Informatics for All

The Informatics Europe perspective

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What is Informatics Europe ?

- Informatics Europe represents the academic and research community in Informatics in Europe and neighbouring countries

- Departments and research laboratories

- Promote, shape and stimulate quality research, education, and knowledge transfer in Informatics in Europe

- A non-profit membership association based in Zurich, Switzerland

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What is the ACM Europe Council ?

- Aims to increase the level and visibility of Association for Computing Machinery (ACM) activities across Europe

- ACM is the world's largest educational and scientific computing society

- ACM Europe Council comprises European computer scientists committed to fostering the visibility and relevance of ACM in Europe

- Organize and host high-quality ACM conferences

- Encourage greater participation of Europeans in all dimensions of ACM

- Improve computer science education

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Previous joint report (2013)

Informatics Education: Europe cannot afford to miss the boat

- Informatics is a **major enabler of technology innovation**, ... and the key to the future of Europe's economy

- Informatics education, unlike digital literacy education, is **sorely lacking in most European countries**

- Not offering appropriate informatics education means that Europe is **harming its new generation of citizens**, educationally and economically

- Unless Europe takes resolute steps to change that situation, it will turn into **a mere consumer of information technology and miss its goal of being a major player**

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2017 report

- Report on the status of Informatics Education in Europe

- Joint effort of Informatics Europe and ACM Europe Council

- Downloadable, as the previous one, from

http://informatics-europe.org

Are We All In The Same Boat ? (2017)

- Investigation of the situation in 55 education autonomous administrative units (in 39 countries)

