From meaningful information to representations, enaction and cognition

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Extended Abstract

The notions of information, representation and enaction entertain historical and complex relations with cognition. Historical relations because representational structures belong to the central hypothesis of cognitive sciences. Complex relations because cognitive sciences apply the notion of representation to animals, humans and robots, and also because the enactive approach tends to disregard the GOFAI type of representations. In this wide horizon of relations, we propose to look at a systemic approach that could bring up a common denominator for information and representations in the build up of cognition, and also keep a link with the enactive approach. Our purpose is to show that systems submitted to constraints can generate meaningful information to maintain their natures, and consequently build up meaningful representations that have some compatibility with the enactive approach. Such a systemic approach to the notion of meaningful information could then make available a link between enaction and meaningful representations. The first part of the presentation is about reminding that cognition does not exist per se, but is related to the system that builds it. We look at cognition as constituted by dynamic meaningful representations built up by systems that have constraints to satisfy in their environments. Cognition is considered here at the level of the system that builds it and uses it in order to maintain its nature in its environment. Such a systemic approach fits with evolution. Organisms build representations to cope with survival constraints (frogs build representations of moving black dots in order to satisfy food constraints). Humans build representations and cognition to satisfy constraints that are conscious and unconscious. Artificial systems can use representations and cognition to run activities related to constraints implemented by the designers or coming from the environment (a goal to reach being considered as a constraint to satisfy). In the second part of the presentation we define what are a meaningful information and a representation for a system submitted to a constraint in its environment, and we link these to the enactive approach. We define a meaningful information (a meaning) as an information generated by a system submitted to a constraint when it receives an external information that has a connection with the constraint. The meaning is precisely that connection. The meaning belongs to the interactions that link the system to its environment. The function of the meaning is to participate to the determination of an action that

will be implemented in order to satisfy the constraint. (Menant, 2003). The satisfaction of the constraint goes with maintaining the nature of the system in its environment. A Meaning Generator System (MGS) is defined correspondingly. It is a building block for higher level systems. We present some characteristics of the MGS (groundings of a meaning, domain of efficiency and transfer of meanings, networking of meanings, evolutionary usage). The MGS approach is close to a simplified version of the Peircean triadic theory of signs (Menant, 2003, 2005). We define the representation of an item for a system as being the dynamic set of meaningful information corresponding to the item for the system in its environments (an elementary representation being made of a single meaningful information). These representations link the system to its environment by their meaningful components related to the nature of the system. These representations are different from the GOFAI ones. The possibilities for linking these notions of meaning and representation with the enactive approach come from the structure of the MGS: the need for an action is the cause of the meaning generation by and for the system. The action on the environment is for the system to maintain its nature (its identity). The MGS links together the generation of meaningful representations, the nature of the system, and the interactions with the environment. This can be considered as close to enacting a world by meaning generation (Di Paolo and all 2007), and to the enactive concept of sense making (De Jaegher, Di Paolo 2007). We propose that basing the definition of a representation on the notion of meaningful information generated by a system submitted to a constraint can open a way for making the notion of representation compatible with the enactive approach. In the third part of the presentation, we consider some cases of meaningful information and representations for organisms and for robots. Regarding organisms, the MGS can be used in an evolutionary context by looking at the evolution of the systems and of the constraints. Purpose is to modelize the generation of meanings and of representations in order to make available a tool usable for different levels of evolution, as evolution has a place in cognitive sciences (Proust, 2007). Constraints for basic life are survival constraints (individual and species). Group life constraints are also to be considered. Reaching the level of humans in evolution brings in new constraints that cannot be clearly identified as they have to take into account human consciousness which is today a mystery (the "hard problem"). On an evolutionary standpoint, human constraints come in addition to the ones existing for non human organisms. We can make some hypothesis on the nature of human constraints (Maslow pyramid based constraints, anxiety limitation…). For robots, the MGS is initially based on the design of the robot. The meaning generated within a robot is initially derived from the constraints implemented by the designer and from the environment. But some non calculable or non predictable evolutions of the

robot can introduce meanings that look proper to the robot. This last point can be linked to the notion of autonomy in robots. In such examples, the dynamic management of meanings thru the MGSs in their environments keeps the link with the enactive approach. We finish the presentation by summarising the points addressed and by proposing several continuations.

