Clustering Analysis of Online Teaching Cases and Evaluation of Teaching Results

https://doi.org/10.3991/ijet.v18i03.38055

Shuyuan Bi, Wei Liu(✉)
Department of Foreign Languages, Tangshan Normal University, Tangshan, China
liuwei@tstc.edu.cn

Abstract—To facilitate front-line teachers to provide more efficient cases for classroom teaching activities in limited teaching time, it is necessary to conduct clustering analysis of online teaching cases. The existing clustering study on text-based teaching resources focuses on the representation and fusion of different views of texts and the discovery of consistent clustering allocation, and ignores the high-dimensional sparsity of text data. To this end, this paper studies clustering analysis of online teaching cases and evaluation of teaching results. This paper gives the design flow of online teaching with case teaching as the core and proposes a text multi-view clustering algorithm based on case subject alignment, and presents a clustering model structure based on subject alignment. Based on the grey system theory, this paper compares online classroom teaching results before and after teachers use clustering algorithm to process teaching cases. Finally, the experimental setup is given, and the effectiveness of the proposed algorithm is verified by experiment.

Keywords—online teaching, case teaching method, clustering analysis, evaluation of teaching results

1 Introduction

Along with the deepening of the new round of higher education curriculum reform and STEAM educational idea, case teaching method which emphasizes the interdisciplinary teaching idea, has become a hot topic in current higher education research [1–4]. Case teaching method is practiced by front-line teachers in colleges and universities in various disciplines, especially in the open and interactive online teaching application scenarios where the teaching method is more flexible [5–11]. Compared with other teaching methods, case teaching method boasts three advantages: First, it encourages students to think independently; second, it guides students to focus on ability instead of knowledge; third, it attaches importance to two-way communication [12–15]. To facilitate front-line teachers to provide more efficient cases for classroom teaching activities in limited teaching time, it is necessary to conduct clustering analysis of online teaching cases, and maximize the advantages of case teaching method, so as to further improve online teaching results.

Xiao [16] puts forward a comprehensive research case teaching based on Moodle teaching system. It analyzes the application of Moodle teaching system in teaching under the six sigma management method, and establishes an object learning system under dynamic environment by means of modularization, interactive analysis and research-based case teaching model. Taking the aesthetic link of vocational quality course in colleges and universities as an example, the concrete teaching mode is designed. Wang [17] analyzes the application of case teaching method in the teaching of business management. This paper combines experimental comparison method and questionnaire method to study, and finds that the traditional teaching model cannot meet the needs of modern business management teaching. The experimental result shows that the experimental group by case teaching method has been significantly improved in all aspects. The traditional case teaching method and micro teaching method need face-to-face communication between teachers and students, which has temporal and spatial limitations. WeChat, as a mobile learning platform, can break through the limitations of teaching time and space and realize the diversification of teaching methods. In literature [18], the beneficial complementation of the WeChat platform with case teaching method and micro teaching method not only stimulates students' learning interest and stimulates their enthusiasm, but also improves students' self-learning ability, comprehensive analysis ability and clinical thinking ability in the application of laboratory teaching, which is worth popularizing and applying in laboratory practice teaching. Case teaching method is an effective teaching method to cultivate students' ability and improve their quality. Through computer-aided technology, designers can express themselves through a new form of artistic expression, which brings profound changes to the aesthetics and thinking of artistic design. Hao [19] suggests that science and technology should be combined with artistic connotation, which will promote the sustainable development of computer-aided artistic design. Case teaching method is to choose a typical case teaching method according to the needs of teaching objectives and contents, in order to better carry out artistic design teaching. In literature [20], a descriptive and analytical approach is used in a specific case study in which freshmen majoring in architecture are divided into three different teaching strategies in a design studio, namely, model making, sketch drawing and combination of the two. The result shows that physical model plays an important role in the development of students' performance in the whole project design process.

The existing clustering study on text-based teaching resources focuses on the representation and fusion of different views of texts and the discovery of consistent clustering allocation, and ignores the high-dimensional sparsity of text data. At the same time, there are few researches on the innovation of the algorithm of enhanced text view representation learning. Attaching semantic information to a text view sample is a key way to obtain the key characteristics of a text view, and the existing methods do not explore the complete semantic and structural information to obtain a good clustering allocation effect. For this reason, this paper takes English online teaching as an example to study clustering analysis of online teaching cases and evaluation of teaching results. In Chapter 2, this paper presents the online teaching design flow with case teaching as the core. Besides, this paper proposes a text multi-view clustering algorithm based on case subject alignment to solve the problem that the traditional clustering algorithm ignores the inconsistency of different views in the data structure of text-based teaching resources. Then a clustering model structure based on subject alignment is given.

In Chapter 3, based on the grey system theory, this paper compares online classroom teaching results before and after teachers use clustering algorithm to process teaching cases. Finally, the experimental setup is given, and the effectiveness of the proposed algorithm is verified by experiment.

