Preliminary Reader
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5th European Neuro-IT and Neuroengineering School: Cognition & Action

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Abstracts

Bruno Averbeck

LECTURE: Activity in prefrontal cortex during dynamic selection of action sequences

WORKSHOP: Probabilistic representations in cortex

Selecting the correct action or sequence of actions within dynamic environments involves representing the possible actions, as well as assigning values or probabilities to each action, such that an informed selection can take place. Recently, advances in experimental and computational work have addressed several aspects of this problem including: (1) How can populations of neurons represent not just a single action but multiple actions simultaneously? (2) How can each action be assigned a value or the probability that executing the particular action will lead to a reward? (3) Where in the brain are multiple actions represented? Experimental work has shown that representations encoding multiple actions and their values can be found in both prefrontal cortex and dorsal premotor cortex, in the context of an eye-movement and a reaching task, respectively. Furthermore, these representations follow the predictions of computational models. Thus, convergence of theoretical and experimental work is beginning to define the neural code for multiple action representation and selection, as well as the cortical substrates of these processes.

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Izahr Bar-Gad

LECTURE: Stimulating the brain: the neglected part of neural interfaces.

Over the years, great effort has been invested in recording neuronal activity and decoding the information it represents. The field of brain machine interfaces (or neural interfaces) focuses primarily on translating this information into a form usable by machine-driven algorithms. However, the complementary side of interfacing with the brain, i.e. transmission of information from the machine to the neural tissue, remains to a large extent overlooked. This lecture will explore the possibilities of altering neuronal activity using electrical stimulation. It will specifically assess neural stimulation in the context of treating multiple neuronal disorders associated with malfunction of the cortico-basal ganglia loop. The lecture will address some of the key questions in the field:

• What are the effects of electrical stimulation on neuronal elements?
• What is the mapping between stimulation patterns and neuronal activity?
• What underlies the therapeutic mechanism of deep brain stimulation?

WORKSHOP:Mechanisms of deep brain stimulation.

Deep brain stimulation (DBS) is a standard treatment for advanced stage Parkinson's disease and an emerging new treatment for additional movement and behavioral disorders associated with the malfunction of the cortico-basal ganglia loop. However, despite its clinical success, the underlying mechanism of this therapy remains obscure. Early studies assumed that the mechanism of DBS in the cortico-basal ganglia loop is equivalent to ablation due to its similar therapeutic effects. However, recent studies unravel a complex picture of stimulation driven neuronal activity. In this workshop, we will discuss recent articles describing in-vivo and in-vitro experiments complemented by computational modeling studies. The workshop will address the following questions:

• What underlies the therapeutic mechanism of deep brain stimulation for the different disorders?
• What are the effects of electrical stimulation on neuronal elements in the cortico-basal ganglia loop?

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2) Garcia L, D'Alessandro G, Bioulac B, Hammond C. High-frequency stimulation in Parkinson's disease: more or less? Trends Neurosci. 2005
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Paolo Dario

LECTURE: Gesture and facial expressions for emotional human-robot interaction

Paolo Dario, Cecilia Laschi, Pericle Salvini, Massimiliano Zecca

The recent trend toward developing a new generation of robots that shall participate in our lives and exist in human environments has introduced the need for formulating proper paradigms of interaction between people and robots. For instance, new applications for robots in health, education, entertainment, the home, and work environments require them to collaborate with people as capable partners. Such robots must have human-oriented interaction skills and capabilities to work with us as teammates, learn from us or teach us, as well as communicate with and understand us. The goals of the interaction between people and robots might potentially span physical, cognitive, task-based, social, or emotional dimensions.
The study of emotions and gestures recognition and expression is a promising research area involving robotics and artificial intelligence researchers as well as neuroscientists and cognitive scientists.
As a matter of fact, designing robots capable of gesture and emotional expression/recognition has a twofold objective. On the one hand, from a scientific point of view, the modelling of emotions in autonomous robots can contribute towards improving the knowledge on the generation of emotions in human beings, and moreover to better understand the neurological and psychiatric disorders in human beings related to impairments in socialisation and emotions perception, such as autism, schizophrenia etc. On the other, for the robotic engineer the goal is to improve the human-robot interaction. By endowing robots with the ability to express and understand emotions and gestures, human beings can communicate with robots more easily in applications such as personal assistance, entertainment and education.
The lecture will provide the students with basic principles and technologies for the design and development of robots for facial expressions and gestures to be used for human-robot interaction. The state of the art will be reviewed to outline the main approaches adopted. The lecture will then focus on the main scientific problems and the engineering solutions, by analyzing a few case studies of expressive robots developed by taking into account the neurobiological and neurophisiological bases of human emotions.

