Educating in socially responsible Informatics: the next frontier

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ACM Conf. "Information Technology for Social Good", Rome, Sep.2021

(from the House of the Tragic Poet in Pompeii)

- **Informatics** is the largest common root of the various names in Europe of the discipline known in many parts of the world as Computer Science or Computing

Content

- **Digital & Informatics**
- An historical perspective
- Social challenges
- Educational implications

Does it sound familiar?

- Informatics is an idealistic and optimistic science. For most of our existence, we focused on all of the good that automating people's actions can do... But it’s clear now that we didn’t do enough to prevent our tools for being used as harm as well … we didn’t take a broad enough view of our responsibility and that was a big mistake ...

CNN politics

16 Posts

↑ 43 New Updates

SORT BY Latest

3:08 p.m. ET, April 10, 2018

Read Mark Zuckerberg's full opening remarks

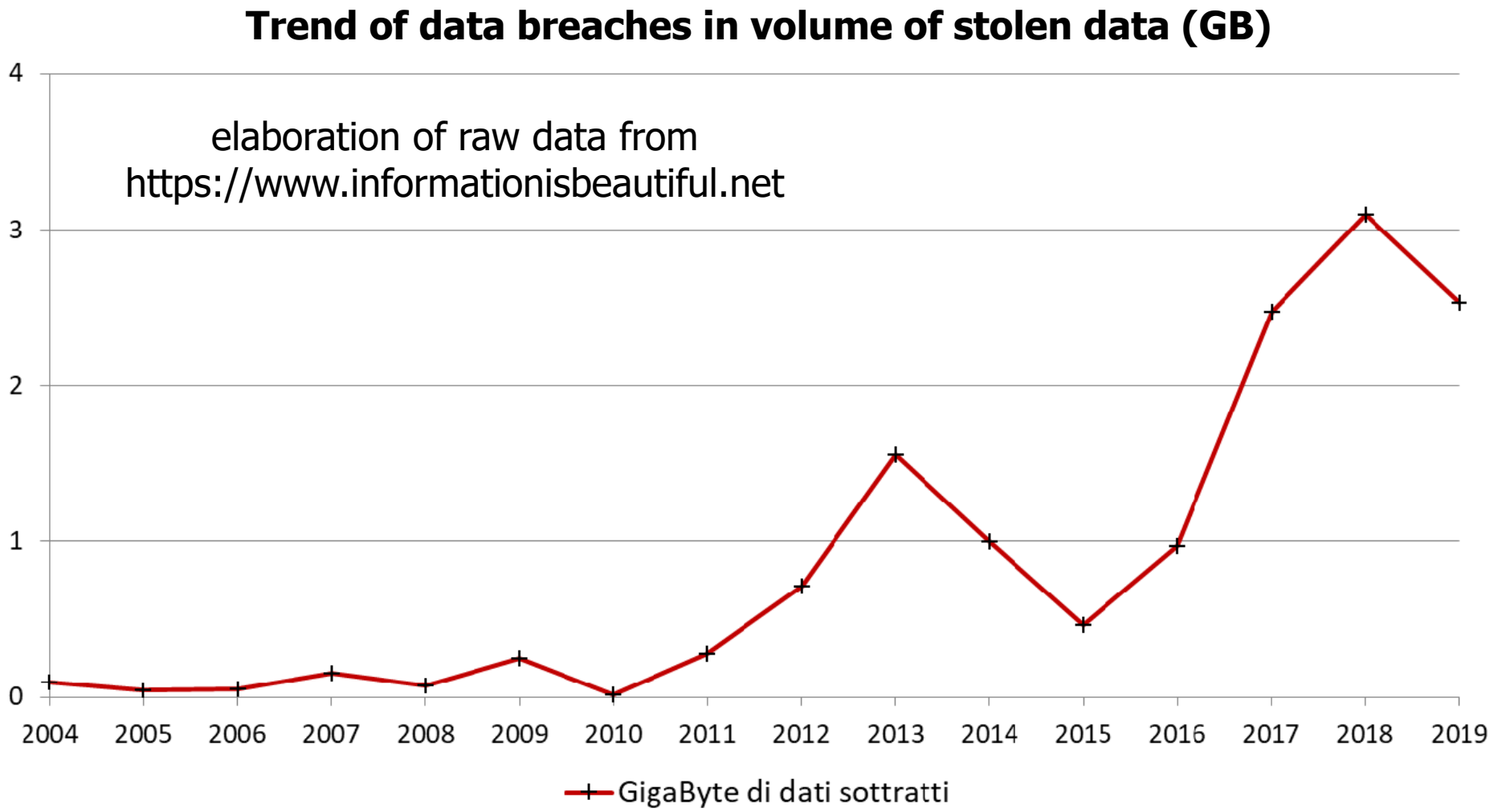
https://edition.cnn.com/politics/live-news/mark-zuckerberg-testifies-congress/h_908afd7a7eabfdc60a62e21700493e2c

