Keeping Family of Computing Related Disciplines Together

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Abstract
There are efforts underway to define each of several flavors of computing disciplines, including computer science, computer engineering, information science, information technology, and software engineering. The purpose of this work is to show that we can accomplish more if we avoid some of the effects of fragmentation and bring together all the computing related disciplines as a large community rather than as a set of disjoint small groups. This work is bringing together the combined elements of all the computing disciplines, showing the relationship between individual topic areas, activities, and intended program outcomes. This will make it possible to create the body of knowledge that is a union of the parts and it will pave the way for the creation of a structure useful for curriculum development, curriculum revision and maintenance, and identification of accreditable programs. This will make it possible to identify the areas of the union of disciplines that are not well attended to, open up opportunities for new emerging areas of study, and support development of interdisciplinary programs. An initial prototype of the interactive structure intended to accomplish these goals will be presented. Discussion of potential benefits of the system and innovative ways to use it will be encouraged.

Categories and Subject Descriptors
K.3.2 [**Computers and Education**]: Computer and Information Science Education – curriculum, Accreditation, Self-Assessment.

General Terms
Design, Standardization.

Keywords
Curriculum, Computing-related Disciplines

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1. INTRODUCTION
In recent years, the discipline of computing has matured to the point of having distinct sub-elements, with groups from each developing curriculum recommendations, accreditation criteria, conferences, professional societies and publications. While there are many advantages to this diversification and the detailed development efforts it produces, there are also potential difficulties if the view of the discipline as a whole is lost. If the various parts of computing remain connected, there are opportunities for accomplishing common goals, setting an agenda for progress, and contributing collectively to meet broader ne[1]eds.

This paper reports on a project that is attempting to describe the computing and information related disciplines as a whole. It does not in any way limit the development of the separate components; rather, it helps to identify the domain of each of them and to make clear what areas of the combined disciplines are well served and which are in need of attention. Further, the project supports the emergence of new areas by showing clearly how they relate to the established fields and how they address a need.

The project addresses the need for a clear picture of the computing and information-centric disciplines from multiple perspectives. It provides resources for curriculum developers, clearly illustrating the components of the field and their relationships. It serves program assessors by mapping the topic areas to each other and to accepted objectives and outcomes. [RL1]In addition, it offers benefits to potential students and their parents, who often wonder what are the differences between the various computing related programs. [RL2]Employers could use it to determine what competencies they can expect from graduates of various types of programs. Guidance counselors will find this material useful in advising students about their choice of major. [RL3]Government agencies will find it useful in defining job classifications. Accreditation agencies will find it very useful in determining whether or not a given program has well formulated objectives and mechanisms in place to address those objectives.[RL4]

2. Preliminary Design
The goals of the project are practical functionality. This is to be a useful device that captures a great deal of information and makes

it available in a very useful form to a variety of audiences. One vehicle for producing the underlying structure is a concept map tool such as the one developed by the Institute for Human and Machine Cognition (IHMC). [Deleted phrase is at the wrong level of detail for the surrounding discussion]Though the concept map tool is useful for organizing topics and relationships among topics, outcomes, and objectives, these maps quickly become unwieldy. Fortunately, the cmap tool exports an XML representation which allows easy reformatting in more user conscious ways.

The design of this combined representation is not yet complete. However, there are multiple goals guiding the development. The combined representation of all computing and information-related disciplines will join all available classification schemes, including the body of knowledge in arterial from all sections of CC2001, the ACM Computing Classification Scheme and others. This is proving to be a challenging aspect of the project as various committees express similar goals in different language and also use the same terms to express different meanings. One clear, unambiguous representation of all the fields, merging their language and preserving their special meanings is a difficult task. The team includes representatives from all the CC2001 [RL5]groups and seeks input from wider audiences in each area of the discipline. To be useful, the work will require guidance from people close to the disciplines and wide distribution of plans and compromises.

As this project proposes, it will become easy to recognize what are the distinguishing features of computer science, information systems, software engineering, computer engineering, and information technology programs. Further, as new programs are developed and establish their places in the firmament of computing and information-related disciplines, it will be easy to see where they overlap the older disciplines and where they offer a unique perspective. As new technologies and new ideas broaden the combined field, it will be clear what has not been integrated into any regular field of study and what is shared by a number of disciplines.

In the final representation, these fields will not only be listed, but will be closely related to each other so that dependencies are easy to see. Prerequisites will be easy to identify as will topics that require significant background preparation before being addressed. The project intends to match topic areas with objectives and outcomes so that it is clear what areas must be studied as part of meeting an objective or outcome. The relevant topics are not sufficient for this, of course, but are part of the collection of topics and activities and environmental considerations.

In the following example, the project results are referred to as the Computing and Information program Developer or CIPD. That is a temporary title, but conveys some of the goals of the project. The following scenario illustrates potential use of the resulting tool.

