

## SOCIAL-BASED GUIDANCE AND SELF-ADAPTIVITY WITHIN ENROLMENT PROCESSES

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### ABSTRACT

This paper introduced new dynamic scenarios for better management of the activities related to the term enrolment process within a university student information system, and present a model solution where the students will be making better choices with regard to the length of studies and accomplishing the right set of skills for the right degree and specialization, while at the same time optimally using resources. In the first part of the paper an introduction is made and the necessity of such system is explained together with the positioning of the solution within the student interests and the time-frame with regard to the processes of term enrolment and class timetable scheduling. The last part of the paper discusses the way in which the earlier introduced virtual academic adviser can be used to perform the proposed integrated scenario for term enrolment and class schedule within an overall self-adaptive framework that controls the behaviour of the system actively and automatically and only requests action from the involved participants when needed.

### INTRODUCTION

This paper presents the ongoing work in extending the existing student information system to incorporate adaptivity, social navigation and guidance in the process of university admission, term enrolment and course selection at the beginning of each term. This process is the place where students have the choice of direction for their further academic development, since when initially admitting to the university, rare are the number of students who have a truly confident and competent vision of their future path.

Many students join the university only in order to have better chance of employment, without truly understanding the academic area they have chosen. As seen from the perspective of many university professors, the education level of incoming first year student is constantly dropping and many professors associate this with negligence and drop of the quality of the high-school programs. So, many prospective students didn't even have a chance to have a proper education up to pre-university level, so to be able to truly understand the curricula at the university and the level of knowledge that will be required from them in the end. That is why, many students just go with the flow and pick a department and study program at the university just because their high-school friends did so, due to various factors that range from popularity, word of mouth, to how nice is the web page or how big were the advertisements of the department. Of course, there are much more students that investigate important issues, like: how advanced or futuristic does the curricula sound like, how influential are the professors with regards to the market, the com-

panies, institutions and the government. Still even in this case the prospective students rarely consider how prepared they are for the university, how inclined their interests are towards the specific discipline that is chosen and if they will succeed.

This process can continue in the first 3 study years, until the student is truly prepared to make valid choices. So the problem of better and more personalized choice is an ever-valid problem that is increasing year after year. In the past, 2 decades ago there was practically no choice once the student entered the study program – the studies were to be finished successfully within a certain deadline. Later, many renovations of the curricula and the study process were introduced, the last one being towards the Bologna process and ECTS, introducing more and more course options within each study program every year.

Unfortunately, there is a significant complication that students experience, which is rooted in the way the Bologna process and ECTS (European Credit Transfer System) is implemented at the university and the multitude of misalignments created by the ever-changing legislation. There are some misalignments that can lead the student to have to re-enrol again the same study year, because he has not passed a critical course or set of courses, thus prolonging the total length of studying. There is also regular possibility where a student can be allowed to go on and enrol a new term, with a new set of courses, while still not completely finished with the courses from the last term. In this case, if the student fails some of the courses from the last term, he will lose the right to be examined in the new courses, although he was allowed to attend the classes and midterm exams. So in the end the student will have failed courses from two consecutive terms and will have to take them again, but not at the same time because of course inter-dependencies. This creates further administration complications and if the student is not careful enough can also prolong the length of the studies. In fact many students take 5, 6 years or more, to finish a 4-year long study program.

One general problem with all the process involving communication with students is the constant and severe lack of administration staff and lack of academic advisers, as opposed to the enormous rise in the number of students. The role of the academic advisers is to work with the student in the creation of effective and streamlined plan, with a choice of courses that would benefit the education of each student especially taking into account the compromise that less-successful students usually have to make – the compromise between the interests and capabilities.

It is worth mentioning that besides the choice within the study program, the students can choose courses from a number of other study programs leading to differing specializa-

tions, even within a single university department. In addition to that there are many other possibilities for students – other departments of the university usually offer some inter-discipline course, external professional courses and certifications and even the possibility of student mobility between universities in Europe, where the student can migrate for a short period to another university and enrol courses there which have later to be officially recognized by the home university.

It seems that all this gives the student an abundance of choice, but unfortunately not every choice is a good one. Bad choice can lead to spending time on courses that would not be recognized towards the degree and this could turn out to be a setback in the studies, prolonging them for additional year or more. In this paper we discuss the introduction of new scenarios for better management of the dynamic processes and choices that the student experience within the university student information system, and present a model solution where the students will be making better choices with regard to the length of studies and accomplishing the right set of skills for the right degree and specialization.

