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DI TRENTO

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The future of AI

Fausto Giunchiglia

A few insights into the possible futures of Artificial Intelligence

Artificial Intelligence?

Artificial Intelligence: our community

IJCAI 1969 (Selected List)

- HEURISTIC PROBLEM SOLVING
- THEOREM PROVING
- PROGRAMMING SYSTEMS AND MODE FOR ARTIFICIAL INTELLIGENCE
- SELF-ORGANIZING SYSTEMS
- PHYSIOLOGICAL MODELING
- INTEGRATED ARTIFICIAL INTELLIGENCE SYSTEMS
- PATTERN RECOGNITION--SIGNAL PROCESSING
- QUESTION-ANSWERING SYSTEMS AND COMPUTER UNDERSTANDING
- MAN-MACHINE SYMBIOSIS IN PROBLEM SOLVING

IJCAI 2007

- Constraint Satisfaction
- Knowledge Representation and Reasoning
- Planning and scheduling
- Search
- MultiAgent systems
- Uncertainty
- Learning
- Web/ Data mining
- Natural Language processing
- Robotics

Artificial Intelligence?

Artificial Intelligence

=

Sensing

+

Representing

Reasoning

Learning

+

acting

… and Computer Science?

John McCarthy's view

(http://www-formal.stanford.edu/jmc/whatisai.html)

Q. What is artificial intelligence?

A. It is the science and engineering of making intelligent machines, especially intelligent computer programs. It is related to the similar task of using computers to understand human intelligence, but AI does not have to confine itself to methods that are biologically observable.

Q. Yes, but what is intelligence?

A. Intelligence is the computational part of the ability to achieve goals in the world. Varying kinds and degrees of intelligence occur in people, many animals and some machines

Strong or Weak AI ? (*)

(http://en.wikipedia.org/wiki/Strong_AI)

Strong AI is artificial intelligence that matches or exceeds human intelligence—the intelligence of a machine that can successfully perform any intellectual task that a human being can. Strong AI is also referred to as "artificial general intelligence“ or as the ability to perform "general intelligent action".Strong AI is also closely related to such traits as sentience, sapience, self-awareness and consciousness.

Some references emphasize a distinction between strong AI and "applied AI" (also called "narrow AI"or "weak AI"): the use of software to study or accomplish specific problem solving or reasoning tasks that do not encompass (or in some cases are completely outside of) the full range of human cognitive abilities.

(*) NOTE: Alan Budny pointed out that this definition is historically not correct,. Still it is good enough for the goals of this talk.

John McCarthy's answer (continued)

Q. Does AI aim at human-level intelligence?

A. Yes. The ultimate effort is to make computer programs that can solve problems and achieve goals in the world as well as humans. However, many people involved in particular research areas are much less ambitious.

See also: John McCarthy "The future of AI – A manifesto", AI Magazine, V26, N4, 2006.

Question

Human-level intelligence

or

Human-like intelligence

???

John McCarthy's answers (continued)

Q. Isn't AI about simulating human intelligence?

A. Sometimes but not always or even usually. On the one hand, we can learn something about how to make machines solve problems by observing other people or just by observing our own methods. On the other hand, most work in AI involves studying the problems the world presents to intelligence rather than studying people or animals. AI researchers are free to use methods that are not observed in people or that involve much more computing than people can do.

My interpretation: Human-Like intelligence is THE main way to achieve human-level intelligence (think of the AI metahors, e.g. planning, knowledge level, NLU, vision, …)

The fundamental assumption of (strong) AI

Artificial intelligences will be actors (e.g., expert systems, problem solvers, programmed computers, robots, …) that will live in environments (the world) which are not themselves artificial intelligences.

A clear distinction between what is INside an artificial intelligence (the "myself") and what is OUTside an artificial intelligence (other intelligences, artificial intelligences or the environment).

… similarly to what happens for humans

Therefore … steps towards artificial intelligence should be mostly taken by trying to build more and more intelligent actors.

Weak AI: intelligent environments

Intelligent …

… cars

… homes

… keys

… tunnels

… and more.

…and computer science?

The future of AI (personal opinion)

It is very unlikely that the “traditional” approach to strong AI will achieve its long term goal.

It is unlikely that the “traditional” approach will produce large scale (as opposed to niche) breakthroughs in its way to (not) achieving its long term goal

It is very likely that **weak AI will achieve its short term goals** (more specifically, building intelligent environments), also via a strong synergy with computer science

Weak AI is the best way towards strong AI.

