

On Some Intrinsic Limitations of Credit Transfer Systems

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Abstract: After a brief introduction in which the usefulness of credit point systems is explained, the relevant features of these systems are described. As an example the European Credit Transfer System (ECTS) is discussed and credit transfer within the United States is mentioned as well. In this context it is pointed out that credit transfer on a purely formal level appears difficult although it would be rather desirable from an administrative point of view. In order to analyze these intrinsic limitations of credit transfer systems an abstract model is presented and some techniques from the field of pattern recognition are applied to it. The results thus gained provide strong evidence that credit transfer on a purely formal level using a linear discriminant as in the present systems is not likely to work in general. Hence the learning agreement, as utilized in the ECTS system, is seen to play an important role. Finally some recent results on knowledge spaces are noted.

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Introduction

With the growing together of the member states of the European Union (not only economically but also politically), the importance of student mobility has increased significantly. This has been recognized for quite some time and thus, to facilitate student movement across borders, the European Credit Transfer System (ECTS) has been operational for more than a decade. Many details of this system have been modeled on the American credit points system which was introduced towards the end of the 19th century, cf. e.g. [Dal] for further information. However, it must be clearly understood that the American system (in contrast to the ECTS) was originally not designed to facilitate transfer between universities within the whole of the United States and indeed does not necessarily do so if one neglects transfers within the same federal state. In fact it came into being as a consequence of the introduction of an “elective system” which replaced the former rigid curriculum. In Europe, strangely enough, in some sense the development took the opposite direction: After the ECTS had been created, at least within Germany, courses had to be assigned credit points somewhat artificially. Since the Bologna decision, cf. [Bol], and the subsequent ubiquitous introduction of Bachelor- and Master courses, however, modularization of courses took place virtually everywhere and thus an almost automatic assignment of ECTS credits to courses was the result. In addition the rapidly changing technological environment very naturally lead to the concept of “life-long learning”, which became very important indeed in Germany in view of the rapidly rising unemployment figures. The realization of this concept necessitates an extension of the credit point system since accumulation of points must be possible. Whilst simple in principle this may be technically quite cumbersome since a large amount of data has to be held within a suitable database for a long time.

Of course, there are significant draw backs to credit point systems, as pointed out e.g. in [Dal]. Nevertheless the authors are convinced that, at least to facilitate student mobility, they are extremely useful.

In the light of the preceding considerations it may thus come as a surprise that it is the purpose of this paper to point out some intrinsic problems arising from credit transfer systems.

Credit Transfer Systems (Relevant Features)

All credit systems (transfer or accumulation system) encompass two essential (for the purposes of this paper) components, namely credit points and grades. It should be clearly understood that the two concepts are almost disjoint and must not be confused (as is often the case). A student who has successfully attended a course c collects a certain number of credit points. The *number of points* is usually derived in a well-defined fashion from the theoretical work load associated with c (as given e.g. by the number of working hours/ semester required). The *grade* achieved in contrast describes the quality of the student’s work in that course. The only connection between the two concepts thus arises from the fact that a student will only be able to collect credit points if he has achieved at least the pass mark for the course in question. If, for example, a student wishes to transfer his examination results achieved abroad under the ECTS then he has to have achieved the required number of credit

points (usually 30 per semester, 180 for a Bachelor's degree). In addition the grades achieved abroad are converted by an ingenious scheme (described in the ECTS user's guide, cf. [ECT]) since within Europe there is an abundance of grading systems. This, in the experience of the first named author (who acts as ECTS coordinator for his university), works quite satisfactorily if a suitable learning agreement (as also required by the ECTS) has been signed. However, there is a strong feeling amongst many administrators that the grade conversion should be a purely formal procedure as indeed it was possibly envisaged at the start of the ECTS.

