On the relation between cognition and behaviour: An embodied perspective

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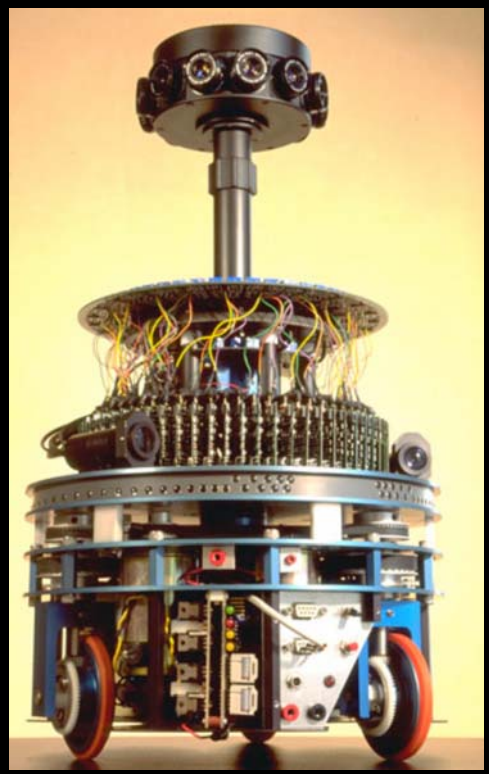
Outline

Investigating the relation between behavioral and cognitive processes through a synthetic self-organizing approach

a. **The synthesis of artificial agents can be employed as a tool for theoretical research aiming at modeling cognition and intelligence in natural organisms**

b. **The identification of new methods that allow artificial agents to develop their skills autonomously might lead to the development of a new generation of artifacts with the robustness, adaptability, and sociability of natural organisms**

Active Perception & Sensory-Motor Coordination



[Franceschini et al. 1991]

[Floreano et al. 2002-2006]

The roles of sensory-motor coordination in categorization

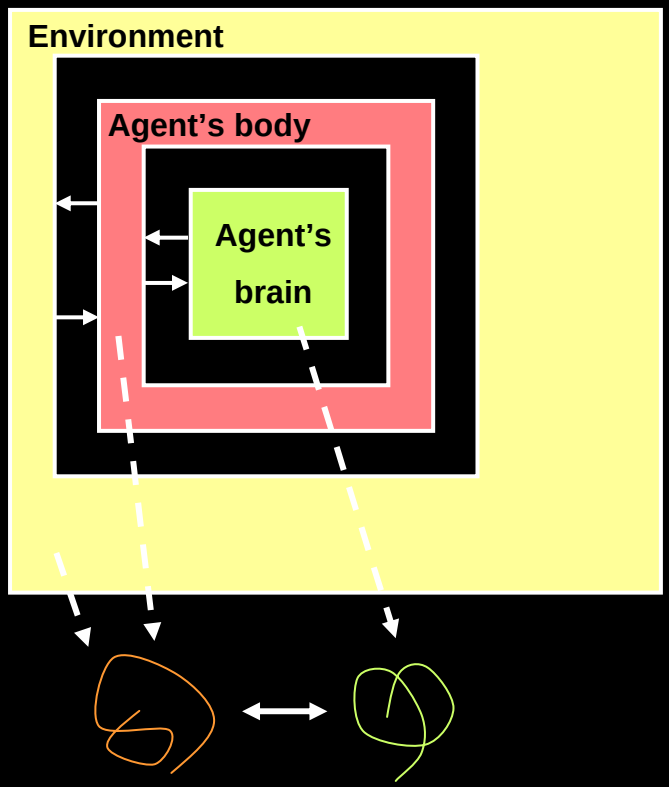
Behavioral categorization, i.e. skills in which behavioral differentiation arises as a result of sequences of interactions between the agent, its body, and the environment that are not mediated by a categorical perceptual process. [Nolfi, 2002]

