

# CONTEXT AWARE RECOMMENDATIONS IN THE COURSE ENROLMENT PROCESS BASED ON CURRICULUM GUIDELINES

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## ABSTRACT

This research is a part of an ongoing project for development of an integrated student information system, aiming to incorporate self-adaptivity, personalization and social navigation, both in the overall management of university processes, and throughout the course work. In this paper the focus is on the advancement of the existing course recommendation framework to a more context-aware level. The model presented in this paper aims to increase the personalization in processes happening at the beginning of the academic term and the start of the teaching. The first part of the paper presents recent development on the modernization of the process of term enrolment and the virtual academic adviser component. The evolution of the virtual adviser is discussed that allows the student to change and experiment with different study paths and specializations without affecting the overall length of the studies. In the second part of the paper, a new framework is described that is based on the model of knowledge given in referent curriculum guidelines from professional organizations. This model is then used to offer course recommendations that are more inclined to the context

## KEYWORDS

E-learning, LMS, learning management, recommender system, information systems.

## 1. INTRODUCTION

Throughout the years, higher education in EU was extensively revised and new curricula and managed study processes were introduced. The most significant revision was the alignment towards the Bologna process and ECTS. In each revision, more and more options within the study programs were given to students. Nowadays, mandatory courses are only 50 percent of the programs, while the rest is left on the student to choose. Elective courses are offered by other study programs at the same department, inter-disciplinary courses from other departments, and corporate courses that can also be recognized as credits. Finally, student mobility has evolved and through EU programs such as Erasmus, the student can spend a short period at another university and enrol courses there. This creates administration considerations regarding the overall quality of the study process, and in addition to that raises a significant burden on the student – which path to choose?

We addressed some of these issues with *profiles* – groups of related courses that are not enforced, but only used to recommend paths towards a certain specialization. Unfortunately, the students are rarely in position to strictly align to the recommendations. As unemployment rises, they might be forced to work during studies and support themselves and their families, resulting in a decrease in the pace of studying – lowering the number of enrolled credits. If this is not possible, they are usually in danger to fail a course. This, creates even more problems – the student can inadvertently make wrong decisions. Together with the complexities in the process due to course inter-dependencies and prerequisites, it could later turn out that the student has no other choice but to prolong the total length of the studies. In fact, this case is not a rarity, since many students take 5 or 6 years to finish a 4-year long study program. This problem can be mitigated, with better communication with the academic advisers. But, as the number of students is constantly increasing, the quality of the communication with the assigned academic advisers decreases. This is where the need for systemic tools becomes obvious. Tools that will help the students to assess their situation on their own and act upon it.

## 2. VIRTUAL ADVISER AND COURSE RECOMMENDATIONS

During earlier efforts, a generic model of the study process was built and it was used as a base to create a new system for management of the study processes. This system, presented in Ajanovski (2010), introduced the following functionalities: static structure of the studies – study programs, subjects and curricula; dynamic processes – course offering in each term, online courses and timetables; and students status – admissions, enrolments, mobility and recognition. In Ajanovski (2011) the implementation of a virtual academic adviser component was discussed. This component was intended to help alleviate the problem of course selection and the influence of the selection over the future semesters. The virtual adviser generates a forecast map of possible future enrolments of the student, based on his history and enables the student to experiment with the most important new scenarios: change study program and change order of courses in order to optimize and balance the load during the studies, and if desired, graduate as early as possible.

This development gave the student better overview over the context of his situation and enabled wiser choices. This also opened-up possibility to include social navigation elements and include automated course recommendations based on the history of enrolments at the institution. The current implementation of the latest virtual academic adviser, that uses a course recommender engine is displayed in Fig. 1. The focus is on the upper part where the map of the possible future enrolments is shown, term by term. The projection extends until the semester in which the student would be able to graduate. Each future semester has a label with the form  $+n$ , which means  $n$ -th semester in the future. This effort was presented in Ajanovski (2013).

