Game Model of Regional Education and Economic Development Based on Association Rule Mining Algorithm

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Abstract. Aiming at the problem that the game model studies the relationship between regional education and economic development, it will lead to a certain contradiction, which will lead to a long time to obtain game analysis results. This paper proposes a regional education and economic development game based on association rule mining algorithm model. Collect and process data on regional education and economic development; define the subject of regional education and economic development; use Apriori algorithm to implement association rule mining on the relationship between the two, and realize the game of the relationship between regional education and economic development through the coupling degree function, and thus complete mining based on association rules Algorithmic regional education and economic development game model building. Through comparative experiments, it can be concluded that the proposed game model can more quickly obtain the results of game analysis, and through the analysis of coupled and coordinated development, we can come up with suggestions for coordinated development of higher education and regional economy.

Keywords: Association rule mining algorithm · Regional education · Economic development · Coupling degree function · Game model

1 Introduction

In the era of the beginning of the knowledge economy, the rapid development of science and technology, and the globalization of economic development, especially China’s implementation of the strategy of rejuvenating the country through science and education and the development of the western region, and China’s accession to the WTO and the establishment of the ASEAN Free Trade Area, this has brought regional economic and social development Opportunities for development have come, but severe challenges have also been raised. The implementation of the strategy of rejuvenating the country through science and education can essentially be attributed to two interconnected aspects: first, economic development and social progress must rely on scientific and technological progress and educational development; second, scientific and technological progress and educational development are always oriented to economic and social progress [1–3].

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From the perspective of systems science, if the entire society is regarded as an organic system, then economy and education are two important subsystems. And the coordinated development of education and economy as a complex system, its complexity is mainly reflected in the diversity of its constituent elements, the interrelated dynamics and diversity, and there is a dynamic material cycle within the system and between the system and the environment. Energy flow, information transfer and value addition. A qualitative analysis alone is not enough to grasp the behavioral and functional characteristics of the system as a whole. Higher vocational education is an important part of China’s modern education system, and it has a relationship that promotes and restricts each other’s regional economic development [4]. Regional economy plays a decisive role in the development of higher vocational education and restricts the scale, speed and quality of higher vocational education development to a certain extent. At the same time, vigorously develop higher vocational education and realize its positive interaction with economic and social development. It is directly related to the healthy development of higher vocational education and the implementation of the strategy of strengthening the country by talents, and to the overall situation of regional economic and social development. In the context of the country’s vigorous promotion of the development of higher vocational education, studying the game relationship between the two has far-reaching practical significance.

At present, the regional economy is developing rapidly, the industrial structure adjustment and upgrading cover a wide range and great efforts, but the development of vocational education is relatively weak, and there are many problems, such as the inconsistency of professional settings and regional economic structure, the employment structure is not compatible with regional economic development, The traditional teaching model is inconsistent with social practice requirements, the layout structure of economic development is not compatible with the layout structure of higher vocational education, etc., which is not conducive to the development of the regional economy in the region. Since higher vocational education directly serves the industry or local economic development, how to determine the direction and scale of running a higher vocational education based on social needs, how to set majors and determine the needs around the city’s economic development needs and strategic development direction Talent training objectives and models have become the fundamental tasks for the development of higher vocational education in this region. It is particularly important and urgent to study and discuss the relationship between regional vocational education and economic development. The game model has been widely used in many fields due to its many advantages [5, 6]. However, the traditional game model for the development of the relationship between regional education and economy has the disadvantage of slow analysis speed. Association rule mining algorithms can mine associations between different data from big data [7–10]. Based on the above analysis, a game model of regional education and economic development based on association rule mining algorithm is proposed.
2 Research on the Game Model of Regional Education and Economic Development Based on Association Rule Mining Algorithm

Aiming at the relationship between regional education and economic development, a regional education and economic development game model based on association rule mining algorithm is used to study it. The overall relationship between regional education and economic development is shown in Fig. 1.

Using the game model of regional education and economic development based on association rule mining algorithm, the specific steps to study the relationship between regional education and economic development are described below.