### MODEL OF THE STUDY PROGRAMS AND CURRICULA

In order to explain the positioning of the new envisioned introductions to the system, we explain the most important components of the earlier information system (explained in more detail in [1]).

Figure 1 represents some of the constituting elements of a study process in an institution. Each Institution consolidates all of its current study offerings in one Plan. There can be many Plans through the course of history, some are minor revisions of earlier study plans, some are complete rewrites. Each Plan (or revision) has several study Programs on offer. Each of the Programs can lead to a certain Degree, and in fact in the case of interdisciplinary programs it can lead to more than one degree.

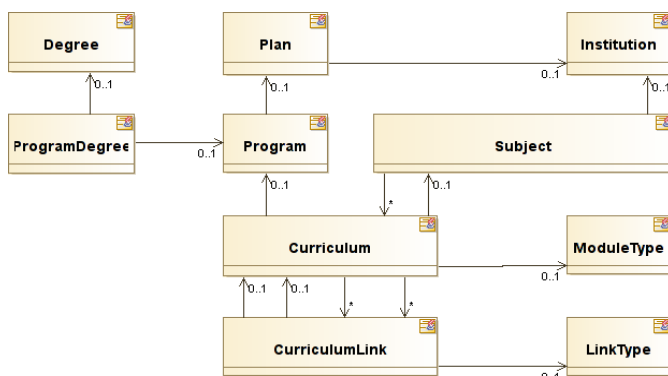


Figure 1: Most important elements defining the curricula.

The Institution can be accredited to teach in many study areas and specific Subjects in each area. The Curriculum is in fact the way a certain Subject is taught according to some Program and is of certain ModuleType, which means that has specific role within the Program. The Curriculum can differ from one to another Program (depending on the Degree, or because of the changes of the Plans through the history).

The prerequisites and relation between two Curricula are modelled as CurriculumLinks, and there are several LinkTypes that dictate the semantics of the established relations,

forming a large graph of interconnections in several layers. An example of a subset of this graph, for a single Program and restricted to two of the most important LinkTypes is shown in Figure 2.

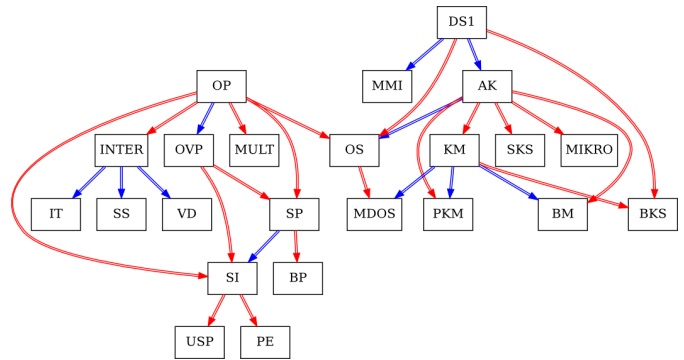


Figure 2: CurriculumLink graph showing two LinkTypes.

### SOCIALLY ADAPTIVE VIRTUAL ADVISER

As part of earlier development efforts presented in [2] we explained in detail the need for the introduction of a special component in the system that enabled small amount of adaptivity towards the needs of the student. The virtual academic adviser component gave the student more personal guidance in the process of technical rearrangements of the personal study plan in order to experiment future scenarios with various choices before discussing the final scenario with the real adviser and submitting the application for term enrolment.

The first version of the virtual academic adviser enabled the student to try a what if experiment with the various choices on offer – such as number of credits per year, choose another study program and specialization profile, rearrange the order of enrolment of courses per future terms etc. After these experiments the student would decide on some preferred scenario and enrol the term according to the profile and the official rules. In case there were any issues with some scenario, the student could discuss them with the real adviser. It should be noted that the role of the adviser is to give advice and not decide on behalf of the student, and once the choice is legitimate, the adviser can not prevent the student from enrolment, but can only suggest better options.

The second version of the virtual academic adviser is developed with two additional features: giving the students manual and automated course recommendations and introduction of a new integrated process for term enrolment, class scheduling and construction of timetables. Within this evolution mechanisms for mutual dynamic self-regulation of the processes of term enrolment and class scheduling are investigated.

### COURSE ENROLMENTS FOR REGULAR STUDENTS

The integration of the virtual adviser with the course recommendations can be best explained in the context of the screen-shot presented in Figure 3. The top of the screen shows statistics relevant to the general progress and achievement of the student, such as: total number of credits achieved, speed of studying, remaining number of mandatory and elective credits to fulfil. The main part of the screen is reserved

for a map of courses, per term. The display is chronologically sorted from bottom to top, and is divided in two parts.

