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Humanized Computing for Mass Customization Application in Curriculum Management

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Abstract
Universities may set similar courses due to disciplinary crossing. Facing the problem that undergraduates have numerous tasks and limited time, we designed a mass customization model which will automatically provide every student with a suitable curriculum to maximize their degree of satisfaction when the student enters a set of courses. Our calculating model of curriculum satisfaction is based on the assumptions that curriculum satisfaction is proportional to its similarity and that curriculum satisfaction is inversely proportional to credits. With regard to a student who chooses n courses, his satisfaction model is total degree of satisfaction divided by total credits. We manually screened out 84 pairs of courses about science and engineering, social science and humanities, and made use of their Chinese names and Chinese course description on the site of Office of Educational Administration, and segmented words based on statistical principles and calculated the course similarity by using vector space. In addition, we make supplement to curriculum similarity by the use of artificially-designed questionnaires.

Keywords Mass customization · Curriculum resource · Undergraduate

1 Introduction

Along with development of the times, the society sets a higher demand on talent training of colleges and Chinese citizens become more rational to their needs for higher education. Meanwhile, traditional talent training mode faces challenges due to complex and variable society and increasing personalization of talent demand. With the premise of a relatively large number of students, the most pressing issue about higher education is how to efficiently cultivate talents with diversity and individuality. The thought of "Mass Customization" is a significant method to address the conflict between

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standardization and individualization of higher education training mode. This project attempts to provide students with customized curriculum arrangement service in a standardized training system so as to meet the needs of students, colleges and universities and enterprises.

It is well-known that college students in modern era should be equipped with good socasial interpersonal skills and comprehensive qualities rather than only focus on academic performance. And they should strengthen their self-cultivation through learning, making friends, doing part-time jobs and being highly involved in campus activities. It would be of benefit to the improvement of students' comprehensive qualities during limited time if we can work out a program which can meet their needs for courses and reduce their time cost. This is the starting point of this research project.

From the perspective of colleges and universities, higher educational appropriations were controlled by the government in the traditional planned economic system. Nowadays, tuition revenue accounts for an increasing high proportion after the enrollment expansion of universities from 1999 especially in the stage of higher education popularization. During the period from 1999 to 2004, the share of national fiscal appropriation over total revenue decreased from 54.66% to 39.82% in many universities whose main task is to train practical talents [1]. Increasing dependency on tuition revenue makes colleges and universities attach more importance to educational cost in the stage of higher education popularization.

The society now features disciplinary crossing, knowledge fusion and technology integration. There is no exception of high-tech achievements that is not the result of multidisciplinary intersection and fusion. Under this circumstance, departments may conduct similar courses, for example, both Department of Information Management and School of Information Science and Technology conduct courses about information security [2]. Therefore, it is possible to implement mass curriculum customization because of interdisciplinary.

In addition, enterprises have increasingly high requirements on versatile talents in today's society. Take machinery majors for instance, mechanical graduates take up occupations mainly focusing on secondary industry especially manufacturing. Modern manufacturing industry has a higher requirement on the knowledge and skills of the graduates. Some companies need personnel who are not only equipped with knowledge about electricity and optics but also knowledge about technique and management. For computer majors, they not only need programming skills, but also need to have keen insight into popular areas such as image processing [3, 4] and artificial intelligence. It is necessary to grasp the latest research progress in related research directions. Under this circumstance, learning some interdisciplinary courses in different departments would be beneficial for students to integrate several disciplines and comprehend features of other disciplines which will help them to broaden horizon and acquire comprehensive knowledge.

This project introduced the mass customization in manufacturing system into curriculum system which is certainly a research area extension of mass customization as well as an exploration of system innovation about higher education. For colleges and universities, applying some methods of manufacturing system like mass customization and value engineering contributes to curriculum system optimization and training students who will develop in an all-round way and meet the needs of the society and in turn improve competitiveness of colleges and universities. From another point of view, students can spend more hours in activities that enhance their comprehensive qualities that are beneficial to their future.

In this paper based on some assumptions we will present the satisfaction degree model of a student who chooses n courses. In the first part of the model based on the information from the website of Office of Educational Administration of Peking University, we selected manually similar courses between Division of Science, Division of Information and Engineering, Division of Social Science and Division of Humanities and collected their information. After words segmentation the similarity degrees between courses information were calculated through possible vector space model. In the second part, the courses similarity degrees were further studied through application of artificially-designed questionnaires which made supplement to programmed algorithm. The questionnaires investigated similarity degrees of a pair of similar courses in three aspects including content, degree of difficulty and assessment. The similarity degrees were calculated through the combination of two courses. Integrating the first two parts of the model, we created mass curriculum customization model. For an undergraduate, we assume that the set of courses he wants to choose is {A,B, C,...,}:(1) if there are no similar courses in this set, we will not make recommendation; (2) if there are, we will make curriculum recommendation by providing a better course set {A',B′,C′, …}on the basis of the model.

