THE QUALITY CERTIFICATION MARK FOR ITALIAN UNIVERSITY DEGREE PROGRAMS IN COMPUTER SCIENCE

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ABSTRACT

The new rules recently introduced in the Italian University organization force the academic community to face the issue of quality assessment and certification of undergraduate and graduate degree programs. The autonomy that has been granted to each University in the specification of the curricula allow the faculties to design their products both with respect to the requirements of the work market, and with respect to the cultural expectations of their potential students. Unfortunately, the quality of Computer Science curricula is at risk, as Computer Science is often confused with the use of computer technologies, while disregarding the complexity of methodologies and scientific tools that are behind them. The Italian Association of Computer Science University Professors (GRIN) promoted a common effort involving almost all of the Italian Universities towards the elicitation of the "product qualities" of undergraduate and graduate degree programs in Computer Science, and characterized the constraints to be fulfilled in order to obtain the GRIN quality certification. There is no other similar initiatives in the Italian academic context. In order to manage this certification process, a web site is maintained by the NESTOR Laboratory at Università di Roma "Tor Vergata". About 40 university degree programs in Computer Science obtained the 2004 GRIN quality certification mark. This project has been supported by the Italian Council of University Deans (CRUI).

1. INTRODUCTION

Proficiency in Computer Science is nowadays a must for everyone, and being a good Computer Scientist is (still) a passport for a very qualified job. This is why a university degree in Computer Science is a tempting opportunity for many students and their families. It allows to enter the restricted number of privileged people that not only know how to deal with computers and networks, but that have the intellectual skills to foresee the directions of the emerging technologies and take part of their future development.

However, there is still a lot of confusion about what teaching and learning Computer Science really means. Nobody would say that being a good car driver is the same as being a good mechanical engineer (there is a non trivial difference between a driving licence and a university degree!), though this is exactly what happens when Computer Science is identified with (and thought as) the use of current hardware and software technologies, while disregarding the scientific foundations and the methodologies that characterize this discipline.

Computer Science is a very dynamic area, where the obsolescence of its artefacts is getting more and more swift-passing. Thus, the challenge for any University degree program in Computer Science is to provide the students solid scientific and technological bases so that they may have the edge in this field not only after graduation, but still in the following 10-15 years. Thus, every Computer Science University degree program is required both to provide a solid scientific and technological background, and to cover as much as possible the wide spectrum of disciplines exploiting the computer science methodology.

The autonomy that has been granted to Universities in the specification of their curricula forces the faculties to highly qualify their products with respect to the plethora of courses that are offered in the educational market. Students and families get often confused by radio and TV commercials. Also when focussing just on curricula offered by the University system, it is very difficult to evaluate the values of curricula that look very similar. The same holds for enterprises and recruitment agencies, having hard time to classify the different Universities with respect to the quality of each undergraduate and graduate degree program, as the contents and the structure of the whole University system has deeply changed in the last three years.

In this context, each University delivering a degree program in Computer Science should be fair enough to guarantee that their curricula cover the basic spectrum of scientific knowledge in Computer Science, and that courses are given by qualified professors. Unfortunately in Italy the second condition above is often disregarded, as there are Universities degree programs in Computer Science where not even one faculty member has a PhD neither in Computer Science nor in Computer Engineering.

The Italian Association of Computer Science University Professors (GRIN, http://www.di.unipi.it/grin) promoted a common effort involving almost all of the Italian Universities towards the elicitation of the "product qualities" of undergraduate degree programs in Computer Science, and characterized the constraints to be fulfilled in order to obtain the GRIN quality certification. Rules and results of this certification process are made public, in order to provide families and enterprises to do the right choice.

There is no other similar initiative in the Italian academic context. In order to manage this certification process, a web site is maintained by the NESTOR Laboratory at Università di Roma "Tor Vergata". The result of the 2004 certification process are available at the URL http://crui.nestor.uniroma2.it/certificazione/beta/ by connecting as generic user.

In 2004, there were 39 Italian Universities offering undergraduate degree programs in Computer Science. The total number of degree programs in Computer Science was 57. At this date, 31 Universities (and 29 undergraduate programs) obtained the GRIN 2004 quality certification mark.

