Know your body through intrinsic goals

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ABSTRACT

Newborn children start from their earlier months to explore their body. This activity allows them to autonomously form a sensorimotor map that constitutes the core of future cognitive and motor development. In this work we propose that this acquisition of early knowleged is not guided by random motor-babbling, but is levered by intrinsic goals autonomously generated and set by the children. During the initial motor-babbling, the agent forms representations of sensory events. When the system realises the possibility to re-activate those representations through its motor behavior, it will be intrinsically motivated to improve its competence in obtaining those specific events. More precisely, the discovered events become intrinsic goals that guide both the learning and the selection of motor actions. To explain our hypothesis we built a computational model of early sensorimotor development that uses intrinsically-motivated goals to guide the exploration of the agent's body. The model is based on four components: (1) a competitive neural network, supporting the acquisition of abstract representations based on experienced changes in the sensory input;(2) a selector that on the basis on competence-based intrinsic motivations (CB-IMs) determines the pursued goal and which motor resources will be trained to obtain that goal; (3) an echo-state neural network that controls the movements of the robot and supports the acquisition of the motor skills; (4) a predictor of the accomplishment of the pursued goal, used to measure the improvement of the system compentence; (6) the generator of the CB-IM signal that biases the:w activity of the selector. and hence to intrinsically motivate the selection of its goal. The model is used as the controller of a simulated agent in a 2D environment, composed of two kinematic 3DoF arms. Sensory information from self-touch is used by the system to form goals and guide skill learning. Results are presented, together with their possible implications for the empirical experiments. Moreover, the model will be discussed in realation to possible

application to design new open-ended learning robotic architectures able to act in unstructured environments.

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1 THE MODEL

We describe here a system-level model implemented to explain the hypothesis that intrinsiclly generated goals guide learning at the very first stages of sensorimotor development. The model is made of several interacting functional components. A first component, the goal generator (GC), implements the unsupervised generation of internal categories of sensory inputs. These categories will be used in the model as abstract representations of the world that can be targeted as goals. The GC takes information from touch sensors distributed all over the body of the agent (see below). This information is filtered so that only somatosensory increments are retained. This information about sensory saliency is further transformed so that it results in a two-dimensional retina composed of horizontally-distributed receptive fields. Figure **??** shows this process. The one-dimentional body space of the agent (two arms and a line-shaped torso) is converted in a two-dimensonal touch retina.

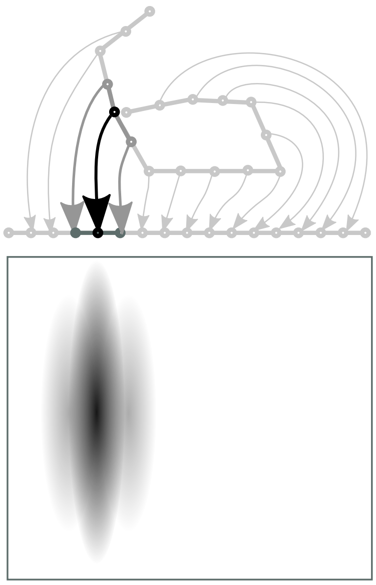

Figure 1.

In the current implementatiion the GC is a self organizing map (SOM).

The model is based on five components: (1) a competitive neural network, supporting the acquisition of abstract representations based on experienced changes in the sensory input; (2) a selector that on the basis on competence-based intrinsic motivations (CB-IMs) determines the pursued goal and which motor resources will be trained to obtain that goal; (3) an echo-state neural network that controls the movements of the robot and supports the acquisition of the motor skills; (4) a predictor of the accomplishment of the pursued goal, used to measure the improvement of the system competence; (5) the generator of the CB-IM signal that biases the activity of the selector.

2 RESULTS