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TRAIN OF THOUGHT ON LINKS BETWEEN ARTIFICIAL INTELLIGENCE, ENACTION AND VIRTUAL REALITY

During this talk, I will

- ... Show examples
- ... Argue about needs of autonomous models for virtual reality
- ... Try to link that with recent advance in embodied AI
- Circumspection
- Open-ended reflexion
- Which are the possible links between enaction, artificial intelligence and virtual reality ?

Example 1 : Interactive Multiagent systems



Fabrice
Harrouet

- Emergence
- Multiplicity (because human interaction)

Example 2 : Human/Machine interaction



Ronan
Billon

Démonstration au Quartz

Festival ANTIPODES

mars 2008

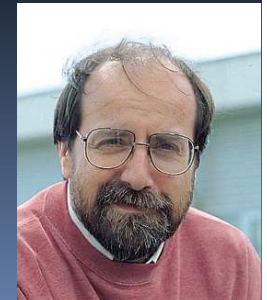
- Coordination Human/Virtual world (time/imitation/variation)
- Embodiment

Other examples



And me ?

- When I was young I dreamt to be a musician.
- But I did cybernetic and computer science studies.
- My first researches concern artificial intelligence (GOFAI) . It was frustrating
 - ...there was no music.
- Later I joined the laboratory of J. Tisseau which deals with virtual reality and multiagent systems



Virtual Reality ?

- **Oxymoron or/and pleonasm**
- **Virtual** : means that something has all the effect and consequence of a particular thing, but is not officially recognized as being that thing.
- **Reality (1)** : Thing which exists: resistance, permanence. (Oxymoron)
- **Reality (2)** : A ' 'representation ' '. (Pleonasm)

Two points of view about virtual reality



Realism
Sensible
Re-cognizing



Credibility
Intelligible
Understanding

Interaction : To live



Third person



First person

Cues to do that

- *"Reality rests upon one mediation between perception, action (and mind). Virtual reality has to favor this mediation."*
- *"Reality resists us. We'll believe in virtual reality if we find again resistance"*

[Tisseau 2001]

- Resistance could arrive at some levels of interaction

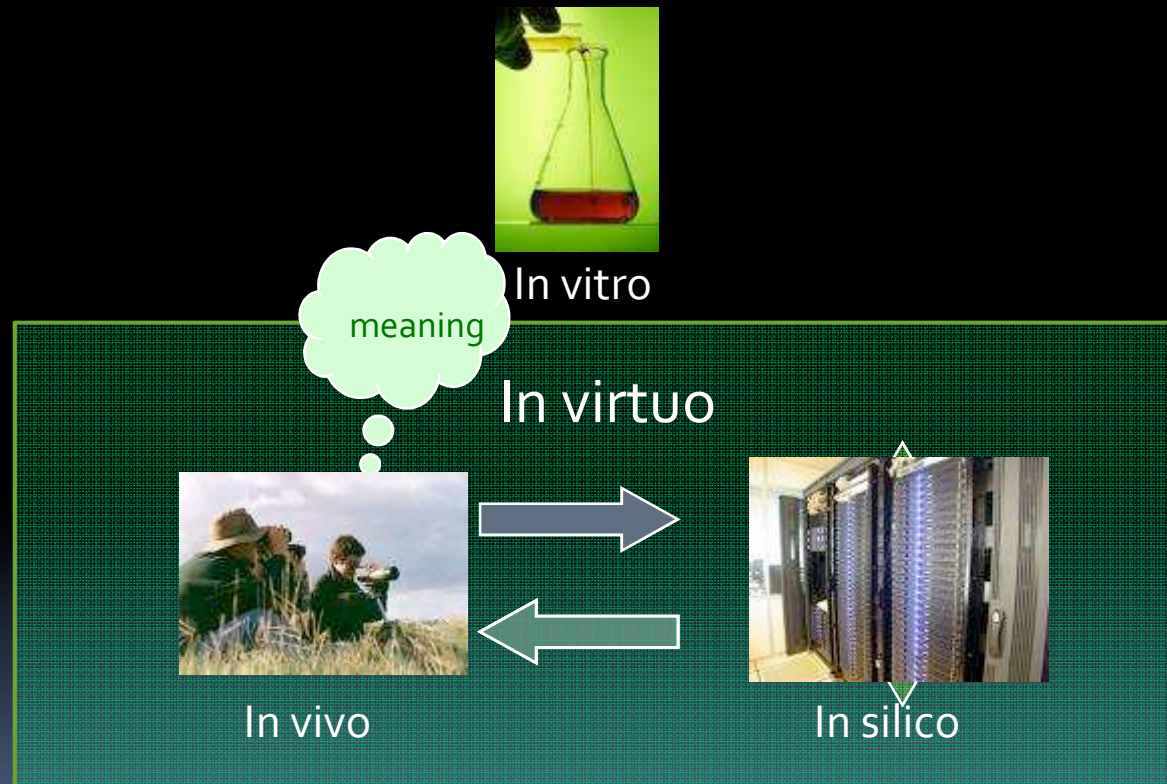
Resistance but mediation action/perception