2. CERTIFYING THE QUALITY OF UNDERGRADUATE AND GRADUATE DEGREE PROGRAMS IN COMPUTER SCIENCE

The scenario of Italian University degree programs in Computer Science is characterized by two relevant factors:

- the broad autonomy of each University in the specification of the curricula within the same national constraints results in very different curricula yielding the same legal value, and
- the lack of resources asks for a very low-cost quality assessment.

The GRIN Association decided to adopt the following criteria, in order to avoid the need of heavy organizational duties: The quantity of data to be treated should be quite limited; data should be easy to get and to check; data should be already available at each site, as part of the usual public information provided to potential students. The GRIN quality certification is based on the verification of the fulfilment of a set of constraints on the programs.

The general guidelines to define the certification rules are as follows:

- The percentage of courses in Computer Science in the degree program has to be high.
- The main areas of Computer Science should be properly covered
- The degree program should not too much focussed on a single area.

Two certification levels were designed, the first one aimed at undergraduate degree programs (*certificazione base*), the second one for graduate degree programs or for very demanding undergraduate programs (*certificazione avanzata*). Observe that also graduate programs having an interdisciplinary character might be granted a first level certification.

According to the ACM-IEEE classification, a list of 11 main Computer Science areas was identified, as depicted in Fig.1, and a detailed list of subtopics were associated to each of them.

A. Foundations
B. Algorithms
C. Programming
D. Computer Languages
E. Computer Architectures
F. Operating Systems
G. Data Base Management Systems
H. Network Computing
I. Software Engineering
L. Human Computer Interaction – Graphics - Multimedia
M. Knowledge Representation

Fig.1: Main Computer Science Areas

The certification rules are defined in terms of credits (cfu): a credit is the European measure unit corresponding to 25 hours of learning activities, including lectures, training, and individual study for the average student. In the practice, each credit corresponds to an average of 8/10 hours of class lectures, including exercises and laboratory activities. An academic year corresponds to 60 credits. Each Italian undergraduate degree program (*laurea triennale*) corresponds to 180 credits.

In order to be eligible for the GRIN quality certification mark, each University degree program in Computer Science must satisfy the following constraints:

- At least 78 cfu must be assigned to learning activities in Computer Science or in Computer Engineering.
- At least 60 cfu (out of the 78 above) must be assigned to learning activities in the 11 areas listed in Fig.1
- At least 7 areas (out of the 11 listed in Fig.1) must be covered by at least 6 cfu.

It is easy to verify that these rules strictly correspond to the three criteria presented above. The first rule guarantees that more than 1/3 of the program is specifically dedicated to Computer Science topics; the rest of the credits should cover mathematical and physical foundations, more specialized topics, or complementary aspects (e.g., legal, economical, and ethical issues). The second rule guarantees a good coverage of the main areas of Computer Science; observe that credits assigned to the same area can be spread among different courses. Finally, the third rule prevents from degree programs whose scope is too narrow: at least half of the 11 areas must be properly covered, say by at least 48 hours of lectures.

3. THE CERTIFICATION PROCESS MANAGEMENT

Each year, the chair of each Computer Science degree program may apply for the GRIN quality certification by inserting in the certification web site the data concerning the activated curricula, and the syllabus of each course taught. For each course, the following information has to be provided: total number of credits, number of credits labelled as "computer science", and corresponding area (see Fig.1). A synthetic description of the contents of each credit in the 11 areas has to be inserted as well. The quality certification is issued by the GRIN National Educational Committee on the basis of these data. It is important to notice that all these data are made public in the web, and they offer the reader a complete and synoptic picture of almost all of the Academic degree programs in Computer Science (also of the Universities that do not fulfil the certification requirements). Moreover, this systematic list of the contents allows to refine the "Diploma Supplement" each European University is required to provide his students.

As mentioned before, in order to manage the certification process, a web site is maintained by the NESTOR Laboratory at Università di Roma "Tor Vergata". By selecting the link *utente generico* in the home page of the certification site (Fig.2), the list of the Italian Universities which obtained the GRIN quality certificate is shown. The other link (*utente registrato*) is reserved to the chair of each University degree program in Computer Science to insert and update data before the annual application deadline for certification.

