Contents

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OCNS Exec Board and Program Committee, as well as numerous CNS participants for the scientific content, Agnes Janßen for tips, tricks, comments and many parts of the text, Daniel Bartz for the majority of the touristic part, Maria Kramarek and Matthias Guggenmos for the vicinity map, Cathleen Grimsen, Christian Albers & Agnes Janßen for careful proofreading, and the World Wide Web, Google, Flickr, and my digital camera for providing many of the pictures and illustrations.

'Erratum Necesse Est!' – L.A. Tex and G.H Ost-View

Organization for Computational Neurosciences (OCNS)

Board and Executive committee

Once a year, elections for the board of directors and the executive committee are held. If you are interested in serving on these, please email http://president@cnsorg.org for further information.

2009 Executive Committee

President: Ranu Jung (Arizona State U, USA) (2006-2009)
Vice-President and Secretary: Dieter Jaeger (Emory U, USA) (2006-2009)
Vice-President: Klaus Obermayer (Technische Universität Berlin, Germany) (2008-2011)
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CNS*2009 Program Chair: Don Johnson (Rice U, USA) (2008-2011)

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CNS*2009 Travel Grants: Tim Lewis (U California-Davis, USA)
CNS*2009 Workshop Chair: Dieter Jaeger (Emory U, USA)

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Members of the program committee are appointed for a three year, non-renewable term. If you are interested in being a program committee member, please email http://program@cnsorg.org or http://president@cnsorg.org.

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Hide Cateau (RIKEN, Japan)
Markus Diesmann (RIKEN, Japan)
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Andreas Herz (TU Munich, Germany) (2009)
John-Dylan Haynes (Charité Berlin, Germany) (2009)
Klaus Obermayer (TU Berlin, Germany) (2009)

The CNS*2010 and CNS*2011 competitions for proposals to host the local meetings have been closed and decided. We now seek local organizers for CNS*2012 for a North American location and CNS*2013 for a non-North American location. Please contact the OCNS president at http://president@cnsorg.org if you are interested in hosting a CNS meeting. A call for proposals to host the CNS*2012 meeting will be placed in August 2010.

Reviewers

If you would like to become a member of the CNS review committee, please email
http://program@cnsorg.org.

2009 Reviewer

Kurt Ahrens, Athena Akrami, Peter Andras, Toru Aonishi, Amir Assadi, Francesco Battaglia, John Beggs, Jan Benda, Upinder Bhalla, Kim Avrama Blackwell, Alla Borisyuk, Amitabha Bose, Romain Brette, Vladimir Brezina, Carmen Canavier, Jeremy Caplan, Michela Chiappalone, Claudia Clopath, Albert Compte, Sharon Crook, Gennady Cymbalyuk, Peter Dayan, Paolo DelGiudice, Ramana Dodla, Peter Erdi, Jean-Marc Fellous, Nicolas Fourcaud-Trocme, Erik Fransen, Matthieu Gilson, Bruce Graham, Lyle Graham, Sonja Gruen, Cengiz Gunay, Christian Hauptmann, J. Michael Herrmann, Mikael Huss, Hide Ikeno, Dieter Jaeger, Szabolcs Kali, Amir Karniel, Leslie Kay, Aurel A Lazar, Maciej Lazarewicz, Tim Lewis, John Lewis, Benjamin Lindner, Marja-Leena Linne, Christiane Linster, William Lytton, Mark McDonnell, Georgi Medvedev, Paul Miller, Samat Moldakarimov, Abigail Morrison, Tay Netoff, Hiroshi Okamoto, Eckehard Olbrich, Sorinel Oprisan, Pooya Pakarian, Michael (Mike) Paulin, Hans Ekkehard Plesser, Panayiota Poirazi, Bernd Porr, Patrick Roberts, Horacio Rotstein, Jonathan Rubin, Yukata Sakai, Ko Sakai, Emilio Salinas, Simon Schultz, Chang-Woo Shin, Asya Shpiro, Karen Sigvardt, Frances Skinner, Leslie Smith, David Sterratt, Aonan Tang, Natalia Toporikova, Benjamin Torben-Nielsen, Todd Troyer, Mark van Rossum, Alessandro Vato, Nada Yousif, Yuguo Yu, and Michael Denker.

Fundraising

OCNS, Inc is a US non-profit, 501(c)(3) serving organization supporting the Computational Neuroscience community internationally. We seek sponsorship from corporate and philanthropic organizations for support of student travel and registration to the annual meeting, student awards and hosting of topical workshops. We can also host booth presentations from companies and book houses. For further information on how you can contribute please email http://sponsorship@cnsorg.org.

CNS*2009 Sponsors

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Bernstein Center for Computational Neuroscience Berlin, Germany (Grant 01GQ0410)

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HFSP Journal, France

The International Neural Network Society, USA

National Science Foundation, USA

Neuralynx, USA

Springer Science and Business Media, USA

MIT Press, USA

Timetable

	TUTORIALS	MAIN MEETING			WORKSHOPS & NEUROINF. SYMPOSIUM	
	Saturday, July 18	Sunday, July 19	Monday, July 20	Tuesday, July 21	Wednesday, July 22	Thursday, July 23
8:00		Registration				
8:10						
8:20						
8:30			Registration	Registration	Registration	Registration
8:40						
8:50						
9:00	Tutorials (BBAW), Morning Session	Welcome, Announcements	Announcements	Announcements	Workshops & Neuroinformatics Sympoisum (BBAW & Hilton), Morning Session	Workshops (BBAW & Hilton), Morning Session
9:10			Invited Talk	Invited Talk		
9:20						
9:30		Frontiers in Computational Neuroscience Lecture				
9:40						
9:50						
10:00						
10:10			Break	Oral 20		
10:20						
10:30		Break		Break		
10:40			Featured Oral 2			
10:50						
11:00		Featured Oral 1		Featured Oral 3		
11:10						
11:20			Oral 8			
11:30						
11:40		Oral 1	Oral 9	Oral 21		
11:50						
12:00	Lunch Break	Lunch Break	Oral 10	Federal Programs for Computational Neuroscience	Lunch Break	Lunch Break
12:10						
12:20			Lunch Break			
12:30				Business Meeting		
12:40						
12:50						
13:00				Lunch Break		
13:10						
13:20						
13:30	Tutorials (BBAW), Afternoon Session	Invited Talk			Workshops & Neuroinformatics Sympoisum (BBAW & Hilton), Afternoon Session	Workshops (BBAW & Hilton), Afternoon Session
13:40						
13:50			Oral 11			
14:00						
14:10			Oral 12			
14:20						
14:30		Oral 2	Oral 13			
14:40						
14:50		Oral 3	Oral 14			
15:00				Poster P184-P367		
15:10		Oral 4	Break			
15:20						
15:30		Break				
15:40			Oral 15			
15:50						
16:00		Oral 5	Oral 16			
16:10						
16:20		Oral 6	Oral 17			
16:30	Break				Dinner Break	Dinner Break
16:40		Oral 7	Oral 18			
16:50						
17:00	Registration and Reception in Panorama Foyer, Hilton	Dinner Break	Oral 19			
17:10						
17:20			Break			
17:30						
17:40						
17:50						
18:00			Cruise		Workshops (BBAW & Hilton), Evening Session	Workshops (BBAW & Hilton), Evening Session
18:10						
18:20						
18:30						
18:40						
18:50						
19:00		Poster P1-P183		Break		
19:10						
19:20						
19:30						
19:40						
19:50						
20:00			Dinner (until 0:00, first buses leave 23:00)			
20:10						
20:20						
20:30						
20:40						
20:50						
21:00				Party (until 2:00), Announcement CNS*2010, Awards		
21:10						
21:20						
21:30						
21:40						
21:50-23:00						

General Info

- **Location**

  The main meeting will be held in the Ballroom at the Hilton Hotel in downtown Berlin from Saturday 18th to Tuesday 21st, July 2009. The workshops, including a Neuroinformatics Symposium, will take place in the Berlin Brandenburgische Akademie der Wissenschaften (BBAW) from Wednesdy 22nd, July to Thursday 23rd, July 2009. Before the main meeting participants have the opportunity to attend the so-called Bernstein Tutorials on Saturday 18th July, 2009. There will be an official reception on Saturday as from 17:00 to 23:00 in the Hilton's Panorama Foyer.

  If you decide to attend a part of the conference for which you did not pre-register, you can register on-site at one of our terminals using your credit card.

- **Registration**

  Registration for the tutorials respectively main meeting and workshops will be open in the BBAW (entrance Markgrafenstr.) from 8:00 on Saturday 18th July. Additional possibility to register will be from 16:00 the same day in the Panorama Foyer Hilton, as well as on Sunday from 8:00 and on Monday/Tuesday from 8:30. Registration on the workshop days is located in the BBAW and opens at 8:30.

  The staff at the registration will try to help you whenever you are in need (look out for the red name tags!) Additionally, T-Shirts can be bought there for USD 15 or €11.

- **Internet**

  Wireless Internet access in the hotel and in the BBAW is provided at no charge. Please don't use the connection for large down- or uploads as the bandwidth is limited.

  During the main meeting, we provide access to **two** networks for providing smooth service:

  (A) You may either log into the 'swisscom' network, with the user name 'Conf/CNS' and password 'CNS', or

  (B) log onto the 'cns2009hilton' network, using the WEP key 'deadbeef09' (no user name, nor password required).

  During the tutorials and workshops, use procedure (B) for WLAN access in the Hilton, or use network 'cns2009' in the Berlin-Brandenburg Academy of Sciences (no WEP key, nor user name or password required).

  If everything fails, please ask the CNS staff (red name tag) for help, or listen to the talks or poster presentations instead.

- **Oral sessions**

  If you give a talk in the main meeting, please bring your own laptop for a smoothly running presentation without surprises. However, we will provide a backup machine with Windows XP operating system with a combination of Office 2003 (Powerpoint)/Acroread/Ghostview, but there may be the typical problems with missing fonts etc.

  Please plan to arrive early and hook up your laptop to our equipment prior to the start of the session. It's your time that's elapsing...!

For all other requests involving 'exotic' equipment (like iPODs connected to old Commodore 64 home computers or the like), please contact http://local@cnsorg.org prior to the conference.

For oral presentations given during the workshops, please bring your own laptop (and your own talk, of course!).

- **Poster Sessions**

  Poster boards will be supplied in the course of Sunday morning; half of it can be set up in Salon Corinth respectively Salon Humboldt either during lunch break or after 17:00. During the break from 17:00 to 19:00 the remaining poster boards will be set up in the Ballroom. There will be time enough to hang them (Posters P1-P183). Poster boards are numbered according to abstract numbers as they appear in the index. Due to the big number of participants we unfortunately have to remove part of the poster boards after the first session and store them somewhere in the hotel. They will again be taken out before the 2nd poster session (P184-P367) on Tuesday 21st July from 15:00 to 19:00. For each session participants are entitled to get two drinks (corresponding vouchers can be found in the package you receive at the registration desk). Additional drinks must be bought at the bar in the ballroom.

- **Tutorials**

  Before the main meeting on Saturday 18th July there are ten different tutorials taking place at the BBAW at the Gendarmenmarkt, very close to the conference site. Most of the participants already made their choice for the tutorials they are interested in, but so long as the rooms are not overcrowded you may decide to change your preference on site. Cold drinks, coffee/tea and small snacks will be put at your disposal.

  For attendees not being able to attend the tutorials, we provide the CD with all the contributions and a bootable version of the NEST neural network simulation environment for USD 10 or €7 at the registration desk.

- **Workshops**

  Workshops will also take place at the BBAW in the Leibniz Hall and rooms 1-6 from 22nd to 23rd July. A Neuroinformatics Symposium will be held in the Einstein Hall (4th floor of this building) on Wednesday. Coffee and tea will be put at your disposal. Same as for the tutorials, many participants already made their choices for the workshops and as said before are free to change in case of need. A reception desk will be prepared at the entrance Markgrafenstr. and hopefully all your problems can be solved there. The rooms have been distributed preliminarily (see program). Any changes will be posted on large boards.

  For technical assistance, please contact the registration desk or ask our helping staff (red nametags).

- **Boat Cruise and Banquet**

  The CNS social event in 2009 will be a boat cruise on the river Spree and a banquet in the Orangerie of the Palace Charlottenburg. Detailed information can be found starting on page 161. You are kindly requested to bring the voucher for the boat cruise and the banquet with you (in your conference package).

  Extra banquet tickets can be bought at the reception for USD 70 or €50.

- **CNS Party**

  The CNS Party in 2009 will take place in the Universal Hall on Tuesday 21st July. Partcipants are supposed to go there on their own, or with some guided crowd leaving the Hilton at about

20:00. A description can be found starting on page 163. We will have live music, hopefully inducing you to move your legs and maybe ending in a jam session. As usual, prizes will be awarded to the best student presentations during the party. Prizes will be awarded after review by the judging panel. The announcement of CNS*2010 will terminate the 'official' part of the main meeting, but dancing can go on!

- **Time and Space**

  Times throughout this program book will be given in 'European' notation, i.e. 0:00 to 12:00 from midnight to 12 a.m., and 12:00 to 23:59 from noon to 11.59 p.m.

  All length scales are given in the metric system. Remember that 100 feet are about 30 meters, one inch is 25.4 millimeters, and one yard is either a court or about 90 centimeters.

  Discover by yourself if 30 degrees centigrade is too hot or too cold!

- **Getting Around in Berlin**

  For your convenience, we provide an English map ('*Stop&Go Berlin City Map*') with additional information on public transport, and a brochure with the touristic highlights, which both are included in your conference package. See also the maps in the 'Overview' and 'Fun and Recreation' sections of this book.

  Berlin is divided into quarters like 'Stadtmitte' or 'Mitte', 'Charlottenburg', 'Kreuzberg', 'Friedrichshain', 'Tiergarten' and alike. In the other sections of this book, we will mention these quarters for a coarse orientation, together with a legend where to find e.g. restaurants on the *Stop&Go Berlin City Map* .

- **Lunches, Dinners and Sightseeing**

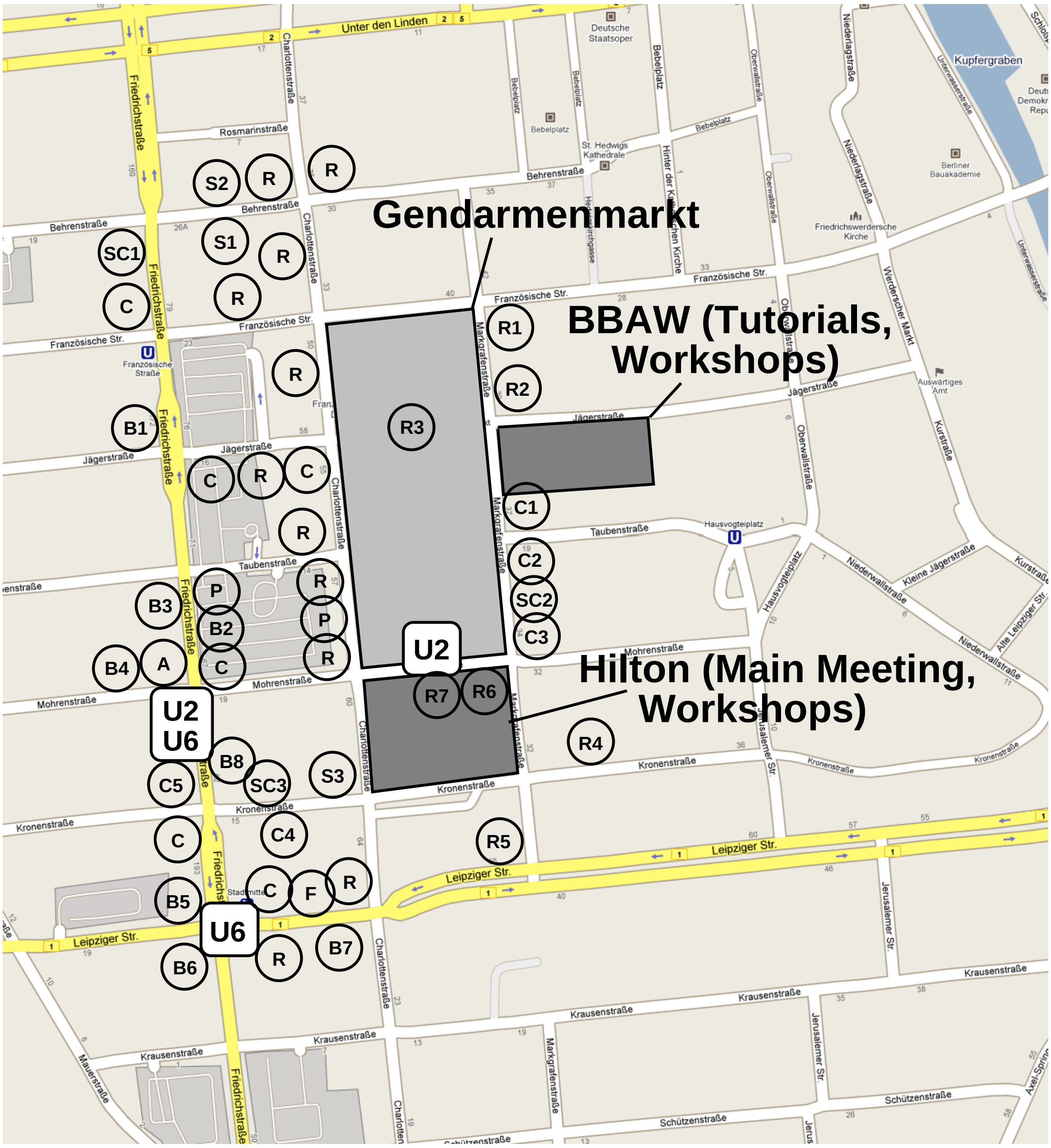
  For having lunch during the breaks, there is a nice and affordable self-service restaurant on the street level in the Hilton hotel (between 6 and 8 Euros per main course). If you want to have an **excellent** hot chocolate or chocolate cake, sneak quickly away to 'Faßbender und Rausch', a café and chocolate store located just opposite the Hilon on the Charlottenstraße.

  Furthermore, there are numerous small restaurants, coffee places, snack bars and the like in the vicinity of the Hilton (see map at the end of this section).

  If you insist in having something really special, see from page 167 for a small listing of interesting Berlinian dining establishments – enjoy!

- **Banking**

  Banking services are available from a multitude of places in the vicinity of the conference. Have a look at the map at the end of this section



Vicinity map of conference – Abbreviations are: **C** = Café, **S** = Snacks, **F** = Food, **R** = Restaurants, **B** = Banks.

C1 Brasserie 'Am Gendarmenmarkt'
C2 Shan Rahimkhan (Indian Café)
C3 Einstein Café
C4 Starbucks
C5 Einstein Café (another one)

SC1 Lindner
SC2 Quchina
SC3 Lagano Lifestyle Café

S1 Pizza
S2 Subway
S3 Soups

F1 Kaisers and Schlecker
F2 Lidl

B1 Money Exchange
B2 PostBank
B3 Deutsche Bank
B4 Berliner Bank
B5 Sparkasse
B6 City Bank
B7 DHB Bank
B8 Dresdner Bank

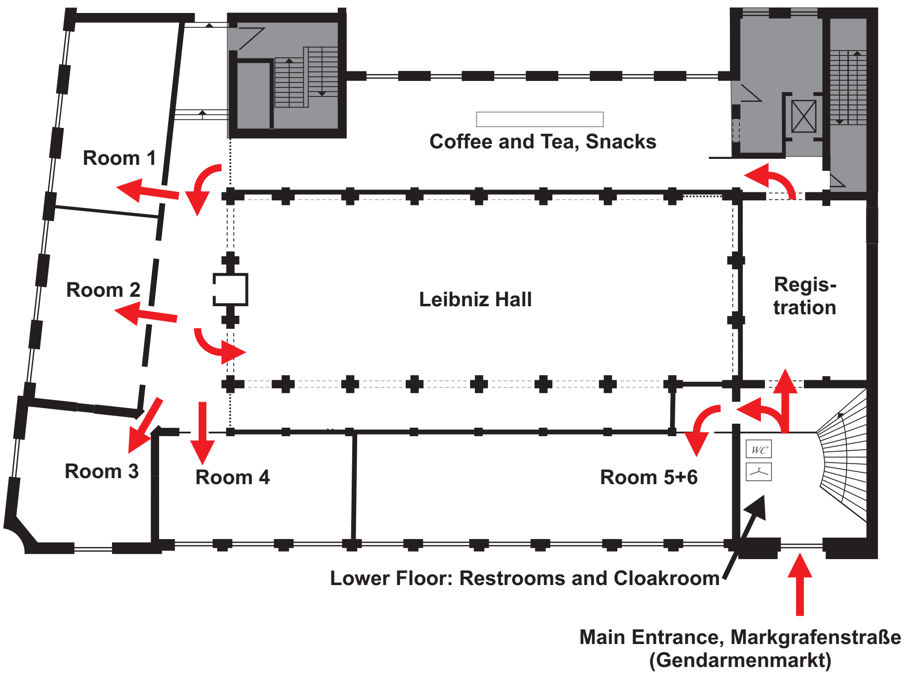
R1 Bistro am Gendarmenmarkt
R2 Amici am Gendarmenmark
R3 Konzerthaus Berlin
R4 Braustübl
R5 City Hotel Restaurant
R6 Restaurant Gendarmenmarkt
R7 Mark Brandenburg

Bernstein–Tutorials

Saturday July 18, 2009

supported by:
Bernstein Group for Computational Neuroscience
Bremen, Germany

Floor plan: Tutorials in the Berlin-Brandenburg Academy of Sciences (BBAW)



Time	Room 1	Room 2	Room 3	Room 4	Room 5+6	Leibniz Hall
9:00-12:00	Tutorial 5 (Steven Schiff)	Tutorial 8 (Kenji Doya)	Tutorial 3 (Felix Wichmann)	Tutorial 6 (Matthias Bethge)	Tutorial 9 (Hans Ekkehard Plesser)	Tutorial 7 (Peter Latham)
13:30-16:30		Tutorial 1 (Jutta Kretzberg)	Tutorial 10 (Stefan Kiebel)		Tutorial 2 (Sophie Denève)	Tutorial 4 (Lars Schwabe)

9:00–14:00 **Registration (Berlin-Brandenburg Academy of Sciences, see also map on page 27)**
After 14:00, the registration will move to the Panorama Foyer in the Hilton hotel and reopen at 16:00

9:00–16:30 **Tutorials (Berlin-Brandenburg Academy of Sciences)**
See next page for list of tutorials, and from page 37 for the corresponding abstracts.

T1 Spike train analysis

***Jutta Kretzberg* (Room 2, 13:30-16:30)**

University Oldenburg, Germany

T2 Neural basis of probabilistic computations

***Sophie Denève* (5+6, 13:30-16:30)**

École Normale Supérieure, Paris, France

T3 Tools and Methods in Psychophysics

***Felix Wichmann* (Room 3, 9:00-12:00)**

Technical University Berlin, Germany

T4 Activity-dependent Synaptic Plasticity and Neuronal Adaptation

***Lars Schwabe* (Leibniz Hall, 13:30-16:30)**

University Rostock, Germany

T5 Neural Control Engineering – The Emerging Intersection of Control Theory and Neuroscience

***Steven Schiff* (Room 1, 9:00-12:00, 13:30-16:30)**

Pennsylvania State University, PA, USA

T6 Probabilistic Models of Natural Stimuli and Neural Populations

***Matthias Bethge* (Room 4, 9:00-12:00, 13:30-16:30)**

Max-Planck Institute for Biophysical Cybernetics, Tübingen, Germany

T7 Neural Coding

***Peter Latham* (Leibniz Hall, 9:00-12:00)**

Gatsby Unit, University College London, UK

T8 Reinforcement learning – a tool for cracking the neural codes of behavioral learning

***Kenji Doya* (Room 2, 9:00-12:00)**

Okinawa Institute of Science and Technology, Japan

T9 Large-Scale Neuronal Network Models: Principles and Practice

***Hans Ekkehard Plesser* (Room 5+6, 9:00-12:00)**

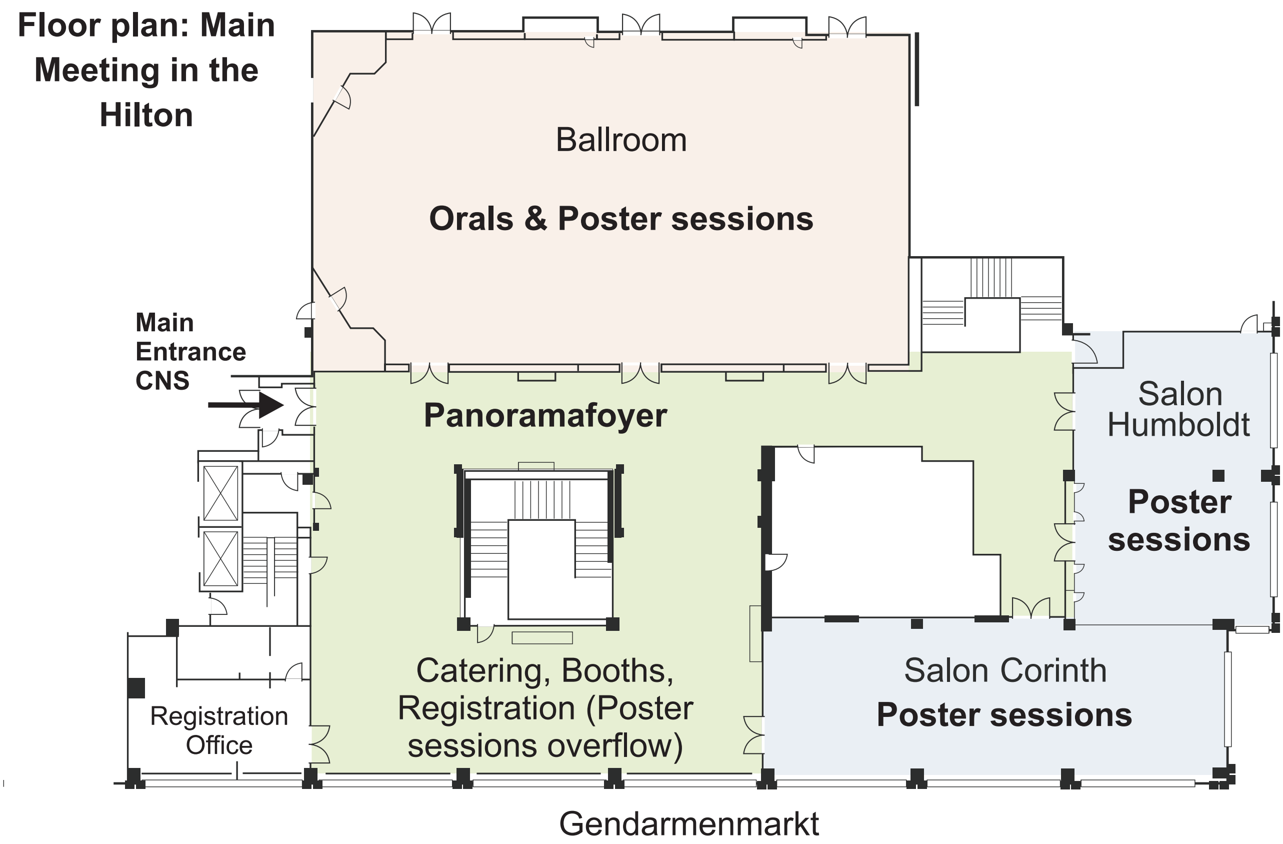
University of Oslo, Norway

T10 Analysis methods for functional neuroimaging data

***Stefan Kiebel* (Room 3, 13:30-16:30)**

Max-Planck Institute for Human Cognitive and Brain Sciences, Leipzig, Germany

Main Meeting



The abstracts for all invited, featured and other oral contributions can be found on pages pp.43.