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, worsening and worsening year after year…



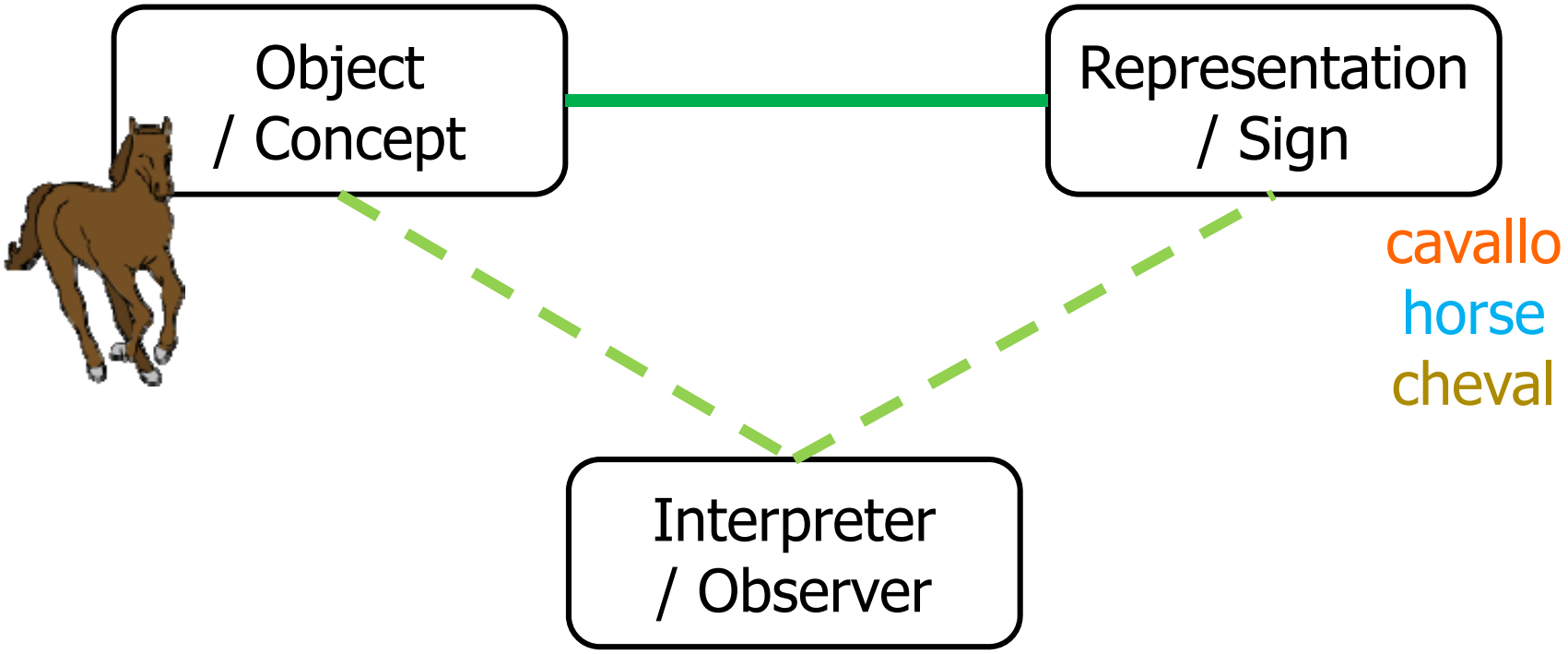
- The only counter measure is education to build awareness

What is Informatics?

