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Data-Driven Entrepreneurship in Green Hydrogen Economy: An Integrated Framework for Entrepreneurial Enterprises in the Era of Big Data

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Abstract. In the era of big data, in order to improve the aggregation effect of start-ups, a digital framework with a promoting role has been formed. This paper proposes a data-driven approach in the context of the green hydrogen economy. Firstly, the data function was used to collect, classify and sort out the entrepreneurial data to form an orderly data set. Then, with the help of data-driven functions, the nonlinear reorganization of start-ups is carried out to verify their discreteness, the correlation between the hydrogen economy and start-up data is mined, and an integrated framework is formed through iterative calculation. The results show that there is a significant correlation between the hydrogen economy and start-ups, and big data can drive the integrated development of start-ups, and the data-driven method proposed in this paper can accurately identify start-up data, with a recognition rate of 90%, which is better than the previous machine learning methods and decision tree methods, and has strong big data mining capabilities. Therefore, there is a significant correlation between the hydrogen economy, big data, and start-ups, and a data-driven approach can identify the relationship between the two and facilitate the construction of an integrated framework.

Key words. Green Hydrogen Economy, Data-driven Entrepreneurship, Start-ups, Association Rule Algorithms.

1. Introduction

With green hydrogen economic data driving entrepreneurship, more people are devoting themselves to entrepreneurship. In the era of big data, enterprise entrepreneurship is the stage of enterprise development and growth, which will be related to the development. In gradually improving the management level, it is necessary to mine and analyze the relevant data, build a data collection model in big data, and realize the integrated framework management of start-up enterprises. The research on the data mining model is of great significance, to improving start-up enterprises' information management and scheduling. The research on the integration framework of start-up enterprises in the era of big data has attracted the attention of relevant. Literature puts forward research on the integration framework system of entrepreneurial data dynamics based on the Internet of Things. The perception layer of the research system collects and fuses data to protect entrepreneurial data [1]. The storage layer adopts the data storage service system to obtain enterprise entrepreneurship data from the perception layer and realizes the reasonable scheduling of enterprise entrepreneurship integration framework in the era of big data through the functions of constraint software. The system can upload and view data synchronously and realize the safety management of enterprise entrepreneurship data, but this method has the problem of poor overall integration. The literature proposes an Internet-based enterprise entrepreneurship data collection method. Through search strategy [2], obtain enterprise entrepreneurship-related information, analyze the obtained entrepreneurship-related data information, automatically extract the relevant data information, analyze the enterprise entrepreneurship collection results, complete enterprise entrepreneurship data collection, and realize the integration framework research of entrepreneurial enterprises in the era of big data. This method has the advantages of flexibility and diversity, but the accuracy of data collection is low because of the large number of open-source libraries [3]. Given the problems existing in the above literature methods, this paper puts forward an integration method for data-driven entrepreneurial enterprises. The green hydrogen economy based on the association rules algorithm, establishes an information model of entrepreneurial enterprise data statistics. Combines it with a nonlinear sequence reorganization method, to fuse the entrepreneurial enterprise data, and then carries out association rules data mining. Simulation experiments verify the effectiveness of the proposed algorithm [4].

2. Mathematical Construction of Venture Enterprise Integration Framework

In order to realize the integration of data-driven entrepreneurial enterprises in the green hydrogen economy in the era of big data, we should first classify the data of entrepreneurial enterprises in the era of big data, and use association rules data mining algorithm to extract the sequence analysis and features in the process of data integration of entrepreneurial enterprises [5]. Then, the multiple regression analysis function is used to extract the statistical feature quantity of start-up enterprise data, and the start-up enterprise data in the era of big data is reconstructed. The redundant features in the data of start-up enterprises are deduplicated, and the data information of start-up enterprises is fused by the fuzzy information clustering method [6].