The literature review of this paper firstly focuses on the previous theoretical and practical research on mass customization. In particular this paper will give a more detailed description on mass customization in educational area. Then this paper will introduce the theories and methods of model building. The final part dwells on the test result of the model and analysis of the result.

2 Literature review

2.1 Relevant research on the concept of mass customization

The thought of Mass Customization was firstly put forward by American futurist Alvin Toffler in his book Future Shock published in 1970 [5]. In this book he brought up with a brand-new production mode assumption that we can offer products and service with specific demand to customers consuming cost and time similar to standardized and mass production. The term Mass Customization was firstly used by Stan Davis in his book Future Perfect in 1987 [6]. Combining the concepts of Mass Production and Customization, Davis thought mass customization can reconcile the contradiction between customization and mass production. In 1993 in Mass Customization: The New Frontier in Business Competition, Joseph Pine II was the first scholar to give a systemic discussion to mass customization and put forward the complete theoretic frame of mass customization which he thought will change the manufacturing industry in twenty-first century [7]. This marks the start of theoretic and practical study of mass customization. After that book, Joseph Pine II published a large number of papers on journals about management, mechanical designing and manufacturing.

Though there are divergences of the concepts of mass customization, they can be divided into two schools. The first is the generalized complete concept of mass customization. The other concept is on a narrow sense which regards mass customization as a system. The former school is represented by Start Davis and B. Joseph Pine II. Davis defined mass customization as a production model which provides every customer with customized products and service through a process of high sensitivity, elasticity and integration in order to meet the needs of customers in the one-of-a-kind manufacturing method without sacrificing scale economy. Wang Qihe thought fundamentally mass customization is actually to offer products and service that can meet individual demands with the efficiency of mass production so as to reconcile the contradiction between personalization and standardization [8]. Many scholars defined mass customization as a system that utilizes information technology, flexible process and organizational structure to provide a wide range of products and service with a cost close to that of mass production to meet the special needs of individual users [9]. We adopt Dan Bin's definition of mass customization here. He thought that as a modern production and management mode, mass customization produces and sells customized products and offers service on the basis of mass production facing a diversified and subdivided market and personalized needs. It helps enterprises gain the economy of scope through providing customized products and service to every custom with high agility, flexibility and integration in the manufacturing process [10].

2.2 Researches on the application of mass customization

At present, many scholars in China and abroad have been researching mass customization in a number of fields, including real estate, hardware, journalism, home furnishing, apparel industry and tourism.

As for the research about mass customization in the field of real estate, Zhu Zhixin thought the main approach of room products mass customization is the modularization of components which means building modularized components and product customization that can be assembled into final products and service. In other words, with an attempt to segment market as far as possible it treats customers with unique personality as a market segment and makes customers change their position from choosing houses after building to initiatively taking part in the design of products before development relying on modern technology, proper customization procedure and the revolution of marketing concepts [11]. On this basis, Zhu Qinghua put forward a proposal that to realize the mass customization in real estate field, a customer-oriented modularization design surface (if customers choose their favorite options from a variety of menus, the system will automatically produce a vivid 3D rendering. If they are not satisfied with it, they can make some modifications.) should be built, the business process should be mended, a thorough supply chain and an efficient information system should be established [12].

In the hardware field, Ye Zhiyuan came up with the idea of utilizing the parameterized function of software to build model for parameterized design of series of hardware and to associate hardware with relevant parameters of products when the model is called. During the change of products, the model can achieve the goal of automatically calling relevant parameter groups from the parameters charts and produce hardware of the right size to adapt to the product so as to ensure the accuracy of the location of corresponding assembling holes. And thus it provides an effective solution for the modeling of hardware for furniture in mass customization. Taking slide screw as an instance, the feasibility of this method was verified by use of software [13].

In the journalism industry, Zhu Youqin studied the mass customization of news based on the NewsML which is a succinct frame standard of news information processing with expandability and flexibility. It inherits these characters of succinctness, expandability and flexibility from XML and is independent from transmission medium. He also established a prototype system of news mass customization on the base of NewsML by applying the advanced technologies of intelligent computing, metadata and multi-dimensional data cube [14].

As for the home furnishing, Lin Hai proposed the method of the mass customization of furniture design, including the design methods for standardized and unitized design of furniture, product-family-oriented furniture design, and furniture modeling design, pluggable design, follow-up design and products allocation. He thought that there are three stages in the furniture design process, successively defining stage of furniture products, designing stage of furniture structure and the stage of furniture design [15]. Proceeding from the concept of mass customization of furniture and being in accordance with the current situation of furniture industry, Li Bing and other scholars researched and analyzed the design method of mass-customization-oriented furniture modularization and hidden essential techniques, such as modular coding, division, connector, allocation and maintenance. They provided a feasible design method for achieving mass customization in furniture industry and efficiently resolved the conflict between the need for furniture mass customization and production manufacturing devices [16].

