

The four concepts of informatics

From pedagogical questions to epistemological ones

Define curricula for informatics: **define informatics**

How can we define a science?

What is mathematics?, What is physics?, What is psychology?

Which **objects** does it study: abstractions, matter, psyche...

Which **methods** does it use: reasoning and computation, observation and experiment...

Another question?

What are the fundamental **concepts** in this science?

Science is not just about studying objects with a method, but also about developing new concepts to speak about them

Number → divisibility

Planet → motion

Psyche → emotion

Predicates rather than terms

Language of propositions rather than truth conditions

What are the concepts of informatics?

An empirical approach

You: program

Someone: algorithm

You: program and algorithm

Someone else: programming language

You: program, algorithm, and programming language

...

But also

Programming language + query language \longrightarrow language

Macintosh + PC \longrightarrow personal computer

Personal computer + petascale computer \longrightarrow computer

Robot + computer \longrightarrow machine

As general as possible

Automaton: language

Grammar: language

Protocol: algorithm

Network: machine

Parallel: machine

Visualization: data

When the process stabilized

Language

Algorithm

Machine

Data

The rôle of education and research management in this stabilization

Observe the creation of masters (and laboratories)

A new masters: some concept(s) was not taken into consideration by the previous ones

Education and research management **does part of the work** (an example of collective intelligence)

But to be used with care: some human factors as well

Language

A great variety of languages: programming languages, specification languages, query languages...

Formal languages: nothing to do with natural languages

Simple grammar, small vocabulary

Extensible vocabulary (creation of words, scope...)

North-North-North \neq three times north

An old concept

The language of numbers (Sumerian scribes)

Scores

Algebra ($x^2 - 2x + 1 = 0$)

Eyeglasses (OD: -4,50 (+2,00) 35° OG: -3,75 (+1,25) 65°)

Chemistry (H₂O)

Addresses (Av. 18 de Julio 1968, Montevideo, Uruguay)

Logic

Algorithm

A great variety: sequential, parallel, synchronous and asynchronous, distributed, protocols, non deterministic, probabilistic, quantum...

When you know the algorithm, you can solve all the problems (e.g. calculus)

The algorithms exist even non formulated (ants)

Being able to do it vs. being able to formulate how you do it

An old concept

Sumerian scribes again

al-Khwarizmi (decimal notation)

Calculus

Probabilities

Machine

A great variety: computers, networks, robots, 3D printers...

A physical object (mass, energy dissipation...)

Material substrate (does not and) does matter: different levels of abstraction

One machine for everything

An old concept

Mills

Hero of Alexandria

Pascal

Vaucanson

Jacquard

Hollerith

Von Neumann, Eckert, and Mauchly

Data

A great variety: images, texts, sounds, video, structured, unstructured...

Representation

Compression, error correction, encryption

Structuration (file systems, DB, Web)

Access to data (search engines...)

Quantitative

Data exists independently of algorithms, but raw data is useless

An old concept

Library of Alexandria

Printing press

Surveying

A structure for these concepts?

Informatics is not the science of algorithms (Euclid designed an algorithm but he is was not an informatician)

Informatics is not the science of machines (mills, steam engines...)

Informatics is the science of machines that execute algorithms

The two meanings of “mechanical”

Algorithm: mechanical: machine

A mystery: recent idea (Pascal, Babbage, Lovelace, Turing)

First algorithm and machine

Then: algorithms must be expressed in a **language** (why? machine, equation)

And: what algorithms operate on must be represented: **data** (why?, machine)

Do these concepts structure a science or a technology?

Judging a proposition true (Second principle of thermodynamics)

Building an object with a purpose (Steam engine)

The status of negative results

A separation between thermodynamics and steam engine construction

Réflexions sur la puissance motrice du feu et sur les machines propres développer cette puissance

All four concepts are very old

But their **structuration** in a coherent science/technology is new

In the 18th century: **Cugnot** (steam engine) and **Euler** (an algorithm to solve differential equations)

Nothing in common

The four traditions of informatics

How should we call the auditorium?

Frege

al-Khwarizmi

Pascal

Gutenberg

The four traditions at school

Math teachers: algorithms

Technology teachers: machines

Librarians: information

(No) linguistic teachers: language

But all are doomed to fail, as all teach a small part of informatics as informatics is the science/technology of neither of these concepts, but of **their relation**