WORKSHOP:TBA

REFERENCES: TBA

Kerstin Dautenhahn

LECTURE: Challenges in Human-Robot Interaction: Socially Assistive Robots

The lecture will discuss state of the art research regarding human-robot interaction in the context of two scenarios: A Cognitive Robot Companion (research carried out within the European Integrated Project COGNIRON, www.cogniron.org), and robots as therapeutic toys (as part of the Aurora project, www.aurora-project.com, and the European STREP IROMEC). The key issues for a robot companion are a) to be useful, i.e. to be able to perform tasks that assist people in their homes, and b) to behave socially, i.e. the robot's appearance, behaviour and cues expressed in interaction with people need to be acceptable and comfortable to people. The lecture will exemplify research within COGNIRON aiming at a socially acceptable robot companion. The second issue to be addressed, i.e. robots as therapeutic toys, is related to research in rehabilitation and assistive robotics. Key issues in this field will be highlighted by presenting examples from our work on using robots as therapeutic toys for children with autism, an area that poses many challenges e.g. in terms of engineering, robotics, interface and interaction design, therapy, and ethics.

Key questions to be addressed in the lecture include:
- What are scientific challenges for a robot companion?
- When do we need robots with social skills?
- What are the key robotics/engineering as well as human-centred issues?
- Can robots be useful in therapeutic contexts?
- Which experimental methods are appropriate for different human-robot interaction scenarios?
- Can we define a robotic etiquette for a robot companion?
- How do robot appearance and behaviour influence the way people respond to it?

WORKSHOP:Companions, Friends, Tools or Toys? – Roles of Robots in Human Society

The workshop discuss issues related to the acceptability of robots in human society, and different roles they might adopt. These views reflect different lines of research in the field of Human-Robot Interaction but they also impact on our views of future applications and scenarios for robots in our lives. Ethical issues are important to consider in particular in applications where robots will be used in our everyday lives, either in a work/office setting, as part of our household, or as assistants in public places, hospitals etc. These issues are exemplified in current research on 'Androids', i.e. robots that are meant to be indistinguishable in behaviour and appearance from humans. Other examples include research on people's views and attitudes towards robots.

Key questions to be discussed in the workshop include:
- Are relationships with robots different from our relationships with other machines, e.g. cars or toasters?

- How are androids different from other humanoid or non-humanoid robots?
- What roles of robots can we envisage, beyond the distinction of companion-friend-tool-toy which is either inspired by human roles or roles of machines?
- Can we think of new applications for human-friendly robots?
- others (depending on interest/feedback from participants)

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1) K. Dautenhahn (2003) Roles and Functions of Robots in Human Society - Implications from Research in Autism Therapy, Robotica, 21(4), pp. 443-452.
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3) P. H. Kahn, Jr., B. Friedman, D. R. Perez-Granados, N. G. Freier (2006) Robotic pets in the lives of preschool children, Interaction Studies, 7:3, pp. 405–436
4) K. MacDorman, H. Ishiguro (2006) The uncanny advantage of using androids in cognitive and social science research, Interaction Studies, 7:3, pp. 297–337

Ezequiel di Paolo

LECTURE: Evolutionary robotics - A tool for thinking about autonomy, agency and social interaction.

In this talk, I examine the motivations for using Evolutionary Robotics (ER) as a scientific tool for studying minimal models of cognition, with the advantage of being capable of generating integrated sensorimotor systems with minimal (or controllable) prejudices. These systems must act as a whole in close coupling with their environments, which is an essential aspect of real cognition that is often either bypassed or modeled poorly in other disciplines.

This methodology permits a constant questioning of assumptions that at first might look innocent. The process is one of reaffirming the meaning of sometimes slippery concepts such as embodiment, autonomy and agency. I will illustrate the process at work with a series of examples drawn from recent ER work. One such model explores what might it mean for an agent to have "preferences" from a dynamical systems perspective. The results (using models of homeostatic neural-dynamics) have interesting implications for understanding autonomy and agency. Similar models exploring the perseveration of object reaching in infants (A-not-B error) indicate the potential of the method to inform theories in psychology.

Another series of models demonstrate how social interaction can result in the emergence of a new collective domain of dynamics that is not strictly under the control of the individual participants. In this domain, apparently complex cognitive performance - such as recognizing social contingencies - are implemented as a result of the social interaction dynamics and not as an individual activities. The results are suggestive of similar mechanisms at work in infant detection of social contingency and have predicted empirical results in human interaction.

WORKSHOP: Enaction - Asking the difficult questions facing embodied cognition.

This workshop will explore the proposed new paradigm of enactive cognitive science. What is it about? What are its central ideas? How does it differ from more established views? What challenges must it face?