2.1 Regional Education and Economic Data Collection and Processing

First, the relevant data is retrieved from the regional education and economic development database to realize the collection of regional education and economic data. After that, make preliminary processing on the above data. Select the regional education and economic development index system: an index that reflects the development level of higher education. The development level of higher education in a region can be reflected by several indicators. The differences in these indicators can be used to compare the overall level of higher education development in various regions. Eleven indicators reflecting the development level of higher education were selected, namely: enrollment of junior college students per 10,000 people, junior college graduates per 10,000 people, reading...
per 10,000 master students, readings per 10,000 doctoral students, Number of universities, number of students burdened by each university teacher, proportion of employed population in higher education, per capita higher education funding, number of college graduates and above per 100,000 people, average number of students per university and income from major foreign institutions.

Select indicators that reflect the level of economic development: Similarly, select 10 indicators that reflect the level of economic development: GDP per capita, GDP growth rate, per capita disposable income of urban residents, per capita net income of rural residents, increase in secondary industry The proportion of value in regional GDP (referred to as the value added of the secondary industry), the proportion of value added in the tertiary industry, the urbanization rate, the consumption rate, the proportion of total imports and exports in various regions in the total national imports and exports, and the per capita regional fiscal revenue. When calculating the degree of order of parameters, for time-varying data, such as GDP, GDP per capita, etc., the maximum and minimum values are bounded, and the country has indicators for setting standards, such as the teacher-student ratio (1:14) and other related Indicators are actually calculated in accordance with nationally prescribed standards.

2.2 Defining the Subject of Regional Education and Economic Development

Establish regional economic development and regional education relations. Because the regional government plays a very important role in regional education and economic development, consider it into the relationship between the two, and speculate based on the game, through scientific calculation and evaluation, to study regional college talent training and regional economic development Trend.

Assume the following: regional government G, regional economy E, regional university U, now E regional economy is guaranteed and supported by regional government G to apply for a talent program of 10,000 to regional university U, to carry out the construction of local talent industry innovation incubation center, university the return on investment is r. Because of the guarantee and support of the regional government G, the university U believes that the regional economy E has the ability to develop, and that the university U is also a local university and has a close relationship with the regional government G. Therefore, the regional economic development has obtained talents and technology with higher efficiency. Stand by. According to the objective conditions of regional government G between regional economy E and regional university U, the following assumptions are made: the regional government has two kinds of behaviors: contract compliance and breach of contract. The probability of compliance is \( P_G (0 \leq P_G \leq 1) \) and the probability of default is \( 1 - P_G \). Therefore, at \( P_G = 1 \) o’clock, the regional government was very committed, and three years after the construction and operation of the talent industry innovation incubation center, the regional government actively urged the regional economic industry to increase the number of talents in regional universities. At \( P_G = 0 \) o’clock, the regional government completely defaulted, and the regional finances did not have the ability to support the regional economy E. They could only delay it, and the subsequent government continued to improve.

Regional economy E has two types of behaviors, honesty and dishonesty. The probability of honesty is \( 1 - P_L \) and the probability of dishonesty is \( 2 P_L (0 \leq P_L \leq 1) \).
When $P_L = 1$, the regional economy loses trust and the regional economy resorts to the regional government. At $P_L = 0$ o’clock, regional economic integrity, with the support of regional governments and the help of regional finances, absorb talents from regional universities U on time.

As a support and guarantor, the regional government G has financial and policy pressures. If regional economic and industrial innovation incubation is successful, regional finance will have income $B_L$. The support and guarantee cost of the regional government G is $C_L$ (financial fund guarantee, state-owned land support, government guarantee, etc.; after the regional economic industry innovation incubation E successfully receives talent and scientific research support from the regional university U, it will be further absorbed at maturity, and the benefit will be $L(r - i)$. When the regional economic industry loses trust, the gain is $L(1 + r)$, and its reputation is lost $M_L$.

Through the above, the establishment of the relationship between regional education and economic development is completed.

### 2.3 Association Rule Mining

After processing the data and making relevant assumptions, the Apriori algorithm is used to perform association rule mining.

