, the non-isomorphic subtree pattern under four nodes can be obtained by adding a node numbered 4 to the nodes of the first non-isomorphic subtree pattern under three nodes, as shown in Figure 4.

In Figure 4, three non-isomorphic sub-tree patterns under four nodes are obtained, and then a node with a number of 4 is added to the second non-isomorphic subtree pattern under three nodes, respectively. The results are shown in Figure 5.

Figure 2 Non-isomorphic subtree pattern under two nodes

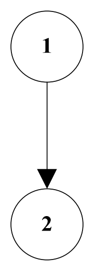


Figure 3 Non-isomorphic subtree pattern under three nodes

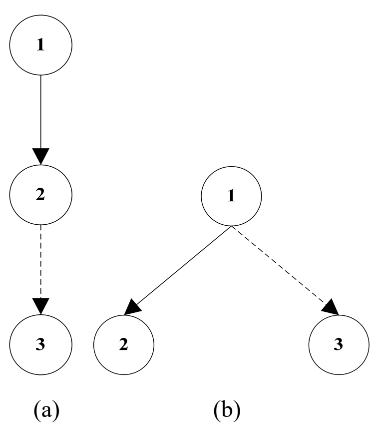


Figure 4 The non-isomorphic subtree pattern under four nodes

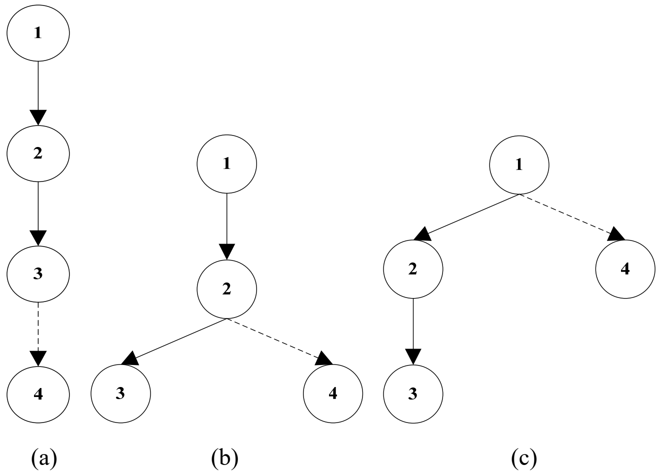
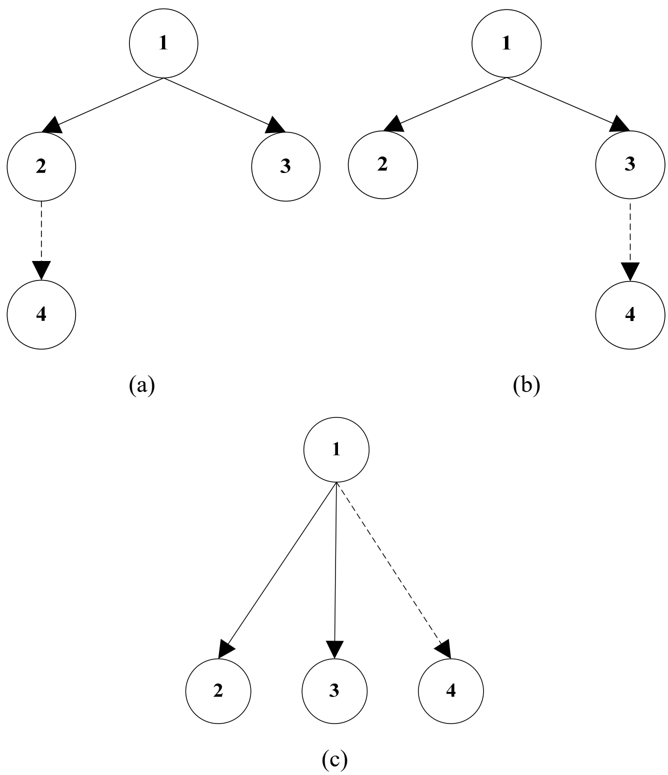


Figure 5 The non-isomorphic subtree pattern under four nodes



As can be seen from Figures 5(a) and 5(b) are subtrees of two isomorphic patterns, and they are also isomorphic with Figure 5(c) in Figure 4.