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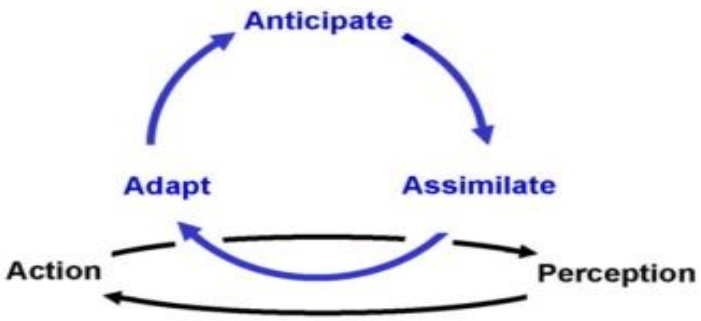
Presentation

1) Cognition process. System submitted to constraints

a) Cognition, Cognitive Systems. Definitions:

*** Cognition as a cycle of anticipation, assimilation, and adaptation embedded in, contributing to, and benefiting from a continuous process of action and perception.** (D. Vernon 2006)



*** Cognition for animals, humans and robots.**

*** Cognitive process uses transfer of information**

b) Cognition and systems submitted to constraints.

*** No cognition per se.**

***"earliest living organisms ... subject to a constraint of viability"** (Stewart, J. 1996)

*** Cognition: system/agent that has constraints to satisfy in its environment.**

*** system – constraint – perception/action**

- Mouse – Survival - Seen cat as danger, actions

- Bicycle rider – Equilibrium - Pressure on palm of hand on handle bar, actions

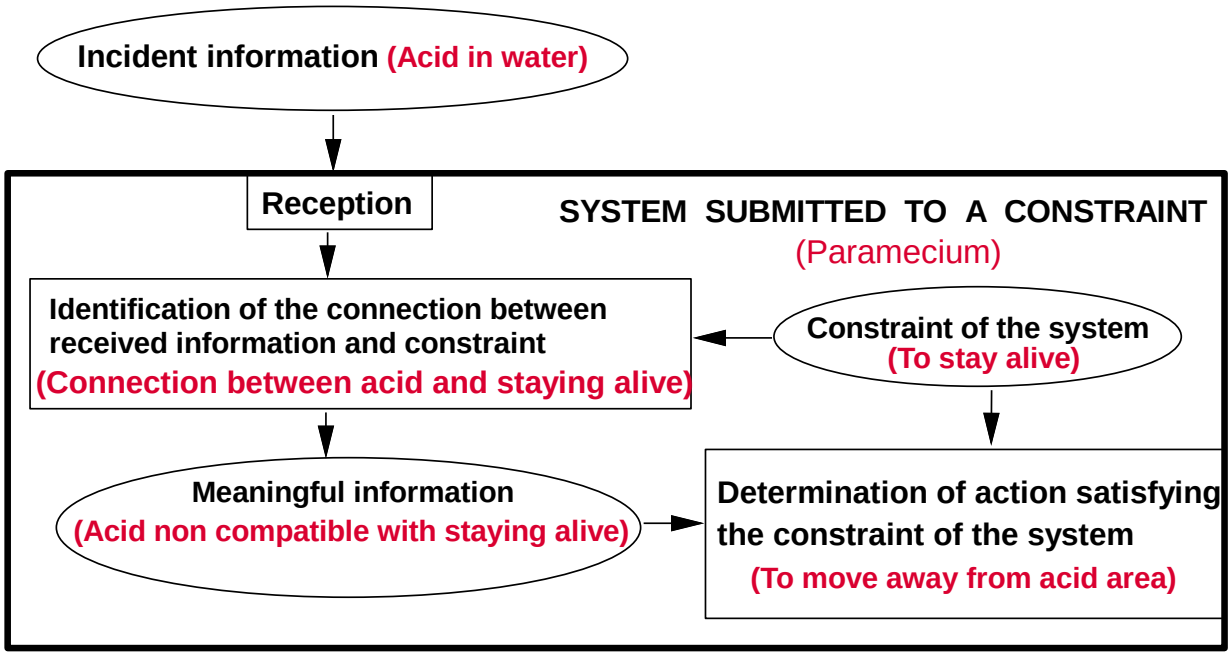
- Researcher - Need to understand/discover - Conference as new data, actions