- Surprise
- Regularity



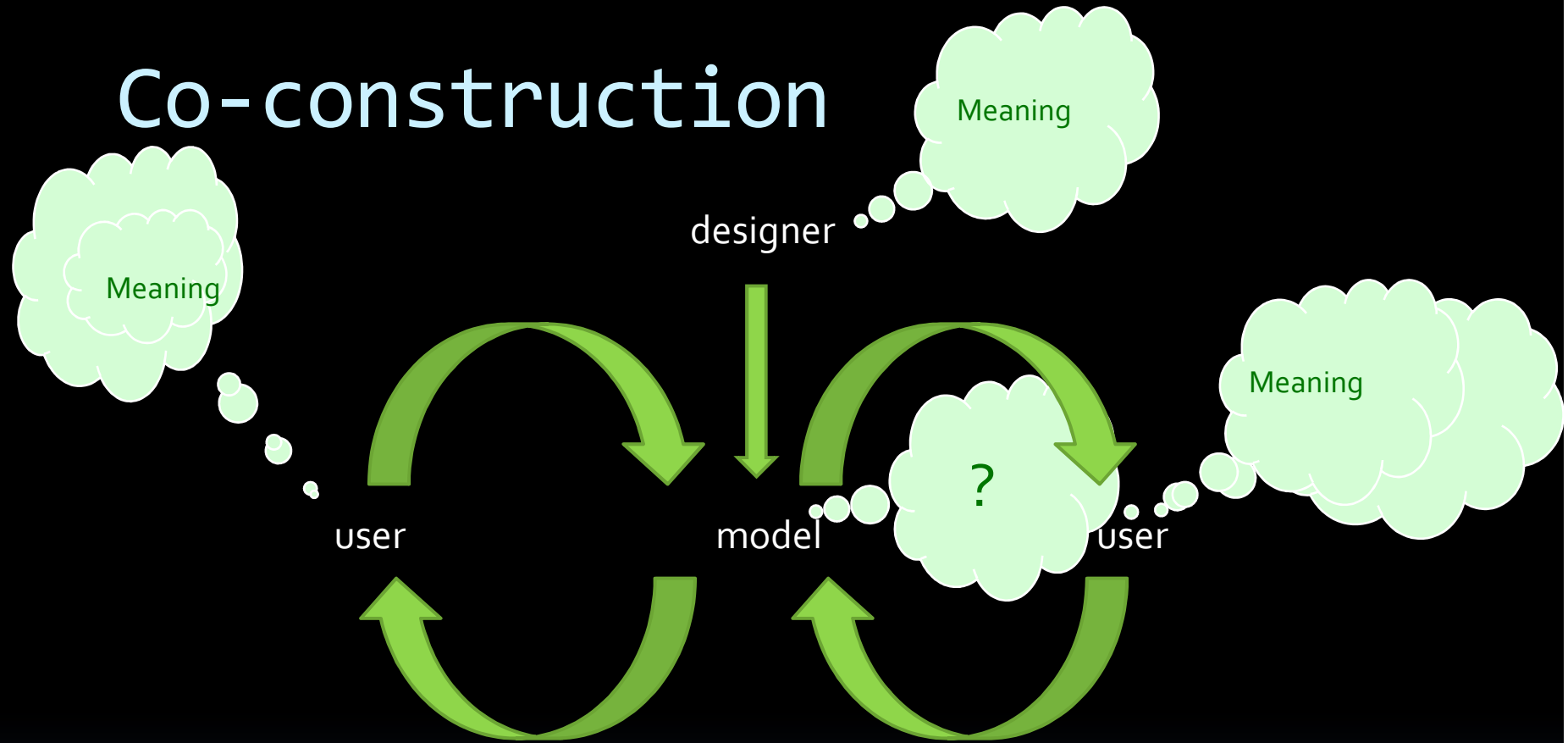
- Artificial models for virtual reality must be Autonomous but Interactive

Participative simulation: Man in the loop



- To live the simulation, to construct a meaning

Co-construction



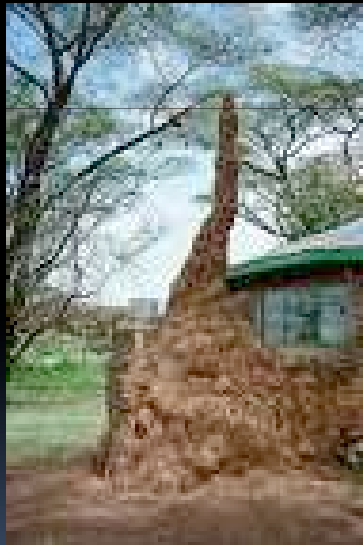
- In a virtual reality perspective, Co-construction entails that models must deal with something like co-development, emergence and creativity by means of human/machine interaction.

On the machine side

- Toward Constructivist AI [Vaario, Drescher]
- Construction during Interaction
- Emergence , 'artificial' drift
- As biologist could start from autopoiesis, we search a starting point which allows this features.

- Not GOFAI compliant (no pre-given world)
 - Frame problem,
 - Common-sense,
 - Know-how,
 - Agency,
 - Sense-making,
 - ...

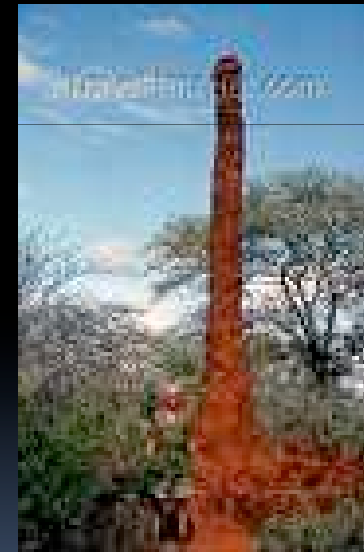
First clue: Multiagent systems



[Ferber 2003]



