Growing Connections in Computational Neuroscience

Report on a German-U.S. Collaborative Symposium
Munich, June 8-11, 2008

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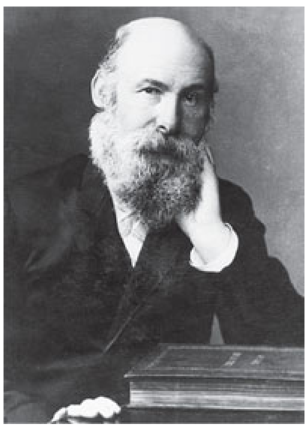
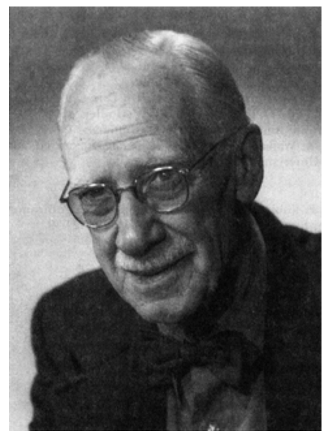
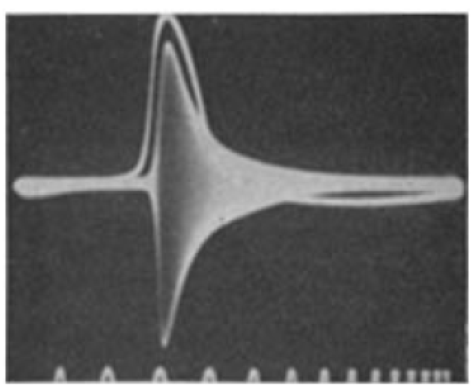


Julius Bernstein



Kenneth Stewart Cole



Cover pictures

Portraits of Julius Bernstein and Kenneth Cole, and a key figure from a 1939 paper by Cole and Curtis. The figure demonstrates a dramatic increase in nerve membrane conductance during passage of an action potential. This result is a direct experimental confirmation of an essential feature of Bernstein's theory of the action potential. Though their work was separated by a few decades, Cole's studies in the United States were inspired by Bernstein's work in Germany at the beginning of the 20th century.

Cole, K.S. and Curtis, H.J., *J Gen Physiol* **22**, 649-670 (1939)

Acknowledgements

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Contents

Executive Summary

This report summarizes the discussions of a group of researchers in computational neuroscience, from Germany and the United States. The topic of discussion was the need and the potential for setting up a structure that would facilitate closer collaborations between researchers from both countries. Two important core issues that may be addressed by funding agencies in the two countries are:

1. Collaborative projects in Computational neuroscience would greatly benefit from a transparent procedure that would allow the funding agencies in both countries to handle proposals in a unified way. It is especially important to develop a structure that allows for a single review process for collaborative proposals.
2. There is an increasing need for a flexible exchange of researchers at various career stages between the two countries. Various practical examples and possibilities for realizing this were discussed.

Introduction

From June 8-11, 2008 a symposium entitled “Growing Connections in Computational Neuroscience” was held in Munich, Germany. The symposium, hosted by the Bernstein Center for Computational Neuroscience Munich, was attended by scientists active in computational neuroscience, and by representatives from German and U.S. funding agencies. The aims of the meeting were twofold: First, to present a broad and attractive scientific program, highlighting the newest developments in the field in Germany and the United States, and second, to discuss opportunities, needs, and impediments for scientific collaboration in this field between the two countries. This report summarizes these discussions, reflecting broad consensus among the participants on a variety of issues related to improving and streamlining scientific exchange between the United States and Germany, specifically in the field of computational neuroscience. Those issues will be discussed below, but it is probably helpful first to provide some perspective on the special characteristics of this new and strongly interdisciplinary research field. We therefore start with a brief description of its scientific roots and culture, followed by an overview of research support as it developed in both countries in the recent past.