- **automated processing of representations**
- Representations, i.e. signs without an intrinsic meaning
- Automated, i.e. mechanical, like a clock (levers & gears)
- Processing, i.e. effective transformation carried out by an agent

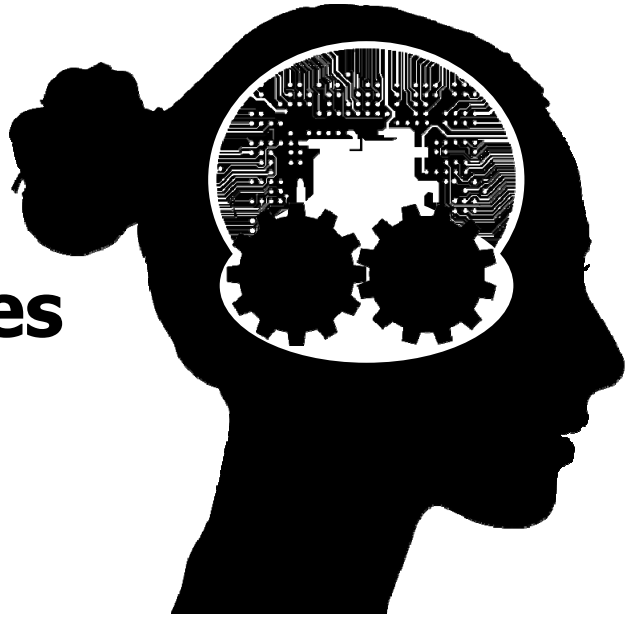
The question of meaning

- Signs are "symbols", they refer to a meaning, but only for a (human) interpreter



The great power of informatics (1)

- The agent executes instructions
  whose **meaning is unknown**
  to manipulate representations
  whose **meaning is unknown**



- Through this we obtain **machines** replicating human behaviour

The great power of informatics (2)

- "instructions" are representations themselves…
- …and can be manipulated

- SELF-LOOP: representations manipulating representations

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

E.Nardelli. *Do we really need computational thinking?*, Comm. ACM, Feb. 2019

More than 50 years ago…

- « The most valuable acquisitions in a scientific or technical education are the **general-purpose mental tools** which remain serviceable for a lifetime. »
- « I rate natural language and mathematics as the most important of these tools, and **computer science as a third**. »
- « The learning of mathematics and computer science together has pedagogical advantages, for the basic concepts of each reinforce the learning of the other. »

[George Forsythe, *What to do till the computer scientist comes*. Amer. Math. Monthly (1968)75:454-462.]

The third essential "language"

- Natural language: social relations
- Mathematics: quantitative relations
- Informatics: transformation processes

Informatics as the “new math”

- « CS like math is unique in the sense that many other disciplines will have to adopt that way of thinking. It offers a sort of **conceptual framework for other disciplines**, and that's fairly new. »
- « The curriculum is changing to fulfill the true promise of CS, which is to provide a **conceptual framework for other fields**. »
- « Students need to understand there's more, vastly more, to CS than writing the next version of Windows or Unix. »

[Bernard Chazelle, Computer Science looks for a remake, ComputerWorld, May 2006.]

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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**

The first power revolution

- Invention of the printing press
  - technical revolution: faster replication of texts
  - social revolution: faster spreading of knowledge
- Replicability of texts **breaks the power of authority**
- Overcomes time and space constraints
- Through books, knowledge can arrive to anyone who can read

The second power revolution

- Automated machines (*industrial revol.*)
  - technical revolution: faster production of objects
  - social revolution: overcoming of physical barriers to movements
- Replicability of physical strength **breaks the power of nature**
- Industrial machines boost physical capabilities of humankind
- Physical artefacts significantly change the world and the way we live in

The third power revolution

- Digital machines (*informatics revol.*)
  - technical revolution: faster transformation of data
  - social revolution: spreading of "dynamic cognitive artefacts"
- Replicability of ***actionable knowledge*** (*actionable* = "*ready to be put in action*") breaks the power of human intelligence
- Amplifies cognitive capabilities of humankind
- Cognitive machines
  - Its activation generates knowledge
  - Affects the cultural sphere

Consequences

- We cannot really envision them...
- Cognitive machines are successfully substituting people in many tasks
  - Completely specifiable tasks
  - Low conceptual complexity

Software development

- Development of informatics systems is generally late and over-budget in an embarassing way.
- The true development is the maintenance

E.Nardelli. The maintenance is the implementation OR Why people misunderstand IT systems, ECSS-10.

