Proposal for an half-day Tutorial on:

Evolutionary and Adaptive Robotics

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Scope

With the term Adaptive Robotics we refer to Evolutionary and/or Developmental methods that allow to synthesize robots that evolve/develop their skills autonomously in interaction with the physical, and eventually social, environment on the basis of an adaptive process driven by the ecological condition in which the robot operate and on the basis of an utility function designed by the experimenter. This means that the way in which the robots solve their adaptive task as well as the detailed characteristics that allow the robot to display their skills in interaction with environment are shaped by the adaptive process (i.e. are not designed by the experimenter). As we will illustrate in this tutorial, these methodologies are particularly suitable for the development of robots that are embodied (i.e. that are able to exploit properties originating from the numerous interactions occurring over time between their body and the environment) and situated (i.e. that are able to exploit the properties arising from the fact that they can modify the next experienced sensory states through their action). In other words robots that, besides being provided with a physical body and beside being situated in a physical environment, are able to exploit the opportunities that their embodied and situated nature provides to them. Moreover, as we will demonstrate, these methodologies are particularly suitable for the development of embodied cognition skills, i.e. internal processing capabilities that are "grounded" on simpler behavioral and cognitive skills and, ultimately, on fine-grained sensory-motor interactions.

List of topics/research to be covered

1. Behavior and cognition as complex adaptive systems (Beer, 2000; Keijzer, 2001; Yamashita & Tani, 2008; Nolfi, 2009)
2. Adaptive Robotics: Evolutionary and Developmental Methods (Nolfi & Floreano, 2000; Weng et al., 2001; Weng. 2004; Oudeyer, Kaplan, & Hafner, 2007; Floreano, Husband & Nolfi, 2008)
3. Case studies:
3.1. Body/brain co-evolution (Lipson & Pollack, 2000; Bongard & Pfeifer, 2003; McHale & Husbands, 2004, Bongard, 2010)
3.2. Reaching and Grasping and object Manipulation in Humanoid Robots (Massera et al., 2007; Tuci et al, 2010; Bongard, 2010)
3.3. Co-evolving Predator and Prey Robots (Nolfi & Floreano, 1999, Nolfi 2011)
3.4. Evolution of cooperation and communication robotic swarms (Baldassarre et al., 2007; Floreano et al. 2007; De Greef & Nolfi, 2010; Mitri et al. 2009, 2011; Sperati et al. 2001; Wischmann, Floreano & Keller 2012)
3.5. Development of Integrated Language and Action skills (Sugita & Tani, 2005; Steels, 2010; Tuci et al. 2011)
4. Open Issues, Challenges and Promising Research Direction

Intended Audience

The tutorial will be of interest for who want to know the method, the state-of-art in this field, and the advantages/drawbacks of different methodologies. The themes presented aim to be self-explanatory and do require previous knowledge. At the same time the tutorial aims to provide useful information also for those that are already familiar with evolutionary and/or developmental approaches to robotics and are interested in knowing the progresses achieved during the last years, the failures, and the challenges for the future.

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