A. Overall Description of the Integration Framework

If the scatter set of start-up enterprise data is set as y, the eigenvalue is set as $P_k = (P_{i1}, P_{i2}, \cdots, P_{iD})$, the green hydrogen economy is set as θ, and the data drive is set as α, then the fuzzy association rule function of start-up enterprise data can be expressed as Formula (1):

$$P_k(y) = \sum_{k=1}^{K} \alpha \cdot y \left| \mu_k \right. \tag{1}$$

Among them, μ is the evaluation concept set of data characteristics of start-up enterprises. In order to improve the analysis effect of enhanced scatter index, the correlation function is added as $f(x)$, x obtaining data on behalf of big data approaches, The nonlinear recombination function of the data is $lin(x)$. Then the feature quantity of association rules for mining the data attribute relationship of start-up enterprises in the era of big data is expressed as:

$$\max_{x_{a,b,d,p}}(y) = \sum_{a \in A} f(x_{a,b,d,p}) \cdot V_p \left| lin(x) \right. \tag{2}$$

Among them, $x_{a,b}$ is the initial value of data, x_a is the initial value of data set, x_b is the initial value of data drive and V_p is the driving effect of data [7].

Among them, the correlation function is a function constructed by using the correlation between big data, which mainly counts the classification value and weight value of entrepreneurial data, and establishes the correlation function, aiming at identifying the direct correlation of data. The reorganization function is to reorganize, sort and reconstruct data according to relevance, and its main basis is the relevance of data to form data weight. Due to the data reconstruction and corresponding assignment, the formed function is a nonlinear function, and the functional relationship under the constraint of big data is calculated. Since hydrogen economy and start-up enterprises belong to different fields, it is necessary to obtain corresponding data through big data technology and carry out standardized processing to establish the connection between them, so it is necessary to conduct correlation analysis. In addition, due to their own industry constraints, hydrogen economy and start-up companies must impose constraints and build nonlinear sequence functions to improve the analyzability of data, reduce the impact of industry ownership on results, and improve the accuracy of analysis.

B. Data Description of Green Hydrogen Economy

Since the time series of data distribution scalar of start-up enterprises is established as $x(t)$ and the characteristic distribution model of data information flow of start-up enterprises is given as $x_1, x_2, \cdots, x_n \in C^m$ [7], the development process of a green hydrogen economy is shown in Formula (3).

$$f(H_{ac}) = \begin{cases} 1 - \dfrac{H_{ac}}{\max(H_{ac}) + l} \\ \log_2 H_{ac} \end{cases} \tag{3}$$

Among them, H_{ac} is the development of a hydrogen economy and l is the amount of economic development driven by data. If there is an economic inflection point in the development of hydrogen economy, it will affect the overall development of the economy, so it is necessary to calculate the economic inflection point $\omega_{ji}(x+1)$ [8]. Among them, the development of hydrogen economy is mainly to have an impact on the production environment and social environment, improve the sustainability of the environment, is conducive to the long-term development of the entire social economy, and at the same time, there are technical barriers to the development of hydrogen economy, and can obtain more intellectual property rights and environmental protection policies, so it has potential economic growth advantages, and there are significant differences between the development of economic energy and traditional economy, and it has significant advantages in energy conservation and emission reduction, production costs and environmental governance costs, and can create more opportunities for the society and obtain strong support between the government and various departments, so it is said that economic development has strong environmental advantages and potential advantages, so this paper will be data-driven and light economy The development is linked to form an effective non-relationship, which is as follows. If the potential development points of a hydrogen economy is α, employment opportunities is x, the calculation formula is as follows:

$$\omega_{ji}(x+1) = \omega_{ji}(x) - \alpha \frac{\partial x}{\partial \omega_{ji}} \tag{4}$$

Among them, $\omega_{ji}(x+1)$ is corresponding to the corresponding integration project, $z_{ji}(x+1)$ is the calculation formula of the integration project corresponding to the inflection point is as follows.

$$z_{ji}(x+1) = \omega_{ji}(x+1) \left| z_{ji}(x) \right. \tag{5}$$

Through the above analysis, it is found that the inflection

point of the computing economy is the key to realizing green hydrogen economic computing, and it is also the main content of start-up research in the era of big data, which lays a foundation for realizing the reconstruction of data information feature quantity of start-up enterprises [9].