2 Text clustering algorithm of online teaching cases

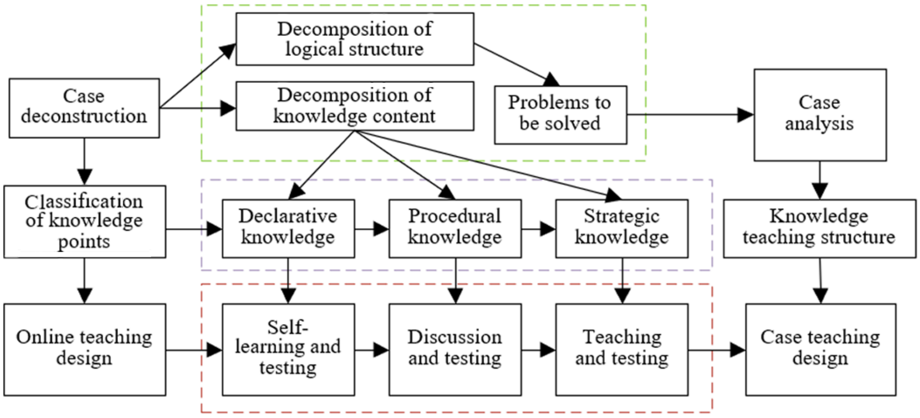


Fig. 1. Teaching design flow centered on case teaching

The teaching design centered on case teaching consists of three steps: Case deconstruction, classification of knowledge points and online teaching design. Through decomposition of logical structure and decomposition of knowledge content, teaching case deconstruction divides the knowledge points that need to be taught into three types: declarative knowledge, procedural knowledge and strategic knowledge. Students can complete the learning of different types of knowledge through online self-learning and testing, discussion and testing, teaching and testing, and teachers can complete the case teaching design by designing the above teaching links. Figure 1 shows the teaching design flow centered on case teaching. It can be seen from the figure that clustering analysis of teaching cases is very important for teachers to design case teaching.

In most existing text-based teaching resources, the idea of most clustering algorithms is to first learn the fixed feature representation of a single sample, and then cluster based on the similarity of the learned feature representation. This clustering idea ignores the inconsistency in data structure of different views of text-based teaching resources, which leads to difficult algorithm convergence and poor clustering performance. To solve the above problems, the constructed clustering algorithm need to be able to autonomously learn the structural features of different views from text-based teaching resources, so as to better deal with sample sets of different length and different display forms. In order to improve the clustering effect of online teaching cases, this paper proposes a text multi-view clustering algorithm based on case subject alignment. A subject inference network based on variational self-encoder is constructed to explore and learn the data structure of teaching cases through deep variational inference, and to output the feature representation of the subject to which the cases belong. At the same time, a strategy-based supplementary generation network is built to simultaneously supervise the subject learning and clustering allocation under different views of online teaching cases.

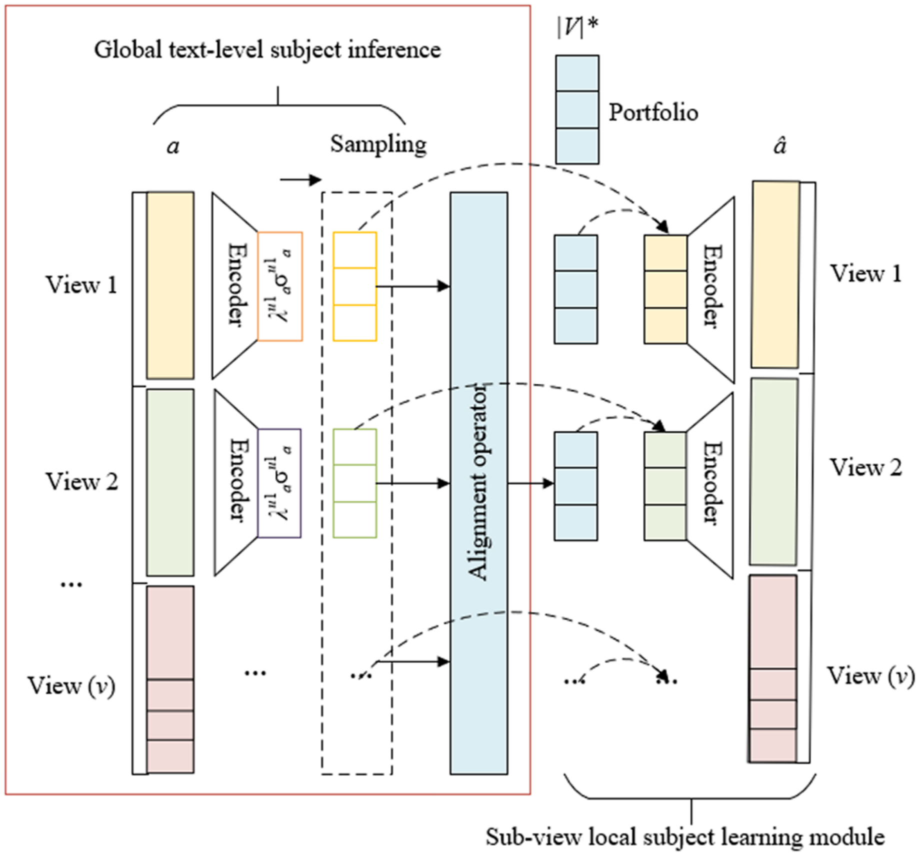


Fig. 2. Network structure of global text-level subject inference for online teaching cases