Saturday July 18, 2009

16:00–23:00 **Registration (Panorama Foyer Hilton)**

17:00–23:00 **Opening Reception (Panorama Foyer Hilton)**

Sunday July 19, 2009

8:00 **Registration**

9:00 **Welcome**
Ranu Jung (President, OCNS), Thomas Rachel (State Secretary, BMBF) and Udo Ernst (Local Organizer)

9:30 I1 **Frontiers in Computational Neuroscience Lecture**
Networks in motion – intrinsic function and control
Sten Grillner

10:30 **Break**

11:00 F1 **Featured Talk**
Describing and exchanging models of neurons and neuronal networks with NeuroML
Sharon Crook, R. Angus Silver and Padraig Gleeson

11:40 O1 *Emergence of behavioral primitives in self-organizing control and composition of behavior for autonomous robots*
Georg Martius and J. Michael Herrmann

12:00 **Lunch**

13:30 I2 **Invited Talk**
Neuroinformatics and computational neuroanatomy: From Cajal to the Internet, and beyond
Giorgio Ascoli

14:30 O2 *Irregular firing, quasi-stationary state and spike-time dependent response*
Srdjan Ostojic, Camille de Solages, German Szapiro, Clément Léna and Vincent Hakim

14:50 O3 *Sparse coding of natural communication signals in midbrain neuron*
Katrin Vonderschen and Maurice J Chacron

15:10 O4 *Calcium sensor parameters and readout configurations for activity-dependent homeostatic regulation of pyloric network rhythms in the lobster stomatogastric ganglion*
Cengiz Günay and Astrid A. Prinz

15:30 **Break**

16:00 O5 ***Rich single neuron computation implies a rich structure in noise correlation and population coding***
Sungho Hong and Erik de Schutter

16:20 O6 ***Bayesian estimation of the time-varing rate and irregularity of neuronal firing***
Takeaki Shimokawa and Shigeru Shinomoto

16:40 O7 ***Dual coding in an auto-associative network model of the hippocampus***
Daniel Bush, Andrew Philippides, Phil Husbands and Michael O'Shea

17:00 **Dinner Break**

19:00–23:00 **Poster Session**
P1–P183

Monday July 20, 2009

8:30 **Registration**

9:00 **Announcements**

9:10 I3 **Invited Talk**

Sharing the fruits of our labor: Can data-sharing advance discovery in neuroscience?
Gwen Jacobs

Neuroinformatics Theme

10:10 **Break**

10:40 F2 **Featured Talk**

Realistic mean field forward predictions for the integration of co-registered EEG/fMRI
Ingo Bojak, Thom F. Oostendorp, Andrew T. Reid and Rolf Kötter

11:20 O8 *What does a neuron 'see'? Limitations imposed by the statistics of afferent inputs to a neuron*
Mark D. Humphries

11:40 O9 *Fast and reliable methods for extracting functional connectivity in large populations*
Yasser Roudi, Joanna Tyrcha and John Hertz

12:00 O10 *Sequential sparsing by successive adapting neural populations*
Farzad Farkhooi, Eilif Muller and Martin P. Nawrot

12:20 **Lunch**

13:50 O11 *Neural networks with small-world topology are optimal for encoding based on spatiotemporal patterns of spikes*
Petra E. Vertes and Tom Duke

14:10 O12 *Identification of functional information subgraphs in cultured neural networks*
Vadas Gintautas, Luis M. A. Bettencourt and Michael I. Ham

14:30 O13 *Optimal correlation codes in populations of noisy spiking neurons*
Gasper Tkacik, Jason Prentice, Elad Schneidman and Vijay Balasubramanian

14:50 O14 ***A network of reverberating neuronal populations encodes motor decision in macaque premotor cortex***
Maurizio Mattia, Pierpaolo Pani, Giovanni Mirabella, Stefania Costa, Paolo Del Giudice and Stefano Ferraina

15:10 **Break**

15:40 O15 ***A bistable synaptic model with transitions between states induced by calcium dynamics: theory vs experiment***
Michael Graupner and Nicolas Brunel

16:00 O16 ***Structural plasticity, cortical memory, and the spacing effect***
Andreas Knoblauch

16:20 O17 ***Partial response to supra-threshold excitation desynchronizes spiking neurons***
Christoph Kirst and Marc Timme

16:40 O18 ***A probabilistic framework to infer connectivity from function: A study of change detection and adaptation***
Nabil Bouaouli and Sophie Denève

17:00 O19 ***Cooperative synapse formation in the neocortex***
Tarec Fares and Armen Stepanyants

17:20 **Break**

18:00–23:00 **Cruise on the river Spree, and Dinner in Schloß Charlottenburg**

Tuesday July 21, 2009

9:00 **Announcements**

9:10 I4 **Invited Talk**
Constraints imposed by dendrites on spike timing dependent synaptic plasticity
Idan Segev

10:10 O20 *How chaotic is the balanced state?*
Sven Jahnke, R.-M. Memmesheimer and Mark Timme

10:30 **Break**

11:00 F3 **Featured Talk**
Large scale model of the human brain
Eugene M. Izhikevich

11:40 O21 *Control of the temporal interplay between excitation and inhibition by the statistics of visual input*
Jens Kremkow, Laurent Perrinet, Cyril Monier, Yves Frégnac, Guillaume S. Masson and Ad Aertsen

12:00 **Federal Programs for Computational Neuroscience**

12:30 **Business Meeting**
Organization for Computational Neuroscience

12:55 **Introduction of new OCNS Board members**

13:00 **Lunch**

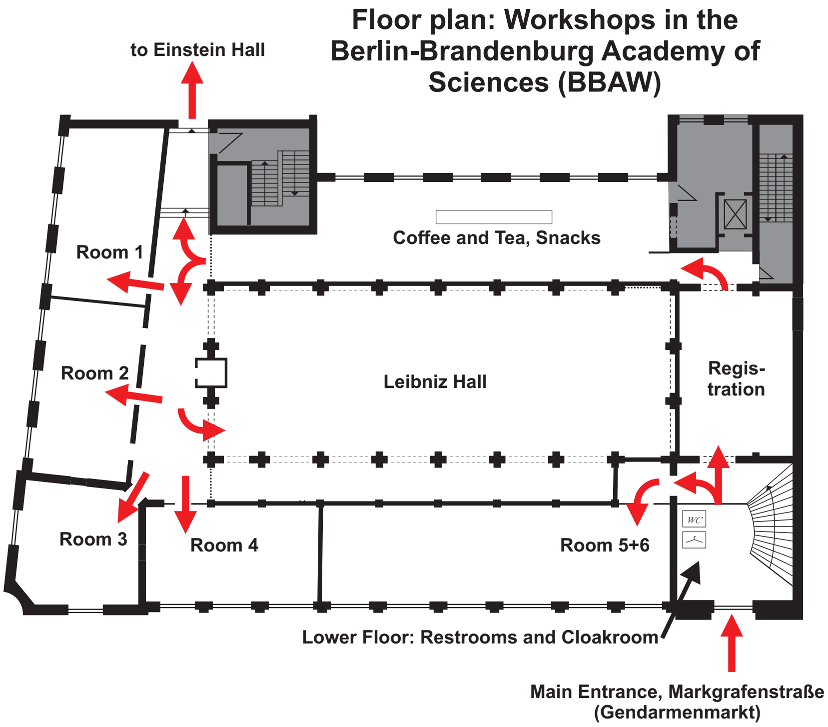
15:00–19:00 **Poster Session**
P184–P367

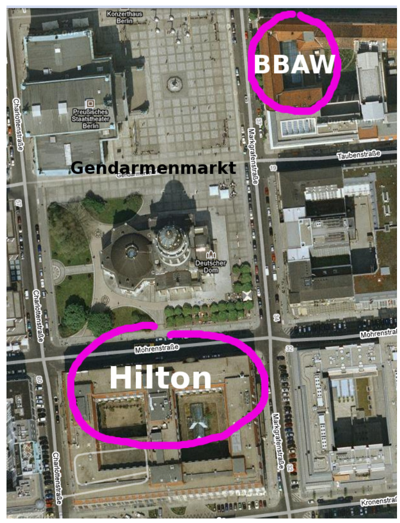
21:00-2:00 **CNS Party in the Universal Hall**
Distribution of Poster Awards
Announcement of next year's meeting
Closing of the conference

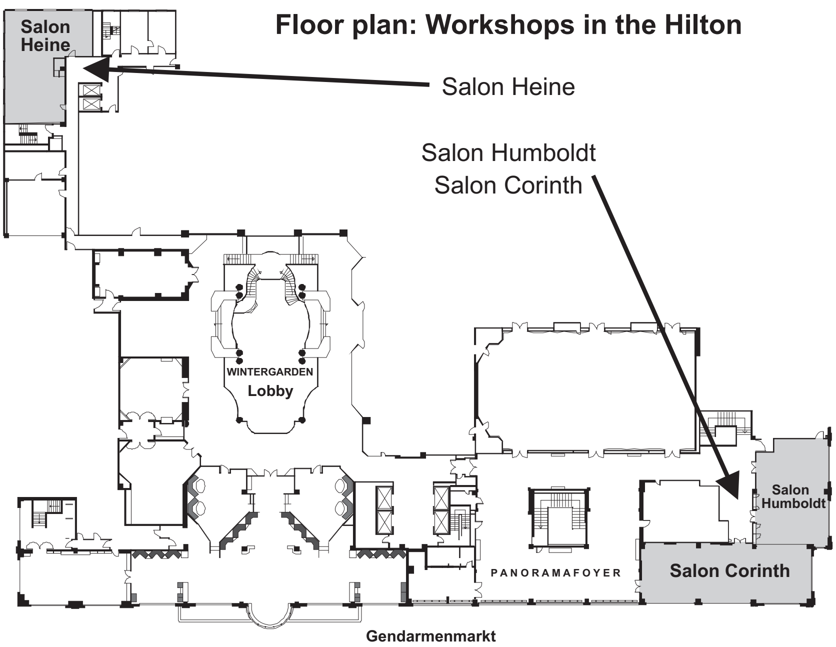
Workshops

Wednesday July 22 & Thursday July 23, 2009

Floor plans







Detailed Schedule

Changes in the schedule will be announced and signposted both in the foyer of the Hilton and in the Berlin-Brandenburg Academy of Sciences.

Wednesday 22th				
Where?	**Room**	**Morning**	**Afternoon**	**Evening**
Hilton	Salon Heine	W2 (Methods of Information Theory)		
	Salon Humboldt	W4 (Large Cortical Oscillations)		W11 (Quantitative Models of Natural Behaviour)
	Salon Corinth	W10 (Activity-Dependent Structural Plasticity)		W15 (Modern Mathematical Neurodynamics)
BBAW	Room 1	W5 (Modeling Migraine)		
	Room 2	W9 (Olfactory learning and memory in insects)		
	Room 3	W6 (Automated Parameter Fitting for Compartmental Models)		
	Room 4	W15 (Modern Mathematical Neurodynamics)	W8 (Modeling neural mass action in brain networks)	
	Room 5+6	W12 (Python in Neuroscience)		
	Leibniz Hall	W14 (Statistical analysis of multi-cell recordings		W3 (Career Development Workshop)
	Einstein Hall	Symposium Neuroinformatics		

Thursday 23th				
Where?	**Room**	**Morning**	**Afternoon**	**Evening**
Hilton	Salon Heine	W2 (Methods of Information Theory)		
	Salon Humboldt	W4 (Large Cortical Oscillations)		
	Salon Corinth	W11 (Quantitative Models of Natural Behaviour)		
BBAW	Room 1	W5 (Modeling Migraine)		
	Room 2	W9 (Olfactory learning and memory in insects)		
	Room 3	W1 (Anesthesia and Sleep)		
	Room 4	W13 (Multistability in Neurodynamics)		
	Room 5+6	W12 (Python in Neuroscience)		
	Leibniz Hall	W7 (Cortical Microcircuit Models)		
	Einstein Hall			

Titels and Organizers

The abstracts for all workshops can be found on pages pp.77 For up-to-date versions and detailed schedules of the talks, please see the http://www.cnsorg.org web pages or have a look at the schedule boards near the registration.

WS Symposium on Neuroinformatics –
Data Sharing and Data Analysis in Neurophysiology

Einstein Hall (BBAW), Wednesday 22nd, 9:00-12.00 & 13:30-16:30

Andreas Herz
LMU Munich, Germany

Martin Nawrot
FU Berlin, Germany

Thomas Wachtler
LMU Munich, Germany

The global scale of Neuroinformatics offers unprecedented opportunities for scientific collaborations between and among experimental and theoretical neuroscientists. To fully harvest these possibilities, coordinated activities are required that support neuroscientific research by improving key ingredients – data access, data storage and exchange, and data analysis. This symposium, organized by the German National Node of the International Neuroinformatics Coordination Facility (INCF), brings together experts in the area of data sharing and data analysis in neurophysiology, who will present specific approaches and tools that have also fostered their own scientific research.
The symposium features full-length talks by the main speakers, followed by discussions.
One topic area addressed by the speakers will be the development of open-source tools for data analysis. Ad Aertsen (BCCN Freiburg) will talk about FIND, an integrated analysis toolbox for multiple-neuron recordings and network simulations. Jan Benda (BCCN Munich) will address the issues of automated data and metadata acquisition and online analysis, introducing the software relacs. Hemant Bokil (Cold Spring Harbor Laboratory) will present the Chronux software package for the analysis of neural data, and Eilif Muller (EPFL) will talk about efforts to develop Python modules for neuroscience and neuroinformatics.
Such data analysis tools are also being integrated into larger frameworks or the management and sharing of tools and data among neuroscientists. In recent years, several initiatives have been established to develop such integrative platforms. One of them is the project 'Code Analysis, Repository and Modeling for e-Neuroscience', CARMEN, a UK-wide initiative to develop a virtual laboratory for neurophysiology, which will be introduced by Colin Ingram (University of Newcastle). Fritz Sommer (UC Berkeley) will present the data sharing efforts of the Collaborative Research in Computational Neuroscience (CRCNS) funding program in the US. Shiro Usui will introduce the Japan National Neuroinformatics Node, and in particular its digital archive for vision science, the Visiome Platform.
These presentations will clearly show that the way we gather, analyze and distribute experimental data is undergoing major changes. We therefore expect lively discussions about the current scope and future development of tools for data sharing and data analysis in neurophysiology.
The German National Neuroinformatics Node is funded by the Federal Ministry of Education and Research (BMBF), located at Ludwig-Maximilians-Universität Munich, and an integral component of the Bernstein Network for Computational Neuroscience (NNCN).

9:00–9:10 **Opening**

9:10–10:00 ***CARMEN: An e-science virtual laboratory supporting collaboration in neuroinformatics***
Colin D. Ingram, Colin D. Ingram, Paul Watson, Jim Austin and Leslie S. Smith

10:00–10:50 ***CRCNS.ORG: A repository of high-quality data sets and tools for Computational Neuroscience***
Jeff L. Teeters and Friedrich T. Sommer

10:50–11:10 **Coffee Break**

11:10–12:00 ***INCF Japan-Node: Visiome and Simulation Platforms***
Shiro Usui, Yoshimi Kamiyama and Tadashi Yamazaki

12:00–13:00 **Lunch Break**

13:00–14:00 **Posters**

14:00–14:50 ***FIND – A unified framework for neural data analysis***
Ad Aertsen, Christian Garbers, Antje Kilias, Ralph Meier, Martin P. Nawrot, Karl-Heinz Boven and Ulrich Egert

14:50–15:40 ***Chronux: A Platform for Analyzing Neural Signals***
Hemant S. Bokil, Peter Andrews, Hiren Maniar, Bijan Pesaran, Jayant Kulkarni, Catherine Loader and Partha P. Mitra

15:40–16:20 **Coffee/Posters**

16:20–17:10 ***Closed-loop electrophysiological experiments and metadata management with RELACS and LabLog***
Jan Benda and Jan Grewe

17:10–18:00 ***Caring for the environment: The blooming 'Python in Neuroscience' ecosystem***
Eilif Muller, Andrew P. Davison

18:00–18:30 **Discussion**

Federal Ministry of Education and Research, Germany

National Network for Computational Neuroscience, Germany

W1 Anaesthesia and sleep: recent experimental and theoretical aspects

Room 3 (BBAW), Thursday 23rd, 9:00-12.00 & 13:30-16:30

Axel Hutt
Chargé de Recherche, INRIA CR Nancy - Grand Est Équipe CORTEX CS20101, 54603 Villers-lès-Nancy Cedex, France. E-mail: axel.hutt@loria.fr

W2 Methods of Information Theory in Computational Neuroscience

Salon Heine (Hilton), Wednesday 22nd, 9:00-12.00 & 13:30-16:30 and Thursday 23rd, 9:00-12.00 & 13:30-16:30

Aurel A. Lazar
Department of Electrical Engineering, Columbia University

Alexander G. Dimitrov
Center for Computational Biology, Montana State University

W3 PhD and Postdoc Career Development Workshop

Leibniz Hall (BBAW), Wednesday 22nd, 18:00-21:00

Lars Schwabe
Dept. of Computer Science and Electrical Engineering, Inst. of Computer Science, Adaptive and Regenerative Software Systems, University of Rostock, Germany, E-mail: lars.schwabe@uni.rostock.de

W4 Large Cortical Oscillations: Mechanistic and Computational Aspects

Salon Humboldt (Hilton), Wednesday 22nd, 9:00-12.00 & 13:30-16:30 and Thursday 23rd, 9:00-12.00 & 13:30-16:30

Caroline Geisler
Center for Molecular and Behavioral Neuroscience, Rutgers University, Newark, NJ, USA.

Horacio G. Rotstein
Department of Mathematical Sciences, New Jersey Institute of Technology, Newark, NJ, USA.

W5 Modeling Migraine: From Nonlinear Dynamics to Clinical Neurology

Room 1 (BBAW), Wednesday 22nd, 9:00-12.00 & 13:30-16:30 and Thursday 23rd, 9:00-12.00 & 13:30-16:30

Markus A. Dahlem
Institut für Theoretische Physik, TU Berlin

Sebastiano Stramaglia
Physics Department of the University in Bari, Italy

W6 **Automated Parameter Fitting for Compartmental Models**

Room 3 (BBAW), Wednesday 22nd, 9:00-12.00 & 13:30-16:30

Erik De Schutter
Okinawa Institute of Science and Technology, Japan

W7 **Cortical Microcircuit Models of Information Processing and Plasticity**

Leibniz Hall (BBAW), Thursday 23rd, 9:00-12.00 & 13:30-16:30

Vassilis Cutsuridis
Department of Computing Science and Mathematics, University of Stirling, Stirling FK9 4LA, U.K.

Thomas Wennekers
Centre for Theoretical and Computational Neuroscience, University of Plymouth, Plymouth, U.K.

W8 **Modeling neural mass action in brain networks using delay differential equations**

Room 4 (BBAW), Wednesday 22nd, 13:30-16:30 & 18:00-21:00

Fatihcan M. Atay
Max Planck Institute for Mathematics in the Sciences, Leipzig, Germany

Thomas Knösche
Max Planck Institute for Human Cognitive and Brain Sciences, Leipzig, Germany

W9 **Olfactory learning and memory in insects**

Room 2 (BBAW), Wednesday 22nd, 9:00-12.00 & 13:30-16:30 and Thursday 23rd, 9:00-12.00 & 13:30-16:30

A. Yarali
Research Fellow, MaxPlanck Institute for Neurobiology, Martinstried, Germany. E-mail: yarali@neuro.mpg.de

J. Wessnitzer
Research Fellow, University of Edinburgh, UK, E-mail: jwessnit@inf.ed.ac.uk

W10 **Activity-Dependent Structural Plasticity – from cell cultures to cortical networks**

Salon Corinth (Hilton), Wednesday 22nd, 9:00-12.00 & 13:30-16:30

Markus Butz
Neuroinformatics Group, Dept. for Integrative Neurophysiology, VU University Amsterdam, E-mail: mbutz@falw.vu.nl

Arjen Van Ooyen
Neuroinformatics Group, Dept. for Integrative Neurophysiology, VU University Amsterdam, E-mail: arjen.van.ooyen@cncr.vu.nl

W11 Quantitative Models of Natural Behaviour

Salon Humboldt (Hilton), Wednesday 22nd, 18:00-21:00 and Salon Corinth (Hilton), Thursday 23rd, 9:00-12.00 & 13:30-16:30 & 18:00-21:00

Aldo Faisal
Cambridge

Greg Stephens
Princeton

W12 Python in Neuroscience

Room 5+6 (BBAW), Wednesday 22nd, 9:00-12.00 & 13:30-16:30 and Thursday 23rd, 9:00-12.00 & 13:30-16:30

Eilif Muller
Laboratory of Computational Neuroscience, Ecole Polytechnique Fédérale de Lausanne, Switzerland

Jens Kremkow
Institut de Neurosciences Cognitives de la Méditerranée, CNRS, France
Bernstein Center for Computational Neuroscience, Albert-Ludwigs-University Freiburg, Germany

Andrew Davison
Unité de Neurosciences Intégratives et Computationelles, CNRS, France

Romain Brette
Ecole Normale Supérieure de Paris, France

W13 Multistability in Neurodynamics

Room 4 (BBAW), Thursday 23rd, 9:00-12.00 & 13:30-16:30

Gennady Cymbalyuk
Georgia State University

W14 Statistical analysis of multi-cell recordings: Linking population coding models to experimental data

Leibniz Hall (BBAW), Wednesday 22nd, 9:00-12.00 & 13:30-16:30

Matthias Bethge
Tübingen, E-mail: mbethge@tuebingen.mpg.de

Jakob Macke
Computational Vision and Neuroscience Group, MPI for Biological Cybernetics, Tübingen, E-mail: jakob@tuebingen.mpg.de

Philipp Berens
Computational Vision and Neuroscience Group, MPI for Biological Cybernetics, Tübingen, berens@tuebingen.mpg.de

W15 Modern Mathematical Neurodynamics: Bridging Single Cells to Networks

Room 4 (BBAW), Wednesday 22nd, 9:00-12.00 and Salon Corinth (Hilton), Wednesday 22nd, 18:00-21:00

Marc Timme
Network Dynamics Group, Max Planck Institute for Dynamics and Self-Organization and Bernstein Center for Computational Neuroscience (BCCN) Göttingen

Bernstein–Tutorials

T1 Spike train analysis

***Jutta Kretzberg* (Room 2, 13:30-16:30)**

University Oldenburg, Germany

This tutorial will focus on the analysis of neuronal population activity as it is obtained in extracellular multi-electrode recordings. After a short review of basic concepts of spike train analysis (e.g. receptive field measurement, tuning curves, PSTH), I will introduce two more advanced methods to estimate stimulus properties based on neuronal responses: Bayesian stimulus reconstruction and metric based clustering. For all analysis methods covered in the tutorial Matlab routines will be provided and applied to multi-electrode recordings from the retina.

T2 Neural basis of probabilistic computations

***Sophie Denève* (5+6, 13:30-16:30)**

École Normale Supérieure, Paris, France

Our sensory input is noisy and ambiguous and the consequences of our actions are not completely predictable. For all these reasons, perception and behavioural choices require probabilistic inference. We will consider how neurons and neural populations could compute, represent and exploit uncertainties and probabilities. We will show that spike trains of integrate and fire neurons provide a natural basis to represent probabilistic evidence in a perpetually changing world. This leads us to reconsider the nature of signal and noise in the variable responses of cortical neurons.

T3 Tools and Methods in Psychophysics

***Felix Wichmann* (Room 3, 9:00-12:00)**

Technical University Berlin, Germany

The tutorial will cover some of the essentials of modern psychophysical methods and tools:

1. Signal detection theory and (proper) forced-choice paradigms.
2. The method of constant stimulus versus adaptive procedures.
3. Psychometric function estimation and Monte-Carlo based goodness-of-fit assessment.
4. Limits of currently available display technology in visual psychophysics.