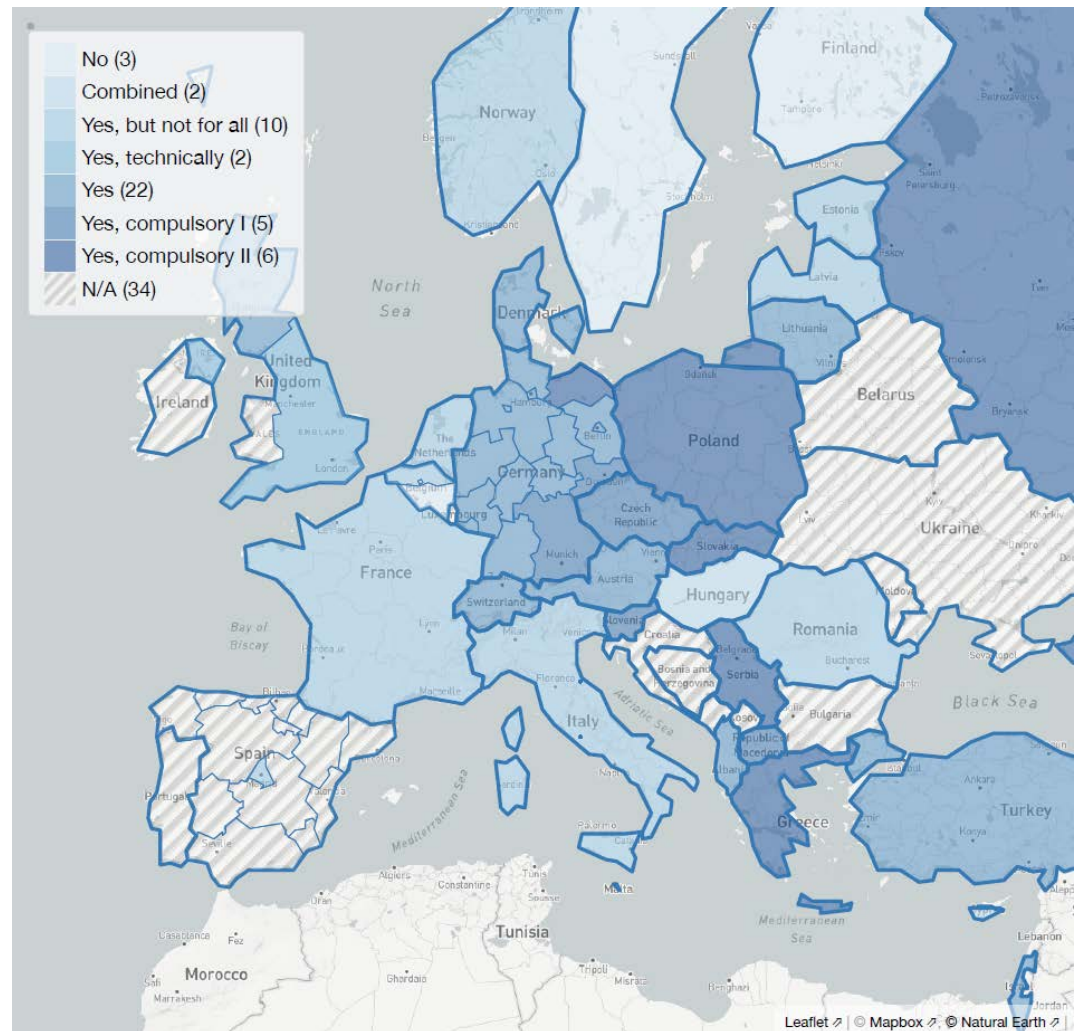- A 2 years effort

- An interactive map accessible on line

    http://cece-map.informatics-europe.org

Informatics: first contact

- 12% primary

- 50% lower secondary

- 38% upper secondary

Kindergarten (0)
Primary (6)
Lower Secondary (27)
Higher Secondary (20)
N/A (31)

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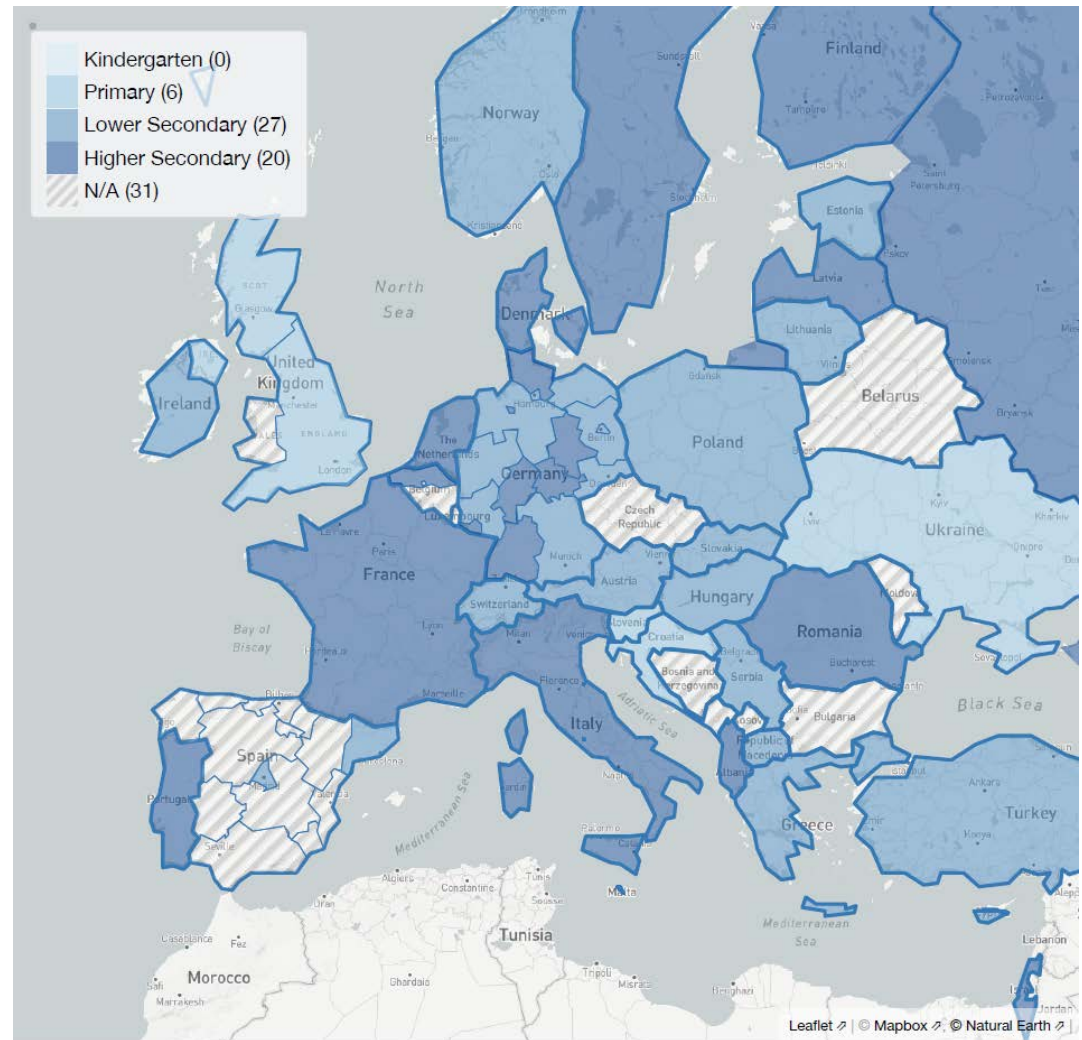
Informatics: availability in secondary school