  - The first implementation it's easy
  - Subsequent adaptations costs more and more
  - That's why open source is often free

- Previous automation was never like that

Differences

- Human intelligence is not "like" a clock mechanism
- Human intelligence can:
  - Adapt to a changing environmente
  - Manage new or modified requirements/ constraints
  - Learn from mistakes and experience
- Artificial Intelligence can only learn what it has been programmed to learn

AI for the layperson

- It has eventually allowed people to understand what is informatics really is
- Substituting human brains with automated clocks
- Boosting capabilities of human brains

- This is clearly apparent in "pattern recognition" tasks

But…

- Cognitive machines are completely detached from what it means to be human beings

- When it comes to decisions affecting people and society we need the **embodied intelligence** of human beings, not the artificial intelligence of cognitive machines

Which use for AI?

- It's an enabling technology, much like relational databases in the '80 and '90 (B.Evans)
  - A "standard" component of informatics systems
  - Able to provide some "generic" data processing in an "intelligent" way
  - It will be highly scenario and context dependant

- Understanding AI requires a basic understanding of informatics

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Dangers of digitalization

- From a partial statistical description of the past to the mandatory prescription of the future
- After lunches judges are more benevolent !?!? [Danziger *et al.*, PNAS, 2011]
- It's just a correlation, there are other organizational causes [Weinshall-Margel & Shapard, PNAS, 2011]
- France has forbidden analytics on judges' activity is well taken [Artificial Lawyer, 2019]
- Incorporeal decision systems risk stealing human beings of their most precious and more characteristic qualities, free will.

A social challenge

- Social space and digital space are intertwined
- Those who control data control society
- Any vision of society cannot avoid dealing with this element
- « *For a mainstream political party today to abandon responsibility over the "digital" is tantamount to abandoning responsibility over the future of democracy itself*. »

  Evgeny Morozov, *The price of hypocrisy*, 2013.

Data madness…

- Wired 2008, *The end of theory: the data deluge makes the scientific method obsolete*.
- « We can stop looking for models. We can analyze the data without hypotheses about what it might show. We can throw the numbers into the biggest computing clusters the world has ever seen and **let statistical algorithms find patterns where science cannot**. »
- « The new availability of huge amounts of data, along with the statistical tools to crunch these numbers, offers a whole new way of understanding the world. Correlation supersedes causation, and **science can advance even without coherent models, unified theories**, or really any mechanistic explanation at all. »

Theory is more important than ever…

- C.S. Calude, G. Longo: *The Deluge of Spurious Correlations in Big Data*, Foundations of Science, pp. 1-18, March, 2016

- Given any arbitrary correlation on sets of data, there exists a large enough size such that any data set larger than that size realizes that type of correlation.
- Since this large enough data set is arbitrary, it could have been obtained by a random number generator which, by design, excludes any underlying structure or rule that could justify action through possible future extensions.
- It is exactly the size of the data that allows the result: the more data, the more arbitrary, meaningless and useless (for future action) correlations will be found in them.
- The scientific method can be enriched by computer mining in immense databases, but not replaced by it.

"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)

What to do…

- We are much more than a thousands data points collected in the past
- We are first and foremost citizens, not consumers
- Defend privacy and detach from surveillance
- No privacy, no freedom
- No freedom, no democracy

Ethical issues

- What should we use automatic decision systems for?

- Technology should be in the service of people and not the other way round

When Computers Decide:
European Recommendations on Machine-Learned Automated Decision Making

Informatics Europe & EUACM
2018

INFORMATICS EUROPE

acm Europe Council

euacm ACM Europe Policy Committee

Manifesto on Digital Humanism

- Vienna, may 2019

https://dighum.ec.tuwien.ac.at/dighum-manifesto/

- Democracy and inclusion
- Privacy and freedom of speech
- Fairness and transparency
- Regulations of the markets
- Decisions affecting individual or collective human rights must be made by human beings.

https://dighum.ec.tuwien.ac.at/perspectives-on-digital-humanism/

Digital Humanism is young; it has evolved from an unease about the consequences of a digitized world for human beings, into an internationally connected community that aims at developing concepts to provide a positive and constructive response. Following up on several successful workshops and a lecture series that bring together authorities of the various disciplines, this book is our latest contribution to the ongoing international discussions and developments. We have compiled a collection of 46 articles from experts with different disciplinary and institutional backgrounds, who provide their view on the interplay of human and machine.

