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Some Compared Perspectives of Artificial Cognition and Philosophy, with Evidence of Possible Mutual Benefits

Prof. Dr. Jean-Daniel Dessimoz, MBA, HES-SO / HEIG-VD

11.30 – 12.00, 27 November 2013

http://lara.populus.org/rub/3

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Institut d'Automatisation Industrielle LaRA
Laboratoire de Robotique et Automatisation

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http://www.heig-vd.ch, http://lara.heig-vd.ch

Keywords: Cognitics, Cooperative Agent, Piaget, Real-time Intelligent Control, Industrial Robot

Content

1. Introduction
2. Some Aspects of Philosophy
3. Some Aspects of Automated Cognition
4. Compared perspectives
5. Conclusion

Slides on website: http://lara.populus.org/rub/3

More text in comment fields

1. Introduction 1 of 4

- **Philosophy and cognition overlap to a large extent**
- **Nevertheless, each retains important distinctive properties**

  Philosophy addresses most general elements, integrative beyond the boundaries of cognition

  Cognition aims at a complete coverage of its specific domain, which has exploded in terms of content
- **This communication suggests however that a cross feeding of results achieved in the respective fields mutually helps, and may even be required.**
- **Some concrete examples in this regard are shown here**

1. Introduction 2 of 4

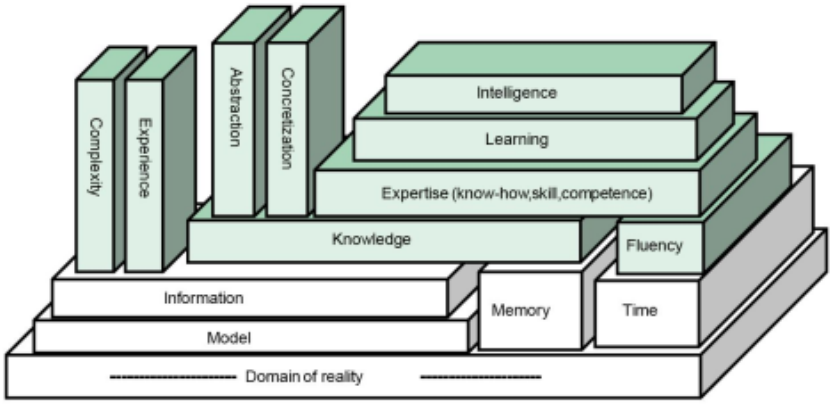


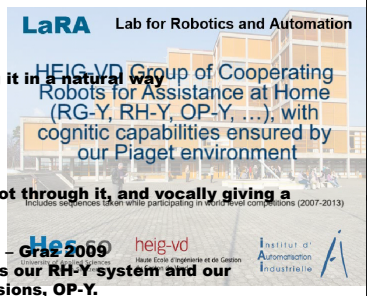
Fig. On the basis of classical concepts (in white; to be revisited though) the green elements are introduced in the formal "MCS" theory for cognition [1]

1. Introduction 3 of 4

State of the art – re. VIDEO at IJCAI 2013 – Beijing, China [2]

Titre:
HEIG-VD Group of Cooperating Robots for Assistance at Home (RG-Y, RH-Y, OP-Y, ...), with cognitic capabilities ensured by our Piaget environment
(2007-*2013*)
Includes sequences taken while participating in world.level *competitions*.

Subtitles for vidéo clip *013.05.jj*



Robocup@Home - Copycat – Atlanta 2007
Programming new motions and tasks just by showing, by doing it in a natural way

Robocup@Home - FastFollow – Suzhou 2008
Guiding a robot at home just by naturally walking in front of it

Robocup@Home - Walk and Talk– Graz 2009
Teaching new topologies and paths at home by guiding the robot through it, and vocally giving a specific name to key locations

Robocup@Home - OC- Robot based gesture control, and crab gait – Graz 2009
Ordering motions by control gestures form a distance ; includes our RH-Y system and our omnidirectional platform with 4 wheels and independant suspensions, OP-Y.

Concept for Robust locomotion on uneven grounds and in staircases – Webots
Beyond the robust robot locomotion capabilities of OP-Y on flat grounds, a concept has been developed in graphically and physically simulated world, and can be driven in real-time.

ic Video on PC

7

1. Introduction 4 of 4

Robocup@Home - OC- Beer and snacks for Daniel – Singapore 2010
Natural H-R communication, multirobot cooperation and H-Machine mediation with NAO humanoid, all integrated in our Piaget environment for system development, programming, and real-world control.