- 22% compulsory

- 44% available to all

- 20% available to some

- 6% not available

Legend:
- No (3)
- Combined (2)
- Yes, but not for all (10)
- Yes, technically (2)
- Yes (22)
- Yes, compulsory I (5)
- Yes, compulsory II (6)
- N/A (34)

Informatics: enrolment in secondary school

- What percentage of all students typically enrols?

- Lack of official statistics
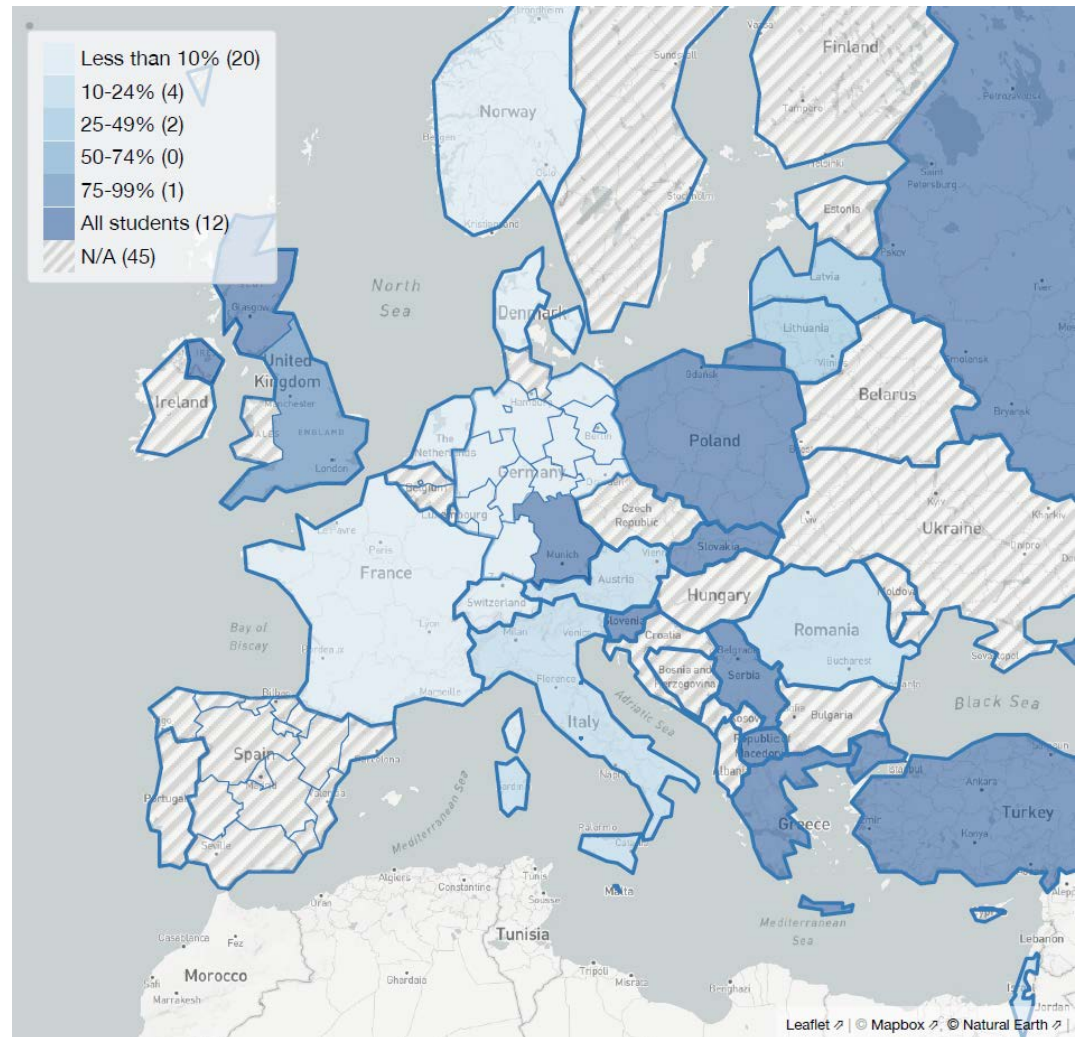
Major findings