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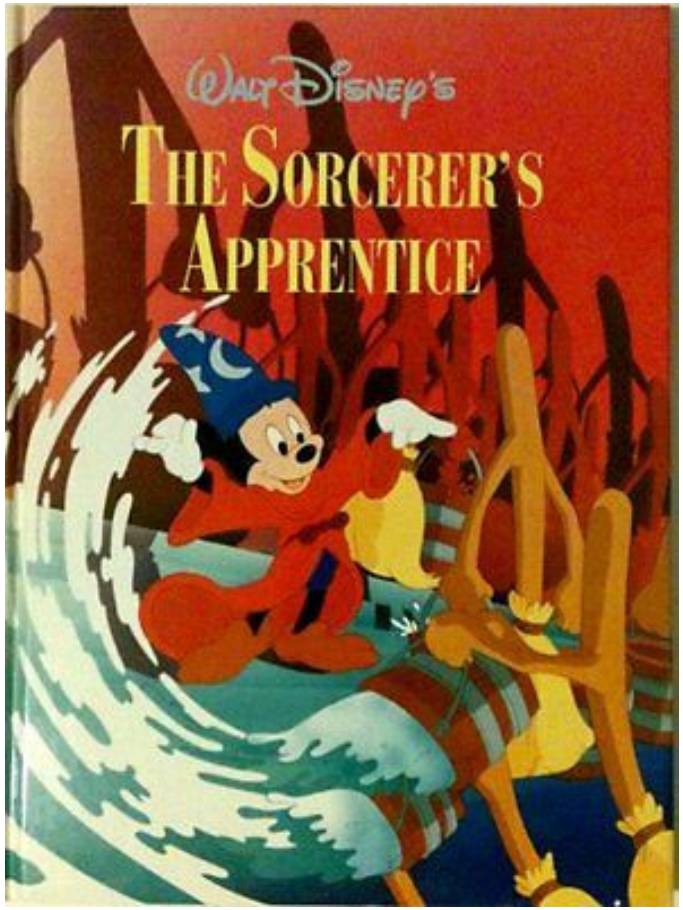
Forgetting about education

- 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*)



Why education?

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

- Well-prepared citizens able to understand and decide

- Universal education is the corner stone of democracy

How to prepare citizens ?

- Until two centuries ago: basic literacy…
- … the 3 R's: **R**eading, w**R**iting, a**R**ithmetic
- Last century…
- … **prepare citizens** for the society