T4 Activity-dependent Synaptic Plasticity and Neuronal Adaptation

Lars Schwabe ***(Leibniz Hall, 13:30-16:30)***

University Rostock, Germany

Summary

In this tutorial we consider rules and mechanisms for synaptic plasticity, normalization and competition as well as recent spike-based learning rules (supervised and reinforcement-based). In addition, we consider short-term adaptation at the synapse and single-cell level as well as their functional consequences for network dynamics and sensory coding. After the tutorial the participants will be able to model both phenomena at different levels of description and utilize them in their own modeling studies.

Abstract

The goal of this tutorial is to give an overview of the mathematical models of activity-dependent synaptic plasticity and neuronal adaptation as well as their functional consequences for the representation and processing of sensory information. Activity-dependent synaptic plasticity is the mechanism, which governs the build-up, maintenance, and change of the connections between neurons. Hence, it probably plays a key role in development, learning and memory. Neuronal adaptation refers to the change in responsiveness after constant stimulation, and it may correspond to adaptation at the single-cell or synapse level. It is believed to be the underlying mechanism of perceptual phenomena like, for example, perceptual aftereffects. After the tutorial the participants will be able to model both phenomena at different levels of description. In particular, they will be able to utilize these models in their own research in order to further explore the consequences of these two mechanisms for network dynamics and the functions realizes by such networks. All models are motivated and illustrated with examples (taken mainly, but not exclusively, from the visual system). Recent advances and open questions are discussed.

Topics

- Brief recap of the relevant biophysics
- Rules and corresponding mechanisms for plasticity, normalization and competition
- Consequences for activity-dependent development
- Recent spike-based learning rules (supervised and reinforcement-based)
- Input-driven vs. output-driven adaptation: single-cell vs. synaptic mechanisms
- Consequences for network dynamics and sensory coding

T5 Neural Control Engineering – The Emerging Intersection of Control Theory and Neuroscience

Steven Schiff ***(Room 1, 9:00-12:00, 13:30-16:30)***

Pennsylvania State University, PA, USA

1. Linear Kalman Filtering
2. Nonlinear Kalman Filtering
3. The Hodgkin Huxley Equations
4. The Fitzhugh-Nagumo Equations
5. The Bridge from Kalman Filtering to Neuronal Dynamics
6. Spatiotemporal Neural Dynamics
7. Parkinson's Disease
8. Controlling Neuronal Dynamics with Electrical Stimulation
9. Empirical Spatiotemporal Models
10. Brain Machine Interfaces
11. All Models are Wrong – Formalizing Model Inadequacy
12. A View Towards Future Applications

T6 Probabilistic Models of Natural Stimuli and Neural Populations

***Matthias Bethge* (Room 4, 9:00-12:00, 13:30-16:30)**

Max-Planck Institute for Biophysical Cybernetics, Tübingen, Germany

Forenoon: Probabilistic Models of Natural Stimuli
Afternoon: Probabilistic Models of Neural Populations
Both natural stimuli and neural recordings can exhibit complex statistical structure. Therefore, flexible statistical models are needed for capturing this complexity in a quantitative manner. In particular, probabilistic methods provide a principled framework for comparing and evaluating different models. In the morning session of the tutorial, we will discuss model classes for describing the statistical structure of natural images and their relevance for sensory coding. The afternoon session will consist of a self-contained introduction to probabilistic models of spiking neurons. Our focus will be on the generalized linear model framework and related model classes. In each session we will aim to point out relationships and commonalities between different approaches.
Further information will be posted on the following webpage:
http://www.kyb.tuebingen.mpg.de/bethge/tutorials/cns2009

T7 Neural Coding

***Peter Latham* (Leibniz Hall, 9:00-12:00)**

Gatsby Unit, University College London, UK

We study neural coding because we want to answer the question: 'what are spike trains telling us?'. Although the answer is still 'we don't know,' over the last several decades considerable progress has been made, and we now know much more than we did even ten years ago. In this tutorial, I will describe standard and not-so-standard methods for answering this question, what we have found, and where we are going.

T8 Reinforcement learning – a tool for cracking the neural codes of behavioral learning

***Kenji Doya* (Room 2, 9:00-12:00)**

Okinawa Institute of Science and Technology, Japan

The theory of reinforcement learning evolved in the field of machine learning based on the intuition of animal learning from reward and punishment. Now the framework has been utilized for quantitatively modeling choice behaviors of rats, monkeys, and humans, and for fishing for neural correlates of decision making and action learning. This tutorial will present the mathematical basics of reinforcement learning and some case studies of how it is used for the analyses of behaviors, neural firing, and brain imaging data.

T9 Large-Scale Neuronal Network Models: Principles and Practice

Hans Ekkehard Plesser ***(Room 5+6, 9:00-12:00)***

University of Oslo, Norway

Simulations are widely used to study the dynamics of neuronal networks, but computational neuroscientists seldom reflect on the modeling process: How do we move from our understanding of experimental findings about neuroanatomy and -physiology, first to mental models of neuronal networks, and then to simulations performed by computer? Do our computer simulations really simulate the models we have built in our minds? How well do we succeed in describing our simulated models to our colleagues when writing papers? We will discuss these topics in the first part of the tutorial, building on theoretical work on modeling in physics and ecology, as well as examples from the neuroscience literature. In the second part of the tutorial, we will discuss how to describe large-scale neuronal networks well in scientific publications. We will particularly discuss the advantages of high-level descriptions of neuronal networks, using the Topology Module of the NEST simulator as an example. Participants are invited to bring their laptops for hands-on experiments. Bootable live-DVDs with a complete NEST installation will be provided.

T10 Analysis methods for functional neuroimaging data

Stefan Kiebel ***(Room 3, 13:30-16:30)***

Max-Planck Institute for Human Cognitive and Brain Sciences, Leipzig, Germany

In systems neuroscience, researchers acquire data using techniques such as functional magnetic resonance imaging (fMRI) and magneto- and electroencephalography (M/EEG). These data show indirect evidence of neuronal activity, acquired from the whole brain. This tutorial will first cover the standard analyses for fMRI and M/EEG, which are used for locating brain responses in space and time. In the second part of the tutorial we will go beyond these standard analyses and cover recent developments for inferring effective connectivity, i.e., interactions among brain areas. In particular, the tutorial will focus on 'Dynamic Causal Modelling', a state-space approach to model activity caused by neuronal networks, where we will go through the relevant details and illustrate the approach using some example studies. In the last part of the tutorial, we will motivate the use of Bayesian model selection in neuroimaging studies and will show that this kind of inference is particular relevant for M/EEG studies.

Invited Presentations

I1

Sten Grillner *is a professor at the Karolinska Institute's Nobel Institute for Neurophysiology in Stockholm. His research is focused on understanding the cellular bases of motor behavior with a focus on the mechanisms underlying selection of behavior and the neural bases of in particular locomotion, posture, orienting and eye movements. His research extends from ion channels and synapses to network mechanisms and behavior utilizing a multitude of techniques from patch clamp and cellular imaging to modeling and studies of behavior. He exploits the lamprey as a model organism but also mammalian models for the studies of posture and selection mechanisms.*

He has been able, based on detailed cellular knowledge, to successfully model the networks responsible for the command and pattern generating systems for locomotion including steering and posture. His work continues along several research paths, including the role of the basal ganglia for selection of different patterns of motor behavior, tectum for steering and eye motor coordination, the physiological role of different modulator systems acting through the spinal networks, and different ion channel subtypes contributing to neuronal function. Professor Grillner is a member of the Academia Europaea, Royal Swedish Academy of Science and the Nobel Assembly, and has received a number of awards including the Bristol Myers Squibb award in 1993 and the Reeve–Irvine award in 2002. He was a co-recipient, with Thomas Jessell and Pasko Rakic, of the inaugural Kavli Prize for Neuroscience in 2008 for 'discoveries on the developmental and functional logic of neuronal circuits'.

Networks in motion – intrinsic function and control

The lamprey is one of the few vertebrates in which the neural control system for goal-directed locomotion including steering and control of body orientation is well described at a cellular and synaptic level. In this lecture I will review the extensive modelling at a large-scale level, which we are performing not only of the brainstem spinal cord networks underlying propulsion, but also the tectal mechanisms involved in steering and the forebrain mechanisms underlying selection of different aspects of motor behavior. We are able to model the system with compartmental Hodgkin-Huxley neurons and with the approximate number of neurons that are responsible in the behaving animal (10000 neurons at spinal level). We also demonstrate how the network activity and direction of motion can be controlled by interacting only a few of the hundred segments. This arrangement simplifies the control of motion and steering.

I2

Giorgio Ascoli *is head of the Computational Neuroanatomy Group at the Krasnow Institute for Advanced Study and a faculty member of the Molecular Neuroscience and the Psychology Departments at George Mason University. He received his M.Sc. (Laurea) from the University of Pisa and his Ph.D. from the Scuola Normale Superiore in 1996, where he investigated drug-protein binding. As a Guest Researcher at the former Laboratory of Adaptive Systems of the NIH, he worked on the structural characterization of a learning-associated neuronal protein, Calexcitin, and on the Prion protein, the infective agent of Mad Cow disease.*

On the experimental side, his current research involvement is in neurochemistry and neuroanatomy. The main effort of his Computational Neuroanatomy Group is to model dendritic morphology (the 'shape' of brain cells) and its influence on neuronal electrophysiology. One of the products of his group is L-Neuron, a modeling tool that generates and describes realistic neurons. One the current research projects of his group is anatomically plausible neural networks and their relation to Alzheimer's disease. His main long-term scientific and philosophical goal is to establish a working model for the highest cognitive functions such as human consciousness.

Neuroinformatics and computational neuroanatomy: From Cajal to the Internet, and beyond

The stunning diversity of neuronal shapes and sizes within and among morphological classes raises fundamental questions on the developmental mechanisms ('how'), defining structural features ('what'), and functional consequences ('why') of such natural variability. Revolutionary progress in answering these questions has been enabled by the recent development of powerful experimental methods to label dendritic and axonal arbors, high resolution optical microscopy to image them, and computer-assisted techniques to three dimensionally trace these structures. In particular, the digital representation of neuronal reconstructions allows quantitative analysis and computational simulations of branching structures, and their relationship with electrophysiological activity and network connectivity. At the same time, the increasing public availability of these data in internet-available archives allows additional discovery through meta-analyses and large-scale data mining. I will illustrate several examples of this approach with an emphasis on the rodent hippocampus. Moreover, I will provide a hands-on demonstration of databases of experimental data and available analytical tools that are particularly relevant to biologically realistic neuroscience models.

I3

Gwen Jacobs *is a professor in the Department of Cell Biology and Neuroscience at Montana State University. She became Director of the Complex Biological Systems graduate training program in 1999. Upon its inception in July of 2000, she became the Chair of the Department of Cell Biology and Neuroscience. Professor Jacobs research and scholarship efforts fall into four different areas: 1) basic neuroscience research on sensory processing, 2) basic and applied research on informatics and data sharing techniques for the neuroscience community, 3) implementation of IT-based infrastructure for the science and education communities and 4) science pedagogy. Her research has focused on understanding the cellular mechanisms of information processing in a simple sensory system, the cricket cercal sensory system, using a combination of anatomical, physiological and modeling techniques. In neruoinformatics, she participates in the NeuroSys project, which strives to enable individual investigators to annotate their data, through the construction of in lab databases. She also leads the Lariat Networking Project that has developed and implemented a plan to provide a high-speed telecommunications network for biomedical researchers in six institutions in rural states in the West. Her role in this project is to identify research applications that will be enhanced by the network and to introduce investigators at each of the Lariat sites to new research and training opportunities made available through this project.*

Sharing the fruits of our labor: Can data-sharing advance discovery in neuroscience?

Many research communities have embraced the ideals and practices of sharing their data through a variety of approaches including nationally supported databases, community archives, group collaboration and ways of making personal data collections publically available. The rapid increase in new research discoveries within the genomics, protein structure and systems biology communities provides good evidence of the value and power of data-sharing. In contrast, neuroscientists have been faced with significant challenges to achieve similar levels of success. This presentation will address these barriers, highlight some of the success stories within the neuroscience community and discuss some of the tools, techniques and trends in neuroinformatics that enable new discoveries through data-sharing efforts.

I4

***Idan Segev** is the David and Inez Myers Chair in Computational Neuroscience at the Hebrew University of Jerusalem. There, he is a member of the Institute of Life Sciences, the Department of Neurobiology and the Interdisciplinary Center for Neural Computation. Idan Segev's research team utilizes computational tools ranging from cable theory to compartmental modeling to statistical methods and information theory to study how neurons, the elementary microchips of the brain, compute and dynamically adapt to our ever-changing environment.*

More recently, he has worked jointly with several experimental groups worldwide in an endeavor to model in detail the cortical column: a functional unit containing thousands of intensely but very specifically connected networks of neurons. This project also aims at developing automated methods for generating models of the different electrical and morphological classes of neurons found in the column. The ultimate goal is to unravel how local fine variations within the cortical network underlie specific computations (e.g., the orientation of a bar in the visual system) and may give rise to certain brain diseases or to a healthy (and 'individual') brain.

Constraints imposed by dendrites on spike timing dependent synaptic plasticity

The effect of dendrites on excitatory synapses undergoing spike-timing-dependent-plasticity (STDP) was explored in a computational study. Two cases were examined (i) the somatic spike is the only 'supervisor' for synaptic plasticity for all dendritic synapses and (ii) local Ca spikes could also serve as additional supervisors for synaptic plasticity. We show that in the first case, the efficacy of distal synapses tend to diminish following linear STDP rule and proximal synapses eventually dominate. Adding a small multiplicative component to the STDP rule, whereby already strong synapses tend to be less potentiated than depressed (and *vice versa* for weak synapses) did partially 'save' distal synapses from 'dying out'. Another successful strategy for generating 'synaptic democracy' following STDP is to increase the upper bound for the synaptic conductance (g_{max}) with distance from the soma. With two (or more) local supervisors for synaptic plasticity, competition ensues between their corresponding dendritic synaptic 'students'. When apical synapses independently generate Ca-spikes, the apical tree synapses become dominant at the expense of proximal synapses. However, when a back propagating action potential (BPAP) is required for the initiation of dendritic Ca-spike, synapses at both basal and apical zones live in peace. Only under this condition will somatic synapses survive. The functional implications of these findings will be discussed.

Contributed Talks

F1 Describing and exchanging models of neurons and neuronal networks with NeuroML

Sharon Crook[1], **R. Angus Silver**[2], **Padraig Gleeson**[2]

[1]Dept. of Mathematics and Statistics, School of Life Sciences, Center for Adaptive Neural Systems, Arizona State University, Tempe, Arizona, 85287, USA
[2]Dept. of Neuroscience, Physiology and Pharmacology, University College London, London, WC1E 6BT, UK

Contact: Sharon Crook(sharon.crook@asu.edu)

The Neural Open Markup Language (NeuroML) project is an international, collaborative initiative to facilitate the exchange of complex neural models, allow for greater transparency and accessibility of models, enhance interoperability between simulators and other tools and support the development of new software and databases [1–3]. The increasing enthusiasm in the computational neuroscience community for standards that allow for greater simulator interoperability and model publication is driving current efforts, which focus on the key objects that need to be exchanged among existing applications and try to anticipate those needed by future applications. Examples of these objects include descriptions of neuronal morphology, ion channels, synaptic mechanisms, and network structure. The process of creating these common specifications encourages discussion among users of independently developed applications, which leads to succinct descriptions of the essential elements of models. NeuroML is an Open Source project based on XML, as it provides the transparency, portability and extensibility required in these efforts. The openness of the standards and the encouragement of feedback from the community are some of the guiding principles of the NeuroML initiative.

The declarative specifications for NeuroML are arranged into levels, with higher levels adding extra concepts at different spatial scales, an approach that ensures that the specification is provided in a modular way. Mappings exist between NeuroML elements and several commonly used simulators including NEURON [4], GENESIS [5] and PSICS [6], and a number of tools are available which allow a user to create and validate NeuroML documents and to generate code for model implementation by multiple simulators from these documents. In particular, the model development application neuroConstruct can import and write NeuroML documents as well as generate output for simulating neuron or neuronal network activity using either NEURON, GENESIS, PSICS or PyNN [7]. Currently, NEURON can import and export cells in NeuroML format, and import/export of NeuroML is in beta testing for PyNN, which is a Python package for simulator independent specification of neuronal network models [8]. The use of NeuroML with PyNN provides a connection between the NeuroML descriptions of large-scale neuronal network models and additional simulators.

Overall, NeuroML provides a valuable contribution towards simulator interoperability as well as model publication and exchange. The NeuroML standards will facilitate a broad range of research goals in computational neuroscience.

Acknowledgements
Partial support for this work was provided by the Wellcome Trust. We also thank the International Neuroinformatics Coordinating Facility and the National Science Foundation for support of NeuroML through workshop and travel funding.

References
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F2 Realistic mean field forward predictions for the integration of co-registered EEG/fMRI

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Brain activity can be measured non-invasively with functional imaging techniques. Each pixel in such an image represents a neural mass of about 105 to 107 neurons. Mean field models (MFMs) approximate their activity by averaging out neural variability while retaining salient underlying features, like neurotransmitter kinetics. However, MFMs incorporating the regional variability, realistic geometry and connectivity of cortex have so far appeared intractable. This lack of biological realism has led to a focus on gross temporal features of the EEG. We address these impediments and showcase a 'proof of principle' forward prediction of co-registered EEG/fMRI for a full-size human cortex in a realistic head model with anatomical connectivity, see figure.

MFMs usually assume homogeneous neural masses, isotropic long-range connectivity and simplistic signal expression to allow rapid computation with partial differential equations. But these approximations are insufficient in particular for the high spatial resolution obtained with fMRI, since different cortical areas vary in their architectonic and dynamical properties, have complex connectivity, and can contribute non-trivially to the measured signal. Our code instead supports the local variation of model parameters and freely chosen connectivity for many thousand triangulation nodes spanning a cortical surface extracted from structural MRI. This allows the introduction of realistic anatomical and physiological parameters for cortical areas and their connectivity, including both intra- and inter-area connections. Proper cortical folding and conduction through a realistic head model is then added to obtain accurate signal expression for a comparison to experimental data. To showcase the synergy of these computational developments, we predict simultaneously EEG and fMRI BOLD responses by adding an established model for neurovascular coupling and convolving 'Balloon-Windkessel' hemodynamics. We also incorporate regional connectivity extracted from the CoCoMac database [1].

Importantly, these extensions can be easily adapted according to future insights and data. Furthermore, while our own simulation is based on one specific MFM [2], the computational framework is general and can be applied to models favored by the user. Finally, we provide a brief outlook on improving the integration of multi-modal imaging data through iterative fits of a single underlying MFM in this realistic simulation framework.

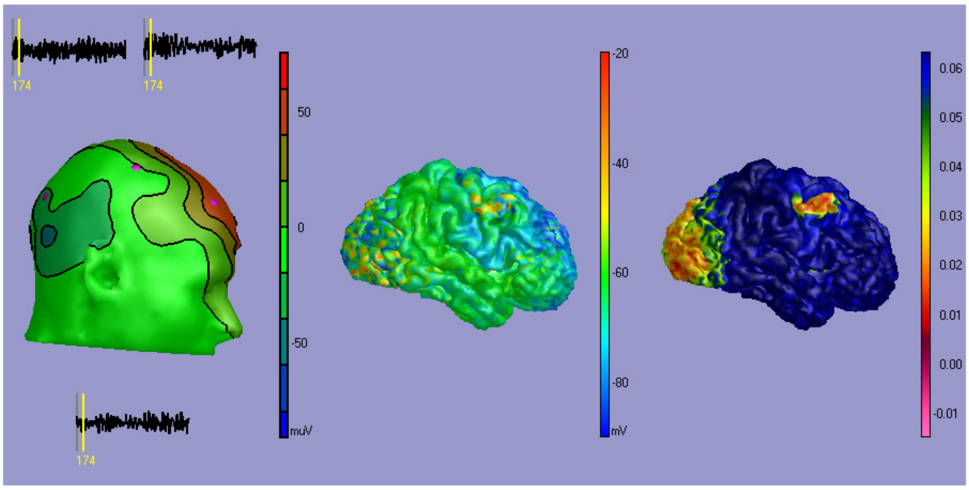

Figure. MFM prediction of simultaneous EEG and fMRI with local, contralateral and visual connectivity. Left: EEG scalp potentials. Middle: MFM excitatory soma membrane potential h_e. Right: fMRI BOLD response.

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F3 Large scale model of the human brain

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Introduction
I will describe an ambitious project of constructing a detailed large-scale thalamocortical model based on experimental measures in several mammalian species. The model spans three anatomical scales: (1) It is based on global (white-matter) thalamocortical anatomy obtained via diffusion tensor imaging (DTI) of a human brain. (2) It includes multiple thalamic nuclei and six-layered cortical microcircuitry based on in vitro labeling and three-dimensional reconstruction of single neurons of cat visual cortex. (3) It has 22 basic types of neurons with appropriate laminar distribution of their branching dendritic trees. The model simulates one million multi-compartmental spiking neurons calibrated to reproduce known types of responses recorded in vitro in rats. It has almost half a billion synapses with appropriate receptor kinetics, short-term plasticity, and long-term dendritic spike-timing dependent synaptic plasticity (dendritic STDP).

Results
Spatio-temporal dynamics of the simulation show that some features of normal brain activity, although not explicitly built into the model, emerged spontaneously. Even in the absence of external input, the distribution of firing rates among various types of neurons is similar to that recorded in vivo - pyramidal neurons fire just a few spikes per second with the lowest firing rate observed in layer 2/3, whereas basket cells fire tens of spikes per second with the highest firing rate in layer 5. Individual neurons exhibit somatic and dendritic spikes, forward- and back-propagation of spikes along the dendritic trees, and spike-timing-dependent plasticity that is coupled to the dendritic compartments rather than to the somatic spikes. The model spontaneously generated rhythms and propagating waves that had frequency distributions, spatial extents, and propagation velocities similar to those observed in mammalian in vivo recordings (including humans). In a fashion similar to human data, the simulated fMRI signal exhibited slow oscillations with multiple fronto-parietal anticorrelated functional clusters.

The computer model allowed us to perform experiments that are impossible (physically or ethically) to carry out with animals. For example, we put the model into the noiseless regime to demonstrate that it can produce self-sustained autonomous activity. We perturbed a single spike in this regime (out of millions) and showed that the network completely reorganized its firing activity within half a second. I will discuss the results of simulations of structural perturbations (lesions, strokes, and tumors) and their effect on the global dynamics, as well as the effect of sleep oscillations on synaptic plasticity, learning, and memory.

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O1 Emergence of behavioral primitives in self-organizing control and composition of behavior for autonomous robots

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Autonomous robots as well as animals process sensory information for the purpose of generating behaviors that are adapted to their respective environments. This includes the selection of behaviorally relevant perceptual features, the adaptation of control mechanisms and the storage and the recall of behavioral episodes for planning and execution. A robot as model of animal behavior should achieve sensorimotor control without being specifically programmed, but by exploring the behaviors that arise from the physical interaction between its body and the environment.

Self-organizing behavior. Efficient behavioral exploration can be obtained by the homeokinetic principle [1], a dynamical systems approach to robot control that establishes a self-tuned balance between sensitivity of actions to sensory inputs and predictability of the perceptual consequences of actions. The principle is effective in training artificial motor neurons to generate coherent movements that are suitable to explore the behavioral manifold [2]. Simultaneously, internal representations of the robot dynamics are learned by associative memory networks in the robot, which then play the role of an efference copy.

Composing behavioral primitives. In the present contribution we introduce an agent-based approach where a number of internal expert networks compete for the correct prediction of the control actions of a homeokinetic controller. As a result each agent achieves control over a specific reproducible behavior that forms a behavioral primitive. The obtained collection of behaviors is specific for the robot and the environment, but the elementary behaviors can be selected and combined to control the robot successful also in new environments. The composition of behaviors is achieved by a standard reinforcement learning algorithm with intrinsically determined rewards. The composition of the primitives is shown to be efficient for set of experts, but cannot be achieved when low-level actions used as elements. Videos of various robots (Figure 1) illustrates the study that also includes different degrees of specificity of the internal representations (Figure 2) and comparisons with classical methods.

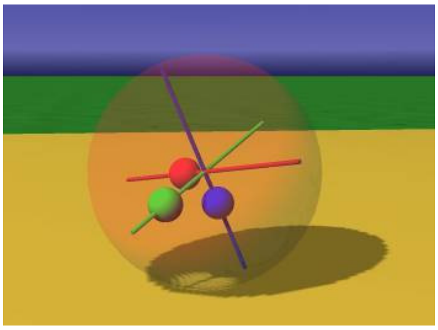

Figure 1. Simulated spherical robot actuated by three internal masses that are moveable along their axes

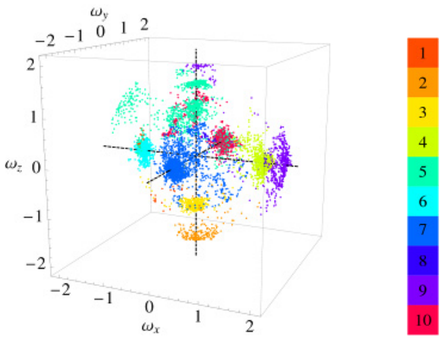

Figure 2. Partition of the space of angular velocities of the spherical robot by a set of control agents.

In conclusion, exploration of behavioral spaces by self-organizing control leads to the emergence of behavioral primitives that can be composed in order to generate complex goal-oriented behavior and can be used in motor planning.

