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Towards informatics as a discipline: search for identity

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Abstract

A changing discipline like informatics can be questioned with respect to its identity and its core concepts and skills. This concern is being expressed by the focus group papers and has led to this editorial paper. We discuss the different paradigms or views with respect to informatics that can be identified and comment on the resulting fragmented approach of the discipline. We advocate a more integral, generic and coherent approach. And we present some preliminary thoughts and notions as input for a search for the identity of the discipline, resulting in a first draft working definition for informatics as a discipline.

Keywords

Informatics, other disciplines, curriculum (general), taxonomies, educational profiles, professional profiles

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1 A CHANGING DISCIPLINE

Informatics is a young discipline and has already seen many changes in its young life. Since the first electronic computer was introduced for performing numerical calculations, a lot has changed. Turing and Church have given informatics a theoretical fundament based on the concept of algorithm. The technology of informatics has developed from calculating device (number processor), via automating device (data processor), information system (information processor) to personal tool (interactive information processor) and intelligent agent (interacting knowledge-based process).

At the basis for this development is the stored program computer which can change its own program and therefore can adapt its behaviour. Application of informatics turns out to be possible and feasible in areas which are not immediately and directly associated with just data or information processing. We are moving from a world of information processing in which the concept of the algorithmic process was central, to an even richer world of interaction in which the concept of interacting processes is central. By this the fundaments of the discipline are changing.

2 IDENTITY AS A COMMON CONCERN

This book, being the proceedings of the IFIP/WG 3.2 Working Conference held in August 1997 at the University of Twente in the Netherlands, contains three so-called focus group papers, which are the result of the focus group discussions at the conference. A common area of discussion and concern in these papers is the identity of informatics as a discipline and the related allocation and demarcation of a conceptual core of informatics for both informatics majors and noninformatics majors. We illustrate this by quoting from the focus group papers below.

An ongoing identity crisis for informatics

There is considerable variance in what is perceived to be the discipline of informatics. This results in a lack of professional identity: the public does not really know what informatics is about and the business community frequently does not recognize informatics as a discipline in its own right. Unlike disciplines such as medicine and law, it is not possible to state a simple mission for informatics in terms of its role in society. At the heart of this problem is the rapid expansion of the field, the lack of agreement on what constitutes the core of the discipline and the need to produce a coherent integrated body of knowledge and skills concerned with systems design and implementation. Rapid changes that have made computing accessible to noninformatics professionals have raised questions about what the discipline of informatics is and will the discipline continue to exist.

(Turner and Hughes *et al.*, 1998)

The future

Changes to the environment of both informatics and education have raised many challenges which must be addressed by those involved in informatics education. Is informatics education a discipline in crisis? If the discipline does not respond in an appropriate manner to the rapidly changing environment this may well be the case.

(Turner and Hughes *et al.*, 1998)

Informatics as an amalgamation of various fields

The broad field of informatics has increasingly been defined to be an amalgamation of the fields of computer science (CS), information systems (IS), software engineering (SE), and computer engineering (CE). Informatics may be seen then as computing in a very general sense. Yet though the term is in fairly wide use, there has been given no attention to those core concepts of informatics that would be essential for the development of relevant curricula. By its very definition, we see that the core concepts of informatics are in the intersection of the core concepts of CS, IS, SE and CE, respectively.

(Lidtke and Myers *et al.*, 1998)

Controversial proposals?

The listing of the preceding core topics, concepts, and experiences (.....) has been influenced by the personal knowledge and experiences of the focus group members, representing the various subfields of informatics. But this list is not simply the reflection of current practice that is common to all those subfields. Indeed, in places we advocate topics that may not be part of the current curriculum or knowledge base of one or more classes of informaticians. Thus we assume that some of the preceding may be quite controversial.

(Lidtke and Myers *et al.*, 1998)

Introductory informatics for all students

Therefore we have concentrated on developing a proposed conceptual core for an introductory informatics course. We strongly advocate that this core knowledge should be learned by both nonmajors and majors in informatics, since these fundamental informatics concepts are relevant to virtually all students in the modern academic world.

(Grandbastien and LeBlanc *et al.*, 1998)

Programming or not?

Conversely, we think it quite possible that a course based on this core might include no programming at all. We do believe though that such a course should include a 'construction experience', that is students should be required to get experience constructing formal problem solutions by doing one or more of: writing algorithms, creating spreadsheets, programming in visual languages, etc. As suggested by the previous point, we believe that courses based on this core can

have a wide variety of implementations. The level of detail to which these concepts are developed and the methods used in the course might depend significantly on the audience.
(Grandbastien and LeBlanc *et al.*, 1998)

3 PARADIGMS IN ISOLATION OR IN COHERENCE?

Computing as a discipline

The paper 'Computing as a discipline' by Denning *et al.* (1989) was a major breakthrough in that it attempted to describe the discipline in terms of different styles of thinking and working (paradigms). Three paradigms were identified: theory (rooted in mathematics), abstraction (rooted in science) and design (rooted in engineering). The discussion on how to view our discipline has been continued in a special issue of ACM Computing Surveys (1995) by quite a range of distinguished authors.