The format will be that of a debate following sometimes unconventional techniques and group work. The discussion will centre about the exploration of central questions that traditional cognitive science has not quite resolved yet:

- What is the relation between life and mind?
- What is autonomy?
- How is a system capable of sense-making (relating to its own world in terms of meaning)?
- How do can we move from low-level, sensorimotor explanations to higher-forms of cognition?
- What is the role of modelling techniques in generating and testing enactive ideas?

These questions pose some fundamental research challenges that are often obscured by conventional, cognitivist approaches to mind. Dynamical and embodied perspectives face the same challenges, but present us with the opportunity of re-framing some of these questions in novel, potentially radical ways. For instance, what sort of bodily action is remembering a telephone number? Can we describe different modes of everyday behaviour in terms of dynamical systems? Is there a collective, autonomous level that emerges in social interaction and is not fully under the control of the participants?

We will, of course, not resolve these questions definitively, but we will propose ways in which these questions can be fruitfully formulated that can inspire future research.

REFERENCES:

1) Di Paolo, E. A., Rohde, M. and De Jaegher, H., (Forthcoming) Horizons for the Enactive Mind: Values, Social Interaction, and Play. In J. Stewart, O. Gapenne and E. A. Di Paolo (eds), Enaction: Towards a New Paradigm for Cognitive Science, Cambridge, MA: MIT Press.
2) Di Paolo, E. A., and Iizuka, H., (Forthcoming) How (not) to model autonomous behaviour BioSystems Special issue on Modelling Autonomy.
3) Di Paolo, E. A., Rohde, M. and Iizuka, H. (Forthcoming) Sensitivity to social contingency or stability of interaction? Modelling the dynamics of perceptual crossing New Ideas in Psychology Special issue on Dynamics and Psychology.
4) Harvey, I., Di Paolo, E. A., Tuci, E., Wood, R., Quinn, M., (2005). Evolutionary robotics: A new scientific tool for studying cognition. Artificial Life, 11(1/2), pp. 79 - 98.

Andreas Engel

LECTURE (backup): Neural dynamics in sensory and motor systems: towards a unifying picture

Over the last two decades, a large body of evidence has accumulated suggesting that timing in neural activity provides a key mechanism that allows the brain to select and integrate distributed signals into meaningful patterns. While this has mostly been investigated in sensory systems, research on processing in movement-generating circuits, both at the cortical and subcortical level, has yielded similar results, suggesting a converging set of common principles. I will discuss data from which such a unifying picture is likely to e- merge, supporting the hypothesis that communication through neural coherence may pro- vide a common functional principle in perception, sensorimotor integration and action se- lection.

WORKSHOP (backup): Action-oriented views on neural processing

In cognitive science, we currently witness a “pragmatic turn” away from the traditional representation-centered framework towards a paradigm based on the notions of „situatedness“ and „embodiment“, which focuses on understanding the relevance of cognition for action, and the real-world interactions of the brain. Such an “action-oriented” paradigm has earliest and most explicitly been developed in robotics, and has only recently begun to gain impact on cognitive psychology and neurobiology. The basic concept is that cognition should not be understood as a capacitiy of deriving world-models, which then might provide a “database” for thinking, planning and problem-solving. Rather, it is emphasized that cognitive systems are always engaged in contexts of action that require fast selection of relevant information and constant sensorimotor exchange. The workshop will discuss recent neurobiological evidence supporting this „pragmatic turn“ and the implications of this view for future research strategies in cognitive neuroscience.

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2) Engel AK, Moll CKE, Fried I, Ojemann GA (2005) Invasive recordings from the human brain – clinical insights and beyond. Nature Reviews Neuroscience 6: 35-47
3) Engel AK, König P (1993) Paradigm shifts in neurobiology: towards a new theory of perception. In: Casati R, White G (eds) Philosophy and the cognitive sciences. Proceedings of the 16th Wittgenstein Symposium. Wittgenstein-Gesellschaft, Kirchberg: 131-138

More articles to be found at http://www.40hz.net/Downloads.html

John Findlay

LECTURE: Eye movements and visual search

A key idea in the control of saccadic eye movements is that the choice of saccade destination is made from a hypothetical salience map, which will be elaborated in the presentation by John Findlay at the meeting.

WORKSHOP: Eye movements and visual search

Vision is an active process. The eyes seek information using a pattern of rapid saccadic movements interspersed with fixation pauses. Typically, the eyes choose up to five new fixation locations each second. Understanding how the brain programs these movements has been an exciting challenge for neuroscientists, The task of visual search is particularly critical in this respect since the way the eyes are programmed in search tasks demonstrates how visual information is used actively. Moreover, there is a long tradition of studies of visual search and its relation to visual attention.