For multi-view text data of online teaching cases $A = \{a^u\}_{u=1}^{U}$, the subject feature information under different views of online teaching cases is extracted by multi-channel input. Figure 2 shows the network structure of global text-level subject inference for online teaching cases. In order to infer the subject representation of the complete view structure of online teaching cases, it is necessary to complete the alignment of hidden layer representation of different view bodies of online teaching cases, which is completed by the alignment operator based on the attention mechanism introduced in this paper. Sub-view local subject learning module and global text-level subject inference are the main components of the subject inference network based on the variational self-encoder. In the first module, the views of online teaching cases are independent of each other, and the data flow is the same as the depth variation generation model framework. Assuming that the original text representation of the current view of online teaching cases is represented by a^u, the activation function of encoder portion of the view u is represented by h_o^u, the following formula the inference network $(w^u(c^u|a^u))$:λ corresponding to each view u of online teaching cases.

$$f^u = h_o^u(Q_o^u a^u + y_o^u), \lambda^u = Q_\lambda^u f^u + y_\lambda^u$$
$$\log\phi^u = Q_\phi^u f^u + y_\phi^u, w^u(c^u \mid a^u) = M(c^u \mid \lambda^u, (\phi^u)^2) \tag{1}$$

After linear mapping of f^u, λ^u and $log\varphi^u$ can be obtained, and a posteriori distribution $w(c^u|a^u)$ can be constructed. The potential subject representation of the current view of online teaching cases can be further obtained through re-sampling as shown below:

$$c_o^u \sim w(c^u \mid a^u) \tag{2}$$

An alignment module is for fusing views and capturing overall structure information, the input of which is the view subject representation set $C_o = \{c_o^u\}_{u=1}^U$ obtained by traversing all views of online teaching cases. Assuming that the learning global text-level representation variable is represented by c_h and the alignment operator is represented by $ALAT()$, the following formula gives an expression for the alignment process:

$$c_h = ALAT(C_o) \tag{3}$$

The alignment of view subjects of online teaching cases is the key to the application of the global text-level subject inference module in different views. The subject alignment of view subspace structure representation of online teaching cases is to fuse all view feature representations of the extracted online teaching cases. Similar to the self-attention mechanism in *BERT* algorithm, the *Key*, *Query* and *Value* of the alignment operator based on the attention mechanism introduced by the algorithm are represented by K, Q and V. The following gives three detailed steps for subject alignment:

1. Calculate a similarity quantization value between view feature representations $SIM(Q,K_i)$, $i\epsilon\{1,2,\ldots,V\}$;
2. Empower the views of online teaching cases $\mu_i = softmax(SIM(Q,K_i))$, $i \epsilon (1,2,\ldots,V\}$;
3. Calculate $c_h=\sum_i \mu_i * V$ and output the alignment result.

In the multi-view generation module of online teaching cases, in order to obtain view semantics as much as possible on the premise of making full use of the potential subject representation of the current view, this paper introduces the global subject representation obtained through learning. In addition, each text view of online teaching cases is generated by a two-layer neural network. Assuming that the global text-level subject representation is c_h, the learned local view-level subject is represented by c_o^u, and the fusion strategy of c_h and c_o^u is represented by ε, the following formula gives an expression for generating a view-level subject representation c_e^u for each text view u of online teaching cases based on the first layer of neural network:

$$c_e^u = \varepsilon(c_h, c_o^u) \tag{4}$$

Assuming that the fusion parameters are represented by β_h and β_o, the fusion strategy expression is:

$$\varepsilon(c_h, c_o^u) = \beta_h \times c_h + \beta_o \times c_o^u \tag{5}$$

The second layer of neural network is used to generate an online teaching case text with multiple views. It is assumed that *one-hot* representation of each word is a_i^u, the reconstructed output of the algorithm generation part is represented by $\hat{a}_i^u$. For each word a_i^u in the u-th view of the current online teaching case text a, the following is its generating process expression:

$$\hat{a}_i^u = \frac{exp\{-c_e^u Q_c^u a_i^u\}}{\sum_j exp\{-c_e^u Q_e^u a_j^u\}} \tag{6}$$

Assuming that the number of words in the current text view u of online teaching cases is represented by M^u, and the target distribution of the view u is represented by $MF^u(c^u)$, the optimization target of the algorithm can be given by:

$$K_{nu} = \sum_{u \in U} O_{w^u(c^u|a^u)} \sum_{i=1}^{M^u} \log MF^u(a_i^u \mid c^u) - E_\Gamma[MF^u(c^u) \,\|\, w^u(c^u \mid a^u)] \tag{7}$$