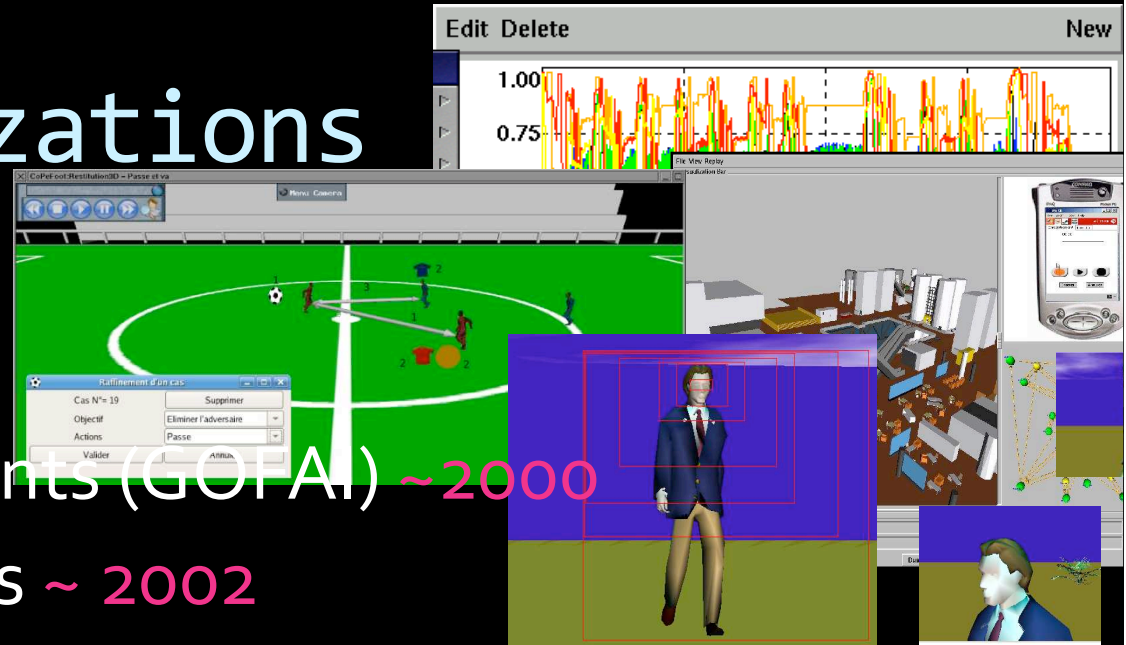
Stygmergy



Some realizations

- Intentional agents (GOFAl) ~2000
- Stressed agents ~ 2002
- Interaction Man/Machine simulations ~2002
- Collaborative work simulation ~2007

- Interesting but not exciting. Require a general model of autonomy , evolution and co-development.



Reflexion

- What does cognitive science say about
 - Autonomy ?
 - Interaction ?
 - Co-xxxxx ?
- Enaction !

An so ...

- I read some books, I really found that it's lastly an exciting clue , I came to the former enaction schools, and ...
- I'm here ... sorry

Enactive inspiration: embodied-embedded AI

- From biology to high level cognition
 - Biology -> teleology [Kant]
 - self-production -> norm, value and adaptivity [Jonas]
 - autopoiesis -> cognition [Varela]
- Enactive Robot Vision [Suzuki & Floreano 2008]
- Enactive artificial intelligence [Froese & Ziemke 2008] :
 - Requirement for the design of an enactive artificial agent
 - Self systemic/sensori-motor /coupling identity regulation
 - At some levels of description

Boundaries in complexity

Reality

High level cognition

Nervous system

Multicellular organisms

Autopoietic principles

Physico-chemical

Virtuality

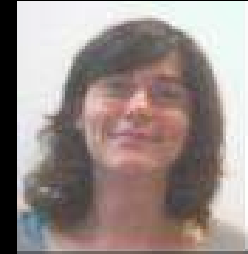
Actually, no comparable
Complexity in computers
(at any level)