In tourism, Liu Yuqing thought that the conditions of the implement of the mass customization of service are the modularization of tourist products and service, the building of management database of customers' information and the maximization of market segmentation [17]. The service models include themed and cooperative customization which means tourists participate in the design and adaptive customization of tourist products and service. Formal customization will only change the delivering methods of service and means that providing customers with standard service products in various methods according to their preference and elasticity pricing customization.

Wang Zhihong et al. thought that to achieve the mass customization of garments, they should research the management of supply chains of the mass customization of garments across enterprises on different nodes of the supply chain [18]. On this basis they produced two models of supply chains of garments in these two manufacturing modes. They also analyzed the features of supply chains management for the mass customization of garments, designed and presented the structure of informative system of supply chains management of it. Foreign scholar Nayak established a set of methods in which customers can use the 3-dementional measuring technology to store their body data in computers and producers can use special designing software to tailor customized garments with proper price [19].

Utilizing the Service-Oriented Architecture (SOA), Dietrich made research on the mass customization of footwear industry. They thought the validity of the members' integration of the supply network of mass customization can be improved through the building of SOA informative system. SOA enables commercial network to be presented in the form of science and technology. Through the combination of role model and product model the mass customization based on SOA can be used in order process and other manufacturing processes [20].

In the electronics industry, Partanen reviewed the elements of mass customization used in high-speed production system and on the basis of theories built a model which came from electronic industry and several manufacturing companies based on the fast-growing project entities [21].

Some scholars summed the problems of mass customization up as key techniques and correlative techniques, product development, design and production of mass customization, thought, methods and strategies to achieve mass customization and the management of its implementation [22].

Although current researches cover several fields, they are mainly theoretical expositions and the advantages of mass customization. Moreover, the methods to achieve mass customization are omnibus methodologies without referring to the achievement of specific modeling and techniques. Although the advantages and inevitable trend of mass customization are recognized in every field, the research has not been carried out thoroughly. In some popular areas, such as artificial intelligence [23], the Internet of Things [24, 25] and Computer Vision [26, 27], mass customization models still have great potential.

2.3 Researches of mass customization in education

Scholars also have carried out some research on the mass customization education.

Wang Qihe thought that mass customization education (MCE) is an educational mode which combines schools, teachers, students, clients and environment and makes full use of various educational resources of schools guided by systematic thought and overall optimizing idea. According to the individual needs of clients, it offers customized graduates and service with the support of information technology, standard technology, modular technology and agility talents cultivation technology and with low cost, high quality and high efficiency [28].

The implementation strategy of mass customization for independent colleges including modularization design suggested by Wang Qihe is the foundation of mass customization education. The so-called modularization refers to the process of standardizing products and components to divide mass-customized products into several standard modules and assembling them to produce customized products on the basis of comprehensive analysis of customers' needs. Here are some implementing measures for mass customization education. We need to have a full understanding of current situation, update educational thoughts, build information technological platform, precisely acquire customers' information, optimize strictures, improve the flexibility and agility of the system and establish new evaluation standards for educational quality so as to ensure the healthy development of mass customization education (Strategy and Measures of Mass Customization Education for Independent Colleges) [29]. Sheng Ya also regarded modularized curriculum structure as the foundation of the mass customization of education. He thought that the problem of current mass customization education lies in the research on the modularization of similar education and mainly focuses on the level of higher vocational education and curriculum system. Some colleges implemented modularized teaching methods whose starting point is driven by internal power and which are not in accordance with the real social situation. In other word, they are not driven by external needs and cannot meet the requirements of enterprises. As a result, the research on mass customization in education should be enhanced urgently [30].

Unlike these scholars, Yang Yanan supported mass customization teaching with Learning Analytics. It refers to collecting, analyzing and arranging the data of students to forecast and estimate students' learning and to dig information from learning data and to analyze the relation between them. It also includes calculating effect factors, taking proper intervention measures and value-added assessment (to estimate whether the intervention has effectively positive effect). In his articles, he analyzed the functional model and operating model of Learning Analytics [31].

Wilson put forward a method to realize the set of multi-functional courses for core courses. Mass customization can be achieved by increasing the flexibility of the curriculum, which is mainly completed through three dimensions: flexibility of content, of time arrangement and of courses. And the changes of module form, computer technology and management can improve the flexibility of these three dimensions. The existing technology can atomize the building of modules [32].

Waslander did practice in 17 German junior high schools. The result of data analysis shows that the education provided by these schools is different in six dimensions. In these different models, there are four kinds of distinct schools, namely extremely personalization, extremely non-personalization, and two kinds of medium personalization. The author analyzes the inherent contradiction of the risks of these strategies [33].

Schuwer raised a question: how to use the open educational resources to achieve a reasonable quality and expenditure. It can be achieved by imitating the industrial science and technology, namely setting the starting point integrated the terminal products with customer's demand, to make the course equipped with open and closed materials, and learning services provided by institutions. And the current IT support is the necessary material of this learning model [34]. Phillips thought that open and distance education provides new chances for transmission of educational resources and the resources of the supporters for schools. They discussed the evaluation and transmission of this resource. XML technology and reusable teaching materials are used to promote automatic transmission of online induction training [35].