Acknowledgment: The project was supported by the BCCN Göttingen grant #01GQ0432.

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O2 Irregular firing, quasi-stationary state and spike-time dependent response

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Neurons in vivo emit action potentials in a highly irregular manner. One generic feature of the corresponding distribution of inter-spike intervals (ISIs) is the presence of long exponential tails, and neuronal firing is therefore often described as a Poisson process. Such a strong irregularity sharply contrasts with periodic firing elicited by a constant input current, so that the origin of the randomness in the firing has long been a matter of debate. It is nowadays considered that irregular neuronal firing is due to a highly fluctuating drive generated by a balance between excitatory and inhibitory synaptic inputs to the neuron. The statistical properties of the neuronal firing and the underlying membrane potential dynamics in response to such a noisy drive have remained difficult to fully characterize. In this study, we relate the Poisson-like firing to the existence of a quasi-stationary state of the underlying membrane potential dynamics, and explore the implications of the convergence to this state on the response properties of the neuron.

We study analytically the stochastic dynamics of the membrane potential distribution between two successive action potentials, for an integrate-and-fire neuron receiving noisy synaptic inputs. We find that for long enough periods since the firing of the previous action potential, the dynamics converge to a quasi-stationary state, in which the membrane potential distribution becomes independent of time except for a global exponential decay. Once this quasi-stationary distribution has been reached, the firing probability per unit time becomes constant, and the subsequent firing is a Poisson process with a rate that depends on the amplitude of background noise. For in vivo-like background noise amplitudes, the convergence time to the quasi-stationary state is significantly shorter than the mean ISI, so that the quasi-stationary state dominates the dynamics.

The fast convergence to the quasi-stationary state has important implications on the response properties of the neuron. We examine the spike-time dependent response (SDR), which we define as the modification in the timing of the next AP due to a given synaptic input, as function of the timing of this input. In absence of noise, the SDR is equivalent to the well studied Phase Response Curve and the response depends strongly on the timing of the input. In contrast, for in vivo-like background noise, the timing of the input quickly becomes irrelevant because of the fast convergence to the quasi-stationary state. These theoretical findings are corroborated by in vivo and in vitro experiments.

Acknowledgements
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O3 Sparse coding of natural communication signals in midbrain neurons

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Sparse neural codes (i.e. codes in which neurons respond only to a few stimuli) have been widely observed across animal taxa [1–4]. Theoretical studies suggest that sparse neural codes critically depend on non-linear mechanisms [5]. However, the network and cellular properties that enable the observed sparse responses remain unclear. We investigated sparse coding in neurons within the midbrain torus semicircularis (TS) in the weakly electric fish Apteronotus leptorhynchus, which is equivalent to the inferior colliculus in the mammal. These fish generate a quasi-sinusoidal electric field via the electric organ discharge (EOD) with a characteristic frequency that varies across individuals. When two individuals come into contact, interference between their EODs will give rise to a beat phenomenon. Male Apteronotus leptorhynchus will transiently increase their EOD frequencies in a stereotypical manner during agonist encounters or courtship rituals: these chirps will occur in conjunction with the beat and must be distinguished by either the other male or the female (Figure 1). We performed in vivo patch clamp recordings to study TS neural responses to chirps occurring on top of the beat pattern. We found that one neuron type responded almost exclusively to chirps in a most peculiar manner. These neurons had little or no activity during the beat and fired a single action potential in response to the chirp (Figure 2). Chirp detection was negatively correlated with phase locking to the beat suggesting a segregation of information flow in midbrain neurons. Moreover, the chirp detection abilities were highly superior to those found in neurons afferent to TS. This indicates that separate streams of information arise in the torus and may be used to guide different behaviors by higher brain regions. We investigated the cellular mechanisms underlying this sparse coding. A combination of mathematical modeling and further experiments indicate that shunting inhibition hyperpolarizes the membrane potential below the firing threshold during the beat and increases the membrane conductance which promotes coincidence detection of synaptic input caused by the chirp. We speculate that a potassium conductance then hyperpolarizes the membrane potential after the first action potential: thereby enabling these neurons to respond to each chirp with a single action potential. Our findings reveal cellular mechanisms for the segregation of information flow and sparsening of neural responses to behaviorally relevant stimuli. These mechanisms may generalize to other sensory systems with which the electrosensory system shares similarities: in particular the auditory system.

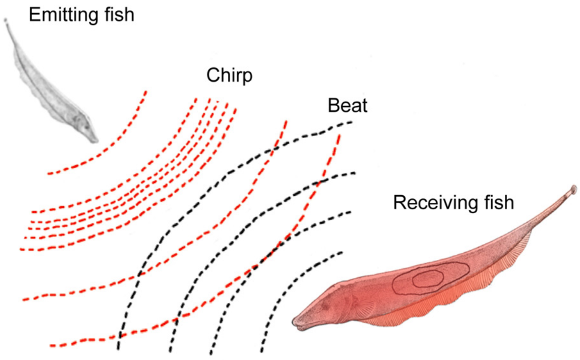

Figure 1: Chirps are transient frequency rises superimposed on top of the beat caused by two fish's EOD.

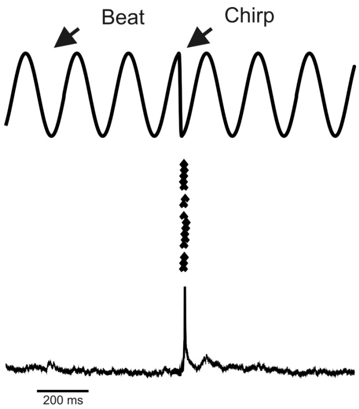

Figure 2: Response of midbrain neuron to natural communication signal 'chirp.'

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O4 Calcium sensor parameters and readout configurations for activity-dependent homeostatic regulation of pyloric network rhythms in the lobster stomatogastric ganglion

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In central pattern generating (CPG) neural networks, activity-dependent homeostatic regulation (ADHR) has been proposed to explain the experimentally observed robust activity that persists in spite of constant molecular turnover and environmental changes. In the pyloric CPG network of the lobster stomatogastric ganglion (STG), ADHR is dependent on and correlated with levels of intracellular calcium, which acts as a second messenger that affects ion channel and synaptic properties of the cell. Previous studies showed that calcium sensors can be used to maintain stable activity levels in individual model neurons [1] and pyloric rhythms in one model network [2]. For regulation, these studies used deviations of the calcium current from a target value. However, they did not address the choice of sensor activation and inactivation variables, and the robustness of selected parameters and sensor configurations in the network. To address these issues, we developed a testbed that judges the quality of a sensor by using its readings to make a prediction about whether a network activity pattern is functional.

To make predictions, we used a classifier trained with sensor readings from a model pyloric network database [3]. Based on their selected activity characteristics being similar to biological data, 2% of these networks were labeled as functional. In each testbed with different sensor placements and parameters, the percentage of functional networks correctly predicted by the classifier is indicated with a success rate.

Directly using the average calcium concentration from the three model cells of the network resulted in a 52% prediction success if shuffled, establishing a control case, compared to 77% without shuffling. Using average calcium current instead of the concentration, we obtained a similar success (77%), supporting the choice by earlier calcium sensor models [1,2]. We confirmed that the success rate increased by the addition of activation (78%) and inactivation (86%) variables in the averaged sensors, showing that the inactivation component is indispensable (see Figure). By testing all combinations of selected activation and inactivation parameters, we found their optimal values. It is biologically reasonable for the sensor minimal and maximal values to be involved in regulation and using them in addition to the sensor averages increased the success to 87%. Finally, using the fast, slow and DC sensors proposed earlier [1] together in the same cell marginally increased the success further to 88%. Taken together, our results suggest that activity sensing for ADHR of the pyloric network can potentially be achieved with relatively few, simple calcium sensors and that the properties of these sensors need not necessarily be adjusted to the particular role of each neuron in the network.

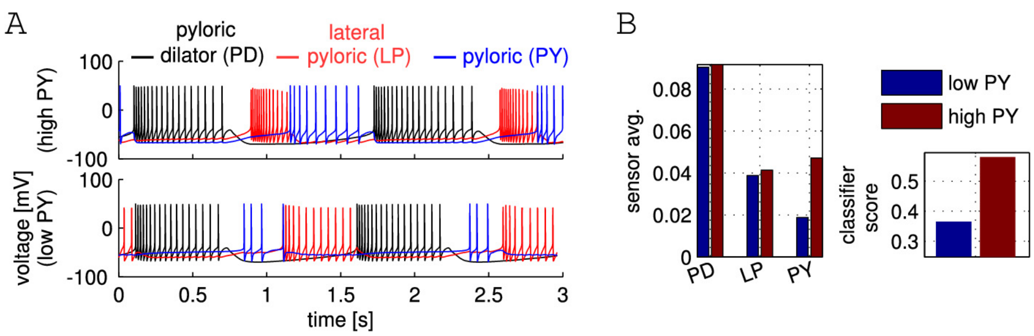

Figure: A. Activity patterns of the three model cells for a functional (top) and a non-functional (bottom) network. B. Sensor averages (left) show low activity in the PY model cell, which reduces the classifier score (right) below the 'functional threshold' of 0.5 to make a correct prediction.

Acknowledgments

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O5 Rich single neuron computation implies a rich structure in noise correlation and population coding

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Pairwise correlation in a population activity is a widely observed neural phenomenon. In particular, even with the same mean stimulus, noisy fluctuations in the population firings are often correlated, and this so-called noise correlation has attracted a lot of attention in regard to whether it might transfer independent information beyond a mean population response [1]. However, in the context of the common input model where a common input noise drives the noise correlation, a recent influential study suggested that the noise correlation must have a simple relationship with the average firing rate, or more precisely the average gain, and therefore claimed that the noise correlation might not carry any independent information [2].

In this work, we carried out a model study to probe the correlation-gain/rate relationship with biophysically defined single neuron models and found out that the relationship with gain actually fails to capture large noise correlations in some models. We suggest that this is closely related to the type 3 excitability of these neuron models. Type 3 excitability has been seen recently in model studies [3] and in some cortical neurons in the in vitro [4, 5] and in vivo-like conditions [6]. One of its interesting and relevant characteristics is that a type 3 neuron encodes not only the stimulus mean but also the variance [3–5,7]. By using an artificial functional model, we showed that these variance sensitive neurons, when given common noise, can generate sharply synchronized spikes, which contribute to the correlation that the correlation-gain relationship fails to predict.

Our result implies that a population of individual neurons with this rich coding strategy might use the correlation/synchrony as an extra channel for information transfer at the population coding level. Therefore the population code would not be an average of the individual responses where the fluctuations around the mean firing are simply suppressed by a population size.

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O6 Bayesian estimation of the time-varing rate and irregularity of neuronal firing

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Introduction

Spike trains generated by cortical neurons possess specific characteristics such as firing irregularity (see Figure A) other than the firing rate. Recently, our study revealed that the firing irregularity is rather specific to individual neurons and invariant with the time and the modulation of firing rate by using a metric for analyzing the time-local irregularity of spike events [1,2]. On the other hand, it was also reported that the firing irregularity varied significantly according to behavioral contexts in some other cortical area [3]. Therefore, we wish to examine how easily the firing irregularity is varied with the firing rate more systematically. For this purpose, we developed a Bayesian estimation method that allows us to estimate both the instantaneous rate and irregularity for a given spike sequence [4]. In our new framework, we first consider the stochastic process of generating spikes under a given rate and irregularity, and then invert the conditional probability distribution to infer the rate and the irregularity from the data.

We applied our new method to the experimentally recorded spike data taken from Neural Signal Archive [5] (see Figure B), and revealed that there is a systematic correlation between firing rate and firing irregularity, and that the degree of the variability in the firing irregularity greatly depends on the cortical areas.

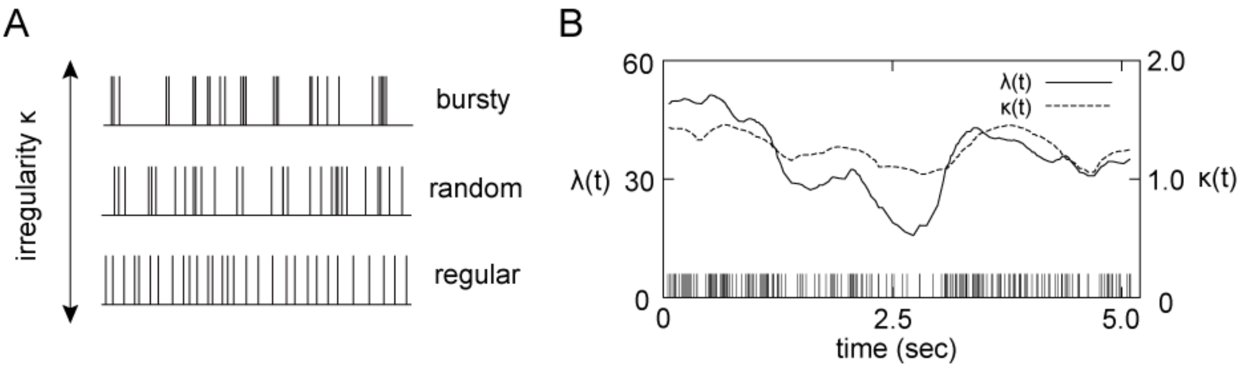

Figure. (A) Sample sequences of events with identical rate and different irregularity, which may be termed bursty, random (Poisson), or regular. (B) The MAP estimate of the instantaneous rate $(mbda(t)$ and irregularity $\kappa(t)$ for the spike sequence $\{t_i\}$ recorded from a V1 neuron of a Macaque (nsa2004.4; Neural Signal Archive[5]).

Acknowledgements

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O7 Dual coding in an auto-associative network model of the hippocampus

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Introduction. The activity of pyramidal cells in the hippocampus has been empirically demonstrated to encode both spatial and non-spatial cues by means of a dual code [1]. The phase of place cell firing with respect to the theta oscillation encodes spatial information: primarily the position of an animal and its current heading [2]. Conversely, firing rate has been demonstrated to encode a variety of non-spatial cues, including running speed, complex visual stimuli and concepts [3–5]. Here we present a novel spiking neural network model which is, to our knowledge, the first to use a dual coding system in order to learn and recall associations between both temporally coded (spatial) and rate-coded (non-spatial) activity patterns.

Methods. The postulated function of the hippocampus in spatial and episodic memory has been widely and successfully modelled using auto-associative networks [6]. Here we use a spiking auto-associative network with a novel STDP rule that replicates a BCM-type dependence of synaptic weight upon mean firing rate. An abstract acetylcholine signal tied to the theta oscillation modulates external input, synaptic currents and synaptic plasticity [7]. Place cell activity consists of a compressed temporal sequence of neural firing within each theta phase. Non-spatial cues, which are present at a subset of the locations traversed, are represented by neural bursting at the peak of the theta phase.

Results. We simulate the network moving along a circular track of 50 place fields with objects present at five equidistant locations. Following learning, we demonstrate that

1. The external stimulation of any place cell generates the sequential recall of upcoming place fields on the learned route;
2. The external stimulation of any place cell generates the recall of any object that was previously encountered at that place;
3. The external stimulation of cells which encode an object generates recall of both the place at which that object was observed, and the upcoming place fields on the learned route; and
4. The network performs pattern completion, meaning that only a subset of cues is required for this recall activity to be generated.

This model is the first known network instantiation of an asymmetric STDP rule which can mediate both rate and temporal coding. Furthermore, it provides the first demonstration of an auto-associative network that can use this dual code to integrate dynamic and static activity patterns and thus model the disparate mnemonic functions ascribed to the hippocampus.

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O8 What does a neuron 'see'? Limitations imposed by the statistics of afferent inputs to a neuron

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Neurons encode information in their spike trains. In a range of neural systems, every spike train and potentially each spike is supremely important [1], so important that, given appropriate input, many neurons can reliably repeat their spike timing with startling accuracy [2]. Yet a target neuron sees many such spike trains in its afferent input. And the statistics of such a group of spike-trains are well described by simple models that pay no heed to the single spike or even the single spike train. How then do we reconcile the success of these simple models with the complexity of encoding within and decoding of spike trains [1,3].

First, we set out to understand just how accurate these simple models are. They are often used for qualitative understanding of problems [1] and that is certainly an approach used here. But we show that these simple models can be pushed hard before they break down and thereby can give quantitative insight. We build a framework that directly generates the set of spike-events that occur across all the target neuron's inputs and that encapsulate many simple models of the individual spike trains. Nonetheless, these spike-event generators are sufficiently simple for us to gain analytical insight into exactly how the structure of the input to a neuron is dependent on the number, rate and correlation of the individual spike trains. As an example, we use this to model the global properties that arise from weak pair-wise correlations between spike trains [4].

The framework's most interesting prediction is that the global statistics of the afferent input to a single neuron converge for a wide range of properties of the individual afferent spike trains, thus obscuring potentially important properties of those spike trains. How then does information carried by individual spike trains become decoded into the output of a neuron? This question stands in contrast to much previous work that has focused on decoding the spike train correlates of continuous stimuli [1,3]. We show, because of the obscuring effects on individual trains, our framework predicts that strongly asymmetric distributions of synaptic conductances are necessary for reliable reproduction of output spike trains in response to common components of different sets of inputs [2]. Thus, we posit this as the reason for such distributions in the vertebrate brain, recently described in many neural circuits [5].

Acknowledgements
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O9 Fast and reliable methods for extracting functional connectivity in large populations

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The simplest model for describing multi-neuron spike statistics is the pairwise Ising model [1,2]. To start, one divides the spike trains into small time bins, and to each neuron i and each time bin t assigns a binary variables $s_i(t) = -1$ if neuron i has not emitted any spikes in that time bin and 1 if it has emitted one or more spikes. One then can construct an Ising model, $P(\mathbf{s}) = Z^{-1}\exp\{\mathbf{h}'\mathbf{s} + \mathbf{s}'\mathbf{J}\mathbf{s}\}$ for the spike patterns with the same means and pair correlations as the data, using Boltzmann learning, which is in principle exact. The elements J_{ij} of the matrix $\mathbf{J}$ can be considered to be functional couplings. However, Boltzmann learning is prohibitively time-consuming for large networks. Here, we compare the results from five fast approximate methods for finding the couplings with those from Boltzmann learning.

We used data from a simulated network of spiking neurons operating in a balanced state of asynchronous firing with a mean rate of 10 Hz for excitatory neurons. Employing a bin size of 10 ms, we performed Boltzmann learning to fit Ising models for populations of size N up to 200 excitatory neurons chosen randomly from the 800 in the simulated network. We studied the following methods: A) a naive mean-field approximation, for which **J** is equal to the negative of the inverse covariance matrix, B) an independent-pair approximation, C) a low rate, small-population approximation (the low-rate limit of (B), which is valid generally in the limit of small Nrt, where r is the average rate (spikes/time bin) and t is the bin width [3], D) inversion of the TAP equations from spin-glass theory [4] and E) a weak-correlation approximation proposed recently by Sessak and Monasson [5]. We quantified the quality of these approximations, as functions of N, by computing the RMS error and R^2, treating the Boltzmann couplings as the true ones. We found, as shown in figures a and b, that while all the approximations are good for small N, the TAP, Sessak-Monasson, and, in particular, their average outperform the others by a relatively large margin for N. Thus, these methods offer a useful tool for fast analysis of multineuron spike data.

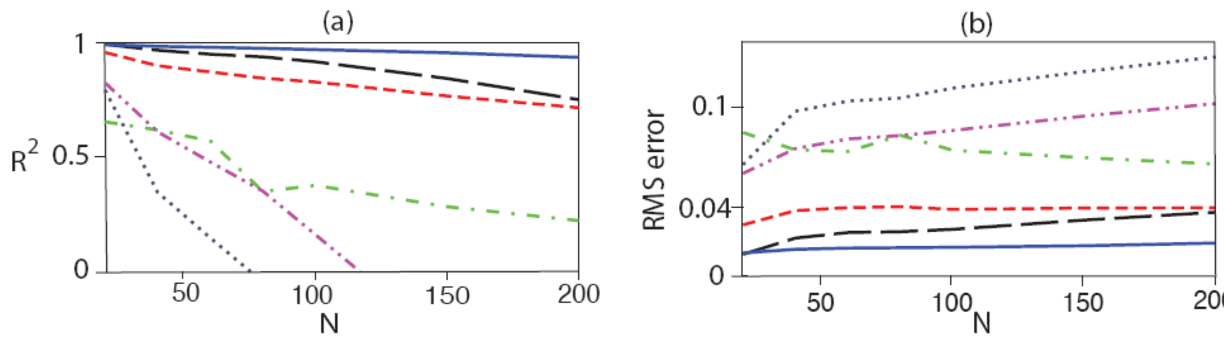

Figure: (a) R^2 and (b) RMS error for various approximate methods. Green (dashed dotted), naive mean-field; Purple (dashed double-dotted) low-rate, small N; Gray (dotted) independent-pair; Red (dashed), TAP; Black (dashed), Sessak-Monasson; Blue, average of TAP and Sessak-Monasson.

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O10 Sequential sparsing by successive adapting neural populations

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In the principal cells of the insect mushroom body, the Kenyon cells (KC), olfactory information is represented by a spatially and temporally sparse code. Each odor stimulus will activate only a small portion of neurons (spatial sparseness) and each stimulus leads to only a short phasic response following stimulus onset (temporal or lifetime sparseness) irrespective of the actual duration of a constant stimulus. The mechanisms responsible for the temporally sparse code in the KCs are yet unresolved.

Here, we explore the role of the neuron-intrinsic mechanism of spike frequency adaptation (SFA) in producing temporally sparse responses to sensory stimulation in higher processing stages. SFA is an ubiquitous phenomena found in many different model systems. Our single neuron model is defined through a full five-dimensional master equation for a conductance-based integrate-and-fire neuron with spike-frequency adaptation [1]. We study a fully connected feed-forward network architecture in coarse analogy to the insect olfactory pathway. A first layer of ten neurons represents the projection neurons (PNs) of the antenna lobe. All PNs receive a step-like input from the olfactory receptor neurons, which was realized by independent Poisson processes. The second layer represents 100 KCs which converge onto ten neurons in the output layer which represents the population of mushroom body extrinsic neurons (ENs).

Our simulation result matches well with the experimental observations. In particular, intracellular recordings of PNs show a clear phasic-tonic response that outlasts the stimulus [2] while extracellular recordings from KCs in the locust express sharp transient responses [3]. We conclude that the neuron-intrinsic SFA mechanism is sufficient to explain a progressive temporal response sparsening in the insect olfactory system. Further experimental work is needed to test this hypothesis empirically.

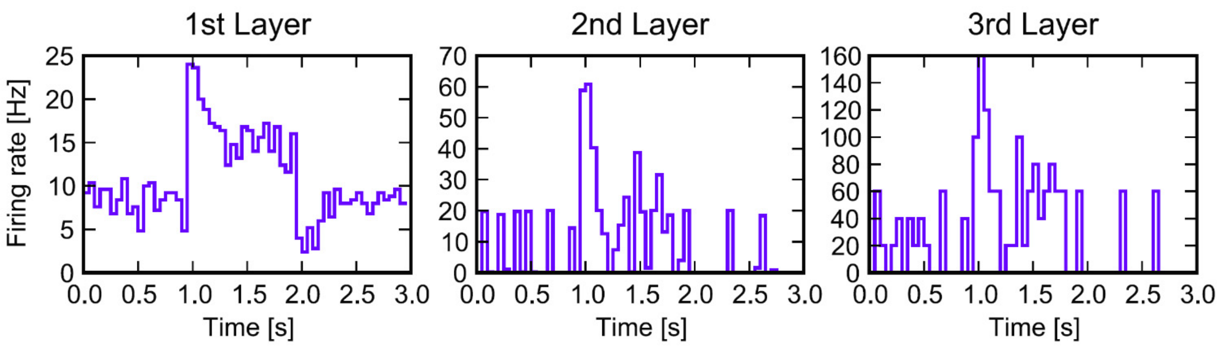

Figure. Layer-specific population response in a simplified feed-forward network of the insect olfactory pathway. Average population response in the first layer (left) to a step-like Poisson input shows a phasic-tonic response as observed in antennal lobe projection neurons. In the second layer (middle) the population response profile is dominated by a sharp onset transient and tonic firing is diminished. The final output layer (right) with reduced adaptation current integrates convergent input.

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O11 Neural networks with small-world topology are optimal for encoding based on spatiotemporal patterns of spikes

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Despite a wealth of knowledge at the micro- and macroscopic scales in neuroscience, the way information is encoded at the mesoscopic level of a few thousand neurons is still not understood. Polychronization is a newly proposed [1] mechanism of neuronal encoding that attempts to bridge this gap and that has been suggested to underlie a wide range of cognitive phenomena, from associative memory to attention and cross-modal binding. This encoding is based on millisecond-precision spatiotemporal firing patterns, corresponding to so-called polychronous groups, that have been shown to emerge spontaneously in networks of spiking neurons with axonal conduction delays and spike-timing-dependent plasticity.

Here, we investigate the effect of network topology on the ease and reliability with which input stimuli can be distinguished by such a network based on their encoding in the form of polychronous groups. We find that, while scale-free networks are unreliable in their performance, small-world and modular architectures perform an order of magnitude better than random networks at such discrimination tasks in a variety of situations. Furthermore, we find that these topologies introduce biologically realistic constraints on the optimal input stimuli for the system, performing best with inputs consistent with the topographic organization known to exist in many cortical areas. Finally, we investigate the capacity of such networks to distinguish between signals involving overlapping sets of input neurons and suggest that, for optimal performance, the network should be locally as well as globally small-world but should only show large-scale modularity.

These topological constraints on both networks and stimuli seem consistent with the first experimental findings on the cortical network architecture (see review [2] and references therein), suggesting that these are optimal for information processing through polychronization.