Compliant motion for cooperating, mobile domestic robot, 2011
In addition to our programmed and non-contact guiding modes, our RH-Y robot can be driven in compliant mode for accurate and natural positionning.

Multimodal control for cooperating robots at the Opening ceremony of the International Exhibition of Inventions, in Geneva, 2012
Our RH-Y, OP-Y and NAO, robots and humanoid, are remotely supervised with multiple possibilities based on our Piaget environment, to effectively switch them in real-time in temporary autonomous, cooperating or « slave » modes, featuring various instantaneous levels of cognitive performance.

TeleGrab
Our RH-Y robot is remotely supervised by a human with reduced mobility, with multiple possibilities based on our Piaget environment, to effectively grasp an object and carry it to a freely chosen location. Control can in real-time be switched in autonomous, cooperating or « slave » modes, featuring various instantaneous levels of cognitive performance. Yverdon-les-Bains, Switzerland, 2013.

Final note
Our systems integrate numerous contributions from science, technology and commercial systems, which cannot be all quoted here but are nevertheless gratefully acknowledged.

HEIG-VD, JDZ, *013.05.18*

2. Some Aspects of Philosophy

1 of 3

- Philosophy literally means "love of wisdom" [3-6]
- It was used in Ancient Greek to refer to a field very broad, to any pursuit of knowledge :
  - not only core cognitive elements, such as formal logic and syllogisms
  - but also domains considered today on their own, such as physics, sciences and politics

2. Some Aspects of Philosophy

2 of 3

- Cognition has been explored for millennia. This holds especially true if we can reconnect the appropriate tracks through the multiple apparent, superficial changes that indeed have occurred in languages and traditions through many centuries since Ancient times [e.g. 7].
- Yet serious limitations remain:
  - in the era and context of Ancient Greece, cognition was exclusively human, but in no way bound to animals or inanimate objects (this is understood here in “terrestrial” terms, for otherwise cognition could also then be associated to gods and other mythical or transcendental beings).
  - even in the most developed, contemporary works, the point has not yet been reached where cognitive concepts are both rigorously defined and widely accepted, with quantitative scales, on the contrary of the case holding true for probably all physical entities (and more).

2. Some Aspects of Philosophy
3 of 3

- **Re. In fact even today philosophy keeps addressing the universal view, and in this sense keeps including the other domains (physics, sciences, politics, etc.), though in their most abstract forms only.**

3. Some Aspects of Automated Cognition 1 of 7

- **Advances in tools and techniques > automation and, more recently, out of necessity, to a formal and quantitative theory for cognition.**
- **In this evolution, by scientific approach > epistemic observation and a theory including axiomatic definitions of core concepts and the proposal of related metrics [1, 8-10].**
- **Cognition : faculty, ensured by specific internal structures and operative flows, to process and deliver information rationally, with high performance levels, for example in terms of complexity, knowledge, abstraction, learning, or expertise**
- **Historically rather exclusively considered in human context,**
- **Today, and increasingly, concerning also man-made artifacts (re. artificial cognition, cognitics, traditionally commonly described as AI, and, e.g., world-level competitions of robots cooperating with humans).**

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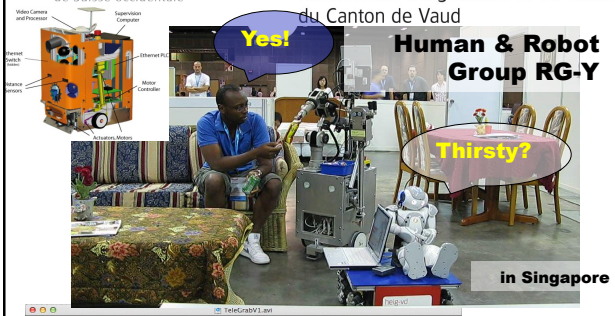
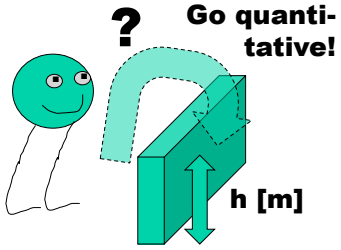
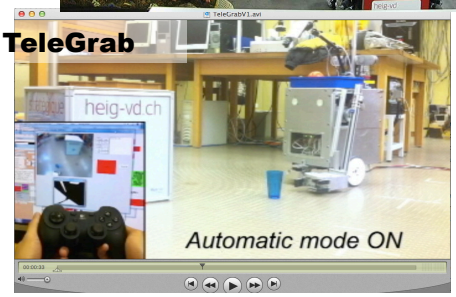


