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Elective Subject Selection Recommender System

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Abstract— Performance of student is dependent on their subject select and faculty's expertise who teach the subject. Sometimes subject selection done by the student. Few students' select subject wisely, few of them select because of friend influence, faculty influence, without thinking on it. To reduce the cost and related overhead department tries to reduce the variety of elective. Wisely selected and offered subject will increase the performance of student and throughput of the faculty. In this paper a recommender system is proposed which find the score of knowledge level for student and score of faculty score. These scores will be used to recommend the right subject to adept faculty of that subject.

Keywords- Subject recommender system, student performance prediction, educational data mining, faculty expertise predictor, performer or underperformer

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I. INTRODUCTION

Number of researches conducted in educational data mining to predict the performance of student. In this sequence, this paper discusses the problem of subject selection and a recommendation system which may help student and faculty to find right subject selection.

Subject selection for a student is arduous. At the time of choosing one option out of many S/he always feel himself/herself at square. Everyone suggest any one option from available choices on their belief, perception and experience. Student move here and there, from one point to another, to get right selection of subject.

In the above scenario, student always look to those persons who are adept in providing right subject selection. Most of the time, these persons suggest on the basis of general perception not on student personal expertise level. Even a faculty or department also thinks about what subject should be circulated among the student. Answer of this subject process is always mysterious. Student, who are looking for some conclusion, have ambiguities and uncertainties. This causes significant anxiety. Even after subject selection they think about "Is his/her decision right?

Is it possible to build a method for subject recommendation which can suggest a student that what could be right subject?

Recommender system enhance the teaching and learning, recommend good solution, analyze data and offer data to modify activity plan[6][7][8][9]. In the last few years recommendation system provided valuable solution in opting one choice out of available many choices by focusing on logical relationship. So people may behave intelligently who feel weak while choosing sticking with chose decision.

Proposed recommender system will focus on student assessment do in the past course. For faculty this recommender system uses his/her assessment at college level and post education their engagement in the subject field. Student assessments are traditional method to predict student performance such as failing or passing or forecasting successful completion of the course, in this continuation predicting the classification of degree or achievement.

Data mining in last few years extracted a lot of information from student data. This information's helped in handling of student and increase students expertise level.

In this paper proposed method will offer student to select most suitable subject for opting the elective subject as well as faculties get assigned tight subject. Once, both of them in right subject then overall learning will be at highest. As well as both select subject wisely rather than blindly.

II. LITERATURE REVIEW

Mori M and Chan P K [1] in their paper used single decision tree, single decision tree with rule pruning, random forest and random forest with k-fold cross validation fro predicting student performance in final exam. They studied 110 students and identified feature then applied machine learning algorithm for finding correlation among behavioral feature and performance and identified important behavior.

Bhatnagar S and Desmarais M [2] used DALITE instruction tool to generate data from educational process. This data is used to determine uncertainty, about the concept by predicting word selection and outcomes in end of semester. They were interested in when student switch from right to wrong and vice versa, effect of teacher, student at risk and student failure factor.

Ren Z. et.al. [3] developed a real time model which tracks the participation of student to predict students future performance using multi-regression models.

Labarthe H et.al. [4] tried to understand and reduce the attrition rate in student during massive open online courses (MOOCs) by providing recommendation system. They evaluated respondents on four categories i.e. attendance, completion, success and participation. At the end they concluded that student were more engaged when they received recommendation.

Bydžovská H [5] presented a course enrollment recommender system to recommend curses which are beneficial for student.

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In a research organized by Kaser T, Koedinger K R and Gross M expressed that intelligent tutoring system build model to predict student knowledge. For this parameter fitting and contained information how students learn are important factor. Various techniques used for student modeling like Bayesian Knowledge Tracing (BKT) [14], Bayesian networks [11, 15, 16], performance factors analysis [17] and Additive Factors Models (AFM) [12, 13]. They extensively evaluated properties and parameters of logistic regression and discussed that "despite the different fit, prediction accuracy of regression model is very similar.

Segal A et al. proposed a new algorithm for personalizing educational content to students that combines collaborative filtering algorithms with social choice theory." Their approach "approach can potentially be used to support both teachers and students, by automatically tailoring problem sets or exams to the abilities of individual students in the classroom, or by informing students about topics which they need to strengthen."

