

Graduate School Recommender System: Assisting Admission Seekers to Apply for Graduate Studies in Appropriate Graduate Schools

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Abstract— In this paper, we present an applied research on designing and developing a recommender system for graduate admission seekers which can help them to choose graduate school matching their entire academic profile. Here we have developed a technique to transform relational database for students' all types of relevant information into a universal database format using academic data of successful students who have already got opportunity to study abroad. After that we have developed an algorithm for grad school recommender system which can calculate similarity between training and test data set based on weighted scores using mean squared deviation similarity metrics. We have used K-nearest Neighbor algorithm for calculating top N similar users for the test users and recommend Top K universities to users from N similar users. Finally our proposed recommender system will recommend list of universities to apply for graduate admission to pursue higher study abroad with funding.

Keywords— *Artificial Intelligence; Recommender System; Data Mining; K-nearest Neighbor; Higher Study Abroad.*

I. INTRODUCTION

Many students pursue graduate studies leaving their homeland after completing their undergraduate level of study. The process of getting opportunity of graduate studies with full funding is very systematic as well as competitive. Lots of students apply different universities of different countries for their graduate study with their academic profile as well as standardized test scores such as GRE, TOEFL, and IELTS. Institutions offer admission to suitable candidates based on their academic profile, standardized test scores, experience in job as well as research. But in this entire process university selection is the most crucial step for applying to graduate admission. The knowledge acquired from the database of successful applicants will be sufficient to find answers to such questions as: Which factors determine the funding opportunity for the applicants to a particular grad school? What categories of students usually get full fund in M.Sc. or PhD in a graduate school? Which key factors are necessary to achieve funding in graduate studies after selecting appropriate grad school? Data mining techniques [1, 11] are very much useful to discover such kind of hidden knowledge from the fundamental as well as complex data types.

Bangladesh is one of the most educated countries in South Asia. After completing undergraduate studies lots of students try to pursue higher education abroad. Some of them succeed and get admission into their desired programs in desired universities. A non-profit organization collects all of those students' data and forms a universal database [2] so that other students get benefit from that. The main objective of this research study is to design and develop a recommender system for graduate admission seekers which can assist them to choose graduate school matching their entire profile using academic data of students who have already got the opportunity to pursue higher study abroad.

In this paper, we have developed a technique to transform the relational database for students' all types of relevant information into a customized universal database in anonymous form using academic data of a successful student using the universal database [2]. After that we have developed an algorithm for grad school recommender system which can calculate similarity between training and test data set based on weighted scores using mean squared deviation similarity metrics. The weighted scores are calculated from prior information of successful applicants such as undergrad CGPA, GRE, TOEFL Scores etc. which is in the universal database. We have used K-nearest Neighbor algorithm for calculating top N similar users for the test users and recommend top K universities to the users from N similar users. Last of all, our proposed recommender system will recommend list of universities to the users suggesting to apply for graduate admission which is beneficial for students who have profound desire as well as students who are trying to pursue higher study abroad with financial support.

II. MOTIVATION

In the beginning of 20th century education became a key factor in influencing international understanding. Public opinion and potentially influential foreign policy can be affected by people's changing attitudes caused by increasing international responsibility [27]. Students who aim to study abroad for higher education are able to learn more about world affairs, can develop new perspectives on academic subjects as well as real-world issues, achieve proficiency in a foreign

language, experience personal growth, and develop valuable career skills [24, 25]. Because of increasing global awareness benefits of study abroad for higher education have been identified study abroad influences student learning and personal development [17]. It can improve once global perspective, cross-cultural awareness and make students aware of their own national identity and influence how they view people from other nationalities [15, 21].

For many reasons students pursue higher education abroad. Some study abroad to raise their job prospects, improve their proficiency in a foreign language, or study under an expert in the academic field [24, 26]. Others to find personal freedom, seek adventure, or gain understanding of another culture [22]. Unfortunately a majority of students do not participate in study abroad programs for higher education. Those students cite time and money as major factors that impact their decision. Other reasons include difficulty in transferring credits, unnecessary for their major, delayed graduation, and no knowledge of a foreign language [22, 25]. But many non-English speaking countries offer programs in English so students do not need knowledge of a foreign language to study abroad. By getting proper guidance from our proposed recommender system student can take a decision to choose appropriate graduate school to study abroad properly.

