Why history matters in school informatics

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> Der Gleichklang von »Informatik« und »Mathematik« ist sicher alles andere als zufällig.
>
> [Klaeren and Sperber 2001, p. 5]

Abstract. *??*

When discussing history of informatics, many authors focus on the history of machines for computing and technical means of their realization, ranging from relays to integrated circuits. The starting point may vary, sometimes reaching back to mechanical instruments, and important technical innovations are highlighted as landmarks for the development of automated computing. The punch card as a means of data storage is an emportant example that serves as a pace setter.

However, there is much more to history of informatics than concrete machines. This might be approached by looking at various definitions of informatics as a scientific discipline. In many European countries (e. g. France, the Netherlands, Italy, Poland) the term *Informatics* is used. Scandinavian countries use *Datalogy*, and the Anglo-American countries speak of *Computer Science*. Let us collect some of the definitions:

Definition 1 (Informatics — etymological) *Etymologically, informatics can be derived from* infor*mation and auto*matic.

This definition follows the french concept of "Informatique", which was proposed by DREYFUS in 1962. In 1967, the Académie Française defines:

Definition 2 (Informatics — Académie Française) *Science du traitment rationnel, notamment par machines automatiques, de l'information considerée comme le support des conaissances humaines et des communications dans les domaines technique, économique et social.* 1967

The first definition of Informatics in german language was supplied by STEINBUCH:

Definition 3 (Informatics — Steinbuch, 1957) *Vor etwa zwanzig Jahren entdeckten Ingenieure in USA und Deutschland unabhängig voneinander, daß die Verfahren der Nachrichtentechnik auch für andere Aufgaben nützlich sind, Aufgaben, bei denen die Überwindung der räumlichen Entfernung ganz unwesentlich ist. Sie fanden, daß man mit elektrischen Schaltungen Zahlenrechnungen durchführen kann, und zwar mit einer Schnelligkeit, wie sie bis dahin einfach unvorstellbar war. Damit begann die automatische Informationsverarbeitung. Wir nennen sie <Informatik> [Steinbuch 1957].* 1957

About twenty years ago, engineers in USA and Germany independently dicovered that methods from communications engineering are useful for other tasks — tasks for which overcoming geographical distance is not the issue. They found that numerical computations can be performed by electric circuits in a hitherto unthinkable speed. This founded the automatic information processing. We call it <informatics>.

Informatics as a science is an offspring of mathematics, eletrical engineering and physics, and the first scientists in the field came from these areas as well as from economics, operations research and cybernetics which were also influential. In a way, the early definitions of informatics can be understood as an effort of seperation from mathematics and electrical engineering.

Let us now look more closely at the concepts of information and automatics.

Information as a central though multidimensional concept of informatics

The analysis of the word "informatics" leads to the concept of information (see Definition 1). As a first
characterization of "information" we can use Shannon's Information Theory, which provides a mathematical 1948
theory for determining the "information contents of a message". This yields a minimal coding for a message. Along with this, the unit "bit" [1] was introduced as a unit for the information contents.

However, this concept of information is only sustainable for some aspects of informatics, because it reduces information to the aspect of transfering data. There are more dimensions to "information" than this. It becomes clear that within informatics, information is not only connected with technical issues but also with (human) intentions. These cannot be formalized adequately. In fact, until today computer scientists did not come up with a universal definition of this concept that is so fundemental to their science. The multi-dimensionality of the concept leads to misunderstandings that can be avoided if agreements on the intended meaning of "information" are made in certain contexts.

In connection with didactic issues, the 3 layers data, knowledge, and information with their respective connections to syntax, semantic and pragmatic proved to be useful.