In conclusion, more and more schools realized that in order to improve the students' satisfaction degree and provide more suitable talents for enterprises, mass customization education is the trend. The solutions proposed by domestic scholars are mainly that achieving the mass customization through the form of curriculum modularization. However, the solution of Yang Yanan is to use data analysis to infer marketing factors and propose intervention measures. Foreign scholars mainly focus on computer and networking. They thought that open educational resources and the mode of distance education can meet the needs of mass customization education. Solution of Wilson can be applied to offline schools. And the idea that the computer can automatically generate the modularized curriculum structure is a key reference for us. As for the mass customization of education, foreign scholars haven't put forward an appropriate solution yet.

3 Modeling

Here the model for courses satisfaction is summarized as follows. For each user, when a certain courses set is input, he can obtain the courses set with the highest satisfaction degree. Here, we adopt a less rigorous assumption: Curriculum satisfaction is proportional to curriculum similarity.

For instance, if the similarity degree between course A and B were 80%, then the students' satisfaction degree of selecting course B rather than course A would be 80%.In this way, we assume users' satisfaction degree of selecting courses they want is 100%, the satisfaction degree of the rest courses will be calculated by courses similarity. To simplify the model, we will only take the similarity of pair courses into consideration.

However, we found that the way to decide on replacing courses or not only by considering the level of the similarity is not comprehensive. Without considering the costs, it is apparent that selecting all the courses is the most satisfactory situation for the users (students). However, for each course, the more similar its content with other courses and more credit it holds, the higher cost it is and lower satisfaction it keeps. Therefore, we use the course credit as a replacement cost for courses. Courses satisfaction degree is in inverse proportion to the credits.

For a student who selects n courses, his satisfaction degree model will be as follows:

$$\frac{\sum_{i=1}^{n} I(Xi)Satisfaction(Xi)}{\sum_{i=1}^{n} I(Xi)Credits(Xi)} \quad (1)$$

Among them, when one chooses course Xi, I (Xi) equals to 1; While I (Xi) equals to 0 when one doesn't choose it. $I(Xi)=\begin{cases}1, & Xi\ is\ chosen\\ 0, & Xi\ is\ not\ chosen\end{cases}$. Thus, for a given set of input courses, we will transform this question into finding the maximum of above formula by using the model.

Here is the simplest example of the above model: the user (student) wants to select the 3-credit-course A, while there is a course B keeps 80% similarity with course A. There are three options for the user to select course (A, B), (here neglecting the case that selecting neither of them): (1) (1,1) refers to selecting course A and B at the same time;(2)(0,1) means selecting course B;(3)(1,0) represents selecting A. Calculating in accordance with the above model, the option with the highest satisfaction degree is (0,1), namely selecting course B. As can be seen if course A keeps high similarity with course B while the credit of the former is less than the later, the student will be more satisfied with selecting course A, which is in line with the Thinking Paradigm of student courses selecting in the daily life. Again, let's make another assumption: Students can only select one relatively course per semester.

Taking into account that both credit and satisfaction degree are non-negative, formula (1),therefore, can actually be transformed into the situation that the course with higher *Satisfaction*(*Xi*)/*Credits*(*Xi*) value is recommended for a similar courses pair.

3.1 Calculation method for courses similarity degree

Considering that courses within the same category enjoy high similarity and convenience to select, we divide all departments of Peking University into three categories according to the information on the website of Peking University Office of Educational Administration:(1) Science and Engineering;(2) Social Sciences;(3)Humanities. In the three categories, we artificially found out 40 pairs of science and engineering, 33 pairs of social sciences and 11 pairs of humanities similar courses respectively, among which a few similar courses are interdisciplinary. For each pair of similar courses, we calculate the similarity degree of courses based on Chinese courses names and Chinese courses description provided on the website of the Office of Educational Administration.

3.1.1 Information collection

In the process of information collection, we utilized the information on the website of the Peking University Office of Educational Administration. According to the courses information, we artificially selected 40 pairs of science and engineering courses, 33 pairs social sciences courses and 11 pairs of humanities similar courses and collected down the course information (course name and course description). For the convenience of data processing, different courses pairs were segmented by "$$", different courses in courses pairs were segmented by "$$$", and course name and course description were segmented by "$$". All the newline characters were replaced by spaces characters and all the above information was stored files with utf-8 encoding format.

The dictionary we used is Sogou common word dictionary [36], which provides gbk coding for each word as well as the frequency of the statistics of Sogou Laboratory.