Frieze A M and Yadegar J [19] discussed 3 dimensional assignment problem for scheduling a tutor to a class. Poore A B and Rijavec N [20] discussed three algorithm i.e. Lagrangian Relaxation algorithm, Greedy algorithm and branch and bound algorithm for handling three dimensional assignment problem. They concluded that Lagarangian Relaxation algorithm is best.

Pandey U K and Pal S [21] developed a model to find adept teacher using latent variable. Their model is based on student feedback and predicts that what kind of characteristic a faculty has. If the faculty's assigned in their strong zone on the identified characteristic then their performance will better.

III. MOTIVATION

In higher education institution (HEI) of India all university and colleges are centrally monitored by University Grant Commission. Time to time this apex body provide recommendation for all HEI. Universities are autonomous body and have their own syllabus whereas colleges follow syllabus of university from which they are affiliated. Recently UGC recommended to adopt CBCS pattern for HEI so that students can select subject of their interest.

In state Chhattisgarh of India, Universities started adopting CBCS course pattern. MATS University Raipur adopted CBCS pattern in session 2015-16. It is mandatory for all students to complete duties defined for completion of semester. In every semester students get option of elective subject. The process of selecting one elective out of available elective choice is hard for students. Most of the time selection is based on most selected subject, friend group, favorite faculty, social behavior etc.

This subject selection significantly impact on their study progress and final result.

IV. PROPOSED RECOMMENDER SYSTEM

Core idea behind this recommender system is based on student's expertise in all those subjects which constitute the elective subject and faculties' expertise in elective subject.

Subjects can be classified into two categories on the basis of constituent subject i.e. Starter subject and Derived subject. Starter subject do not need any previous knowledge of that field or subject offer basic knowledge to start the course. These subjects content provide basic concept of the subject, and will help in later semester. Derived subject includes higher level of knowledge and rather than providing basic knowledge their content is based on some other subjects which constitute the derived subject content.

In the figure 1 three sets i.e. subject S, elective T and faculty F is shown using network diagram. In the figure subject is represented with S1, S2, S3……….Sn, here n represent that number of subject which will be used to constitute m number of elective (T1, T2……Tm). T1 elective is constituted using subject S1, S2 and Sn, whereas Elective Tm is constituted using S3 and Sm. Elective subject is any subset of subject set S= {S1, S2, S3……Sn). Faculty set F contains the list of faculty who are able to teach the elective. Every faculty has different expertise level for each elective. Faculty's expertise in respective elective will be dependent on number of factors i.e. number of hour's particular subject, which constitute the elective, taught; teaching ability, research paper published in the field of elective etc. While assigning the class, faculty expertise must be consider to get highest productivity by increasing the learning skill.

Proposed recommender model is used to provide right subject for student and most appropriate faculty
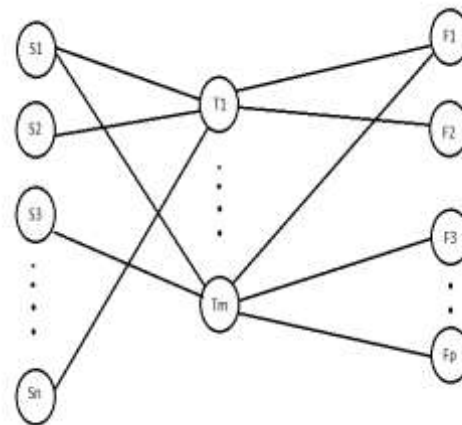

Figure 1: Network diagram of the subject selection

Data Structure: Proposed recommender model requires various data table to store and summarize the data obtained from students and faculties. Some of them are data cube architecture thus it is mandatory to use schema of data warehouse. These data tables are

- **Student record:** The data table as shown in figure 2 has three dimensions i.e. Student, Elective and Subject (which constitute the elective subject). Student dimension shows the list of student who are willing to study the offered elective subject. Elective dimension shows the name of electives offered to the group of student. Subject dimension shows the name of all subjects which constitute any offered elective relevant for group of student. Cells (intersection of all three dimensions is termed as cell) will hold the marks obtained by student in respective subject. These obtained marks will be used for the purpose of finding the score of student in respective elective.
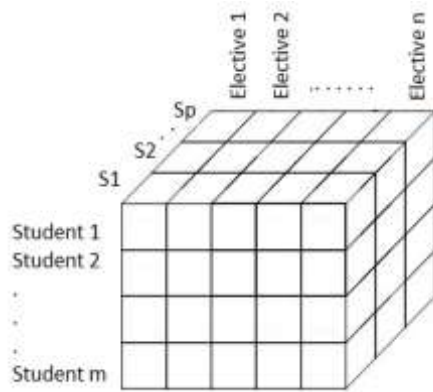
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Figure 2: Data cube architecture of Student for each elective and score obtained in studied subject relevant to elective