Scientific Background

Computational neuroscience ranks among the most tightly integrated multidisciplinary areas of scientific research today, drawing from an enormously broad range of traditional disciplines. To name just a few, cognitive psychology, molecular biology and animal physiology, genetics, biochemistry, experimental and theoretical physics, computer science and mathematics, all make recognizable contributions to the field. Progress is driven by tight collaborations between workers in different disciplines, in particular by collaboration between researchers from experimental and theoretical backgrounds. Intellectually, there are deep connections to some of the most fundamental questions that have occupied humankind, notably those touching on the material substrate of perception and thought. Increasingly, it is also realized that developing a deeper understanding of the brain in both health and disease will depend on computational approaches to the brain and behavior. For example, a variety of neurological disorders stem from the engagement of normal compensatory mechanisms in response to injury, resulting in network level effects, such as epilepsy, or dystonia. Thus an understanding of integrative, network level aspects of brain function is essential to understanding, and ultimately treating, these pathologies. Deepening our understanding at the network level will largely depend on theoretical and computational approaches, as will the development and implementation of brain-machine interfaces. In addition to these medical applications, computational neuroscience will likely also contribute to practical applications ranging from autonomous vehicles to intelligent systems.

It is perhaps worth asking what sets computational neuroscience apart from many other areas of research. Ultimately, the goal, in one form or another, is to understand how brains work. Progress on this question requires a sophisticated knowledge of anatomical and physiological detail, combined with a language for describing phenomena at a systems or network level that is necessarily mathematical. Historically, these areas of expertise developed in very disparate fields, and this merging of different forms of knowledge and techniques is a very special feature of present day computational neuroscience. As experimental methods have become more and more refined, results have tended to become much more quantitative, and amenable to mathematical analysis. At the same time, at the level of theoretical analysis it has become clear that "strict reductionism" is usually a fruitless approach to complex systems. Or, in the words of a theoretical condensed matter physicist:

> The behavior of large and complex aggregates of elementary particles, it turns out, is not to be understood in terms of a simple extrapolation of the properties of a few particles. Instead, at each level of complexity new properties appear, and the understanding of the new behaviors requires research which I think is as fundamental in its nature as any other. (Anderson, 1972)

This obviously implies that there is "interesting theory" to be done at any level of complexity. The confluence of these developments in experiment and theory has created a broad and exciting dialogue between bench style experimentalists and theoretically trained researchers, each contributing part of the expertise needed to tackle the problem. More broadly, there are clear emerging trends in university undergraduate education that build on the interactions between the experimental life sciences and the quantitative, theoretical tradition, and computational neuroscience certainly is a prominent example in this development (see for example Bialek and Botstein, 2004).

As will be discussed below, several initiatives in the United States and Germany have been very successful at improving and deepening this dialogue. For computational neuroscience, the key to progress is a steady, critical discussion between able experimentalists and mathematically accomplished theorists who develop new theoretical concepts and produce quantitative predictions that can be tested by experiment. Historically, this steady interaction has been extremely fruitful in more traditional areas of science, and it is exactly here that collaboration between the United States and Germany in computational neuroscience should start to intensify.

Programmatic Background

Over the last decade both Germany and the United States have developed an infrastructure for coordinating and funding research and education in computational neuroscience. As a result of these efforts, both countries now play worldwide leading roles in this emerging and rapidly developing field.

In the United States, the National Science Foundation (NSF) and National Institutes of Health (NIH) joined forces to support research by establishing a funding structure through the Collaborative Research in Computational Neuroscience (CRCNS) program. Notable private organizations that are active in this field are the Sloan Foundation, which started supporting theoretical neurobiology in 1994, and the Swartz Foundation. In addition, since 1992 there has been an internationally visible educational component in the form of a summer course (entitled "Methods in Computational

Neuroscience") offered by the Marine Biological Laboratory in Woods Hole, Massachusetts.

In Germany, four Bernstein Centers for Computational Neuroscience were established in Berlin, Göttingen, Freiburg and München in 2004-2005 by the Federal Ministry of Education and Research (BMBF). In 2006-2007, BMBF funding for smaller Bernstein Groups, Bernstein Collaborations, and the Bernstein Prize followed. In 2008, four new BMBF-funded *Foci: Neurotechnology* projects followed. Following on the success of the existing Bernstein Centers, in late June 2008 the BMBF announced a competition to provide additional funding for up to five regionally organized Bernstein Centers for Computational Neuroscience, aimed to be in operation by the end of 2009. In addition, several private and semi-governmental organizations in Germany, such as the German Academic Exchange Service (DAAD), the German Research Foundation (DFG), the Alexander von Humboldt Foundation, and the Volkswagen Foundation, are developing interests in the field of computational neuroscience.

