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12.11.2015 9:00 - 12.11.2015 16:30
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# Cognition for Effective Control

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# Introduction 1 of 2

- **Cognition per se did not receive yet the scientific and technical attention it should, in view of the importance it has proved in the evolution of mankind, from the early times a million years ago to the recent boost of our highly developed societies in terms of information processing and communication. After all, it is well cognition that appears as the key factor for the privileged ecological niche humans have crafted for themselves in the known universe.**
- **Cognition is mostly ensured in humans by neural resources located in the brain. This relates to the implementation material however, the "hardware" in reference to computer infrastructures.**
- **The MCS theory of cognition [1] has been made for the purpose of carrying cognition over to machine-based infrastructures, in particular, robots; thus to implement automated cognition, a scientific and technical field named as "cognitics".**
- **This MCS theory of cognition is however very general, thus it is notably also applicable to humans, with similar benefits, e.g. in terms of quantitative assessment of core properties.**

# Introduction 2 of 2

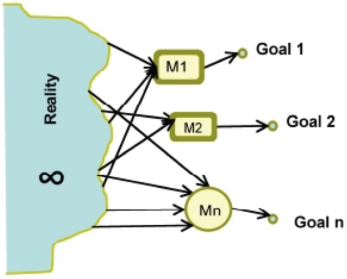
- In order to contribute to an improved situation, five theses relating to cognition have been published recently [2], :
  - Cognition to perceive, explore and model the world
  - Cognition to define alternative worlds and possible futures, visions, triggering anti-causality
  - Cognition for effective control
  - Automated cognition – Cognitics for large scale deployment
  - Social cognition for team forming, and achieving more benefits, in common, a well as from an individual perspective.
- The current contribution, as shown in title, extends the third thesis, "Cognition for effective control ", for which six most significant aspects will be presented, according to the plan that follows.

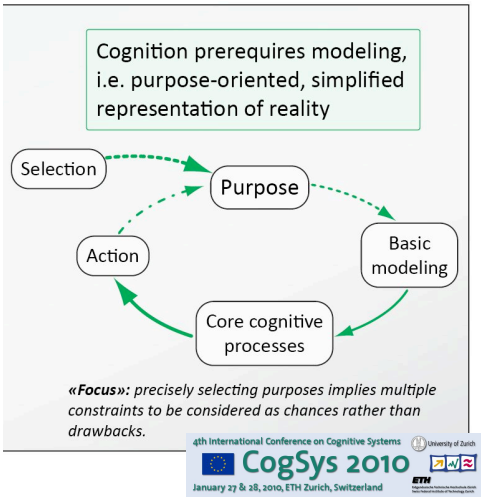


# Content

# 1. Modeling, incl. reality, target, goal and vision

- **First, control implies the definition of a target state, a more or less elaborate model of what reality is aimed at, as a future goal; for example just a voltage level, the location of a robot, or the vision of a desired, complex, different, and possibly future, world.**

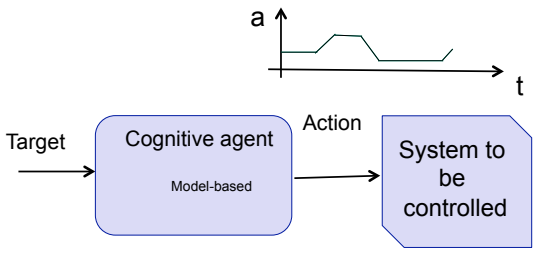




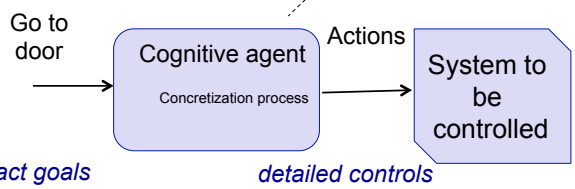

# 2. Modeling sequences of control actions

- **In some cases, a sequence of control actions, appropriately specified, may lead to the desired, goal state. In this case, in addition to the modeling of final stage, some modeling must also be elaborated for all intermediate actions to perform in order to reach there (e.g. "recipe", "open-loop" sequence or program)**



## 3. Expanding control actions as a concretization process (incl. e.g. planning)

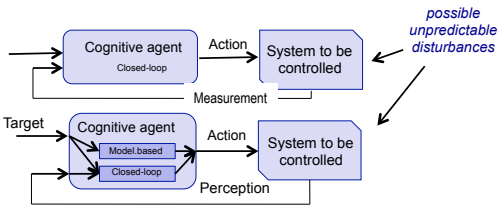
- **Actions are first defined in cognitive terms, as pieces of information (messages) of relatively high and abstract content (goal). Then this must usually be expanded into more detailed directives, as a concretization process. For example a motion law will constrain acceleration and speed parameters so as to reach the target location in best conditions; or for more complex situation, some planning, with joint coordination and obstacle avoidance may be mandatory**