No continuity from sensor
to motor

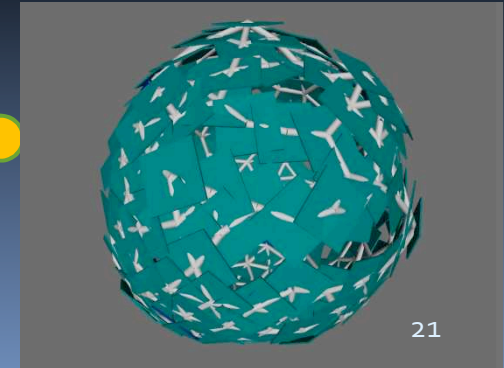
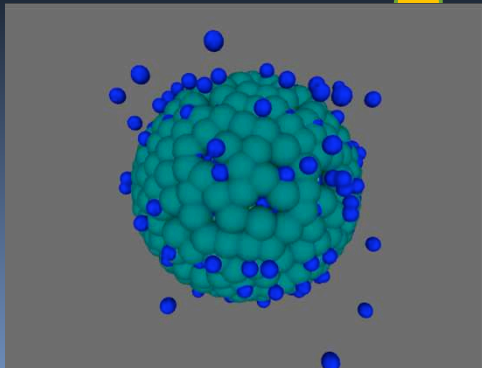
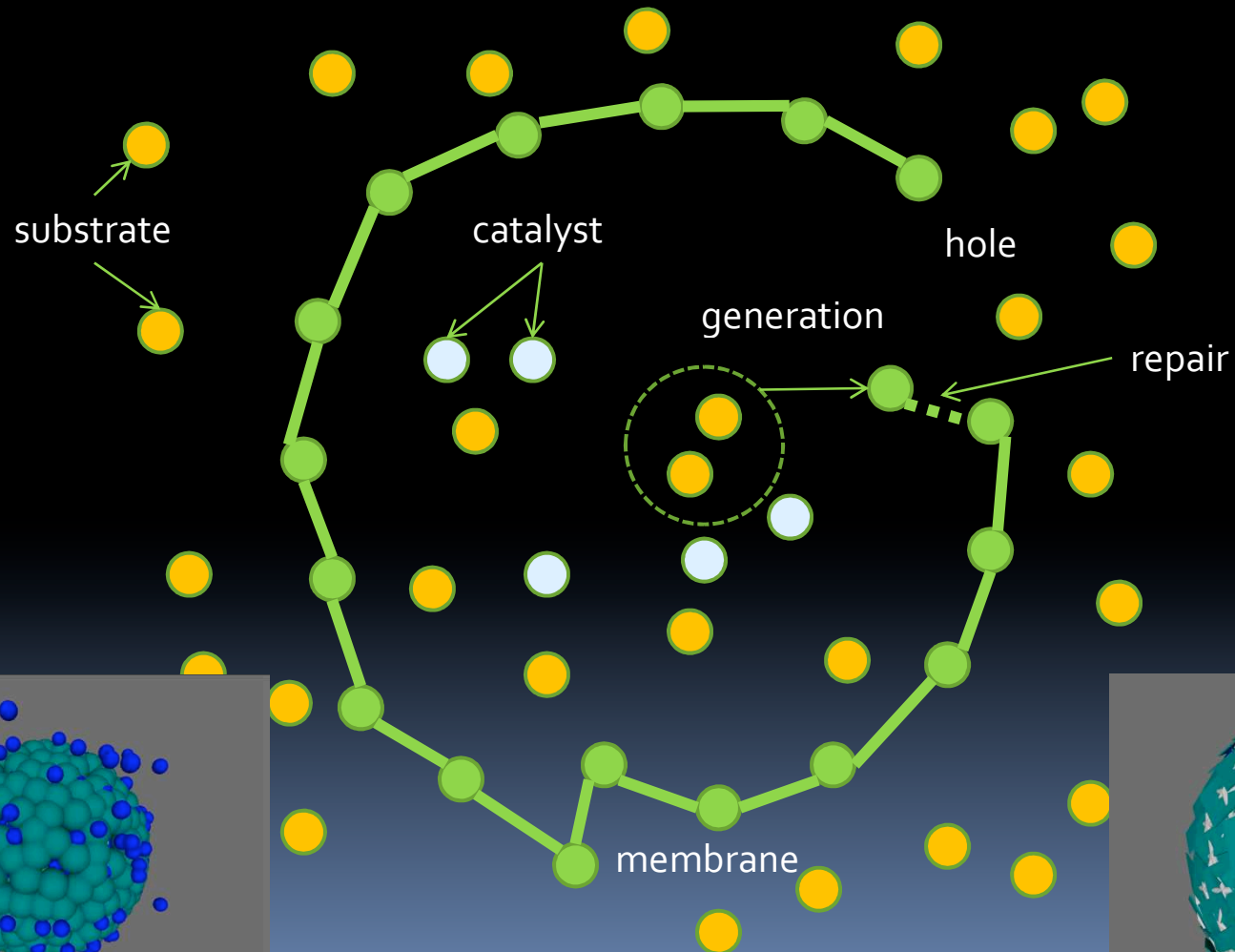
No metabolism

So what ? (Miles Davis)