According to the above analysis, the detailed process of solving the subtree pattern with K nodes is as follows:

1 design and construct a non-isomorphic subtree pattern under two nodes

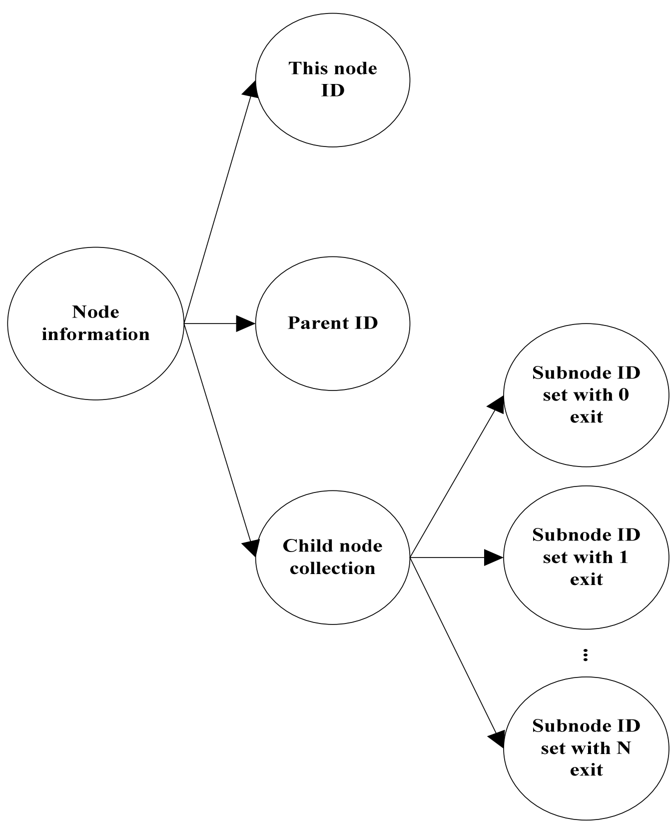
2 for the various subtree patterns with n nodes, a node numbered n + 1 is added under each node of the tree to form a subtree pattern with n + 1 new nodes

3 detect whether the encoding of the pattern has appeared in the set or not, if not, then add it to the tree encoding set

4 assuming that the current number of nodes is less than K, iterate Steps 2 to 4, otherwise, ended it.

Based on the above, each node in the tree corresponds to a function, in order to adapt to the following calculation of the number of isomorphic subtrees, nodes in the tree store additional information to ensure that the tree building process has high efficiency (Yang et al., 2017; Chen et al., 2017). The schematic diagram of tree node information structure is shown in Figure 6. Each node needs to record the ID of its own node and its parent node. The child node information is classified and stored based on its outgoing. The child node whose outgoing is 0 is stored, and then the operation whose outgoing is 1. By analogy, the above nodes are stored in the dictionary, where the Key value is the ID of the node.

Figure 6 Schematic diagram of node information structure in tree



The number of isomorphic subtrees is calculated as follows.

Assuming that the root node of the subtree t_K is R_{t_K}, it is necessary to compare R_{t_K} with all the nodes in the tree T, and accumulate the number of isomorphic subtrees calculated each time to obtain the final result, that is the number of isomorphic subtrees of t_K in the tree T. However, the comparison between root nodes can be divided into two parts, one part is the corresponding results of leaf node R_{t_K} and child node R_T, the other part is the corresponding results of non-leaf child node R_{t_K} and non-leaf child node R_T. Following are the steps of comparing a node R_T in T with root node R_{t_K} of t_K:

1 The out degree of R_T is defined as D_T, the out degree of R_{t_K} is defined as D_{t_K}, and the number of child nodes in leaf nodes in R_{t_K} is defined as $D_{t_{0K}}$.

2 If $D_T < D_{t_K}$, return 0.

3 If R_T and R_{t_K} are illegal, return 0.

4 Computing the first part, that is, the arrangement results of leaf node R_{t_K}: $A_{D_T - D_{t_K} + D_{t_{0K}}}^{D_{t_{0K}}}$, $D_T - D_{t_K} + D_{t_{0K}}$ represents the number of child nodes whose degree is greater than 0 in matching D_{t_K} removed from D_T, from which $D_{t_{0K}}$ is screened out and arranged simultaneously.

5 To calculate the second part, it is necessary to calculate the corresponding correlation of all non-leaf child nodes in two trees. The results are listed in Table 1.

