Research Challenges

Many Open Questions

- Phylogenetic configuration (cf. development)
- Tradeoff with ontogeny (precocial vs altricial)
- Autonomy
- Embodiment (humanoid vs. structural coupling)
- Deliberation
- Reasoning
- Development
- Learning
- Memory
- Representation
- Language
- Communication
- Goal achievement
- Prospection
- Motivation
- Planning
- Recognition
- Concept formation

Research Challenges

1. Methods for continuous learning and development
2. Minimal architectures
3. Goal identification and goal achievement
4. Generalization

Research Challenges

- Methods for continuous learning and development
  - Learning mechanisms: fast, incremental, continuous, large capacity, graceful degradation
  - Representations & feature sets: efficient and extendable
  - Learning domains: perceptual & conceptual, and mapping between them
    - Perceptual to conceptual mapping (to facilitate expression, deliberation, communication)
    - Conceptual to perceptual (to facilitate action)
  - Learn parameters (populate existing representations and mappings)
  - Learn system identification (develop new representations and mapping) … very hard!

Research Challenges

- Minimal Architectures
  - Balance between phylogeny and ontogeny

Research Challenges

- Goal identification and goal achievement
  - Cognitivist: easy as goals are specified explicitly as the outcome of cognitive behaviour
  - Emergent: hard as behaviour is a non-specific emergent consequence of a set of system dynamics
    - Stipulate goals as constraints or boundary conditions (phylogenic configuration or ontogenic development)
  - Four types of goals
    - Learned self-initiated goals (unsupervised)
    - Trained externally-initiated goals (supervised)
    - Reactive goals
    - Intentional or reflexive goals

Research Challenges

- Generalization
  - Transferrability of competences or skills from one context to another
  - Requires faculty for generalization
    - Analogical reasoning
    - Metaphorical deliberation
    - Manipulation of visual memory
  - Paradigm-dependent
  - Does it require establishment of some form of inter-agent cognitive communication
    - Language
    - Speech
    - Gesture

Key Research Topics for the Future

Imagination

Self-Modification

Plasticity

Redundancy

Internal Dynamics

Social motives

The value system: creating order

Let's try again ….

A cognitive system is an autonomous anti-entropy engine whose function is to preserve the system's autonomy

Some Viewpoints

Our conscious perception of the external world is in terms of the actions we can perform upon the objects around us.

Granlund99

Perceiving is not strictly speaking *in* the animal or an achievement of the animals nervous system, but rather is a process in an animal-environment system.

Kelso, 1995

Cognition is effective action

Maturana and Varela, 1987

Perception is equivalent to the construction of invariances through a sensory-motor coupling by means of which the organism becomes viable in its environment

Varela, 1979

The aim of science is not things themselves, as the dogmatists in their simplicity assume, but the relations among things; outside these relations there is no reality knowable.

Henri Poincaré

Context is everything. Remove context and everything goes with it.

Scott Kelso, 1995

Ontogeny preserves the autonomy of an organization, it does not construct it.

Tom Ziemke, 2001.

Intelligence is concerned with that faculty of mind by which order is perceived in a situation previously considered disordered.

H. A. Fatmi and R. W. Wong, Nature, 220, 1970.

All models are wrong
Some are useful

George Box

Cognition allows us see things as they might be ….

potential affordances

Banksy

Banksy