- **Elective subject detail:** The data table shown in figure 3 shows the weight of subject in offered elective. Total of weight of one elective must be sum of subject's weight which constitutes the elective. The sum of weight. As shown in figure 3 Elective 1 is constituted using 3 subjects S1, S2 and S3 and their respective weights are 0.3, 0.4 and 0.3. The weight of these subjects are assigned by the curriculum designer and verified by elective subject specialist. Once the weight is finalized it is stored in the database as shown in figure 3. This weight table is used to prepare the student score in respective elective.

Elective 1	Subject	Weight
E1	S1	0.3
E1	S2	0.4
E2	S2	0.25
E1	S3	0.3
.	.	.
.	.	.
.	.	.
.	.	.
.	.	.
.	.	.

Figure 3: Weight of subject in each subject for specific elective

- **Student elective score:** The data table shown in the figure 3 stores the total score for each elective of every student. To find the score of elective following formula will be used

$$Elective\ score = \sum_{i=0}^{n} S_i * W_i \qquad (1)$$

Where i indicate subject number
S_i indicate obtained score percentage in the ith subject
W_i indicate weight of ith subject in curriculum

Using this formula score of each elective is calculated. Value of S_i is obtained from the data table shown in figure 2 and weight of each subject W_i is obtained from data table shown in figure 3. After multiplying

subject percentage score with respective weight value of each subject which constitute the elective curriculum, sum all of them. This data table is used to recommend the most suitable elective subject for the student.

Student	Elective I	Elective II	....
1			
2			
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Figure 4: Students efficiency in each elective

- **Faculty record:** Another important factor is faculty who play a vital role in performance of student. Faculty's knowledge base in subject/elective, demonstration skill, higher end knowledge in terms of research publication etc will play effective role in deciding faculty's expertise. A 3 dimensional data cube is shown in figure 5 is used to store all relevant scores to find the effectiveness of faculty in any elective. This data cube has three dimension to store faculty list (Faculty 1, Faculty 2…….), elective subject (Elective 1, Elective 2….) and factors (S1, S2…….) affecting the expertise of the faculty's in elective.
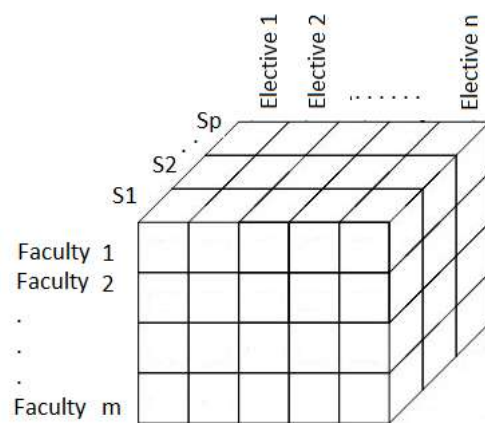

Figure 5: data cube architecture for faculty and His/her expertise in each subject for specific elective

Factors which define expertise of faculty will include following points.

➢ Teaching ability of faculty: Teaching ability of a faculty will vary from one subject to another subject depending on the knowledge in the respective subject. But the way of representation, explanation, communication skill, students' belief etc. are personal feature of faculty. S/he uses this skill for any subject

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whether s/he studied earlier or teaching first time. Finding the teaching ability of a faculty feedback collected from student by providing questionnaire. This questionnaire may be direct question or indirect question which contains question covering all characteristic of teaching ability. The total ability is stored on 10 point scale.

➢ Score in Subject studied by faculty: Newly recruited faculties do not have any teaching experience of subject. In this case student obtained score in respective subject at the time of study will be used to identify the skill level in the elective subject. But with the time this knowledge deteriorates if faculty is not in touch with the subject. This deterioration is similar to depreciation in any product. Score in subject is calculate using following formula

$$Score = Obtained\ marks * \frac{(10-(current\ year-studied\ year))}{100} \qquad (2)$$

Here, current year is the year for which score is calculated, studied year is the year in which faculty studied this subject first time, obtained marks is score in percentage of respective subject, score is final score stored for respective subject and 10 is point scale. This formula is used to find the score of every subject as well as elective.