3.1.2 Word segmentation

Compared with the English word segmentation, the problem computers has to face is the Chinese word segmentation when processing Chinese text. English words are segmented with space, while Chinese words are different. Therefore, the first step of processing Chinese natural language is to solve the problem of Chinese word segmentation, among which, the Maximum Matching Algorithm is a relatively easier one. For example, "XX class is very interesting" can be segmented into "XX/class/is/very/interesting" very well in Chinese. But when facing some ambiguous sentences, the Maximum Matching Algorithm will be hard up. So "Nanjing Yangtze River Bridge" will be segmented as "Nanjing/Mayor/River/Bridge" rather than "Nanjing/Yangtze/River/Bridge" in Chinese way.

Due to all kinds of deficiencies of Chinese word segmentation program based on the Maximum Matching Algorithm, here we chose the word segmentation based on the statistical theory. For a Chinese strings, if one can use the words $s_1s_2\ldots s_n$to represent one of the ways of word segmentation of the string, then the larger $P(s_1s_2\ldots s_n)$ is, the more conformed the word segmentation program is to people's common usage. That is to transform the segmentation task into finding $P(s_1s_2\ldots s_n)$MAX. According to the joint probability, the formula (2) is as follow.

$$P(s_1s_2\ldots s_n) = P(s_1)\prod_{i=2}^{n} P(s_i|s_1\ldots s_{i-1}) \tag{2}$$

Here please allow us to make a less rigorous (Sometimes even failed) assumption, each word appears being independent from one another.

Namely when $s_1s_2\ldots s_n$is independently, formula (2) can be transformed into:

$$P(s_1s_2\ldots s_n) = \prod_{i=1}^{n} P(s_i) \tag{3}$$

In this case, word segmentation problem will be transformed into finding the maxima of formula (3) and we will adopt the method of dynamic programming to solve the problem.

As for string s with the lengths of n, $s[a:b]$ indicates the words from Sa + 1 to Sb + 1. If $p[i]$ indicates the optimal solution for $[i:n-1]$, namely finding the maxima of formula (3), then here are the initial state:

$$p[0:n{-}1] = 0 \; p[n] = 1 \tag{4}$$

And the state transition equation:

$$p[i] = \max_{1\ll j\ll n-i} freq(s[i:i+j{-}1]) + p[i+j] \tag{5}$$

Among which, $freq(s[i:i+j-1])$ represents the frequency of words $s[i:i+j-1]$ in the dictionary.

3.1.3 Similarity calculation

We utilize the vector space model to calculate the similarity degree among course information, and here is a brief introduction to vector space model:

1) Two text stream to be compared:

A:. Weather is nice.
B:. Weather is good.

2) Word segmentation:

A:. Weather/is/nice
B:. Weather/is/good

3) Duplication deletion and all words listing: Weather/is/nice/good
4) Word frequency vector generation: $\overrightarrow{A}$ =(1,1,1,0) $\overrightarrow{B}$ =(1,1,0,1)
5) Calculation: $sim(\mathrm{A},\mathrm{B})=\cos\left(\overrightarrow{A},\overrightarrow{B}\right)=\frac{\overrightarrow{A}*\overrightarrow{B}}{\left|\overrightarrow{A}\right|*\left|\overrightarrow{B}\right|}$ =2/3

After word segmentation, you can calculate the word frequency vector for the two texts and the Dot Product of word frequency vector. For each pair of similar courses, we calculate the similarity degree among course names and course descriptions respectively, then averaged them. According to the vector space model, the closer course name and course description is to 1, the higher the courses similarity degree will be.

3.2 Questionnaire calculation method for courses similarity

In order to fully study the similarity degree of the selected courses, we artificially designed a questionnaire to research on the curriculum similarity one step further, becoming a supplement to the program algorithm. In order to get an easier expression, we called the similarity degree calculated through program code the "machine calculation similarity ", and called the similarity degree calculated through questionnaire the "artificial calculation similarity".

The respondents of the questionnaire were teachers and students (including but not limited to teachers and students at Peking University) who had simultaneously selected or audited two similar courses, or teachers or teaching assistants who had some basic knowledge about two courses of Peking University. Questionnaire used the Likert scale (Ranges from 0.0 to 1.0, among which, 0.0 means totally different while 1.0 means exactly the same), which inspected the similarity degree of the two courses in terms with the content, difficulty and assessment the respondents had thought of. The three weighted by the proportion of 6:3:1.

Generally, it is assumed that the courses data set ϕ has ξ pairs of similar courses, and each pair of similar courses denoted as (ci1, ci2)(i = 1,2, …, ξ;similarly hereinafter). For courses pairs(c_{i1}, c_{i2}), we find n_i respondents. Suppose that the respondent $m_{ij}(j=1,2,\dots,n_i)$ considered the content similarity of courses pair (c_{i1}, c_{i2}) is$s_{m_{ij}_content}$, difficulty similarity $s_{m_{ij}\_difficulty}$, test similarity$s_{m_{ij}_test}$, then the artificial calculation similarity of the courses pair (c_{i1}, c_{i2}) issim_man_i:

$$sim\_man_i=\frac{1}{n_i}\sum_{j=1}^{n_i}s_{m_{ij}\_content}w_{content}+s_{m_{ij}\_difficulty}w_{difficulty}+s_{m_{ij}\_test}w_{test}\quad w_{content}=0.6\ w_{difficulty}=0.3\ w_{test}=0.1 \tag{6}$$