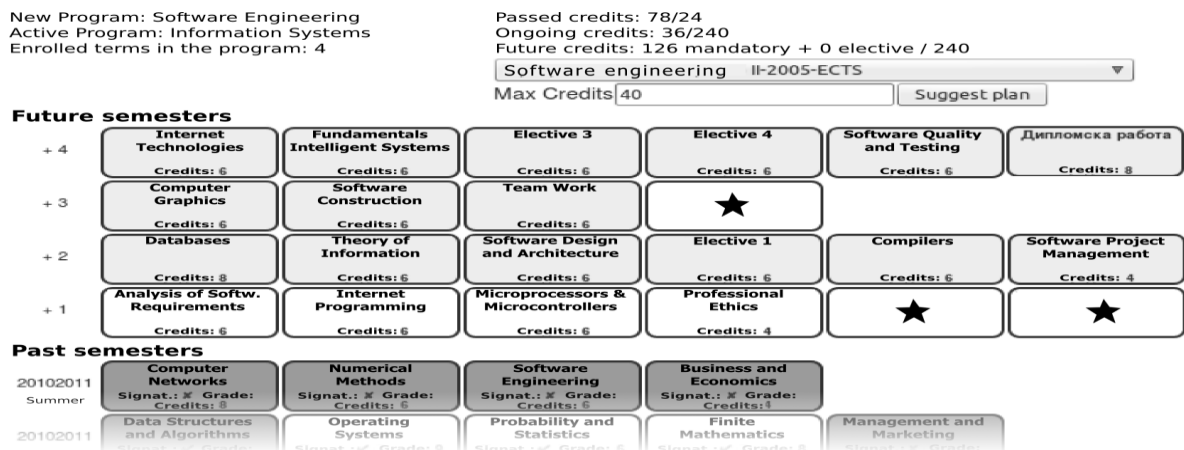


Figure 1. Current state of the virtual adviser.

The plan that the adviser generates is based on the study programs definition and the chosen profile by the student. First the mandatory courses are taken into account and each of them is placed in the earliest possible future term. After this all electives from the current chosen specialization are placed. In each step courses are arranged according to the maximum number of credits per semester, and in which semester they are on offer and prerequisites are taken into account to decide on priority. In the end, slots are created for all free-choice slots that will fill the future plan up to a total number of credits required to finish the study program.

In order to increase flexibility the recommender system Easyrec was chosen, an open-source software, where recommender engines can be developed, plugged-in and experimented with. The system allows easy integration with any application due to the REST API. The historical data on course enrolments was imported in the system to prevent the cold-start problem and later, student course grades were imported as course ratings. This gave the possibilities to:

- indicate popular course selections among similar students;
- recommended courses based on what similar students passed with a good grade;
- indicate recommended programs to switch to.

Since the mandatory courses are already laid out on the map and only elective courses are later filled-in by the students, there is no real danger of misguided automated recommendations. The only question is satisfaction of the students with the relevance. All course offers are listed and top recommended courses are annotated with an icon, so if the student is not satisfied – the possibility to choose any other course remains.

### 3. CONTEXT AWARE RECOMMENDATIONS AND GUIDELINES

Initial experiments confirmed that the recommendations are in line with the expectations, but the approach with a generic recommender based on history of course enrolments and grades does not help with offering something new and in the general academic area (unless it was popular in the past with related students). So, the software would implicitly incline the students towards local popular courses from the same department and related study programs. Since using recommender engines to issue course recommendations is not a new topic an investigation of some other efforts was done.

There are many publications that show that students will use good recommendations and that they can lead to better success. Some of them were influential for this research. For example, in O'Mahony and Smyth (2007), a system for offering course recommendations is discussed in an environment where only 20% of the study program is elective and the number of places per course is limited. In this research, the analysis is not made on specific instances of course enrolments, but on the pairs (code, student) where the code is a token from the course code, usually signifying the academic discipline. With this the domain was reduced to about 80 disciplines from about 2000 courses, in order to have better recommendations. This gave the idea to try to use knowledge areas and topics instead of courses. The authors Itmazi and Megías (2008) analyse and discuss various systems for recommendations and filtering in a massive and open course management system, where students are free to choose among many courses. They propose an integrated framework that filters the list of courses according to different criteria in several steps using different types of recommender and filtering systems. This gave the idea to implement an external recommendation system such as Easyrec, which could be plugged-into and used from several applications, and for several different measures. Vialardi et al. (2011) define the notions of a measure of student potential and course complexity and later this measure is used to forecast the success of the student in a certain course. Based on this forecast, the course is recommended to the student or not. This gave the idea to use student grades as rating for how relevant a course is to the success-fulness of a student.