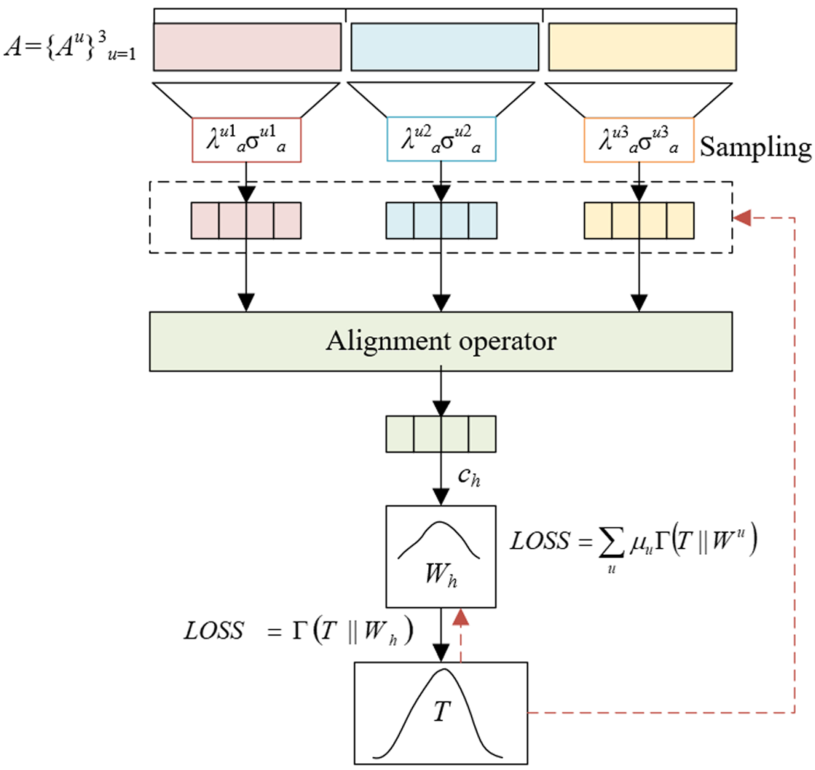


Fig. 3. Clustering model structure based on subject alignment

In order to obtain the mapping of low-dimensional subject distribution of views of online teaching cases in high-dimensional text space in low-dimensional text space, this paper constructs a clustering model based on subject alignment based on the deep variational generation model. Figure 3 shows the clustering model structure based on subject alignment. This model carries out subject alignment and feature fusion for multi-view information of online teaching cases. The self-supervised clustering layer in the model performs text clustering allocation after the model completes the learning of global text-level subject representation. According to the structural feature of the model, random noise may be introduced when the model conducts probability distribution inference and re-sampling, which makes the fine-tuning of the mapping of subject features of different levels uncertain. To realize the learning of the contribution of different views of online teaching cases to the consistent clustering and ensure the robustness of the model to the random sampling of local sub-view of online teaching case text. The proposed clustering algorithm based on subject alignment sets constraints for the potential representation of sub-views.

Based on the number of class clusters of a given online teaching case sample set, the optimization objective of the proposed clustering algorithm is divided into a clustering soft allocation of global text-level presentation W_h and a clustering soft allocation of local sub-view-level presentation $\{W^u\}_{u=1}^{U}$. The target distribution generated by W_h corresponding to the current online teaching case sample is T distribution. KL divergence is denoted by $\Gamma()$. Thus, this paper first calculates the difference between W_h and T distribution, then calculates the difference between $\{W^u\}_{u=1}^{U}$ and T distribution, and constructs the loss function of the algorithm by the sum of the two kinds of differences.

$$LOSS = \Gamma(T \parallel W_h) + \sum_u \mu_u \Gamma(T \parallel W^u) \tag{8}$$

As can be seen from the above formula, T distribution is defined by W_h, and c_h can be obtained by processing the partial sub-view set C_o of online teaching cases based on the alignment operator. Therefore, the self-training process based on multi-view data of online teaching cases can be regarded as the minimization process of loss function value.

3 Evaluation of teaching results based on grey system

To verify the effectiveness of the proposed clustering algorithm for online teaching cases, this paper compares the online classroom teaching results before and after teachers use the clustering algorithm based on the grey system theory. The grey relational degree evaluation has a low requirement for research samples and a small amount of calculation, so it can carry out multi-layer complex evaluation, thus realizing quantitative description of the development and change of the object and comparative study of the relational degree among the evaluation indexes. Based on the correlation and evolution law of uncertain evaluation index data in the online classroom teaching results, the problems in the implementation of case teaching method and online teaching classroom can be identified, which is helpful for teachers to improve teaching strategies step by step and finally to promote teaching efficiency and quality.

The specific calculation steps of the grey relational degree evaluation method are described in detail as follows:

Assuming that there are m influence factors of online teaching classroom teaching results, each factor has n index sequences, and the original index data sequence is $n \times m$, the expression is given in the following formula:

$$A = (A_{ij})_{n\times m} = \begin{bmatrix} A_{11} & \cdots & A_{1n} \\ \vdots & \ddots & \vdots \\ A_{n1} & \cdots & A_{nm} \end{bmatrix} (i = 1,2,\ldots,nj = 1,2,\ldots,m) \tag{9}$$

Based on the following formula, the index data are treated with dimensionless method:

$$a'_{ij} = \frac{a_{ij}}{a_{1j}} \tag{10}$$

The comparison sequence and reference sequence of the evaluation index are given by:

$$a_{0j} = (a'_{01}, a'_{02}, \ldots, a'_{0m}) \tag{11}$$

$$a_{ij} = (a'_{i1}, a'_{i2}, \ldots, a'_{im}) \tag{12}$$

The correlation coefficient between the comparison sequence and reference sequence can be calculated by the following formula:

$$\Omega_{ij} = \frac{\min_i \min_j \left|a'_{0j} - a'_{ij}\right| + \varepsilon \max_i \max_j \left|a'_{0j} - a'_{ij}\right|}{\left|a'_{0j} - a'_{ij}\right| + \varepsilon \max_i \max_j \left|a'_{0j} - a'_{ij}\right|} \tag{13}$$