3. A scenario illustrates the goal

The College of Information Sciences and Technology at Newtown University has established programs in computer science, information systems, software engineering and information technology. All are well regarded and the graduates are successful in their careers and in further study. Responding to an expressed need from the community, the college wishes to produce a specialization in information security. Graduates will have courses that span the existing programs and will have a strong focus on security issues in every aspect of computing and information studies. Looking at the Computing and Information Program Developer (CIPD), the committee finds that this is not a unique goal. Relevant outcomes are included in the list of those that have been investigated and related to appropriate topics and activities. Committee members select the related outcomes and find that the associated topics do indeed span the disciplines and include some topics that are not always included in any standard program. Many of the topics highlighted by the CIPD were expected by the committee, but a few were unanticipated. Their new program design will be stronger because of the thorough review of all areas of the computing and information related disciplines. As they work, and discuss their progress with their advisory board, they discover that there is a security related goal that is not yet represented in CIPD. They add this goal to their list and give careful thought to the topics and activities that will support it. When they finish, they submit the new goal and its associated topics and activities to the CIPD review board to be considered for adding to CIPD. The submission is reviewed, as a journal submission would be, suggestions come back from the reviewers, are incorporated into the plan and benefit the new program at Newtown University and become available for others to consider as well.

Part of the motivation for this project is that it is not easy to find a totally complete list of computing-related topics. This means that innovators work from partial lists and from their own necessarily limited experiences. A complete list of all related topics will provide valuable input to the process of program development. Naturally, such a list cannot be static. There must be well organized procedures for continuous update as new topic areas emerge and as new outcomes are recognized. One way of doing this is to treat the CIPD as a publication with an editor and an editorial board. Suggested changes would be submitted to the CIPD review board and accepted changes added to the CIPD.

The process of producing the CIPD involves review of all significant curriculum documents related to the computing and information fields. These include all of the volumes of the recent curriculum recommendations referred to as CC2001 [2, 3]. The computer science, software engineering, and information systems volumes are complete and posted. The computer engineering and information technology volumes are in development. This project team includes active members of all of these development teams and the latest versions of their topic lists are available for inclusion in this work. However, these are not enough. Relevant work has been done elsewhere and will be incorporated into this project. Work by the ACM Two Year College Committee is relevant [4] as is work done in Europe to define profiles of professionals in the information and communications technology (ICT) fields [5].

4. Conclusion

This project will produce an interactive structure for representation and exploration of the unified body of knowledge of all of the computing and information related disciplines. Further, this structure will provide linkages from topic areas and activities to outcomes. A user will be able to specify an outcome and see the related topic areas and activities needed to accomplish that outcome.

The system will identify elementary, intermediate, and advanced topic areas. It will allow review of a proposed program of study to determine if there is sufficient introductory material to prepare for study of advanced topics, for example. The system will support the development of new programs of study by showing how the relevant topics are related and which existing curriculum models include which topics.

The results of this project will have additional, practical application:

Support of program development. Innovative and creative programs will be able to identify where they are in the spectrum of computing related topics and will be able to describe their offerings clearly.

Assistance with program validation. Accreditation efforts have been moving toward outcome-based assessment. The result of this work will allow a program to identify its objectives and show the topics and activities related to accomplishing those objectives. The purpose of accreditation activity can then be closer to its goals of determining that reasonable objectives are in place and that the program requirements and the environment of the institution are appropriate to accomplish the objectives.

Support updates of curriculum recommendations. Because this mechanism will be extensible and easily updateable, massive curriculum recommendation efforts will not be required. Instead, the contents of a computing related program can be derived from the dynamic list of topics and activities, and associated with the desired objectives[RL6].

Relationships with related disciplines. The computing disciplines rely on related areas and need to remain connected with relevant advances in such areas as electronics, physics, mathematics, psychology, management, biosciences, neurosciences, linguistics, and more. These connections will be easy to add to this structure.[RL7]

Development of interdisciplinary programs. The integration of computing and various other disciplines is leading to a number of exciting new areas of study and research. This representation of the union of all the computing disciplines will give a clear view of the areas that they bring to the table in these new areas. For example, a program in bioinformatics can clearly see the topics that computing has to offer and can select the ones that are best suited to the goals of the interdisciplinary program.

The answer to the question “Will we be able to create a common understanding of excellence in our discipline?” is crucial for the quality of our educational programs. This can be achieved by developing a standard framework for looking at computing curricula, which could be used worldwide. For this purpose, a large-scale effort combining existing approaches is necessary.

In order to promote the health and benefits of the application of computing, it is essential to harness the energies and experiences of leaders in computing education around the world to produce a systematic method for comparing and merging curricular efforts and for assessing the potential contributions of proposed programs of study [6].

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