- **Informatics** is not on par with other scientific disciplines in school
- Students can graduate from secondary school without ever being exposed to **Informatics**

- **Digital Literacy** is accepted as an educational subject
- Teaching of **Digital Literacy** does not follow a generally accepted curriculum

- **Teacher training** in Digital Literacy is generally not appropriate
- **Teacher training** in Informatics is in place but budget shortages severely undermine teachers availability

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What is *Literacy* ?

- Literacy centuries ago...
- ... the 3 R's: **R**eading, w**R**iting, a**R**ithmetic

- On the basis of these...
- ... **prepare citizens** for the society

⟹ History, Geography, Literature, Arts, ...

- And later on...
- ... prepare citizens for the **industrial** society

⟹ Physics, Biology, Chemistry, ...

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What is *Digital Literacy* ?

- Somebody calls it the 4th R...

- ... but it is much more!

- Now we have to prepare citizens for the **digital** society

$\Longrightarrow$ Informatics (or Computer Science or Computing or ...)

- **Informatics**: the science underpinning the development of the digital world

- Informatics is a cornerstone of Digital Education

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What is *Digital Education* ?

- **Digital** is an "umbrella" terms covering all the modern technologies based on computers

- Think to it like an evolution of "industrial"

  "Industrial revolution" $\Longrightarrow$ "Digital revolution"

  "Society of machines" $\Longrightarrow$ "Society of digital machines"

- To prepare citizens for the *industrial society* we introduced scientific and technological education in all schools: Physics, Chemistry, Biology, ...

- We have now to introduce in all schools the science and technology behind the *digital society* : **Informatics**

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But Informatics is not a science, just another technology… ?!?

Which objects does Informatics study?

- **information processes**:

- **automated** **processing** of **representations**

- Automated, i.e. mechanical, like a clock

- Representations, i.e. signs without an intrinsic meaning

- Processing, i.e. the dynamics of the executing agent

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Beware of language issues! (1)

- **Informatics is not only "being/going digital"**
- "Digital" is a way of representing facts by means of digit
- It is (almost) as old as the language

- **Informatics is not "the new english"**
- A language is only a tool to give concreteness to thinking
- Success depends mainly on professional and human competences and not on foreign language knowledge

http://link-and-think.blogspot.com/2017/10/dal-coding-a-borges.html

Beware of language issues (2)

- **Informatics is not (just) "coding"**, as Mathematics is not (just) "table of Pythagoras"

- Multiplication is (just a) <u>part of</u> Arithmetic
- Arithmetic is (just a) <u>part of</u> Mathematics (Geometry, Algebra, Probability, Statistics, Analysis, ...)

- Coding (or programming) is (just a) <u>part of</u> the software development process
  - Analysis – Design – Coding (Programming) – Testing – Debugging
- Software is (just a) <u>part of</u> Informatics (Data Representation, Algorithms, Programming Languages, Computing Systems, Distributed Computing, Human-Computer Interaction, ...)

Beware of language issues (3)

- **What about "computational thinking" ?**
- It's the habit of thinking developed by doing Informatics, like "mathematical thinking" is habit of thinking of Mathematicians

- Physicist: masses, forces, fields, …
- Biologist: cell, organism, metabolism, …
- Mathematician: quantity, relation, structure, …
- Informatician: automaton, algorithm, program…

- Would one teach "mathematical thinking" or "biological thinking" in schools?

Computational thinking: an informal example

From the "Apollo 13" movie

https://www.youtube.com/watch?v=vNaNxwATJqY

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Why speaking about "computational thinking" ?