Automatics — the dynamic view on the processing of data

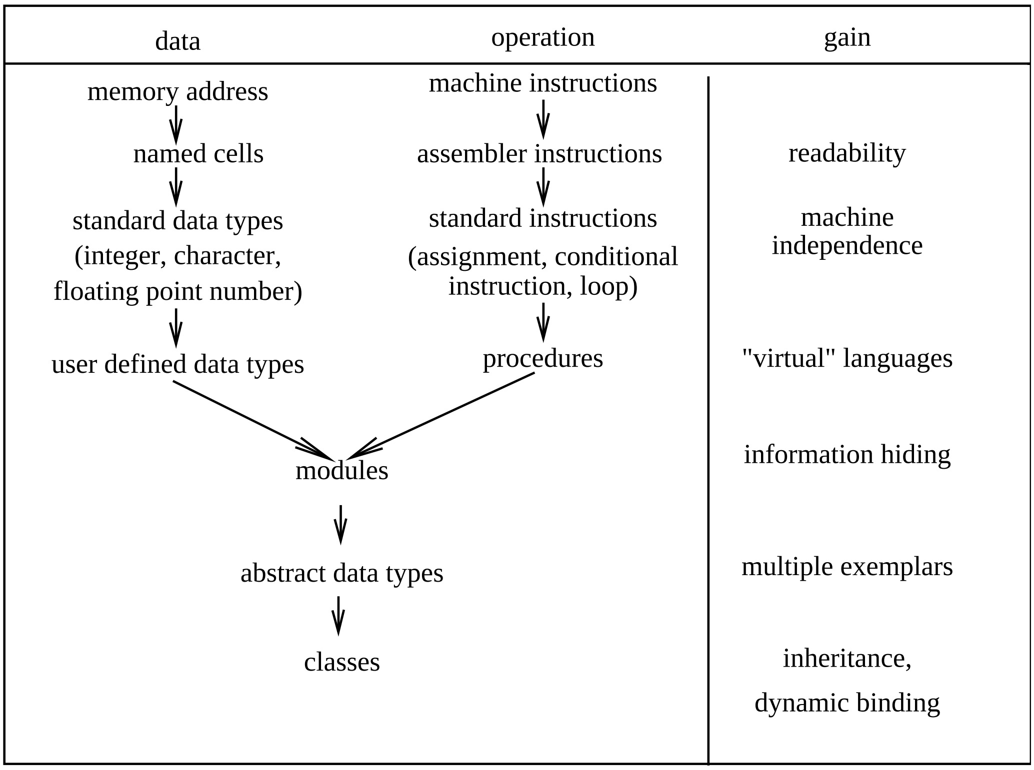
Definition 4 (Automatics) *The automatics associated with an object is its ability of self-control.*

This definition focuses at the dynamic component inherent to the object. It is characteristic for informatics systems: they work autonomous in the context they are designed for. They are programmed in order to produce output data that is dependant on the concrete input values.

Historical determination of the subjects of informatics

In the early days of informatics the endeavour to master and use the technical artefact of a computer is central. Milestones are the idea of programs being data, thus enabing the construction of compilers, and the
construction principle formulated by [von Neumann 1945]. Since then, this construction principle is called 1822
the von Neumann architecture. Some of the underlying ideas were formulated in 1822 by BABBAGE for the
Analytical Engine, thus one might as well speak of the BABBAGE principle.The civil engineer ZUSE constructs 1941
the world's first working computer in 1941. Moreover, he invented the first higher level programming language (Plankalkül). The relationship between the effort needed for constructing and using hardware and software changes, such that there is an increasing interest in methods for developing and maintaining software. This

[1] basic indissoluble information unit (bit), to be distinguished from Bit for binary digit.



cf. [Mössenböck 1992, p. 10]

Figure 1. Development of abstractions in programming languages

leads to the development of more abstract languages for the description of algorithms and programs on von Neumann machines (known as the von Neumann languages), cf. Fig 1.

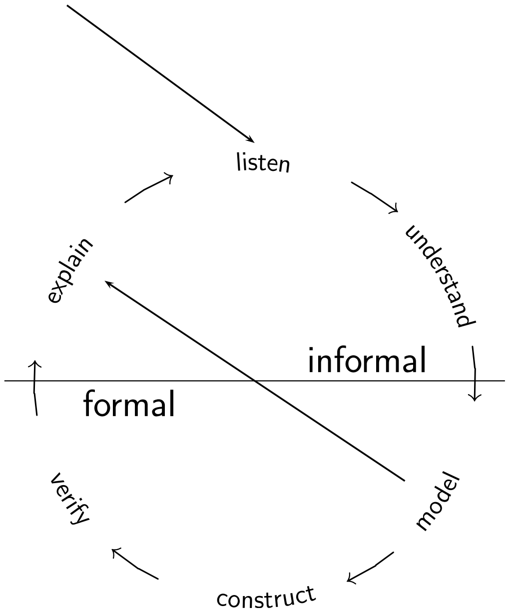
1959

Starting in 1959, the von Neumann language ALGOrithmic Language (ALGOL) is specified [Backus u. a. 1963], the syntax is given by a grammar in Backus-Naur-form [Backus 1959]. Besides its usefulness for writing computer programs, it also facilitates publishing and discussing algorithms. Although initially manufacturers of computers rarely support ALGOL by providing a compiler, the language has great influence on the development of what is known as the ALGOL family of programming languages. “Jedes Programm sollte ein publizierbares Produkt sein. Das unterscheidet sich grundsätzlich vom üblichen Ziel, dass das Programm läuft!” (Every program should be a publishable product. This goal is fundamentally distinct from the usual aim that the program runs.) [Reiser and Wirth 1994].