Human & Robot Group RG-Y

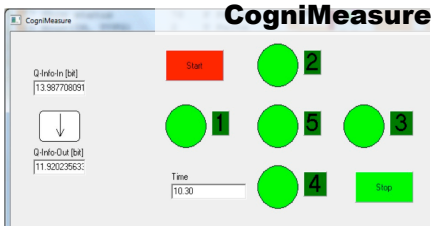


Go quanti-tative!

TeleGrab



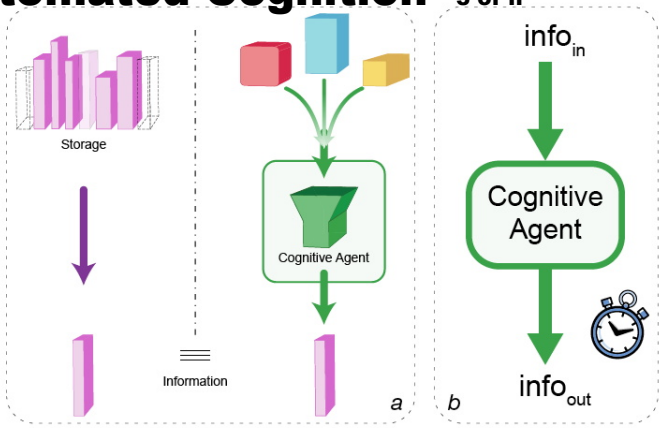
CogniMeasure



3. Some Aspects of Automated Cognition

3 of n

Cognition



Schematic view of cognition. (a) Cognition and, effectively, cognitive systems generate information.
(b) Cognitive properties can be quantatitatively estimated on the basis of the input-output information flows, and time.

3. Some Aspects of Automated Cognition 4 of n

MCS Theory of Cognition

entity	*brief description*
Model	Goal oriented, elementary representation
Information	Builds-up receiver's opinion
Complexity	Amount of information required for description
Knowledge	Capability to crank out the right information
Expertise	Capability to crank ***fast*** the right information
Learning	Increasing the quantity of expertise
Experience	Amount of information witnessed
Intelligence	Ratio of learning versus experience

intuitive description of cognitive concepts defined elsewhere in MCS, along with specific measuring equations and units.

3. Some Aspects of Automated Cognition 5 of n

MCS Theory of Cognition

Information:	$n = \sum p_i \log_2(1/p_i)$ [bit]
Knowledge:	$K = \log_2(n_{out}\, 2^{n_{in}}+1)$ [lin]
Fluency:	$F = 1/\Delta t$ [s^{-1}]
Expertise:	$E = K \cdot F$ [lin/s]
Learning:	$\Delta E = E(t_1)-E(t_0)$; >0 [lin/s]
Experience:	$R = r(n_{in}+n_{out})$ [bit]
Intelligence:	$I = \Delta E/\Delta R$ [lin/s/bit]
relative Agility:	$A_r = \tau/T$

T: $Fluency^{-1}$ and communication delays
τ: Reaction time of target system, to be controlled

Equations for assessing quantitatively the core properties in cognition. Information keeps its classical definition though (re. Shannon 1948)

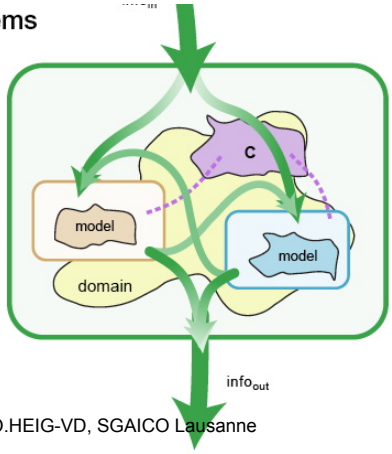
3. Some Aspects of Automated Cognition 6 of n

