CprE / HCI 585X: Developmental Robotics

Spring 2011
Monday and Wednesday, 2:10-3:30pm
Howe Hall, room 1242
Iowa State University
Ames, Iowa 50011

Instructor: Alexander Stoytchev

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Course Description: This class provides an introduction to the emerging interdisciplinary field of Developmental Robotics which crosses the boundaries between robotics, artificial intelligence, developmental psychology, and philosophy. The main goal of this field is to create autonomous robots that are more intelligent, more adaptable, and more useful than the robots of today, which can only function in very limited domains and situations. The basic research hypothesis of developmental robotics is that truly intelligent robot behavior cannot be achieved in the absence of a prolonged interaction with a physical or a social environment. In other words, robots must undergo a developmental period similar to those of humans and animals.

The class will focus on representations and algorithms for robot learning that facilitate and/or benefit from a developmental period. At the end of this class you will have an understanding of the current state of the art in developmental robotics and will be able to conduct original research. As a side effect, you may also gain a deeper understanding of the development of human intelligence.

Topics to be Covered: The class will cover the following topics: Introduction to the field and overview of robotics. Principles of Developmental Robotics. What is Intelligence. The principle of embodiment - or why should intelligent agents have bodies. The sense of self, body schema representation, self-detection and self-recognition in robots. Exploratory behaviors and their role in learning and development. Learning about objects and their affordances. Computational representations of affordances. Grasping and Manipulation. Learning to use objects as tools. Intelligence tests for robots. Theories of development and their application to robotics. The nature v.s. nurture debate. The enactive approach to cognition. Action in Perception. Sensing and sensory self-organization. Sensory substitution. Attention and saliency models. Change blindness and inattentional blindness. Intrinsic motivation. Categorization. Grounding of Categories. Metaphors we live by. Embodied arithmetic and Number Sense. Representations of Space and Time. The philosophy of cognition. Theory of Mind. Developmental disorders. Language learning. Statistical learning. Social learning and Human-Robot Interaction.

Textbook & Readings: There is no required textbook for this class. The lectures will be based on a number of sources most of which are available for download from the Internet (links will be provided on the class web page). Reading material that is not available on-line will be placed on reserve in the library.

Organization*: This class will be taught as a seminar. The students will be expected to read the assigned papers for each lecture in advance and to actively participate in class discussions.

* The instructor reserves the right to change any and all aspects of this class for whatever reason or no reason at all (a.k.a., academic freedom).

Prerequisites: This is a joint graduate and advanced undergraduate class. Previous exposure to at least 2-3 of the following fields is recommended but not required: robotics, artificial intelligence, computer vision, statistics, linear algebra, psychology, philosophy. Programming skills (e.g., knowledge of C/C++) will be required for the homework assignments and for the final project. We will cover a lot of reading material so you must be able and willing to read 50-100 pages per week. The most important prerequisite of all, however, is your interest in the course, motivation, and commitment to learning.

For best results take two lectures weekly. Common side effects may include sweatiness, nervousness, lack of sleep, and diarrhea. Talk to your instructor if this class is right for you.

Students with Disabilities: Iowa State University complies with the Americans with Disabilities Act and Section 504 of the Rehabilitation Act. Any student who may require an accommodation under such provisions should contact the instructor as soon as possible and no later than the end of the first week of classes or as soon as you become aware. No retroactive accommodations will be provided in this class.

Homework Assignments: There will be five homework assignments. You will have approximately two weeks to complete each one of them. These assignments will be used to emphasize and clarify important concepts discussed in the lectures.

Final Project: The final project must be a research or design project that is related to the topics covered in class. You may choose to work individually or in small groups (2-3 members each). Working in groups, however, is highly recommended. You are encouraged to select a topic for your final project as soon as possible. A written project proposal (10-15 pages) will be due on March 10. The final project report (25-30 pages) will be due on April 21. Each team will be required to present the results of their final project during the last week of the semester.

Policy on Collaboration: You are encouraged to form study groups and discuss the reading materials assigned for this class. You are allowed to discuss the homework assignments with your colleagues. However, each student will be expected to write his own solutions/code. Sharing of code and/or text is not allowed.

Attendance: You are expected to attend every class and participate in the class discussions. If you miss a class, it is your responsibility to find out what we talked about, including any announcements that were made in class.

Grading: Your grade will be determined as follows:

Class participation:	10%
Homework assignments:	50% (5 $\times$ 10% each)
Final Project Proposal:	10%
Final Project:	30%