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Study on abnormal behaviour recognition of MOOC online English learning based on multi-dimensional data mining

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Abstract: In order to overcome the problems of low recognition accuracy and long recognition time of traditional English learning abnormal behaviour recognition methods, this paper proposes MOOC online English learning abnormal behaviour recognition method based on multi-dimensional data mining. Firstly, set up the multi-dimensional association item set of MOOC online English learning behaviour, mine the learning behaviour data for correction. Secondly, students' MOOC online English learning behaviour characteristics are extracted from students' target contour and blinking behaviour characteristics. Then, taking this as the training sample subset, the individual member classifier is constructed by the mixed perturbation method to classify the learning behaviour. Finally, the abnormal behaviour identification of MOOC online English learning is completed. The experimental results show that the proposed method has high accuracy and short recognition time.

Keywords: multi-dimensional data mining; MOOC online English learning; abnormal behaviour; mixed perturbation method; individual member classifier.

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1 Introduction

Modern educational technology and educational concept are constantly updated. More and more colleges and universities take MOOC as the core of multimedia online teaching, which is the development trend of educational discipline. English is a very important subject in modern education (Liao et al., 2018). The effect of English teaching is directly related to teachers' personal skill level, ignoring the importance of mutual interaction in teaching activities, resulting in a significant decline in teaching quality. Therefore, MOOC online English teaching came into being (Xiang et al., 2018).

MOOC online English teaching makes full use of the existing multimedia technology and Internet to realise online teaching through text, pictures, audio, video and other online multimedia methods. Teachers and students use online teaching methods to carry out offline teaching simultaneously, so that different students can receive the same educational course, customise 'appropriate' learning plans and learning contents teach students in accordance with their aptitude and knowledge level, make the advantages of network learning, and break through the regional and knowledge limitations of classroom teaching in traditional teaching, it is important to enable students to learn and disseminate knowledge online, check their shortcomings in time, study targeted, and effectively improve the effect and efficiency of education. However, in the process of MOOC online English education, children will have abnormal behaviours such as playing mobile phones and sleeping, which reduces the efficiency of MOOC online education. In order to improve students' performance, scholars in relevant communities have studied the identification methods of abnormal behaviours in online English learning to solve these problems (De et al., 2018).

Yang et al. (2018) proposed a MOOC online English learning abnormal behaviour recognition method based on deep learning, collected MOOC online English learning behaviour data, extracted MOOC online English learning behaviour characteristics by using three-dimensional dense connection deep network structure, obtained normal and abnormal behaviour characteristics, constructed MOOC online English learning abnormal behaviour recognition model, and trained the model through VGg, Output abnormal behaviour recognition results. This method has fast implementation speed, but poor reliability. Guan et al. (2018) propose user-defined abnormal behaviour detection based on deep neural network, obtains students' MOOC online English learning behaviour data through video monitoring, preprocesses the learning behaviour data by fine-grained analysis, takes the abnormal behaviour characteristics as the input of the model, and constructs the MOOC online English learning abnormal behaviour recognition model by using deep neural network, Combined with deep learning technology, the model is trained to output the recognition results of students' abnormal behaviour in English learning. However, the accuracy of the above methods for MOOC online English learning abnormal behaviour recognition is low, resulting in the unsatisfactory recognition effect. Wang and Lu (2020) extract the collected classroom abnormal behaviour features by integrating temporal correlation, trains the extracted features through DBN network, and inputs the training results into the constructed classroom abnormal behaviour recognition model to identify classroom abnormal behaviour. This method can identify students' abnormal behaviour in all aspects, but the recognition takes a long time. Yu et al. (2018) improved the 3D convolution two-way neural network, combined with the monitoring equipment of two cameras, constructed the MOOC online English learning behaviour feature extraction model, extracted the MOOC online English

learning behaviour features of different students, fused them, and classified the students' MOOC online English learning behaviour features by using the classifier. According to the classification results, identify students' abnormal behaviours in MOOC online English learning. However, the above methods take a long time to identify abnormal behaviours in MOOC online English learning, resulting in low recognition efficiency.