Assuming that the absolute difference between A_i and A_0 corresponding to the j-th index is represented by $|a'_{0j} - a'_{ij}|$, the maximum absolute difference between the two levels is represented by $max_i max_i |a'_{0j} - a'_{ij}|$, and the resolution coefficient is $\varepsilon \in (0,1]$, the following formula is the calculation formula of the correlation coefficient of data treated with dimensionless method:

$$\Omega_{ij} = \frac{\varepsilon \max_i \max_j \left|a'_{0j} - a'_{ij}\right|}{\left|a'_{0j} - a'_{ij}\right| + \varepsilon \max_i \max_j \left|a'_{0j} - a'_{ij}\right|} \tag{14}$$

The correlation coefficient of each index and its corresponding weight can be further calculated for the relational degree by the following formula:

$$b_i = \frac{1}{m} \sum_{j=1}^{m} \Omega_{ij} \times \theta_i \tag{15}$$

Based on the ascending order of the relational degree value, the quality of the evaluation index reference sequence can be judged.

4 Experimental setup

In order to verify the effectiveness of the proposed clustering algorithm, this paper takes English online teaching scene as an example to design a contrast experiment for multi-view text clustering, including two aspects: multi-view generation of online teaching cases and multi-view clustering of online teaching cases.

In the clustering model constructed in this paper, two *MLP* hidden neural layers with hidden units of different number are set in each view channel. The activation function used in the neural layer is *ReLU* function, which is parameterized as λ^u, φ^u, f_o^u and f_h. In the multi-view supplementary generation network of online teaching cases, c_h and c_o^u can be processed with splicing strategy according to the difference of supplementary strategy, i.e., $c_e^u = [c_h, c_o^u]$. The dimension of c_e^u can be set as L, and the fusion parameters β_h and β_o are initialized as 0.5. Compared with other reference algorithms limited by the number of views participating in the experiment, the proposed algorithm can process all views of online teaching cases at the same time without treating each view as a single sample set, which is the biggest performance advantage of this algorithm.

This paper evaluates the performance of view generation of all algorithms based on perplexity. Assuming that the total number of online teaching cases in the sample is denoted by M, the length of the i-th text is denoted by K, and the generation probability of sample x is expressed by $GO(a) = \int GO(a|c)GO(c)dc$, the following formula is to calculate the parameter:

$$PER = exp\left(-\frac{1}{M}\sum_{i}\frac{1}{K_i}logGO(a_i)\right) \tag{16}$$

5 Experimental result and analysis

The algorithms involved in the contrast experiment are *DeepWalk* algorithm, *DNGR* algorithm and *SGNS* algorithm, respectively corresponding to the contrasts algorithms 1, 2, 3. In this paper, standardized mutual information is used as the evaluation index to evaluate the clustering performance of clustering algorithm. Figure 4 shows the convergence of different clustering algorithms intuitively. It can be seen from the figure that the index values of all algorithms increase rapidly with the increase of iteration, and the convergence speed of the algorithm in this paper is slightly slower than that of other algorithms mainly because the number of parameters of the algorithm in this paper is obviously larger than that of other algorithms. When the number of iterations reaches about 30, the algorithm in this paper tends to be stable and the performance index value reaches the optimum.

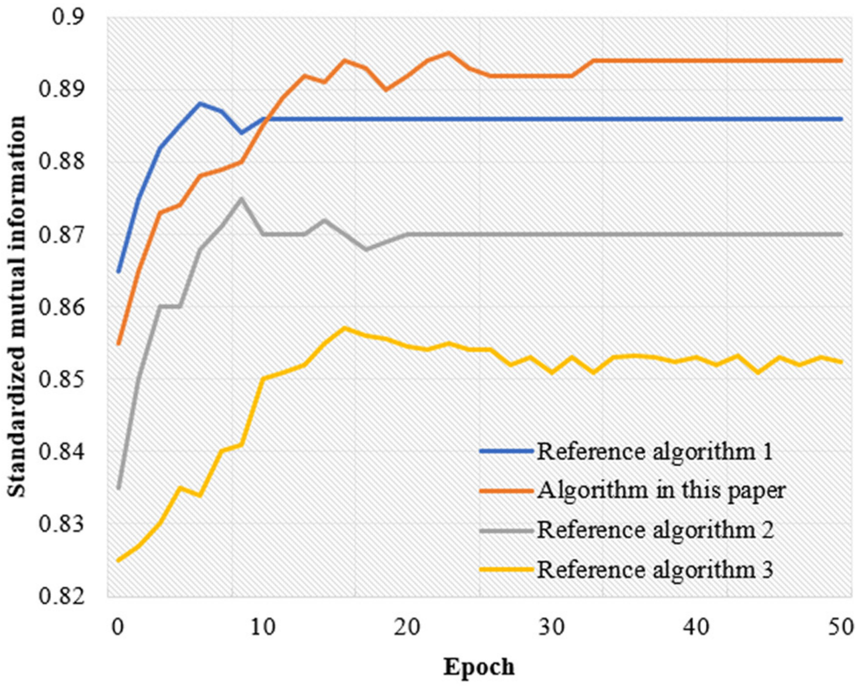


Fig. 4. Convergence of different clustering algorithms

Table 1. Comparison of text generation performance of online teaching case sample set