To disperse the interests to a wider area of specializations and inter-disciplinary courses, we decided to try an alternative approach with a more general model of the knowledge, that can be mapped to an existing model of studies, so that students could seek courses that are from the general academic area, or which push for similar learning goals. This is similar approach to the one investigated by O'Mahoney and Smyth, the difference is that a more generic model is used that is codified universally, so it can be used in an inter-university environment. The model we start with, as the initial building block, is the concept-model of the curriculum architecture used in the documents on ACM and AIS curriculum guidelines by Topi et al. (2010). This model is used to define the structure of curricula proposed by ACM and AIS for undergraduate and graduate studies in information systems, but since it is a generic model it can be used in any academic discipline. The simplified concept model of the curriculum architecture presented in the referenced documents is shown in Fig. 2.

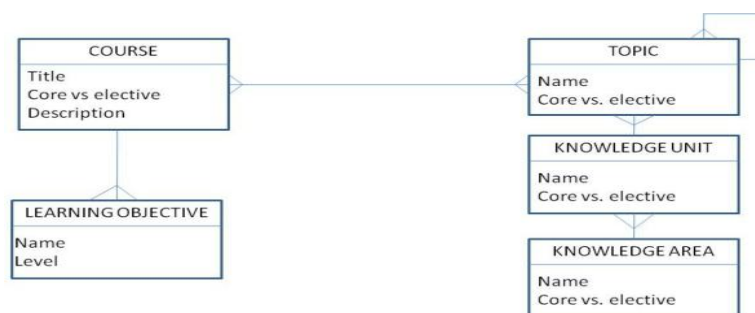


Figure 2. Simplified Concept Model of the Curriculum Architecture

This model is interesting for our problem since it defines the relationships between knowledge areas, knowledge units and topics per unit on one hand, and the proposed courses together with all learning objectives in each course, on the other hand. For each discipline, all knowledge areas are listed, with knowledge units and topics. Finally, for each course comprising the guidelines a mapping is given to covered knowledge topics. Since many universities offer similar or sometimes even the same courses as in the guidelines, it is possible to define a map from actual university courses on offer to the codified knowledge

areas, units and topics from the guidelines. Depending on the detail that the university has for each course and their own study programs, this map can be used to build relations between students and codified knowledge areas, and even a map of interests per unit. Relations are formed for the pairs: (**student, area**) and if given enough detail from the student information system database even ratings/grades per area could be calculated with the triplets (**student, area, average/aggregate grade**).

This enables the usage of a recommender engine to reach indirectly to courses that have covered a similar set of topics, but from another perspective. Such courses would not be directly found as relevant with the usual approach based on history of course enrolments. The difference between our original and this approach, is that the first one gives recommendations blindly (course content is disregarded and only historical data is taken into account), while the second approach is more tailored towards the generic pieces of content that truly build a course (as defined by the curricula guidelines). In addition to that, not only are similarities found indirectly from the content, this is done in a structured way – via comparison to a reference structured model of curricula, which gives the possibility to perform structured navigation through the recommendations and enable the student to choose an elective course with broader sense of its context.

#### 4. CONCLUSION AND FUTURE WORK

The observations during the experimental tests with a generic recommender engine conclude that it is mainly useful for offering courses that are within the same department, or courses that are unrelated but are strongly popular. The system could skip entire sets of courses that have similarities, but were enrolled by entirely different populations of students from two different departments. This proposal takes into account a more structured approach directly related to reference categorization of course content and uses it to analyse historical data and offer recommendations within context. Since the system is only used in positions where the student has a free choice and in such situation bad recommendations could not hinder the pace of studying of the student, there are no negative side-effects. The measure of success of the recommendation system has yet to be discussed, as at the time being it can only be evaluated by the subjective satisfaction of the students from the issued recommendations. The success of the overall solution with the virtual adviser is also a topic of discussion and further research, since it can be measured in several ways – decreasing total number of empty term slots, decreasing average length of prolonged studying, etc.

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