Acknowledgements
We thank Eugene Izhikevich and Danielle Bassett for helpful advice and discussion.

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O12 Identification of functional information subgraphs in cultured neural networks

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Abstract
We present a general information theoretic approach for identifying functional subgraphs in complex neuronal networks where the spiking dynamics of a subset of nodes (neurons) are observable. We show that the uncertainty in the state of each node can be written as a sum of information quantities involving a growing number of variables at other nodes. We demonstrate that each term in this sum is generated by successively conditioning mutual information on new measured variables, in a way analogous to a discrete differential calculus. The analogy to a Taylor series

suggests efficient optimization algorithms for determining the state of a target variable in terms of functional groups of other nodes. We apply this methodology to electrophysiological recordings of cortical neuronal network grown in vitro. Despite strong stochasticity, we show that each cell's firing is generally explained by the activity of a small number of other neurons. We identify these neuronal subgraphs in terms of their redundant or synergetic character and reconstruct neuronal circuits that account for the state of target cells.

Acknowledgements
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O13 Optimal correlation codes in populations of noisy spiking neurons

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In most areas of the brain, information is encoded in the correlated activity of large populations of neurons. We ask how neural responses should be coupled to best represent information about different ensembles of correlated stimuli. Three classical population coding strategies are independence, decorrelation and error correction. Here we demonstrate that balance between the intrinsic noise level and the statistics of the input ensemble induces smooth transitions between these three coding strategies in a network composed of pairwise-coupled neurons and tuned to maximize its information capacity.

We extend recent work [1,2] and theoretically explore small networks of neurons of the 'Ising' form whose joint probability of firing is determined both by external inputs and by couplings between pairs of neurons. The neurons are taken to be binary, to represent spiking or silence. We then find the pairwise couplings to maximize information conveyed by neural states about different input ensembles in the presence of intrinsic noise. We consider two kinds of ensembles – binary patterns, and correlated Gaussian inputs – and vary the noise levels parametrically to scan the range of network behaviors.

For binary input ensembles at a high noise level, the optimal neural coupling reinforces the input correlations: a simple form of autoassociative error correction. As the noise level decreases, the coupling goes to zero: the neurons become independent. The Gaussian input ensemble leads to the same optimal network behavior at high noise as for the binary ensemble. This regime is characterized by the emergence of metastable states that serve as 'memories' of the input patterns in the sense of a Hopfield network. The weights in a Hopfield net are often chosen by hand to store the desired patterns; here autoassociative memory emerges as an automatic consequence of maximizing information capacity. Furthermore, in this regime single neuron variability overestimates the variability of the code, suggesting that 'noise' in single neurons is partly a misinterpretation of redundant population codes. At low noise, there is a new optimal network strategy: decorrelation of the stimulus. The absence of a decorrelating regime in the binary ensemble can be understood intuitively by the fact a correlated binary stimulus ensemble has comparable number of input and output states, while the Gaussian ensemble features an infinite number of possible input states, enabling decorrelation to fill the bandwidth efficiently.

Our analysis predicts specific changes in effective network couplings in response to stimuli with different statistics, which can be measured in extensions of experiments of [1,2].

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O14 A network of reverberating neuronal populations encodes motor decision in macaque premotor cortex

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We investigate, through in-vivo experiments and theoretical models, the dynamic mechanisms subserving motor decision tasks. The proposed computational framework is based on local reverberations in multiple neuronal subpopulations. Signatures of such reverberations are identified in the simulated multi-modular network of spiking neurons and recognized in the analysis of recorded neural activity. The reported experimental results are compatible with a neuronal substrate in which several local populations undergo sudden transitions as a late reaction to a visual stimulus. Often, such transitions are very plausibly supported by strong local recurrent feedback as in models of decision making [1]. Transitions also occur without clear evidence of local reverberation; the combined evidence suggests the coexistence of 'active' and 'passive' modules, the latter responding to the activity of the first ones, which together cooperate in order to represent a distributed and well stereotyped motor program.

Results. We recorded from dorsal premotor cortex (PMd) of two monkeys required to reach quickly a target randomly appearing in one of two opposite peripheral positions (movement conditions) after a go-signal (no-stop trials), but to withhold the movement whenever an intervening stop-signal was shown after a random delay (stop trials). We selected recordings showing a significant increase, in at least one movement condition, of MUA activity during no-stop reaction time (the epoch between the go signal and the movement onset). Sixty-one percent (68/112) of these recordings are characterized by a sharp upward transition (SUT) of the MUA signal, the time of which is strongly correlated with the movement onset at the single trial level. On average, upward transitions precede the movement onset by 110 ms and are completed in less than 100 ms.

The predictive value of the SUT time of occurrence is strengthened by the behavioral outcome of the stop trials. In 'wrong' stop trials, when the monkeys fail to cancel the movement, an early SUT is observed while either none or later SUT are observed in 'correct' stop trials. Taken together, the evidences from stop and no-stop trials support the speculation that the occurrence of a SUT in PMd is causally related to movement onset. In a sizable fraction of the recordings during the reaction times, the MUAs have a bimodal distribution, which suggests the existence of two preferred levels of firing rates; this is consistent with observations from single unit recordings [2] and compatible with attractor-like dynamics of the probed neuronal population [1,3,4]. We furthermore probed during reaction time the Fourier spectral features of the raw electrophysiological signal in 20 ms sliding windows. Low-activity and high-activity periods show clearly different modulations of the spectral power in medium (50-230 HZ) and high-frequency (230-1080 Hz) bands. MUA with unimodal distributions do not show the above modulation of power spectra; their transitions can be thought to be driven by the input they receive from other reverberating modules.

Simulations of multiple populations of synaptically coupled leaky integrate-and-fire neurons with recurrent excitation and inhibition [4] reproduced qualitatively well the observed MUA dynamics. In particular, randomness in SUTs emerges from intrinsic fluctuation of spiking activity. For strong enough AMPA/NMDA recurrent couplings, simulations reproduced both bimodal distributions of firing rate and spectral modulations observed from experiments, reinforcing the picture of neural populations capable of multi-stable dynamics and high input susceptibility, supported by local activity reverberation, as a plausible interpretation of experimental evidence.

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O15 A bistable synaptic model with transitions between states induced by calcium dynamics: experiment vs theory

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Synaptic plasticity is thought to underlie learning and memory, but the mechanisms that give rise to observed changes in synaptic efficacy are still poorly understood. Numerous experiments have shown how synaptic efficacy can be increased (LTP) or decreased (LTD) purely by presynaptic stimulation at different frequencies, doublets of pre- and postsynaptic spikes, spike-doublets at different frequencies and spike-triplets. A few experiments suggest that these long-term synaptic changes are all-or-none switch-like events between discrete states. Models addressing the issue of maintenance of the synaptic state during the early phase of LTP/LTD show that signaling cascades influencing calcium/calmodulin-dependent protein kinase II (CaMKII) phosphorylation and dephosphorylation could give rise to a binary switch durably maintaining the synaptic state. However, a mechanistic model explaining how the biological machinery present at the synaptic site can lead to the experimentally observed synaptic changes is still lacking. In particular, it has been shown difficult in modeling studies to account for all plasticity outcomes evoked by various experimental stimulation protocols.

We present a model of a single synapse submitted to trains of pre- and postsynaptic spikes evoking calcium transients. The synaptic efficacy is taken to be proportional to the phosphorylation level of a kinase (e.g. CaMKII) and has two stable fixed points at resting conditions, endowing the system with bistability. Changes of the synaptic efficacy are driven by de- and phosphorylation processes which themselves are driven by calcium elevations. De- or phosphorylation are activated as long as the calcium concentration stays above the de- or phosphorylation threshold, respectively. The response of the synapse model to various experimental protocols known to induce synaptic plasticity experimentally is studied numerically and analytically.

We show that the proposed simple yet biologically founded synapse model reproduces qualitative plasticity results by virtue of two opposing pathways – protein de- and phosphorylation – that activate at distinct calcium levels. In particular, the model explains how: (i) low frequency pre-synaptic stimulations induce LTD while high frequency stimulations induce LTP; (ii) pre before post spike-doublets at intermediate frequency induce LTP while post before pre doublets induce LTD; (iii) only LTD is induced at low frequency by post-pre doublets, and doublets at high frequency induce LTP independent of pre-post timing; (iv) there is an asymmetry between pre-post-pre and post-pre-post triplets, i.e. our model shows potentiation for post-pre-post triplets and no change for pre-post-pre triplets. In a step towards more realistic activity patterns, we investigate synaptic changes induced by pre- and postsynaptic Poisson firing at different rates.

In all these scenarios, we present analytical calculations of transition probabilities between the two stable synaptic states, which allow us to understand in detail how experimental plasticity outcomes are related to the underlying synaptic machinery. We can furthermore make predictions about how changes in the calcium dynamics or the de- and phosphorylation pathways affect synaptic plasticity results. The model demonstrates that synaptic changes driven by calcium transients evoked by pre- and postsynaptic activity patterns reproduce naturally the nonlinearities of observed plasticity outcomes.

O16 Structural plasticity, cortical memory, and the spacing effect

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The neurophysiological basis of learning and memory is commonly attributed to the modification of synaptic strengths in neuronal networks. Recent experiments suggest also a major role of structural plasticity, including elimination and regeneration of synapses, growth and retraction of dendritic spines, and remodeling of axons and dendrites [1]. Here, I develop a simple model of structural plasticity and synaptic consolidation in neural networks and apply it to Willshaw-type network models of distributed associative memory [2]. The model assumes synapses with discrete weight states. Synapses with low weights have a high probability of being erased and replaced by novel synapses at other locations. In contrast, synapses with large weights are consolidated and cannot be erased. Analysis and numerical simulations reveal that this model can explain various cognitive phenomena much better than alternative network models employing synaptic plasticity only.

In previous work, I have shown that networks with low anatomical connectivity employing structural plasticity in coordination with stimulus repetition (e.g., by hippocampal memory replay) can store much more information per synapse by 'emulating' high effective memory connectivity close to potential network connectivity [2]. In this work, I present additional simulations and analyses suggesting that networks employing structural plasticity suffer to a much lesser degree from catastrophic forgetting than models without structural plasticity [3] if the number of consolidated synapses remains sufficiently low. The reason for this effect is that early memories get stored with a higher effective connectivity than recent memories. Therefore the ability to learn new items fades gradually without affecting remote memories. The same effect may explain Ribot gradients in retrograde amnesia much better than previous models relying on gradients in replay time [4].

Another salient feature of memory is the spacing effect [5] where learning new items is more effective if rehearsal is spread out over time compared to the case when rehearsal is done in a single time block. For example, rehearsing a list of vocabulary two times for ten minutes each is more effective than doing a single rehearsal for twenty minutes. The spacing effect is a remarkably robust phenomenon and can be found in many explicit and implicit memory tasks in humans and many animals being effective over many time scales from single days to months. This suggests that there should be a very general learning mechanism underlying the spacing effect. However, current explanations rather suggest very specific mechanisms referring to detailed implementations of memory systems including attention, novelty, and context processing. While these explanations may well account for some detailed characteristics of the spacing effect in some specific memory tasks, I suggest that the common underlying mechanism at the cellular level is structural plasticity in sparsely connected neural networks. This is supported by simulation experiments and analyses showing that simple models of structural plasticity and consolidation robustly reproduce the spacing effect. The interpretation is that ongoing structural plasticity can reorganize the network during the long time intervals between two rehearsal periods by growing a lot of new synapses at potentially useful locations. Therefore, subsequent training can strongly increase effective memory connectivity and thus reduce retrieval noise. In contrast, single block rehearsal can increase effective memory connectivity only slightly above anatomical connectivity. This leads to the hypothesis that the spacing effect is as robust and general as observed in various experimental paradigms because structural plasticity is a ubiquitous feature of many neural networks in the human and animal brain. The spacing effect occurs over many time scales because also structural plasticity works over many different time scales corresponding to elimination and regeneration of synapses, spines, axons, and dendrites, ranging from minutes to months or even years.

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O17 Partial response to supra-threshold excitation desynchronizes spiking neurons

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Desynchronization of neuronal dynamics is highly relevant, occurring for example in pathological synchronized neuronal activity involved in Parkinson tremor or in epileptic seizures [1–3]. Several mechanisms for desynchronization have been proposed and are based on heterogeneity, noise, or delayed feedback [1–6]. Here we reveal a different desynchronization mechanism based on the neuron's partial response to supra-threshold inputs [7–9]. In medical applications, desynchronization may be controlled by appropriate low-level drugs that change a neuron's intrinsic response properties.

Typically, a spike generated at the soma affects the dendritic part only indirectly due to intra-neuronal interactions. Thus excitatory input charges may partly remain on the dendrite and contribute to the membrane potential integration after the reset at the soma [10–12]. Several multi-compartment models have been proposed to characterize this effect. For instance, in a two-compartment model [13] of coupled dendrite and soma, the membrane potential at the soma is reset after spike emission, while the dendritic dynamics is affected only by the resistive coupling to the soma.

Here we propose an idealized neural network model that captures the partial response to residual input charges after spike emission by a partial reset. We analytically study the effect of the partial reset onto the collective network dynamics and uncover a desynchronization mechanism that causes a sequential desynchronization transition: In globally coupled neurons an increase in the strength of the partial response induces a sequence of bifurcations from states with large clusters of synchronously firing neurons, through states with smaller clusters to completely asynchronous spiking. The mechanism is robust against structural perturbations in the network and neuron properties.

We link our simple model to biophysically more detailed ones by comparing spike time response curves (STRCs). STRCs encode the shortening of the inter-spike intervals (ISI) following an excitatory input at different phases of the neural oscillation. An excitatory stimulus that causes the neuron to spike will maximally shorten the ISI in which the stimulus is applied. Additionally the following ISI is typically affected as well. This effect can be characterized by an appropriately chosen partial reset in our simple system.

We find a similar desynchronization transition in networks of two-compartment conductance based neurons when varying the resistive coupling between soma and dendrite. By linking the two-compartment neuron model via STRCs to our simple model we observe a change in the partial reset strength and identify it as the underlying desynchronization mechanism.

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O18 A probabilistic framework to infer connectivity from function: A study of change detection and adaptation

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A marked feature of sensory neurons is their propensity to respond more strongly to transient rather than to steady stimuli. While a variety of mechanisms, like short-term depression and spike rate adaptation, boost responses to higher temporal frequencies, change detection as a key aspect of sensory processing remains largely unexplored. To test this hypothesis, we use a novel probabilistic framework and show quantitatively the importance of feed-forward inhibition in detecting sudden 'appearance' of stimuli. The model accounts for some coding strategies in the early visual system and suggests a neuronal microcircuit that could achieve this function.

Assuming Markov dynamics of real world stimuli and Poisson input spike trains, we derive an ideal observer that computes on-line the probability of a sudden stimulus appearance by reading out changes in input firing rates. The resulting integration dynamics resembles that of real neurons. It predicts a biphasic, nonlinear synaptic integration consisting of a fast, transient excitation followed by a slower long lasting inhibition. The same stimulus exciting the cell at short delays inhibits it at longer ones. However, the properties of this integration (i.e. the strength and time constants of excitation and inhibition) depend on the temporal statistics of stimuli and the reliability of input spike trains.

We then explore what this general framework implies for neural coding in terms of temporal receptive fields (tRFs), contrast adaptation and spike-time precision in early visual areas. We found that our model reproduces the firing statistics of the retina and LGN in response to time- (and contrast-) varying stimuli. Particularly, sharp peaks in the resulting PSTH are well described. The predicted tRFs resemble those of 'ON' and 'OFF' retinal ganglion cells and LGN cells. Interestingly, as a result of model nonlinearities, their shape adapts to input contrast as experimentally reported. Integration dominates at low contrasts, while temporal derivation occurs at higher ones. Moreover, in agreement with experimental data, the bursts of spikes obtained are preceded by strong inhibition while isolated spikes are not.

As a biophysical implementation of this adaptive change detection model, we suggest a microcircuit that is commonly observed in many sensory areas. Namely, a pyramidal neuron targeting another pyramidal neuron both directly with a depressing synapse and indirectly with a facilitating synapse through an inhibitory interneuron. Finally, we show how this inhibition modulates the performance in detection and discuss its more general role in sensory processing over different timescales.

O19 Cooperative synapse formation in the neocortex

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Introduction. Neuron morphology plays an important role in defining synaptic connectivity. Clearly, only pairs of neurons with closely positioned axonal and dendritic branches can be synaptically coupled. For excitatory neurons in the cerebral cortex, such axo-dendritic oppositions, or potential synapses, must be bridged by dendritic spines to form synaptic connections. To explore the rules by which synaptic connections are formed within the constraints imposed by neuron morphology, we compared the distributions of the numbers of actual and potential synapses between pre- and post-synaptic neurons forming different laminar projections in rat barrel cortex. Quantitative comparison explicitly ruled out the hypothesis that individual synapses between neurons are formed independently of each other. Instead, the data are consistent with a cooperative scheme of synapse formation, where multiple-synaptic connections between neurons are stabilized, while neurons that do not establish a critical number of synapses are not likely to remain synaptically coupled.

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O20 How chaotic is the balanced state?

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Local cortical circuits often exhibit highly irregular spiking dynamics that appears to be random. Such irregular dynamics are commonly considered as a 'ground state' of cortical circuits. In a fundamental work, van Vreeswijk and Sompolinsky [1] suggested that a 'chaotic balanced state' underlies this irregular cortical activity. In such a state, strong inhibitory and excitatory inputs to each neuron balance on average and only the fluctuations generate spikes. Moreover, the original high-dimensional network dynamics and a slightly perturbed version of it rapidly diverge from each other, suggesting that chaos is the dynamical mechanism that induces irregularity. Here we show analytically and numerically that irregular balanced activity may equally well be generated by collective dynamics that is not chaotic but stable almost everywhere in state space. This dynamics has the same coarse statistical features as its chaotic counterpart (see figure). Our results reveal that chaos is not necessary to generate irregular balanced activity in an entire class of deterministic spiking neural networks. Most importantly, the results also indicate that not chaos or stochasticity, but some other dynamical mechanism may actually underlie the irregularity observed in cortical activity.

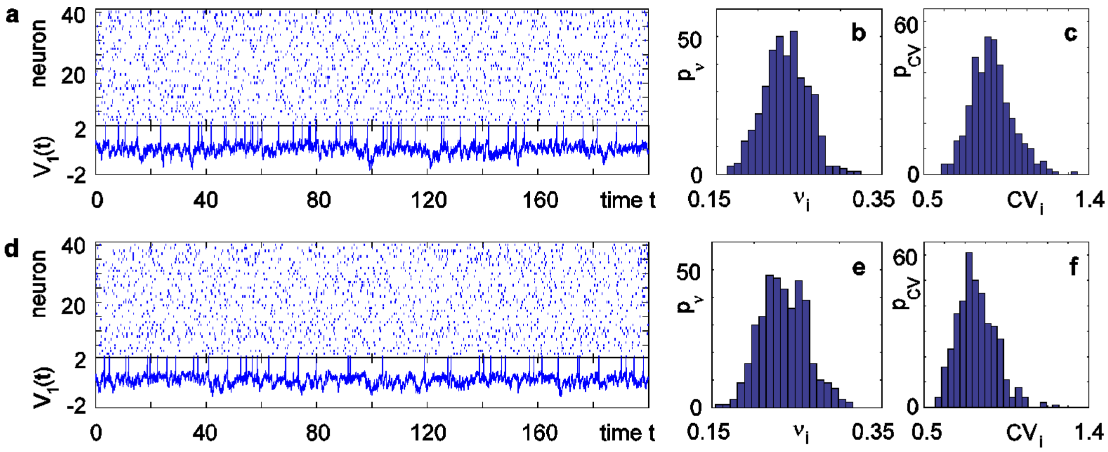

Figure. Irregular dynamics in purely inhibitory (a-c) and inhibitory and excitatory (d-f) coupled random networks of identical leaky integrate-and-fire neurons (N=400). Starting with a network where all connections are inhibitory, we consecutively replace inhibitory connections by excitatory ones. We reduce the external current to keep the average input to a single cell constant. Whereas the spiking activity is similar and highly irregular in both regimes, we demonstrate that the first one is stable while the second one is chaotic. (a,d) The upper panel displays the spiking times (blue lines) of a subset of 40 neurons. The lower panel displays the membrane potential trajectory of one single neuron. (b,e) Histogram of mean firing rates, vi. (c,f) Histogram of the coefficients of variation, CVi, averaged over time.

Acknowledgements
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O21 Control of the temporal interplay between excitation and inhibition by the statistics of visual input

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Introduction. In the primary visual cortex (V1), single cell responses to simple visual stimuli (drifting gratings) are usually strong but with a high trial-by-trial variability. In contrast, when exposed to full field natural scenes with simulated eye movements, the firing patterns of these neurons are sparse but highly reproducible over trials [1]. So far the mechanisms behind these two distinct different response behaviours are not yet fully understood. Different mechanisms are candidates for controlling spike timing precision and models are needed to clarify their respective contribution, which may be of thalamic or intracortical origin. As a first step, we investigated which aspects of the neuronal dynamics can be explained by balanced feedforward excitation and inhibition and its dependency upon the spatio-temporal statistics of the different stimuli. We built a simple model of the early visual system (LGN,V1). The thalamocortical connectivity was similar to the gpush-pullh architecture used in [2], with additional depressing thalamocortical synapses [3]. The model was written in PyNN [4] using NEST [5] as simulator. Indeed, the model can reproduce the main response characteristics of first-order thalamo-cortical neurons in layer 4 of cat V1. During drifting gratings, excitatory and inhibitory conductances of cortical neurons were anti-correlated [6,7], such that excitation can be freely integrated and induce multiple spikes. In contrast, during natural scenes the conductances were correlated, with inhibition lagging by few milliseconds [1,8]. This small lag between excitation and inhibition induces a strong selectivity to synchronous inputs, with a consequence that the responses became sparse and precise. However, some key aspects of the in vivo recordings in cat area V1 cannot be explained, such as selective reduction of stimulus-locked subthreshold noise during natural scene viewing, precise firing during fixational eye-movements and center-surround non-linearities, opening the door for future investigation about the role of intra-cortical recurrent connectivity in further shaping the neuronal responses to natural images. In conclusion, our study points that correlated inhibition can explain, at least in part, sparse and reliable spiking activity as observed in response to natural scenes. This is consistent with its role reported from other sensory modalities and cortical areas [8]. Thus correlated excitation and inhibition could be a general mechanism to induce sparse and precise spiking in the nervous system.

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Neuroinformatics Symposium

S1 CARMEN: An e-science virtual laboratory supporting collaboration in neuroinformatics

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Studies of neural networks and the processes they control frequently employ recording techniques to determine temporal patterns of activity within individual neurons and their interactions. Neuroinformatics is the rapidly growing science that addresses the manipulation and analysis of the vast volumes of data generated from such techniques. However, although these data are often difficult and expensive to produce, they are rarely shared and collaboratively exploited, and dissemination of new analysis methods may be restricted by issues of software and file compatibility. CARMEN (Code Analysis, Repository and Modeling for e-Neuroscience) aims to address these issues by creating an environment for handling time series data and for deploying analysis algorithms using distributed computing technology.

The CARMEN infrastructure builds heavily on software developed in previous e-science projects. The 'Cloud' architecture allows the co-location of data and computation (avoiding the need to repeatedly transfer large quantities of data) and enabling users to conduct their science through a web browser. The data handling capabilities of the CARMEN portal have recently been deployed, enabling registration of users and upload of data files. The primary data consists mainly of files of electrophysiological data, for which we use Storage Resource Broker to manage the distributed store. To provide a description of experimental protocols, an extensible metadata schema has been developed [1] and implemented using templates to avoid the necessity of re-entering values for common protocols. A security layer enables the contributor to control access rights to both the data and metadata, so that the originator and collaborators can share and analyze the data in a private environment until publication when the data may be made public. This repository satisfies the requirements of funding agencies to make research output publicly available and provides a resource for computational neuroscientists.

The project consortium is developing new analysis methods including spike detection services that use wavelet and morphology techniques [2], a spike sorting methodology that extends WaveClus [3], information theoretic analysis and Bayesian network analysis to determine causal relations, and algorithms for resolving spike synchrony. An associated thick client tool, Signal Data Explorer, provides data visualization, signal processing and pattern matching capabilities. Because analysis applications need to be executed on a wide range of data formats, we have specified a uniform file and format structure for data sharing and communication between applications [4]. We are implementing an enactment engine to enable linking of applications into more complex and user-defined workflows.

Acknowledgements
Development and testing has been conducted by the members of the CARMEN consortium (www.carmen.org.uk). This work is supported by the Engineering and Physical Sciences Research Council (EP/E002331/1).

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S2 CRCNS.ORG: A repository of high-quality data sets and tools for Computational Neuroscience

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As in all areas of science, the interplay between experiment and computational theory is essential for making progress in understanding the brain. However, unlike many areas of science in which experimental data are routinely made publicly available, in neuroscience the normal procedure is that neurophysiology data is only available through direct contact with the experimentalists who produced the data. This paradigm greatly limits the accessibility of neurophysiology data, hindering effective progress in computational neuroscience. To help remedy this situation, the online repository CRCNS.ORG was created in 2008 to publicly disseminate high-quality neurophysiology data sets from various systems and species [1]. The goals of the repository are to serve the communities of Computational and Systems Neuroscience by providing experimental data for testing new algorithms for data analysis and modeling, and to also help experimentalists by sharing stimuli and software tools for designing experiments for which the results can be directly compared to previously obtained data. In addition, the CRCNS.ORG website provides forums and a 'Market Place' for researchers and students to discuss and get help using data sets or other resources. We hope this approach will facilitate the creation of on-line communities of people interested in solving particular problems and that their exchange of information will also facilitate faster progress in computational neuroscience.