Within the United States, as mentioned in the introduction, a similar credit point system is applied. In contrast to the European situation, however, there is only one grading system (implemented by computing the so-called grade point average (GPA)). Hence one would expect that a transfer between American universities would be far simpler than in Europe. Unfortunately, with a few exceptions, this does not seem to be the case: The equivalent of an individual "learning agreement" apparently does not exist and an exchange between universities say in Michigan and California would be quite complicated in general, not to mention the almost impossible exchange between some obscure provincial university and one of the famous universities like Harvard, Yale, Princeton, Berkeley or Stanford (to mention but a few). Of course it must be admitted that a comparable exchange within Europe (where Yale etc. could be replaced by Oxbridge or the likes) still poses special problems as well.

In view of these facts it appears that there are some problems concerning the use of a credit transfer system on a purely formal level. Hence it seems justified to apply some fairly recently developed mathematical techniques from the field of pattern recognition to indicate how these might arise.

Credit Transfer Systems (Abstract Model)

In this section the transfer of credit points only is being considered (the grade conversion problem does not arise in the US context and in any case may be treated by similar arguments, cf. e.g. [Fal2]).

So consider two different universities U_1 and U_2 say, offering courses $c_{11}, c_{12}, \dots, c_{1m}$ respectively $c_{21}, c_{22}, \dots, c_{2n}$ with associated credit points $p_{11}, p_{12}, \dots, p_{1m}$ respectively $p_{21}, p_{22}, \dots, p_{2n}$. Suppose further that a transferral of points for a semester is considered (for definiteness think of 30 credit points being required). If now the c_{ij} are interpreted as Boolean variables taking the values 1 if the relevant course has been successfully attended and 0 otherwise, then students can be classified as successful respectively unsuccessful students according to whether

$$\begin{array}{l} c_{11}p_{11} + c_{12}p_{12} + \dots + c_{1m}p_{1m} \geq \text{respectively } < \text{ at } U_1 \\ c_{21}p_{21} + c_{22}p_{22} + \dots + c_{2n}p_{2n} \geq \text{respectively } < \text{ at } U_2 \end{array} \quad (*)$$

This imposes a "partial order" on students at both universities in the sense that a successful student will be deemed better (only academically of course!) than an unsuccessful student at either university, whilst nothing is being said about a preference amongst successful (or unsuccessful) students.

Of course, in order to obtain a fair transfer and guarantee uniform standards, it would be necessary that at U_1 precisely the same students will be deemed successful as those at U_2 . Given the large variety of courses and corresponding different weightings across Europe alone it is by no means obvious that it will be possible to create a fair transfer system in general (if it were, then one could indeed install a suitable transfer system operating on a purely formal level).

Indeed, a formal analysis will provide strong evidence that such a system will not be possible in general. In order to carry out the mathematical investigation some techniques that originated from the field of pattern recognition and have also successfully been used in a financial context, cf. [Fal3], as well as in information retrieval, cf. [Fal1], will be utilized.

Some Mathematical Results and their Consequences

The left hand side of the inequalities appearing in (*) above is called a “linear discriminant”. The significance of this terminology may easily be discerned as follows: Consider two courses only at U_1 and forget about the Boolean nature of the variables c_{11} and c_{12} and rather consider them as general weightings for the points scores. Then it is immediately obvious that if students are identified with their points scores, considered as points with coordinates (p_{11}, p_{12}) in the plane, the separation between successful and unsuccessful students at U_1 is effected by the straight line $c_{11}p_{11} + c_{12}p_{12} = 30$.

Moreover it is also easy to see, that if there were two successful students at U_2 achieving points scores $(10,30)$ and $(30,10)$ at U_1 and two unsuccessful students at the same university with points scores $(10,10)$ and $(30,30)$ at U_1 , then it would be impossible for any given weighting of the courses at U_1 to separate them as described.

This, admittedly somewhat artificial, example may help to illustrate the problems arising: If a partial order is defined on the students by U_2 , then the partial order must be such that it can be realized using a suitable straight line by U_1 . If such is the case, then the students are said to be separable by U_1 .