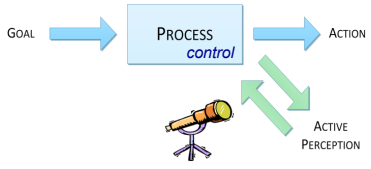





## 4. "Closed-loop", whereby feedback is acquired: perception and exploration ("active perception")

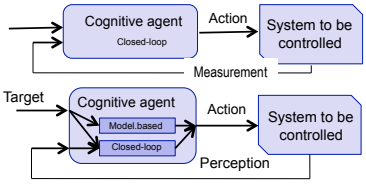
- **In general, systems are embedded in reality domains where unpredictable disturbances may occur, or worse, where much is yet unknown. For simpler cases in control, a Boolean estimate of the situation, or possibly a scalar value may prove sufficient to support decisions; and for more complex cases, other cognitive faculties/functionalities are required, such as perception or even exploration, which is an active process to gather information in unknown domains. Here control is classically said to be « closed loop » : actions applied by the control system (CS) onto the system to be controlled (TBCS) are fed backwards to the control system, via measurements and perceptive paths**

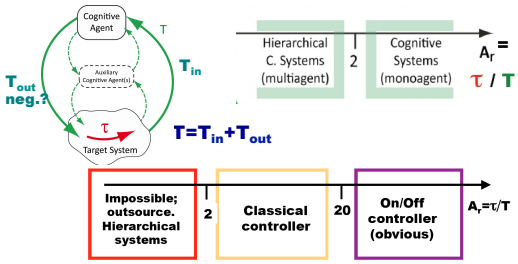


## 5. Adaptation to time properties and compensation by prediction

- **In closed-loop cases, some critical time properties of CS versus TBCS are required, to allow for success. Moreover, in these cases, and more specifically when controllers make a difference, i.e. in « slower » cases, expertise can further help tuning for best performances. Thus in particular, a sound, cognitive approach may often compensate for otherwise uncompressible reaction times. For example in robot control, instantaneous accelerations and speeds are largely dictated by higher-level controllers, which may consequently lead to so-called a priori components, instead of relying on feedback components essentially resulting from errors.**

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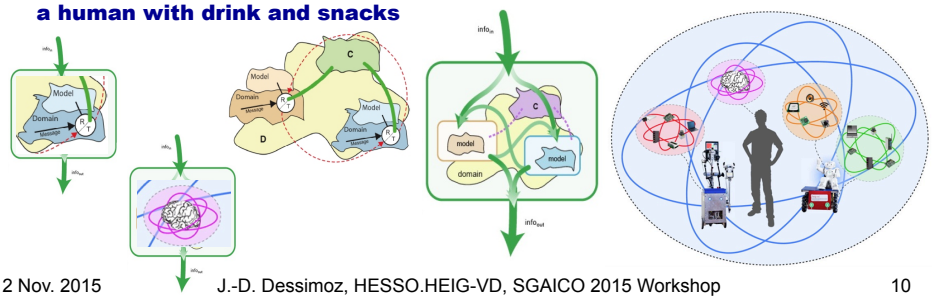
## 6. Cascaded, hierarchical, multi-agent, autonomous and "social" systems; and sub-systems

- **As control systems gain in scope, multiple agents appear and patterns of sociology must develop. This ranges from classical, hierarchical systems, with windows of autonomy at lower levels, to broader, group patterns, where common communication channels and shared cultural references support novel coordinated, collective behaviors, as if ensured by a single, overall meta-agent. From a cognitive perspective, individual thinking and meditation then evolve towards group discussions and deliberation, with the perspective of defining effective subsequent control steps. For example in the Robocup@Home case demonstrated in Singapore, our RH-Y robot group consisted in three major agents (robots) cooperating to serve a human with drink and snacks**



# Conclusion

- **Cognition appears as a crucial faculty to harness, i.e. to implement on machines; robots. And even more so, to understand, for humans!**
- **Here the case of cognition is developed for the case of effective control:**
  - **Modeling some reality, targets, goals; possibly visions**
  - **Modeling sequences of control actions (e.g. thermal process)**
  - **Expanding control actions as a concretization process (incl. e.g. planning)**
  - **Acquiring information in complex, unknown, or "closed-loop" systems : perception and exploration ("active perception")**
  - **Adaptation to time properties, compensation of long delays by prediction**
  - **Cascaded, hierarchical, multi-agent, autonomous and "social" systems; and sub-systems.**



# ACKNOWLEDGMENT

**The author gratefully acknowledges the support of numerous partners, government agencies and sponsors that made this research and associated publications possible.**

# Thanks for your attention!

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# References


1. **J.-D. Dessimoz, "Cognition, Cognitics, and Team Action – Five Theses for a Better World", New Research Frontiers in Intelligent Autonomous Systems , WS-NRF , IAS Conference 2014,, IAS-13, Venice, Italy, 19 July 20142.**
2. **Dessimoz, J.-D., "Cognitics - Definitions and metrics for cognitive sciences and thinking machines", *Roboptics Editions*, Cheseaux-Noréaz, Switzerland, ISBN 978-2-9700629-1-2, pp169, January 2011.**
3. **Jean-Daniel Dessimoz, "Cognition for a Purpose - Cognitics for Control", CogSys2010, 4th International Conference on Cognitive Systems, 27th & 28th January 2010, ETH Zurich, Switzerland**
4. **La Régulation, Intersections, Magazine de l'enseignement technologique et professionnel, Schneider Electric, Juin 2004, 18pp**