To illustrate how our system works, electrophysiological and behavioral (eye movement) data sets are available in the repository; the procedure by which experimentalists who wish to contribute data to the repository may do so can be easily mastered. Current data sets include single unit and multiunit recordings from the primary visual cortex of both macaque and cat, recordings from rat auditory cortex and thalamus, simultaneous recordings from two auditory brain regions in zebra finch, simultaneous recordings from rat hippocampus, and human eye movements. Envisioned enhancements to the repository include a new scheme for storing neurophysiology data that allows the data and metadata to be accessible using on-line web applications for both visualization and simple analysis. Having data available on-line in this way will greatly simplify the process of initially examining data because it alleviates the need to download a large data set and setup local client applications to use the data set. It is expected that the new storage scheme will also be useful for improving the organization of data stored within a laboratory. There remain opportunities and obstacles of publicly sharing neurophysiology data in the light of feedback that CRCNS.ORG has received from data users and contributors.

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S3 INCF Japan-Node: Visiome and Simulation Platforms

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Introduction

The INCF Japan-node at RIKEN BSI coordinates activities of neuroinformatics research in Japan. Committees from selected research areas have developed their platforms (PFs) on the base platform system XooNIps (http://xoonips.sourceforge.jp/). Currently eight platforms are opened accessible in public (http://www.neuroinf.jp/): Visiome PF, Brain-Machine Interface PF, Invertebrate Brain PF, Neuroimaging PF, Integrative Brain Research PF, Cerebellar Development Transcriptome Database, Cerebellum PF, Dynamic Brain PF. Simulation PF is under development. It is based on a virtual machine technology that provides for testing models and/or software on each platform, including models on ModelDB at SenseLab.

Visiome Platform

Increasingly, researchers have a need for published data that can be archived so that they can be accessed, uploaded, downloaded and tested. The Visiome Platform (http://platform.visiome.neuroinf.jp/) [1] is being developed to answer this need as a web-based database system with a variety of digital research resources in vision science. This includes contents such as mathematical models, experimental data, illusion designs, visual stimulus generation codes, demonstration movies and analytical software tools. Since reproducibility is a key principle of the scientific method, it is essential that published results be testable by other researchers using the same method. However, for example, most modeling articles do not contain enough information to reproduce and verify the results due to lack of initial conditions, incomplete parameter values and so on. The Visiome Platform has been designed to make the items reusable. Users can browse the Platform to surf the field of vision science or seek specific topics of interest. The Platform accepts and provides archive files including any formats of model, data or visual stimulus with files of explanatory figures, program sources, 'readme' and other related files. Models we have developed are now browsed and downloaded, and users can reproduce simulation results described in the original papers. The Visiome Platform contains a growing collection of the published model/tools and supports the field of neuroinformatics by making high-quality models readily available.

Simulation Platform

Each platform under the J-node contains a variety of computational models as well as research papers, experimental data and analysis tools, all of which will enable the researcher to share knowledge on neuroscience and to accelerate their research. Although a number of computational models are available on other platforms and databases, preparing the environment to carry out simulations using these models is still inconvenient. If a model is written for neural simulators such as NEURON or GENESIS, we must install these simulators on our computers. If a model is written in MATLAB, one must purchase MATLAB, even for a trial run. Thus, we are launching a web computing service called Simulation Platform (SimPF) [2]. Users can run a trial of models that are registered on neuroinformatics databases such as ModelDB and platforms under J-node. All procedures use a web browser and do not install any software on local computers. A user is asked to upload a script of a model to SimPFand, then SimPF assigns a virtual machine (VM) for the user from SimPF clouds and connects the VM automatically to the user's browser via the VNC (Virtual Network Computing) protocol. In summary, SimPF lets the users be free from preparing the environment to carry out simulations and thereby supporting and speeding up their research. We hope it can be also used to validate models for journal reviews.

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S4 FIND – A unified framework for neural data analysis

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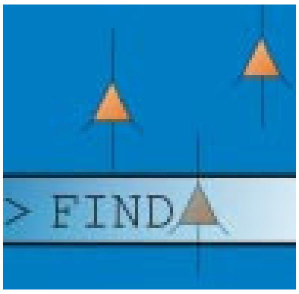

The complexity of neurophysiology data has increased tremendously over the last years, especially due to the widespread availability of multi-channel recording techniques. With adequate computing power, the current limit for computational neuroscience is the effort and time it takes for scientists to translate their ideas into working code. Advanced analysis methods are complex and often lack reproducibility on the basis of published descriptions. To overcome this limitation we developed FIND (Finding Information in Neural Data; [1]) as a platform-independent, open-source framework for the analysis of neuronal activity data based on Matlab (Mathworks).

Here, we outline the structure of the FIND framework and describe its functionality, our measures of quality control, and the policies for developers and users [2]. Within FIND, we have developed a unified data import from various proprietary formats, simplifying standardized interfacing with tools for analysis and simulation. The toolbox FIND covers a steadily increasing number of tools. These analysis tools address various types of neural activity data, including discrete series of spike events, continuous time series and imaging data. Additionally, the toolbox provides solutions for the simulation of parallel stochastic point processes to model multi-channel spiking activity. We will illustrate the functioning of FIND by presenting examples of its application to different types of experimental data[3,4], both from in vitro and in vivo recordings, and of recording data from simulated network models [5,6].

Acknowledgements
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S5 Chronux: A Platform for Analyzing Neural Signals

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Neuroscientists are increasingly gathering large time series data sets in the form of multichannel electrophysiological recordings, EEG, MEG, fMRI and optical image time series. The availability of such data has brought with it new challenges for analysis and has created a pressing need for the development of software tools for storing and analyzing neural signals. In fact, while sophisticated methods for analyzing multichannel time series have been developed over the past several decades in statistics and signal processing, the lack of a unified, user-friendly platform that implements these methods is a critical bottleneck in mining large neuroscientific datasets.

Chronux (www.chronux.org) is an open source software initiative that aims to fill this void by providing a comprehensive software platform for the analysis of neural signals. It is a collaborative research effort currently based at Cold Spring Harbor Laboratory that has grown out of the work of several groups [1–5]. The current version of Chronux includes a Matlab toolbox for signal processing of neural time series data, several specialized mini-packages for spike sorting, local regression, audio segmentation and other data-analysis tasks typically encountered by a neuroscientist, and a user interface (UI) designed specifically for analysis of EEG data. The eventual goal is to provide domain specific UIs for each experimental modality, along with corresponding data management tools. In particular, we expect Chronux to support analysis of time series data from most of the standard data acquisition modalities in use in neuroscience. We also expect it to grow in the types of analyses it implements. This talk provides an overview of the platform, emphasizing the spectral analysis toolbox and the EEG UI. We also illustrate the use of Chronux in selected recent publications.

Acknowledgements
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S6 Closed-loop electrophysiological experiments and metadata management with RELACS and LabLog

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For many electrophysiological experiments, time is precious. Online analysis and visualization, automated experimental protocols, and closed-loop experimental designs that generate stimuli based on the recorded responses considerably improve the yield of a recording. For example, simply displaying processed results online in addition to the raw voltage traces already gives the experimenter valuable quantitative information during a running experiment. Probing the neuron with stimuli that are outside its dynamic range can be avoided. Advancing individual electrodes can be automated, increasing the chances of a dual recording.

In addition, closed-loop experiments are the basis for novel experimental designs [1]. For example, stimulus parameters can be tuned iteratively to find the optimal stimulus that maximizes the mutual information between the stimulus and the evoked spike-train response. Also, finding sets of stimulus parameter that result in the same response can be implemented much more efficiently on a closed-loop system. This iso-response method is a powerful method for characterizing neuronal filter properties.

RELACS [2] is a fully customizable software platform specifically designed for closed-loop electrophysiological experiments. Filters and spike detectors can be applied instantly on the recorded potentials. Freely programmable, hardware-independent C++ plugins can access the preprocessed data for further online analysis, visualization, and stimulus generation.

Data can be reused much more easily if they are annotated with metadata that specify the conditions under which the dataset has been recorded, describe the applied stimuli and provide general information about the recorded cell and the experimental setup, as well as an outline of the experimental objectives. RELACS automatically stores most of such metadata during each recording.

The metadata are stored in a MySQL database that is managed by LabLog [3]. This way, the recorded metadata are immediately secured for long-term data management and data mining purposes. Early and automatic handling of the data and their metadata is one of the key issues for data sharing with colleagues or dealing with public data repositories. Since metadata play a fundamental role for data management, data sharing and data analysis, an interface definition is needed. We therefore propose a simple XML schema that specifies metadata by properties (extended key-value pairs) that are organized in a hierarchical structure. Within this schema, we suggest a common and extensible vocabulary for key properties to make the metadata understandable across applications.

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S7 Caring for the environment: The blooming 'Python in Neuroscience' ecosystem

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Recent years have seen a bloom in adoption of the Python environment in Neuroscience [1]. Widely used simulators, such as NEURON and NEST, have recently deprecated legacy programming interfaces in favor of modern yet mature Python equivalents [2,3] as complex work-flows flourish in the modern, expressive and intuitive Python language with its thriving ecosystem of both Neuroscience specific and general-purpose modules.

This shift to a standard general-purpose interpretive language, widely used outside of Neuroscience, has engulfed the simulator development community relatively rapidly and without central coordination. A plausible explanation is that the field was in critical need of the solutions Python offers. Python allows simulation developers to outsource interpreter development to the computer science community, while unifying simulation with analysis work-flows traditionally performed in MATLAB. Python has powerful parallel computing features without restrictive licensing costs and opens new possibilities to implement the on-going interoperability needs of the field [4]. Specifically, it has made PyNN possible, a shared API between NEURON, NEST, PCSIM and Brian with support for MOOSE/Genesis 3 and NeuroML export in development [5].

PyNN facilitates the development of conceptually satisfying and productivity boosting higher level modeling concepts in a simulator-agnostic way while still allowing simulator-specific optimization, with an elegant side effect: The software investments required for making use of exotic neuron solvers such as the FACETS VLSI neuromorphic hardware (http://www.facets-project.org) are minimized, as all state-of-the-art work-flow infrastructure is available once basic API compliance is implemented. Porting existing models implemented using the PyNN API to such platforms becomes trivial and verification is straightforward in comparison to results obtained using NEURON or NEST.

For students, Python is an attractive alternative to the traditionally domain-specific languages of the field, as competence thereof represents a widely recognized practical and employable skill. As such, long running courses like the Advanced Course in Computational Neuroscience (http://www.neuroinf.org/courses/EUCOURSE/F09) have started to feature Python as an important part of their curriculum.

Acknowledgements

This work was supported in part by the Swiss NSF and by the EU under the grant IST-2005-15879 (FACETS).

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Workshops

W1 Anaesthesia and sleep: recent experimental and theoretical aspects

Room 3 (BBAW), Thursday 23rd, 9:00-12.00 & 13:30-16:30

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General anaesthesia (GA) has attracted much research attention in recent years since new experimental findings on the molecular action of anesthetic agents shed some more light on the underlying mechanisms. In addition several theoretical models have been developed in recent years which, for instance, reproduce the power spectrum changes in EEG during anesthesia. Interestingly sleep shows similarities to anesthesia, such as the loss of consciousness. Further the thalamus seems to play an important role both in GA and sleep. Hence it is assumed that both phenomena are based on similar neuronal mechanisms. The workshop aims to present some recent aspects on the modeling and the experimental side of both phenomena and hence allows for an interaction of both research fields.

W2 Methods of Information Theory in Computational Neuroscience

Salon Heine (Hilton), Wednesday 22nd, 9:00-12.00 & 13:30-16:30 and Thursday 23rd, 9:00-12.00 & 13:30-16:30

Aurel A. Lazar
Department of Electrical Engineering, Columbia University

Alexander G. Dimitrov
Center for Computational Biology, Montana State University

Methods originally developed in Information Theory have found wide applicability in computational neuroscience. Beyond these original methods there is a need to develop novel tools and approaches that are driven by problems arising in neuroscience.

A number of researchers in computational/systems neuroscience and in information/communication theory are investigating problems of information representation and processing. While the goals are often the same, these researchers bring different perspectives and points of view to a common set of neuroscience problems. Often they participate in different fora and their interaction is limited.
The goal of the workshop is to bring some of these researchers together to discuss challenges posed by neuroscience and to exchange ideas and present their latest work.
The workshop is targeted towards computational and systems neuroscientists with interest in methods of information theory as well as information/communication theorists with interest in neuroscience.

W3 PhD and Postdoc Career Development Workshop

Leibniz Hall (BBAW), Wednesday 22nd, 18:00-21:00

Lars Schwabe
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Most of the attendances of the Computational Neuroscience Conference probably agree that studying the brain and the nervous system is a stimulating intellectual challenge with a multitude of applications. Since the brain and the nervous system are among the most complex organs, understanding it requires the most sophisticated tools, instruments, and methods. In other words, our field requires broad thinkers with outstanding analytical, mathematical, technical and quantitative skills. When being close to the end of your PhD work or already in a so-called Postdoc position, you might already be such a broad thinker with many skills. But what's next?

This workshop is about you and your career. We will have presentations tailored for PhD students close to the end of their PhD work, who search for funding opportunities and positions, and presentations for Postdocs, who search for ways of funding their own independent research. Moreover, we will also have field reports of people, who successfully applied for funding and who can talk about all those issues, which might be useful when you plan the next steps in your career. The workshop closes with a round-table discussion (approx. 30 min) with the speakers, some senior faculty and postdocs from our field. The idea behind this round-table discussion is to have the senior faculty outline their view of an 'ideal' postdoc candidate and to give hints for applying for postdoc positions as well as tips for the transition to your own independent research and group. All talks are scheduled together with a short discussion. The round-table discussion, which is another opportunity to ask questions, and selected talks will be recorded and published as a podcast (similar to the Nature Jobs podcast).

W4 Large Cortical Oscillations: Mechanistic and Computational Aspects

Salon Humboldt (Hilton), Wednesday 22nd, 9:00-12.00 & 13:30-16:30 and Thursday 23rd, 9:00-12.00 & 13:30-16:30

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Horacio G. Rotstein
Department of Mathematical Sciences, New Jersey Institute of Technology, Newark, NJ, USA.

Oscillatory activity at various frequency ranges have been observed in various areas of the brain (hippocampus, entorhinal cortex, olfactory bulb among others), and are believed to be important for cognitive functions such as learning, memory, navigation and attention. These rhythms have bee studied at the single cell level, as the result of the interaction of a neuron's intrinsic properties, at the network, as the result of the interaction between the participating neurons and neuronal populations in a given brain region, and at higher levels of organization involving several of these regions. The advances in this field have benefited from the interaction between experimental and theoretical approaches. The purpose of this workshop is to bring together both experimentalists and theorists with the goal of discussing their results and ideas on the underlying mechanisms that govern the generation of these rhythms at variouls levels of organization, and their functional implications for cognition.

W5 Modeling Migraine: From Nonlinear Dynamics to Clinical Neurology

Room 1 (BBAW), Wednesday 22nd, 9:00-12.00 & 13:30-16:30 and Thursday 23rd, 9:00-12.00 & 13:30-16:30

Markus A. Dahlem
Institut für Theoretische Physik, TU Berlin

Sebastiano Stramaglia
Physics Department of the University in Bari, Italy

A World Health Organization report lists migraine as number four of the most disabling chronic medical disorders. The focus of the workshop is on modeling the pathophysiological processes underlying migraine with aura, a process called cortical spreading depression (CSD). CSD is a nearly complete depolarization of brain cells with massive redistribution of ions between intracellular and extracellular compartments. CSD evolves as a nonlinear wave in gray matter regions of the brain. A review entitled 'Pathophysiology of the migraine aura – The spreading depression theory' summarizes the key features of CSD and its links to migraine [1]. Several mathematical models of nonlinear cortical dynamics have been suggested [2] and neural network models describe well the neurological symptoms experienced during migraine [3]. Hadjikhani et al. observed in human several characteristics of CSD using high-field functional magnetic resonance imaging (fMRI) during visual migraine aura [4], and the first direct electrocorticographic recordings were performed demonstrating the existence of CSD in acutely injured human [5]. Neurological aura symptoms can be extremely variable as documented in illustrations and descriptions collected on the Migraine Aura Foundation website (www.migraine-aura.org) and provide a window on brain functions [6].

W6 Automated Parameter Fitting for Compartmental Models

Room 3 (BBAW), Wednesday 22nd, 9:00-12.00 & 13:30-16:30

Erik De Schutter
Okinawa Institute of Science and Technology, Japan

Several factors have caused an increase in the demand for methods that are able to automatically fit the parameters of neuron models. More and more computing power becomes available to neuroscientists so is less difficult to extensively explore the fitness landscape created by, for example, varying the densities or kinetics of the ion channels in a neuron model. Because of the detail used in some compartmental neuron models, it is becoming difficult to hand-tune these parameters. Also the advent of massive modeling efforts like the Blue Brain project has increased the number of cell types that need to be modeled, and the effort that is put into the field. This workshop brings together neuroscientists that have proposed different techniques to search the fitness landscape for optimal parameters that generate neuron model output reproducing experimental data well. But while a lot of progress has been made we are clearly not (yet) as good at parameter fitting as the integrate-and-fire modelers and a wide variety of approaches are being pursued. The workshop will focus on methodological issues: speakers have been invited to give talks that not only point to success, but also to failures or problems encountered.

W7 Cortical Microcircuit Models of Information Processing and Plasticity

Leibniz Hall (BBAW), Thursday 23rd, 9:00-12.00 & 13:30-16:30

Vassilis Cutsuridis
Department of Computing Science and Mathematics, University of Stirling, Stirling FK9 4LA, U.K.

Thomas Wennekers
Centre for Theoretical and Computational Neuroscience, University of Plymouth, Plymouth, U.K.

The brain, from the neocortex to the spinal cord, consists of various parts that are built of repetitive microcircuits. These circuits adapt to the specific functions they have to perform by means of synaptic plasticity. Understanding what constitutes microcircuits and how they learn and interact is fundamental in the neurosciences, because they form the interface from cell biophysics to higher cognitive functions. The goal of this workshop is to provide a resume of the current state-of-the-art of the ongoing computational research avenues concerning cortical microcircuits with particular emphasis on the functional roles of the various inhibitory interneurons in information processing and synaptic plasticity. Computational network models that are tightly grounded on experimental data are particularly welcome.

Specific aims:

- What is a microcircuit? What circuits have been identified?
- What elementary functions do microcircuits perform?
- What types of synaptic plasticity rules are used?
- How do microcircuits interact? How do they form larger functional networks?
- How do perception, action, attention, or learning and memory arise from local microcircuits and their global interaction?
- How does the activation of a microcircuit show up in brain-signals on a larger scale like local field potentials, surface EEG, or fMRI?

W8 Modeling neural mass action in brain networks using delay differential equations

Room 4 (BBAW), Wednesday 22nd, 13:30-16:30 & 18:00-21:00

Fatihcan M. Atay
Max Planck Institute for Mathematics in the Sciences, Leipzig, Germany

Thomas Knösche
Max Planck Institute for Human Cognitive and Brain Sciences, Leipzig, Germany

Information processing in the brain is largely based on dynamic interaction within a complex network of neurons. Neural mass action plays an important role in this process and is, in contrast to single neuron activity, accessible to non-invasive measurement by EEG, MEG and fMRI. Therefore, mathematical models for the dynamic behaviour of interconnected neural masses are suitable for the description of the relationship between neural activity, brain measurements and psychological functions. The finite transmission speed within these networks causes time delays and creates special challenges for the mathematical treatment. In this workshop, techniques will be presented and discussed, which (1) describe masses of neurons by their mean membrane potentials and firing rates, (2) model interactions between these masses, in particular under consideration of time delays, (3) incorporate biological knowledge into the models, (3) solve the resulting systems of delay differential equations effectively and (4) analyze the dynamic properties of the models, in particular through bifurcation diagrams.

W9 Olfactory learning and memory in insects

Room 2 (BBAW), Wednesday 22nd, 9:00-12.00 & 13:30-16:30 and Thursday 23rd, 9:00-12.00 & 13:30-16:30

A. Yarali
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J. Wessnitzer
Research Fellow, University of Edinburgh, UK, E-mail: jwessnit@inf.ed.ac.uk

Summary:
The neural circuit underlying insect olfaction and olfactory associative learning is anatomically and physiologically well-studied, calling for detailed computational models, which then can be challenged by the available knowledge of insect olfactory behaviour. We aim to facilitate this process by bringing together the researchers from the experimental and theoretical sides. On the 1st day, after an overview of the anatomy and the electrophysiology of the insect olfactory pathway, we will discuss the available models pertaining to this circuit; such discussion will be extended to pheromone processing as well. We will then consider the key behavioural phenomena, which such models need to account for- e.g. effects of odour-similarity, processing of odour-mixtures. On the 2nd day, we will evaluate the current knowledge on the sites and kinds of synaptic plasticity along the olfactory pathway as well as the available computational models. Finally, we will discuss the key behavioural phenomena, which need to be accounted for: effects of event-timing, memory dynamics, role of outcome expectation and motivation.

Program:
This workshop focuses on key issues in olfactory learning and memory research. Our aim is to bring together researchers from the experimental and theoretical fields investigating the functioning of insect olfactory systems. Our goal is to identify the key questions motivating interdisciplinary research, to map the range of theoretical frameworks, empirical techniques and technologies currently used, and to bring together theoretical and experimental researchers investigating insect olfaction. We want to address our research questions through conventional short presentations by invited keynote speakers, selected workshop participants, discussion/ poster sessions. We encourage demonstrations of computer simulations giving the participants opportunities to use and evaluate these systems under the guidance of the designers.

W10 Activity-Dependent Structural Plasticity – from cell cultures to cortical networks

Salon Corinth (Hilton), Wednesday 22nd, 9:00-12.00 & 13:30-16:30

Markus Butz
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Recent trends in modelling activity-dependent network formation focus on the role of structural plasticity for homeostasis and self-organized criticality. Understanding the full range of principles guiding self-organization of neuronal networks is relevant for repair of brain lesions (i.e. due to stroke) as well as for reorganization associated with learning. Recent time-lapse imaging studies of the living brain reveal new insights into how the brain rewires its networks under physiological and pathological conditions. A main principal of this reorganization as shown by a wealth of experimental data is the mutual interdependency of neuronal activity, neurotransmission and neural morphogenesis. Here, we propose a one-day workshop for presenting theoretical approaches that complement concrete experimental studies as these raise further questions for experimental testing. Thus, the workshop consists of four blocks of talks each focussing on one particular aspect of structural plasticity. The discussion following each block of talks is to exchange ideas between modellers and experimentalists.

W11 Quantitative Models of Natural Behaviour

Salon Humboldt (Hilton), Wednesday 22nd, 18:00-21:00 and Salon Corinth (Hilton), Thursday 23rd, 9:00-12.00 & 13:30-16:30 & 18:00-21:00

Aldo Faisal
Cambridge

Greg Stephens
Princeton

While we record the precision of an action potential with microsecond accuracy and characterize the impact of single amino acids on protein function, we often describe the behavior of a whole organism by eye. We seek to address this imbalance and sharpen our fundamental understanding of neural computation by organizing a 2 day workshop composed of an interdisciplinary set of speakers, both computational and experimental, engaged in quantitative behavioral analysis of a variety of systems from bacteria via Drosophila and mice to humans.

The need for the quantitative study of behaviour in genetic organisms is becoming increasingly pressing, as we can readily capture approximately exhaustive set of intrinsic behavioral coordinates as well as neural recording and genetic manipulations. A major challenge in analyzing behavior is to discover an underlying simplicity, which reflects the underlying mechanisms that generate it. Moreover such an analysis should preserve natural variability and not average out as it often contains meaningful information about the generating mechanisms.

This workshop is intended to address two main questions:

1. How should we build models that quantify natural behavior, such that behavioral variability is reflected in a full, yet tractable manner?
2. How can we use these models to relate underlying behavioral mechanisms to neural and genetic data?

We believe that advanced statistical and probabilistic methods can be used to analyse the unconstrained natural behaviour including relevant variabily. This approach offers a principled route to extract relevant features of behavioural performance and compare individual animals in a more objective manner than using highly constrained behavioural experiments. Moreover these models can be generative in nature providing us with an objective measure to distinguish between observed behaviours.

W12 Python in Neuroscience

Room 5+6 (BBAW), Wednesday 22nd, 9:00-12.00 & 13:30-16:30 and Thursday 23rd, 9:00-12.00 & 13:30-16:30

Eilif Muller
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Jens Kremkow
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Andrew Davison
Unité de Neurosciences Intégratives et Computationelles, CNRS, France

Romain Brette
Ecole Normale Supérieure de Paris, France

Python is rapidly becoming the de facto standard language for systems integration. Python has a large user and developer-base external to the neuroscience community, and a vast module library that facilitates rapid and maintainable development of complex and intricate systems.

In this workshop, we highlight efforts to develop Python modules for the domain of neuroscience software and neuroinformatics. Moreover, we seek to provide a representative overview of existing mature Python modules for neuroscience and neuroinformatics, to demonstrate a critical mass and show that Python is an appropriate choice of interpreter interface for future neuroscience software development. There will be a tutorial & demo sessions where visitors with laptops can install and get introduced and acquainted with Python and the various software. For the impatient, some tutorial material is already available at http://neuralensemble.org/cookbook. Many of these efforts will appear in the forthcoming special topic "Python in Neuroscience" in Frontiers in Neuroinformatics, and several are already available in preliminary form [1].

This workshop is supported in part by the European Union under the Bio-inspired Intelligent Information Systems program, project reference IST- 2004-15879 (FACETS, http://www.facets-project.org), and by the Bernstein Center for Computational Neuroscience (BCCN), Albert-Ludwigs-University Freiburg, Germany (http://www.bccn.uni-freiburg.de).