	Sample Set 1		**Sample Set 2**		**Sample Set 3**	
	View 1	**View 2**	**View 1**	**View 2**	**View 1**	**View 2**
DeepWalk	692	697	1623	1474	3417	2341
DNGR	714	603	1815	1692	4251	4628
SGNS	435	514	1429	1358	3069	2951
Algorithm in this paper	362	581	1302	1075	3847	2047

Table 1 shows the comparison result of text generation performance of different algorithms for online teaching case sample set. As can be seen from the table, compared with all contrast algorithms, *SGNS* algorithm and the algorithm in this paper have achieved better results. The performance improvement of the algorithm in this paper is more obvious on the sample set 2 where the two views are more related. The main reason is that the algorithm in this paper emphasizes learning consistent global text-level subject representation while strengthening the extraction of common features of local sub-view-level representation of online teaching cases. Due to the particularity of sample set 3, the difference in perplexity of *DeepWalk* and the algorithm in this paper is less than 60, so it can be ignored.

After parameter optimization, the clustering performance of different algorithms is evaluated by clustering accuracy rate, recall rate and F1 value. Figure 5 shows the comparison result of clustering performance of different algorithms. It can be seen from the figure that the clustering accuracy of the algorithm in this paper is better than that of other clustering algorithms in the contrast experiment. Figure 6 shows the clustering visualization result of different algorithms. The algorithm in this paper improves the feature representation in the clustering process of online teaching cases. The text structure in the original online teaching case text space is not compact enough and the boundary of class cluster is fuzzy. However, with the increase in the number of iterations, the class cluster information of online teaching case text sample becomes clear gradually until the class cluster shape is compact and dense and the text is clear and separable.

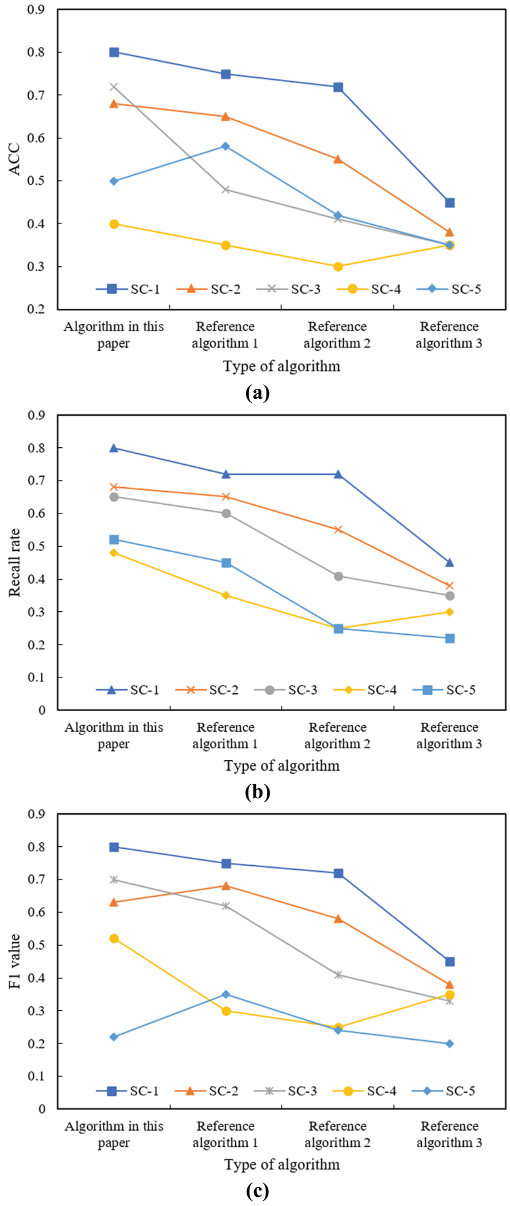
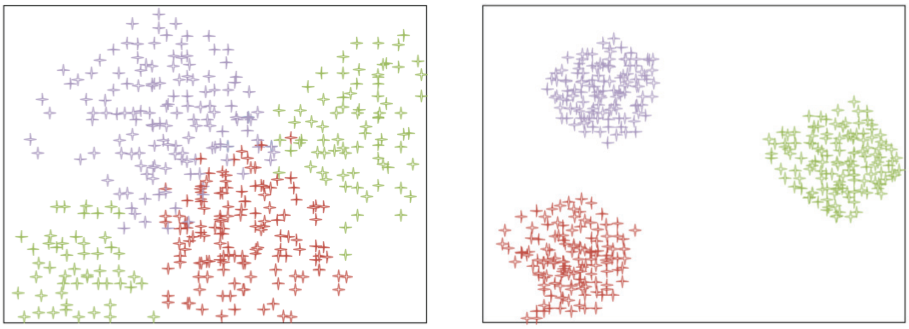


Fig. 5. Comparison of clustering performance of different algorithms



(a) (b)

Fig. 6. Clustering visualization result of the algorithm in this paper

This paper takes concept of introducing teacher's cases, the purpose of introducing cases, the comprehensiveness of cases, the enlightenment of cases, the practicality of cases, the authenticity of cases, the dynamics of teaching process and the subjectivity of students as independent variables, while uses the application effect of online teaching cases after clustering as a dependent variable to carry out multiple linear regression analysis. Table 2 gives a summary of evaluation algorithms. From the table, we can see that the square value of model *R* is 0.836, which means that the above independent variables can explain 83.6% of the change of the application effect of online teaching cases after clustering. Table 3 is the result of variance analysis, showing that the algorithm has passed verification, which indicates that the algorithm is significant to evaluate the teaching results of online teaching cases after teachers use clustering.