First, online English learning behaviour data acquisition. The multi-dimensional association item set of MOOC online English learning behaviour is determined by multi-dimensional association rules to obtain English learning behaviour data and mine online English learning behaviour data.

Secondly, English learning behaviour data preprocessing. Taking the learning behaviour data mining results as the data set, the students' MOOC online English learning behaviour features are extracted from the students' target contour and blinking behaviour features, and the English learning behaviour features are corrected through HSL transformation.

Then, MOOC online English learning abnormal behaviour classification and recognition. A subset of training samples is established based on the corrected behaviour characteristics as input, and an individual member classifier is constructed by the hybrid perturbation method to classify the learning behaviour, so as to realise the recognition of abnormal behaviour in MOOC online English learning.

Finally, experimental verification and summary. The recognition effect of MOOC online English learning abnormal behaviour is verified by the experiment of behaviour recognition accuracy and recognition time-consuming, and a conclusion is drawn.

2 Recognition of abnormal behaviours in MOOC online English learning

2.1 MOOC online English learning behaviour mining based on multi-dimensional association rules

Multi-dimensional association rules can obtain the characteristic relationship of English learning abnormal behaviour from different dimensions and effectively mine the relationship between MOOC online English learning behaviour data.

Set the multi-dimensional associated item set $I = I_1, I_2, \ldots, I_k$, where k is the number of multi-dimensional associated items, and I is called the k-item set (Al-Dhamari et al., 2020).

Set X and Y to represent itemsets, $X \rightarrow Y$ to represent a association rules by MOOC online English learning behaviours, and use support to indicate the probability of itemsets X and Y itemsets appearing in all itemsets at the same time. Then the probability by $X \rightarrow Y$ is greater (Liu et al., 2020), which means:

$$\sup(X \rightarrow Y) = \sup(X \cup Y) = P(X \cup Y) \tag{1}$$

P is used to represent learning behaviour, which is represented as eigenvector. Setting min_sup indicates minimum support (Song et al., 2019). When itemset X occurs, the probability of itemset Y is confidence, which lays a foundation for the subsequent recognition of abnormal behaviour in MOOC online English learning. The conditional probability of multi-dimensional association rule results is calculated according to the confidence, which is:

$$\mathrm{conf}(X \to Y) = \sup(X \cup Y)/\sup(X) = P(Y \mid X) \tag{2}$$

If the multi-dimensional association rule $X \to Y$ satisfies condition $\sup X \to Y \geq$ min_sup, the abnormal behaviour data result E is expressed as:

$$E = \mathrm{conf}(X \to Y)/\min\_\mathrm{conf} \tag{3}$$

In the formula, min_conf represents the minimum confidence degree (Fan et al., 2020).

2.2 MOOC online English learning behaviour feature extraction

Taking the extracted MOOC online English learning behaviour image of students as the object, determine a sliding window of n*n, slide the whole image through the sliding window, and extract the hog feature of online learning behaviour face. The sliding window is evenly divided into several small blocks, and the gradient value and direction of pixel x_0 in all small blocks are calculated. Assuming that the pixel point is x_0 and there are 8 field points x_i around, the calculation mode of feature points is shown in Figure 1.

Figure 1 Calculation mode of feature points

x_1	x_2	x_3
x_4	x_0	x_5
x_6	x_7	x_8

If the gradient value of the pixel points in the small block is within 60–80 degrees, in the square graph, the count of the block in the fourth direction is increased by 1, and the pixel points in the small block are weighted and projected in the detection window to obtain the hog feature of the small block, so as to complete the hog feature extraction of the sliding window in the whole image. According to the above principles, students' MOOC online English learning behaviour characteristics are extracted from students' target contour and blinking behaviour characteristics.

1 Target contour feature extraction

Let y represent a pixel, and its intensity value s(y) can be expressed as:

$$s(y) = \mu + \sum_{r \in D} \theta(r) + \varepsilon(y) \tag{4}$$

where μ is the average brightness; ε(y) is noise item; θ(r) is a series of model parameters, representing pixel weights. Extract the pixel points in the input visual cognitive image whose pixel intensity value is higher than the set threshold value, and the feature points are the target contour feature extraction results. From the contour features, we can see the movement of the student target.