To this day algorithms are often formulated in pseudocode in the literature. Thereby syntactical elements of ALGOL, Modula-2 and less formal parts in natural language are used. Algorithms and data structures, their implementation in informatics systems and the theory associated with them constitute an important (and undisputed) part of informatics.

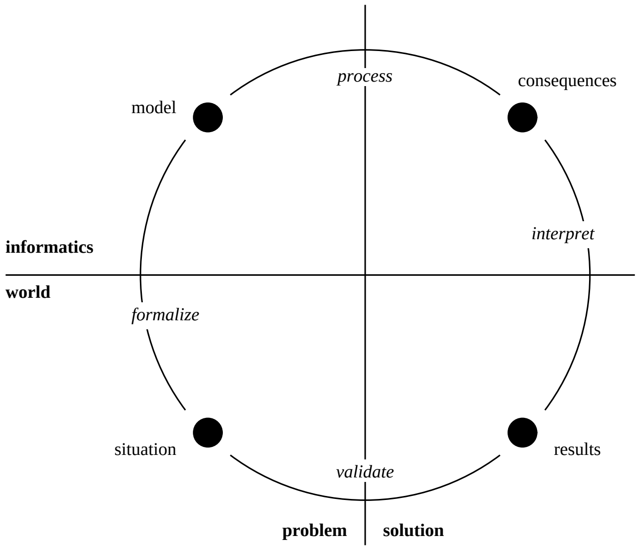
Following [Floyd 1997, pp. 238], “creation and use of informatics systems that take their context and the relationship to human intelectual acitvity into consideration” is a summarizing “pragmatic characterization of informatics”. Furthermore, [Floyd 2001, p. 49] “doing informatics means to model the operational form and to supply the autooperational form[2]”. Regarding this aim, the method of formalization as a prerequisite of creation and automatisation plays a key role in the realization of informatics systems. The activity needed therefor is called modelling. A specific feature of models in informatics is that their implementation makes the model itself acting in the part of reality it is designed for. Thus the model affects and even changes the reality.

[2] diese Formen erklaeren



cf. [Klaeren and Sperber 2001, p. 6]

Figure 2. Developing an informatics–product



cf. [Humbert and Puhlmann 2004, p. 71]

Figure 3. The process of modelling in informatics

Various definitions of informatics

ADAM defines: [Informatics is the] science of integral information systems, that tries to describe, explain and design the world around us, the environment and the world of symbols in their manifold interactions [Adam 1971, p. 9]. It is very dubious to objectify the structures of a puristic mathematic way of thinking within the language of abstract automata and to force these creations on a manipulable society using clever marketing [Adam 1971, p. 11]. — In the light of the monopoly position of a company for operating systems for desktop computers this judgement appears to be very much up do date. It highlights that in the last decades informatics has experienced a process of concentration and monopolisation that is unparalleled elsewhere.

WEIZSÄCKER names two structural sciences: mathematics and informatics [von Weizsäcker 1971]. With this he associates the claim of informatics to supply automated information processing for other disciplines. Independent from their technical implementation, concepts of structuring, such as building hierarchies or modules, are valuable methods for controlling and handling complexity.

Another characterization is given by [Bauer 1974, p. 335]: "With the elements coding through symbols,
mechanisation of operations with symbols, and programmable sequence control of operations we have the 1974
basis of the contents of informatics. This science culminates in the composition of these elements in a program which implements an algorithm. Thus it can be thought of as the science of programming of information processing by means of symbol processing." BAUER characterises informatics as neither mathematics nor electrical engineering but as an engineering-arts science (or arts-engineering science, if you prefer). [Bauer 1974, p. 336]. This shows clearly a difference to Weizsäckers position.

In 1975, CLAUS states that "Fundamental methods rather than special realizations are in the fore [. . .] Hence 1975
the subjects of informatics are primarily of logical nature and independant from machines" [Claus 1975, p. 11]. Hereby Claus strengthens Weizsäckers view of informatics and emphasizes the role of "algorithms and data structure" which are described by means of formal languages and executed within logical calculi.

Influenced by the cybernetics' concept of information, GENRICH and PETRI regard informatics as "science of the strictly controlled flow of information" [Genrich 1975], [Petri 1983]. This puts the specification of processes together with their societal usefulness in the center. Then, assessing informatics systems is not only about the quality of their structure and their efficiency but also considers their embedding into social application areas.