   In Table 1, R_{Ti} represents the i^{th} non-leaf child node of R_T, $R_{t_{Kj}}$ represents the j^{th} non-leaf child node of R_{t_K}, a, b, c,... represents the total number of isomorphic subtrees when the corresponding R_{Ti} and $R_{t_{Kj}}$ are roots. At this point, it needs to recurse back to Step 1.

6 When a table is listed, the data in the table is combined. Each combination describes the corresponding relevance of non-leaf child nodes in two subtrees.

7 The number of isomorphic subtrees of R_{t_K} in R_T is multiplied by the final results of the two parts.

Based on the calculation process of the number of isomorphic subtrees mentioned above, a set of characteristic vectors about tree T can be obtained. According to these vectors, it is very convenient to calculate tree similarity or clustering (Qiang and Dai, 2016; Tang et al., 2016). According to the characteristics of business innovation strategy data, the number of isomorphism of each sub-tree will be quite different. In this paper, formula (1) is used to calculate the similarity between vectors to achieve the partition of business innovation strategy data based on structural characteristics.

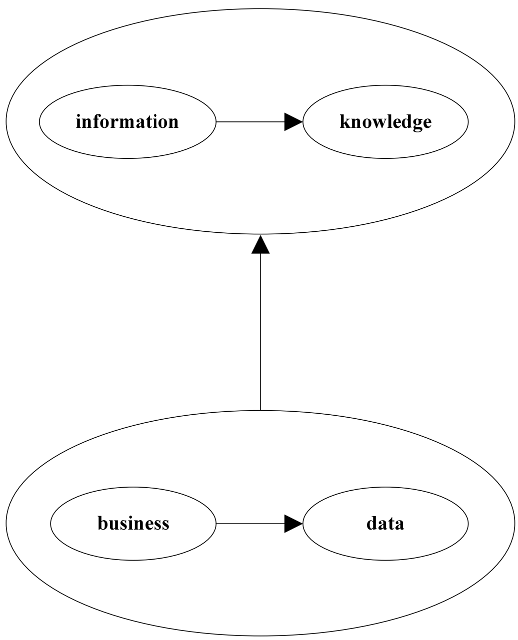
$$S(A, B) = \frac{\sum_{i=1}^{n} \min(A_i, B_i)}{\sum_{i=1}^{n} \max(A_i, B_i)} \tag{1}$$

In the formula, A and B represent two sets of eigenvectors and their length is n. A_i and B_i represent the i^{th} corresponding value of eigenvectors, $\min(A_i, B_i)$ represents the smaller values in A_i and B_i, and $\max(A_i, B_i)$ represents larger values in A_i and B_i.

Table 1 Corresponding correlation between non-leaf child nodes R_T and R_{t_K}

	R_{T1}	R_{T2}	R_{T3}	$\cdots$
$R_{t_{K1}}$	a	b	c	$\cdots$
$R_{t_{K2}}$	d	e	f	$\cdots$
$\vdots$	$\vdots$	$\vdots$	$\vdots$	$\ddots$