C. *Association Rules Data Mining and Fusion*

On the basis of the reconstruction of high-order feature quantity of start-up enterprise data $set(X)$, to collect start-up enterprise data is $s_1, s_2, \cdots, s_i$, it is necessary to propose the data collection method of base start-up enterprise m [10], [11], [12], and the data extraction should use association rules, so association rule data mining is expressed as:

$$set(x) = \left[\vec{s}_1, \vec{s}_2, \cdots, \vec{s}_i\right] \cdot m \tag{6}$$

In Formula (6), $K = N - (m-1)\tau$ represents the dimension of integration and embedding of data sources of start-up enterprises, N represents the sampling dimension of data characteristics, m is a natural number, and $s_i = \left(x_i, x_{i+\tau}, \cdots, x_{i+(m-1)\tau}\right)^T$ represents the characteristic quantity of spatial distribution [13], [14], [15]. The data on hydrogen economic development and enterprise innovation is private data. Some enterprises only publish listed data and internal data but do not publish it. However, big data technology can dig deep into the internal data of enterprises through the correlation between the network and the server. In the process of data mining, there are problems such as data security, data leakage, data privacy and data security regulations. Therefore, the encryption process of big data or information is mainly divided into two dimensions. One dimension is to reduce the amount of data obtained and find key eigenvalue data. The other is to correlate or qualitatively analyze the data and divide the data into two categories: valid and invalid to protect the data. Assuming that $\min \dfrac{set(x)}{\sum set(x)}$ is the minimum amount of big data acquisition and $f(H_{ac})$ is the binary classification function of data, then the acquired data is $r(x)$. Quantitative recursive analysis is carried out on start-up enterprise data by using the quantitative regression analysis function, and the association rule data fusion of start-up enterprise data is expressed as follows:

$$r(x)\begin{cases} \min \dfrac{set(x)}{\sum set(x)} \\ f(H_{ac}) \end{cases} \tag{7}$$

Combined with the reconstruction method with random characteristics, the data information of start-up enterprises is mined, and the relationship *rel*(*x*) between mining and fusion is obtained. The calculation formula is as follows:

$$rel(x) = r(x) \xrightarrow{l} set(x) + \delta \tag{8}$$

Among them, Γ is the government incentives. The results of big data start-ups after government incentives are adjusted, and the calculation formula is:

$$\Delta rel(x) = \frac{\sum rel(x)'}{N} \cdot \Gamma \tag{9}$$

Assuming that the tax function of hydrogen economy is $f(H_{ac})$, the technical standard of hydrogen energy is a, and the government's support policy is Φ, then the comprehensive result of hydrogen economy development is $t(H_{ac})$.

$$f(H_{ac}) = \begin{cases} f(H_{ac}) \cdot \Phi \cdot a, \Phi \in \max(H_{ac}) \\ a, x \in N \end{cases} \tag{10}$$

Since indicators such as economic policies, incentive systems, technical barriers and employment opportunities will all have an impact on the development of the hydrogen economy and the development of its potential, it is necessary to conduct a correlation analysis on its comprehensive analysis results, as follows.

$$t(H_{ac}) = \left\| (\sum f(H_{ac}) - H_{ac}) \to \delta \right\| \tag{11}$$

Where, δ is the degree of data relevance. When calculating the data of big data start-ups, association rules data mining should be carried out through reconstruction technology. At the same time, according to association rules data mining, the data of start-up enterprises are integrated, paving the way for the integration framework of start-up enterprises in the era of big data.

D. Integration Framework for Start-up Enterprises

Combined with the above-mentioned data mining process of big data start-up enterprises and the nonlinear sequence reorganization method, the data framework of start-up enterprises in the era of big data is constructed as $Str(H_{ac}, x)$. At the same time, the correlation in the data of start-up enterprises is judged and the initial point is constructed. The calculation formula is as follows:

$$Str(H_{ac}, x) = \sum_{set(x)} \frac{f(H_{ac})}{\Delta rel(x)} \left| r(x) \xrightarrow{\max_{x_a, b, d, p}(y)} P_k(y) \right. \tag{12}$$