Key questions:

1. Early theories of visual search distinguished serial and parallel processes. How well has this distinction been maintained?
2. It is possible to shift visual attention without moving the eyes (covert attention). Do covert attention shifts play a role during active visual search?
3. How much forward planning occurs in the control of eye movements?
4. What forms of visual memory are involved in visual search?
5. Are the destinations of eye movements during search chosen in an optimal manner?

The workshop will concentrate on three recent papers that extend the proposal:
Godijn and Theeuwes show how the control signals develop dynamically
Caspi et al use a powerful technique to show when perceptual information is selected
Najemnik and Geisler suggest that a likelihood computation is made for each eye movement

REFERENCES:

1) Godijn R and Theeuwes J (2002). Programming of endogenous and exogenous saccades: Evidence for a competitive integration model. Journal of Experimental Psychology. Human Perception and Performance, 28, 1039-1054.
2) Caspi A, Beutter B R and Eckstein M (2004). The time course of visual information accrual guiding eye movement decisions. PNAS, 101, 13086-13090
3) Najemnik J and Geissler W S (2005). Optimal eye movement strategies in visual search. Nature, 434, 387-391.

Rainer Goebel

LECTURE: BOLD communications and neurofeedback

Several medical conditions (e.g., brain injury, stroke, progressive neurological diseases) can lead to complete paralysis while largely preserving sensory and cognitive functions and associated brain activation. The resulting inability to communicate impedes to assess the patient's state of consciousness. Recently, Owen et al. succeeded in using imagery tasks during functional magnetic resonance imaging (fMRI) to demonstrate preserved conscious awareness in a paralyzed patient. We investigated whether subjects can learn to efficiently communicate by controlling activity in three different brain areas. A multivariate "brain reading" pattern classifier is currently developed, which will allow to present letters on the screen during "mental writing". We show that healthy subject can learn in a few hours to communicate via the BOLD signal and we are currently working with Adrian Owen to apply the developed approach to vegetative state patients hoping that we can then not only acquire information about the patients' state of consciousness but additionally about their wishes and thoughts.

WORKSHOP: Real-time fMRI: Principles, possibilities and limitations

Optimized software and increasingly powerful computer hardware allow analyzing functional Magnetic Resonance Imaging (fMRI) data in real-time almost at the same quality level as is typically performed off-line, i.e. after data acquisition. Advanced real-time fMRI (rt-fMRI) allows statistically analyzing complex experimental designs, includes important preprocessing steps such as 3D motion correction, Gaussian spatial smoothing and drift removal, and performs spatial normalization for visualizing analyzed data in stereotactic space and for integrating previously extracted spatial information such as regions-of-interest (ROIs). Typical applications of advanced real-time fMRI include quality assurance, adaptive experimental designs, neurosurgical monitoring and neurofeedback. In this workshop principles of real-time fMRI, possible applications as well as limitations will be discussed.

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3) deCharms, C., Maeda, F., Glover, G. H., Ludlow, D., Pauly, J. M., Soneji, D., et al. (2005). Control over brain activation and pain learned by using real-time functional MRI. PNAS, 102 (51), 18626-18631.

Auke Ijspeert

LECTURE: Control of locomotion: from biology to robotics and back

Animal locomotion control is in a large part based on central pattern generators (CPGs), which are neural networks capable of producing complex rhythmic patterns while being activated and modulated by relatively simple control signals. These networks are located in the spinal cord for vertebrate animals. In this talk, I will present our work on developing numerical models of CPGs in lower vertebrates (lamprey and salamander). I will also present how we test the CPG models on board of amphibious robots, in particular a new salamander-like robot capable of swimming and walking. The goal of the project is to explore three important questions related to vertebrate locomotion: (i) the modifications undergone by the spinal locomotor circuits during the evolutionary transition from aquatic to terrestrial locomotion, (ii) the mechanisms necessary for coordination of limb and axial movements, and (iii) the mechanisms that underlie gait transitions induced by simple electrical stimulation of the brain stem. If time allows, I will also briefly present how abstract CPG models can be used control the locomotion of quadruped and humanoid robots.

WORKSHOP: Locomotion control in animals and robots

The control of locomotion is a fundamental skill both for animals and for robots. It is also an area in which fruitful collaborations between biology (e.g. neuroscience and biomechanics) and robotics can take place. In this workshop, I propose to explore two questions:

1) what is the right balance between central and peripheral mechanisms in the control of locomotion? in particular how are centrally generated rhythms from CPGs coordinated with chains of reflexes?

2) what are the pros and cons of using robots as tools to study animal locomotion?

REFERENCES

The workshop involves the following three papers, which will help address the first question (the most important one), and to a less extent the second one.