Suppose the result of "machine calculation similarity" for courses pair(c_{i1}, c_{i2}) is sim_mac_i, then the total similarity degree sim_i for courses pair(c_{i1}, c_{i2}) is:

$$sim_i=(n_{max}-n_i+1)sim_{mac\,i}+sim_{man\,i}\ln(n_i+1) \tag{7}$$

The natural logarithm factor was introduced in sim_i calculation, the purpose of which was to control the reliability of "artificial calculation similarity". When the number of respondents n_i of a certain courses pair is very small, the sim_man_i item will be controlled within a small range of absolute value, and play a multiple role; When $n_i > e \approx 2.7 > 2$, its value can play a role of being equal to or more than 100%. In particular, when a certain courses pair failed to find the corresponding respondents (n_i = 0), $sim\_man_i = 0$; when $n_i = n_{max}$, sim_mac_i can only play the role of 100%. In order to make sim_i still falls into the range of [0,1], here, the author will use linear formula to exercise the normalization processing towards sim_i, that is:

$$sim_i`=\frac{sim_i}{sim_{i-max}} \tag{8}$$

In this formula, sim_{i-max} represents the maximum of sim_i through calculation.

3.3 Limitations of model calculations

Limitations of this model view from the four angles below.

1) Unigram Model

Here we referenced the unigram model (the context is independent from models) in word segmentation, which is the simplest and easiest Natural Language Processing Model to implement. But the assumption that the model utilized is to be considered: each word is independent from each other. As a matter of fact, the semantic association between languages is very common. Therefore, there are still some defects of the word segmentation algorithm, besides, the calculation accuracy is not high. Although utilization value of this algorithm model is not actually ideal, we use it here concerning that there are many ready corpus available for this model, for instance, the statistics of input methods. As it has advantages and easy to implement, we utilized this method for modeling. For further improving the model in the following, we consider the use utilizing 2-g model to better modeling.

2) Corpus

According to word segmentation algorithm of probability model, detailed vocabulary of dictionary (corpus) determines the quality of the word segmentation in large measure. We have chosen to utilize the common word dictionary with Sogou input method, so a part of the words may still not be included in the dictionary. Given that there are a lot of specialized vocabulary in the courses of institutes of higher learning, take the course of Modular Forms in School of Mathematical Sciences for example, there may be errors in word segmentation. Therefore, if have chance in future, we may use texts with more specialized vocabulary such as the scientific literature, popular science books and others to make the corpus training. Only by doing so can such statistics for text corpus be closer to the text for course description.

In addition, this model did not include the stop-word list. Therefore, the problems such as synonymy and near synonymy had not taken into consideration, resulting in a certain amount of inaccuracies in the frequency statistics.

3) Vector Space Model

During the survey, we found that the texts of course description on the website of the Office of Education and Administration at Peking University were generally shorter (no more than 200 words). Thus, we could avoid excessive vector dimension to some extent by utilizing the vector space model. Because there were generally higher extent disparities among the documents (courses description), and we didn't compare multiple courses introduction, so here we did not calculate the words idf (inverse document frequency). Vector space also adopted the assumption that the words were independent from one another statistically, and the defects of the assumption also have been mentioned in unigram model. There were some problems in the vector space model, such as false positive and false negative match, failed to express the word order, etc., which are to be perfected by the extension of natural language processing algorithm.

4) Courses Satisfaction Calculation

It is here measured the cost with credits mainly on account of the easy accessibility of data. In fact, the cost of the courses on the one hand came from the academic hours, on the one hand the difficulty of the courses themselves. If courses difficulty and credits were jointly to estimate cost, the result could be more ideal. What's more, the author's model is still in a relatively primitive stage, so linear calculation was utilized solely here to consider the cost, the validity of which remains to be determined.

4 Results and discussion

4.1 Courses similarity calculation results

According to the model built in the third part of this paper, we calculated the similarity degree of the courses collected, as shown in the following figures.

Figure 1 represents the calculation results of the courses in the Social Sciences category. Figure 2 represents the calculation results of the courses in the Science and Engineering category. Figure 3 represents the calculation results of the courses in the Humanities category.