In the reconstructed data space of start-ups in the era of big data, the principal component features are used to constrain the data framework of start-ups and make the framework within a reasonable range. The formula is as follows:

$$Str(H_{ac}, x)' = [Str(H_{ac}, x) \left| t_a \right.] \cdot \varepsilon_t^a \tag{13}$$

Where, $Str(H_{ac}, x)'$ is the iterative result of the initial point. Set the average value t_a of data fusion of start-up enterprises in the era of big data to ε_t^a, and the dynamic adjustment rate. In the data information management of entrepreneurial enterprises in the era of data-driven entrepreneurial big data in the green hydrogen economy, the macro and micro constraints of entrepreneurial enterprise data are and, and the results of nonlinear sequence reorganization function are obtained [16], [17], Q and V are the distribution of enterprise data, the

sequence is expressed as:

$$\max Str(H_{ac},x)' = \frac{\sum Str(H_{ac},x)'\left|Q\right. + Str(H_{ac},x)'\left|V\right.}{ac} \quad (14)$$

Based on association rules, this paper mines and fuses entrepreneurial data in the era of data-driven entrepreneurship in the green hydrogen economy, and then completes the integration research of data-driven entrepreneurship in the era of big data in green hydrogen economy according to the data fusion sequence distribution of entrepreneurial enterprises.

3. Analysis of Research Process and Steps

For the research on the integration framework of start-up enterprises in the era of data-driven start-up big data in the green hydrogen economy, the following steps should be completed:

Firstly, collect the data on a green hydrogen economy, and establish the method of related data according to the requirements of data-driven entrepreneurship. At the same time, the enterprise data in the era of big data is classified and the data set is constructed.

Secondly, the data of enterprises are processed by quantitative regression analysis function, which promotes the integration of green hydrogen economy and data-driven economy, and $f(H_{ac})$ forms a standardized data set after integration.

Then, the data analysis framework of the enterprise economy is established, the content $Str(H_{ac},x)'$ of the framework is formed, and the initialization of the framework is completed.

Finally, the framework is constrained, and 50 iterative calculations are completed to form a comprehensive data processing, and the final data set is output $\max Str(H_{ac},x)'$.

4. Practical Case Analysis

A. Introduction of Sample Data

Taking the data of Zhongtai Co., Ltd., Jingneng Power Co., Ltd., Jingke Technology Co., Ltd., Sunshine Power Co., Ltd. and other enterprises as the research objects, the data were tracked from 2018 to 2023 to build a data set. Collect the requirements of the green hydrogen energy economy put forward by the country, and build an integration framework for start-ups. The specific data format is shown in Table 1.

Table 1. Basic Information of Data Set

DATA SET	NUMBER OF DATA SAMPLES	NUMBER OF ATTRIBUTES	ANALOGICAL NUMBER
Zhongtai shares	720	16	3
Jingneng power	1011	26	5
Jingke science and technology	6336	28	11
Solar power source	689	59	3
Other enterprises	521	38	7
F=10.244			
P<0.05			
Safe>0.90			

Note: Numerical data are public data, and secondary data are unpublished data.

From the contents in Table 1, we can see that the distribution of sample data is reasonable, in the normal distribution area, and the sample data is independent and shows good correlation, so the sample data can be further analyzed.

B. Accuracy of Start-up Enterprise Integration Framework Construction

Through the calculation and analysis of sample data by different methods, the data collection accuracy of big data start-ups is compared, and the results are shown in Figure 1.