Figure 7 Diagram of business intelligence



2.2 *Business intelligence and data visualisation*

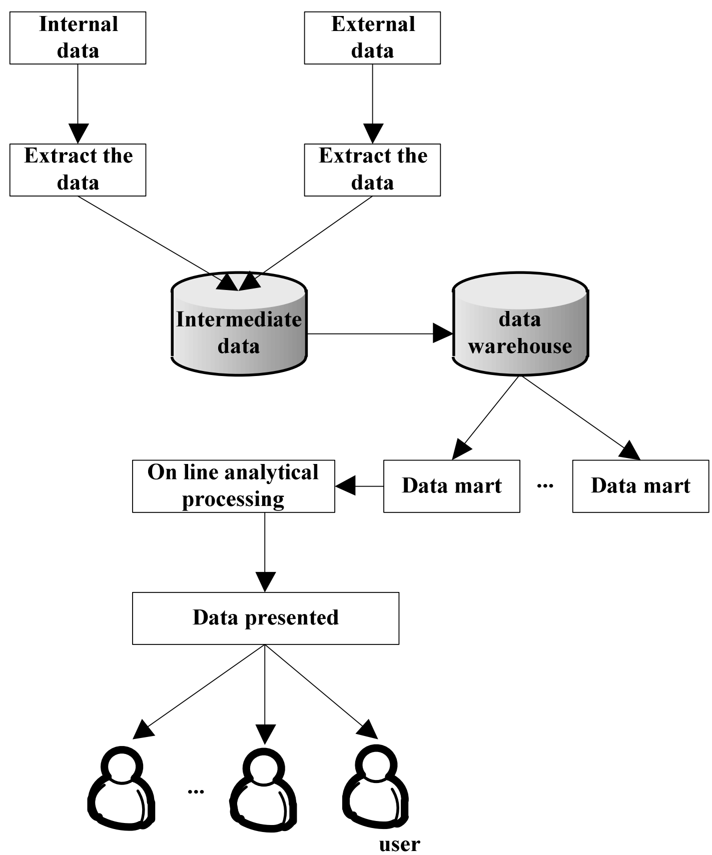
Business intelligence is also BI. The description of BI in this concept is: business intelligence represents a series of definitions and methods, which can play an auxiliary role in the proposal and final formulation of business decisions. It mainly uses the fact-based support platform to provide effective knowledge. BI technology can provide technology and methods for efficient analysis of data information for enterprises, including collection, environmental control and data analysis. At the same time, these data information are transformed into usable information, and then dispatched to other departments of the enterprise. Its ultimate goal is to enable decision makers at all levels of the enterprise to obtain useful knowledge and make scientific plans easily.

From a technical point of view, business intelligence combines with data warehouse, online and data information mining technologies to load processed data into enterprise data warehouse or data mart to obtain a global view of enterprise data (Qu and Ou, 2018; Hong et al., 2018; Du and Yu, 2018). Then, scientific analysis tools are used to process data efficiently and transform information into useful knowledge for decision-making. In the end, the knowledge is directly fed back to the client, and the corresponding reference opinions and theoretical support are given for enterprise decision-making.

In fact, business intelligence is also an efficient solution strategy. In business intelligence system, business intelligence is a process of transforming data from business to information and knowledge, as shown in Figure 7.

As can be seen from Figure 7, the common management system is to convert various types of business into data in the process of operation. But in the business intelligence system, it is based on the common management system, further processing data into information, which can be transformed into knowledge that can assist leaders to make decisions. This process is essentially the research process of business intelligence (Liu and Geng, 2017; Li, 2016b; Ye, 2017). Figure 8 is a diagram of business intelligence process.

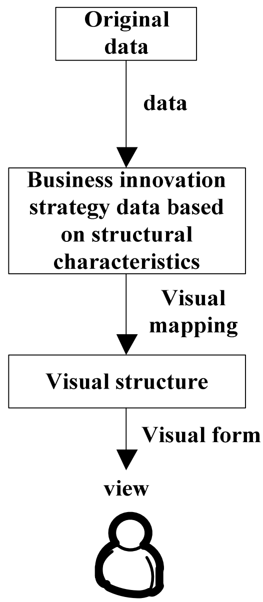
Figure 8 Diagram of business intelligence process



According to Figure 8, the main steps of business intelligence process are as follows: collecting internal and external data, and extracting feature data. The feature data is transformed into intermediate data and stored in the value warehouse as warehouse data. Divide warehouse data into multiple datasets. After online analysis and processing, it becomes the supply data to provide to users.

Integrated with the diagram of business intelligence process, the visualisation transmission model of business innovation strategy data is shown in Figure 9.

Figure 9 Visualisation transmission model of business innovation strategy data based on human-machine interaction



In Figure 9, the original data of business innovation strategy are processed based on structural characteristics, and converted into various types of visualised structural data, so as to meet the needs of different classes of users, improve the accuracy of visualisation transmission and user satisfaction. It is transmitted online to relevant personnel to complete the visualisation transmission of business innovation strategy data.