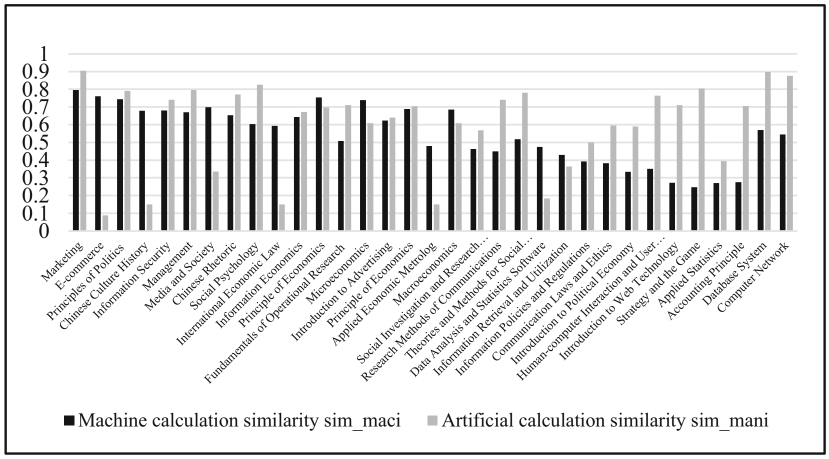
4.2 Simulation results for curriculum resources mass customization

According to the algorithm model and similarity calculation results above, we simulated three courses selection process, so as to better illustrate the application of the model.

1) **Student A in College of Environmental Sciences and Engineering**

The original courses set.
Course Number: 12733010.
Course Name: Environmental Chemistry.
Academy: College of Environmental Science and Engineering.
Credits: 3.
Satisfaction Degree: 0.333.
Course Number: 12734010.
Course Name: Engineering Drawing.
Academy: College of Environmental Science and Engineering.
Credits: 3.
Satisfaction Degree: 0.333.
Recommended courses set.
Course Number: 1034630.
Course Name: Environmental Chemistry.
Academy: College of Chemistry and Molecular Engineering.
Credits: 2.
Satisfaction Degree: 0.467.
Course Number: 12733010.
Course Name: Environmental Chemistry.
Academy: College of Environmental Science and Engineering.

Fig. 1 Calculation results of courses pair similarity - Social Sciences



Credits: 3.

Satisfaction Degree: 0.333.

It can be concluded that, student A in College of Environmental Science and Engineering should have chosen two courses of "Environmental Chemistry" and "Engineering Drawing" in his own academy, according to the university's educational programs. However, our model recommended him the "Environmental Chemistry" course in College of Chemistry and Molecular Engineering with fewer credits, which improved his satisfaction degree towards this course. There were two similar Engineering Drawing courses. However, we still recommend the original course after calculating satisfaction degree and cost ratio by this model because the original one was more appropriate.

2) **Student B in Guanghua School of Management**

The original courses set.

Course Number: 2830170.

Course Name: E-commerce.

Academy: Guanghua School of Management.

Credits: 3.

Satisfaction Degree: 0.333.

Course Number: 2532260.

Course Name: Information Economics.

Academy: Guanghua School of Management.

Credits: 3.

Satisfaction Degree: 0.333.

Course Number: 2838160.

Course Name: Data Analysis and Statistics Software.

Academy: Guanghua School of Management.

Credits: 2.

Satisfaction Degree: 0.5.

Recommended courses set.

Course number: 3032230.

Course Name: E-commerce.

Credits: 2.

Academy: Department of Information Management.

Satisfaction Degree: 0.488.

Course Number: 3030720.

Course Name: Information Economics.

Credits: 2.

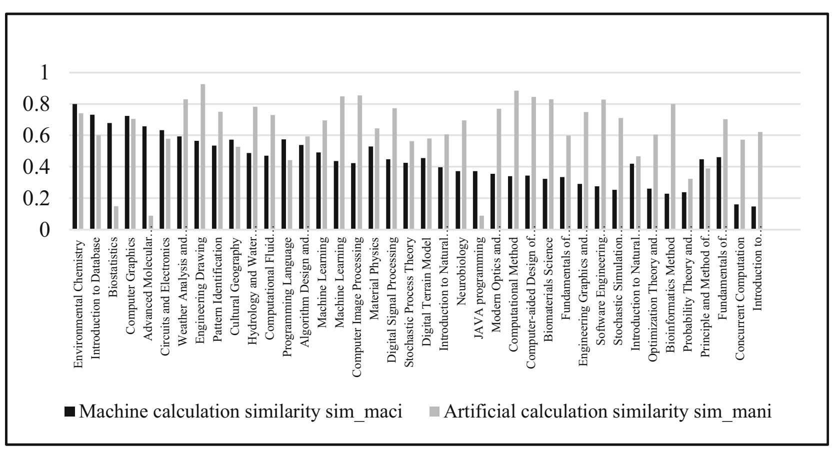
Academy: Department of Information Management.

Satisfaction Degree: 0.355.

Course Number: 2838160.

Course Name: Data Analysis and Statistics Software.