Fig.2: The certification site home page

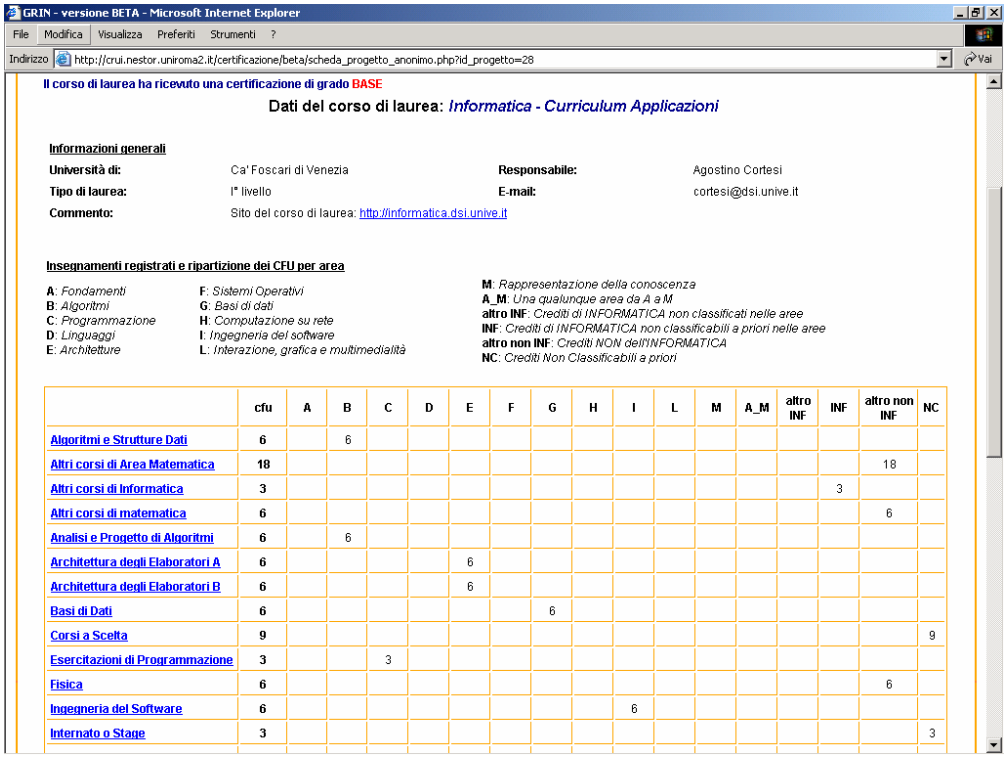
The generic user may then go through the list of all undergraduate degree programs that received the GRIN quality mark. In the rightmost column of the list, the level of obtained certification mark is shown (see Fig.3): *BASE* means that this degree program obtained the base quality mark; *AVANZATA* means that the program obtained the advanced quality

mark; finally, the empty space means that the program has not yet fulfilled all the requirements to be eligible for the quality certificate.

Corsi di laurea di primo livello	Università di	Responsabile	Certificazione
Informatica - Percorso A: Sistemi basati su conoscenza	Bari	Maria Francesca Costabile	AVANZATA
Informatica - Percorso B: Progettazione del software	Bari	Maria Francesca Costabile	AVANZATA
Informatica - Percorso C: Sistemi di elaborazione intelligenti	Bari	Maria Francesca Costabile	AVANZATA
Informatica e Comunicazione Digitale	Bari	Vito Leonardo Plantamura	BASE
Informatica	Basilicata	Martin Funk	BASE
Informatica	Bologna	Maurizio Gabbrielli	BASE
Scienze dell'Informazione	Bologna - sede di Cesena	Marilena Barnabei	BASE
Informatica - Curriculum Applicazioni	Ca' Foscari di Venezia	Agostino Cortesi	BASE
Informatica - Curriculum Generale	Ca' Foscari di Venezia	Agostino Cortesi	BASE
Informatica - Curriculum Gestionale	Ca' Foscari di Venezia	Agostino Cortesi	BASE
Informatica - Curriculum Sistemi	Ca' Foscari di Venezia	Agostino Cortesi	BASE
Informatica	Cagliari	Francesco Aymerich	BASE
Informatica - Indirizzo Informatica e Management	Camerino	Flavio Corradini	BASE

