PACO-PLUS: Perception, Action und Cognition through Learning of Object-Action Complexes

PACO+

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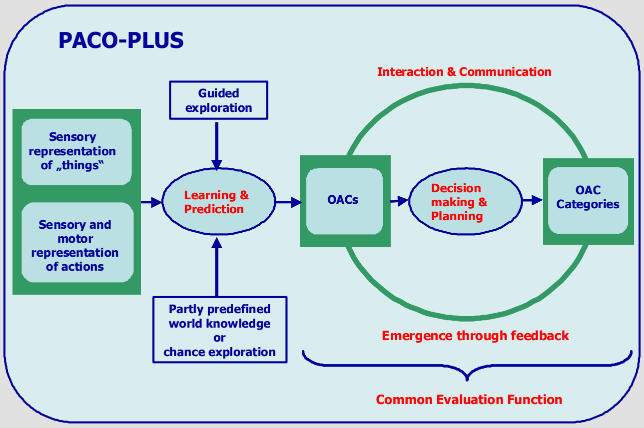
Emergence of OACs



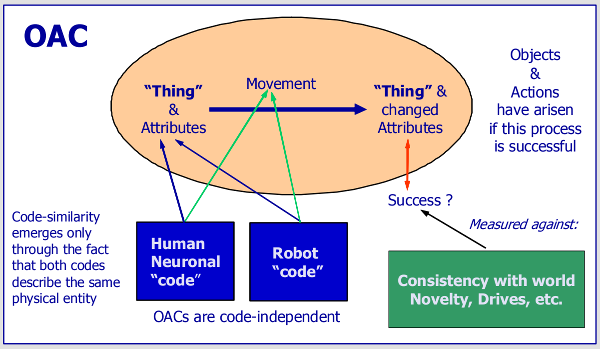
Approach and Guiding Principles

PACO-PLUS aims at the design of a cognitive robot that is able to develop perceptual, behavioural and cognitive categories in a measurable way and communicate and share these with humans and other artificial agents.

Assumptions:

- Objects and Actions are inseparably intertwined in cognitive processing; that is "Object-Action Complexes" (OACs) are the building blocks of cognition.
- Cognition is based on reflective learning, contextualizing and then reinterpreting OACs to learn more abstract OACs, through a grounded perception and action cycle.
- The core measure of effectiveness for learned cognitive structures is: Do they increase situation reproducibility and/or reduce situational uncertainty in ways that allow the agent to achieve its goals?

Processes Realizing Learning of OACs



- How can the robot build a model of the task relevant objects, attributes and actions?
- How can the robot identify actions with reproducible consequences?
- How can the robot discover action-relevant attributes of an object?

Main Project Objectives

Technical cognitive system with sensorimotor primitives to enable learning, recursive refinement and chaining of Object-Action complexes (OACs).

Cognitive capabilities will emerge through pure and guided exploration as well as unsupervised learning.

- Invariant, multisensory representations of objects through actions performed on them.
- New actions by extrapolation within the OAC space along constraints given by motor capabilities and Gestalt statistics.
- Theoretical framework for a conjoint measure for learning (and action) success.
- Decision making and planning system in a continuous perception-action space.
- Planning system capable of leveraging OACs, making use of the capability to learn new OACs and leverage the uncertainties associated with execution in a principled framework.
- Cognitive architecture informed by neurophysiological and psychological findings on the mechanisms and knowledge structures that drive natural cognition as well as theory and practice from research in robotics, vision, machine learning, artificial intelligence, linguistics, and cognitive science.

Main Achievements in 2006

- Advanced hardware development for embodied cognition and the associated sensorimotor processes.
- Multimodal object representations for generating OACs using visual and tactile information.
- General action representations enabling the emerging of OACs.
- Formal specification of the OAC concept based on the Linear Dynamic Event Calculus.
- Learning processes for the acquisition of OACs:
  - machine learning in the sensor-motor space,
  - learning of motor actions by imitation, coaching and practicing.
- Cognitive control architecture that has two memory systems at its disposal:
  - fast-learning multimodal episodic memory,
  - slower-learning semantic memory.

CogSys Cognitive Systems

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