1) A. Ijspeert, A. Crespi, D. Ryczko, and J.-M. Cabelguen. From swimming to walking with a salamander robot driven by a spinal cord model. Science, 315(5817):1416-1420, 2007. This paper presents a CPG model that controls locomotion without sensory-feedback (it will also be presented in the morning talk) Clearly this is an important simplification compared to the real animal, but it shows the power of CPGs to drive locomotion
2) H. Cruse, T. Kindermann, M. Schumm, J. Dean, J. Schmitz. Walknet - a biologically inspired network to control six-legged walking. Neural Networks 11: 1435-1446, 1998. This paper presents a model of locomotion control in the Stick insect. The model is essentially sensory-driven, without centrally generated rhythms, and therefore shows how chains-of-reflexes can produce locomotion.
3) S. Grillner. Biological pattern generation: the cellular and computational logic of networks in motion. Neuron 52: 751-766. 2006. This paper provides a recent

review of how complex motor control can be obtained by the interaction of multiple CPGs and sensory feedback.

Guenther Knoblich

LECTURE: From mirroring to joint action.

Most cognitive scientists and neuroscientists hold the implicit assumption that explaining individual cognition will also result in a good explanation of social phenomena. In my lecture I will challenge this view. I will claim that our social nature does not leave individual cognition unaffected. In the first part I will shortly summarize the findings on mirroring of actions, sensations, and emotions and then discuss different psychological functions that are supported by mirroring. I will conclude that basic perceptual, motor, cognitive, and affective processes are geared towards social understanding. In the second part I will discuss what mirroring does and does not buy us for joint action, that is, actions we perform with others in order to achieve a common goal.

WORKSHOP: Competing (?) theoretical approaches to joint action

The workshop will extend the discussion of joint action. Currently, there are three theoretical camps who use very different principles to explain different types of joint action. The ecological camp conceptualizes joint action in terms of coupled oscillators. The embodied camp focuses on people's common ground in the perceptual and motor domain. The dialogue camp focuses on language use during joint action. The first aim of the workshop is to familiarize everybody with these three perspectives (I will take an embodied perspective during the lecture). The second aim of the workshop is to discuss whether any single theory can be successful to explain joint action. Very likely we will see that different theories need to be integrated for a better understanding of joint action. So far, nobody seems to have a good idea about how this could be done, but maybe the solution will arise during our discussion.

REFERENCES:

1) Marsh, Richardson, Baron, & Schmidt (2006). Contrasting approaches to perceiving and acting with others. Ecological Psychology, 18, 1-38. (Group 1: Ecological)

2) Knoblich, G. (in press). Bodily and motor contributions to action perception. In R. Klatzky et al (Eds): Embodiment, Ego-Space, and Action. Proceedings of the 34th Carnegie Symposium on Cognition. LEA.
3) Sebanz, Bekkering, & Knoblich (2006). Bodies and minds moving together. Trends in Cognitive Sciences, 10, 70-76. Embodied (Group 2: Embodied)

4) Bangaerter & Clark (2003). Navigating joint projects with dialogue. Cognitive Science, 27, 195-225. pdf attached (Group 3 Dialogue)

Peter König

LECTURE: Information foraging and overt attention

In natural behavior humans direct their eyes to parts of the visual scene for detailed processing. Each fixation embodies a decision, and due to the rapid pace of eye-movements billions of such decisions accumulate in our lifetime. Still, our understanding of the mechanisms and objective of this process is far from satisfactory. Here we discuss recent experiments and models investigating interactions of bottom-up and top-down signals in the control of overt attention.

WORKSHOP:Understanding receptive fields

Why are receptive fields of cortical neurons the way they are? We discuss the modern concept of objective functions and optimal representations of natural/relevant stimuli.

REFERENCES

1) Olshausen BA, Field, DJ. Emergence of simple-cell receptive field properties by learning a sparse code for natural images. Nature. 1996 Jun 13;381(6583):607-9.
2) Wyss R, Konig P, Verschure PF. A model of the ventral visual system based on temporal stability and local memory. PLoS Biol. 2006 May;4(5):e120.
3) Wiskott L, Sejnowski TJ. Slow feature analysis: unsupervised learning of invariances. Neural Comput. 2002 Apr;14(4):715-70.

Konrad Körding

LECTURE: Normative models in motor control

WORKSHOP: Normative models in neuroscience

Experimental neuroscientists often base their research on the hypothesis that the part of the nervous system they study is solving some specific problem. This way of thinking is called normative as it asks how the nervous system "should" solve a given problem. In my talk I will discuss recent progress in thinking about the motor system in these terms. In the workshop we will cover how various aspects of the nervous system may be understood as being optimally adapted to the problems solved. Normative models are a quantitative way of asking why the nervous system behaves the way it does.