Fig.3: A partial list of certified degree programs in Computer Science

By selecting the name of a University degree program in the leftmost column of this page, the interested reader may see the details of its organization (see Fig. 4). In particular, for each course in the degree program the corresponding Computer Science Areas are specified, and the distribution of credits with respect to them.



	cfu	A	B	C	D	E	F	G	H	I	L	M	A_M	altro INF	INF	altro non INF	NC
Algoritmi e Strutture Dati	6		6														
Altri corsi di Area Matematica	18															18	
Altri corsi di Informatica	3														3		
Altri corsi di matematica	6															6	
Analisi e Progetto di Algoritmi	6		6														
Architettura degli Elaboratori A	6					6											
Architettura degli Elaboratori B	6					6											
Basi di Dati	6							6									
Corsi a Scelta	9																9
Esercitazioni di Programmazione	3			3													
Fisica	6															6	
Ingegneria del Software	6									6							
Internato o Stage	3																3

Fig.4: A partial list of certified degree programs in Computer Science

By selecting the name of a single course, in the list of certified degree programs, one may see detailed information on it, namely the corresponding areas and an ordered list of its content (see Fig. 5), one item per credit.

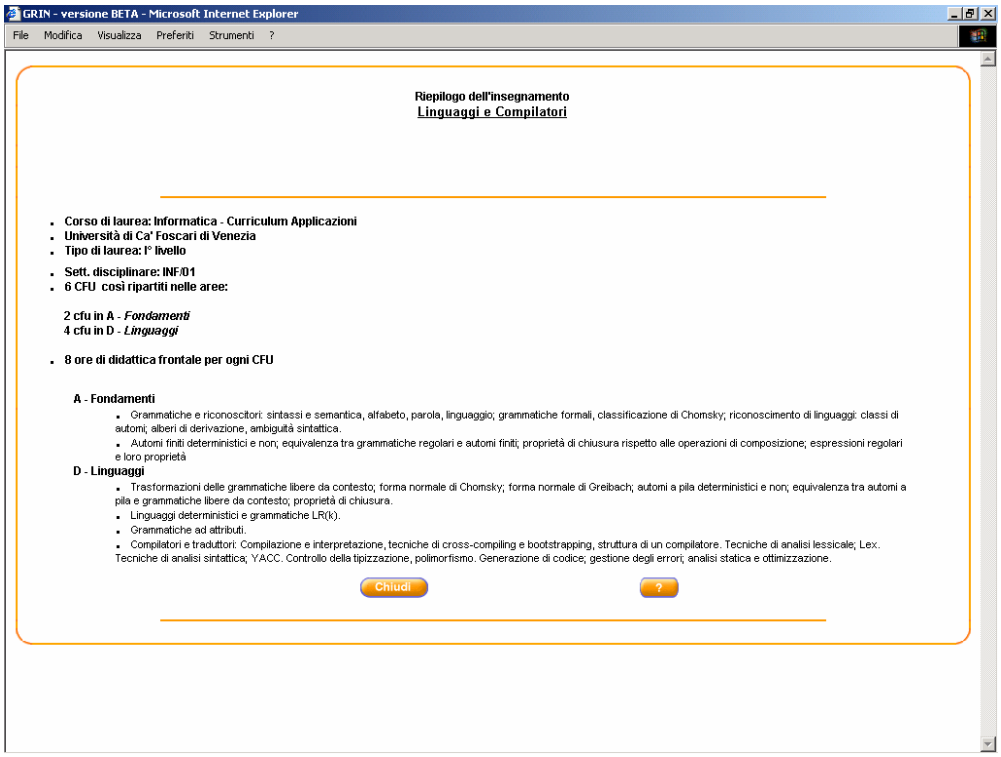


Fig.5: Detailed information on a single course

In the uppermost part of the page of certified degree programs (Fig.3), the link *Corrispondenze insegnamenti* allows to discover semantic correspondences between different courses. The correspondance is based on the 11 areas (Fig. 1), and it can be a valuable base to evaluate the curriculum of a student that moves from a University to another, or that applies for graduate studies in a different University. A sample of its application is depicted in Fig. 6.

