International Symposium on
Constructive Approach to Cognitive Development and Disorders

Date: March 13th, 2017.
Language: English.
Venue: CITEC building, Room 1.204, Bielefeld University
Co-Sponsored by: MEXT KAKENHI "Constructive Developmental Science"
No. 24119001 and supported by the EU FP7 CODEFROR Project (FP7-PIRSES-2013-612555)
Related URL: http://devsci.isi.imi.i.u-tokyo.ac.jp/ and https://www.codefror.eu/

Program

9:00 – 9:30 Opening & Talk: Grounding Robot Cognition in Manual Action

Prof. Dr. Helge Ritter, Neuroinformatics Group, CITEC, Bielefeld University

Abstract:
Cognition is to a large extent about an understanding how to interact with the objects that surround us, how we can grasp and manipulate them, and how we can explore their properties, e.g. by combining touch and vision. The accumulation of experiences from such interactions and their compilation into increasingly refined manual skills starts from our very first days and continues throughout our entire life. And during this process, we gradually take the step from manipulating real objects to being able to imagine such actions, finally abstracted to "grasp things" that are no longer physically concrete but purely mental and abstract. Thus we see manual action very centrally connected to the built-up of much of our cognitive machinery, and it seems tempting to try a replication of such process with robots that can use hands with tactile sensation and actuate them under direct visual feedback. We point out some of the scientific challenges of such approach, take a glance at the interdisciplinary positioning of manual action research between robotics, psychology and neuroscience to elucidate important aspects of how cognition may work and how we might advance the cognitive abilities of robots along with their manual skills, and present examples.

9:30-10:00 Talk: Simulating Fetal Sensory-Motor Experiences and Embodied Neural Learning

Yasuo Kuniyoshi, Professor of Mechano-Informatics, School of Information Science and Technology, and Director of Next Generation AI Research Center, The University of Tokyo, Japan.

Abstract:
Development is a continuous causal process involving complex interaction between genes, body, nervous system and environment. Although the whole process may be too complicated, fetal interaction and development can be relatively more tractable to model. From a dynamical systems point of view, the beginning part of the temporal development trajectory provides an important information about the underlying principles governing the developmental dynamics. We constructed a computer simulation model of a human fetus. It consists of a musculo-skeletal body, uterus, and basic nervous system. It exhibits spontaneous motor development and sensory-motor map organization comparable to human data. Also, by changing the model parameters, we can simulate “atypical” development. Our series of experiments shows that sensory-motor experiences in the fetal period can be crucial to the formation of body representations, which are significantly affected under "preterm birth" conditions, providing new insights about the developmental origins of social cognition and autism spectrum disorders.

10:00 – 10:30 Coffee break

10:30 – 11:00 Talk: Cognitive Mirroring: Computational Approach to Understanding and Assisting Autism Spectrum Disorder

Yukie Nagai, Specially Appointed Associate Professor, Osaka University, Japan
Visiting Professor, Bielefeld University

Abstract:
Autism spectrum disorder (ASD) is a neurodevelopmental disorder characterized by impaired social interaction and

communication as well as by restricted behaviors. Recent neuroscience studies suggest that these characteristics might be caused by atypical sensitivity to prediction error and/or too precise prediction in sensorimotor processing in ASD. It has been suggested that the human brain tries to minimize prediction error, which is calculate as a difference between the bottom-up incoming sensory signals and the top-down prediction (i.e., predictive coding), and that this process in ASD differs from that in typically-developing people.

This talk presents our recently launched research project, which aims to understand and assist people with ASD by means of computational approaches. The project is inspired by JSPS project entitled "Constructive Developmental Science," and intends to design artificial systems that can learn to imitate cognitive processes in humans as if the systems become mirrors of the humans, which we call "cognitive mirroring." We design such cognitive mirroring systems based on the predictive coding theory in order to synthetically understand the underlying neural mechanisms for ASD. Within the project, following four research issues are addressed:
(a) behavioral studies to investigate the principle of human cognition and its disorder from the first person's perspective,
(b) computational modeling studies to design neural network models that synthetically verify the above principle,
(c) interaction studies to quantitatively evaluate human cognition by employing cognitive mirroring systems with the above neural models, and
(d) social application of the cognitive mirroring systems to assist people with ASD in understanding and sharing their cognitive processes.
We hypothesize that characteristics of ASD are accounted for by fluctuations in parameters of the predictive coding models (e.g., imbalance between the top-down prediction and the bottom-up modification, varied reliance on multimodal signals). The talk shows our previous studies to support this hypothesis.

11:00 – 11:30 Towards flexible interaction patterns in HRI

Prof. Dr. Britta Wrede, Applied Informatics Group, CITEC, Bielefeld University

Abstract:
When humans interact to achieve a joint goal, i.e. when teaching or cooperating, they develop ad hoc interaction patterns based on a shared understanding of the situation, allowing them exchange information with an exceptional efficiency. In contrast, interactions with robots tend to be highly pre-shaped – that is, the robot has a pre-specified way how to interpret the signals provided by a user in order to determine its next behavior.

How can we endow robots with a capability to shape interaction patterns in coordination with their interaction partner? In my talk I will give an overview of interaction frames in HRI and present approaches to include situational information in the robot's behavior as a first step towards more flexible robot interaction.

11:30–12:00 Talk: Brain-computer interfaces for human-machine interaction – a novel communication channel and research tool

Andrea Finke, Neuroinformatics Group, CITEC, Bielefeld University

Abstract:
Brain-computer interfaces (BCI) have been originally designed as a communication channel for patients with severe physical disabilities, e.g., paraplegia or even locked-in state. Typical applications include text spelling systems or the control of a robotic arm. When using electroencephalography (EEG) to assess brain activity, they are non-invasive, affordable and safe. EEG-based BCI, however, require a rather unnatural high-level mapping of brain signals onto commands. The latter includes to exploit EEG components, for example the P300 event-related potential, in highly structured settings. Such scenarios neglect the valuable information on ongoing cognitive processes encoded in the brain activity. Thus, we propose to investigate BCI systems that decode these relevant pieces of information and utilize them as a novel means for human-machine interaction (HMI). I will present our recent work toward this goal, which builds on our prior experience with standard EEG-based BCI systems. Our recent studies in particular focus on Fixation-Related Potentials (FRP). We combine EEG and eye tracking technology to investigate, how cognitive processes unfold over time in more real life like scenarios, including how to identify a person's task-related processing difficulties. Here, BCI not only serves as an alternative communication channel for HMI, but also provides a novel research tool. That is, a means to investigate cognitive processes during more real world like interaction, in almost real time and without having to rely solely on group-level data.