REFERENCES:

1) Chklovskii DB, Koulakov AA. Maps in the brain: what can we learn from them? Annu Rev Neurosci. 2004;27:369-92.
2) Konrad P. Kording, Joshua B. Tenenbaum, and Reza Shadmehr. (forthcoming) The dynamics of memory as a consequence of optimal adaptation to a changing body
3) Konrad P. Kording, Joshua B. Tenenbaum Causal inference in sensorimotor integration . NIPS2006

Rolf Pfeifer

OPENING LECTURE: Morphological computation – connecting brain, body, and environment

Traditionally, in robotics, artificial intelligence, and neuroscience, there has been a focus on the study of the control or the neural system itself. Recently there has been an increasing interest into the notion of embodiment – and consequently intelligent agents as complex dynamical systems – in all disciplines dealing with intelligent behavior, including psychology, cognitive science and philosophy. In this talk, we explore the far-reaching and often surprising implications of this concept. While embodiment has often been used in its trivial meaning, i.e. „intelligence requires a body“, there are deeper and more important consequences, concerned with connecting brain, body, and environment, or more generally with the relation between physical and information (neural, control) processes. Often, morphology and materials can take over some of the functions normally attributed to control, a phenomenon called "morphological computation". It can be shown that through the embodied interaction with the environment, in particular through sensory-motor coordination, information structure is induced in the sensory data, thus facilitating perception and learning. An attempt at quantifying the amount of structure thus generated will be introduced using measures from information theory. In this view, "information structure" and "dynamics" are complementary perspectives rather than mutually exclusive aspects of a dynamical system. A number of case studies are presented to illustrate the concepts introduced. Extensions of the notion of morphological computation to self-assembling, and self-reconfigurable systems (and other areas) will be briefly discussed. The talk will end with some speculations about potential lessons for robotics and intelligent and cognitive systems as outlined in the conclusions of the EU/ERCIM "Beyond-the-horizon" initiative.

Short Bio

Rolf Pfeifer received his master's degree in physics and mathematics and his Ph.D. in computer science from the Swiss Federal Institute of Technology (ETH) in Zurich, Switzerland. He spent three years as a post-doctoral fellow at Carnegie-Mellon University and at Yale University in the US. Since 1987 he has been a professor of computer science at the Department of Informatics, University of Zurich, and director of the Artificial Intelligence Laboratory. Having worked as a visiting professor and research fellow at the Free University of Brussels, the MIT Artificial Intelligence Laboratory, the Neurosciences Institute (NSI) in San Diego, and the Sony Computer Science Laboratory in Paris, he was elected "21st Century COE Professor, Information Science and Technology" at the University of Tokyo for 2003/2004, from where he held the first global, fully interactive, videoconferencing-based lecture series "The AI Lectures from Tokyo" (including Tokyo, Beijing, Jeddah, Warsaw, Munich, and Zurich). His research interests are in the areas of embodiment, biorobotics, artificial evolution and morphogenesis, self-reconfiguration and self-repair, and educational technology. He is the author of the book "Understanding Intelligence", MIT Press, 1999 (with C. Scheier). His new popular science book entitled "How the body shapes the way we think: a new view of intelligence," MIT Press, 2007 (with Josh Bongard) has just been published. On 16/17 November 2007 the Artificial Intelligence Laboratory is celebrating its 20th Anniversary with a number of events (for more information, check our webpage – currently “under construction”).

Hans Scherberger

LECTURE: Hand grasping activity in premotor and parietal cortex

Hand manipulations are crucial for human and non-human primate behavior. The talk highlights recent results from electrophysiological recordings in the macaque parietal (AIP) and premotor cortex (F5) while preparing of hand grasping movements. Neurons in AIP and in F5 were found to represent the grip type and target orientation during memory-guided hand movements, and the intended grasping movement (grip type and grip orientation) could be predicted from the population activity in AIP or F5. This suggests that activity in these cortical areas could be used to decode hand grasping movements in real-time, e.g., as needed for the development of a neural prosthesis.

WORKSHOP: Cortical motor planning

In this workshop, we will discuss recent findings related to the cortical planning of arm movements, including:
- the simultaneous encoding of a target goal and the expected value of that action by the same neuron
- the neuronal encoding of movement plans during free-choice behavior
- the representation of planning activity in the local field potential (LFP)

These topics will emphasize the distributed nature of decision making and movement planning for different types of action and across various cortical areas.

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2) Scherberger H, Andersen RA (2007): Target selection signals for arm reaching in the posterior parietal cortex. Journal of Neuroscience 27:2001–2012.
3) Scherberger H, Jarvis MR, Andersen RA (2005): Cortical local field potential encodes movement intentions in the posterior parietal cortex. Neuron 46: 347-354.