We see a multi-view approach both in the paper and in the discussion, but also a clear focus on the areas traditionally called 'computer science', 'computer engineering' and 'computing', excluding other closely related areas. The area of 'information systems', for example, is not explicitly considered, although there are definitely strong connections with the areas mentioned.

Scientific leadership

Suppose that we would ask seven scholars to give their view and definition of the discipline of 'informatics'. Try to guess their answers, if these seven would be, for example, Gene Amdahl, Gordon Davis, Peter Denning, Edsger Dijkstra, Edward Feigenbaum, David Parnas and Josef Weizenbaum. Now suppose that we would lock them in a room - with Bill Gates as technical chairman - under the condition that they only may come out with an agreed definition or description of the discipline of informatics and also with an outline for an academic educational programme incorporating different paradigmatic views. Would there be any chance of success? And would the same experiment with seven physicists, or seven economists, or seven psychologists proceed in a comparable way?

This thought experiment illustrates the fragmentation inherent to our discipline. Views of the discipline are strongly dependent on the specific scientific leadership involved.

Scientific communities

Suppose now, we do the same experiment with representatives of different scientific communities, for example the USA-organizations ACM (Association for Computing Machinery), IEEE (Institute of Electrical and Electronics Engineers) and AITP (Association of Information Technology Professionals) and the international organization IFIP (International Federation for Information Processing). One may expect a better result since these organizations have

demonstrated joint efforts in developing curricula. ACM and IEEE have presented in 1991 their common model Curriculum'91 for 'computing'. ACM and AITP (as well as AIS - Association for Information Systems) have come up with their IS'97 model curriculum for 'information systems' in the beginning of 1997. And IFIP published an update of its modular curriculum on 'computer science' in 1994.

One could question, however, whether a merge of these efforts would be conceivable and valuable in view of a future (re)definition or (re)description of the discipline of informatics.

Informatics: a fragmented adhocracy?

'Can the field of MIS (Management Information Systems) be disciplined?' is the title of a paper by Banville and Landry (1989). In this paper Kuhn's model for the development and progression of science and the role of paradigms is denounced. Not any science can be forced into the 'monistic' view of normal science which is modelled on the 'queen of sciences', physics.

Banville and Landry argue extensively that MIS is an example of a scientific field that can be characterized as a 'fragmented adhocracy'. It is a scientific field which requires a pluralistic view in which several paradigms coexist. Does such an approach not only apply to MIS, but also to the broadly based discipline of informatics?

4 FROM COMPUTING TO INFORMATICS AS A DISCIPLINE

Computer science, computer engineering, information systems, software engineering, artificial intelligence, telematics, multimedia, those are all fields that constitute - in full or in part - informatics as a broad discipline and contribute to it. Rather than having this diversity resulting in 'scientific disintegration' a more integral, generic and coherent approach is needed in the context of scientific and technological progress, acknowledging of course the coexistence of the distinguished fields. Since these fields on their own are linked to a wide variety of other disciplines, scientific leaps are conceivable and well-conditioned on the basis of multi- or interdisciplinary work.

The development of such an integral approach is urgent, as the focus group papers in this book show. The editors of the conference book have decided to add this 'editorial paper' in which some preliminary thoughts and notions are presented that might contribute to a fruitful search for the identity of the discipline of informatics.

Various approaches

In this search one can choose different approaches. We list some of these below and refer - if possible and useful - to papers contained in this conference book.

- **Taxonomies:**

various specific classification systems used for literature (or for curricula) can be compared and balanced (see, for example, the papers by Mulder and Hacquebard, Sheridan and White).

- **Curricula:**
  different characteristic (model) curricula from various organizations and countries can contribute to make the position of a broad informatics curriculum clearer (we refer to the papers by Duchâteau, Geissinger *et al.*, Gupta, Juliff, Ohiwa *et al.*, Robinson, Shackelford and LeBlanc, Vollmar and Gruska).
- **Classes of problems:**
  one could think of the following classes of problems, all to be solved through methods and techniques of informatics: calculation, administration, reasoning, retrieval, communication, information, simulation, controlling, organization, foundation, and what is more (no specific papers to be referred).
- **Processes:**
  several kinds of processes can be distinguished and associated with various intended activities for informaticians (see the papers by Van Weert, Wupper and Meijer).
- **Professional profiles:**
  professional as well as educational profiles can clarify questions with respect to the variance in the discipline and its practitioning (see, for example, the papers by Lidtke and Mulder, Van der Kamp, Van Leeuwen and Smeets).
- **Core concepts and skills:**
  thinking about core concepts and skills is an important key in the search for the identity of the discipline (see the three focus group papers).