2 Blink behaviour feature extraction

Extract the behavioural characteristics of students' online English learning, and determine the basic position of the orbit of online learning students, that is, the position of the left eye and the position of the right eye on the midline of the left 1 / 6 to 1 / 2 area of the face frame. Human pupil localisation is based on successful orbital localisation. Pupil localisation is to find the centre position of the pupil in the human orbit. Pupil centre localisation is obtained by region centre algorithm. On this basis, the inner eye angle is detected and marked by the inner eye angle detection algorithm. Moreover, the basis of feature extraction of students' blinking behaviour in MOOC online English learning is that human eyes blink after staring at a bit on the computer screen, so that the system can record the state of blinking before. Similarly, we can get the feature extraction results of other behaviours generated in the process of students' MOOC online English learning. By clustering and fusing all feature points according to their types, we can get the final comprehensive feature extraction results of students' MOOC online English learning behaviour.

2.3 MOOC online English learning behaviour image data correction processing

Because the extracted MOOC online English learning behaviour image data will be distorted due to interference, it is necessary to correct the MOOC online English learning behaviour image. Because the MOOC online English learning behaviour image data mined above will be distorted due to interference, it is necessary to correct the MOOC online English learning behaviour image. Set the correction objective function, use the HSL conversion function to numerically convert R, G and B in the student behaviour image, and obtain the HSL conversion function H, which is expressed as:

$$H = G - B - R/(\gamma_{max} - \gamma_{min}) \tag{5}$$

In formula (4), the maximum change amplitude of HSL conversion value is expressed in γ_{max}, similarly, the maximum change amplitude of HSL conversion value is expressed in γ_{min}. The learning abnormal behaviour image is substituted into the above transformation function to obtain the image colour disharmony coefficient as follows:

$$P(n, \varepsilon) = \sum_{j=p} (H(q) - S(q))/\delta(q)E \tag{6}$$

The transformation angle of abnormal behaviour image is represented by ε, the pixel points of learning abnormal behaviour image are represented by p, the hue value of abnormal behaviour is represented by H(q), the boundary hue value is represented by S(q), and the distortion correction area is represented by δ(q).

This paper analyses the image harmony degree of students' MOOC online English learning behaviour, and the calculation formula of the influencing factor W is:

$$W = \sum_{m-1}^{i=1} D_i^{MC} P(n, \varepsilon) / D_{i+1}^{MC} \tag{7}$$

D_i^{MC} represents the online learning quality difference at time i, and D_{i+1}^{MC} represents the online learning quality difference at time i + 1. In combination with the feature dynamic selection method, the occurrence probability $p_1(i)$ of abnormal behaviour is calculated as follows:

$$p_1(i) = F_w \Big/ \sum_{N}^{j=1} F_w \tag{8}$$

In formula (7), F_w represents the probability of abnormal behaviour in the student group (Zhao et al., 2021). Therefore, the search operator is used to calculate the crossover probability function p_c and the mutation probability function pm, and the expression is:

$$p_c = k_1 \left(f_{max} - f'\right) / f_{max} - f^*, f \geq f^* \text{ or, } p_c = k_2, f < f^* \tag{9}$$

$$p_m = k \left(f_{max} - f\right) / f_{max} - f^*, f \geq f^* \text{ or, } p_m = k_4, f < f^* \tag{10}$$

Among them, f_{max} represents the maximum probability of abnormal behaviour in the student group, f* represents the mean probability of abnormal behaviour, and f represents the probability threshold of abnormal behaviour.

Combine the above two functions to construct a correction objective function V_E to correct the MOOC online English learning behaviour image:

$$V_E = \left(p_c + p_m\right) / \left(p_1(i) W\right) \tag{11}$$

2.4 Member classifier creation

Taking the training sample subset composed of the corrected learning behaviour characteristics as the input, the differential member classifier is constructed by the mixed perturbation method to cooperate with the training sample subset. The collaborative learning method trains the classifier through the identified data in the sample, divides the unidentified data types, introduces high confidence results into the identified data, and applies the unidentified data to strengthen the classifier after repeated iterations, so as to ensure the accuracy of the classifier and reduce the time cost of the identified data in the training sample. Due to the high imbalance of network data, after extracting the multi class features of network data training samples through the processing module, more training sample book subsets will be generated. If too few member classifiers are used in collaborative learning for each subset, it will lead to problems such as over fitting of member classifiers and decline in accuracy. Therefore, a large number of member classifiers should be created, And there are different member classifiers to improve collaborative learning.