The point, however, is here that these considerations generalize to quite some extent to an arbitrary number of courses. The relevant statistical result is

Theorem [Rip], p. 119: The probability that k patterns (students as represented by their points scores) randomly chosen from any continuous probability distribution in \mathfrak{R}^n and randomly divided into two groups are linearly separable is one for $k \leq n+1$ and in general is asymptotically equal to $\Phi((2n-k)/k^{1/2})$, where Φ denotes the standard Gaussian distribution. Although this theorem does not apply directly to the situation considered here, it is easily seen that it provides an upper bound for the required probability. It follows immediately that the probability for linear separability decreases very rapidly to zero if k exceeds $2n$, since the Gaussian distribution is tightly concentrated around zero.

Hence, for a large number of students, there must be severe doubt, that the separability assumption could hold, even if one concedes that the assumption of random selection (as required by the theorem) of successful/ unsuccessful students is somewhat unrealistic in practice.

Conclusion and Outlook

The results given above do not offer conclusive evidence that credit transfer systems as for example represented by the ECTS cannot work on a purely formal level. Nevertheless they strongly suggest that this is indeed so. In addition the first named author has found that the signing of a learning agreement, as required by the ECTS, does facilitate exchange arrangements in the sense that contents of courses have to be discussed and thus sensible decisions can be arrived at.

This is all the more important since after the Prague Summit on Higher Education 2001, cf. [Pra], the ECTS is to be used as an accumulation system as well. Hence it will have to be applied to approximately 100.000 different degree courses in Europe.

Of course, it would still be rather desirable to have a credit transfer system that works on a purely formal level. The authors do feel, however, that this would necessitate including an evaluation of course contents with respect to difficulty and not just using a linear discriminant thus (partly?) replacing the present learning agreement of the ECTS system. At the time of writing it is not clear how this might be achieved.

It should be noted though that a promising approach to the last mentioned problem has been presented in [Doi], where the concept of knowledge structures and spaces is discussed extensively. These abstract constructs allow the introduction of a hierarchical structure into course modules as well as a compatibility check between different modules and thus possibly a formalization of the learning agreement. The authors of the present paper are about to apply these concepts in a realistic setting. To be more precise: A formal test concerning a compatibility check between Master degree courses in Information Systems Management/ Business Informatics at an American respectively the authors' University will shortly be conducted. It remains to be seen whether the hopes generated by the interesting theory presented in [Doi] can be substantiated by the experimental results.

Literature

- [Bol] Bologna Declaration, European Higher Education Area (EUA), 19th June 1999
- [Dal] F. Dalichow: Kredit- und Leistungspunktsysteme im internationalen Vergleich. Bundesministerium für Bildung, Wissenschaft, Forschung und Technologie, Germany, (1997)
- [Doi] J.-P. Doignon, J.-C. Falmagne : Knowledge Spaces. Springer-Verlag, (1999)
- [ECT] ECTS USERS' GUIDE. European Commission, 31.03.1998
- [Fal1] B.-J. Falkowski: Similarity Measures, Ranking Functions, and Perceptrons. Appeared in: Proceedings of the First International NAISO Congress on Neuro Fuzzy Technologies (NF 2002), ICSC-NAISO Academic Press, Canada/The Netherlands, (2002)
- [Fal2] B.-J. Falkowski; I. Sulk: Zur Existenz von Ranking Funktionen. Appeared in: Proceedings der WIWITA 2002 (3. Wismarer Wirtschaftsinformatiktage), Hochschule Wismar, (2002)
- [Fal3] B.-J. Falkowski: On Scoring Systems with Binary Input Variables. Appeared in: Proceedings of the 6th World Multiconference on Systemics, Cybernetics and Informatics, Vol. XIII, International Institute of Informatics and Systemics, (2002)
- [Pra] Prague Summit on Higher Education. Communique of the Meeting of European Ministers in Charge of Higher Education, 18-19 May 2001
- [Rip] B.D. Ripley: Pattern Recognition and Neural Networks. Cambridge University Press, (1997)