- Car driver - In time arrival - Seen traffic jam as delay, actions

- Robot - Goal to reach - Identified light as direction, actions

2) Constraints. Meaning generation. Meaningful representation. Enaction

a) Constraints. Meaning generation (Menant 2003, 2005)



*** Paramecium submitted to a "stay alive" constraint (Constraint of the system).**

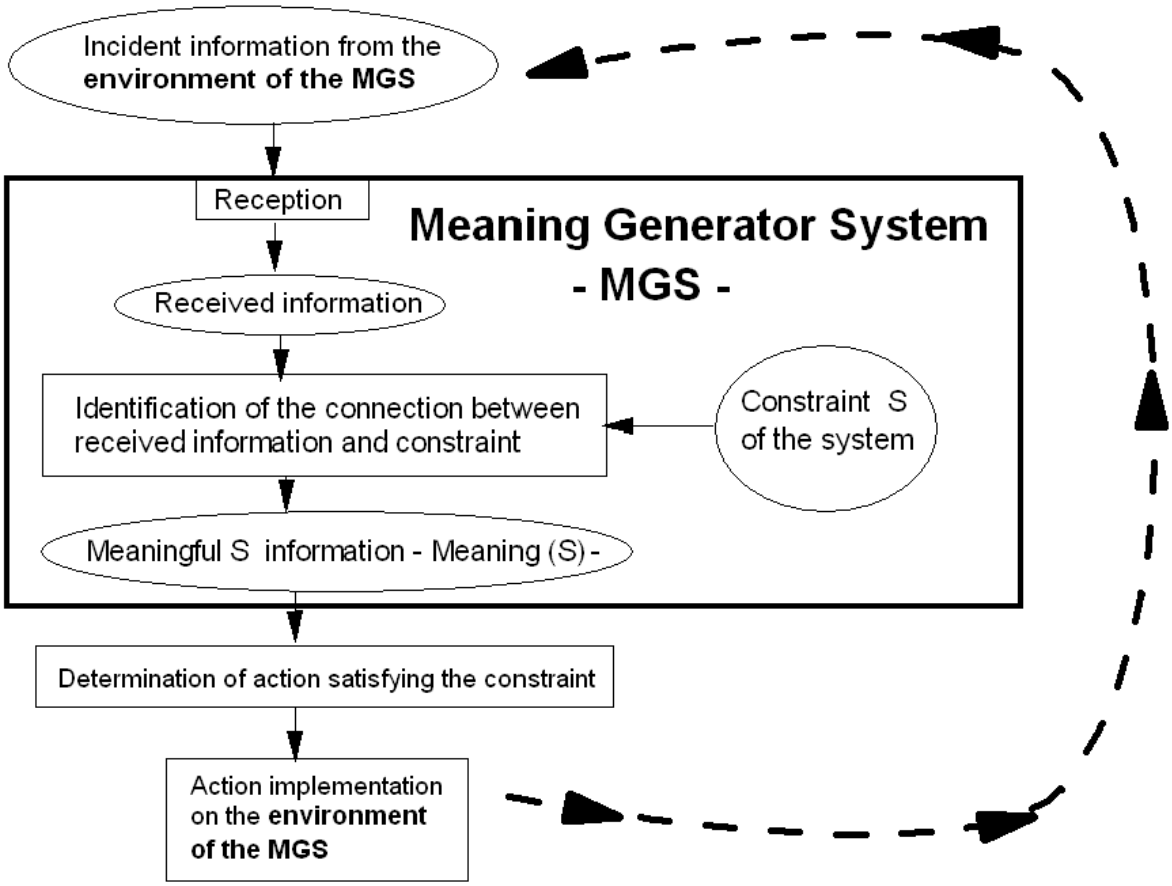
*** Acid non compatible with staying alive (Meaningful information).**

*** Paramecium moves away from acid area (Action to satisfy the constraint).**

*** Meaning by the system and for the system.**

**** A meaning is a meaningful information that is created by a system submitted to a constraint when it receives an external information that has a connection with the constraint.***
The meaning is formed of the connection existing between the received information and the constraint of the system.
The function of the meaning is to participate to the determination of an action that will be implemented in order to satisfy the constraint of the system.

b) Meaning Generator System (Menant 2003, 2005)



*** MGS Properties**

- Constructivist approach. Embedded in perception/action.

