F9

Cognitive Systems

2020 edition

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cognitio

PSI 3560 – COGNITIVE SYSTEMS

class F9

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GENERAL APPROACHES TO COGNITIVE MODELLING

Dynamic systems approach, embodied cognition, embedded cognition and ecological approach, enactive approach

Session F9

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Summary

- Second session (9:20 – 11:00)

- Internalism
  - Representationalism
  - Cognitivism
- Externalism
  - 4E
    - Embodied, embedded, extended cognition
    - Enactive cognition
  - Radical agenda 3E
- Dynamic cognition
  - Cybernetics and enactivist views of dynamic cognition

Representationalism

- Representations
  - Words or sentences of a language *versus* neuronal activations
    - Are they representations of the same nature ?
    - They refer to something, they denotate some entity.
      - What do they represent ?
        - » Content:
          - Can one say that both of these representations have content ?
            - If so, what is it ?
            - How they get their content ?
    - Contents of mental representations may include:
      - Objects (atomic or composed), properties, structures, propositions and relations
        - » Perhaps more

Cognitivism and representationalism

- Cognitive systems are cognitive because they can build, store and manipulate representations.
  - Computational processes are responsible for the appropriate manipulation of these representations
  - Consequently, defining cognition in terms of computations performed on representations restrict theses processes solely in the head (brain). De Jesus (2015)

- Internalism → inside the brain
- Externalism → outside the brain

4E approaches

- 4E
  - Embodied, embedded, enacted and extended
    - That cognition is 4E means that it depends on
      - The agent's body, and
      - Its interaction with the physical and social environment
    - That the corporal, motor and interactive aspects that go beyond the brain play a functional and constitutive role in cognitive processes.

4E approaches

- Embodied
  - The body is constitutive of cognition
    - The mind is based on embodied experiences

- Embedded (situated)

Affordances →



  - The embodied mind is embedded in an environment that offers opportunities for interaction
- Enacted

***En*… actions →**



  - Cognition emerges through couplings between the embodied agent and the world
- Extended

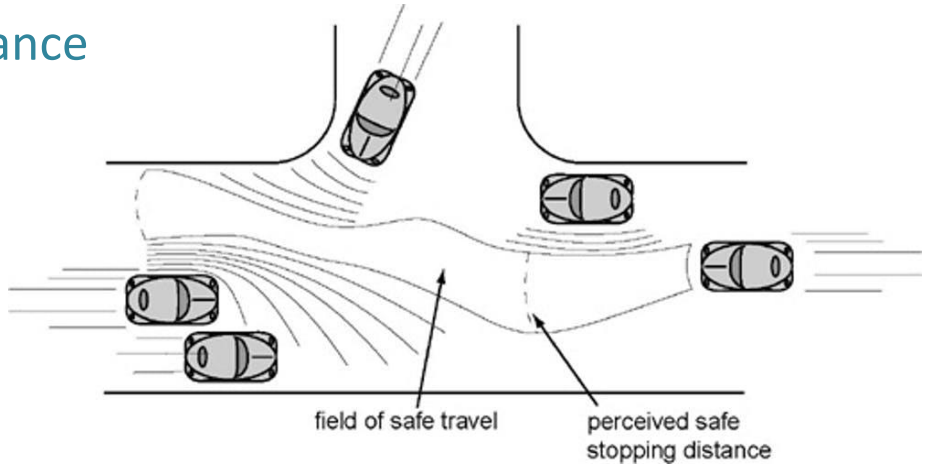
Extensions →



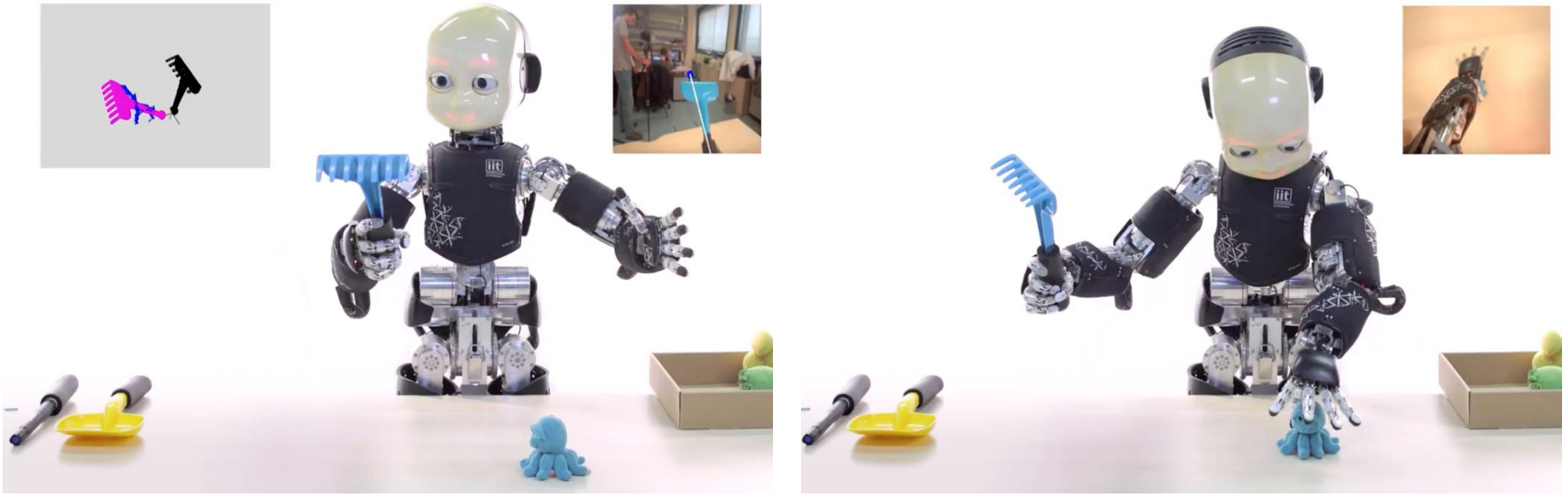
  - Cognition involves (includes, extends into) the outside world in which the embodied mind is embedded.