The creation process of individual member classifier based on mixed disturbance is as follows:

Input: Parameter perturbation quantity V, characteristic index subset E_1, E_2, …, E_M and training sample subset Y_1, Y_2, …, Y_N.

Output: The individual member classifier set E_{all} and its corresponding training sample set X_{all}.

1 FOR i = 1 to M.

2 FOR j = 1 to N.

3 Based on MOOC online English learning behaviour feature subset E_i, project training sample subset Y_j, and obtain the expression of sample $X_{i,j}$ relative to MOOC online English learning behaviour feature index subset as follows:

$$X_{i,j} = E_i / Y_j s(y) \tag{12}$$

4 According to the above formula, calculate its Reg_{Low} and select the ω and A parameters of V.

5 FOR k = 1 to v.

6 Generate individual member classifier $e(e_{i*j*k})$ by using parameters ω and A:

$$e\left(e_{i*j*k}\right) = X_{i,j}\omega / A \tag{13}$$

7 Through the above formula, obtain the training sample Xi,j relative to the generated individual member classifier:

$$X_{i,j} = X\left(e_{i*j*k}\right) \tag{14}$$

8 The training sample $X_{i,j}$ is added to the training sample set E_{all}, and the individual member classifier is created.

2.5 Recognition of abnormal behaviours in MOOC online English learning

According to the individual member classifier created above, students' MOOC online English learning behaviour is classified to identify abnormal behaviour.

Based on the above analysis, the detailed process of identifying abnormal behaviours in MOOC online English learning can be obtained as follows:

Input: feature index subset E_1, E_2, …, E_U relative to each member classifier and integrated classifier $E_{resemble}$.

Output: identification results.

1 The iteration time is set as T, and the MOOC online English learning behaviour data obtained in the last iteration is BT.

2 Based on the characteristic index E_{object}, the identified MOOC online English learning behaviour data BT was obtained.

3 Projection vector BT_{T-1} according to the relative feature index space E_i of the member classifier e_i.

4 Sort and vote on the classification identification results output by each classifier in the vector BT_{T-1} in $E_{resemble}$.

5 Based on the simple majority principle, output the final identification of the flow. If this identification is – 1, it is recognised as abnormal behaviour. If this identification is 1, it is normal behaviour.

6 Return to the recognition result and start the next iteration.

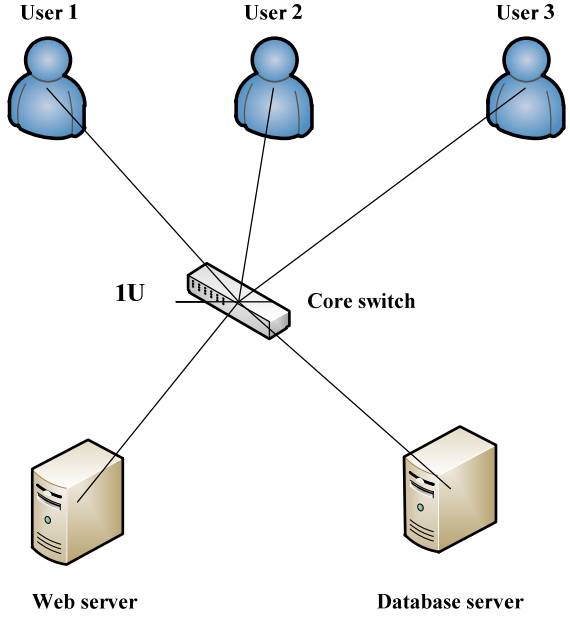
Since then, the recognition of abnormal behaviour of MOOC online English learning has been realised. This method uses multi-dimensional association rules to obtain the implicit association information between data in different dimensions, so as to effectively mine the deep-seated relationship between MOOC online English learning behaviour data and obtain more comprehensive data association information; The HSL conversion method is used to correct the distortion of behaviour image data, which improves the accuracy of data extraction; The classifier realises the classification and recognition of online English learning behaviour, and improves the recognition accuracy of MOOC online English learning abnormal behaviour.