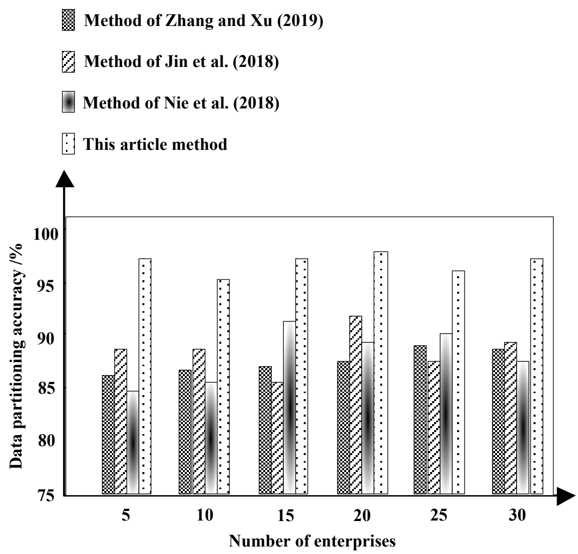
In order to realise the visual transmission of business innovation strategy data, the data of business innovation strategy is divided based on the structural characteristics, and finally the visual transmission of data is realised. In order to verify the effectiveness of the method, further experimental verification is needed.

3 Experiments and discussion

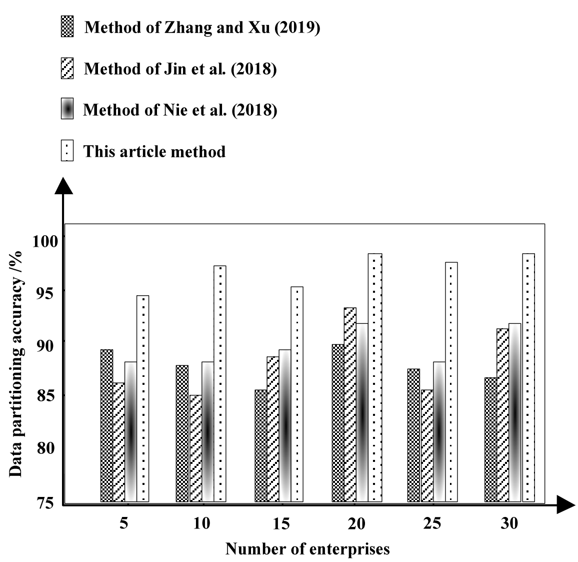
In order to verify the effectiveness of data visualisation transfer method of business innovation strategy based on structural features, a correlation experiment was carried out. The experimental platform is built on MATLAB, and the experimental data comes from the actual data of small and medium-sized enterprises and the data from the survey and scoring of middle and high-level leaders. After sorting out, the experimental data size is

5g, and the total number of experimental target enterprises is 30. Taking the accuracy of visual data partition and user satisfaction of data visual transmission as experimental comparison indexes, the proposed method was compared with Zhang and Xu (2019), Jin et al. (2018) and Nie et al. (2018) methods.

Figure 10 Accuracy comparison of different research methods, (a) accuracy of the method in reference and the proposed method under 10 tests (b) accuracy of the method in reference and the proposed method under 20 tests (c) accuracy of the method in reference and the proposed method under 30 tests

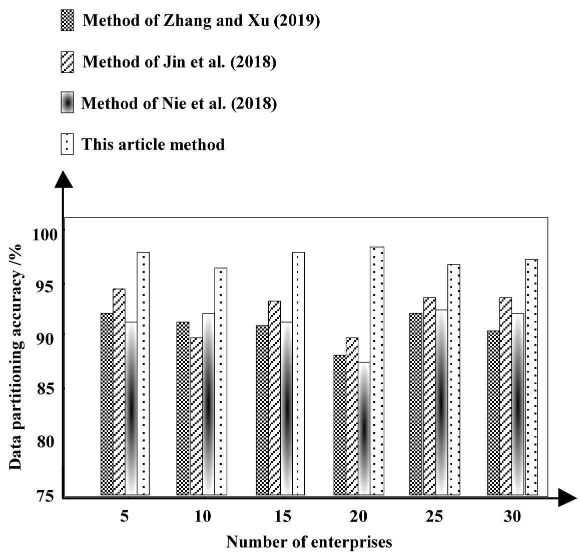


(a)



(b)

Figure 10 Accuracy comparison of different research methods, (a) accuracy of the method in reference and the proposed method under 10 tests (b) accuracy of the method in reference and the proposed method under 20 tests (c) accuracy of the method in reference and the proposed method under 30 tests (continued)



(c)