Fig. 2 Calculation results of courses pair similarity - Science and Engineering



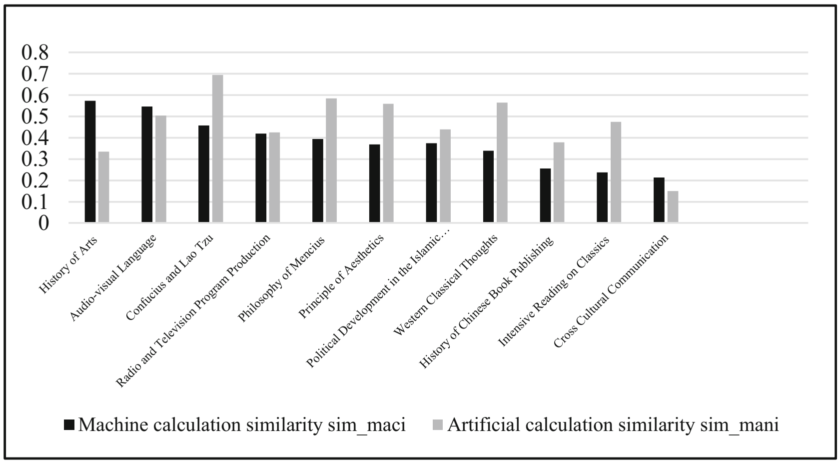


Fig. 3 Calculation results of courses pair similarity – Humanities

Academy: Guanghua School of Management.
Credits: 2.
Satisfaction Degree: 0.5.

Student B in Guanghua School of Management has similar courses pair for three courses. It can be seen from the result that, model calculation recommended the courses of Department of Information Management, which has a lot of similar courses compared with Guanghua School of Management. Considering their high similarity degree and lower credits, it was a nice choice to treat them as elective courses.

3) **Student C in School of Arts**

The original courses set.
Course Number: 4332710.
Course Name: History of Western Arts.
Academy: School of Arts.
Credits: 2.
Satisfaction Degree: 0.5.
Course Number: 4331541.
Course Name: Principle of Aesthetics.
Academy: School of Arts.
Credits: 2.
Satisfaction Degree: 0.5.
Course Number: 4331821.
Course Name: Film and Television Program Planning.
Academy: School of Arts.
Credits: 2.
Satisfaction Degree: 0.5.
Course Number: 4331792.
Course Name: Audio-visual Language.
Academy: School of Arts.
Credits: 2.
Satisfaction Degree: 0.5.
Recommended courses set.
Course Number: 4332710.
Course Name: History of Western Arts.
Academy: School of Arts.
Credits: 2.
Satisfaction Degree: 0.5.
Course Number: 4331541.
Course Name: Principle of Aesthetics.
Academy: School of Arts.
Credits: 2.
Satisfaction Degree: 0.5.
Course Number: 4331821.
Course Name: Film and Television Program Planning.
Academy: School of Arts.
Credits: 2.
Satisfaction Degree: 0.5.
Course Number: 4331792.
Course Name: Audio-visual Language (Film Language).
Academy: School of Arts.
Credits: 2.
Satisfaction Degree: 0.5.

It can be seen that, recommended courses has no changes because of low courses credits themselves, less similar courses and fewer related courses with other academies in School of Arts.

For each user, when a certain courses set is input, calculation model for courses satisfaction output the courses set with highest satisfaction degree. Based on the two assumptions that courses satisfaction is proportional to curriculum similarity and courses satisfaction degree is in inverse proportion to the credits, for a student who chooses n courses, the satisfaction degree model for him is calculated as:

$$\frac{\sum_{i=1}^{n} I(Xi)Satisfaction(Xi)}{\sum_{i=1}^{n} I(Xi)Credits(Xi)} \tag{9}$$

When one chooses course Xi, I(Xi) equals to 1; while I(Xi) equals to 0 when one don't choose it.

$$I(Xi) = \begin{cases} 1 & \text{Choose class } Xi \\ 0 & \text{Do not choose calss } Xi \end{cases} \quad (10)$$

For a given input courses set, we converted it into a maximum value problem through the above model. In the word segmentation, we proposed the model based on statistics by referring to unigram. Therefore, the task of word segmentation was transferred into finding the maximum value. We used the dynamic programming method to solve the problem. After word segmentation, two document word frequency vector and the scalar product of it were calculated according to the vector space model. For each pair of similar courses, we calculated the similarity degree of the course names and course description respectively and averaged the two. In order to compensate for the defects of the machine, we have carried out a questionnaire survey on the teachers and teaching assistants who have some basic knowledge about the two similar courses. Questionnaire used the Likert scale, which inspected the similarity degree of the two courses in terms with the content, difficulty and assessment the respondents had thought of. The three weighted by the proportion of 6:3:1.

The word segmentation method we used had referred to the unigram model, but the assumptions it had made was to be considered. To further improve the model, we considered using the 2-g model to better modeling. The common word dictionary with Sogou input method we have chosen is deficient somewhat in terms of terminology, and the document similarity of the dictionary and course description is not high. In addition, there was no stop-word list in this model, so the natural language processing such as synonyms and near synonyms were not considered. In the use of vector space model, as the text similarity was not high in multicourse description texts, we did not calculate the inverse document frequency of words. At the same time, the cost of the course was too simple, for we only considered the issue of the credits. Therefore, its validity is to be discussed. All these problems will become the important direction for future improvement and resolution.

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