➢ Number of hours, subject taught which constitute the elective or, elective subject: Faculties get new insight of the subject by teaching it. Teaching multiple times a single subject enriches the knowledge level of faculty. Thus teaching experience is used to find the faculties expertise.

➢ Research paper published/ Article writing: Faculties vindication is established by their demonstration of knowledge in terms of research paper and article writing in public domain. Research paper and article give faculty to think in new dimension of the subject as well as they show up gradation of faculties' knowledge.

➢ Number of columns in which score is more than zero: It could be possible that a faculty will make score in only one factor whereas other factor has get less importance in finding the faculties expertise. Thus number of columns in which faculty score more than '0' will be considered as bonus point. Here 0 indicates that faculty had exposure in that factor. Count all factors which has more than 0 values.

• **Summarize faculty expertise in elective:** Following formula is used to find the final score for an elective of one faculty.

$$Final\ score = S_a + \sum_{i=0}^{n} S_i * W_i + \sum_{k=1}^{m} \frac{S_k}{60} + S_l * 2 + N \qquad (3)$$

Where
S_a is teaching ability of ath faculty
S_i is score obtained in subject which constitute the elective
W_i is weight of the ith subject which constitute the elective
S_k is number of hours k^{th} subject taught by faculty

S_l is number of research paper/ article published
N is number of column having more than 0 value.
n is number of subject which faculty studied and constitute the elective
m is number of subject which faculty taught earlier and constitute the elective

In this formula S_a is the name of column which store the teaching ability grade of the faculty. The value for this column is in the range of 1 to 10.

S_i is the name of subject, which a faculty studied during his/her studies and contain the score obtained using equation (i). W_i is the weight of respective subject in the curriculum. If the faculty has studied that elective then its weight is 1 whereas for other subjects' weight obtained from table shown in figure 3. This S_i may be more than one column. So sum of all score and its multiplication along with weight is added.

S_k is name of subject which is related with the elective. Columns related with S_k store the number of hours a faculty taught earlier. 60 hours is considered as 1 point. It is possible that faculty taught more than one subject earlier, thus calculates the point for each subject by dividing 60 to number of hours taught and then sum all point of each taught subject.

S_l is number of research paper published by the faculty in the field of elective subject area. This factor has been used to know the depth of the faculty in the field of elective subject. Weight of research paper is 2 point per paper. It is possible that a faculty did not study or taught any subject earlier. In this case if a faculty wants to be the part of any elective subject which neither s/he studied or taught can use this dimension getting their expertise.

N is number of columns in which a faculty score more than 0 value.

Equation 2 is used to calculate the faculty expertise and obtained score will be stored in the table as shown in the figure 6.

Faculty	Elective I Expertise	Elective II Expertise	....
1			
2			
.			
.			
.			

Figure 6: Faculties expertise in each elective

V. WORKING PROCESS

Working process of the recommender system is very simple. Student related data for specific elective is stored in the table. Institution can fetch record from the digitally stored data or student can enter their detail using application software which asks for information related to the elective selection. Similarly faculty detail is collected from faculties and processed to find score of any faculty in respective subject.

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Highest score elective must be offered to student for study and faculties having highest score in elective must be offered to teach.

VI. ADVANTAGE

At the time of subject selection student is always in puzzle. Department also look to minimize the number of elective for saving the cost and reducing related overhead. The advantage of this recommender system is that the student will know his/her possibility of success in different electives. Table shown in figure 4 is used to recommend the appropriate elective for the student. Subject organizer (person responsible for organizing classes of elective with consultation of student) will use to understand that which subject should be offered to student by minimizing the failure ratio. Department will use table shown in figure 6 to find the most adept faculty for any elective.

Proposed recommender system will help in allocating and selecting subject for faculty and student respectively immediately. Even they can use this recommender system analysis with human intelligence to take alternative choices for group of students.

VII CONCLUSION

Proposed recommender system is based on students score obtained in past assessment examination and faculties expertise in respective subject. This recommender system can also used for compulsory subject for allocating faculty.

Actually assessment is like a lamp to look inside the student about learning development. Most of the evaluators consider assessment score to predict that nothing left in the student to do better. But there are some factors like curiosity; self-efficacy, belonging, interest, faculty expertise in subject etc. play a vital role in learning. Assessment method developed with this presupposition that learner will never learn anything new after the test. But if importance of persistence, critical thinking interest etc. communicated to the student then they will do much better.