Artificial autopoiesis and MAS

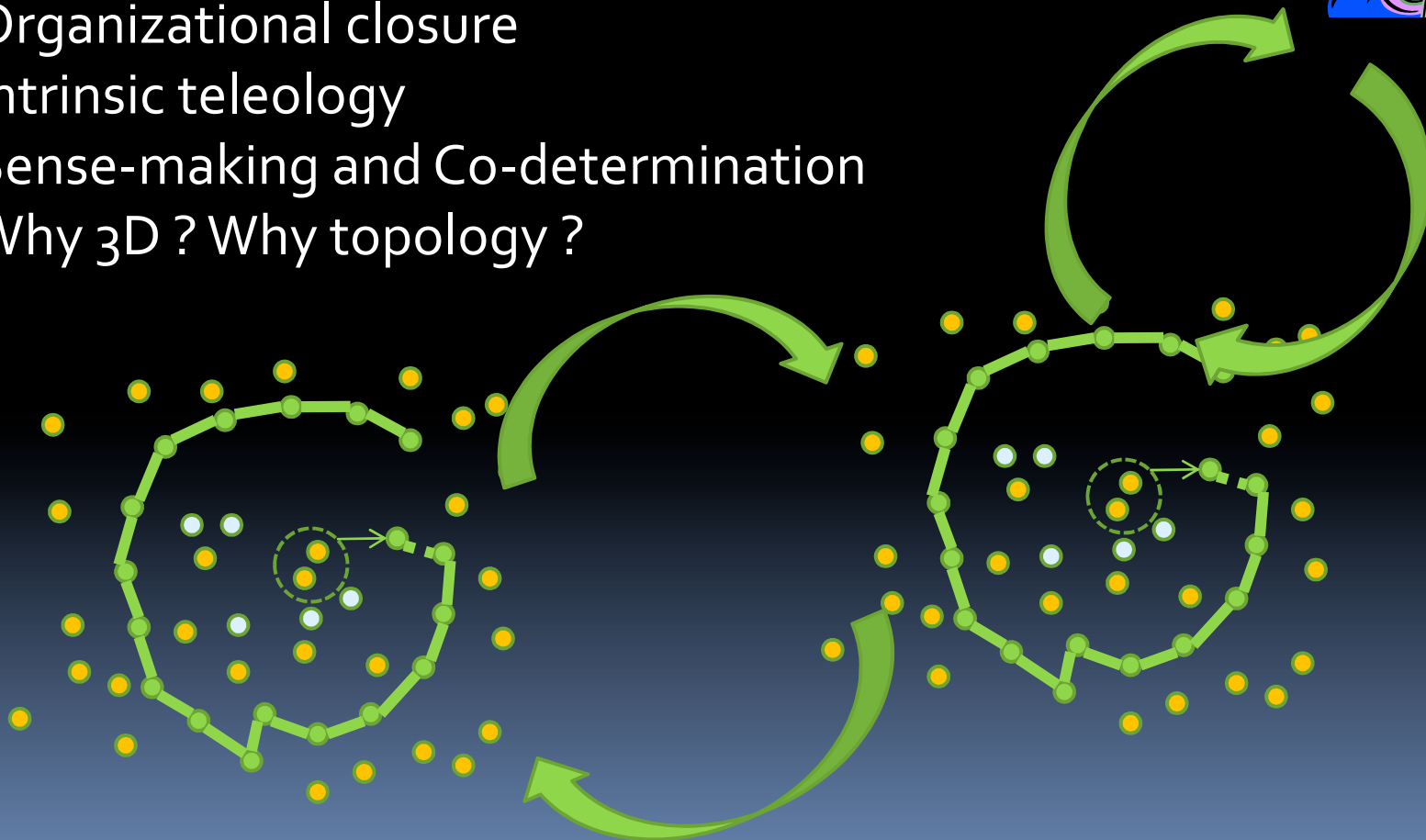


Kristen Manac'h



Problems ...

Relevance is not in biological details but in autonomy :
Autopoiesis is a blueprint for:
Organizational closure
Intrinsic teleology
Sense-making and Co-determination
Why 3D ? Why topology ?

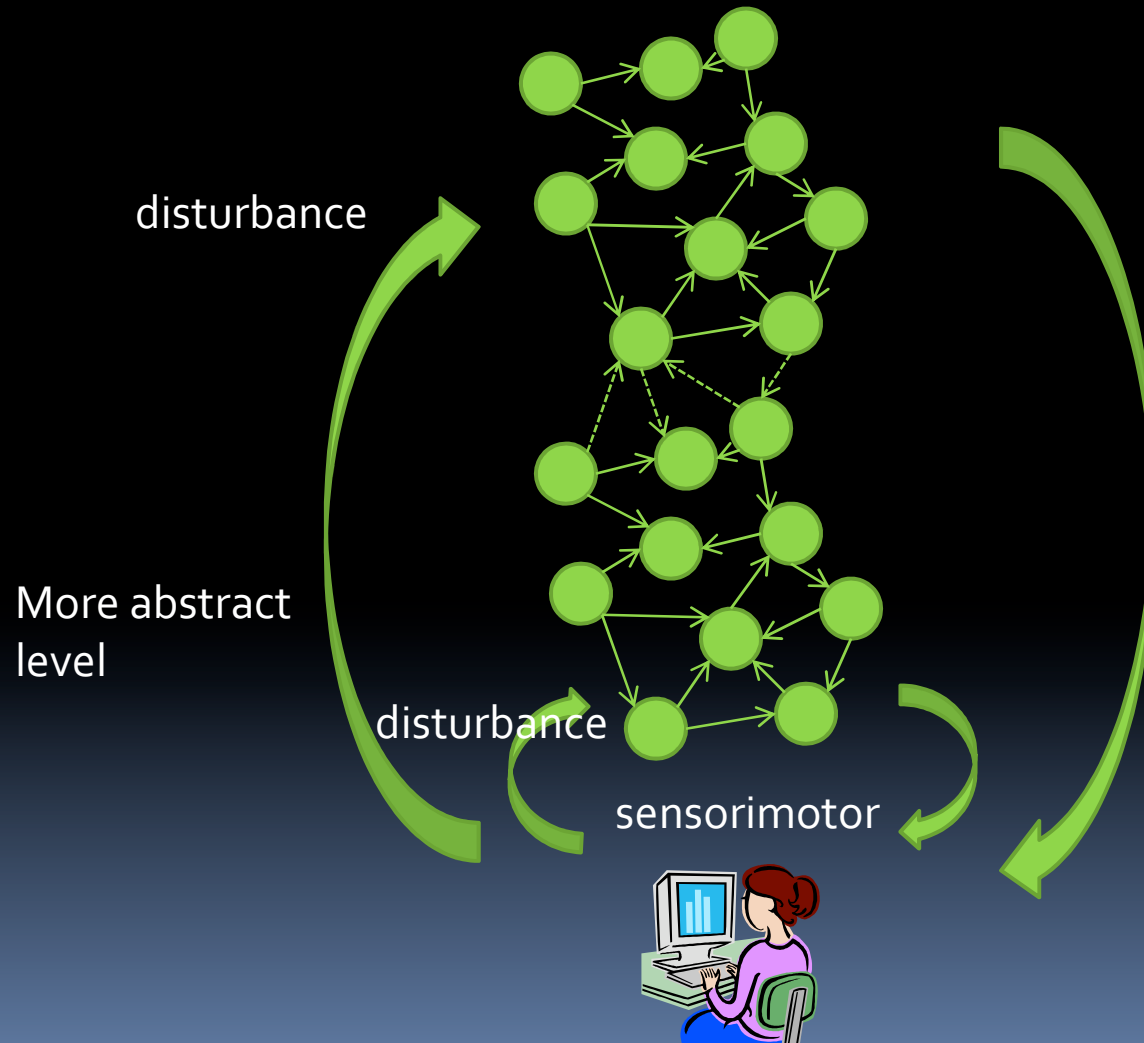


First question : Abstraction in the computing domain ?

▫ *A network of processes of production (transformation and destruction) of **components** that produces the **components** that: (i) through their **interactions** and **transformations** continuously regenerate the network of processes (relations) that produced them; and (ii) constitute it as a concrete unity in the **space** in which they (the components) exist by specifying the **topological domain** of its realizations as such a network.*
(Maturana and Varela, *Autopoiesis and Cognition* (1980), p.79)

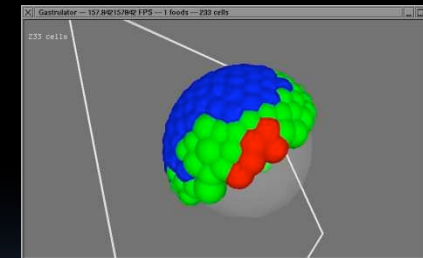
- Which **components**, **space** and **topological domain** ?
- Which **interactions** into the model and with the model ?
- Primacy of adaptivity to autopoiesis for agentivity [Di Paolo 2005]

Abstraction ?