3 Simulation experiment analysis

3.1 Experimental scheme

In order to verify the effectiveness of the MOOC online English learning abnormal behaviour recognition method based on multi-dimensional data mining in practical application, a simulation experiment analysis is carried out. In the experiment, 300 students were randomly selected from the MOOC platform to perform different learning behaviours in the experimental network environment, and these behavioural data were collected as experimental network user behaviour data. The time period of the collected data was 7 a.m. on June 5, 2020: From 00 to 19:00 in the evening of the same day, the collected network traffic is about 28G. Build MOOC online English learning platform as the environment topology, as shown in Figure 2.

Figure 2 Topology diagram of learning platform (see online version for colours)



The operating system of this platform is Windows10.

3.2 Experimental parameters

The data used in the experiment is the MOOC online English learning behaviour data of the students in the above platform, and a data set is extracted as the experimental sample, of which there are 9 training sets and 1 test set. The sample data set information is shown in Table 1:

Table 1 Experimental data set information

Dataset	*Data scale*	*Number of attributes*	*Number of categories*
Zoo	101	17	7
Banding	138	29	2
Monk1	124	6	2
Monk2	169	6	2
Vote	300	16	2
Crx	490	15	2
Soybean	683	35	19
Anneal	898	38	6
Hypo	2,514	29	5
Letter	20,000	16	26

3.3 Experimental index

1 Accuracy of abnormal behaviour recognition in online English learning. The higher the recognition accuracy of online English learning abnormal behaviour, the more accurate the recognition effect is. On the contrary, the lower the recognition accuracy of online English learning abnormal behaviour, the worse the recognition effect is.

2 Identification time of abnormal behaviour in online English learning. The shorter the recognition time of online English learning abnormal behaviour, the higher the recognition efficiency. On the contrary, the longer the recognition time of online English learning abnormal behaviour, the lower the recognition efficiency.

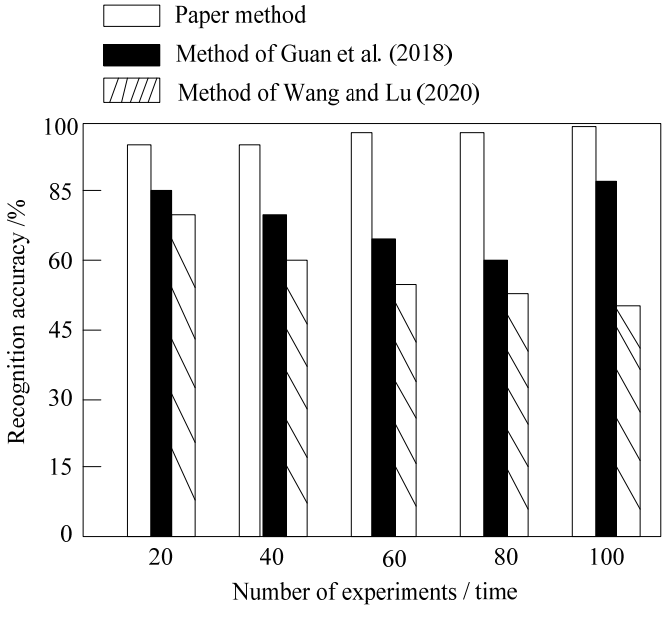
3 Experimental methods. In this paper, the user-defined abnormal behaviour detection method based on deep neural network is adopted, and the experimental verification is carried out based on the fusion temporal correlation method.

3.4 Experimental result

3.4.1 Learning abnormal behaviour recognition accuracy

In order to verify the effectiveness of this method, the recognition method proposed in this paper, the neural network recognition method proposed in Guan et al. (2018) and the fusion timing recognition method proposed in Wang and Lu (2020) are used to compare and analyse the recognition accuracy of MOOC online English learning abnormal behaviour, and the recognition accuracy results of learning abnormal behaviour are shown in Figure 3.