The failure of strong AI

The science and engineering of strong AI are based on concepts / notions (most noticeably, the “myself”) which are metaphors of natural phenomena which are still largely unknown, and this will remain so for a long while

The implementation of strong AI on top of artifacts has run and it will run into major implementation problems (not least, time and space scalability, backward compatibility)

The gap between AI / computer science and the life sciences (e.g., neurosciences, bio-tec) is far too big and it is unclear whether it will ever be filled

The strong AI research agenda does not fit the evolution of science, engineering and ultimately, the world

The success of Weak AI (1)

The world is being globally infra-structured and connected (optical networks, satellites, wireless networks);

Towards the *anytime, anywhere, anybody* (including machines) paradigm;

Intelligent environments will be enabled FAR BEFORE intelligent actors

The weak AI research agenda is compliant to the world evolution

The success of Weak AI (2)

When building intelligent environments we understand the plumbing. We are building the plumbing.

We do the science and engineering building on top of artifacts which are the results of our science and engineering

The artificial intelligence metaphors are well rooted in the evolution of computer science and its pervasive impact on the world

Weak AI and Computer Science

The need to cover the full cycle

Sensing – representing/ reasoning/learning/ acting

where each component is non trivial

Computer Science will provide the plumbing

Artificial Intelligence will provide the "right" interdisciplinary metaphors (semantics!) for building intelligent machines (e.g., AOSE vs. AOP)

(Weak) AI and Computer Science will definitely converge.

From strong AI to weak AI

Not only intelligent thermostats (or advice takers, or child machines, or intelligent robots) …

From remote controls to intelligent remote controls via Interactive TV (connected to the Internet)

From cars to intelligent cars via e-mobility (intelligent roads, tunnels, …)

… overall: towards intelligent actors embedded in intelligent (indoor and outdoor) environments with no clear cut IN/OUT.

Give up the “myself” metaphor.

From weak AI to strong AI

The run-time integration of multiple (artificial) environments and actors, **not anticipated at design time**, will produce unexpected, not anticipated, non trivial results.

The union will be more than the sum of the parts

Complexity will make it impossible to locate the precise location / cause (if it existed at all) of some machine behavior (… **towards intelligence?).**

Bug (behavior?) fixing (change?) no longer by brain surgery!

A paradigm shift: Managing diversity in knowledge

(EC FP7 FET, Helsinki Nov 2006, F. Giunchiglia)

Consider *diversity* as a *feature* which must be maintained and exploited (while in operation, at run-time) and not as a *defect* that must be absorbed (at design time).

A paradigm shift

- ***FROM:*** knowledge assembled by the *design-time combination* of basic building blocks. Knowledge produced *ab initio*
- ***TO:*** knowledge obtained by the *design* and *run-time adaptation "… with a sense of time and context "* of existing building blocks. Knowledge no longer produced *ab initio*

***New methodologies* for knowledge representation and management**

- design of (*self-*) *adaptive context - aware* knowledge systems
- develop methods and tools for the management, control and use of *emergent* knowledge properties

A paradigm shift: Managing diversity in knowledge

- Correctness?
- Completeness?
- Good enough answers [CIA 2003, Open Knowledge]
- (In)consistency?
- Reusability
- Adaptability
- Context (locality plus compatibility) [KR 1998]
- Implicit assumptions [ECAI 2006, Living Web 2009]
- First order logics?
- Conjunction + …???
- Reasoning?
- Simple reasoning + interaction

- Human in the loop
- Crucial role of Coordinated distributed computation:

•C-C

- •Data/ Knowledge interoperability [ISWC 2003, ESWC 2004, …]
- •Reasoning interoperability (e.g., NLP+ SAT) [FroCoS 2004]

•C-H, H-C, H-C-H, C-H-C

- •Human Computer Interaction (HCI)
- •Social sciences, organizational sciences, …

•H-H

- •Social sciences, psychology, …

From weak AI to strong AI: where will it happen first?

Simple acting/ complex sensing and representation
(e.g., Question/ Answering systems,
monitoring of closed and open environments)

… much later

Complex acting, sensing and representation
(e.g., robotics)

Reasoning: already well developed, open issue of how to integrate it in the full S/RRL/A cycle

Will we eventually build an artificial intelligence?

Most likely, whatever artificial intelligence we will build, it will NOT be human-like intelligence

Most likely, we will build human-level artificial intelligence, with a high variance

Will we call it Intelligence?

Intelligence and human intelligence (McCarthy)

Q. Isn't there a solid definition of intelligence that doesn't depend on relating it to human intelligence?

A. Not yet. The problem is that we cannot yet characterize in general what kinds of computational procedures we want to call intelligent. We understand some of the mechanisms of intelligence and not others.

… does it matter whether we will call it intelligence?

A lot! But this is another talk.

Thank you!