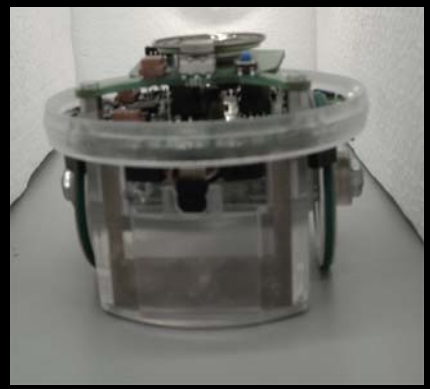
Active categorical perception, i.e. skills in which the way in which the agent interacts with its environment ensures that the stimuli experienced by the agents present the regularities that can be used to perceptually differentiate functionally different situations. [Pfeifer & Scheier, 1997; Lungarella & Pfeifer, 2001; Beer, 2003]

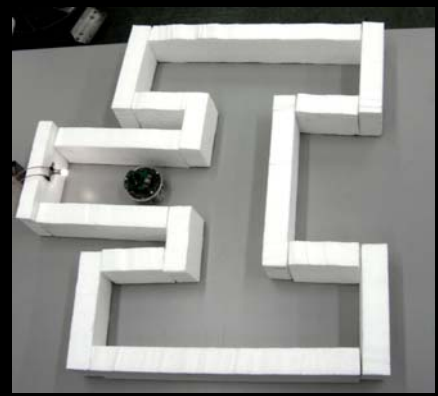
Action-mediated categorization, i.e. skills in which perceptual categories are based on agent/environmental regularities that are generated through agent-environmental interactions [Nolfi, 2005]

The exhibition of selected behavioral skills might **facilitate the development** of categorization abilities to be acquired through learning [Metta et al., 1999; Metta and Fitzpatrick, 2003]