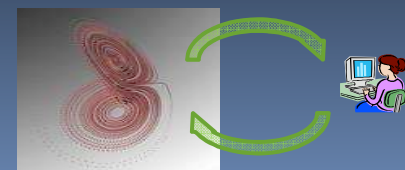


Our orientations

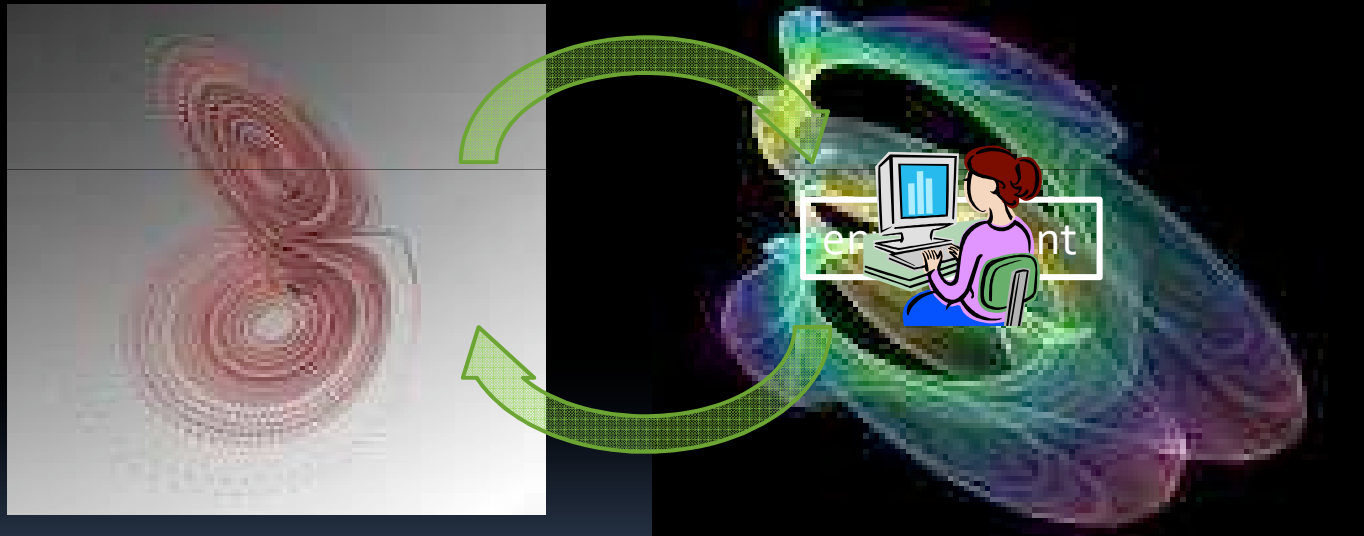
- Biological level: Understanding morphogenesis principle from real biological aspect. Formalizing and modeling the role of the environment on the development of zebra-fish, in silico (Alexandra).



- Toward human/machine co development : Artificial dynamical cognition, in virtuo (Kristen)



Artificial dynamical cognition and evolutionary robotics (1/2)



Autonomous and anticipative behavior :

$$(\dot{s}, \dot{m}, \dot{c}) = F(s, m, c)$$

Beer, Di Paolo, Ziemke, Nolfi, Floreano, Suzuki, Ikegami ...

Artificial dynamical cognition and evolutionary robotics (2/2)

- None of the processes involved can be interpreted as memory or “representation” in the traditional sense.
- Dynamical systems can outstrip the frame problem [Tani].
- Chaotic behavior can produce novelty [Tani]
- The challenge is to find parameters which allow to maintain an observable behavior in spite of disturbance.
- Evolutionary robotics provides a solution based on a Darwinist metaphor.
- Ultra-Stability allows self-adaptation [Ashby, Di Paolo].

The problem of the ontogenesis part (2/2)

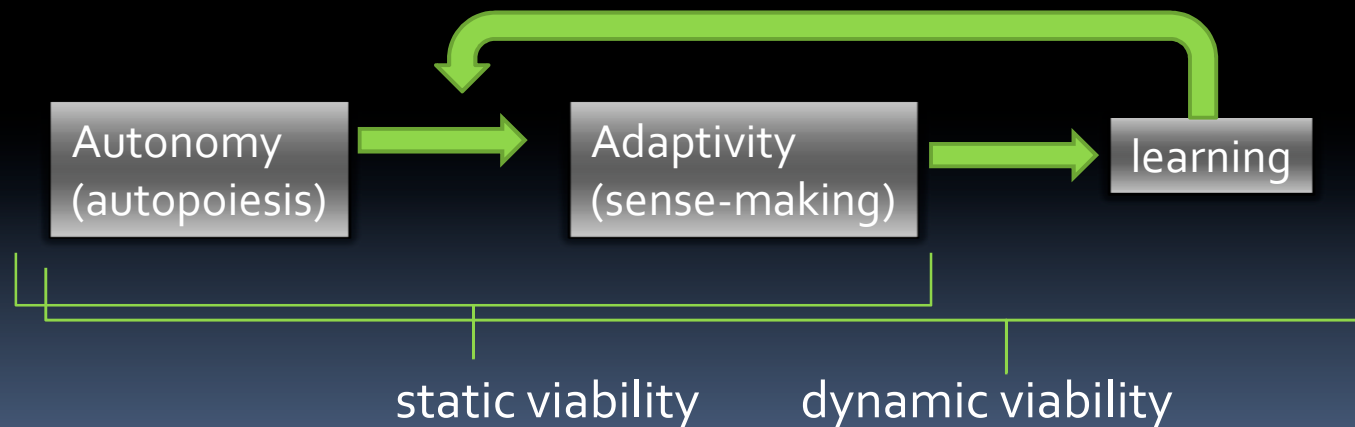
- The challenge is to introduce irreversibility and evolution/development in dynamical systems.
- Nevertheless, complex ontogenesis gives rise to the problem of the ratio phylogeny/ontogeny in evolutionary robotics.

