A Web-Based Decision Support System for Course Alternatives in the Study Programme Broker CUBER

Latifa Boursas, Jörg Keller and Sarah Magerkurth
FernUniversität Hagen
Germany
{latifa.boursas,joerg.keller}@fernuni-hagen.de

Abstract: The EU-funded project CUBER strives to develop a web-based course broker facility where prospective students can inform about study programs offered by the CUBER partners. As these students might want to tune existing programs to their interests, course alternatives should be offered by the system to support this tuning. To do this, the CUBER systems needs a mechanism to automatically derive whether two courses can be exchanged in a program or not. We report on our achievements towards this mechanism.

Introduction

Prospective students currently find information about study opportunities on the internet either at institutions´ web sites or in collections provided by third parties. The former have the disadvantage that many sites have to be visited in order to get a market overview. The latter have the disadvantage that the information often is incomplete or not detailed enough. The CUBER project (CUBER Project Partners, 1999), funded by the European Commission under the IST-programme in the 5th framework, strives to develop a web-based facility where institutions themselves provide information about their study programmes at a level of detail that comprises meta-data of single courses. The prospective student can search this information to find courses or study programmes satisfying his needs and interests. The CUBER consortium comprises distance teaching institutions and conventional universities of all over Europe. Often a prospective student is not satisfied with a study programme as it is offered. He might want to exchange a particular course in that programme against a course that better suits his interests and needs. However, that course might only be offered by another consortium member. So the question arose whether the student can receive a recommendation by the system whether this exchange is possible. This recommendation should naturally not be based on static exchange tables, as these would be too cumbersome to maintain. In the sequel, we will report about our approach to solve this problem.

Automated Course Exchange

The goal of CUBER´s Workpackage 9 "Credit Point System Integration" is the automation of course acknowledgement. Consider the situation of a student planning to enrol into a study programme, who wishes to exchange a course A of his programme against a course B by another provider that better suits his particular interests and needs. Currently, the student requests this exchange at his local administration. The request is granted or denied after some administrative process which takes weeks or even months. Requests of this kind also happen when a prospective student is tailoring a programme offered to him by the CUBER system. In this case, however, a decision has to be done by the system as the student expects an immediate response. A similar kind of request happens if a prospective student requests acknowledgement of courses he has already completed successfully in a previous study. An immediate answer is necessary here as well in order to enable the student to guess his total workload to complete the programme offered to him by the CUBER system. Note, that the above "decisions" are not binding for the institutions involved. Therefore they might be considered a best effort guess. On the other hand, this guess may only differ from the institution's final decision in very peculiar instances, in order not to risk acceptance by the system's users. In order to find out to what extent course acknowledgement can be automated, we first looked for an existing system that is recognised at least all over Europe, is used in practice on a large scale, and allows transfer and acknowledgement of study success internationally. The only system implementing these points is the European Credit Transfer System ECTS (European Commission, 2002). It serves as an instrument for providing academic recognition of short study periods in relation with student mobility when comparing academic qualifications from different countries.

While ECTS does not allow automatic acknowledgement of courses, the process is strictly formalised. Furthermore, ECTS provides an established and unified "currency", the ECTS credit points which reflect the amount of work necessary to pass a course in relation to the required Curriculum (Csanyi and Keller, 2001).

In the first part of our study, we considered the case that both courses A and B are offered by CUBER partners, i.e. that metadata for both courses are available to serve as input to the acknowledgement algorithm. We started with a survey of the practice of course acknowledgement in the institutions, and partly, in the countries, that participate in the CUBER project. To do this, a questionnaire was distributed to all CUBER partners. The questionnaire contained questions about ECTS and on the current procedures for course exchange and acknowledgement. We evaluated the questionnaires received (Galindo, Kautonen and Keller, 2001). From the findings of this survey, we extracted the rules and parameters representing the process of course acknowledgement, i.e. the decision process whether one course can be exchanged against another. We identified the information about courses needed to evaluate those rules and parameters, and verified that this information is present in the course metadata. In accordance with with the findings of a study to evolve ECTS into the European Credit System ECS (Adam and Gemlich, 2000), we found that the decision process involves

- the courses´extent, e.g. the number of ECTS credits assigned to them;
- the courses' placement in the curriculum, e.g. whether they are undergraduate or graduate;
- the courses' examination methods, i.e. whether only presence of students was checked, whether assignments were evaluated, or whether there was an examination at the end of the course;
- the courses´contents, i.e. whether the topics covered by the courses match sufficiently.