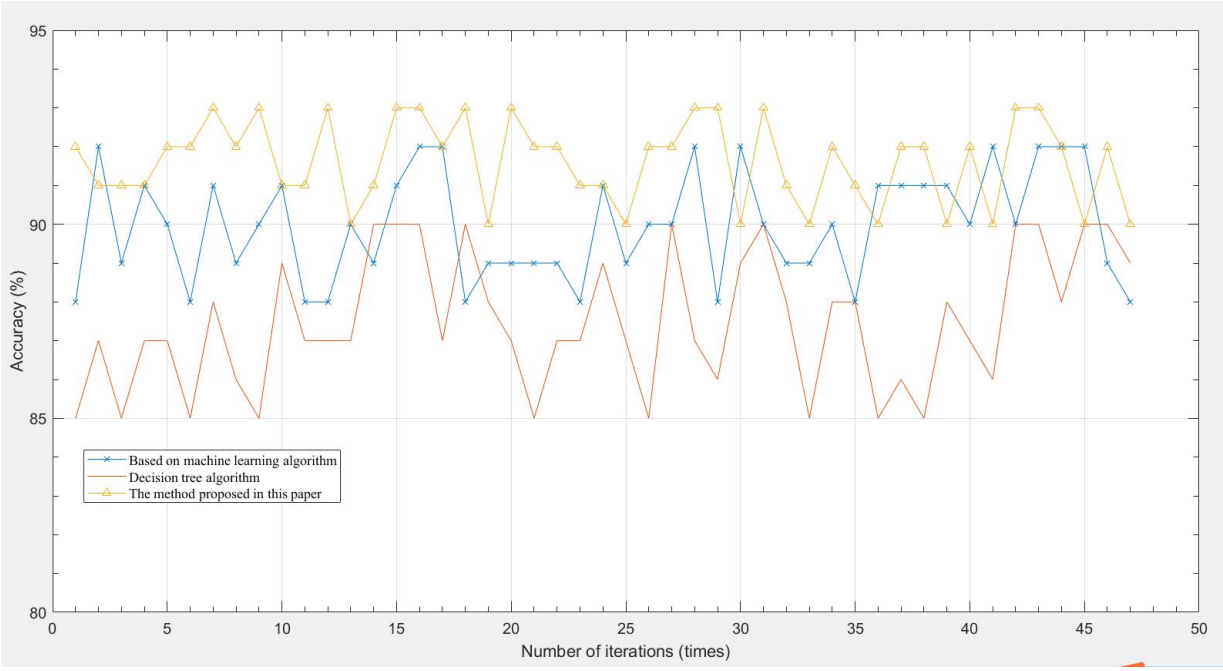

Figure 1. Comparison of Data Collection Accuracy of Big Data Start-ups with Different Algorithms

By analyzing Figure 1, it can be seen that compared with the other two algorithms based on decision tree and machine learning, the data collection accuracy of big data start-up enterprises proposed in this paper is always higher than 91%, while the data collection accuracy of big data start-up enterprises based on decision tree and machine learning algorithms can only reach 92%, among which the data collection accuracy of big data start-up enterprises based on machine learning algorithm is as low as 85%, and the data collection accuracy of big data start-up enterprises fluctuates greatly, indicating that the stability of this algorithm is poor. This shows that the algorithm based on association rules proposed in this paper has high stability for integrated data mining of data-driven entrepreneurial big data start-ups in the green hydrogen economy.

C. Comparison of Data Mining Capabilities

Taking the data set Sonar as an example, this paper compares the accuracy of data mining of big data start-ups with the association rule algorithm proposed in this paper, decision tree algorithm and machine learning algorithm. The comparison results are shown in Figure 2.