Proposed recommender system is like a lighthouse for students and faculty who are in dark. So they choose subject logically and take necessary steps in chosen subject.

REFERENCES

[1] Mori M and Chan P K, "Identifying Student Behaviors Early in the Term for Improving Online Course Performance", Proceedings of the 9th International Conference on Educational Data Mining, 611-612

[2] Bhatnagar S. and Desmarais M, " Text Classification of Student Self-Explanations in College Physics Questions", Proceedings of the 9th International Conference on Educational Data Mining, 571-572

[3] Ren Z, Rangwala H and Johri A, "Predicting Performance on MOOC Assessments Using Mulit-Regression Models", Proceedings of the 9th International Conference on Educational Data Mining, pg 484-489

[4] Labarthe H, Bouchet F, Bachelet R and Yacef K, "Does a Peer Recommender Foster Students' Engagement in MOOCs?", Proceedings of the 9th International Conference on Educational Data Mining, Pg 418-423.

[5] Bydžovská H, "Course Enrollment Recommender System", Proceedings of the 9th International Conference on Educational Data Mining, Pg 312-317.

[6] Loll, F. and Pinkwart, N. 2009. Using collaborative filtering algorithms as elearning tools. In Proceedings of the 42nd Hawaii International Conference on System Sciences.

[7] Recker, M. M., Walker, A., and Wiley, D. 2004. Collaborative information filtering: A review and an educational application. International Journal of Artificial Intelligence in Education, Volume 14 Issue 1, pp. 3-28.

[8] Vuorikari, R., Hummel, H., Manouselis, N., Drachsler, H., and Koper, R. 2011. Recommender Systems in technology enhanced learning. In Recommender systems Handbook, pp. 387-415. Spriger Verlag.

[9] Romero, C., Zafra, A., Luna, J. M., Ventura, S. 2013. Association rule mining using genetic programming to provide feedback to instructors from multiple-choice quiz data. Expert Systems 30(2): 162-172.

[10] Kaser T, Koedinger K R and Gross M, "Different parameters - same prediction: An analysis of learning curves", Proceedings of the 7th International Conference on Educational Data Mining, Pg 52-59.

[11] E. Brunskill. Estimating Prerequisite Structure From Noisy Data. In Proc. EDM, pages 217–222, 2011.

[12] H. Cen, K. R. Koedinger, and B. Junker. Is Over Practice Necessary? - Improving Learning Efficiency with the Cognitive Tutor through Educational Data Mining. In Proc. AIED, pages 511–518, 2007.

[13] H. Cen, K. R. Koedinger, and B. Junker. Comparing Two IRT Models for Conjunctive Skills. In Proc. ITS, pages 796–798, 2008

[14] A. T. Corbett and J. R. Anderson. Knowledge tracing: Modeling the acquisition of procedural knowledge. UMUAI, 4(4):253–278, 1994.

[15] J. P. Gonz´alez-Brenes and J. Mostow. Dynamic Cognitive Tracing: Towards Unified Discovery of Student and Cognitive Models. In Proc. EDM, pages 49–56, 2012.

[16] J. P. Gonz´alez-Brenes and J. Mostow. Topical Hidden Markov Models for Skill Discovery in Tutorial Data. NIPS - Workshop on Personalizing Education With Machine Learning, 2012

[17] P. I. Pavlik, H. Cen, and K. R. Koedinger. Performance Factors Analysis - A New Alternative to Knowledge Tracing. In Proc. AIED, pages 531–538, 2009.

[18] Segal A, Gal Y, Katzir Z, Shani G and Shapira B, "EduRank: A Collaborative Filtering Approach to Personalization in E-learning", Proceedings of the 7th International Conference on Educational Data Mining, Pg 68-75.

[19] Frieze A M and Yadegar J, "An Algorithm for Solving problems with Application to scheduling a Teaching Practice", Journal of the Operational Research Society Vol. 32 No. 11

[20] Poore A B and Rijvaec N, "Three Algorithms for a Class of Multidimensional Assignment Problems", Journal of Computing and Information Technology- CIT 2, 1994, 1, 25-37

[21] Pandey U K and Pal S, "Mining data to Find Adept Teachers in Dealing with Students", I J Intelligent Systems and Applications, 2012, 3, 27-33 DOI: 10.5815/ijisa.2012.03.04