Extending the variety in views

The discipline of 'computing' was described in Denning *et al.* (1989) according to three different paradigms or views, as mentioned before:

- theory (rooted in mathematics);
- abstraction (rooted in science);
- design (rooted in engineering).

In describing 'informatics' as a discipline we should modify and extend on these three paradigms or views. We propose a first attempt here - quite open to discussion - with the following five views:

- theory (linked not only to mathematics, but also to linguistics and philosophy);
- empiricism (linked not only to science, but also to psychology and economics);
- design (linked not only to engineering, but also to management science);
- ambiguity (linked to psychology, philosophy, economics and social sciences in general);
- application (linked to technology in general and social sciences in general).

A working definition for informatics

The discipline of 'computing' was defined in Denning *et al.* (1989) as follows:

> 'The discipline of computing is the systematic study of algorithmic processes that describe and transform information: their theory, analysis, design, efficiency, implementation and application. The fundamental question underlying all of computing is: "What can be (efficiently) automated?"'

Again, we propose a first draft working definition for the discipline of 'informatics', which hopefully will contribute to a fruitful discussion:

> 'The discipline of informatics deals with
> the manipulation of *objects*
> with the aim to solve a *problem,*
> specified by a *requirements analysis*
> under a given set of *constraints,*
> resulting in a maintainable working *system*
> with an *automated* component,
> in which *men and machine* interact adequately.'

Clearly this draft working definition abstracts from specific processes such as:

- program specification, software engineering and programming software systems;
- information analysis and the design and implementation of information systems;
- configuration specification and the design and construction of computer systems.

By using the generic term 'objects' the draft working definition - one could say - is object oriented, which is not meant to be limitative with respect to object oriented methods and techniques, but rather serves as a generalization for other familiar terms, such as 'data structures', 'entities', 'records', etc.

The problems to be solved can be of any of the different classes that we have distinguished before. The result should be a maintainable working system which implies attention for system exploitation. Also note the emphasis on the interaction between men and machines.

5 CONCLUSION

The discipline of 'computing' seemed well-defined in 1989 in the paper by Denning *et al.* But now we are moving to a discipline (which we have denoted by the common European term 'informatics') with a somewhat different identity. This editorial paper is meant to state questions to be resolved in this respect and to present some ideas as input for an ongoing discussion.

6 REFERENCES

ACM Computing Surveys (1995), **27** (1).

Banville, C. and Landry, M. (1989) Can the field of MIS be disciplined?. *Communications of the ACM,* **32** (1), 48-60.

Denning, P.J., Comer, D.E., Gries, D., Mulder, M.C., Tucker, A.B., Turner, A.J. and Young, P.R. (1989) Computing as a discipline. *Communications of the ACM,* **32** (1), 9-23.

Grandbastien, M., LeBlanc, R.J., Jr *et al.* (1998) A common core for noninformatics majors, in *Informatics in higher education: Views on informatics and noninformatics curricula* (eds. F. Mulder and T.J. van Weert), Chapman & Hall, London.

Lidtke, D.K. and Myers, P. *et al.* (1998) A common core of concepts for informatics majors, in *Informatics in higher education: Views on informatics and noninformatics curricula* (eds. F. Mulder and T.J. van Weert), Chapman & Hall, London.

Turner, A.J. and Hughes, J. *et al.* (1998) Informatics education: trends, problems and the future, in *Informatics in higher education: Views on informatics and noninformatics curricula* (eds. F. Mulder and T.J. van Weert), Chapman & Hall, London.

7 BIOGRAPHY

Fred Mulder is working at the Dutch Open University from its start in 1983 and is full professor in informatics education since 1991. From 1993 till 1996 he was dean of the Faculty of Engineering. He holds degrees in chemical engineering (Bachelor), applied mathematics (Engineer) and theoretical chemistry (Ph.D.). After a postdoc research project in Canada, he went to teach informatics and mathematics in higher professional education, prior to his OU career. He has served on various national committees, such as the quality audit committees for informatics programmes at universities as well as higher professional institutes and committees for informatics at secondary schools. He is representing The Netherlands in the education committee TC3 of IFIP.

Tom J. van Weert is director of the undergraduate School of Informatics (Computing Science) of the Faculty of Mathematics and Informatics of the University of Nijmegen, The Netherlands. He also teaches management of large software projects to informatics students developing real software applications in multi-disciplinary teams. Previously he has worked in teacher education, teaching mathematics and informatics, and prior to that as a computer system engineer in an academic environment. His background is in applied mathematics. He has been active within several IFIP Working Groups and is currently chair of IFIP Working Group 3.2 on university education.