References

[Adam 1971] ADAM, Adolf: *Informatik. Probleme der Mit- und Umwelt.* Opladen : Westdeutscher Verlag, 1971. – ISBN 3–531–11108–6

[Backus 1959] BACKUS, John W.: *The Syntax and Semantics of the Proposed International Algebraic Language of the Zuerich ACM-GRAMM conference. ICIP Paris.* Paris : UNESCO, June 1959

[Backus u. a. 1963] BACKUS, John W. ; BAUER, Friedrich L. ; GREEN, Julien ; KATZ, C. ; MCCARTHY, John ; NAUR, Peter ; PERLIS, Alan J. ; RUTISHAUSER, Heinz ; SAMUELSON, Klaus ; VAUQUOIS, Bernhard ; WEGSTEIN, Joseph H. ; WIJNGAARDEN, Adriaan van ; WOODGER, Michael ; NAUR, Peter (Hrsg.): *Revised Report on the Algorithmic Language Algol 60.* diverse Zeitschriften, 1963. – CACM, Vol. 6, pp 1–17; The Computer Journal, Vol. 9, p. 349; Numerische Mathematik, Vol. 4, p. 420. `http://www.masswerk.at/algol60/report.htm` – last visited: 14. Juli 2002

[Bauer 1974] BAUER, Friedrich L.: Was heißt und was ist Informatik? Merkmale zur Orientierung über eine neue wissenschafltichen Disziplin. In: *IBM Nachrichten* 24 (1974), Nr. 223, S. 333–337

[Claus 1975] CLAUS, Volker: *Einführung in die Informatik.* Stuttgart : Teubner, 1975

[Floyd 1997] FLOYD, Christiane: Autooperationale Form und situiertes Handeln. In: HUBIG, C. (Hrsg.): *Cognitio Humana – XVII. Deutscher Kongreß für Philosophie (Sept. 1996)*, Akademie Verlag, 1997, S. 237–252

[Floyd 2001] FLOYD, Christiane: *Informatik – Mensch – Gesellschaft 1. Prüfungsunterlagen.* Universität Hamburg – Fachbereich Informatik, Oktober 2001. – zugl. Informatik – eine Standortbestimmung – Hamburg, September 1998 von C. Floyd und R. Klischewski

[Genrich 1975] GENRICH, Hartmann J.: Belästigung des Menschen durch Computer. In: MÜHLBACHER, Jörg (Hrsg.): *GI – 5. Jahrestagung, Dortmund, 8.-10. Oktober 1975.* Heidelberg : Springer, Oktober 1975 (Lecture Notes in Computer Science 34). – ISBN 3–540–07410–4, S. 94–105

[Humbert and Puhlmann 2004] HUMBERT, Ludger ; PUHLMANN, Hermann: Essential Ingredients of Literacy in Informatics. In: MAGENHEIM, Johannes (Hrsg.) ; SCHUBERT, Sigrid (Hrsg.): *Informatics and Student Assessment. Concepts of Empirical Research and Standardisation of Measurement in the Area of Didactics of Informatics* Bd. 1. Bonn : Köllen Druck+Verlag GmbH, September 2004. – ISBN 3–88579–435–7, S. 65–76

[Klaeren and Sperber 2001] KLAEREN, Herbert ; SPERBER, Michael: *Vom Problem zum Programm.* 3. Aufl. Teubner, 2001. – ISBN 3–519–22242–6

[Mössenböck 1992] MÖSSENBÖCK, Hans-Peter: *Objektorientierte Programmierung in Oberon–2.* 1. Aufl. Berlin : Springer, 1992. – ISBN 3–540–55690–7

[von Neumann 1945] NEUMANN, John von: First Draft of a Report on the EDVAC. In: *University of Pennsylvania* (1945), June. – `http://qss.stanford.edu/~godfrey/vonNeumann/vnedvac.pdf` – last visited: 6. Janar 2004

[Petri 1983] PETRI, Carl A.: Zur 'Vermenschlichung' des Computers. In: *Der GMD-Spiegel* (1983), Nr. 3/4, S. 42–44. – ISSN 0724–4339

[Reiser and Wirth 1994] REISER, Martin ; WIRTH, Niklaus: *Programmieren in Oberon: Das neue Pascal*. New York : ACM Press, 1994

[Steinbuch 1957] STEINBUCH, Karl: Informatik: Automatische Informationsverarbeitung. In: *SEG-Nachrichten (Technische Mitteilungen der Standard Elektrik Gruppe) – Firmenzeitschrift* (1957), Nr. 4, S. 171

[von Weizsäcker 1971] WEIZSÄCKER, Carl F.: *Die Einheit der Natur*. München : Carl Hanser Verlag, 1971