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 $\rightarrow$ divisibility
- Planet $\rightarrow$ motion
- Psyche $\rightarrow$ 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 $\rightarrow$ language

Macintosh + PC $\rightarrow$ personal computer
Personal computer + petascale computer $\rightarrow$ computer
Robot + computer $\rightarrow$ 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
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
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 \((\text{OD: } -4.50 (+2.00) 35^\circ \text{ OG: } -3.75 (+1.25) 65^\circ)\)

Chemistry \((\text{H}_2\text{O})\)

Addresses \((\text{Av. 18 de Julio 1968, Montevideo, Uruguay})\)

Logic
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 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