Figure 3 Comparison results of recognition accuracy of abnormal behaviours in MOOC online English learning



According to Figure 3, the MOOC online English learning abnormal behaviour recognition method based on multi-dimensional data mining proposed in this paper can reach up to 100% accuracy, while Guan et al. (2018) proposed MOOC online English based on neural network The MOOC online English learning abnormal behaviour recognition method of learning abnormal behaviour recognition method has the highest accuracy of only 87%. The MOOC online English learning abnormal behaviour recognition method based on the fusion temporal correlation method proposed in Wang and Lu (2020) is only 75%. The MOOC online English learning abnormal behaviour recognition method based on multi-dimensional data mining proposed in this paper has the highest accuracy in identifying abnormal behaviours in MOOC online English learning.

3.4.2 Learning abnormal behaviour recognition time

In order to verify the effectiveness of the method in this paper, the MOOC online English learning abnormal behaviour recognition method based on multi-dimensional data mining proposed in this paper, the MOOC online English learning abnormal behaviour recognition method based on neural network proposed in Guan et al. (2018) and the Wang and Lu (2020) proposed Based on the fusion sequence correlation method of class abnormal behaviour identification, to identify the abnormal behaviour of students MOOC online English learning, right, the time consumed by the three methods, the comparison results are shown in Table 2.

Table 2 Comparison results of MOOC online English learning abnormal behaviour recognition time/s

Number of experiments/time	*Guan et al. (2018) methods*	*Wang and Lu (2020) methods*	*Paper method*
10	32.02	22.11	5.66
20	33.40	22.44	5.48
30	34.44	23.60	6.85
40	35.66	24.88	6.11
50	37.55	25.64	3.15
60	34.88	28.21	3.45
70	34.66	29.44	5.84
80	38.55	26.11	4.66
90	37.22	25.11	6.55
100	39.65	29.74	8.55

According to Table 2, when the number of iterations is 50, the recognition time of MOOC online English learning abnormal behaviour of Guan et al. (2018) method is 37.55 s, the recognition time of MOOC online English learning abnormal behaviour of Wang and Lu (2020) method is 25.64 s, and the recognition time of MOOC online English learning abnormal behaviour of this method is 3.15 s. When the number of iterations is 100, the recognition time of MOOC online English learning abnormal behaviour of Guan et al. (2018) method is 39.65 s, the recognition time of MOOC online English learning abnormal behaviour of Wang and Lu (2020) method is 29.74 s, and the recognition time of MOOC online English learning abnormal behaviour of this method is 8.55 s. The MOOC online English learning abnormal behaviour recognition method based on multi-dimensional data mining proposed in this paper consumes 8.55 s, which is better than the MOOC online English learning abnormal behaviour recognition method based on neural network proposed in Guan et al. (2018) and Wang and Lu (2020). The proposed classroom abnormal behaviour recognition method based on fusion of temporal correlation consumes a short time for MOOC online English learning abnormal behaviour recognition.

4 Conclusions

This paper proposes an abnormal behaviour recognition method for MOOC online English learning based on multi-dimensional data mining. Calculate the conditional probability of the results of multi-dimensional association rules and mine the MOOC online English learning behaviour image data. However, because the mined MOOC online English learning behaviour image data will be distorted due to interference, it is corrected. The corrected rows are based on the image data, through the target contour features and blink behaviour features. The characteristics of MOOC online English learning behaviour are extracted. According to the feature extraction results, a member classifier is established by using mixed disturbance to classify MOOC online English learning behaviour and obtain abnormal behaviour. The following conclusions are obtained from the experimental results:

1 The recognition accuracy of MOOC online English learning abnormal behaviour of this recognition method is up to 100%, which shows that the recognition accuracy of MOOC online English learning abnormal behaviour of this recognition method is the highest.

2 When the number of iterations is 100, the recognition time of MOOC online English learning abnormal behaviour of this method is 8.55 s, which shows that this method has high recognition efficiency.

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