Andrew Schwartz

LECTURE: Useful signals from motor cortex

WORKSHOP: Behavior as motor output

Volitional movements can be considered as the output of a series of events that involve sensation and cognition. Residue of the neural operations preceding movement can be expected to be found in the execution of behavior. Careful examination of movement features can provide insight into all the operations that lead to the movement. Exciting questions related to the mechanisms of these neural processes such as their causal flow and transfer of information can be addressed by large scale recordings from the brain combined with careful task design and psychophysical observation.

REFERENCES:

1) Schwartz, A.B. and Moran, D.W.: Arm trajectory and representation of movement processing in motor cortical activity. Eur. J. Neurosci. 12:1851-1856, 2000.
2) Taylor, D.M., Helms Tillery, S.I., Schwartz, A.B.: Direct cortical control of 3D neuroprosthetic devices. Science, 296:1829-1832, 2002.
3) Schwartz, A.B., Moran, D.W. and Reina, G.A.: Differential representation of perception and action in the frontal cortex. Science, 303:380-383, 2004.

Tania Singer

LECTURE: Brain mechanisms of empathy

After a definition of the concepts 'cognitive perspective taking' and 'empathy' I will shortly revise the main results of neuroscientific studies on our ability to understand other peoples intentions and believes. I will then show several fMRI studies investigating empathic brain responses elicited by the observation of others in pain and show how these empathic brain responses are modulated by several contextual and stimulus intrinsic factors. Finally, I will show results of two studies exploring the relationship between interoceptive awareness, empathy and pathologies such as Alexithymia and Autistic Spectrum Disorder (ASD). More specifically, I will show some evidence for the suggestion that impaired interoceptive awareness –a symptom observed in Alexithymia- is associated with impaired empathy but not cognitive perspective taking, the latter being frequently observed in patients with ASD.

WORKSHOP:Does empathy for pain involve a sensory component or not?

In empathy research there is a debate to which extend empathy is based on bottom-up automatic simulation based on the activation of the entire brain network sub serving experiences of a given emotion in self or rather on top-down task- and appraisal dependent reactivation of feeling representations. This debate will be illustrated with the example of studies in the domain of empathy for pain.

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1) Singer T, Seymour B, O'Doherty J, Kaube H, Dolan RJ, Frith CD.Empathy for pain involves the affective but not sensory components of pain. Science. 2004 Feb 20;303(5661):1157-62.
2) Avenanti A, Bueti D, Galati G, Aglioti SM. Transcranial magnetic stimulation highlights the sensorimotor side of empathy for pain. Nat Neurosci. 2005 Jul;8(7):955-60.
3) de Vignemont F, Singer T. The empathic brain: how, when and why? Trends Cogn Sci. 2006 Oct;10(10):435-41.
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Tom Ziemke

LECTURE: On the role of emotion in embodied cognition

The lecture addresses different theoretical perspectives on the role of emotion and motivation in embodied cognition (and social interaction), with an emphasis on the grounding of emotion and cognition in homeostatic mechanisms.

WORKSHOP Do robots need emotions?

The workshop addresses different motivations for modeling emotions in robotic systems: (1) as scientific models of natural emotions, (2) as an approach to making robots more adaptive and autonomous, and (3) as an approach to human-robot interaction, i.e. improving human understanding of and bonding with robots.

REFERENCES

1) Lola Cañamero. Emotion understanding from the perspective of autonomous robots Research Neural Networks, 18(4), 445-455, 2005
2) Michael Arbib & Jean-Marc Fellous .Emotions: from brain to robot.Trends in Cognitive Sciences, 8(12), 554-561, 2004
3) Ronald Arkin, Masahiro Fujita, Tsuyoshi Takagi & Rika Hasegawa An ethological and emotional basis for human–robot interaction. Robotics and Autonomous Systems, 42(3-4), 191-201, 2003