Table 2. Summary of evaluation algorithms

R	R^2	Adjustment R^2	Algorithm Error
0.827	0.836	0.751	0.469

Table 3. Result of variance analysis

	Sum of Squares	*df*	Mean Square	*F*	*P* Value
Regression	61.325	7	7.629	36.295	0.014
Residual	24.681	117	0.241		
Total	86.914	162			

Based on the forced regression method, eight independent variables are introduced into the proposed algorithm for overall analysis. Table 4 shows regression coefficients. As can be seen from the table, *VIF* values corresponding to the respective variables are all less than 5, verifying that the proposed algorithm does not exist collinearity problem and autocorrelation problem, there is no correlation between online teaching case samples, and the evaluation effect of the algorithm is good. In conclusion, the concept of introducing teacher's cases, the purpose of introducing cases, the comprehensiveness of cases, the enlightenment of cases, the practicality of cases, the authenticity of cases, the dynamics of teaching process and the subjectivity of students will have a significant positive effect on the application of online teaching cases after clustering.

Table 4. Regression coefficients

	Non-Standardized Coefficient		**Standardized Coefficient**	***r***	***p***	**95%*CI***	***VIF***
	B	**Standard Error**	***Bate***				
Constant	−0.258	0.261	–	−0.947	0.396	−0.625–0.274	–
Concept of introducing teacher's cases	0.162	0.015	0.162	2.635	0.062**	0.063–0.285	1.254
Purpose of introducing cases	0.195	0.096	0.174	2.947	0.029*	0.014–0.327	1.306
Comprehensiveness of cases	0.157	0.035	0.139	2.511	0.017*	0.097–0.275	1.629
Enlightenment of cases	0.136	0.024	0.152	2.385	0.006**	0.029–0.281	1.347
Practicality of cases	0.185	0.017	0.186	2.691	0.037*	0.001–0.257	1.518
Authenticity of cases	0.025	0.082	0.058	1.528	0.214**	−0.036–0.184	1.256
Dynamics of teaching process	0.296	0.067	0.215	3.024	0.026*	0.192–0.327	1.204
Subjectivity of students	0.027	0.031	0.069	0.741	0.419**	−0.029–0.184	1.371

Note: ** and * respectively represent significant parameter estimates at 5% and 10% levels.

6 Conclusion

This paper studies clustering analysis of online teaching cases and evaluation of teaching results. This paper gives the design flow of online teaching with case teaching as the core, proposes a text multi-view clustering algorithm based on case subject alignment, and presents a clustering model structure based on subject alignment. What's more, this paper, based on the grey system theory, compares online classroom teaching results before and after teachers use clustering algorithm to process teaching cases. Finally, the experimental setup is given. Based on the contrast experiment designed for multi-view text clustering, the convergence of different clustering algorithms is shown intuitively. It is verified that when the number of iterations reaches about 30, the algorithm in this paper tends to be stable and the performance index value reaches the optimum. The comparison result of text generation performance of different algorithms for online teaching case sample set is listed, showing that the performance improvement of the algorithm in this paper is more obvious on the sample set 2 where the two views are more related. The comparison result of clustering performance of different algorithms is given. It is verified that the clustering accuracy of the algorithm in this paper is better than that of other clustering algorithms on three sample sets in the contrast experiment. The application effect of post-clustering online teaching cases is used as a dependent variable to carry out a multiple linear regression analysis to verify the effectiveness of the proposed evaluation method of teaching results.

7 References

[1] Hua, S.Y., Ren, Z.W. (2020). "Online + Offline" Course teaching based on case teaching method: A case study of entrepreneurship education course. International Journal of Emerging Technologies in Learning, 15(10): 69–85. https://doi.org/10.3991/ijet.v15i10.13999

[2] Gong, T., Wang, Y., Pu, H., Yin, L., Zhou, M. (2022). Study on the application effect of the case teaching method based on primary teaching principle in clinical teaching of radiology. Computational Intelligence and Neuroscience, 2022: 3448182. https://doi.org/10.1155/2022/3448182

[3] Bai, L., Li, Y., Liu, Z. (2021). An empirical study on the teaching effects of case teaching method in the international finance course under the background of information technology. In 2021 2nd International Conference on Information Science and Education (ICISE-IE), Chongqing, China, pp. 137–140. https://doi.org/10.1109/ICISE-IE53922.2021.00038

[4] Thu, N.T.H. (2020). Communication skills and reflection practice in smart English teaching and learning environment: A case study. International Journal of Emerging Technologies in Learning, 15(17): 221–237. https://doi.org/10.3991/ijet.v15i17.15235

[5] Li, C., Gu, Y. (2020). The application of case teaching method in computer English teaching under OBE mode-taking college English blending teaching of Hetao college as an example. E3S Web of Conferences, 218: 04003. https://doi.org/10.1051/e3sconf/202021804003