Multiple scientific ties between groups from both countries have been established *ad hoc*, usually on a one-to-one basis. There was a clear feeling, expressed by many at the Munich meeting, that researchers in the field would like to lift collaborative efforts to a higher level, and there is a strong desire for a more streamlined and transparent process to achieve this.

U.S.-German Collaboration: Opportunities and Needs

Against the above background a symposium was held in Munich from June 8-11, 2008. The meeting brought together researchers in computational neuroscience from the United States and Germany, with the aim of exchanging scientific ideas, exploring possibilities for future collaboration, and developing strategies for streamlining the exchange of people, educational opportunities, and scientific ideas between the two countries. In addition to purely scientific presentations, the participants in the symposium had a number of intensive discussions on the possibilities for scientific exchange. In the following sections we describe opportunities and needs, as well as challenges for international collaboration in computational neuroscience. Here we have tried to abstract and edit the essence of the discussions that took place during the Munich meeting. Such an overview necessarily highlights the broad outlines and ignores some of the telling details that arose in practice. Because those details can be very illustrative, we have assembled a small selection in an Appendix, to which we refer where appropriate.

As sketched in the earlier sections, computational neuroscience is a field that flourishes in a multidisciplinary setting. Many of the outstanding problems can only be tackled by a combination of approaches, and this requires a breadth of skills that few single investigators possess. To make progress, it is therefore imperative that researchers from different disciplines form collaborative combinations. Depending on the specifics of the problem studied, these combinations can range from cooperation between a pure theorist, or computational expert, with a bench style experimentalist, to cases where theorists and computer scientists work together. Of course, it is also possible that two experimental groups work together on a problem with a computational component. Frequently, collaborations are also formed in much larger groups.

Since the possibilities for finding partners with complementary skills and capabilities are significantly increased by enlarging the pool of available capabilities, there is a natural economy of scale. The parity of the U.S. and German research communities in terms of research quality virtually guarantees that any mechanism for facilitating interactions between the two countries will increase the potential for collaboration and enhance research productivity (see for example Appendix 1A,B). As illustrated in Appendix 1A, the exchange of techniques between the U.S. and German communities can be highly efficient, both financially and in terms of time investment.

The participants of the Munich Meeting strongly voiced that mechanisms for scientific exchange should not be organized around narrowly predefined scientific themes. To begin with, the field evolves quite rapidly, and may have changed its foci by the time specific scientific topics are identified for support. Furthermore, there is a need for a structure that allows investigators to try out new ideas in a setting where two or more groups can work synergistically, and such ideas rarely fit predetermined categories. As to the organization of a support structure, the general feeling was captured succinctly by one participant who noted, "If I am in California, there should be no problem to start a fruitful collaboration with someone in Alabama. The same should apply to U.S.-German collaborations." In this spirit, from the point of view of the investigators, the ideal funding structure for German-U.S. research collaborations would require a single proposal written by two (or more) collaborators from Germany and the United States, with a budget that would be split into a U.S. part and a German part. It is of course reasonable for the funding agencies to insist that the partners make a valid argument for programmatic synergies expected from the proposed collaboration. The proposal should then be reviewed by a single body, and the structure of the funding (if approved) should be worked out by mutual agreement among the participating funding agencies in the two countries. The key here is that there will be a single review process that would review the full proposal. Note that this structure is different from the NSF's existing Partnerships for International Research and Education (PIRE) program, where collaborating parties in the participating countries may need to send in proposals to their own funding agencies, which are then reviewed independently.

In addition to support for research projects, it is important that there is a structure in place to enable the free and flexible exchange of people. The arguments of economy of scale mentioned earlier can also be made for training and teaching a new generation of researchers. Here, the overall impression shared by many at the meeting is that the exchange between Germany and the United States is unbalanced. Many young researchers from Germany visit the United States for postdoctoral studies, and frequently long thereafter. Indeed, a fair number of the U.S. participants at the meeting were German expatriates.

Several German funding agencies are actively promoting exchange: The DFG has a research fellowship program, which supports exchange both ways, the Humboldt Foundation provides various forms of fellowships to researchers to visit Germany, ranging from postdoctoral fellows to highly established researchers. Finally, through its Research Internships in Science and Engineering (RISE) program, the DAAD has a very interesting means of supporting summer research for undergraduate students. Compared to the German situation, the possibilities for obtaining exchange fellowships in the United

States seem less developed. However, the NSF's PIRE program does actively support international exchange through the award of research and training grants.