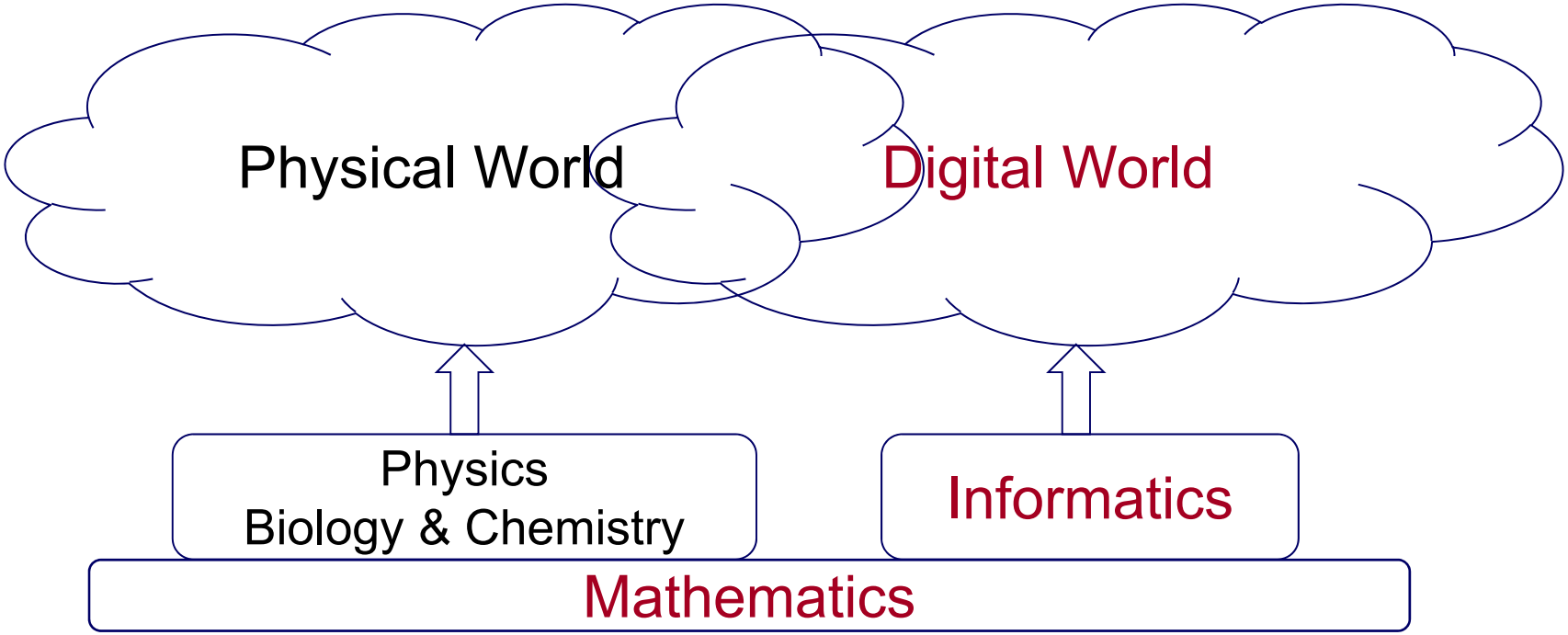
⟹ History, Geography, Literature, Arts, …

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

⟹ Physics, Biology, Chemistry, …

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

⟹ Informatics (or Computer Science or Computing or …


Physical World
Digital World
Physics
Biology & Chemistry
Informatics
Mathematics

Informatics for All
The strategy

ACM Europe & Informatics Europe

February 2018

DOI:10.1145/3310330

BY MICHAEL E. CASPERSEN, JUDITH GAL-EZER, ANDREW MCGETTRICK, AND ENRICO NARDELLI

Informatics as a Fundamental Discipline for the 21st Century

INFORMATICS FOR ALL is a coalition whose aim is to establish informatics as a fundamental discipline to be taken by all students in school. Informatics should be seen as important as mathematics, the sciences, and the various languages. It should be recognized by all as a truly foundational discipline that plays a significant role in education for the 21st century.

The European scene. In Europe, education is a matter left to the individual states. However, education, competencies, and preparedness of the workforce are all important matters for the European Union (EU).

Importantly, there is a recognition that the education systems of Europe do not collectively prepare students sufficiently well for the challenges of the digital economy. These systems need to be fundamentally transformed and modernized. In January 2018, a Digital Education Action Plan,[1] which set out a number of priorities, was published by the EU. The most relevant priority for our initiative is "Developing relevant digital competences and skills for the digital transformation," and the Plan suggests one way to implement this is to "Bring coding classes to all schools in Europe." This is important, but more is needed, as we will explain in this article.

ACM Europe and Informatics Europe. ACM Europe (europe.acm.org) was established in 2008, and Informatics Europe (www.informatics-europe.org) in 2006. From the early days, the two organizations have collaborated on educational matters; through this liaison, they are seen to project to the wider community a single message about aspects of informatics[a] education. In 2013, the two groups set up and funded a Committee on European Computing Education (CECE) to undertake a study that would capture the state of informatics education across the administrative units of Europe (generally, these units are the countries, but within Germany, for instance, there are 14 different administrative units with autonomy regarding education).

The CECE study paralleled the highly influential U.S. study *Running on Empty*[11] that had drawn attention to the state of computer science education in the U.S. The CECE study gathered data from 55 administrative units (countries, nations, and regions) of Europe (plus Israel) with autonomous educational systems through the use of questionnaires and a wide network of reliable contacts and official sources.

The report on that work was published in 2017.[3] The three themes of informatics, digital literacy, and teacher training provided the framework for the study. Informatics was

a In most of Europe, informatics is synonymous with computing or computer science.