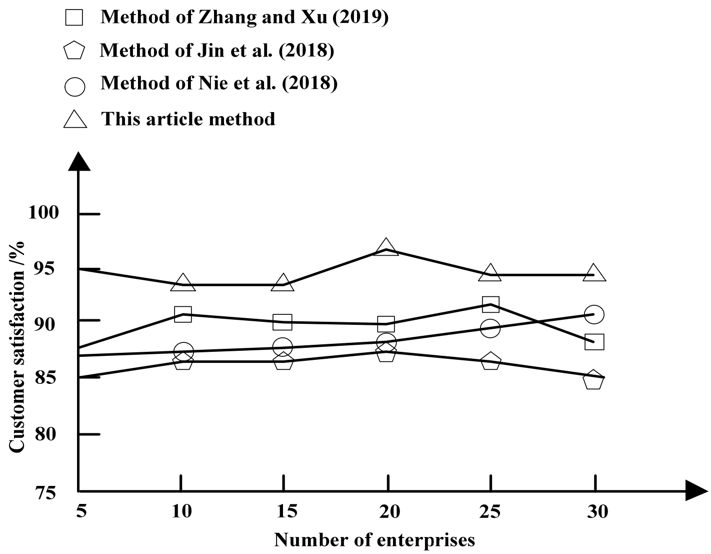
3.1 *Comparison of accuracy of visualisation data partition*

The better the accuracy of visualisation data partition is, the more pertinence and accuracy the process of visualisation transmission are.

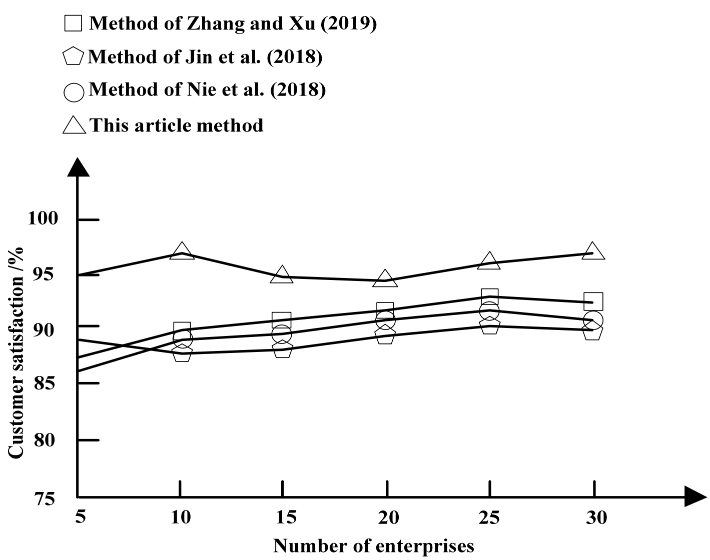
The results of Figure 10 show that the visualisation data partition of the proposed method is higher than that of the comparison methods in references under three different test times. Under 30 tests, the classification accuracy of the proposed method can reach 99.3%, while that of the methods in Zhang and Xu (2019), Jin et al. (2018) and Nie et al. (2018) is 91.2%, 94.6% and 92.2%, respectively. Compared with the three comparison methods, the accuracy of the proposed method is significantly improved, which fully shows that this method has high performance of data visualisation transmission.

Analysis of the experimental results of Figure 11 shows that the user satisfaction of the proposed is better than that of the references. In order to better and more accurately transmit the business innovation strategy data to the relevant users in the form of visualisation, this paper designs the transmission process on the basis of business intelligence, which takes into account the use of structural characteristics to process the data and convert them into various types of visualised structural data, which can meet the needs of different levels of users, and thus effectively improve the users' satisfaction.

Figure 11 Comparison of user satisfaction with data visualisation transmission results in different research methods, (a) satisfaction of middle-level leaders with data visualisation transmission results (b) satisfaction of senior leaders with data visualisation transmission results



(a)



(b)

4 Conclusions

In order to improve the effectiveness of data visualisation of business innovation strategy, a method of data visualisation of business innovation strategy based on structural characteristics is proposed. The following conclusions are proved by theory and experiment. When the method is used to transfer business innovation strategy data, it has high accuracy of data division and user satisfaction. Specifically, compared with the method based on online comments, the data division accuracy of the proposed method is greatly improved, up to 99.3%; compared with the method based on business model, the user horse of the proposed method once significantly improved. Therefore, it fully shows that the proposed transfer method based on structural features can better meet the transfer requirements of business innovation strategy data. In the next step, we can combine this research with the service-oriented architecture system to better meet the needs of enterprise users, and effectively solve the problems in the process of visual delivery.

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