Let the number of fields (attributes) of the regional education and economic data to be analyzed be m and the number of data table records be n. Discretize the data into the form shown in Table 1:

| TID | A | B | C | ... |
|-----|---|---|---|-----|
| 1   | 1 | 0 | 1 | ... |
| 2   | 1 | 0 | 0 | ... |
| 3   | 0 | 1 | 1 | ... |
| 4   | 1 | 0 | 0 | ... |
| ... |   |   |   |     |

Next, generate a set I of m attributes, such as [A, B, C]; find all subsets of Li (except for the empty set and the full set, $i = 1, 2, ..., 2^m - 2$), Such as [B, C], [C], [A, B], [B], [A, C], [A]; and define a counter Ci for each subset.

After that, scan the database and obtain a record set R based on 0 (indicating no inclusion) or 1 (indicating inclusion) for each record. The record set corresponding to the first record in the regional education and economic data is [A, C]. The record set corresponding to the second record is [A], and the record set corresponding to the third record is [B, C] …

After that, we use the subset Li of I to match each record set R. If $Li \subseteq R$, then $Ci$ increases by 1 …
After the database scan is over, $C_i \times 100/n$ can be calculated to obtain the support degree of each subset $L_i$. At this time, you can filter based on the minimum support degree to remove the non-compliant subsets.

Combine the remaining subsets in pairs, as shown in Table 2. Then calculate the confidence based on the counts of $L_i \cup L_j$ and $L_i$, and then output the association rules that meet the requirements according to the minimum confidence.

### Table 2. Association rule generation schematic table

|     | [A] | [B] | [C] | [A, B] | [A, C] | [B, C] | [A, B, C] |
|-----|-----|-----|-----|--------|--------|--------|-----------|
| [A] | $\times$ | $\rightarrow$ | $\times$ | $\times$ | $\rightarrow$ | $\times$ |           |
| [B] | $\rightarrow$ | $\rightarrow$ | $\rightarrow$ | $\times$ | $\times$ |           |           |
| [C] | $\rightarrow$ | $\rightarrow$ | $\rightarrow$ | $\times$ | $\times$ | $\times$ |           |
| [A, B] | $\times$ | $\times$ | $\rightarrow$ | $\times$ | $\times$ | $\times$ | $\times$ |
| [A, C] | $\times$ | $\rightarrow$ | $\times$ | $\times$ | $\times$ | $\times$ |           |
| [B, C] | $\rightarrow$ | $\times$ | $\times$ | $\times$ | $\times$ | $\times$ | $\times$ |
| [A, B, C] | $\times$ | $\times$ | $\times$ | $\times$ | $\times$ | $\times$ | $\times$ |

The set of attributes I is $[S_1, S_2, W_1, W_2, E_1, E_2, E_3]$; find all valid subsets $L_i$ of I. In theory, there are 126 subsets except for the empty set and the full set, but only 35 are really effective, and some of the subsets are shown in Table 3.

Scan the database. For each record, obtain a record set $R$ based on 0 (indicating that it does not contain) or 1 (indicating that it contains). For example, the record set corresponding to the first record in the database in the table above is $\{S_1, W_1, E_1\}$, a subset of I is used to match each record set R. If $L_i \subseteq R$, $C_i$ is increased by one. For example, the subsets $\{S_1, W_1, E_1\}$, $\{W_1\}$, $\{S_1, E_1\}$, etc. are all subsets of the record set, so their corresponding counters are incremented by 1.