Embodied, embedded and extended cognition

- Combination of ideas from Gibson, Heidegger and Merleau-Ponty with computational cognitivism.
  - Action-oriented representations based on affordances
  - Perception is…
    - … direct (very arguable)
    - … of affordances
    - … for action
      - » Ex: field of safe travel
        - is an affordance
        - is for action
  - Extended
    - Blind man's stick (Bateson,1973)



Affordance concept



Source: iCub - Behavior-based use of tool affordances for a table cleaning task – T. Mar, V. Tykhanoff, L. Natale – IIT iCub facility - 2016

Enactive cognition (enactivism)

- Cognition emerges through active embodied interactions with the environment (Evan Thompson)
  - Autopoietic approach - Humberto Maturana, Francisco Varela
    - Autopoiesis
      - » The interaction is a coupling between the embodied agent and the environment
        - The agent is operationally closed (equilibrium)
        - The agent is a structurally coupled with the environment
        - The agent is a self-creating system
  - Sensorimotor approach – Alva Noë
    - Grounding via enaction
      - » Representations are grounded in the environment (S. Harnad)
        - Grounded via sensorimotor cycle

Radical embodied, embedded, enacted

- E. Thompson and F. Varela, R. Chemero
  - Denial that cognition needs representation at all
    - Cognition is self-organized, autonomous and autopoietic
      - *Neurodynamics* is the basis for the realization of the autopoietic cycle
        - » Neural assemblies close the gap between the sensorial availability of information and the motor satisfaction of affordances
        - » Neural assemblies provides this through a dynamic coupling bridging two temporal instances of the environment
    - Drawback: how to select an affordance ? (analogous to the frame problem of A.I. and cognitivism).
      - Possible solutions:
        - » Past experience
        - » Trial-and-error procedures

Dynamics and cognition

- What, when, why ?
  - Time dependence in behavior
    - Not just change and motion…
      - The behavior itself depends on time
      - The same for:
        - » Perception
        - » Cognition
      - To say that behavior, perception and cognition depend on time implies on that
        - » Their mechanisms are themselves functions of time

Dynamic systems approach to cognition

- Sources of dynamic behavior
  - Neuronal level
    - Individual neuron dynamics
  - Circuit and assembly level
    - Dynamics of couplings and interactions
  - Network level
    - Collective dynamics with topological changes
    - Functionally segregated modules
  - Global level
    - Functional interaction of modules

- What means “dynamic” behavior

Dynamic behavior

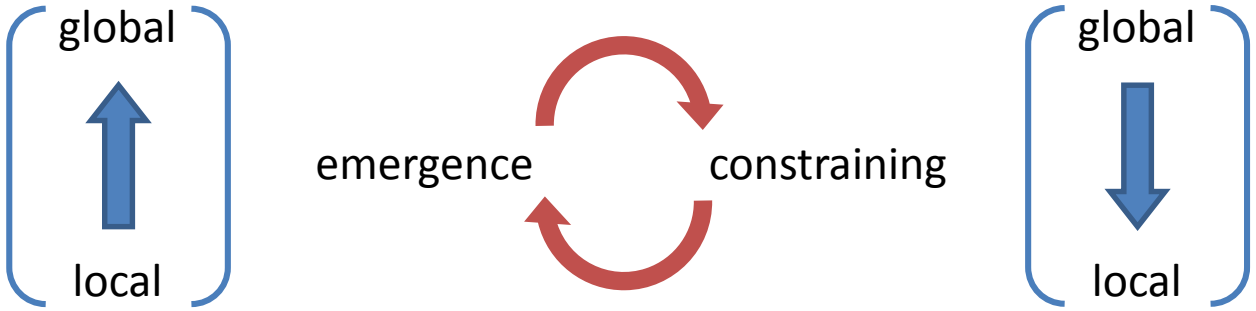
- Features of dynamic behavior
  - Time dependence
    - Time-dependent parameters, explicit time function
  - Dynamic response
    - Differential variability
  - Structural dynamics
    - Diversity of attractors and fixed-points
    - Topological variability
      - Dynamical stochastic variability
      - Order structure
        - » Topological order, phases
          - Phase transitions, bifurcations, criticality
        - » Temporal (dynamic order)
          - Synchronization, rhythm
  - Self-organization and adaptive dynamics

Dynamic cognitive approaches

- Dynamics in cognitive theories
  - Cybernetics → internalist perspective
  - Enactivism → externalism → coupled perspective
  - Cognitive neuroscience
    - Localizationism → a new phrenology ?
      - Functions spatially segregated in modules
      - Emphasizing local dynamics
    - Globalism → kind of holism…
      - Holographic brain (Karl Pribram - 1991)
    - Connectome dynamics
      - Functional interaction among modules/areas
      - Dynamic anatomical-physiologic connectivity

Dynamic cognitive approaches

- Connectome dynamics
  - Functional interaction among modules/areas
  - Dynamic anatomical-physiologic connectivity
    - Self-organization by circular causation



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Michael Arbib and Peter Érdi – Précis of Neural organization: Structure, function, and dynamics - Behavioral and brain sciences (2000) 23, 513–571

This is all for today.

See you next week !