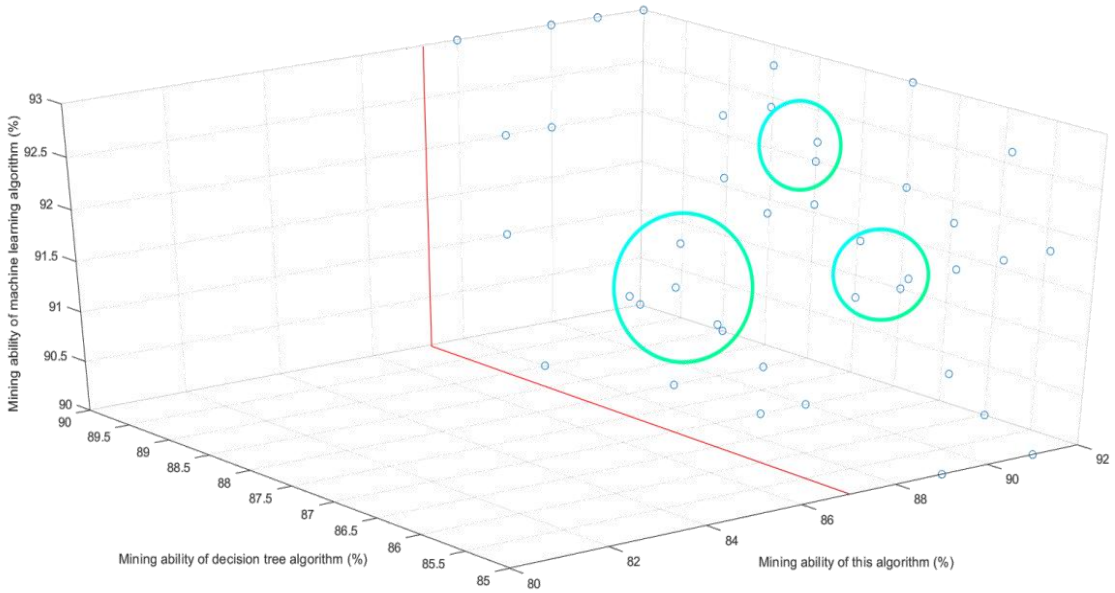

Figure 2. Comparison of Data Mining Accuracy of Big Data Start-ups with Different Algorithms

By analyzing Figure 2, we can see that the data mining accuracy of big data start-up enterprises of three different algorithms decreases with the increase of data volume of big data start-up enterprises. After the data volume of big data start-up enterprises increases to 3000 groups based on the decision tree algorithm, the data mining accuracy decreases the most. The data mining effect of big data start-up enterprises based on machine learning algorithm is

better than that of decision tree algorithm, but there is a big fluctuation problem. However, with the gradual increase of data of big data start-up enterprises, the accuracy of data mining has been higher than 90%, and the curve is relatively stable, which shows that the overall stability of the algorithm proposed in this paper is better, and it can effectively mine the data of start-up enterprises in the era of data-driven start-up big data.

D. Comparison of Data Classification

Taking representative innovative enterprises as the research objects, namely Zhongtai shares, Jingneng power and Jingke science and technology, the corresponding hydrogen economic potential, employment opportunities and environmental protection are analyzed. Data classification is the foundation of data mining. The association rule algorithm, decision tree algorithm and machine learning algorithm proposed in this paper are used for data mining of different data set samples, and the classification performance of the three different algorithms is compared, which is shown in Table 2.

Table 2. Comparison of Data Classification of Different Algorithms

DIFFERENT CASE	DATA SET	PREVIOUS METHODS	METHODS IN THIS PAPER
Zhongtai shares	Hydrogen's economic potential has increased	97	98.74
	Employment opportunities	58	99.02
	Energy saving and emission reduction	64	99.27
Jingneng power	Hydrogen's economic potential has increased	80	85.31
	Employment opportunities	38	88.94
	Energy saving and emission reduction	45	87.32
Jingke science and technology	Hydrogen's economic potential has increased	77	78.32.
	Employment opportunities	53	79.24
	Energy saving and emission reduction	44	79.18

By analyzing Table 2, it can be seen that the number of samples classified by the big data start-up enterprise method based on the association rules algorithm proposed in this paper is higher than that based on the decision tree algorithm and machine learning algorithm, which shows that the data classification of the algorithm proposed in this paper is more detailed. Moreover, the coincidence rate of big data start-up data classification based on the algorithm proposed in this paper is as high as 99.27%, while the coincidence rate of big data start-up data classification based on the decision tree algorithm is as high as 88.94%, and the coincidence rate of big data start-up data classification based on machine learning algorithm is as high as 79.24%. This shows that the algorithm proposed in this paper has stronger data classification ability for big data start-ups and provides a good foundation for data mining. The coincidence rate processing process of the algorithm proposed in this paper is analyzed, and the results are shown in Figure 3.