The overall imbalance may in part be due to the difference in size of the German vs. the U.S. scientific communities, and partly due to Germany's membership of the European Union, which has long promoted European international scientific exchange. But there is also an imbalance of perception: In Germany, it is considered highly desirable for young researchers to advance their careers by gaining international experience. In contrast, a primary concern for young researchers in the United States seems to be that they may drop out of the loop by going abroad, and that it will become that much more difficult to find jobs in a tight market. This is an unfortunate perception, which in the opinion of many at the meeting should be changed. One small but practical contribution to solving this problem may be to promote exchange of students at an earlier stage in their careers. First, this may function to break down cultural barriers, and second, if exchange results in tangible intellectual or scientific progress (see for example Bok, 2005), it may teach students by concrete example that exchange can be very useful. A good example of such a solution is the program for student exchange between the groups of Abarbanel (UC San Diego) and Borst (MPI Martinsried) described in Appendix 1C. This exchange takes place in a well defined institutional context, which in turn favors stable collaboration.

It is evident that there is a need for funding of travel between the two countries. As testified by Carr and Luksch in Appendix 1D-E, e-mail and telephone are certainly helpful, but real collaboration cannot get off the ground without regular face to face contact, both by PIs and frequently also by postdoctoral fellows and even graduate students. It would be highly desirable to have a flexible way to fund travel, for example, following the suggestion made in Appendix 1D, for NIH and NSF to incorporate specific elements inspired by the organization of the Humboldt Foundation.

Summary and Conclusions

Computational neuroscience, due to its strongly interdisciplinary character, naturally builds on collaborations between researchers from different backgrounds. There have been multiple initiatives, both in the United States and in Germany, to create funding structures that promote the style of interaction required for this field to grow. Both countries have a strong, but not terribly large, community of researchers active in computational neuroscience. It therefore makes perfect sense scientifically to utilize the potential for international collaboration between researchers from both countries. These issues were discussed by researchers in the field, and they identified two important core issues that may be addressed by funding agencies in the two countries:

1. The most important need in terms of German-U.S. funding for projects in computational neuroscience is a transparent procedure to allow the different funding agencies to handle proposals consisting of two parties in two different countries. The ideal funding structure for German-U.S. research collaborations would then require a single proposal written by two (or more) collaborators from Germany and the United States, with a budget that would be split into a U.S. part

and a German part. The proposal should then be reviewed by a single body, and the structure of the funding (if approved) should be worked out by mutual agreement among the participating funding agencies in the two countries. The key here is that there should be a single review process that would review the full proposal.

2 There is a need for a flexible exchange of people between the countries, and it was felt that it is especially important to make this possible at very early career stages. The DAAD in particular has developed a very interesting exchange structure for undergraduate students to do summer research. Initiatives such as these should be promoted and extended to different career levels.

References

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Bialek, W., Botstein, D.: Introductory Science and Mathematics Education for 21st-Century Biologists. *Science* **303**, 788-790 (2004)

Bok, D.: *Our Underachieving Colleges: A Candid Look at How Much Students Learn and Why They Should Be Learning More*. Princeton University Press, Princeton, N.J. (2005)

Appendices

Appendix 1: Five examples of collaboration

A. A very successful collaboration, using synergy in research capabilities is the joint work of Mayank Mehta (Brown University) and Bert Sakmann's (MPI Heidelberg) groups. In the words of Mehta: "An example is my collaboration with Bert Sakmann from Germany. I knew how to do tetrode recording in behaving animals and computational modeling. Bert Sakmann knew how to do whole cell recording. When we combined our expertise, within a very short period of time we found many new results about the potential role of sleep in memory formation. This has led to several high-profile papers and novel research directions about the role of sleep in learning. It would have taken a lot more money and time if either Sakmann or I alone had tried doing this research on our own."

B. Christine Linster (Cornell University) has had collaborations through a Human Frontiers research grant: "In the first year of my independent appointment, I obtained a Human Frontiers research grant with Giovanni Galizia (then in Berlin, Germany) and Martin Giurfa (Toulouse, France). The focus of this project was on honeybee olfaction and antennal-lobe function in a collaborative effort including computational modeling, behavioral analysis, and calcium imaging. The collaboration was excellent, and led to several good papers within each lab as well as one collaborative paper. It was overall a very positive experience. The three PIs met several times over the course of the three years of the grant's tenure. We usually met at meetings that all of us attended, for example the Neuroethology Gordon conference or the German Neuroscience Society meeting."