Cognitive Agent and Scalability– Group or subsystems

- Agent: doer or action enforcer; re. embodiment and effectors
- Cognitive agent: agent with primary aspect of cognitive nature

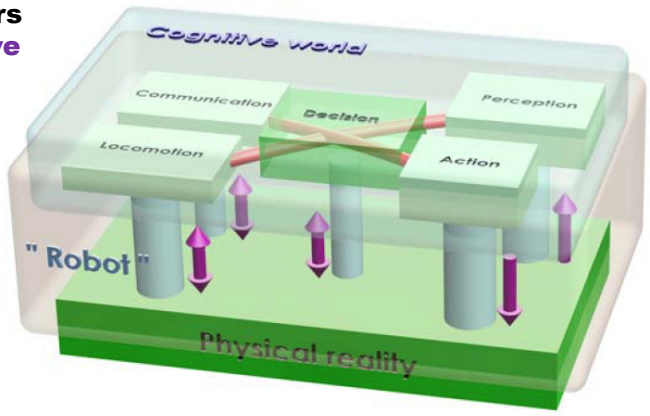
Scalability – Group or subsystems

At an individual scale, single agents update their own models as information is received. Together, as they share common model elements, C (like culture), and interact, they implicitly build-up a group, which globally can also be viewed as a new, single agent



3. Some Aspects of Automated Cognition 7 of 7

Robots : Mediators between Cognitive and Real Worlds



Schematic view of a robot, modeled as featuring 5 essential capabilities. Information flows are shown in red, and energy in purple color.

4. Compared perspectives 1 of 8

- Reality, Truth; Representation, Modeling
- Information
- Wisdom
- Time, and Time aspects in control

4. Compared perspectives 1 of 9

- Reality, Truth; Representation, Modeling
  - Socrates/Plato Allegory of the Cave: usual representations are qualitatively very limited (shadows); philosophers can do better (walk out to sunlight)
  - Kant:
    - no empirical way of observing "self" ;
    - pre-existence of categories

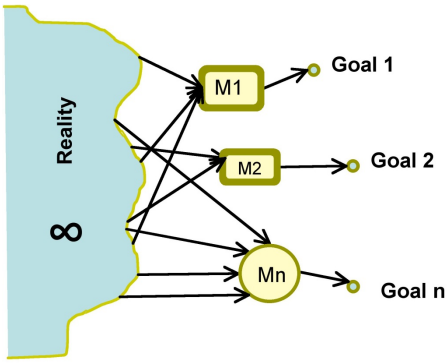
4. Compared perspectives 2 of n

Reality, Truth; Representation, Modeling

- **Reality is very complex**

(∞ [bit]) but selecting a goal typically allows for convenient, infinitely simpler models

- **We aim at designing smart cooperating robots**
- **Philosophy should help humans live well**



4. Compared perspectives 3 of n

Reality, Truth; Representation, Modeling

- **Dimension is a property, not of reality, but of models**
  - **0D modeling:**
    - **Parmenides: What is, is**
    - **Rodney Brooks: the model is the world**
- **Necessity of models**
  - **for speculative philosophy, e.g. utopias**
  - **for cognitive grasp**
    - **of past and future domains**
    - **of remote areas and unreachable dimensions**
    - **of "if" worlds**
    - **of tractable (sub-)domains of reality**

4. Compared perspectives 4 of n

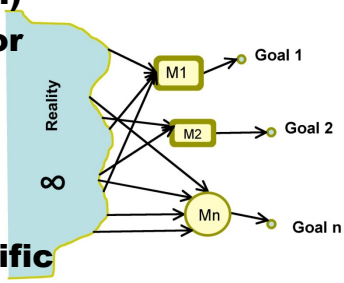
Reality, Truth; Representation, Modeling

The "bad" question:

- **Is a certain model true? (truth)**
  - **of course absolutely not, for reasons of incompleteness**

The "good" question:

- **Is a certain model wise? ("wisdom")**
  - **typically yes!, (in a specific domain, for a specific purpose though)**



4. Compared perspectives 5 of n

- **Information**
  - **In ancient mythologies, information was already important: e.g. Mercure for the Romans, and Hermes for the Greeks, are gods notably responsible for messages exchanges and communication between gods and humans**
  - **In recent times Michel Serres has much discussed the transition from ancient angeology to modern messengers, as well as a transition from material to more volatile, immaterial matters (form-transform-inform) [11, 12]**
  - **In current technical terms, information can be assessed quantitatively, on the basis of a probability calculus**