The Exchange Algorithm

The exchange algorithm allows substitution of a course A by a course B if the comparison in all four categories described above supersedes the thresholds assigned to each category. The first three parameters can be expressed numerically, with partial orders defined on the number spaces used. The ECTS credits are integers by themselves. The placement is numbered from 1 to 5, larger numbers indicating a placement in a later phase of the curriculum. The examination methods are numbered from 1 to 6, larger numbers indicating a more rigid examination method. The threshold values can be fixed individually by each institution. For example, FernUniversität might require that course B must have at least 90% of the ECTS credits of course A, while another CUBER partner only requires 80%. The threshold for the placement might be that course B might be placed at most one level below course A. A similar scheme, or a matrix of valid combinations of examination methods for courses A and B, can be used for the third parameter.

The course content is described in the meta-data by a list of keywords and a field with free text describing the course. Furthermore, each course is assigned a category from a standardised classification of the IT-field, in our case the classification system of the Association for Computer Machinery (ACM) (Association for Computer Machinery, 1998). Each of these three information fields has some disadvantages. The free text is not really suitable for a comparison by a computer because there are too many possibilities to express the content. The category is a very rough measure, it can only be used as a kind of filter to accelerate the comparison of a particular course to a large catalogue of courses, where only those that have the same (or a close) category are considered relevant candidates for exchange. The list of keywords is suitable for a comparison provided that the keywords are assigned to courses in a uniform manner, independent of the person or the institution that assignes the keywords. If this assumption holds, then the comparison can be reduced to a matching algorithm that counts how many keywords are present in both descriptions, and weights this count with the number of ECTS credits per keyword. The ECTS credits represented by the match must be more than the threshold percentage of the total credits for course A, say e.g. 70%, to enable substitution of A by B. The uniform use of keywords provides a challenge for the acquisition of course meta-data. It can be supported by a self-adapting keyword database. For instance, when creating meta-data for a course in a particular category, the authoring interface used for course acquisition could propose keywords used in other courses in that category. As all the thresholds values are somewhat arbitrary, the computations contain some simplifications (e.g. that each keyword represents the same fraction of the course ECTS credits) and the parameters are not completely independent, a decision based on the simultaneous fulfilment of four criteria may turn out to be to restrictive in practice. A possible solution could be to incorporate a more “fuzzy” like decision algorithm to cover situations where a course B supersedes the thresholds in three criteria and almost supersedes the threshold in the fourth. In this case, many institutions tend to accept where the current algorithm would forbid the exchange. In such

borderline cases, and other exceptional cases where prospectives students have the impression that the algorithm is too restrictive, one could amend the user interface by an option to request human, offline re-consideration.

Further Exchange Issues

Our study also considered two further issues related to course exchange. First, prospective students might already have accumulated some academic credits that they may want to have acknowledged in order to reduce the amount of future studies within their program of choice. Second, programs often have structures that include catalogues of courses where a certain number out of these must be completed. In this case, the basic exchange algorithm must be complemented by further rules in order to cover this situation.

If a prospective student wants to substitute a course A in his program by a course B that he has already successfully completed in a previous study, then there are no meta-data available for course B and there is no proof of the successful completion. The latter even holds if course B was offered by one of the CUBER partners, as the CUBER system does not have access to the institutions' student databases. In this case, the prospective student must provide the necessary meta-data and the CUBER system can only make a best-effort guess under the assumption that the information provided by the student is accurate. We concentrated on how the meta-data can be input most efficiently, and how the system might assess the validity of the data. While the student can quickly enter the courses title and the first three parameters with multiple choice select boxes and some helpful text, the input of the content presents some challenge, for reasons similar to the ones given for content comparison. Here, a hierarchical scheme may help to first find the appropriate ACM category. With the help of that category and the title, keywords from related courses can be given as a proposal. This helps to use a consistent notation.