W13 Multistability in Neurodynamics

Room 4 (BBAW), Thursday 23rd, 9:00-12.00 & 13:30-16:30

Gennady Cymbalyuk
Georgia State University

This workshop is focused on the co-existence of regimes of activity of neurons. Such multistability enhances potential flexibility to the nervous system and has many implications for motor control, dynamical memory, information processing, and decision making. The goal of this workshop is to identify the scenarios leading to multistability in the neuronal dynamics and discuss its potential roles in the operation of the central nervous system under normal and pathological conditions. Multistability has been studied combining theoretical and experimental approaches since the pioneering works by Rinzel, 1978 and Guttman et al., 1980. It is intensively studied on different levels. On the cellular level, multistability is co-existence of basic regimes like bursting, spiking, sub-threshold oscillations and silence. On the network level, examples of multistability include co-existence of different synchronization modes, 'on' and 'off' states, and polyrhythmic bursting patterns.

W14 Statistical analysis of multi-cell recordings: Linking population coding models to experimental data

Leibniz Hall (BBAW), Wednesday 22nd, 9:00-12.00 & 13:30-16:30

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Modern recording techniques such as multi-electrode arrays and 2-photon imaging are capable of simultaneously monitoring the activity of large neuronal ensembles at single cell resolution. This makes it possible to study the dynamics of neural populations of considerable size, and to gain insights into their computations and functional organization. The key challenge with multi-electrode recordings is their high-dimensional nature. Understanding this kind of data requires powerful statistical techniques for capturing the structure of the neural population responses and their relation with external stimuli or behavioural observations. The goal of this workshop is to present recent advances in the statistical modelling of neural populations, and to discuss the following central questions:

1. What classes of statistical methods are most useful for modelling population activity?
2. What are the main limitations of current approaches, and what can be done to overcome them?
3. How can statistical methods be used to empirically test existing models of (probabilistic) population coding?
4. What role can statistical methods play in formulating novel hypotheses about the principles of information processing in neural populations?

W15 Modern Mathematical Neurodynamics: Bridging Single Cells to Networks

Room 4 (BBAW), Wednesday 22nd, 9:00-12.00 and Salon Corinth (Hilton), Wednesday 22nd, 18:00-21:00

Marc Timme
Network Dynamics Group, Max Planck Institute for Dynamics and Self-Organization and Bernstein Center for Computational Neuroscience (BCCN) Göttingen

Coordinating neural dynamics across complex interaction networks is crucial for computation and information processing in neural systems and thus provides the key bottleneck linking sensory stimulation, internal memory and actual behavior of humans and higher animals. Currently, experimental resolution for the study of neural circuits progresses at an unprecedented pace, with respect to both anatomical connectivity and dynamical activity of increasingly fine spatial and temporal resolutions. Mathematics provides the unifying language to conceptually understand the vast amount of data available and to make sensible predictions through general models. This workshop aims to provide a computational neuroscience forum from the state-of-the-art mathematical neurodynamics perspective that strives to bridge single cell dynamics and network level description. The broad focus should be on neural modeling, conceptual ideas, and modern techniques to make sense of neural data. We aim at bringing together and stimulating exchange between key contributers from the corners of mathematical and computational neuroscience with topics ranging from synaptic dynamics and learning, via neural correlations and complex network activities to coding and computing strategies.

Sunday July 19 (P1–P183)

P1 The HoneyBee Standard Brain (HSB) - a versatile atlas tool for integrating data and data exchange in the neuroscience community

Jürgen Rybak[1], Anja Kuß[2], Wolfgang Holler[3], Robert Brandt[3], Hans-Christian Hege[2], Martin Nawrot[1,4], Randolf Menzel[1]

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P2 From quantification of 3D morphology of coincidence detector neurons in the MSO to a multicompartmental model

Philipp L. Rautenberg[1,2], Eric T. Reifenstein[1], Christian Leibold[1,2], Benedikt Grothe[1,2], Felix Felmy[1]

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P3 Inference of original retinal coordinates from flattened retinae

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P4 Local planar dendritic structure: a uniquely biological phenomenon?

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[3]Theoretical Neurobiology, University of Antwerp, B-2610 Antwerpen Belgium

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P5 Simulated networks with realistic neuronal morphologies show small-world connectivity

Alexander de Ridder, Frank Postma, Sacha Hoedemaker, Randal Koene, Jaap van Pelt, Arjen van Ooyen

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P6 Thermodynamic constraints on fiber diameter, neural activity, and brain temperature

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P7 Characterizing multiple-unit activity in the anterior cingulate cortex during choice behavior as a stochastic nonlinear process

Emili Balaguer-Ballester[1], Christopher C. Lapish[2], Jeremy K. Seamans[2], Daniel Durstewitz[1]

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P8 Behavioral inhibition during reversal learning in the limbic system: A computational model

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P9 Are age-related cognitive effects caused by optimization?

Hecke Schrobsdorff[1,2], Matthias Ihrke[1,2], Jörg Behrendt[1,3], J. Michael Herrmann[1,4], Theo Geisel[1,2], Anna Levina[1,2]

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P10 A canonical model of signal detection theory

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P11 A theoretical model of emotion processing for optimizing the cost function of discrepancy errors between wants and gets

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P12 Influence of prior expectations on contour integration: Psychophysics and modeling

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P13 On the origin of systematic errors in a simple navigation task

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P14 Is self-control a learned strategy employed by a reward maximizing brain?

Aristodemos Cleanthous, Chris Christodoulou

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P15 Comparing effects of reward size and action contingency on single neurons of monkey medial vs. lateral orbitofrontal cortex

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P16 C. elegans locomotion: a unified multidisciplinary perspective

Stefano Berri[1], Jordan H. Boyle[1], Manlio Tassieri[2], Ian A. Hope[3] and Netta Cohen[1,4]

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P17 Critical adaptive control may cause scaling laws in human behavior

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P18 Neural constraints in kinematics of head-free gaze

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P19 Object-based biasing for attentional control of gaze: a comparison of biologically plausible mechanisms

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P20 Anticipating uncertain events: estimates of probability driving anticipatory eye movements

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P21 Dependence of membrane capacitance estimates on measurement method

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P22 A fast-computational spiking neuron model adaptable to any cortical neuron

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P23 Analytical integrate-and-fire neuron models with conductance-based dynamics and realistic PSP time course for event-driven simulation strategies

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P24 Directed intermittent search model of microtubule cargo transport

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P25 KIR current inactivation modulates dendritic calcium in medium spiny neurons

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P26 TRPC channels activated by group I mGluR in Entorhinal pyramidal neurons support integration of low frequency (<10 Hz) synaptic inputs

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P27 Control of bursting activity by modulation of ionic currents

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P28 Modeling of frog second-order vestibular neurons using frequency-domain analysis reveals the cellular contribution for vestibular signal processing

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P29 Spike-timing prediction in a neuron model with active dendrites

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P30 Electrogenic calcium pump contributes to dopamine neuron repolarization

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P31 Simulation of cytoskeleton influence on spatial Ca2+ dynamics in neuroendocrine cells

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P32 Exploration of the lamprey pallidal neurons – a combined computational and experimental study

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P33 KIR channels in nucleus accumbens MS neurons modulate integration of excitatory synaptic inputs: A computational study

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P34 Modeling the excitability of the cerebellar Purkinje cell with detailed calcium dynamics

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P35 Using stochastic algorithms for constraining compartmental and markov channel models

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P36 Modeling action potential initiation using voltage-gated ion-channels kinetics from L5 pyramidal neurons of the rat cortex

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P37 Spatio-temporal spike dynamics: Localization of single cell currents based on extracellular potentials patterns

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P38 An analytical solution of the cable equation predicts the frequency preference of a passive non-uniform cylindrical cable in response to extracellular oscillating electrical fields.

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P39 Parallel computational subunits in dentate granule cells generate multiple place fields

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P40 Statistical properties of noise-induced firing and quiescence in a Hodgkin-Huxley model

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P41 Activity-type dependent conductance relationships in a model neuron database

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P42 Mechanisms underlying persistent activity in a model PFC microcircuit

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P43 Reduced compartmental model of the periglomerular cell of the mammalian olfactory bulb

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P44 Modeling biological neurons with Josephson junctions

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P45 Stability and sensitivity analysis of reduced compartmental models of primary visual cortical neurons

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P46 Implementation of a Hidden Markov Model in a photoreceptor cell by the biochemical mechanisms of phototransduction

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P47 Comparison of valley seeking and T-distributed EM algorithm for spike sorting

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P48 Neuronal spike exchange on a Blue Gene/P supercomputer: MPI_Allgather vs. DCMF_Multicast

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P49 RTBiomanager: a software platform to expand the applications of real-time technology in neuroscience

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P50 The layer oriented approach to neuroscience modeling languages

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P51 STEPS: Reaction-diffusion simulation in complex 3D geometries

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P52 Using GENESIS 3 for single neuron modeling

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P53 Development of standard brain for silkworm moth, Bombyx mori, linked with a neuron database

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P54 Multiscale modeling and interoperability in MOOSE

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P55 A Java-based simulation environment for networks of simplified neuron models

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P56 Specification and generation of structured neuronal network models with the NEST Topology Module

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P57 Declarative model description and code generation for hybrid individual- and population-based simulations of the early visual system

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P58 Random axon outgrowth and synaptic competition generate realistic connection lengths and filling fractions

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P59 Cepstrum of bispectrum spike detection on extracellular signals with concurrent intracellular signals

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P60 Modeling the development of maps of complex cells in V1

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P61 Low frequency stimulation and resulting short term effects on neuronal activity

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P62 Textural-input-driven self-organization of tactile receptive fields

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P63 Pinwheel crystallization in a dimension reduction model of visual cortical development

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P64 Pattern selection, pinwheel stability and the geometry of visual space

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P65 Is the formation of ocular dominance patterns instructed by molecular labels?

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P66 Analysis of spontaneous activity patterns in developing retina: algorithms and results

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P67 Spontaneous activity in the developing retina emerges at a critical state between local and global functional connectivity

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P68 EEG processing with TESPAR for depth of anesthesia detection

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P69 Practicing fast-decision BCI using a 'goalkeeper' paradigm

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P70 Inter-cortical time delays shape the brain in dynamical networks during rest

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P71 Functional connectivity patterns of ERPs activity during the generation of global and local imagery

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P72 High EEG-gamma-power codes perceptual states of ambiguous motion

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P73 Bridging scales: From cortical single-neuron bursting to macroscopic high-frequency EEG

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P74 Theoretical descriptions of EEG activity: Application to absence seizures

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P75 Modeling brain functional networks using logic relationships

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P76 Multivariate functional connectivity between fine-grained cortical activation patterns

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P77 Sensitivity of EEG/MEG-based reconstruction of neural activity to the finite element model discretization

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P78 The sensitivity of the EEG and MEG inverse solution to anisotropic conductivity - a whole human head simulation study

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P79 Developing new neurophysiological signatures of general anesthesia induced loss of consciousness

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P80 Neuronal correlates of emotions in human-machine interaction

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P81 Spatial distribution of non-linear interdependency measures for focal hemisphere identification in epileptic patients from interictal intracranial EEG

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P82 Synthetic brain imaging on a spiking neural model of parieto-frontal interactions in reaching

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P83 A theoretical analysis of an alternative CUSUM statistic called CUSUM-slope for detecting signals from background noise in a low signal-to-noise environment

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P84 Predicting BCI performance to study BCI illiteracy

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P85 Towards a cure for BCI illiteracy: Machine learning based co-adaptive learning

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P86 Investigating neurovascular coupling using canonical correlation analysis between pharmacological MRI and electrophysiology

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P87 Progress and decay – An information-theoretical view on the Janus face of time

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P88 Burst structure can code different stimulus features in thalamic neuron models

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P89 The tree-edit-distance, a measure for quantifying neuronal morphology

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P90 Reinforcement learning on complex visual stimuli

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P91 Formal concepts expressed by compositional hierarchical Hebbian cell assemblies

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P92 Computing the inverse of the neurophysiological spike-response transform

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P93 Reliability of response spike timings in pulse-coupled networks of neurons

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P94 Spatial organization of evoked neuronal dynamics in 2D recurrent networks, with or without structured stimulation

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P95 Information content and robustness of various types of codes in integrate and fire networks presented with naturalistic stimuli

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P96 Decoding spike train ensembles using the cooperative interaction between task-dependent cortical neurons

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P97 Non-classical receptive field properties reflecting functional aspects of optimal spike based inference

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P98 From computation to biophysics: Functional theory of adaptive neural excitability

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P99 Bayes factor analysis for detection of time-dependent higher-order spike correlations

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P100 Comparison of the spontaneous activity, the linear response, and the stimulus-induced spike synchrony for three different integrate-and-fire models

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P101 Temporal structure of bursting patterns as representation of input history

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P102 Recovery of stimuli encoded with a Hodgkin-Huxley neuron using conditional PRCs

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P103 Neuronal jitter: can we measure the spike timing dispersion differently?

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P104 Sound encoding in auditory pathway, implications for cochlear implants

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P105 Decoding of Purkinje cell pauses by deep cerebellar nucleus neurons

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P106 Neuronal firing patterns and cerebral cortical functions

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P107 Maximum entropy decoding of multivariate neural spike trains

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P108 Higher-order correlations in non-stationary parallel spike trains: statistical modeling and inference

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P109 Information theory based methods to estimate the functional connectivity in dissociated neuronal networks

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P110 The Poisson process with dead time captures important statistical features of neural activity

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P111 The spatial information content of DG inputs

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P112 Single neuron activity-dependent signal processing

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P113 How crickets determine the direction of a flow field

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P114 How a sand scorpion determines the distance to its prey

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P115 Fundamental principles by which the brain could process information: an information management perspective

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P116 Histogram binwidth and kernel bandwidth selection for the spike-rate estimation

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P117 Directed information structure in inter-regional cortical interactions in a visuomotor tracking task

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P118 Optimal odor intensity in olfactory neuronal models

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P119 Simple stochastic neuronal models and their parameters

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P120 Symmetry breaking in soft clustering decoding of neural codes

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P121 Distinct signal processing properties of two populations of electrosensory neurons exhibiting different levels of spike time variability

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P122 Serial interspike interval correlations of excitable neurons with memory

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P123 Reconstruction and classification of stimuli encoded with neural circuits with feedback

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P124 Modeling the mechanisms underpinning sensory adaptation and gain control

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P125 How is stimulus processing of the lateral geniculate nucleus derived from its input(s)?

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P126 A biologically inspired algorithm to deal with filter-overlap in retinal models

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P127 The activity of retinal ganglion cell ensembles in the turtle retina encode velocity of moving objects

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P128 Fast inference of couplings between integrate-and-fire neurons from their spiking activity

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P129 Learning complex cell units from simulated prenatal retinal waves with slow feature analysis

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P130 Studying the precision of temporal neural code: Some limitations of spike train distances

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P131 Theoretical analysis of the information carried by the contrast response functions of M-cells, P-cells and V1 neurons

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P132 Sparse coding with population sketches

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P133 Intrinsic neural response properties are sufficient to achieve time coding

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P134 Efficient coding correlates with spatial frequency tuning in a model of V1 receptive field organization

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P135 Cortico-striatal plasticity for action-outcome learning using spike timing dependent eligibility

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P136 A model of cell specialization using a Hebbian policy-gradient approach with 'slow' noise

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P137 The attention-gated reinforcement learning model can explain experimentally observed changes in tuning curves that follow category learning

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P138 Controlling neuronal fluctuations for directed exploration during reinforcement learning

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P139 Asymmetric STDP in excitatory-inhibitory coupled neurons: a self-stabilizing mechanism?

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P140 A spiking temporal-difference learning model based on dopamine-modulated plasticity

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P141 Modeling cerebellar learning for spatial cognition

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P142 Dynamical emergence of fear and extinction cells in the amygdala – A computational model

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P143 Affect-driven learning in an avalanche neural network modeling early sensorimotor intelligence

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P144 Learning spike-timings based representations of sensory stimuli with leaky integrate-and-fire neurons

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P145 Neural network realization of sensorimotor space organization using predictability and decorrelation

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P146 Modeling the functional connectivity in embodied in vitro neuronal network

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P147 Estimation of spectro-temporal receptive fields based on linear support vector machine classification

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P148 Unsupervised learning of head-centered representations in a network of spiking neurons

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P149 Effects of a modulatory feedback upon the BCM learning rule

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P150 Dopamine mediated dynamical changes in the striatum: a numerical study

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P151 A model of the primary auditory cortex response to sequences of pure tones

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P152 How network structure shapes pairwise correlations between integrate-and-fire neurons

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P153 First-to-fire neurons induced by clustering in sparse networks

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P154 A kinetic theory network model to capture first and second order statistics of population activity in largescale neuronal networks

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P155 Switching to criticality by synchronized input

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P156 Slow population rhythms emerge in noisy inhibitory network models

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P157 Stability criteria for splay states in networks of 'generalized' neuronal models

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P158 Visualization of higher-level receptive fields in a hierarchical model of the visual system

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P159 Implications of the specific cortical circuitry for the network dynamics of a layered cortical network model

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P160 Dynamics of hierarchical neural networks

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P161 Neuronal avalanches recorded in the awake and sleeping monkey do not show a power law but can be reproduced by a self- organized critical model

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P162 Basal ganglia and memory retrieval during delayed match-to-sample and non-match-to-sample tasks

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P163 The computational role of the feedforward inhibition in the striatum network

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P164 A computational model for the excitatory network of the C2 column of barrel cortex

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P165 Parametric Estimation of spike train statistics

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P166 The encoding of alternatives in multiple-choice decision-making

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P167 Analysis of the power spectra, autocorrelation function and EEG time-series signal of a network of leaky integrate-and-fire neurons with conductance-based synapses

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P168 Toward a second order description of neuronal networks

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P169 Neuronal connectivity inference from spike trains using an empirical probabilistic causality measure

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P170 Computational tools for assessing the properties of 2D neural cell cultures

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P171 Inhibitory control of up states and their propagation in the cortical network

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P172 Inhibitory feedback in a small CA3-network

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P173 Improving pattern retrieval in an auto-associative neural network of spiking neurons

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P174 Neural basis of perceptual expectations: insights from transient dynamics of attractor neural networks

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P175 A bilateral band attractor model for the oculomotor system

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P176 Dynamics of non-linear cortico-cortical interactions during motion integration in early visual cortex: A spiking neural network model of an optical imaging study in the awake monkey

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P177 Configuration-specific facilitation phenomena explained by layer 2/3 summation pools in V1

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P178 Neuronal couplings inferred by an efficient inverse Ising method

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P179 Map location affects center-surround modulation in a network model of V1

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P180 Orientation plasticity and the tilt aftereffect in network models of V1

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P181 Mapping between V1 models of orientation selectivity: From a distributed multi-population conductancebased refractory density model to a firing-rate ring model

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P182 Modulation of input gain and response gain by noisy synaptic input

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P183 Control and analysis of spike trains' correlations

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Tuesday July 21 (P184–P367)

P184 The effect of the ventricular system on the electric current in deep brain stimulation

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P185 How autism symptoms could develop at the neuron level: An information management perspective

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P186 Tradeoffs between neuromodulation and synchronized firing in affecting neuronal gain control

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P187 Moving beyond convergence in the pheromone system of the moth

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P188 Divergence alone cannot guarantee stable sparse activity patterns if connections are dense

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P189 Burst firing regulates correlated activity in neurons

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P190 Modelling the activation of neuronal populations during deep brain stimulation

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P191 Modeling the effects of GABA-A inhibition on the spike timing-dependent plasticity of a CA1 pyramidal cell

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P192 Modeling plasticity across different time scales: the TagTriC model

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P193 Dopamine D1/D2 modulation of synaptic plasticity in the prefrontal cortex

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P194 Modeling spike timing dependent plasticity with a retrograde transmitter

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P195 Capacity of networks to develop multiple attractors through STDP

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P196 Mathematical modeling of the Drosophila neuromuscular junction

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P197 Emergent pitch perception using short term plasticity

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P198 The regulatory role of NO-PKG in the cerebellar long-term depression

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P199 Pattern learning using spike-timing-dependent plasticity: a theoretical approach

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P200 Interplay between spike-timing-dependent plasticity and neuronal correlations gives rise to network structure

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P201 Exploring the link between temporal difference learning and spike-timing-dependent plasticity

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P202 Temporal sensitivity of protein kinase A activation in a stochastic reaction-diffusion model of late phase long term potentiation

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P203 Geometry and dynamics of activity-dependent homeostatic regulation in neurons

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P204 Spike timing dependent synaptic plasticity optimized for the synaptic symmetry breaking

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P205 Model of hyperpolarization dependent LTD in MVN neurons

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P206 A model for cortical remapping and structural plasticity following focal retinal lesions

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P207 Activity-dependent bidirectional plasticity and homeostasis regulation governing structure formation in a model of layered visual memory

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P208 Impaired structural plasticity increases connectivity in developing cortical networks

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P209 Therapeutic rewiring by means of desynchronizing brain stimulation

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P210 Formation of synchronous activity through STDP in recurrent neural networks with heterogeneous delays

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P211 Spiking neural network models for memorizing sequences with forward and backward recall

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P212 Spike-timing-dependent plasticity in a recurrently connected neuronal network with spontaneous oscillations

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P213 How Gibbs Distributions may naturally arise from synaptic adaptation mechanisms

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P214 Sharpening projections

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P215 Self-organized criticality of developing artificial neuronal networks and dissociated cell cultures

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P216 Understanding brain plasticity in perceptual learning

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P217 Modeling spontaneous and evoked glutamate release of NMDA receptors

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P218 GABAA receptor plasticity provides homeostasis of neuronal activity in a neocortical microcircuit model

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P219 Model of synaptic transmission in the calyx of Held

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P220 Modeling the origin of functional heterogeneity among auditory nerve fibers

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P221 Constructing dopaminergic signals in response to transient inputs in the ventral tegmental area

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P222 A mechanism underlying short-term synaptic dynamics regulated by neuromodulator based on kinetics of C currents

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P223 Nonlinear behavior of kinetics of calmodulin-calcium complexes

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P224 Estimating the spatial range of local field potentials in a cortical population model

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P225 Finite synaptic potentials cause a non-linear instantaneous response of the integrate-and-fire model

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P226 KA channels suppress cellular responses to fast ripple activity – Implications for epilepsy

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P227 Phase response analysis of a morphological globus pallidus neuron model during irregular spiking: intrinsic and synaptic mechanisms

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P228 NeuroXidence: reliable and efficient analysis of an excess or deficiency of joint-spike events

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P229 Distinguishing brain oscillations - understanding differences in topography, frequency, and incidence by a simple modeling framework

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P230 Phase differences in local field potentials from macaque monkey area V4 predict attentional state in single trials with 99.6% accuracy

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P231 Estimating the contribution of assembly activity to cortical dynamics from spike and population measures

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P232 Using transfer entropy to measure the patterns of information flow though cortex: Application to MEG recordings from a visual Simon task

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P233 Synchrony with shunting inhibition

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P234 Causality analysis between brain areas based on multivariate autoregressive models of MEG sensor data

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P235 A simple Hidden Markov Model for midbrain dopaminergic neurons

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P236 Is the Langevin phase pquation an efficient model for stochastic limit cycle oscillators in real neurons?