4. Compared perspectives 6 of n

- **Wisdom**
  - **In Ancient philosopy, wisdom (prudentia, providentia) is the first of the four cardinal virtues that are recommended for a good life; it plays also a major role in Christian philosophy (re. notably Thomas Aquinas).**
  - **By MCS definitions, wisdom is an expertise in a particular domain, the capability of successfully attaining a chosen goal (an "ultimate" goal). This is compatible with classical views (e. g. Socrates, Plato, Aristotle), with the advantage of a metric system (lin/s)**

4. Compared perspectives 7 of 9

Time

Time is weakly defined in philosophy: "Inconclusive philosophical engagement with the question of time has a long and distinguished history" [13.].

- **E.G.:**

- **St Augustine**
  - **Knows but could not tell!**

- **Kant, with two complementary attitudes [14]:**
  - **intuition, whereby everyone has a spontaneous understanding of the time concept**
  - **rationality (Weltweisheit, philosophy), by which a rigorous, "mathematical", definition could be elaborated**
  - **with no guarantee but chance however to have this latter construct coincide with the former one!**

4. Compared perspectives 7b of 9

Time

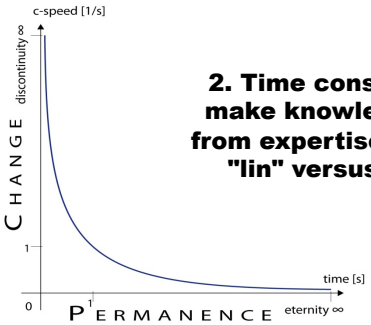
- **Levinas: Time consists in two axes:**
  - **(1) the flowing synthesis of now moments, Husserl's structure of transcendental consciousness (a constructivist view, with pre-cognitive and pre-intentional layers only);**
  - **(2) and a peculiar kind of interruption that Levinas will call the event of transcendence, and to which he relates to as "infinity"[15] (typically the experience of meeting someone else *)**
- **Even in our contemporary time where philosophy and science have both well developed, Rosenberg apologizes for simply defining time as follows: "time is duration" and "duration is the passage of time" [16].**

*** This might be understood as the major importance of contributing to a group, so ultimately a whole, or in a sense, god.**

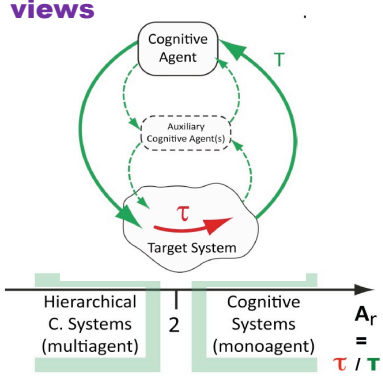
4. Compared perspectives 8 of 9

Time, and Time aspects in control

- **Novel scientific and engineering views**



2. Time considerations make knowledge differ from expertise (re. units: "lin" versus" lin/s")



1. Time characterizes permanence, and its inverse, speed as defined in MCS ontology, i.e., "c-speed", does it for change

3. Time properties are critical for success in control (Ar is the agility of agent relative to the one of target)

4. Compared perspectives 9 of 9

Selected possible reciprocal benefits

- **Among contributions of philosophy**

•Millenia of integrated developments

•Major contribution to human aspects in a modern common culture of human and artificial co-agents

- **Among contributions of (automated) cognition**

•Initial need (thrust) and consequent delivery of a rigorous theory, along with metrics

•Possibility of turning theories into operational techniques,

- **for validation purpose**
- **For deployment possibilities**

5. Conclusion

- **Philosophy, of Ancient origin, human culture**
- **Automated cognition, current trend**
- **Necessity of a quantitative and rigorous approach**
  - **Novel metrics for cognition and cognitics**
  - **Revisiting classical basis**
    - **Reality : out of reach in its completeness**
    - **Modeling**
      - **zero+ complexity , relatively to reality**
    - **Time**
      - **measure of permanence; underestimated importance in traditional views**
    - **Information**
      - **non stationary; as short-living as matches**
      - **subjective**
      - **critically bound to a model**
      - **Possibility of operalization, for validity and deployment**

References 1 of 3

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