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Editorial

Special Issue on Advances in Developmental Robotics

The Special Issue on Advances in Developmental Robotics is dedicated to the developmental robotics research domain and its related applications. This issue aims at presenting an overview of the current trends in this field. This volume includes extended versions of the best research articles presented at the Postgraduate Conference on Robotics and Development of Cognition 2012 (RobotDoC-PhD). This conference was part of the Marie-Curie ITN RobotDoC (http://www.robotdoc.org) and it was organized as a satellite event of the 22nd International Conference on Artificial Neural Networks (ICANN 2012) held in Lausanne, Switzerland. In line with the multidisciplinary character of the RobotDoC project, the RobotDoC-PhD Conference highlighted the importance of fostering collaborations among different scientific fields in order to move forward substantially the research in developmental cognitive robotics. The editorial committee selected outstanding papers which fell within the scope of the issue. The special issue was also opened to submissions from other interested researchers.

The scope of the special issue includes a broad range of topics comprising epigenetic robotics, embodied and situated cognition, neuro-inspired robotics (e.g. motor control, manipulation, memory, navigation), motivational and affective mechanisms (e.g. emotional mechanisms), developmental psychology (e.g. cognitive development and its computational modeling), social interaction (social development, social motivation, joint attention), sensorimotor learning, higher-order cognitive learning (e.g. formation of concepts, mathematical cognition) and work in the core disciplines of developmental robotics (i.e. cognitive science, humanoid robotics, artificial intelligence, developmental psychology, neuroscience).

Developmental robotics offers a new paradigm in the field of robotics and artificial intelligence for overcoming the current limitations in the design of intelligent agents. Differently from other approaches proposed in artificial intelligence (e.g. supervised learning, evolutionary adaptation, engineering approach, etc.) by taking inspiration from developmental psychology and cognitive and neural sciences, developmental robotics provides a new perspective in building a new generation of autonomous robots through the design of cognitive architectures integrating perception, cognition and action, being capable of decision-making and communication. The ultimate challenge of this research field is to build robots that, as biological organisms, during their lifetime can continuously develop new skills - by themselves and by interacting with other agents in unstructured scenarios - which can lead to the bootstrapping of more complex cognitive capabilities. The outcome of this novel interdisciplinary approach to robotics is twofold. On the one hand, progressive understanding of children development can inspire roboticists and emerging theories of artificial cognitive systems; on the other hand, robotic models and humanoids, which can be adopted as platforms to formulate and test new hypotheses on cognitive processes, can have an important impact in developmental psychology and cognitive and neural sciences.

One series of articles featured in this Special Issue focuses on the autonomous learning and adaptation of robotic models for sensorimotor learning. Jamone et al. propose an on-line learning algorithm for the incremental development of multiple tool models for robotic reaching through autonomous exploration. Stulp et al. present an adaptive exploration algorithm through covariance matrix adaptation that enables developmental motor learning. Nguyen et al. propose an active learning algorithm for a socially guided intrinsic motivation learner to achieve multiple outcomes using several learning strategies. Shaw et al. present a biologically constrained architecture that autonomously learns the relationships between coupled sensorimotor systems in order to achieve adaptation for the gaze control of the iCub humanoid robot. This series of articles is closed by the work of Hasnain et al. that presents a synchrony-based perspective for partner selection and attentional mechanism in a Human-Robot Interaction scenario.

The Special Issue also featured a series of article on sensorimotor integration, action generation and sequence learning. Zhong et al. propose a biologically-inspired learning model of predictive sensorimotor integration for a robust and smooth robot docking behavior. Duran et al. present a model based on dynamic field theory and reinforcement learning methods for obtaining and performing a sequence of elementary motor behaviors in the NAO robot. Fichtl et al. present an artificial developing system for learning object relationships that determine the outcome of actions for a robotic manipulator. This series also contain the article proposed by Baxter et al. that presents a model for concept acquisition using a developmental memory model. The Special Issue is closed by a review article by Thill et al. where future challenges in the field of Robot-assisted therapy for autism spectrum disorders are described.

The research presented in this Special Issue will serve as showcase of the progress achieved in the field of developmental robotics in the context of the RobotDoC workshop and project.

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