III. BACKGROUND AND RELATED WORK

Techniques of Data Mining have been used in context of Recommender Systems effectively. In this regard common preprocessing methods like sampling or dimensionality reduction, classification techniques, Bayesian Networks as well as *k-means* clustering algorithm have been carefully observed and a survey has been given consisting of their uses in Recommender Systems in successful application [8]. There has been an impressive literature review exploring the differences between general recommender systems and educational recommender systems along with a general overview about the benefits, challenges as well as limitations of such systems in educational setups [7]. Moreover, data mining techniques has been effectively [12] used in developing a recommendation system to help students to take decisions regarding their course choice considering the similar academic achievements of previous students in different courses in a school of system engineering.

Recommendation systems successfully apply knowledge discovery and data mining techniques to the problem of building personalized recommendations for information, products or services while interacting instantly. Such types of systems like k-nearest neighbor collaborative filtering based ones are very much effective on the web. For this, a revolutionary analysis [19] of different item-based recommendation generation algorithms has been performed considering the computation of item-item similarities and various techniques for acquiring recommendations from them which outperforms user based algorithms. There has been a significant report [16] discussing the effectiveness of item-to-item based collaborative filtering in coping up with the challenges of scalable recommendation algorithms which is capable of reacting with the changes of user data. There is an important study [13] showing the core concepts of

collaborative filtering i.e., evaluating items through the opinions of other people. The study also illustrates its fundamental uses for users of the adaptive web along with the application and evaluation of collaborative filtering algorithms. Again, there has been a praiseworthy research [18] which describes the uses of a content-based predictor to enhance existing user data and after that provides personalized suggestions through collaborative filtering. Along with this, there has been a significant research [10] showing the variety of methods using collaborative filtering and evaluating the recommendation systems using datasets, offline evaluation structure, prediction accuracy, accuracy over time, ranking accuracy, decision support metrics, online evaluation etc. Moreover, an effective study [14] has been presented for evaluating Collaborative Filtering recommendation systems using user tasks, types of analysis and datasets being used, the ways in which prediction quality is measured, evaluation of prediction attributes and user-based evaluation of the system entirely.

There has been a recent study [9] illustrating how recommender systems can be applied to current e-learning systems to guide learners in personalized inclusive e-learning scenarios. Moreover, there is an article [20] investigating the role of recommender systems and their potential in the educational and scientific environment of a virtual university. Besides, there is a web-based recommendation system has been proposed [5] for engineering education e-learning systems. Along with these, recommender system has been deployed effectively for technology enhanced learning [6]. Such recent works on Recommender Systems in the field of education boost us to do research on graduate school recommender system which will be very much helpful for the graduate admission seekers who want to study in a better institution in any corner of the world.

IV. DATA ANALYSIS

A. Academic Profile

Several personal and academic information of a particular student is stored in the universal table. They are collected for the data preprocessing and data analysis.

TABLE I. SELECTED DATA FROM UNIVERSAL DATABASE

Academic Data	Undergrad Department
	Undergrad University
	Overall CGPA
	Research Area
	GRE, TOEFL, IELTS Scores
Personal Data	Research & Job Experience
	Gender

The personal and academic data stated in the above Table I are considered for knowledge discovery regarding academic profile of successful applicants.

B. Graduate Admission Records

As we have experimented with the successful applicants' data who pursue higher study abroad, we have analyzed all records of them such as, Outgoing University, Outgoing Country, Intended Semester, Admission In(M.Sc. or PhD). We

have considered these graduate admission records stated in the below Table II for knowledge discovery regarding better academic institutions all over the world for pursuing higher study.

TABLE II. SELECTED GRADUATE ADMISSION RECORDS FROM UNIVERSAL DATABASE

Graduate Admission Records	Outgoing University
	Outgoing Country
	Outgoing State in Country
	Intended Semester
	Admission In (M.Sc. or PhD).
	Funding
	Application Step

V. PREPROCESSING FOR MINING HIGHER STUDY ABROAD DATABASE

A. Customized Universal Database

A customized universal database is created in which records of all successful applicants from Table I & Table II are utilized. In this universal table redundant records are omitted and all the incomplete records are also omitted from the existing database for the suitability of applying recommender algorithm. For making anonymous, records such as name and other personal information has been omitted in the customized universal table shown in Table III.