- The lower part lists all the terms and courses attended up to date, term by term.
- The upper part represents future terms and course choices (in yellow colour), until the projected graduation year.

The ordering was chosen as such to enable the student to easily understand how far in the study process he is. Terms that are not full in fact indicate the students that there is freedom of choice in that term for extra credits. The boxes are color coded, and in the latest version the coding is according to the following scheme:

- White boxes represent courses that were finished with success (grade in the range 6 to 10);
- Saturated red indicates courses that the student has explicitly failed (grade is 5);
- Pale red boxes represent courses that are finished, not yet successfully passed, but the student still has a chance to take another exam in the near future (grade is *null*);
- Green boxes represent currently active courses (no such situation in Figure 3).

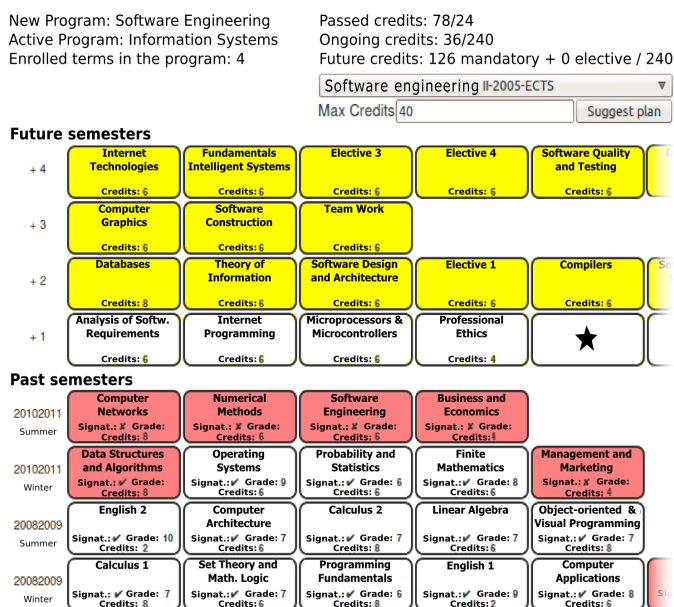


Figure 3: Screen-shot of the virtual adviser

The first implementation of the virtual adviser component used only simple indicators of various performance factors and only in their absolute form (average length of the studying overall, average percentage of students having to re-enrol a course no matter the time period, whether the course belongs to a certain module or whether it is mandatory). The term slots were read-only.

The following behaviour is the result of the latest developments to the virtual adviser component:

- Any slot in the region of future terms is active so that the student can change the list of future courses, rearrange them and also can delete course slots;
- The next term (marked as “+1”) is user for term enrolment when the process is open;

- In all future terms, mandatory courses are laid out at first and all empty places are filled with empty slots marked with a star, that the student can click to choose elective courses from a list of recommendations;
- The map automatically reorganizes itself according to the new choices and new order of mandatory courses, while preserving the slots that the student has modified manually.

As a recommender system, the open-source software Easyrec was chosen with its default set-up and with shopping analogies. For example, if students had shown interest in a course by clicking on it for info, or by adding it to the next term it is similar as showing interest in a product (a book for example). Similar rating for a product are as if students had similar grade for the course. Although there can be opposed views that a higher grade does not imply interest or true knowledge, still students can be grouped together depending on grades they have received for courses). The introduction of this system and the specifics are explained in [3].

In total, all of these developments give tremendous possibilities as an advice or recommendation to students that previously were unimaginable, especially having in mind the number of real academic advisers and how much free time that have for discussions. Some possibilities:

- The student can change to various study programs in order to find a more suitable path to graduations and even finish the studies earlier, if possible;
- Pace of studying (number of credits per term) can be changed in order to balance effort over future terms;
- The student sees a list of recommended popular freely elective choices in the starred slots, based on which are the most often viewed Subjects by other students in the past week;
- The student sees a list of recommended elective choices, based on what other students have attended and passed with similar grade;
- Recommended top study program based on what the other similar students are enrolled to.

It should be noted, that the first layout shown by the system is the recommended layout from the program curricula that the student has chosen. Mandatory courses are laid out first, according to proposed study year and term from the curricula, and then elective courses are put in the free places. With all the changes with the ECTS process, not all students from the same generation study the same set of courses at the same time and not all of them are at the same level. The proposed curricula are strictly followed only by the most accomplishing students, while the rest have a various mix of courses. This results with many empty slots in the future terms map, that allows for variation and gives space for recommendations with no further impact on the overall length of the studies.