On the coupling between agent/environmental and agent's internal dynamics

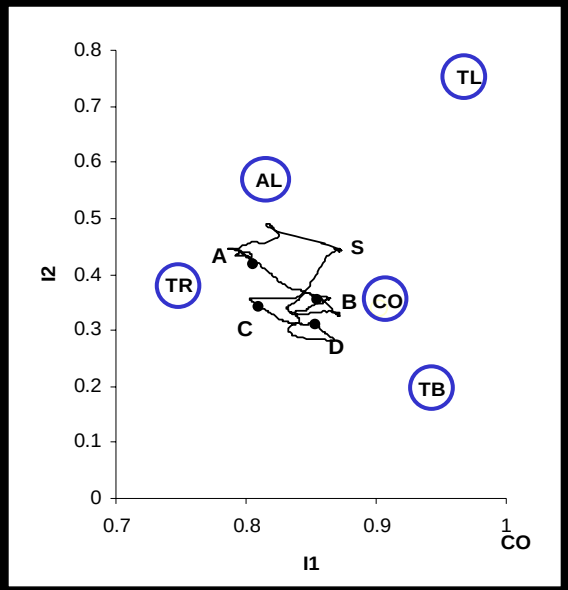


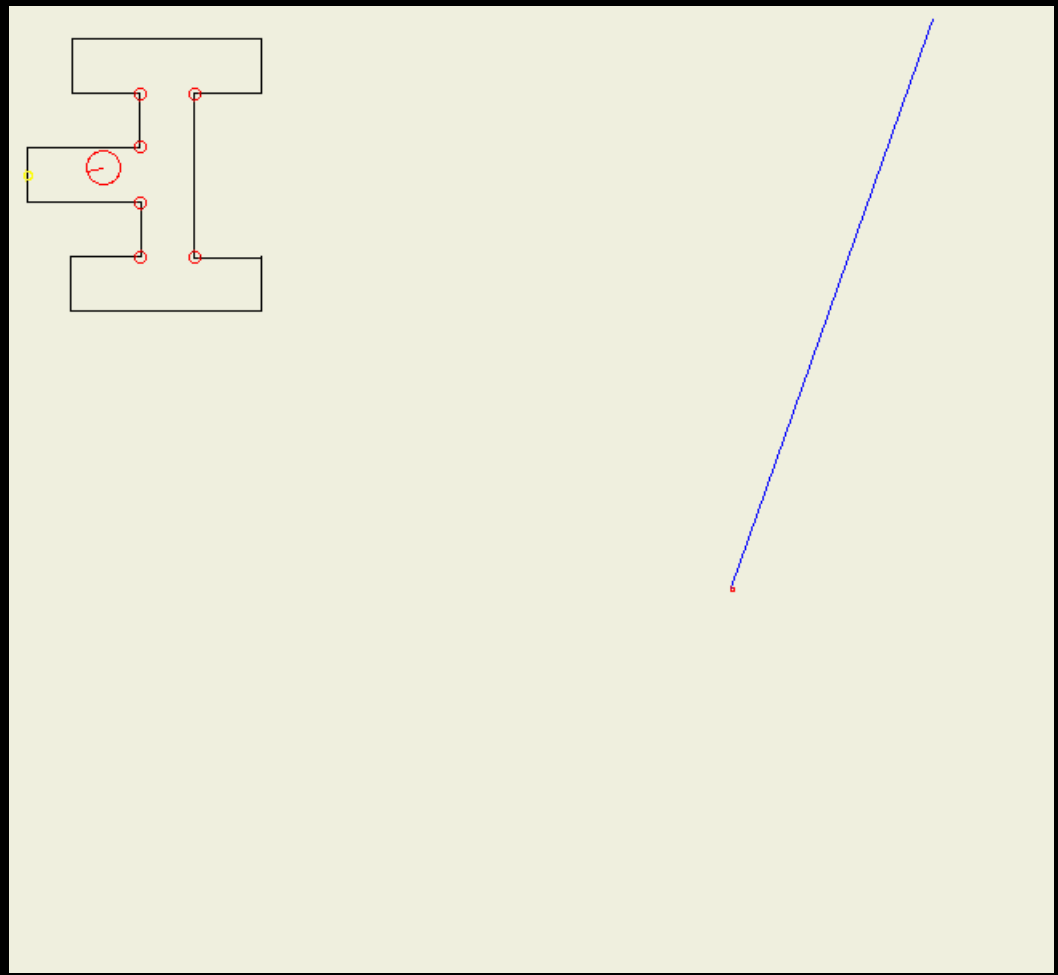




[Gigliotta & Nolfi, in press]

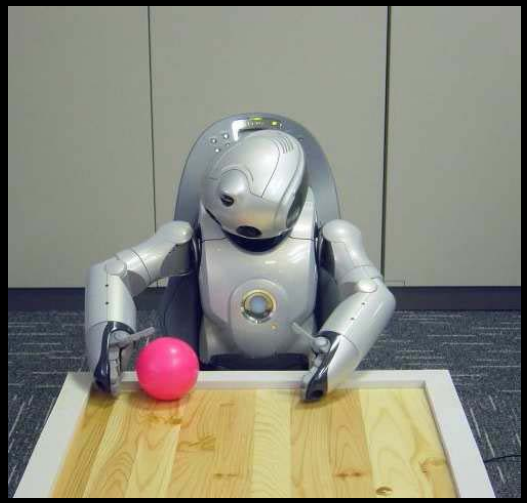
On the coupling between agent/environmental and agent's internal dynamics - 2





[Gigliotta & Nolfi, in press]

Co-development of behavioural, cognitive, and social skills



[Ito, Noda, Hoshimo & Tani, 2006]

The co-development of cognitive and behavioral skills in interaction with the dynamics of the physical and social environment play a crucial role both during the training phase (since it constitute an essential pre-requisite for the possibility to develop multiple behavioral skills) and after the training phase (since it allows the robot to get entrained with the dynamics of the physical and social environment).

Co-development of behavioural, cognitive and social skills in population of robots

www.ecagents.org

[Floreano et al, 2005]

[Steels et al, 2005]

The development of new behavioral abilities poses the basis for the development of communication abilities, and vice versa, the development of new communication abilities poses the basis for the development of further behavioral abilities thus leading to an open-ended developmental process in which progresses create the adaptive conditions for the synthesis of further progresses [Marocco & Nolfi, 2006]

Toward the development of fully autonomous self-organzing agents

There is today a wide agreement on the fact that behavioral, cognitive, and social skills are tightly interdependent phenomena that arise from the interactions of a cascade of more elementary elements and processes.

Developing new methods (i.e. new models, algorithms, and tools) that allow to synthesize self-organizing agents --- agents that are able to develop their behavioral, cognitive, and social skills autonomously while interacting with the physical and social environment.

Identifying a limited set of key processes and mechanisms that, by being able to synthesize properties emerging from the interaction between simpler elements and processes, might lead to the synthesis of artificial systems with a multi-level and multi-scaled organization.