TABLE III. PARTIAL PORTION OF CUSTOMIZED UNIVERSAL DATABASE

Gen-der	Outgoing Country	Outgoing University	Department	Research Interest	GRE Score	TOEFL/IELTS Score	Publications	Funding	...
Male	USA	UC Berkley	CSE	Data Mining	330	115	10	TA	...
Female	Malaysia	UCSI	CSE	Computer Networks	315	90	2	RA	...
...

B. Training and Test Data Set

For the suitability of applying data mining and machine learning algorithm, we have created a training dataset from prior information of successful applicants such as undergrad CGPA, GRE, TOEFL/IELTS Score, Job experience, Research experience, Research area, Intended Outgoing country, Intended Semester, Intended admission program etc. We have computed a weighted score from that training dataset. Again, we have computed another weighted score from test data set which has been formed from the provided information of current applicants such as undergrad CGPA, GRE, TOEFL Scores etc. The purpose of creating training and test data set is to calculate similarity between weighted scores using mean squared deviation similarity metric before applying *k*-Nearest Neighbor algorithm.

VI. DESIGN OF GRAD SCHOOL RECOMMENDER SYSTEM

A. Flow Diagram for Grad School Recommender System

The flow chart for Graduate School Recommender system is illustrated in Figure 1. We have developed a

system for grad school recommender which can calculate similarity between training and test data set based on weighted scores using mean squared deviation similarity metrics. The weighted scores are calculated from prior information of successful applicants such as undergrad CGPA, GRE, TOEFL Scores etc. which is in the customized universal database. We have used K-nearest Neighbor algorithm for calculating top N similar users for the test users and recommend top K universities to the users from N similar users. Finally our proposed recommender system will recommend list of universities to apply for graduate admission.

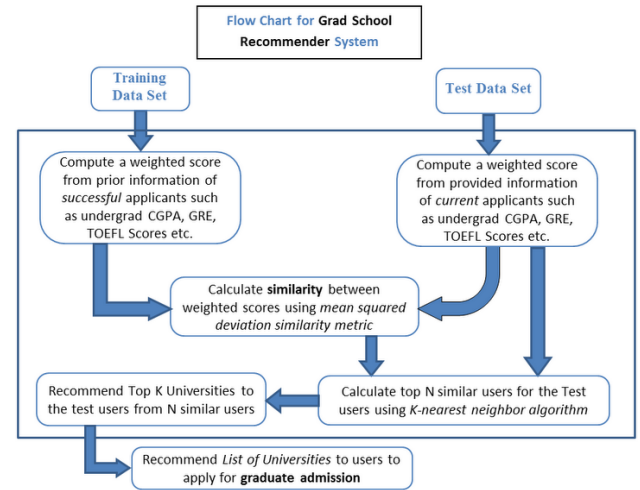


Figure 1. Flow Diagram for Graduate School Recommender System.

B. Algorithm for Grad School Recommender System

According to the flow diagram stated above in Figure 1, we have developed an algorithm (Algorithm 1) for our proposed graduate school recommender system which is illustrated below.

Algorithm1: Grad School Recommender()

Input: *undergraduate university, department, CGPA, GRE Score, TOEFL/IELTS Score, Job experience, Research experience, Research area & Intended Outgoing country, Intended Semester, Intended admission program of User*

Output: *highly recommended N Outgoing University analyzing Universal Table of Previous Successful Students*

1. Calculate a **weighted score** from prior information of successful applicants such as undergrad CGPA, GRE, TOEFL/IELTS Score, Job experience, Research experience, Research area & Intended Outgoing country, Intended Semester, Intended admission program
2. Calculate **similarity** between the users score using mean squared deviation similarity metric
3. For a test user calculate **Top-k similar** users that are similar to him using *k*-nearest neighbor algorithm
4. **Recommend Top-N universities** to the users from the *k*-similar users

VII. IMPLEMENTATION OF GRAD SCHOOL RECOMMENDER SYSTEM

According to the Flow diagram and algorithm described in the previous section, we have designed and developed an android app which will recommend the graduate admission seekers to apply for suitable graduate schools.

