

# A Recommender System for Personalized Exploration of Majors, Minors, and Concentrations\*

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## ABSTRACT

Many students change their majors during college. Choosing the right academic majors, minors, and concentrations within a major in higher education is challenging but crucial in assuring students' overall academic and career success. Personalized prediction of student success in majors, minors, and concentrations will help students better find the right majors, minors, and concentrations for them, so as to timely achieve their academic goals. In this paper, we present a new recommender application for the academic major/minor/concentration selection problem in the educational domain. The proposed major/minor/concentration recommender system is a collaborative filtering-based recommender based on student grade prediction, and provides a variety of personalized predictions and recommendations on majors, minors, and concentrations. It is a useful tool to guide students, advisors, and administrators during the personalized major/minor/concentration exploration (declare/change) process.

## KEYWORDS

Majors, minors, and concentrations; Recommender systems;  
Collaborative filtering; Personalized grade prediction

## 1 INTRODUCTION

Selecting the right academic major, minor, and/or concentration within a major in higher education is challenging for many students. However, such selection can be crucial in assuring students' overall academic success and later career satisfaction and success. Many students change their majors over the course of their college career. Students who pick the right major, minor, and/or concentration tend to do better in the requisite courses and thus get better grades. Those students are also less likely to change their chosen major, minor, and/or concentration or drop out, and thus are more likely to graduate on time.

Students typically choose their major, minor, and/or concentration based on various factors such as their interests, personality, and other considerations [1]. However, we believe that it is also very important to consider how students will perform in their selected major, minor, and/or concentration. Providing students with personalized prediction of success in majors, minors, and concentrations during the exploration process will greatly help

individual students better find their ideal majors, minors, and concentrations and eventually achieve their academic goals.

Recommender systems provide personalized recommendations of items, such as goods, services, or information, that are most likely to be relevant and interesting to users to help them find the items most useful to them [2,3]. Recommender technologies have been applied in a variety of application domains including the traditional e-commerce domain as well as emerging domains such as education and engineering. A number of recommender systems have been developed and deployed in the educational domain for learning, teaching, and academic advising [4,5]. In the educational setting, the typical users are students, teachers, or academic advisors, and the typical recommendable items are educational goods, services, or information such as courses, learning materials, topics, student performance, and grades.

In this paper, we describe a new educational recommender application in order to help guide the college major/minor/concentration exploration and selection process. The proposed recommender can be used as a tool for students in the major/minor/concentration exploration (declare/change) process by providing personalized predictions of success in majors, minors, and concentrations, along with recommendations for individual students. The proposed tool can also be used by administrators and advisors to guide decision-making and improve the academic experience for students at their educational institutions.

## 2 PERSONALIZED EXPLORATION OF MAJORS/MINORS/CONCENTRATIONS

### 2.1 Our Approach

Our goal is to predict how well a student will perform in majors, minors, and/or concentrations, i.e.

- *Given a student and a major, minor, and/or concentration, how will the student perform?*
- *Given a student, in what majors, minors, and/or concentrations will that student perform well?*

An academic major, minor, or concentration typically includes course requirements consisting of core courses and elective courses. A close approximation of a student's performance can be

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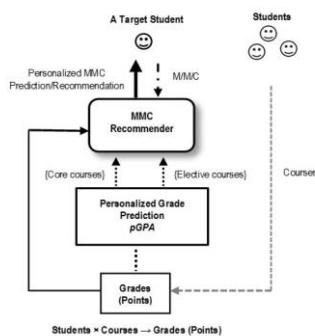
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derived from the grades earned in his or her courses. Thus, we represent a student's performance in a major, minor, or concentration as the grades earned in both core and elective courses required in the major, minor, or concentration. Collaborative filtering recommendation techniques were applied to predict student grades in courses [6,7].

Our approach to major/minor/concentration recommendation is based on personalized student-course grade prediction. From our previous work, we developed a collaborative-filtering-based recommender system called *pGPA* that predicts personalized student grades [6]. Given a student, a course and a semester/term, *pGPA* provides the student's predicted grade in the course and the grade prediction proved accurate enough to support high-level decision making through experimentation on actual student grade data. *pGPA* uses user-to-user collaborative filtering, item-to-item collaborative filtering, and matrix factorization for personalized course grade predictions. To the best of our knowledge, our personalized major/minor/concentration recommender is the first application of collaborative filtering to the major/minor/concentration exploration problem.

## 2.2 A Major/Minor/Concentration Recommender

The proposed major/minor/concentration recommender system called *myMMCheck* is a collaborative filtering-based recommender system using the personalized grade prediction system *pGPA* [6].



**Figure 1: The architecture of *myMMCheck***

The overall structure of *myMMCheck* is depicted in Figure 1. In general, a major, minor, or concentration *MMC* requires  $m$  core courses and  $n$  elective courses. Let  $C_{MMC}$  be the set of all possible sets of  $m$  core courses  $\{c_1, c_2, \dots, c_m\}$  and  $E_{MMC}$  be the set of all possible sets of  $n$  elective courses  $\{e_1, e_2, \dots, e_n\}$  required for *MMC*. Then, the Cartesian product  $C_{MMC} \times E_{MMC}$  is the set of all possible pairs of (a set of  $m$  core courses, a set of  $n$  elective courses) selected from  $C_{MMC}$  and  $E_{MMC}$  respectively. Each pair consists of  $(m+n)$  courses that meet the requirement of *MMC*.

The basic prediction and recommendation process of *myMMCheck* is as follows:

- Given a target student  $S$  and a specific major, minor, or concentration *MMC*, (1) predict the personalized grades for courses in the sets in each pair in  $C_{MMC} \times E_{MMC}$  that have not been taken by the

student at that time and (2) compute the grade point average of the  $(m+n)$  courses in the sets in each pair in  $C_{MMC} \times E_{MMC}$ .

- Given only a target student  $S$ , (1) identify the sets  $C_{MMC}$  and  $E_{MMC}$  for each potential major, minor, or concentration *MMC*, (2) predict the personalized grades for courses in the sets in each pair in  $C_{MMC} \times E_{MMC}$  that have not been taken by the student at that time, and (3) compute the grade point average of the  $(m+n)$  courses in the sets in each pair in  $C_{MMC} \times E_{MMC}$ .

*myMMCheck* can provide a variety of personalized predictions and recommendations on majors, minors, and concentrations:

- For a student with a specific major, minor, or concentration selected by the student, *myMMCheck* predicts how well the student will perform in that major, minor, or concentration by predicting the best overall grade point average along with the list of predicted grades in  $m$  core courses and  $n$  elective courses. The student will have a better perspective on the chosen major, minor, or concentration, and thus can better prepare and perform.
- For a student, *myMMCheck* recommends a list of majors, minors, or concentrations along with the set of  $m$  core courses and  $n$  elective courses in which the student will do well based on the overall grade point average predicted. The student can further explore the recommended majors, minors, or concentrations.

## 3 CONCLUSION AND FUTURE WORK

We have presented a novel recommender application to the personalized major/minor/concentration exploration and selection problem. The proposed educational recommender system is based on a collaborative filtering-based personalized grade prediction system. The proposed recommender can provide a variety of personalized tips on majors, minors, and concentrations and be useful as a guiding tool during the personalized major/minor/concentration exploration (declare/change) process.

As future work, we plan to build a real-world dataset and perform comprehensive testing across curriculums in a higher educational institution. We also plan to incorporate other important factors besides students' performance, including their interests, personalities, and career goals.

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