Phylogenesis/Ontogenesis ratio with evolutionary approaches

- Thousand of tries entail offline simulation (in silico)
- Offline simulation implies a fixed criteria of adaptation (fitness function)
- *Though the viability constraint is expected to be updated [Ikegami & Suzuki 2008]*
- Online interaction (in virtuo) makes evolutionary approaches problematic
- Even co-evolutionary algorithms need a final fixed criteria

Autonomy or Learning (or anticipation) ?

- Does 'complex ontogenesis' mean that the system can learn ? If so, learn what ?
- Auto-adaptation is not learning (irreversibility) [Floreano].
- The "graal" is to find rules that allow "learning to adapt/anticipate".

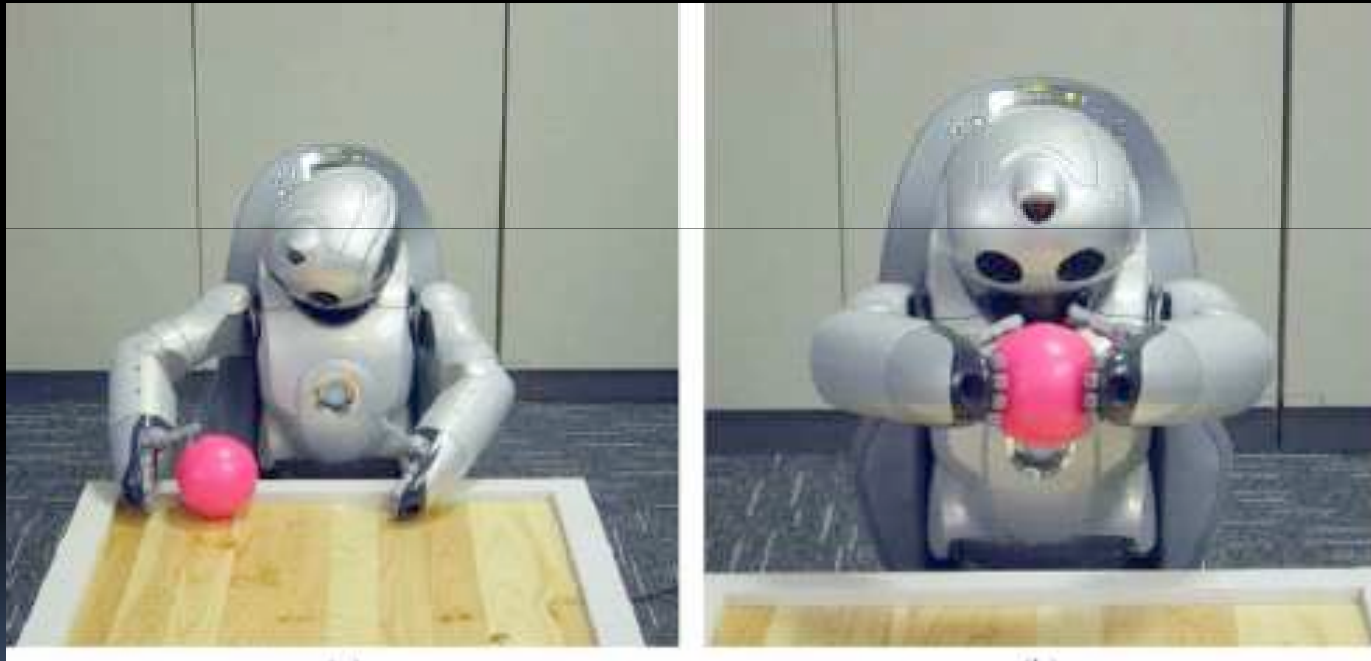


- Balancing between an autonomous 'artificial drift' and an autonomous learning at an internal scale.