A. Home Screen for Grad School Recommender System

The home screen of grad school recommender system (in Figure 2) includes three functionalities which will allow users to get recommendation for the better schools from the system and get guidelines of how to apply for graduate admissions. We also provide an option to add new records to the universal database by the successful applicants.



Figure 2. Home Screen for Grad School Recommender System

B. Recommend Graduate School for Admission

As soon as the user clicks on “Recommend Graduate School for Admission” button, a screen (in Figure 3) will appear where user requires to fill all his/her necessary details to recommend him/her suitable graduate schools matching his/her given profile in this UI.

Figure 3. Recommend Graduate School for Admission Input Screen

C. Recommend Graduate School for Admission Output

As soon as the user clicks on “Recommend” button, our proposed graduate school recommendation system will show list of recommended universities matched with the given profile (shown in Figure 4) to the user.

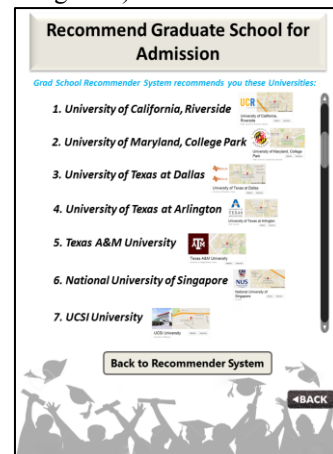


Figure 4. Recommend Graduate School for Admission Output Screen

D. Record Yourself as a Successful Applicant

In the home screen, if any successful applicants got admitted into his/her desired institution, he/she may save his/her entire profile using our designed app. As soon as, the user clicks on “Record Yourself as a Successful Applicants”, the following UI will appear (in Figure 5) which will guide the user to save necessary info for further computation.

Figure 5. Record Yourself as a Successful Applicant Screen

E. Guidelines of Applying for Graduate Admission

Our designed app will guide the user for applying for graduate admission in a organized way. The user can learn details of application steps. The user can also get guidelines of

GRE, TOEFL or IELTS as well as finding research area and professors of particular field which is illustrated in Figure 6.

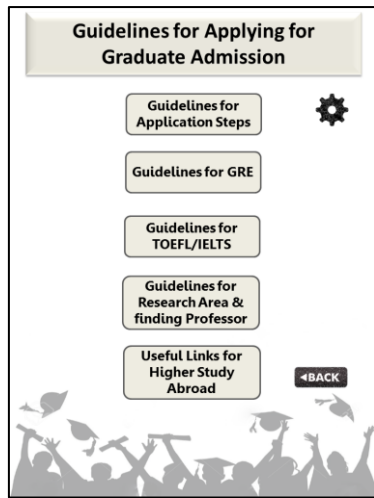


Figure 6. Guidelines for Applying for Graduate Admission Screen

VIII. EXPERIMENTAL EVALUATION AND EFFECTIVENESS OF PROPOSED RECOMMENDER

We have defined term *accuracy* as if the applicant user gets admission into a university which is among *Top-N* recommended universities, and then the recommendation is considered as *accurate*. Because, this is technically or practically not feasible that user gets admission from only one recommended university by the recommender system. An important fact is evident from our experiment is that if the number of recommended universities i.e., *N* is increased, the *accuracy* is also increased. In the Figure 7, *Top-N* recommended universities vs. *accuracy* graph is given.