Agenda

NO	DATE	TIME	TYPE	LECTURER	TITLE
1	Sunday, 15 July 2007	20:00 - 21:30	OL	Pfeifer	Morphological computation – connecting brain, body, and environment
2	Monday, 16 July 2007	9:30 - 10:30	L1	Averbeck	Activity in prefrontal cortex during dynamic selection of action sequences
3	Monday, 16 July 2007	11:00 - 12:00	L2	Körding	Normative models in motor control
4	Monday, 16 July 2007	13:10 - 14:30	L3	Schwartz	Useful signals from motor cortex
5	Monday, 16 July 2007	15:00 - 17:00	W1	Averbeck	Probabilistic representations in cortex
6	Monday, 16 July 2007	15:00 - 17:00	W2	Körding	Normative models in neuroscience
7	Monday, 16 July 2007	15:00 - 17:00	W3	Schwartz	Behavior as motor output
8	Tuesday, 17 July 2007	9:30 - 10:30	L1	König	Information foraging and overt attention
9	Tuesday, 17 July 2007	11:00 - 12:00	L2	Bar-Gad	Stimulating the brain: the neglected part of neural interfaces.
10	Tuesday, 17 July 2007	11:00 - 12:00	L2	Goebel	BOLD communications and neurofeedback
11	Tuesday, 17 July 2007	15:00 - 17:00	W1	König	Understanding receptive fields
12	Tuesday, 17 July 2007	15:00 - 17:00	W2	Bar-Gad	Mechanisms of deep brain stimulation.
13	Tuesday, 17 July 2007	15:00 - 17:00	W2	Goebel	Real-time fMRI: Principles, possibilities and limitations
14	Wednesday, 18 July 2007	9:30 - 10:30	L1	Dario	Gesture and Facial Expressions for Emotional Human-Robot Interaction
15	Wednesday, 18 July 2007	11:00 - 12:00	L2	Scherberger	Hand grasping activity in premotor and parietal cortex
16	Wednesday, 18 July 2007	13:10 - 14:30	L3	Findlay	Eye movements and visual search
17	Wednesday, 18 July 2007	15:00 - 17:00	W1	Dario	Gesture and Facial Expressions for Emotional Human-Robot Interaction
18	Wednesday, 18 July 2007	15:00 - 17:00	W2	Scherberger	Cortical motor planning
19	Wednesday, 18 July 2007	15:00 - 17:00	W3	Findlay	Eye movements and visual search
20	Thursday, 19 July 2007	9:30 - 10:30	L1	Dautenhahn	Challenges in Human-Robot Interaction: Socially Assistive Robots
21	Thursday, 19 July 2007	11:00 - 12:00	L2	Ziemke	On the role of emotion in embodied cognition
22	Thursday, 19 July 2007	13:10 - 14:30	L3	Ijspeert	Control of locomotion: from biology to robotics and back
23	Thursday, 19 July 2007	15:00 - 17:00	W1	Dautenhahn	Companions, Friends, Tools or Toys? – Roles of Robots in Human Society
24	Thursday, 19 July 2007	15:00 - 17:00	W2	Ziemke	Do robots need emotions?
25	Thursday, 19 July 2007	15:00 - 17:00	W3	Ijspeert	Locomotion control in animals and robots
26	Friday, 20 July 2007	9:30 - 10:30	L1	di Paolo	Evolutionary robotics: A tool for thinking about autonomy, agency and social interaction.
27	Friday, 20 July 2007	13:10 - 14:30	L3	Knoblich	From mirroring to joint action.
28	Friday, 20 July 2007	13:10 - 14:30	L3	Singer	Brain mechanisms of empathy
29	Friday, 20 July 2007	15:00 - 17:00	W1	di Paolo	Enaction: Asking the difficult questions facing embodied cognition.
30	Friday, 20 July 2007	15:00 - 17:00	W3	Knoblich	Competing (?) theoretical approaches to joint action
31	Friday, 20 July 2007	15:00 - 17:00	W3	Singer	Does empathy for pain involve a sensory component or not?

Schedule

July 15 to July 21, 2007

Week 28

- Social
- Poster
- Workshop
- Lecture
- Food@HWK

	Sunday 15	Monday 16	Tuesday 17	Wednesday 18	Thursday 19	Friday 20	Saturday 21
9 AM		Datablitz Lecture	Datablitz Lecture	Lecture	Datablitz Lecture	Lecture	
10 AM		Coffee@Posters	Coffee@Posters	Coffee	Coffee@Posters	Coffee	
11 AM		Lecture	Lecture	Lecture	Lecture	Lecture	
Noon		Lunch	Lunch	Lunch	Lunch	Lunch	
1 PM		Lecture	Lecture	Lecture	Lecture	Lecture	
2 PM		Coffee@Posters	Coffee@Posters	Coffee	Coffee@Posters	Coffee	
3 PM		Workshop	Workshop	Workshop	Workshop	Workshop	
4 PM							
5 PM		Posters	Posters	Boattrip/Dinner in Bad Zwischenahn	Posters		
6 PM	Plenary Session Reception HWK	Evening Discussion Dinner HWK	Evening Discussion		Evening Discussion Dinner HWK	Farewell-Party (BBQ)	
7 PM							
8 PM	Opening Lecture	Sports@HWK	TBA		Free evening (Movie/ Sports/Discussion groups)		
9 PM							
10 PM							

Page 1/1