After the database scan is over, $C_i \times 100/n$ can be used to obtain the support of each subset $L_i$. At this time, you can filter based on the minimum support (assuming 50%) to remove the subsets that do not meet the requirements. As shown in Table 3, the subsets $\{S_2, W_2, E_1\}$, $\{W_2, E_1\}$, $\{W_1, E_1\}$, etc. do not meet the requirements, while the subsets $\{S_1, W_1\}$, $\{W_1\}$, $\{S_1, W_2\}$, etc. meet the requirements …

In order to make the attribute classification more explicit, it is divided in the form of a matrix. Let attribute $U = \{u_1, u_2, u_3, u_4, u_5\}$ be the set of divided attribute objects. If the corresponding classification matrix is:

$$R = \begin{bmatrix} 1 & 0 & 1 & 0 & 0 \\ 0 & 1 & 0 & 0 & 1 \\ 0 & 0 & 0 & 1 & 0 \end{bmatrix} \quad (1)$$
Table 3. Attribute subset and count

| Serial number | SubsetLi  | CounterCi |
|---------------|-----------|-----------|
| 1             | {S_2, W_2, E_1} | 0         |
| 2             | {S_1, W_2, E_1} | 0         |
| 3             | {W_2, E_1}     | 0         |
| 4             | {S_2, W_1, E_1} | 1         |
| 5             | {S_1, W_1, E_1} | 5         |
| 6             | {W_1, E_1}     | 0         |
|               | {S_2, E_1}     | 0         |
|               | {S_1, E_1}     | 0         |
|               | {S_1}          | 1         |
|               | {S_2, E_2}     | 5         |
|               | {S_1, W_2}     | 10        |
|               | {W_2}          | 6         |
|               | {S_2, W_1}     | 4         |
|               | {S_1, W_1}     | 10        |
|               | {W_1}          | 14        |
| ...           | ...            | ...       |

The corresponding classification result is \{u_1, u_3\}, \{u_2, u_5\}, \{u_4\}. For example, the corresponding classification matrix is:

\[
R = \begin{bmatrix}
1 & 0 & 0 & 1 & 0 \\
1 & 0 & 0 & 0 & 1 \\
0 & 0 & 1 & 0 & 0
\end{bmatrix}
\]  

(2)

The corresponding classification results are \{u_2, u_4\}, \{u_1, u_5\}, and \{u_3\}. On this basis, fuzzy concept can also be used for fuzzy classification, that is, the object \(u\) in the classified object set \(U\) is considered; it belongs to a certain class with a certain degree of membership, not simply “1” (belonging to) or “0” (Not belong to), is a number between 0 and 1 to indicate the extent to which an object belongs to a certain class. Therefore, each class is considered to be a fuzzy subset of the object set \(U\), so each such classification corresponding to the classification result is a fuzzy matrix \(R\):

\[
R = \begin{bmatrix}
r_{11} & r_{12} & \cdots & r_{1n} \\
r_{21} & r_{22} & \cdots & r_{2n} \\
\vdots & \vdots & \ddots & \vdots \\
r_{c1} & r_{c2} & \cdots & r_{cn}
\end{bmatrix}
\]  

(3)

Each fuzzy classification of the object set \(U\) is classified into \(c\) class corresponds to a fuzzy matrix \(R\) that meets certain conditions; conversely, any fuzzy matrix \(R\) that meets a
certain condition also corresponds to the fuzzy classification of object set $U$ is classified into $c$ class. Finding the best fuzzy classification matrix $R$ under a certain condition, the fuzzy classification corresponding to $R$ is the best fuzzy classification of the object set $U$ under this condition.

Combining the subsets that meet the requirements (but must meet $L_i \cap L_j = \emptyset$, and there is no relevant attribute in $L_i \cup L_j$) to generate the association rule $L_i \rightarrow L_j$. As shown in Table 3, the support levels of the subsets $\{S_1, W_2\}$ and $\{W_1\}$ meet the requirements, but the rule $\{S_1, W_2\} \rightarrow \{W_1\}$ cannot be generated because $W_2$ and $W_1$ are related. The attributes of the subsets $\{S_1\}$ and $\{W_1\}$ meet the requirements, both $14 \times 100/20 = 70\%$, and these two attributes are irrelevant, and the rules can be generated after crossing $\{S_1\} \rightarrow \{W_1\}$ and $\{W_1\} \rightarrow \{S_1\}$; since the subset $\{S_1, W_1\}$ (that is, the union of the two subsets $\{S_1\}$ and $\{W_1\}$) is counted at 10, this time is also possible. Calculate the confidence of these two association rules. Through confidence, use association rules to fully mine regional education and economic data.