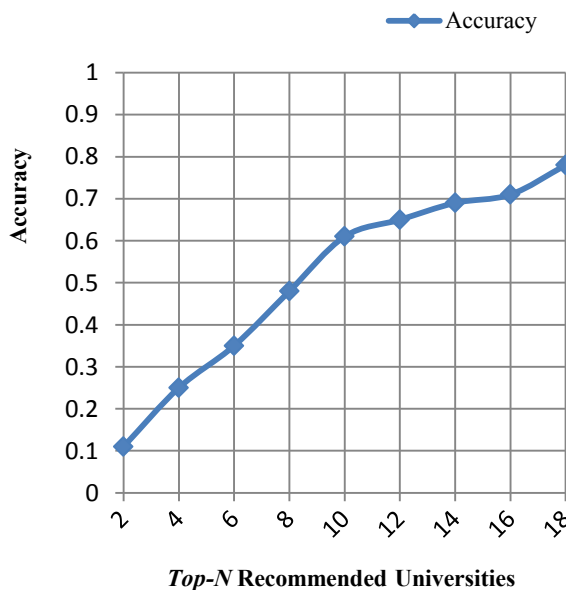


Figure 7. *Top-N* Recommended Universities vs. Accuracy Graph

In our previous work [3], movie is recommended by computing similarity between users where the similarity metrics have been provided [4] which perform perfectly and there exists the dataset of popular MovieLens which can be experimented easily to compare with any existing solution. As in this work, the collection of dataset is very much challenging and we have partial records of successful graduate applicants of only few years. So, to evaluate the recommender system by performing experiment has not been very much convenient. Moreover, we have divided the entire dataset into several train and test datasets. Every time for each test applicant's computed weighted score is considered with the similar weighted score of those applicants from training set, thus we have recommended *Top-N* universities (for our experiment, *N*=10 is considered). In our experiment, it is evident that, applicants get admission into universities from our recommended universities in 65-70% cases of several training-testing dataset. In the Figure 8, how *accuracy* is changed due to the variation of training and test data has been illustrated.

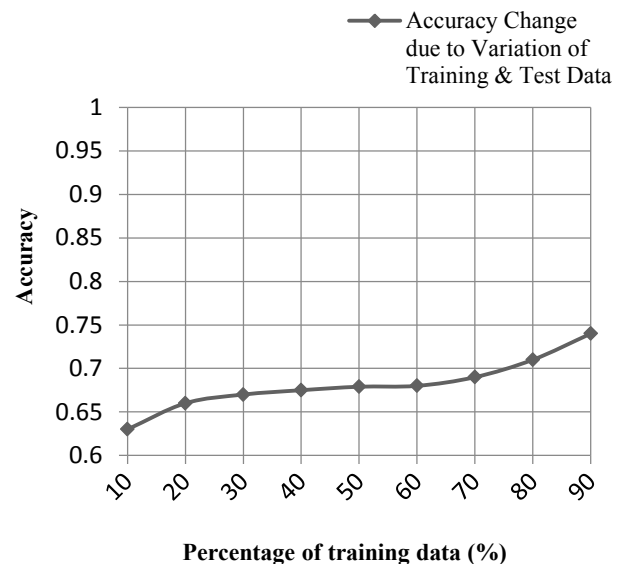


Figure 8. Change of accuracy due to variation of the training and test data

IX. FUTURE WORK

In this research, we have designed and developed a recommender system which will recommend the graduate admission seekers to apply for suitable graduate schools. We have only considered the higher study abroad students' record of Bangladesh. In the future work, we can apply the same technique to students of all other countries for accuracy of our proposed system. Again, we have considered only the records voluntarily given by the successful applicants. We can use the same techniques acquiring real database from all higher educational institutes across the world for the betterment of postgraduate studies. Here, we have recommended considering the applicant-applicant similarity. In future, we can recommend university of same patterns by considering the

university-university similarity. However, some universities are famous for particular field of research. We can consider those factors also. Moreover, our weighted similarity can be tuned further to increase the accuracy of the proposed recommender system. Thus, the developed recommender system can be checked and modified after scrutinizing by the real graduate admission seekers after applying it for choosing graduate schools.

X. CONCLUSIONS

After completing undergraduate level of study, many of the students from different background get the opportunity of pursuing higher study in a better institution outside their homeland. Discovering the hidden knowledge from those students' academic records and applying it properly for decision making will be very much helpful for the students trying to pursue higher study abroad. This knowledge can be traceable through data mining and machine learning techniques. Thus, knowledge discovery from the academic records of successful graduate applicants is very important for the graduate admission seekers in foreign institutions in respect of choosing appropriate higher educational institute. In this research, we have developed a technique of using those academic records of successful applicants for making grad school recommender system which can help the current graduate admission seekers. At first, we calculate similarity between training and test data set based on weighted scores using mean squared deviation similarity metrics. The weighted scores are calculated from prior information of successful applicants such as undergrad CGPA, GRE, TOEFL Scores and all other relevant records found in the universal database. We have used K-nearest Neighbor algorithm in order to calculate top N similar users for the test users and then recommend top K universities to the users from N similar users. That is how our proposed recommender system will recommend list of universities to applicants trying to pursue higher study abroad and eventually assist them to apply for graduate admission in appropriate universities with best possible financial support.

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