C. For a number of years, Axel Borst (MPI Martinsried) and Henry Abarbanel (UC San Diego) have had a joint program to enable students to do rotations, up to a few months long, in their laboratories in Martinsried and San Diego. This program has proved to be very popular with the students. One useful feature of this program is an advisor's visit for a few days at the end of a student's rotation. This provides both some quality control on the student's work, and importantly also contributes to continuity of the collaboration. A nice aspect of this exchange is that it happens in the context of a general agreement between the University of California, San Diego, and the four Bernstein Centers in Germany, namely Berlin, Freiburg, Göttingen, and Munich. As this example illustrates, a well-defined context greatly favors a stable collaboration.

D. Catherine Carr (University of Maryland, College Park) has a long standing collaboration with Hermann Wagner (Aachen University), involving work visits 2-3 times a year. This is a formal collaboration for both DFG and NIH. Collaborations are formed for the intellectual synergy, shared interests and the combination of complementary technical expertise, and that necessitates face to face contact. Professor Carr remarks that it is hard to get money for foreign travel, although that is often the least expensive way of getting things done. Her 2004-2005 Humboldt fellowship proved invaluable. She suggests that NIH and NSF incorporate Humboldt-Foundation-like elements.

E. Since 1998, Harald Luksch (Institute of Zoology, Technical University of Munich) has collaborated with Ralf Wessel (Washington University in Saint Louis, and previously, the University of California, San Diego). The collaboration included several short- and long-term visits by the PIs in the labs and collaborative work, both on an experimental and a theoretical level. Several visits of other lab members of the respective labs in both the United States and Germany were made as well. According to Prof. Luksch, some of the specifically international characteristics that made this collaboration valuable were the contact with a different scientific subculture, different views on how to solve problems, and the American “publication drive,” in which the U.S. part was the main driving force. It was felt that e-mail, phone, etc. are good communication channels once the collaboration is established. However, during the initial phase, it was found absolutely necessary to work together face-to-face to develop a common ground for future interactions. Professor Luksch notes that there clearly is a need to finance collaborative visits, for PIs and also for other lab members such as Ph.D. students.

Appendix 2: Program of the meeting

Growing Connections in Computational Neuroscience

A German-U.S. Collaborative Symposium
Munich, June 8-11, 2008

Sunday, June 8 Location: “Seehaus” in the Englischer Garten

6:00 PM Welcome. *Christiane Buchholz* (BMBF), *Ken Whang* (NSF), *Yuan Liu* (NIH/NINDS)
6:20 PM *Simone Cardoso de Oliviera*: National Bernstein Network for Computational Neuroscience
7:00 PM Dinner

Monday, June 9 Location: Kardinal-Wendel Haus, Mandlstraße 23, 80802 Munich

Chair: Andreas Herz
8:45 AM Connecting Neuroscience in Germany and the United States – Status quo and expectations: Presentations by representatives of U.S. and German Funding Agencies

Ken Whang (National Science Foundation)
Yuan Liu (National Institute of Neurological Disorders and Stroke)
Jan Kunze (Deutsche Forschungsgemeinschaft)
Thomas Hesse (Alexander von Humboldt-Stiftung)
Martin Diestel (for Deutscher Akademischer Austausch Dienst)
Henrike Hartmann (Volkswagen-Stiftung)
Olaf Krüger (BMBF/Projektträger DLR)

10:30 AM Coffee Break

Chair: Rob de Ruyter van Steveninck

10:50 AM AUDITORY PROCESSING – FROM LISTENING TO SINGING
Martin Göpfert: From transducer dynamics to sensory system behavior – identifying the molecular mechanisms that shape the performance of ears
Richard D. Mooney: Neural mechanisms for imitative communication

11:50 AM Short Break

12:00 AM OLFACTION AS A COMPUTATIONAL PROBLEM
Christiane Linster: Computational and behavioral evidence for normalization in the olfactory system

12:30 PM Lunch

Chair: Leo van Hemmen

2:00 PM COMPUTATIONAL APPROACHES TO SINGLE-NEURON DYNAMICS
Dieter Jaeger: Combining dynamic clamp experiments and single neuron modeling to determine synaptic coding properties of deep cerebellar nucleus neurons
Gabriel Wittum: Detailed simulation of neuronal signal processing