- Dynamically links a system to its environment for constraint satisfaction.

- Building block. Links with memory, simulation, scenarios, other MGSs, ...

- Can modify functions/identity/constraints of higher level systems.

- Gives meaning for the system to its environment. Groundings in/out.

- Constraint linked to the nature of system.

- Transmission and networkings of meanings. Evolutionary approach.

- Close to a simplified version of the Peircean triadic approach on sign.

*** Meaning generation is part of cognition.**

c) Representation as set of meaningful information

*** "Representations do not exist independent of individuals for whom they are "meaningful"."** (Scheutz, M. 1999)

*** Representation as a set of meanings relative to the represented item:**
(ex: representation of a cat for a mouse)

- **Real time sensory meaning of item.**
  (seen cat is a danger)

- **Available action scenarios relative to item, with real time update.**
  (stand still, run away. Options updatable by cat movements)

- **Memorized past experiences of item.**
  (new cat or known fast/dumb cat. Cat's habits, past experiences)

- **Anticipated evolutions of item**
  (simulation of direction options)

- **Covers what is represented and the content of the representation.**

d) Meaning Generation, Enactive approach and Representations

*** Meaning generation is part of enaction**

*** "five key "pillars" to the enactive approach: A dynamical systems perspective and emergence, embodiment, biological autonomy, "sense-making" (the creation of meaning), and experience"** (McGann, M. 2006)

*** "sense-making, which we identified as one of the central concepts of the enactive approach"** (Di Paolo and all, 2007)

*** " Weber & Varela (2002) mention valence to refer to initial forms of meaning-generation in the autopoietic system: "Stimuli from outside enter the sphere or relevance of such a unit only by their existential meaning for the keeping of the process of self-establishment."** (Colombetti, G. 2008).

*** "in an enactive perspective, meaning is inseparable from the whole of context-dependent, life motivated, embodied activity, without being at all a hazy concept beyond the reach of scientific understanding."** (Di Paolo and all, 2007)

*** Representations, as made of meaningful information, are to be part of enaction**

3) Examples of meaningful information/representations

SYSTEM	CONSTRAINT	RECEIVED INFORMATION	MEANINGFUL INFORMATION	ACTION
MOUSE	Stay alive (no predators)	Seen cat	Cat presence incompatible with staying alive	Escape via mouse hole (reflex)
FROG	Stay alive (food)	Seen moving black shape	Availability of food	Catch and eat fly (reflex)
HUMAN on a bike	Safety needs	Pressure on hand while riding a bike	State of equilibrium	Move body to keep equilibrium on bike (reflex & anticipating)
HUMAN researcher	Desire to know	Content of books, journals, forums, Presentations,...	New information. Agreement/disagrement New ideas	Contact author, Propose new study (anticipating, thinking)
ROBOT	Reach plug	Blinking light signal	Plug direction indication	Move toward light (automatism)

4) Conclusion and continuations

a) Summary of points addressed:

- Cognition is related to systems having constraints to satisfy in an environment.
- Meaning as generated by a system for constraint satisfaction. Part of cognition.
- Meaning Generator System: building block linking system to its environment.
- Representation: integrated set of meanings relative to the represented item. (Senses, memory, scenarios, anticipation, ...).
- Meaningful information/representations to be part of Enaction.

b) Continuation:

- Enaction and first person experience.
- Enaction and agency, self, identity, autonomy.
- Position of phenomenology in cognitive sciences.
- Evolution from matter to unicellular life (constraints).
- Nature and content of human specific constraints.
- Meaning generation at embodiment/enactive levels.

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