An instrument to explain in brief why computer science is a novel and independent scientific discipline and to denote its "conceptual kernel"

E.Nardelli, *Do we really need computational thinking?*, Comm. ACM, accepted for publication, 2018

- How to explain what the "conceptual kernel" is and why informatics is a novel scientific discipline?

A big misunderstanding…

… computational thinking is a **mental process to solve problems** by following specific methods and tools

I'm an informatician.
I solve problems.

An odd attitude!

Solving problems?

- A *mathematical* solution to a problem is

  a formula defining the answer

- An *informatics* solution to a problem is

  a process computing the answer

- **Process**: an **algorithm** implemented in a **language** executed by an **automaton**
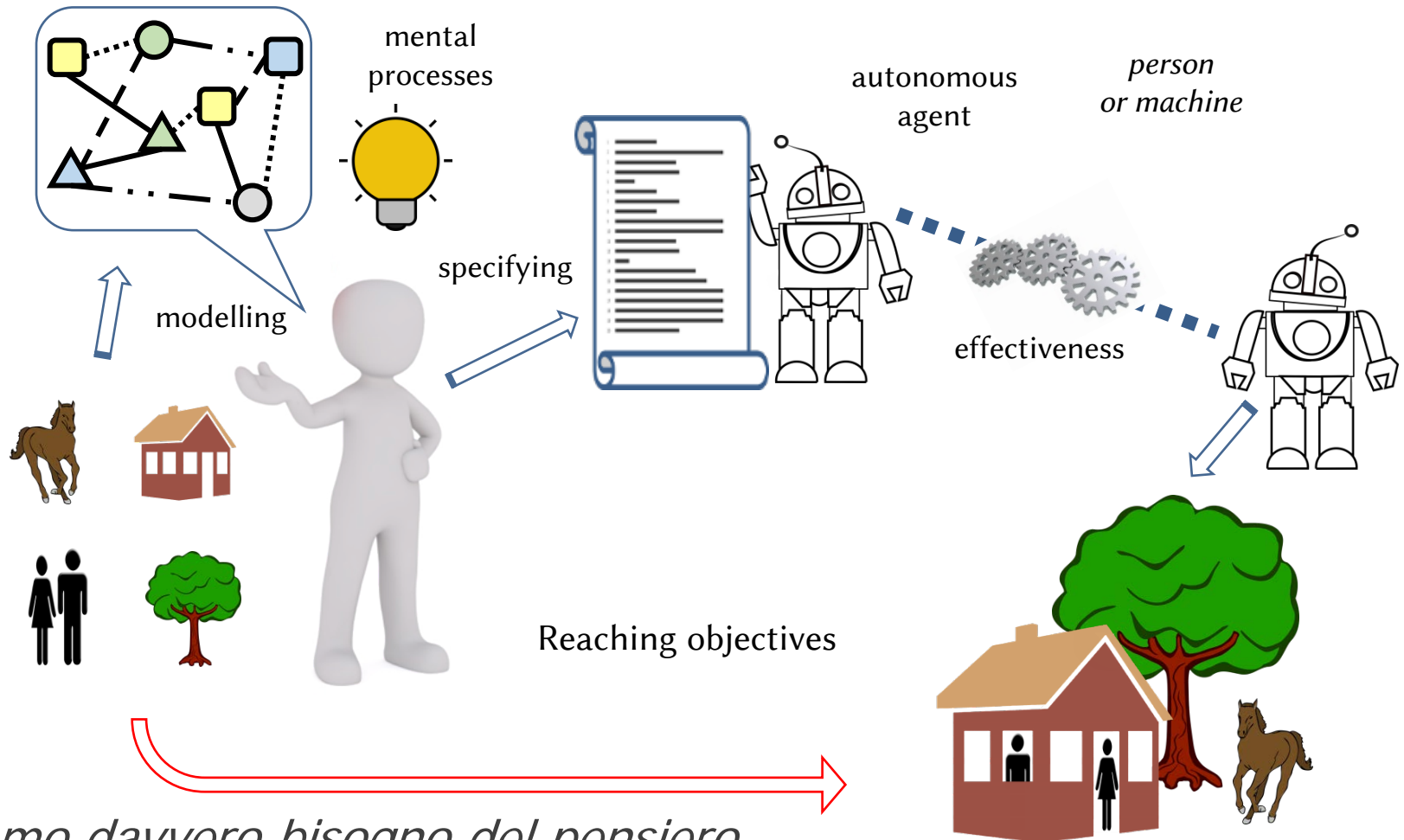
The conceptual kernel of informatics