[6] López-Belmonte, J., Carmona-Serrano, N., Moreno-Guerrero, A.J., Pozo-Sánchez, S. (2020). Digital teaching competence in the development of the blended learning method. The case of vocational training. In 2020 X International Conference on Virtual Campus (JICV), Tetouan, Morocco, pp. 1–3. https://doi.org/10.1109/JICV51605.2020.9375696

[7] Huang, Z., Zhao, W., Shao, Z., et al. (2020). Entropy weight-logarithmic fuzzy multi-objective programming method for evaluating emergency evacuation in crowded places: A case study of a university teaching building. IEEE Access, 8: 122997–123012. https://doi.org/10.1109/ACCESS.2020.3007139

[8] Baranowski, J., Bauer, W., Grobler-Dębska, K. (2021, October). Internet technologies in academic remote teaching: Case study of numerical methods. In IECON 2021–47th Annual Conference of the IEEE Industrial Electronics Society, Toronto, ON, Canada, pp. 1–6. https://doi.org/10.1109/IECON48115.2021.9589340

[9] Nikolarea, E. (2021). Human intelligence (Hi–Nous) and artificial intelligence (AI) in esp/eap teaching and editing of inter-disciplinary research for international communication. case studies and methods. Journal of Systemics, Cybernetics and Informatics, 19(8): 24–38. https://doi.org/10.54808/JSCI.19.08.24

[10] Yu, J., Song, B. (2021). Application effect observation of case method in microbiology teaching based on online teaching. In 2021 International Conference on Education, Information Management and Service Science (EIMSS), Xi'an, China, pp. 27–30. https://doi.org/10.1109/EIMSS53851.2021.00014

[11] Hua, S., Ren, Z. (2020). "Online+ Offline" course teaching based on case teaching method: A case study of entrepreneurship education course. International Journal of Emerging Technologies in Learning, 15(10): 69–85. https://doi.org/10.3991/ijet.v15i10.13999

[12] Sun, Y. (2020). Application of case teaching method in computer English teaching under OBE mode. In E3S Web of Conferences, 189: 03034. https://doi.org/10.1051/e3sconf/202018903034

[13] Duan, S., Li, P. (2020). Application of scenario simulation and group case discussion teaching method in health law teaching. In 2020 International Symposium on Advances in Informatics, Electronics and Education (ISAIEE), Frankfurt, Germany, pp. 54–56. https://doi.org/10.1109/ISAIEE51769.2020.00020
[14] Leite, P., Gonçalves, J., Teixeira, P., Silva, J.P. (2020). PBL versus traditional teaching method: Case study. In 2020 15th Iberian Conference on Information Systems and Technologies (CISTI), Seville, Spain, pp. 1–3. https://doi.org/10.23919/CISTI49556.2020.9141091
[15] Ouyang, H. (2019). Study on the case-based teaching method in the circuit principle course under emerging engineering education. In Proceedings of the 2019 2nd International Conference on Education Technology Management, Barcelona, Spain, pp. 19–23. https://doi.org/10.1145/3375900.3375901
[16] Xiao, F. (2022). A new research-based case teaching method for an occupational quality curriculum based on moodle. International Journal of Emerging Technologies in Learning, 17(9): 67–82. https://doi.org/10.3991/ijet.v17i09.30929
[17] Wang, Y. (2021). The application of case teaching method in business teaching – research on the teaching mode of enterprise strategic management based on "two subjects+ cases". In 2021 2nd International Conference on Computers, Information Processing and Advanced Education, Ottawa ON Canada, pp. 927–930. https://doi.org/10.1145/3456887.3457107
[18] Song, B., Sun, Y., Guo, J., Zhao, D., Tan, J. (2021). Application of case teaching method and Microteaching method in experimental teaching based on wechat platform. In Proceedings of the 2021 International Conference on Bioinformatics and Intelligent Computing, Harbin, China, pp. 407–411. https://doi.org/10.1145/3448748.3448988
[19] Hao, H. (2021). Application of case based teaching method in computer aided design teaching of art and design. In Journal of Physics: Conference Series, 1744(3): 032095. https://doi.org/10.1088/1742–6596/1744/3/032095
[20] Afify, H.M.N., Alhefnawi, M.A., Istanbouli, M.J., Alsayed, A.H., Elmoghazy, Z.A.A.E. (2021). An evaluation of physical model-making as a teaching method in the architectural design studio – A case study at Imam Abdulrahman Bin Faisal University. Ain Shams Engineering Journal, 12(1): 1123–1132. https://doi.org/10.1016/j.asej.2020.07.002

8 Authors

Shuyuan Bi, graduated from Hebei Normal University with the Master's Degree of Arts in English Language and Literature, and now teaches English for non-English majors in Tangshan Normal University. The main focuses of research are on the teaching of listening and reading and the studies of methodology. Email: bishuyuan@tstc.edu.cn

Wei Liu, graduated from Hebei Normal University with the Master's Degree of Arts in English Language and Literature, and now teaches English for non-English majors in Tangshan Normal University. The main focuses of research are on the academic teaching, teaching techniques and the studies of methodology. Email: liuwei@tstc.edu.cn

Article submitted 2022-11-01. Resubmitted 2022-12-29. Final acceptance 2023-01-04. Final version published as submitted by the authors.