2.4 The Game of the Relationship Between Regional Education and Economic Development Based on the Degree of Coupling Function

Use the association rule mining algorithm to fully mine regional education and economic development data. According to the above-mentioned game scenario simulations and hypothetical conditions, the utility of regional government compliance is $1 \ U_{G1}$, and the utility of breach is $U_{G2}$, then:

$$U_{G1} = PL(-CL) + (1 - PL)(BL - CL) \tag{4}$$

$$U_{G2} = PL + (1 - PL)BL \tag{5}$$

Because the regional government is a regional administrative organ, with functions such as policy and social leadership, and a strong organizational credit foundation and authority structure foundation, when the regional government supports and guarantees the regional economy, it will only keep the contract when $U_{G1} > U_{G2}$ Can be solved:

$$F - H > \frac{C}{PL} \tag{6}$$

In formula (6), in order to obtain $PL$, it is assumed that the trustworthy regional government economy allocates a certain income $H_L$ to the regional government, and gains $L(1 + r)$ after receiving the support of the talents of the regional colleges and universities, so the reputation is lost $M_L$. The benefit of the regional economy after integrity is $L(r - i)$; if the regional economy is not supported by talents, the opportunity loss is $L(r - i)$; the U talents of regional universities support the regional economy that does not return on time, and loses the benefit $L(1 + i)$; the talents support the regional economy that returns on time, The return is $L_i$. If regional universities do not provide talent support as agreed, the opportunity loss is $L_i$. The probability of talent output from regional universities is $P_B$, the probability of rejection is $(1 - P_B)$; the probability of regional
economic mistrust is $P_L$, and the probability of integrity is $(1 - P_L)$, so that the game payment matrix between regional economy E and regional university U can be obtained as shown in the Table 4 shown.

**Table 4.** Game payment matrix between regional economy and regional universities

| Regional economy $L$ | Broken promise $P_B$ | Honesty $(1 - P_L)$ |
|----------------------|----------------------|---------------------|
| Regional colleges $U$ | Talent export $P_B$  | $[-L(1 + i), L(1 + r) - M_L - H_L]$ |
|                      | Reject output $(1 - P_B)$ | $[-L_i, -L(r - i)]$ |

Coupling degree $A$ is obtained through the game between regional economic incubation center E and regional university U. The degree of coupling refers to the degree of influence between the two. Here, the degree of coupling between regional education and the economic system can be obtained by calculation, and $A \in [0, 1]$. The larger the value, the higher the coupling level, and the smaller the value, the more uncoordinated. When the value of $A$ is zero, the coupling level is the lowest, and when it is 1, the coupling level is the highest. Set the sequence parameter of the higher education subsystem to $V_1$ and the sequence parameter of the regional economic subsystem to $V_2$, the specific formula is as follows:

$$A = \frac{2\sqrt{V_1 \cdot V_2}}{V_1 + V_2}$$

In this way, it can be concluded that the maximum utility function of the regional economy is $U_L$:

$$U_L = F - A > \frac{C(M + H - I - 1)}{2(r - i)}$$

At this point, the establishment of a regional education and economic development game model based on association rule mining algorithms is completed.

## 3 Experiment

Compare the proposed regional education and economic development game model based on association rule mining algorithm with the traditional regional education and economic development game model to verify whether the proposed regional education and economic development game model based on association rule mining algorithm can be more quickly get analysis results.
3.1 Experiment Procedure

Taking Jiangxi Province as an example, a game model of regional education and economic development based on the association rule mining algorithm is used to study the relationship between education and economic development. Taking the data from 2006 to 2019 as the analysis object, the number of students in the vocational colleges in the region, and the per capita GDP (GDP per capita) were used as indicators to measure the state of education and economic development in the region. Based on the results, explore the relationship between the two. The situation of the two is shown in Table 5.