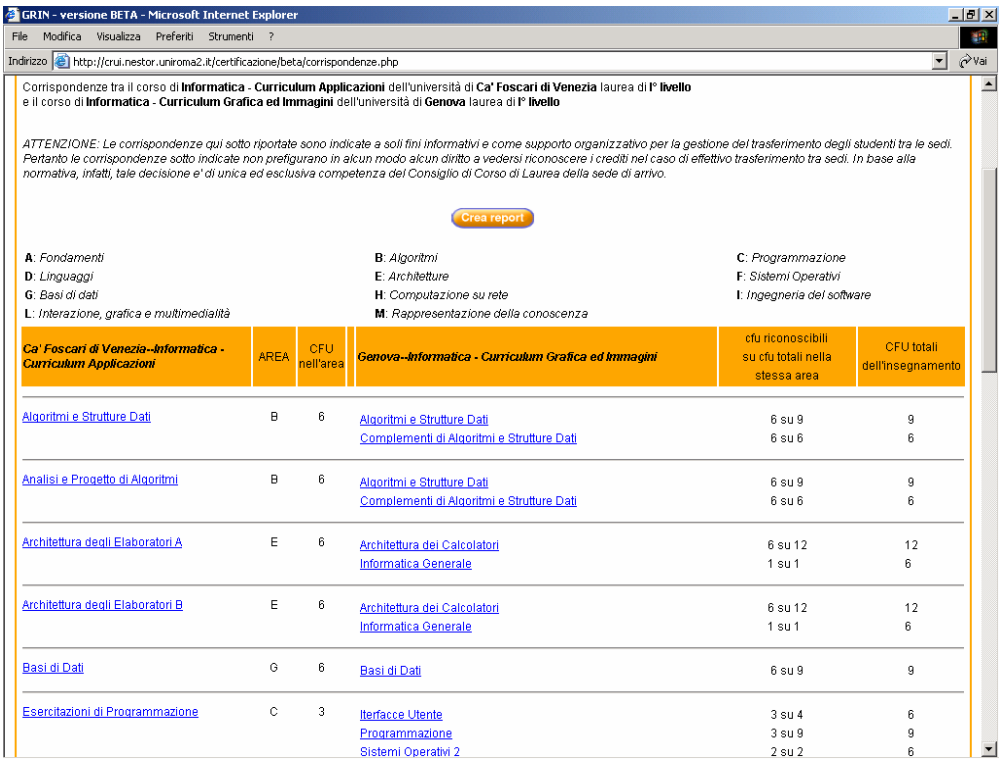


Fig.6: Correspondence between curricula (partial view)

If the last function relates the courses that appear in the curricula of two University degree programs, yielding an overall picture of the compatibility of two different curricula, it can also be very useful to create a relation between a single course in a given degree program with respect to all the courses in the same area offered by different Universities. A sample of application of this function is depicted in Fig. 7, where the lectures on "Languages and Compilers" at Ca' Foscari University in Venice are related with all the courses that may have related contents (with respect to the "Foundations" area) in the other sites.

Fig.7: Correspondence between courses (partial view)

In our opinion there is a great value in the amount of information that has been collected this way on the Italian Higher Education in Computer Science offered by the University degree programs. It is possible, in fact, to build in a bottom-up process an updated "map of knowledge in Computer Science". This is object of current investigation by the GRIN National Educational Committee, aimed at defining a 2005 Italian Syllabus on Computer Science. This will be particularly useful in order to maintain a correspondence between the University curricula and the requirements of the work market. The definition of correspondence relations between academic curricula and professional skills is particularly important in a sector like Computer Science which is in fact crucial for any modern economy.

4 CONCLUSIONS

The GRIN quality certification mark of University degree programs in Computer Science has a value both for the whole Italian Computer Science community (as also the Computer Engineering courses might be included in the picture), but also for the Italian University system, who is making a great effort in the design and experimental evaluation of a quality process models. The system that has been developed for the GRIN quality certification mark can be easily adapted to other fields, and can become an open platform to better understand the weaknesses and the strengths of our Universities also in an international context.

It is noticeable that the experimental evaluation of the system involved almost all of the Italian Universities where a degree program in Computer Science is activated: this confirms the effectiveness and scalability of the system, but also the practicability of this low-cost certification process. The benefits of this project have already been relevant, in terms of virtuous efforts to improve the clarity of the syllabi, to strengthen the link between the name of the courses and their contents, and to openly reveal the main characters of each program of studies.

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