#### COURSE RECOMMENDATIONS FOR PROSPECTIVE STUDENTS

The same virtual academic adviser can be used for high-school pupils that are interested to join the university (prospective students) in order to navigate through the various options for study programs and explore future possibilities. The system will start with an empty history of the person,

because he is not yet a student and does not have any past terms. A person can become a student with a status *Prospective* on as many institutions as interested and as such is able to use the virtual academic adviser, without possibility to truly enrol courses. The future terms map is constructed in the same way, depending on the chosen *Institution* and *Program*.

Since such students will not have course history from that university, they will not be able to get recommendations based on their performance at the studies at the university. Instead, course records from previous institutions could be used being it high-school or a previous university.

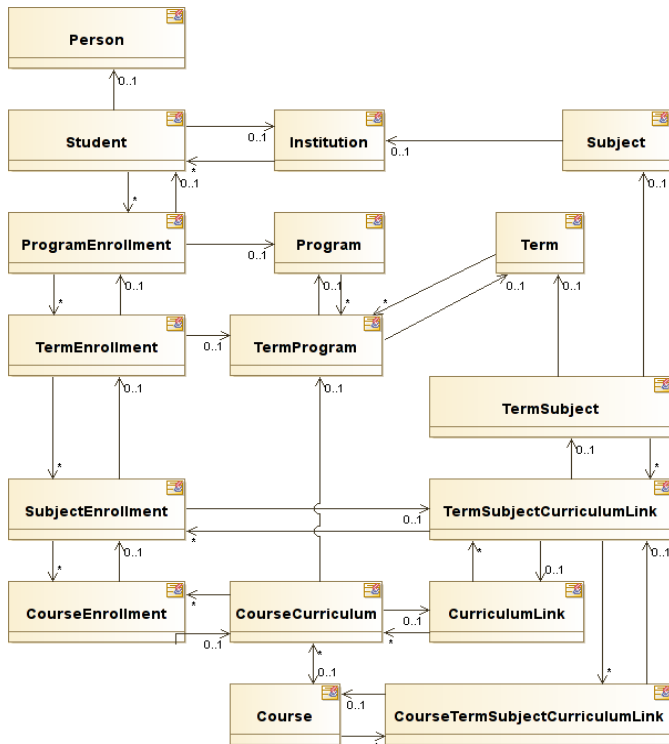


Figure 4: Model of persons, students and enrolments.

The system as-is already supports definitions of curricula for many institutions and many institution types without limits. Each person can be a member as a student at many institutions with different status at each of them (see Figure 4). Of course, the virtual adviser component will not have access to the systems of the earlier institutions of the student, so it will not be able to acquire the data needed for recommendations automatically.

This prospect has already been taken care of from the first versions of the information system. There is a special interface that allows the student to input all of his historical data from previous institutions, study programs, enrolments and grades, and all such inputs will be marked as *Uncertified*. If these records are later officially needed, the student can produce legal documents and the status can be changed by the administration.

Since course recommendations are given per *Subject* and *Curriculum*, students that come from another institution are treated similar to students that change *Program* during the studies. *CurriculumLinks* of a special *LinkType* are used to define similarities between courses, and all similar ones are treated as the same *Subject* and interests sent as such to the recommender engine. Even if that was not the case experi-

ments have shown that the recommender engine was able to successfully recognize such similarities and puts them at the same cluster. If all fails, there are options to manually create the clusters as needed.

If the prospective students want to guard their privacy, and are not willing to input records from previous institutions, or in the case there are too few students from the same institution, the course recommendation part of the virtual adviser will not be able to send sufficient historical data to the recommender engine and will not give expect valid recommendations in return. In such situations, this component is not used at all and all the courses are given to the student in an unsorted list.

#### SELF-ADAPTIVE PROCESS FOR CLASS TIME-TABLE SCHEDULING AND COURSE ENROLMENTS

The process of class time-table scheduling is usually done manually or with the help of a scheduling tool that deals with various constraints. The raising complexity of this process introduced by the increasing amount of possible choice in course selections during the term enrolment is discussed in more detail in [4] and an integrated approach is given with the introduction of a dynamic process that goes back and forth between the processes of term enrolments and creating of class time-tables.