Many study programmes contain parts where a catalogue of courses if offered and the student is to complete a certain number of these courses, which he is free to choose from the catalogue. In this case, our questionnaire disclosed the following policies in use by departments:

1. *one-by-one*, ie. a course B may only replace a course from the catalogue if there is one course A in the catalogue which may be replaced by course B.
2. *no-double-use*, ie. a course B may only replace a course from the catalogue if B's content shows almost no overlap with the remaining courses taken from the catalogue. Some departments require that B must be part of the catalogue's topic, while others only require that B is from the IT-area, or accept any course.
3. *union*, ie. a course B may only replace a course from the catalogue if B's content shows almost no overlap with the remaining courses taken from the catalogue, but shows considerable overlap with the courses from the catalogue that are not taken.

The *one-by-one* policy allows only a quite restricted form of substitution. It is applied if the courses from the catalogue cover some field completely and most or all courses are to be taken. It also has the advantage to be easy to implement, be it on institutional level or as an algorithm. The *no-double-use* policy is quite liberal. It only tries to ensure that a course is not replaced by material that is already covered by the other courses taken from the catalogue. Besides that, any course within the allowed scope is possible. This policy is applied if the catalogue covers a wide area (e.g. "take 3 out of 6 courses from applied computer science"). The *union* policy is a restricted form of the no-double-use policy, it allows a course A from the catalogue only to be substituted by a course B if B's content is covered by existing courses from the catalogue that are not taken. It is applied if the courses from the catalogue cover some field completely.

Implementation in the Search Engine

The CUBER search engine offers the possibility to find courses against which a given course A can be exchanged, assuming the *one-by-one* case is used. In the search engine the user selects a course A and then submits the exchangeability option for this course. From the exchangeability parameters of course A, a search request will be formulated for uploading a pre-selection of courses from the CUBER database. Then each of the pre-selected courses will be compared with the course A. After comparing all uploaded courses, all remaining courses fulfilling the requirements for *one-by-one* exchange with a course A are presented as a search result.

The search request will be formulated with regard to the exchangeability parameters of the given course A. The data elements used are extent, placement, examination method and keywords. For finding courses in the database these parameters have to be transformed into search predicates. Search predicates will be defined with help of the data elements for extent, placement and examination method of the given course A. Courses that fulfil the defined search predicates and in addition have at least one keyword with the keywords of the given course A in common, defines the set of pre-selected courses that will be uploaded from the database. The content comparison is done in the search engine for uploaded courses. The algorithm for the content comparison will be applied to course A and each of the uploaded courses. After the content comparison the remaining courses are returned as the result set for course A. The exchangeability parameters for measuring the courses' extent, placement and examination method are available for all entered courses of the CUBER database. For comparing the content each course of the CUBER system provides a list of checked keywords. The percentage parameters alpha for comparing ECTS credits and beta for measuring the content will be fixed as parameters of the exchangeable algorithm. A search for exchangeable courses will be possible for each course available in the CUBER database. Thus this option can be offered for each course presented in the search interface in form of an "Exchangeability Link" or "Exchangeability Button" assigned to a selected course A. Clicking the "Exchangeability Link" or "Exchangeability Button" will return a list of courses exchangeable with the selected course A.

Conclusions

In the second part of our study, we did a small scale evaluation of the exchange algorithm with courses of two project partners (Csanyi, Galindo, Kautonen and Keller, 2002). The courses were carefully chosen to cover most of the possible outcomes with few courses. The results of the exchange algorithm closely matched the decisions of the institutions. It turned out that the algorithm might be too restrictive in border-cases, which might indicate that a fuzzification as described could be useful. Within the services provided by the CUBER system, flexibility for the user, i.e. the prospective student, is a strategic goal to achieve acceptance. The facilities for course exchange, i.e. by automatic recommendation of possible alternatives to a particular course in a study programme, try to support this goal. The achievements towards automatic exchange or acknowledgement of courses are promising, as the evaluation indicates. Since the end of the CUBER project, the CUBER system is run and used by several project partners in the CUBER trial, i.e an extended test and evaluation phase.

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