| Years | Student (person) | GDP per capita (yuan/person) |
|-------|------------------|-----------------------------|
| 2006  | 432296           | 23601                       |
| 2007  | 500981           | 27506                       |
| 2008  | 805145           | 32146                       |
| 2009  | 574976           | 35781                       |
| 2010  | 597846           | 41125                       |
| 2011  | 557140           | 47225                       |
| 2012  | 534679           | 51478                       |
| 2013  | 548978           | 56784                       |
| 2014  | 614785           | 60147                       |
| 2015  | 594716           | 64152                       |
| 2016  | 584989           | 67845                       |
| 2017  | 601245           | 70129                       |
| 2018  | 612348           | 73248                       |
| 2019  | 597856           | 78453                       |

According to the above data, the relationship between the two is analyzed through the proposed game model. For two different game models, the analysis speed is compared.

3.2 Analysis of Results

Using the proposed regional education and economic development game model based on the association rule mining algorithm and the traditional regional education and economic development game model to analyze the relationship between regional education and economic development, and compare the analysis speed of the analysis results, such as Shown in Fig. 2.

As can be seen from the figure, from 2015 to 2019 as an example, using the traditional regional education and economic development game model, the time required to obtain the analysis results is more than 2 s; the proposed regional education and economics
The development of the game model, based on the association rule mining algorithm, analyzes the data of regional education and economic development, speeding up the analysis speed, and the required analysis time is about 0.5~0.6 s. Through comparison, it is found that the proposed regional education and economic development game model based on association rule mining algorithm can obtain the analysis results more quickly.

Figure 3 shows that the level of development of the regional economic higher education system in Jiangxi Province from 2005 to 2017 has increased year by year. The degree of coupling is also maintained at a high level of about 0.99, but the level of coupling coordination of the system is not satisfactory. The degree of coupling coordination between 2005 and 2007 was only about 0.2, which is in a state of moderate imbalance. This is because in recent years not only the level of higher education in our province is low, but also the level of regional economy is very low. In the three years from 2008 to 2010, the degree of coupling and coordination between higher education and the regional economy in our province was in a state of slight imbalance, and in the period of 2011 to 2012, it was on the verge of imbalance. Beginning in 13 years, the transition from
imminent imbalance to a state of barely coordination. From the data in the appendix, it can be seen that the investment in science and technology projects in Jiangxi Province in 2013 was ten times that in 12 years, and the research results of that year have also been greatly improved. This is likely to be an important reason for the rapid development of coupling and coordination. One. The degree of coupling and coordination of the system in our province began to reach the state of primary coordination in 2016. The degree of coupling coordination is increasing year by year, and from the perspective of the value gap between adjacent years, the value difference between adjacent years in 05–17 is not greater than 0.1, and both are in the range of \([0.01, 0.07]\).

4 Policy Suggestions for Coordinated Development of Higher Education and Regional Economy

According to the coupling analysis results in Fig. 3, the coordinated development of higher education and regional economy needs to follow certain policies. First, we should increase funding for higher education to promote the transformation of teaching and research results; second, we should adjust the discipline and professional structure, and local universities should actively adapt to the needs of economic and social development in Jiangxi Province, meet the needs of knowledge innovation, scientific and technological progress, and education development, and plan rationally. Professional layout and development, dynamic adjustment of majors, to make the professional structure more reasonable, to optimize the professional layout, to provide space for the sustainable development of the profession, and to strive to achieve the structural balance between benign talent training and the demand for talents and the industrial characteristics of a healthy interaction. In the end, special industries in Jiangxi Province should be developed, with characteristic industrial chains as a link, to form clusters with certain competitive advantages, and promote local economic development.

5 Concluding Remarks

Aiming at the disadvantages of the slow analysis speed of the traditional regional education and economic development game model, a regional education and economic development game model based on association rule mining algorithm was proposed. Through comparative experiments, compared with the traditional regional education and economic development game model, the experimental results show that the proposed regional education and economic development game model based on the association rule mining algorithm can obtain the analysis results more quickly.

Using this game model, it is possible to better analyze the relationship between regional education and economic development, which is conducive to the common development of education and economy, and to make the professional structure more reasonable, achieve a balance between talent training and talent demand, and form a certain competition Advantageous clusters promote local economic development.

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