Psychology

Hypotheses to be tested
The following hypotheses are some of the psychological theories that give some insight into the mechanism of ongoing development, and stage transition.

1. **Means-end behaviours** are initially acquired through fortuitous coordinations which result in one known schema facilitating the performance of a second (Willatts, 1999). The successful coordination is remembered, and repeated in new scenarios.

2. Infants autonomously acquire knowledge about various means actions through studying their effects in fortuitous coordinations. The knowledge thus acquired can then be applied to allow effective selection and adjustment of means actions in intentional means-end coordinations (Piaget, 1936, Bruner, 1973).

3. Infants develop an experimental ability through searching for the conditions which can cause certain effects, where those effects are recognised by schemas developed in the previous stage (Piaget, 1936). Experiments lead to new means schemas.

Cognitive Architecture

![Cognitive Architecture Diagram]

Artificial Intelligence

Existing Techniques used for modelling

2. Basic Piagetian schemas for skilled movements captured via Neural Fitted Q iteration (Riedmiller, 2005)
3. Hierarchical reinforcement learning used to combine basic schemas (here the schema becomes an option in the reinforcement learning terminology)
4. Self Organising Maps used to harvest new schemas from clusters of sensor data after random actions (Chaput, 2004)
5. Recurrent Neural networks used to cluster schemas with similar effects (recorded as a time-series of sensor values), and to identify schemas which can produce a required effect (for selection in means end behaviours)

New Techniques Required

1. A new cognitive architecture to model infant cognition (most existing architectures aim to model adult competence and knowledge in a specialised domain)
2. Reinforcement learning options with parameters.
3. Refinement of reinforcement learning options based on their efficacy in a means-end combination.
4. Higher order schemas which manage relationships among lower level parameterised options (i.e. An extension to hierarchical reinforcement learning)

References