FROM

Solving problems

TO

Having problems solved

- "*A difference which makes a difference* "   (G.Bateson)

- Without the **effective** processing agent (i.e., the automaton) there is no informatics

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From solving problems to having problems solved

mental processes

autonomous agent

person or machine

modelling

specifying

effectiveness

Reaching objectives

Abbiamo davvero bisogno del pensiero computazionale?, Mondo Digitale, Nov.2017

The great power of informatics

- The agent executes instructions
  whose **meaning is unknown**
  to manipulate representations (i.e. data)
  whose **meaning is unknown**

- But "instructions" are representations themselves...
- ...and can be manipulated

- SELF-LOOP: representations manipulating representations

A replicating program (1)

def. A   P = ₪;   (*assignment*)

prog.1   P = ₪; print P;   ⟹   ₪

prog.2   P = ₪; print "P";   ⟹   P

prog.3   P = ₪; print "P =" P;   ⟹   P = ₪

def. B   3|₪; stands for ₪; ₪; ₪;   (*a shortcut*)

prog.4   P = 3|₪; print P;   ⟹   ₪; ₪; ₪;

prog.5   P = 3|₪; print "P";   ⟹   P

prog.6   P = 3|₪; print "P =" P;   ⟹   P = ₪; ₪; ₪;

> Print the value of P

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A replicating program (2)

P=2|print "P=2|" P; print "P=2|" P;

The value of P

print "P=2|" P; print "P=2|" P;

A "digital" world we are blind to...

- More and more data

- More and more digital data

- We do not have the senses for the digital world

- One of the root causes for security problems

- The only viable approach is instruction, education and awareness, paying attention to scientific basis

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A sorcerer's apprentice?

- Quelli che s'innamoran di pratica sanza scienza son come 'l nocchiere, ch'entra in navilio sanza timone o bussola, che mai ha certezza dove si vada (Leonardo da Vinci, *Trattato della pittura*)

- Those who fall in love with practice without science are like a sailor who drives a ship without using rudder or compass, who never can be certain where the ship is hailing (Leonardo da Vinci, *Treatise on painting*)

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Data education...

- Data
  - Correctness
  - Completeness
- **The map is not the territory!**

- Data are objective, self-evident and true?
  - The glass is half empty !
  - The glass is half full !
- Data is neither good nor bad, nor is it neutral
  - Modeled after the Kranzberg's first law of technology
- "*There is nothing either good or bad, but thinking makes it so*" (Hamlet, act II)
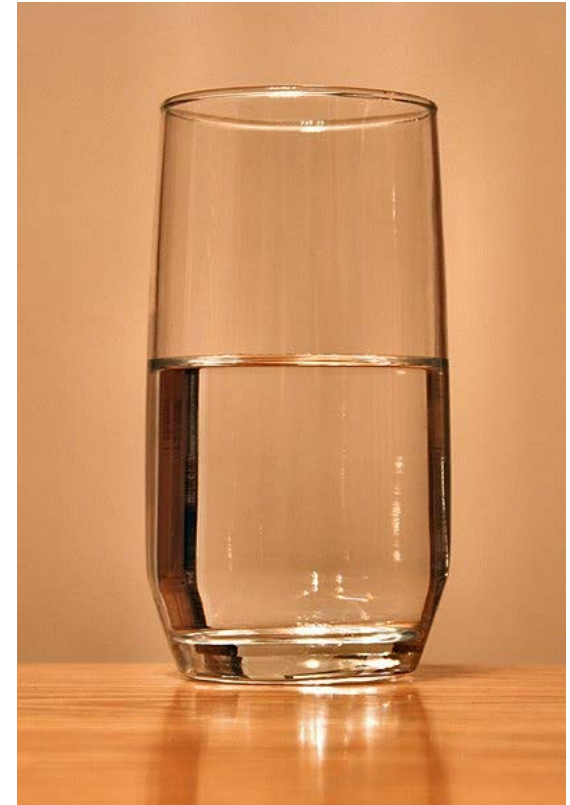
"datification" and "solutionism"