3:00 PM Short Break

3:10 PM BRAIN STRUCTURE AND FUNCTION
Dmitry B. Chklovskii: From neuronal circuit reconstructions to principles of brain design
Claus C. Hilgetag: Paradoxical lesion effects in cat, human and modeled brains

4:10 PM Coffee Break

Chair: Simone Cardoso de Oliviera

4:30 PM HOW DO SENSORS AND MOTORS INTERACT IN THE CORTEX?
Carlos Brody: Flexible sensorimotor mapping: the ProAnti task in rats
Alexander Gail: Planning of visually guided arm movements in the sensorimotor cortex

5:30 PM Short Break

5:40 PM FROM LARGE-SCALE ACTIVITY TO BRAIN-COMPUTER INTERFACES
Miguel Nicolelis: Computing with neural ensembles
Klaus-Robert Müller: Towards brain computer interfacing

6:40 PM “Digestion” – Time for questions that go beyond a single talk

7:00 PM Dinner

8:30 PM Break-Out Sessions on German-U.S. Collaboration

Tuesday, June 10

Chair: Ernst Niebur

9:00 AM VISUAL CORTEX AND THE NATURAL WORLD
Dirk Jancke: From luminance changes to natural scenes: Voltage-sensitive dye imaging in primary visual brain areas
David Fitzpatrick: Imaging experience-dependent emergence of functional circuits in visual cortex
Fred Wolf: A symmetry of the visual world in the design of the visual cortex

10:30 AM Coffee Break

11:00 AM FROM SENSORY INTEGRATION TO PATHOLOGY
Dora Angelaki: Multisensory integration for heading perception in macaque visual cortex
Carsten Mehring: Adaptive optimal control approaches to sensorimotor learning
Stefan Glasauer: Modelling the influence of medical treatment on pathological eye movements

12:30 PM Lunch

Chair: Benedikt Grothe

2:00 PM THE NEURAL BASIS OF ATTENTION AND PERCEPTION
Nava Rubin: A hierarchy of temporal receptive windows in human cortex
Jochen Braun: On the causes of multi-stable perception
Peter König: Feature integration in overt attention

3:30 PM Coffee Break

4:00 PM COMPLEXITY OF SIGNAL PROCESSING IN VISUAL CORTEX
Yang Dan: Analysis of visual cortical receptive field in anesthetized and awake animals
Mriganka Sur: Dynamics of neuron and astrocyte networks in visual cortex

5:00 PM Break-Out Sessions on German-U.S. Collaboration

6:00 PM Excursion

Wednesday, June 11

Chair: Theo Geisel

9:00 AM COMPUTATIONAL VISION
Alexander Borst: Optic flow processing in the cockpit of the fly
Laurenz Wiskott: Learning where- and what-information for visual objects under translation, rotation and zoom

10:00 AM Coffee Break

10:20 AM AUDITORY TUNING AND PLASTICITY
Laurel H. Carney: Computational models for the tuning of inferior colliculus neurons to periodicities in amplitude modulated tones, noise and click trains
Catherine Carr: Short term synaptic plasticity in the auditory system

11:20 AM Short Break

11:30 AM PLASTICITY AND HOMEOSTASIS IN HIPPOCAMPUS AND CORTEX
Mayank Mehta: Place cell plasticity, synaptic plasticity and cortico-hippocampal interaction
Michael P. Stryker: Mechanisms of activity-dependent competition in neocortex

12:30 PM Lunch

Chair: Henry Abarbanel

2:00 PM DYNAMICS OF LARGE SCALE NEURAL NETWORKS
Stefan Rotter: Relating structure and dynamics of neocortical networks
Kenneth. D. Miller: Inhibition-stabilized recurrent networks and selective amplification of neural activity patterns
Sara Solla: Patterns of neural activity in networks with complex connectivity

3:30 PM Coffee Break

4:00 PM CORTICAL SYNCHRONIZATION
Herbert Witte: Model-related analysis of time-variant interrelations and synchronization of activated brain areas
Klaus Pawelzik: Decoding stimuli and attention from the power of cortical synchronization

AN OUTLOOK
Konrad Körding: Normative models in Neuroscience

5:30 PM Coffee Break

Chairs: Andreas Herz and Rob de Ruyter van Steveninck
6:00 PM Connecting computational neuroscience in Germany and the United States – New ideas and future perspectives: Presentations by the rapporteurs of the break-out sessions