As a summary, the proposed integration process starts even before students submit their initial course enrolments for the current term enrolment. An initial time-table has been provided by the respective administrators and during the course selection, the students have to select time slots from the time-table. If the time slots are OK the schedule and term enrolment is approved by the academic adviser (sometimes even automatically). But, if there are not free slots, students are put on waiting lists and it is the job of the supervisor and timetable administrators to oversee this process and perform in-time modifications of the time-tables and waiting lists, create new slots and transfer the students from the waiting lists to new slots. The coordination of the whole process is manually done by the supervisor based on numbers received on regular intervals from the system.

In this paper we propose a further exploration based on this concept with the introduction of self-adaptive mechanisms to this process. Self-adaptive systems usually employ a feedback control loop in which the system monitors it's own operation and changes itself by modifying the operating parameters just before the start of each next cycle [5]. We will employ such control loop in our system as shown in Figure 5.

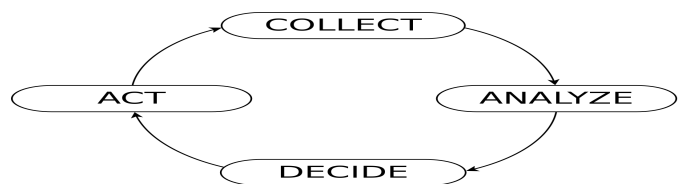


Figure 5: Control loop of the self-adaptive system

The discussed integrated process is susceptible to such modification since it invokes many interactions between the supervisor, academic adviser, time-table administrator and the student back and forth. The original proposition involved



manual monitoring of the system operation from the respective administration staff. However, since there are many types of students in a different context and status, the whole process can sometimes take many days and even up to two months within a single term, until all special cases are clear and satisfied.

The control loop would be implemented as a component within the existing information system and will be used to orchestrate the described integration process, phase by phase, student by student or group by group whatever relevant. In the following few paragraphs the four steps of the control loop will be explained with all the included mechanisms.

In the *Collect* step, the system is monitored and information needed from the students and other system components will be gathered:

- critical time-slots that are almost full
- length of student waiting lists
- numbers of students per each interim status of the enrolment
- numbers of students per year, per group, per status
- number of issues reported by students per category
- number of students without grades for historical enrolments

In the *Analyse* step, the operational status of the system is analysed according to the gathered parameters, historical data and boundary values for several symptoms that are identified in the symptom database:

- new groups will be needed soon on a course
- new teachers will be needed soon on a course
- course resources are exhausted
- courses will not be activated due to lack of students
- students ask for courses that are not on offer
- student grades are not input on time
- increasing number of students have complaints

In the *Decide* step, the system makes decisions on the actions that are to be performed, depending on the severity of the symptoms encountered and how critical are the values of the monitored parameters. In this case mainly the decisions should be made on when and how to act:

- send only information and status via e-mails
- invoke critical alarms to administration staff
- boundary limits can be changed because number of students expected will not exceed significantly
- ask advice on action from administration staff

In the *Act* step, all actions are orchestrated based on the types of decisions that were made and which symptoms were triggered. The actions that are present are:

- status information is sent to all users
- administration staff is informed that there are issues at hand together with the symptom analysis, respective numbers and possible decisions for the decision database
- critical alarms are activated per symptom
- boundary limit are modified and the action is logged
- decisions are logged
- symptoms are logged
- measured parameter values are logged

## CONCLUSION AND FUTURE WORK

The findings observed during the experimental tests with the latest development of the virtual adviser component suggest that even a generic recommender engine can be successfully integrated within the information system processes and it does provide a valid guidance on elective courses. The system is only used in positions where the student has a free choice and bad recommendations could not hinder the pace of studying of the student, only propose courses he will not like. The student also has access to static lists of courses from official curricula and can choose manually. So, the measure of success of the recommendation system has yet to be defined, since it does not obstruct regular processes. At the time being it can only be evaluated by the subjective satisfaction of the students from the issued recommendations.

One of the usual dangers of recommendation systems, popularity avalanche effect, is eliminated by design itself.. Students do not issue free ratings and can not freely mark course as interesting, so the interests will be spread among student groups with similar interests. Course resource limits will prevent over-amplification of interest measures.

On the other hand, the discussed process for integration approach of the term enrolment and course time-table creation can be monitored, analysed and acted upon automatically or manually via the proposed control loop framework. In this case it can be argued that the process is successful if finishes on time – before the official start of the semester. If that is not the case, the framework gives possibility to monitor the percentage of finished cases of student term and course enrolments and gradually increase the severity of symptoms and frequency of issued critical notifications to the administration staff and to students that have not been active.

## ACKNOWLEDGEMENTS

The development of the system is part of the research work under the project ISISng [6], which was partially funded by the Faculty of Computer Science and Engineering in 2012.

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