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Brain Modelling and Cognition

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Neuro-IT Roadmap:

Of high value for the interface between NS and IT !!

Personal favourite (but not exclusively):

The ‘constructed’ brain (chapter 7)

Constructed brain:

Core problem:

Computational architecture of the brain

Computational architecture of the brain

Derives from:

- Basic structure provided by genetic information

  and

- Interaction with outside world (learning)

Computational architecture of the brain

Thus:

Basic structure with learning abilities

produces complex computational architecture

Computational architecture of the brain

Robust process:

with every new individual:

e.g., globally same structure visual cortex (see monkey studies)

e.g., globally same language ability (despite genetic differences)

Computational architecture of the brain

Language ability:

structural similarities between individuals (same language)

and between languages

E.g., child from X can learn language in Y without any difficulty if exposed early on

Computational architecture of the brain

Suggests:

a development process with ‘strong’ dynamical constraints

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a development process with ‘strong’ dynamical constraints

Aim Neuro-IT: implement this process in hardware

Requires understanding of this process (theory, simulations)

How? Possibilities:

Bottom-up approach:

begin with genetic make-up of the brain,

and continue upward

disadvantage: severely unconstrained

How? Possibilities:

Trial-and-error approach:

begin with a more or less arbitrary initial structure

and learning algorithms

disadvantage: could result in a dead-end, even halfway

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‘Back-track’ approach:

develop theory of brain-cognition relation

and use it as a target to see how it could have emerged

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‘Back-track’ approach:

develop theory of brain-cognition relation

and use it as a target to see how it could have emerged

i.e. use it to discover the dynamic constraints that produce the computational architecture of the brain

Theory of brain-cognition relation:

based on:

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Advantage: multiple constraints on different levels of the computational architecture of the brain

Theory of brain-cognition relation:

Project for Neuro-IT