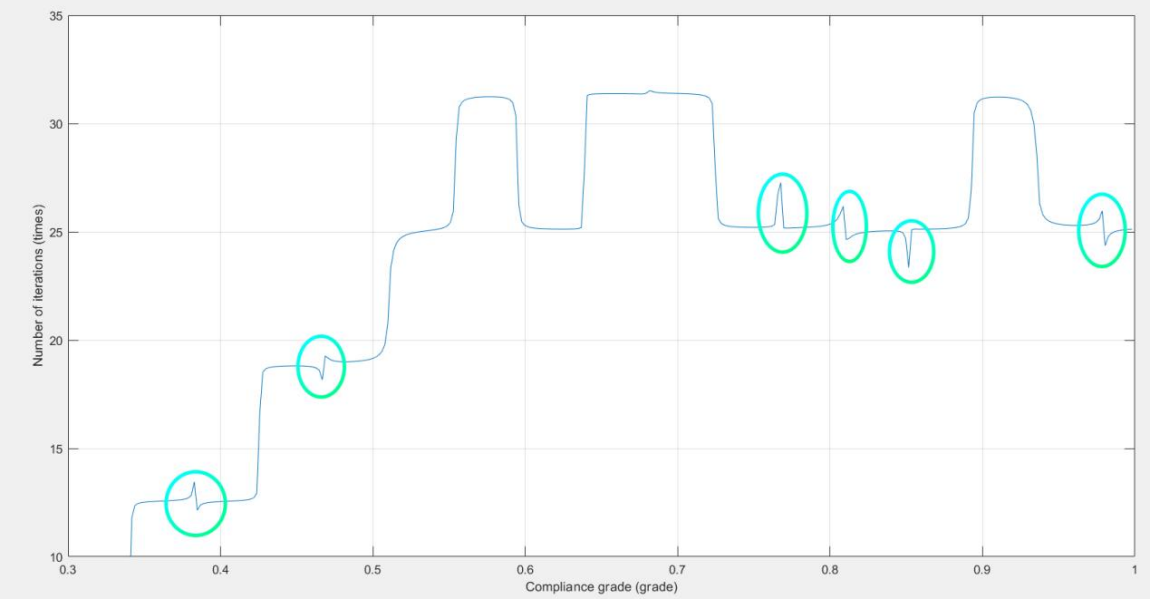

Figure 3. Coincidence Rate of this Algorithm for Integration Framework Construction

In the 0.3, 0.4, 0.7 and 0.8 grades, the coincidence rate fluctuated, but the overall coincidence grade gradually increased. Therefore, the research method in this paper can Through the above analysis, it is found that although the hydrogen economy has strong economic development potential and can obtain policy support, because the society provides more job opportunities, there are still bottlenecks in its development, which are mainly reflected in: 1) the hydrogen economy has not formed a complete industrial chain, and there are deficiencies in the process of industrial analysis and optimization, mainly due to the lack of effective methods, in addition, there are barriers between the new economy and the traditional economy, and the production and development costs are high, and high-quality talents are needed as support, so the overall trend of hydrogen economic development is not obvious2Although local governments vigorously support the development of the hydrogen economy, the degree of technological upgrading and optimization of the structure and content of the hydrogen economy itself is relatively low, facing the limitations of technical objective conditions and hardware.

optimize the integration framework of start-up enterprises and better optimize the project.

3) The development of the hydrogen economy is in its infancy, and it is difficult to invest in human resources and facilities in the early stage, and the economic benefits generated are long, and there is a large gap with the development of the traditional economy and energy, and 4) the hydrogen economy should use its own environmental advantages and employment opportunities to integrate with the traditional energy economy, and gradually optimize and improve the traditional energy economy, so as to achieve its own improvement.

E. Framework Integration under Big Data Intervention

With the increase of data set samples, under the background of big data, different methods are used to compare the integration level of the entrepreneurial enterprise integration framework, and the comparison results are shown in Figure 4.