Enaction-Based artificial intelligence

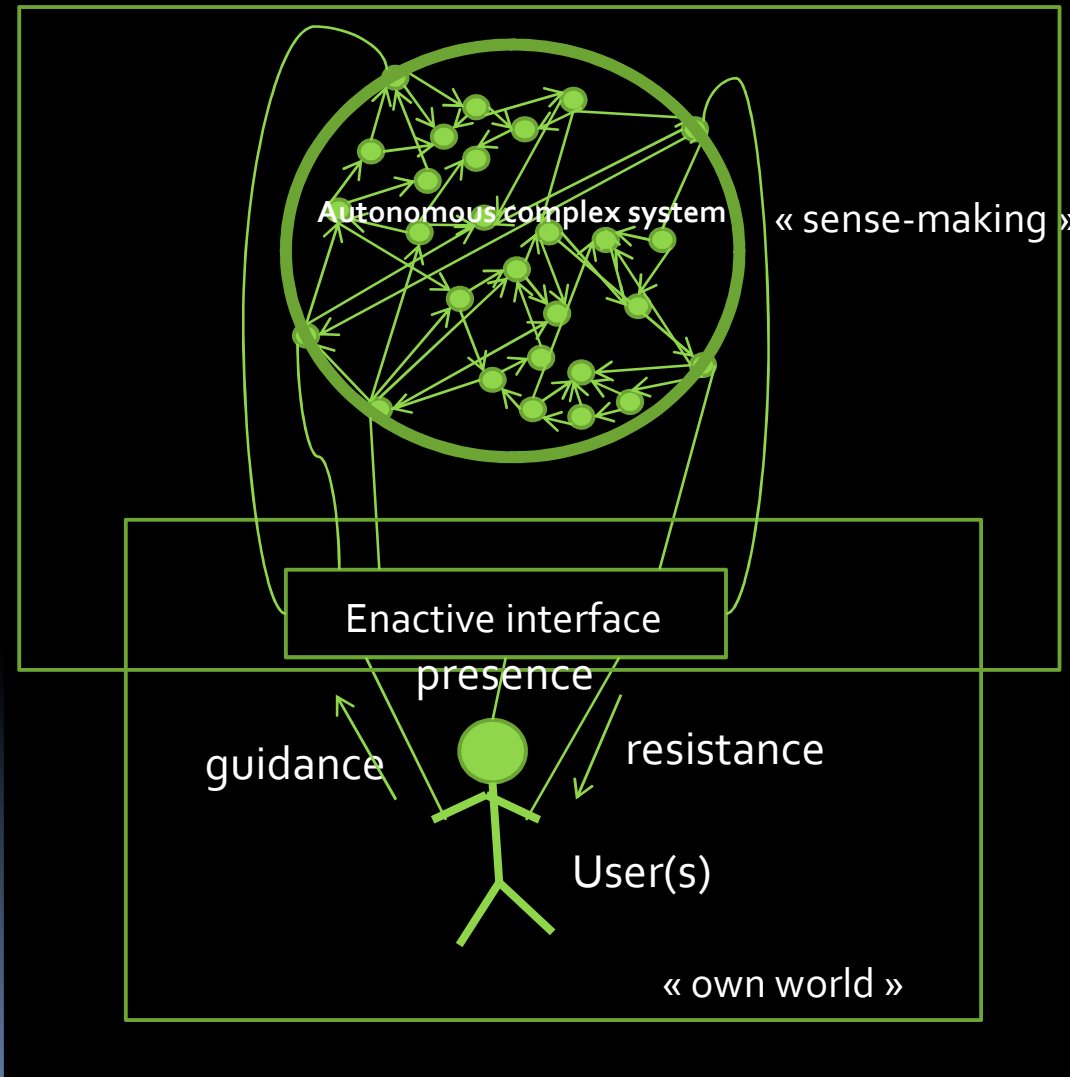
- Enaction as metaphor
 - Concept of first-hand experience and own-world (for a machine) is out of the scope of our study.
 - We retain the concept of sense-making, plasticity, drift, (co)development, ontogenesis, coupling.
 - We address phenomenological question:
 - *Meaning belongs to the relational domain established between environment and agent [De Jaegher & al. 2007] :*
 - What is the consequence if human is the environment of an artificial system ?

Idea on codevelopmental learning: Jun Tani's work



- [Tani, Nishimoto, Namikawa and Masato 2008]

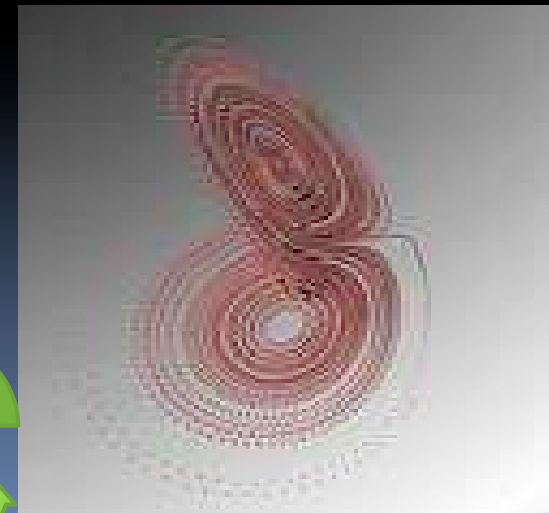
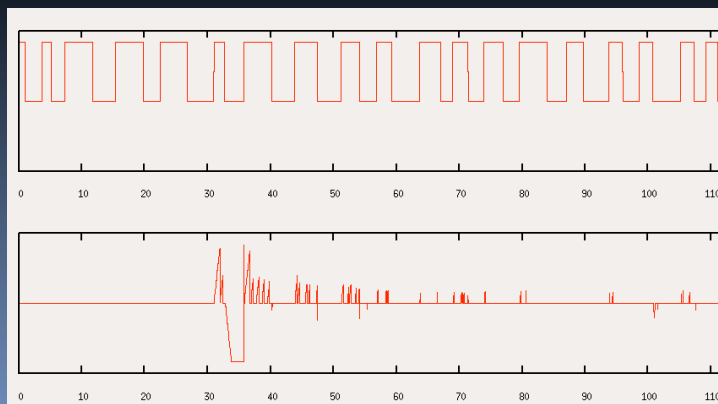
Back to Virtual Reality





First step :

- Possibility of dynamical systems to “learn” at an ontogenesis scale.
- Guidance of a dynamical system.
- Viability is not the realization of a task but the possibility of learning.
- Interactive shaping of behavior.
- Generalization



Some questions

- Is it possible to go toward co-construction of meaning with human/machine by means of such models?
 - May be, if the knowledge is in the interaction.
 - Could phenomenology help us?
 - For memory : morphogenesis or dynamic ?
 - Abstraction (dynamical invariants) ?
 - Relevance of sensorimotor level

Conclusions and future works

- Obviously we can't develop complex virtual reality application by this way.
- One goal is to introducing human in the loop of artificial intelligence.
- It might be possible to establish a virtuous circularity between artificial intelligence, virtual reality and enaction.
- Explaining ontogenesis is an important part of the challenge to develop methodologies for design.
- Inspired by some works of the enactive community, we will work on co-cre-action between dynamical models and human, by the way of an artistic metaphor ...

Thanks

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