7:30 PM Farewell Banquet at “Café Reitstall”

Appendix 3: List of participants

Dora Angelaki, Department of Neurobiology, Washington University, Saint Louis, USA
Henry D.I. Abarbanel, Institute for Nonlinear Science, University of California, San Diego USA
Ad Aertsen, Department of Neurobiology and Biophysics, University of Freiburg, Freiburg Germany
Oguzhan Angay, Institute of Zoology, Technical University of Munich, Freising-Weihenstephan, Germany
Acosta Orlando Arevalo, Institute for Theoretical Physics, University of Bremen, Bremen, Germany
Jan Benda, Institute for Theoretical Biology, Humboldt-Universität zu Berlin, Berlin, Germany
Michael Bendels, Department Biologie II, Ludwig-Maximilians-Universität Munich, Munich Germany
Dagmar Bergmann-Erb, BCCN Munich, Ludwig-Maximilians-Universität Munich, Munich, Germany
Matthias Bethge, Computational Vision and Neuroscience, MPI for Biological Cybernetics, Tübingen Germany
Alexander Borst, Systems and Computational Neurobiology, Max-Planck-Institute of Neurobiology, Munich, Germany
Katrin Brandt, BCOS Freiburg, Albert-Ludwigs Universität Freiburg, Freiburg, Germany
Jochen Braun, Department of Cognitive Biology, Otto-von-Guericke University, Magdeburg, Germany
Carlos Brody, Department of Molecular Biology, Princeton University, Princeton, USA
Christiane Buchholz, Federal Ministry of Education and Research, Berlin, Germany
Moritz Bürck, Physics Department, Technical University Munich, Garching, Germany
Ulrich Büttner, University Hospital Munich-Grosshadern, Ludwig-Maximilians -Universität Munich, Munich, Germany
Simone Cardoso de Oliveira, BCOS, Albert-Ludwigs-University Freiburg, Freiburg, Germany
Laurel H. Carney, Department of Biomedical Engineering and Neurobiology & Anatomy, University of Rochester, New York, USA
Catherine Carr, Department of Biology, University of Maryland, College Park, USA
Nikolai M. Chapochnikov, University of Göttingen, Göttingen, Germany
Dmitri B. Chklovskii, Janelia Farm Research Campus, Howard Hughes Medical Institute, Chevy Chase, USA
Yang Dan, Department of Molecular & Cell Biology, University of California, Berkeley, USA
Florence Dancoisne, BCCN Freiburg, Albert-Ludwigs University of Freiburg, Freiburg, Germany
Martin Distel, Institute of Developmental Genetics, Helmholtz Center Munich, Neuherberg, Germany
Ulrich Egert, Department of Microsystems Engineering, Albert-Ludwigs University of Freiburg, Freiburg, Germany
Udo Ernst, Institute for Theoretical Physics, University of Bremen, Bremen, Germany
David Fitzpatrick, Department of Neurobiology, Duke University Medical Center, Durham, USA
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Giovanni Galizia, Department Biology, University of Konstanz, Konstanz, Germany
Stefan Glasauer, Center for Sensorimotor Research, Ludwig-Maximilians-Universität Munich, Munich, Germany

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Tim Gollisch, Visual Coding Group, Max-Planck-Institute of Neurobiology, Munich, Germany
Benedikt Grothe, Department Biologie II, Ludwig-Maximilians-Universität Munich, Munich, Germany
Henrike Hartmann, Volkswagen Foundation, Hannover, Germany
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Thomas Hesse, Alexander von Humboldt-Foundation, Bonn, Germany
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Peter König, Institute of Cognitive Science, University of Osnabrück, Osnabrück, Germany
Konrad Körding, Department of Physical Medicine and Rehabilitation, Northwestern University, Chicaco, USA
Olaf Krüger, Project Management Agency, Health Research, Bonn, Germany
Jan Kunze, Deutsche Forschungsgemeinschaft, Bonn, Germany
Stephanie Lehmann, Cognitive Biology, University of Magdeburg, Magdeburg, Germany
Christian Leibold, Department Biologie II, Ludwig-Maximilians-Universität Munich, Munich, Germany
Lutz Leistritz, Institute of Medical Statistics, Computer Sciences and Documentation, Friedrich-Schiller-University Jena, Jena, Germany
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Richard D. Mooney, Department of Neurobiology, Duke University Medical Center, Durham, USA
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