Informatics for All: the challenge

A **two-tier approach**

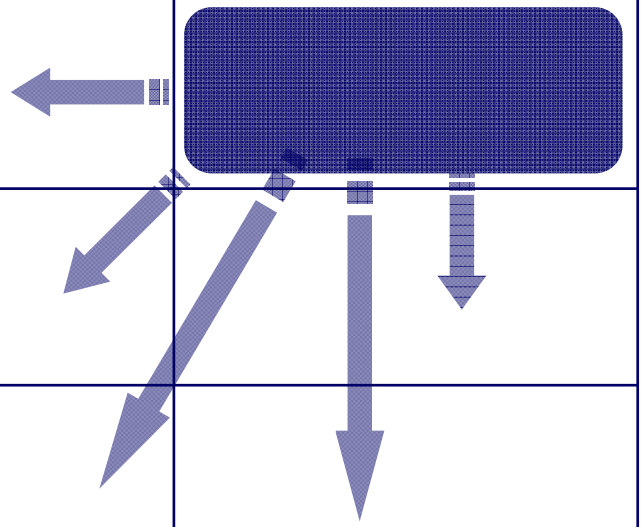
1. Teach informatics as a **specialized** subject starting in primary all the way up to secondary
2. Teach informatics as a method and language capable to offer an additional and specific way to describe and explain phenomena (**integrated** in other subjects)

- 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

A Grand Educational Challenge

Extend Informatics education

Level	Integrated in other subjects	As autonomous subject
University		
Secondary		
Primary		



The "Rome declaration" (March 2019)

- https://informaticsforall.org/rome-declaration

CONSIDERING THAT

the discipline known as Informatics is the scientific core of the digital society, shapes the digital world, and explains how it works and evolves

CALL UPON

all European national and international institutions to exercise their moral suasion power so that the principles of Informatics are included as part of school curricula at all levels

- **Have it signed by your institution !**

The key point for informatics education

- Digital computing systems operate without any comprehension, by the system itself, of what is processed and how it is processed

- « *We are meaning-seeking creatures. Biologically, our nervous systems are organized in such a way that the brain automatically clusters incoming stimuli into configurations*. »

I.Yalom, *Love's Executioner and Other Tales of Psychotherapy*, 1989.

A matter of choices

- Modelling reality in terms of digital data and processing them by means of algorithms is a human activity
  - may be affected by prejudice and ignorance, possibily unconscious or unknown.
- Any choice is the result of a human decision process and is therefore devoid of the absolute objectivity that too often is associated to algorithmic decision processes.

The "computational folly"

- in the biological world there is not such a distinction between hardware and software
- fluctuations are completely absent in the discrete world where Turing machines operate
- every software is only able to represent an abstraction of a real phenomenon
- digital systems, once set in the same starting conditions within a same context, will identically compute always the same result

« *Computer networks and databases, if considered as an ultimate tool for knowledge or as an image of the world live in the nightmare of exact knowledge by pure counting, of unshakable certainty by exact iteration, and of a "final solution" of all scientific problems*. »

G.Longo, *Letter to Alan Turing*, Theory, Culture & Society, 2018.

A proposal for tertiary education (1)

- We need to prepare our students **in a way similar to how they train medical doctors**
  - Start from scientific basis
  - Then progress to the study of system
  - Eventually deal with a human being
- Focus on the specific problem of the specific patient
  - feet firmly planted in science,
  - head aimed at making people and society feel better

A proposal for tertiary education (2)

- Strong basis in discrete mathematics, algorithmics, semantics, systems and networks
- Learn to solve automation problems regarding data processing paying attention to people
- Develop an appreciation for human and social viewpoints regarding digital systems
- User Centered Design – Human Centered Design & Engineering
- Complementing with interdisciplinary and multidisciplinary education from the humanistic and social areas
- Implement digital transformation while improving social well-being of people
- Respect for people and values of a democratic society have to be the guiding forces.

Take away concepts

- Informatics systems are cognitive machines, however do not understand what they do
- Informatics is the third "power revolution"
- The digital world needs to be shaped according to human values (Digital Humanism)
- We have to teach Socially Responsible Informatics

THANKS !

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