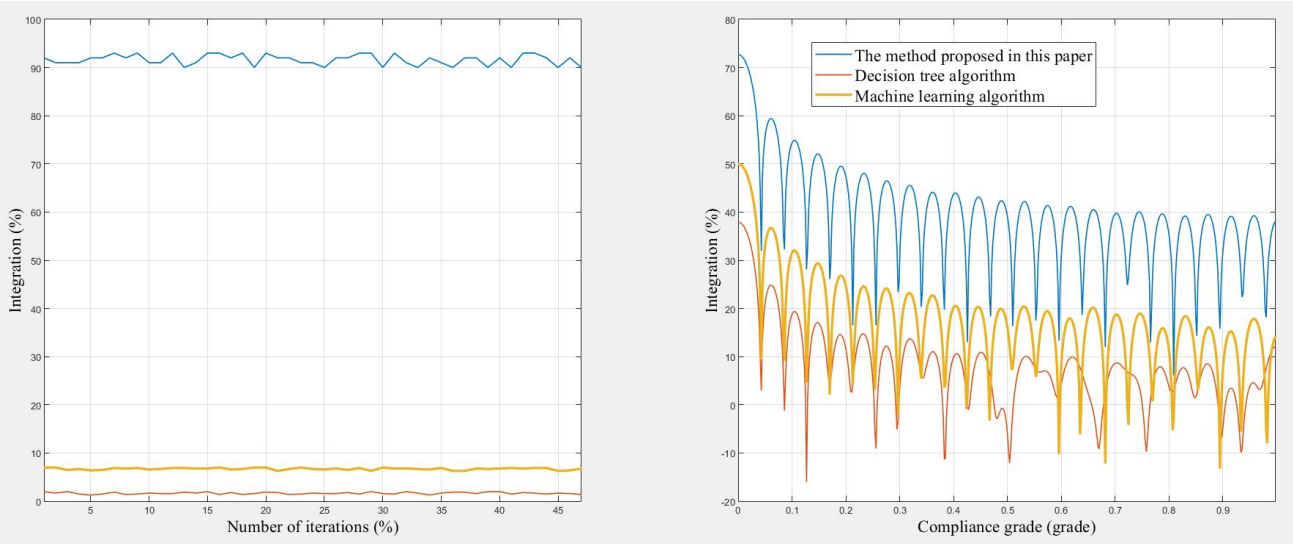

Figure 4. Comparison of Operation Efficiency of Different Algorithms

Comparing the operating efficiency of different algorithms in Figure 4, it can be seen that comparing the decision tree-based algorithm with the machine learning algorithm, the association rule-based algorithm proposed in this paper has the best operating efficiency, and with the gradual increase of the number of data samples of big data start-ups, the overall operating efficiency of the algorithm proposed in this paper has no obvious downward trend, while the operating efficiency of the decision tree-based algorithm and the machine learning algorithm shows an obvious downward trend. This shows that the algorithm proposed in this paper has a better operation effect when applied to the integration of start-ups in the era of data-driven start-ups and big data, and can effectively improve the efficiency of data mining for big data start-ups.

5. Conclusion

In order to realize the integration framework of data-driven start-ups in the green hydrogen economy, the traditional data collection method of big data start-up enterprises lacks planning and analysis of start-up data, which leads to some problems such as poor integration of big data start-up enterprise integration. Therefore, this paper proposes an integration research method of data-driven start-up enterprise in big data era based on association rules, which carries out quantitative recursive analysis on big data start-up enterprise data through quantitative regression analysis function, combined with nonlinear sequence reorganization method to discrete fusion processing on big data start-up enterprise data, and then mines association rules on data-driven start-up enterprise data. Experiments show that the algorithm proposed in this paper is effective and effectively improves the accuracy of data mining. The development of the hydrogen economy has huge advantages in terms of technology and market potential. It can meet the needs of green economic development and provide support for the development of the new energy market. However, the new economy faces many problems and challenges, mainly technical barriers, industry barriers and later cost income. Therefore, innovative enterprises should provide more manpower and technology for the

continuous development of the hydrogen economy and optimize their own technical personnel structure under existing market constraints. Local governments and departments should strengthen the policy guidance of the new economy, provide policy support to innovative enterprises, enhance the economic development needs of innovative enterprises, reduce their own economic taxes, and give more personnel introduction policies. Therefore, the future development of the new economy should start from two aspects. On the one hand, optimize the structure of enterprises themselves and improve the quality of technical personnel. On the other hand, it is necessary to formulate reasonable guiding policies to encourage more enterprises to join in the development of the new economy to form large-scale production.

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