- Using data to measure reality and control society by means of feedback mechanisms

  - algorithmic regulation is the "death of politics" (E.Morozov)

https://www.theguardian.com/technology/2014/jul/20/rise-of-data-death-of-politics-evgeny-morozov-algorithmic-regulation

- "*Politics now governs the effects, instead of governing the causes, a more difficult and expensive task* " (Giorgio Agamben, Atene 2012)

- "*Society cannot give up the burden of having to decide about its own fate by sacrificing this freedom for the sake of the cybernetic regulator* "   (Stanislaw Lem, Summa Technologiae, 1964)

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Informatics: the 3rd "power" revolution

http://www.broadband4europe.com/informatics-third-power-revolution-consequences-part-1/

- 1st "power" revolution (1400): **invention of the printing press**

- … 800 million books after …
- 2nd "power" revolution (1700): **industrial revolution**

- … 800 billion machines after …
- 3rd "power" revolution (1900): **informatics revolution**

Informatics: the 3rd "power" revolution (cont.)

- 1st "power" revolution (1400): **invention of the printing press**
- Replicability of knowledge: *books*
- Overcomes time and space constraints to learn
- Breaks the power of authority ("ipse dixit")

- ... 800 million *books* after ...
- 2nd "power" revolution (1700): **industrial revolution**
- Replicability of physical strength: *machines*
- Boost physical capabilities of humankind
- Breaks the power of the nature

- ... 800 billion *machines* after ...
- 3rd "power" revolution (1900): **informatics revolution**
- Replicability of *actionable* knowledge ("*ready to be put in action*")
- Amplifies cognitive capabilities of humankind
- Breaks the power of human intelligence

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Informatics revolution: the consequences

- We cannot envision them...

- "Digital machines" are substituting people in many tasks
- But without the flexibility and adaptability of human beings

- People will still be needed...
- ...but will have to be properly educated in the science behind these machines

- How can we do it?
- **Informatics for All**

Informatics for All
The strategy

ACM Europe & Informatics Europe

February 2018

Downloadable from
http://informatics-europe.org

- **All students** must have access to ongoing education in Informatics in the school system and Informatics teaching should start in **primary school**

- Informatics curricula should reflect the scientific and constructive nature of the discipline, and be seen as **fundamental to twenty-first century education** by all stakeholders (including educators, pupils and their parents)

- Informatics courses must be **compulsory** and recognized by each country's educational system as being at least **on a par with courses in STEM**

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Informatics for All: the challenge

A Grand Educational Challenge for Europe

A **two-tier approach**

1. Teach informatics as a **specialized** subject starting in primary all the way up to secondary

2. Teach informatics as a method and language capable to offer an additional and specific way to describe and explain phenomena (**integrated** in other subjects)

- Not at all easy to implement! A thought experiment: imagine Mathematics exists only at the university and plan how to introduce it into all school levels

Informatics for All: areas of intervention

For both tiers

- Curriculum
  - Develop fine-grained schools curricula for all levels
  - Develop effective learning materials

- Teachers
  - Appropriately educate teachers at all levels
  - Provide all teacher appropriate support (tools and content)

- Research
  - Understand what to teach
  - Understand when to teach
  - Understand how to teach

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Why teaching informatics in schools?

- Why going to school?

- To prepare citizens for the society
- ... which includes to be able to find a real job

- Well-informed citizens able to understand and decide

- Universal education is the corner stone of democracy

- Learning informatics in schools is needed to prepare well-informed digital citizens (e.g., data, privacy, AI, ...)

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A further added value…

- **Making abstractions concrete**

Wing, J. (2008). "*Computational thinking and thinking about computing*", Philosophical Transactions of The Royal Society

- **"La grande bellezza"** of Informatics

http://link-and-think.blogspot.com/2017/05/la-grande-bellezza-dellinformatica.html

- It is the **only** scientific discipline whose abstractions (i.e., models) can be **mechanically and automatically** executed (simulation of scenarios)

- This **transversal value** allows it to provide additional and useful viewpoints in the study of other disciplines, improving their learning through scenarios building and phenomena simulation

THANKS !!!

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