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P237 Response of integrate-and-fire neurons to noisy inputs filtered by synapses with arbitrary timescales: firing rate and correlations

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P238 Oscillations in an excitatory neuronal network with synaptic depression and adaptation

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P239 Auto-structure of spike-trains matters for testing on synchronous activity

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P240 A mechanism for achieving zero-lag long-range synchronization of neural activity

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P241 Gamma oscillations as integrators of local competition for activity and global competition for coherence

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P242 Inferring coupling strength from event-related dynamics

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P243 Signal-to-noise ratio of the neurophonic potential in the laminar nucleus of the barn owl

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P244 The influence of subthreshold membrane potential oscillations and GABAergic input on firing activity in striatal fast-spiking neurons

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P245 Theoretical approach to the basal ganglia thalamocortical network: oscillators and modulators

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P246 A model for the joint evaluation of burstiness and regularity in oscillatory spike trains

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P247 Conditions for the generation of beta band activity in Parkinson's disease

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P248 Spike synchronization is population specific in the respiratory pattern generator

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P249 On the temporal structure of correlated activity in a pair of neurons

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P250 Resonant response of a Hodgkin-Huxley neuron to a spike train input

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P251 Inferring large-scale brain connectivity from spectral properties of the EEG

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P252 Frequency control in neuronal oscillators using colored noise

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P253 Estimating the temporal precision and size of correlated groups of neurons from population activity

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P254 An accretion based data mining algorithm for identification of sets of correlated neurons

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P255 On the sensitivity of spiking responses to noise

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P256 Bifurcation analysis of synchronization dynamics in cortical feed-forward networks in novel coordinates

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P257 Influence of external input on waxing and waning of neuronal network oscillations

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P258 Synchronization and rate dynamics in embedded synfire chains: effect of network heterogeneity and feedback

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P259 Neural network model for sequence learning based on phase precession

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P260 Multi-objective evolutionary algorithms for model neuron parameter value selection matching biological behavior under different simulation scenarios

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P261 Dopamine modulated dynamical changes in recurrent networks with short term plasticity

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P262 Detection of task-related synchronous firing patterns

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P263 Database analysis of a computational model of an elemental oscillator in the leech heartbeat neuronal network

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P264 Modeling study of gamma oscillations in the mammalian olfactory bulb

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P265 Intense synaptic activity between mitral and granule cells leads to precise spike timing during gamma oscillations in the olfactory bulb

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P266 Negative phase and extended spike-time response curve

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P267 LFP oscillations provide a time reference for excess spike synchrony among V1 neurons

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P268 Enhancing information processing by synchronization

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P269 Dopamine-controlled delta oscillations regulate dynamical and computational regimes in cortical networks

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P270 A comparison of spike time prediction and receptive field mapping with point process generalized linear models, Wiener-Voltera kernels, and spike-triggered averaging methods

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P271 Measuring spike train synchrony between neuronal populations

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P272 Self-generated neural activity: models and perspective

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P273 A dynamic neural field mechanism for self-organization

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P274 Partial synchronization in diluted neural networks

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P275 Hippocampal formation as unitary coherent particle filter

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P276 The MIIND framework: combining population density methods, neural simulations and Wilson-Cowan dynamics into large-scale heterogeneous neural models of cognition

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P277 Multicompartment leaky integrate and fire neuron modeling with multiexponentials

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P278 Synaptic contributions to in vitro hippocampal sharp-wave ripples

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P279 Spatiotemporal structure of evoked gamma rhythms in a minimal multi-layer model of primary visual cortex

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P280 Neural mass models for mimicking brain signals - impact of extrinsic inputs on interneurons and dendritic time constants

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P281 Feedback loops and oscillations in modular hierarchical brain networks: The topological origin of brain rhythms

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P282 Towards a computational model for stimulation of the Pedunculopontine nucleus

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P283 A model for simultaneous encoding of 'where' and 'what' information in prefrontal cortex

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P284 Reduced compartmental Hodgkin-Huxley type models of three different cortical neuron classes

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P285 A survey of dynamical complexity in a mean-field nonlinear model of human EEG

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P286 Emergent phenomena in human EEG: a bifurcation theory approach

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P287 A neural field model for spatio-temporal brain activity using a morphological model of cortical connectivity

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P288 Robust short-term memory in the neuronal field model involving nonlinear dendritic integration

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P289 Back-engineering of spiking neural networks parameters

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P290 Realistic activity propagation for mean field models of human cortex

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P291 Modeling the coupling of single neuron activity to local field potentials

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P292 Power-law autocorrelation of neural activity in models of mental states that are hierarchically organized

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P293 Reservoir computing methods for functional identification of biological networks

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P294 Model and data-driven representations of the sleep cycle using locally linear embedding

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P295 Modeling the complete cardiac ganglion – heart muscle network of the crab Callinectes sapidus

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P296 Real-time activity-dependent drug microinjection

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P297 Snaking behavior of homoclinic solutions in a neural field model

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P298 Relating firing rate and spike time irregularity in motor cortical neurons

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P299 — *withdrawn* —

P300 A model of free monkey scribbling based on the propagation of cell assembly activity

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P301 Predicting changes in neuronal excitability type in response to genetic manipulations of K+-channels

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P302 Optimal coupling in noisy feed forward leaky integrate and fire network

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P303 Calcium window currents, periodic forcing and chaos: Understanding single neuron response with a discontinuous one dimensional map

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P304 Recurrent cortical networks with realistic horizontal connectivities show complex dynamics

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P305 Frequency response functions for cortical microcircuits

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P306 The effect of global context on the encoding of natural scenes

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P307 A computational model of latency based stimulus selection

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P308 Grouping variables in an underdetermined system for invariant object recognition

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P309 Simulating attentional blink with a neocortical attractor model

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P310 A computational approach for modeling the role of the focus visual attention in an object categorization task

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P311 Sources of interspike interval variability in locust auditory receptor cells

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P312 Multilinear models for the auditory brainstem

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P313 Sound localization with spiking neural networks

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P314 Interaural time difference detection by the auditory system model in the presence of phase noise

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P315 Enhancement of signal detection properties by coupling of active hair bundles

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P316 Tending the source of parkinsonism through deep brain microstimulation

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P317 Does striatum support competitive dynamics? A test of this hypothesis using a biologically realistic model of the striatal microcircuit

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P318 New pulse shapes for effective neural stimulation

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P319 Effects of DBS electrode design on the volume of activated tissue

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P320 Employing LFPs and spikes to model the non-linear behavior of the STN

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P321 Reduced models of striatal neurons: dopamine modulation and dynamics

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P322 Quantifying the complexity of neural network output using entropy measures

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P323 Altered respiratory rhythm in a preBötzinger complex model due to addition of low-threshold, noninactivating K+ current and tonic input

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P324 Comparative evolutionary computational analysis of cerebellar purkinje cell structure and function

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P325 — *withdrawn* —

P326 Links between complex spikes and multiple synaptic plasticity mechanisms in the cerebellar cortex

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P327 Influence of action potential onset rapidness to dynamic response of cortical neurons

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P328 Bursting neurons encode the time-dependent phase of the input signals

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P329 Transition between spike patterns induced by spike sorting errors in multi-unit recordings

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P330 Extensive chaotic dynamics in neural networks in the balanced state

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P331 Evaluation of Stroke Impairment Using Time Series Analysis

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P332 Detection of single trial power coincidence for the identification of distributed cortical processes in a behavioral context

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P333 Irregularity of emergent network activity in the local circuit

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P334 Learning cortical representations from multiple whisker inputs

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P335 Quantitative modeling of the dynamics of adult hippocampal neurogenesis in mice

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P336 Back propagating action potential and distant-dependent calcium signaling in CA1 pyramidal neurons

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P337 The role of dendritic plasticity in noise induced synchrony

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P338 Multimodal encoding in a cortical model for spatial navigation planning

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P339 Trial-to-trial variability of phase precession in the hippocampus

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P340 Self-organization of asymmetric associative networks

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P341 Emotion selectively impairs associative memory

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P342 Enhanced neural modulations during BMI experiments: control perspective

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P343 Role of inhibition in the suppression of α-motoneuron hyper-excitability following chronic spinal cord injury

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P344 Modifications in motor cortical spiking dynamics induced by practice

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P345 Inclusion of noise in iterated firing time maps based on the PRC

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P346 Passive current transfer in wildtype and genetically modified Drosophila motoneuron dendrites

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P347 Efficient current-based optimization techniques for parameter estimation in multi-compartment neuronal models

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P348 A new simulation environment to model spontaneous and evoked activity of large-scale neuronal networks coupled to micro-electrode arrays

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P349 Fast encoding/decoding of haptic microneurography data based on first spike latencies

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P350 A dynamic neural model of localization of brief successive stimuli in saltation

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P351 Interplay between spontaneous and sensory activities in barrel cortex: a computational study

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P352 Artificial grammar recognition using spiking neural networks

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P353 A nonparametric Bayesian approach to adaptive sampling of psychometric functions

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P354 Eye dominance induces pinwheel crystallization in models of visual cortical development

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P355 Feedback in a hierarchical model of object recognition in cortex

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P356 Probing the visual system with visual hypotheses

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P357 On the role of the scale invariance and the independent components of natural scenes on the receptive fields of simple cells

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P358 Large-scale computational model of cat primary visual cortex

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P359 Decoding the population dynamics underlying ocular following response using a probabilistic framework

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P360 Can reduced contour detection performance in the periphery be explained by larger integration fields?

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P361 Sparse connectivity selectively reduces diagnostic facial information: An ICA model of congenital prosopagnosia

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P362 Simulation of multiple functions of the retinal circuitry: A computational and a hardware model

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P363 A computational neural network model of perisaccadic mislocalization in total darkness

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P364 Dynamical insights on the history-dependence during continuous presentation of rivaling stimuli

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P365 A global decision-making model via synchronization in macrocolumn units

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P366 A correspondence-based neural mechanism for position invariant feature processing

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P367 Neuronal responses in the cortical area MSTd during smooth pursuit and ocular following eye movements

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Cruise and Banquet

Monday July 20, 2009

Boat cruise on the river Spree
Banquet in the 'Orangerie' of Palace Charlottenburg

The social event of the CNS 2009 in Berlin will start with a boat cruise on the river Spree passing by most the famous attractions in the centre of the town (Mühlendammschleuse, Nikolai-Quarter, Cathedral of Berlin, Museumsinsel (Isle of Museums), Friedrichstraße, Reichstag, Houses of Jakob-Kaiser, Marie-Elisabeth Lüders, Paul-Löbe, Federal Chancellery, Hall of Congress, Moabiter Werder, Castle Bellevue and Ministry of Interior). From the Castle Bridge you already have a view to the Palace of Charlottenburg, where a banquet will be the highlight of the evening.

A glimpse on the mighty vessels majesticly cruising along the river Spree

Two boats will await you for boarding: MV 'Mark Brandenburg' and MV 'Belvedere'. We will start walking to the mooring 'Märkisches Ufer' at 17:30. The walk will last about 20 minutes. Participants who are not able to make this walk are requested to inform the reception accordingly latest by Monday, 20th July 14:00. We will organize group taxis accordingly. The boats are scheduled to leave at 18:00. You are entitled to get 2 drinks free of charge (one alcoholic and one non-alcoholic, or 2 non-alcoholic, if you prefer). For this purpose we prepared the voucher for the banquet accordingly. There are two marked corners which the personnel on the ship will tear off, once you order your drink(s).

Estimated arrival time at mooring 'Tegeler Weg' will be 20:00 – After a small walk (5 minutes) you can enjoy the view to the famous Palace Charlottenburg:

The Great Orangery at Charlottenburg Palace, built between 1709 and 1712, was originally used to overwinter the rare citrus plants of the botanical collection. During summer months, when 500 orange, lemon and sour orange trees adorned the baroque palace gardens, the Orangery hosted sumptuous royal festivities on a regular basis.

Destroyed in World War II, the former greenhouse's exterior has been rebuilt in its original beauty. According to its tradition, the opulent light-flooded ballrooms of the Great Orangery once more provide the perfect setting for all kinds of cultural events, concerts and banquets.

And here we are back in 2009 – 500 orange trees will be replaced by 500 scientists in a sumptuous CNS festivity! Organizers hope that this event will remain unforgettable. You will be received by music from two of our Bremen students (Felix Patzelt – classical guitar and Joscha Schmiedt – Bajan).

You are invited to inspect the park or take a seat already and enjoy another drink. A flying buffet offering extremely delicious bites and bits will make it easy for everybody to enjoy different kinds of food without queueing up. Wine will be served, all other drinks can be ordered directly. Joscha and Felix will be pleased to entertain you further while you are enjoying a coffee.
Although our baroque setting would suggest to bring you back in a sedan carriage, we ordered modern busses for returning to Gendarmenmarkt. The first bus will be waiting at 23:00, further busses will follow in about 10-minute intervals. You will be accompanied to the bus by students.
Please remember to bring your voucher for the banquet with you! If not, you may help our service staff with washing the dishes in the palace's medieval kitchens.

How to go to the Orangerie/Palace Charlottenburg from Gendarmenmarkt or back (for those who get seasick on river boats...):

- Take metro $U2$ (direction 'Ruhleben') to station 'Ernst-Reuter-Platz', then take Bus $M45$ (direction 'Spandau, Johannesstift') and get off at station 'Luisenplatz/Schloß Charlottenburg'. Takes 25 minutes and runs every $5-10$ minutes. Alternatively, get off the metro at station 'Sophie-Charlotte-Platz' and walk about 10 mins. north on the Schloßstr. (sic!). Highly recommended, as you are passing through a quarter with many fine old buildings from the end of 19th century.

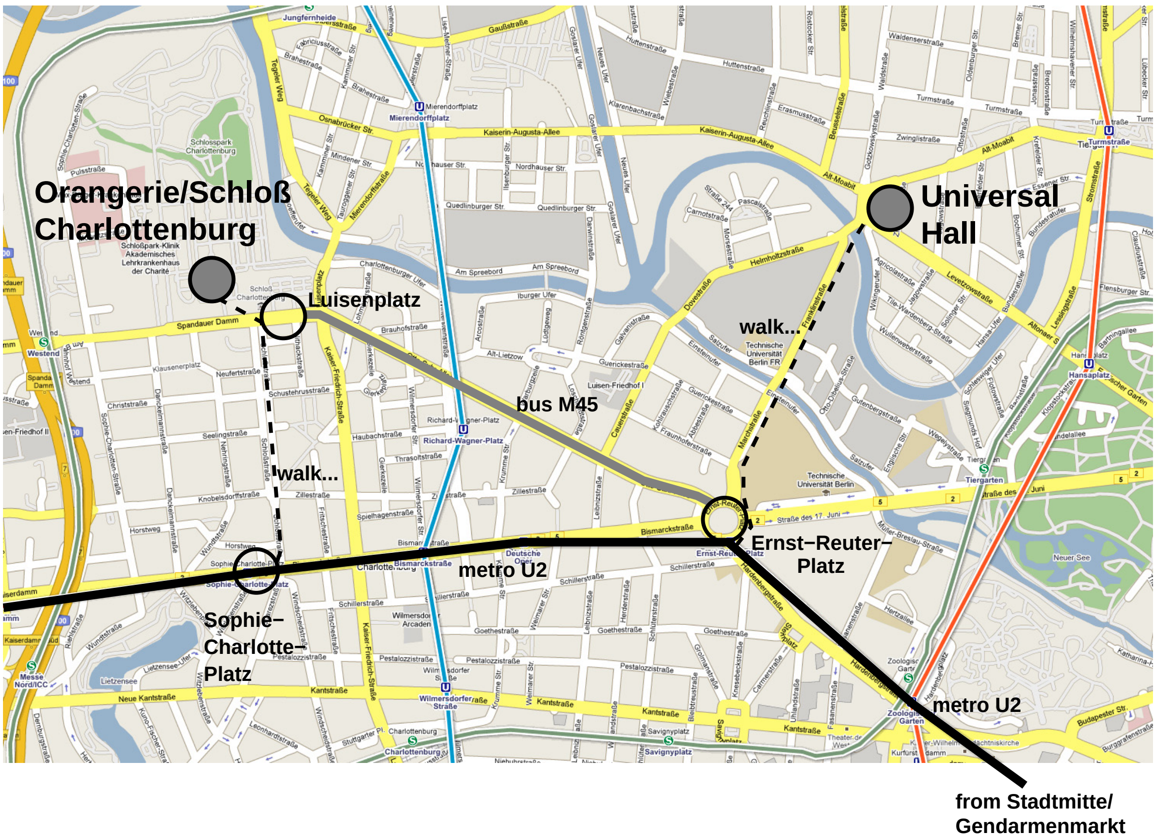
- ...and for those who have to leave earlier, please take the above route in opposite direction, using bus $M45$ (direction 'S+U Zoologischer Garten') and metro $U2$ (direction 'S+U Pankow'). Runs every 10 mins. until midnight.

For directions, see the sketch on the opposite page which also shows the location of the CNS party!

CNS Party

Tuesday July 21, 2009

At the border of the quarters Charlottenburg and Moabit close to the river Spree you find the 'Universal Hall'. It is a typical brick building from the time of rapid industrial expansion in Germany which formerly served as a pumping station. The building offers an incomparable charm and industrial history like no other location.



Participants are invited to join the party at any time. It will officially start at 21:00. To get there, either take metro $U2$ from station 'Stadtmitte' (direction 'Ruhleben') and get off at station 'Ernst-Reuter-Platz' (15 mins. travel time). Then walk north along the 'Marchstraße' and 'Franklinstraße', cross the river Spree and you're there (15 mins walking time). Please try to avoid coming by car; there are only limited capacities for parking in the neighbourhood.
Alternatively...

- Take metro $U6$ from station 'Stadtmitte' (direction 'Alt-Tegel'), change at 'Seestraße' into Bus 106 (direction 'Schöneberg, Lindenhof'), and get off at station 'Alt Moabit/Gotzkowskystraße'. Trip time is between 25–40 minutes, and there is a connection at least every 20 minutes.
- Take metro $U2$ from station 'Stadtmitte' (direction 'Ruhleben'), change at 'Bülowstraße' into Bus 106 (direction 'U Seestr.'), and get off at station 'Alt Moabit/Gotzkowskystraße'. Trip time is about 30 minutes.

A group of 3 ladies (Mareike Schinzel, Tanja Hutterer, Larissa Scharnowske) and one young man (Malte Tönissen) who call themselves 'eskeemo' will welcome you with hot Jazz music. They will partly have their own compositions and partly bring songs you will certainly know. Feel yourselves free to dance, talk and relax after the tough meeting. Maybe this event will end in a jam session? The hall will be available till 2:00 in the morning (and maybe later...)

In between the answer to the question about the best poster presentation will be solved. Hopefully the authors will be there to receive the applause. Also the most funny posters will get special attention. And – be there to learn about the location and setting of next year's CNS conference! Fun is to be expected, and don't worry, there will not be long talks any more!

Drinks can be bought at the bar, and for those who feel hungry, there will be a snack-bar (Hot-Dog-Stand) in front of the building, selling Curry sausages with fries and other typical Berlinian-Cosmopolitan-Snacks-And-Goodies. Smoking is not allowed in the building.

Have fun and enjoy this special atmosphere!

For returning to the Gendarmenmarkt, you can take the above connections in reverse direction (at least every 20 minutes, until 0:30 in the morning). After 0:30, there is a nightbus-connection which runs every 30 minutes, from 0:37 on: Walk on the street 'Alt-Moabit' for about 500 meters in easterly direction to metro station 'Turmstraße'. Take the bus $M27$ (direction 'U+S Pankow') and get off at station 'U Reinickendorfer Str./Fennstr.'. Change into night bus $N6$ (direction 'U Alt Mariendorf') until you reach 'U Stadtmitte'. Takes about 35 minutes.

Local and Touristic Information

Transportation

Public Transport

Berlin has an excellent public transport system which allows you to get to nearly all places as fast as in a car. It consists of short distance trains (S-Bahn), metros (U-Bahn), trams (MetroTram and Straßenbahn) and buses (Bus and Metrobus). **Note that for S-Bahn and metros, tickets have to be stamped in the small machines at the entrances of the train stations prior to boarding! Only in buses and trams you can stamp your tickes (immediately) after boarding.** Otherwise, you will be fined with €40.
The beauty is that all these means of transport can be used with the same tickets, and that you can freely change between these transports during your trip (exception: short trip tickets allow only to change between short distance trains and metros), and that there are only four tariff zone options:

- short trip (Kurzstrecke)
- zones AB
- zones BC
- zones ABC

A short trip ticket is valid for three metro/S-Bahn or six tram/bus stations. Zone 'A' includes Berlin's inner city and the S-Bahn ring line and zone 'B' is the rest of the city. Zone 'C' is Greater Berlin and is needed to reach Schönefeld Airport or the city of Potsdam (see below). This means that you will mainly need 'AB' tickets.
There are single tickets ('AB' €2.10, 'ABC' €2.80), short trip tickets, day tickets, group tickets and 24h/48h/72h/5-day tourist tickets as well (not cheaper than multiple day tickets, but 50% off at a multitude of museums). A day ticket is as expensive as three single tickets, but definitely more convenient. Tickets can be bought at all S-Bahn and metro stations and in the trams (vending machine, coins only) and buses (from the driver, coins and small bank notes). Under http://www.bvg.de/index.php/en/Bvg/Start there is an english journey planner available which gives you detailed instructions on how to get from any station or address to any other station or address.

Public transport at night: In Berlin, it is no (big) problem to get home late at night. On the weekend metros and S-Bahn are less frequent, but at least they are there. In the week, no S-Bahn, metros and trams run between 0:30 and 4:30. Instead, there are night buses and at least for every metro a substitute nightbus, e.g. instead of the metro $U2$ there is the night bus $N2$.

Berlin Central Station: Though with 'Berlin Ostbahnhof' and 'Berlin Südkreuz' there are two other big train stations, you will most probably only need Central Station: All intercity trains pass Central Station and its closer to the city centre.

Airports

Berlin has nowadays two airports: Schönefeld International Airport (SXF) and Tegel International Airport (TXL). From both airports it is only a quick ride to the city:
From Schönefeld you can take the S-Bahn $S9$, direction 'Spandau' to the centre, and you will need an 'ABC' ticket. In order to get to the Hilton Hotel or the Berlin Brandenburg Academy of Science, you can change at the station 'Alexanderplatz' into the metro $U2$, direction 'Ruhleben' and get off at the station 'Hausvogteiplatz'.
From Tegel, you can take the bus TXL to the center (ticket 'AB'). From the bus stop 'Staatsoper Berlin', it is only a short walk to both locations.
For every other destination you can query http://www.bvg.de.

Car Rental Service

If you insist in using a car. there are of course the standard services:

- Europcar Autovermietung, 24H, Alexanderplatz 8, 10178 Berlin (I4)
- Sixt, Leipziger Str. 104, 10117 Berlin (H5)
- Natives prefer the cheaper local company
  'Robben & Wientjes' http://www.robben-wientjes.de...
- ...or do you want to ride the pride of the German Democratic Republic, the famous Trabant ('Trabis')? Then go to http://www.trabitrip.de!

If you are planning for a more extensive round trip through Germany after the conference, you may want to try http://www.holidayautos.com or http://www.fti-touristik.de (sorry, only in German!), who normally offer reasonably priced rental cars with unlimited mileage and all extra insurances already included...

Bike Rental Service

Berlin has lots of bicycle lanes and it is a pleasure to cruise through the city and its parks. There are countless small rental services. The easiest would be to ask at your hotel. There is even a company offering guided tours on bike with various touristic themes at your selection. See details at http://www.berlinonbike.de/english/index.php.

Sightseeing

Berlin Must-Sees: obligatory for every Berlin tourist

Almost all of these Must-Sees are within walking distance from the Gendarmenmarkt. Have a look at your *Stop&Go Berlin City Map* !

Brandenburger Tor (formerly 'part' of the Wall, G4), Reichstag (free admission, fantastic view, but don't bring your guns! – G4), Holocaust Memorial (impressive, G4), Museum Island (culture on-the-block, H4-I4), German Cathedral (H4), French Cathedral (H4) and Cathedral of Berlin (I4) (for our faithful attendees), Berlin Wall (a few pieces are still there, H5, H2, G4 – ask a local Stasi chief officer for details), Rotes Rathaus (I4), Nikolai-Viertel (I4), Märkisches Viertel (ancient downtown, I4/I5), Kaiser-Wilhelm commemoration church (named the 'hollow tooth', E5), Concert House (H4) and Opera (H4), Philharmonie (G5) (for our music-lovers, Yo, Beethoven, Yo!), Checkpoint Charlie (must take your passports with you to cross the border! – H5), ...

Hint: Just walk for five minutes in any direction and you will discover something remarkable, historic, beautiful or simply interesting.

Over the Rooftops of Berlin

- **Television Tower**

  located at Alexanderplatz, the Berlin television tower with its 368 meters is the highest building in Germany. There is a platform at 200 meters with a café and a great view. Unfortunately, entrance and drinks are quite expensive. On the weekend, there are often quite long queues.

  http://www.tv-turm.de, Panoramastraße 1A (Mitte, I4)

- **Park Inn**

  Right next to the television tower, there is the hotel 'Park Inn' which poses a prominent part of the Berlin Skyline as well. At 37^{th} floor, the highest one, you will find a restaurant to sit down, take a coffee and enjoy the view. There is even the possibility of a riskless jump from the roof on the week–end, secured by steel wire ('Base-Flying', http://www.jochen-schweizer.de). No entrance fee, no queues.

  http://www.parkinn-berlin.de, Alexanderplatz 7 (Mitte, I4)

- **Telefunken Tower**

  If you want to see another part of Berlin from above you can go to the Telefunken Tower at Ernst-Reuter-Platz, easy to identify by a big 'T'. The Building has only twenty floors, but there is a refectory of technical university on the top floor. No entrance fee, no queues, cheap coffee and food.

  Ernst-Reuter-Platz 7 (Charlottenburg, D4)

- **Hi-Flyer ('Welt-Balloon')**

  Why climb a high building if you can fly? The Hi-Flyer is a large captive Balloon which is located right in the centre of Berlin and can be seen from nearly everywhere. If you dare you can board and rise to about 150 meters. Not cheap though – and there is no coffee, either!

  http://www.air-service-berlin.de Am Checkpoint Charlie (Mitte, H5)

City Tours

- **Boat Tour**

  For those who missed the conference tour, there are two mini-cruise companies, 'Reederei Riedel' and 'Stern und Kreis' who provide frequent rides on the river Spree, showing the main touristic spots (or, at least, those who can be seen from the water...). Just go to the Museumsinsel (museum island, H4) in the city center, and board at one of the several landing places.

  http://www.reederei-riedel.de/?lang=en (Mitte)

  http://www.sternundkreis.de/English/english.html (Mitte)

- **City Center Bus Tour by BVG**

  Highly recommended! The cheap alternative to 'normal' city tours from private companies. There are two lines of double-decker buses, numbers 100 and the 200, which start at the station 'Tiergarten', run through the city center, pass by a lot of sights before reaching 'Unter den Linden'. Side benefit: You do not have to listen to explanations of a guide.

  http://www.bvg.de/index.php/en/Bvg/Start

- **Trabisafari**

  A guided tour to all the famous sights of Berlin, but not a normal one. This tour is using 'Trabis' (see above). You can steer yourself.

  http://www.trabi-safari.de

Museums

Berlin has over 170 museums. Really. Honestly. Indeed...

You still don't believe it? Go to http://www.berlin.de/international/museums/index.en.php and count for yourself. Ha!

Besides the most famous 'Museumsinsel', we just want to mention a few museums which are really worth seeing...

- **German Museum for Technology**

  Vast collection of everything from technology: computers, trains, engineering, flight, etc, etc, etc, etc. Exceptional!

  http://www.dtmb.de, Trebbiner Straße 9 (Tempelhof, G6)

- **DDR-Museum**

  The history of the former German Democratic Republic

  http://www.ddr-museum.de, Karl-Liebknecht-Str. 1 (Mitte, I4)

- **Filmmuseum**

  A museum about movies. Nice!

  http://www.filmmuseum-berlin.de, Potsdamer Str. 2 (Tiergarten, G5)

- **Mauermuseum**

  A relatively small, but very impressive museum about the wall. Tells the many stories of the people who wanted to escape communism...

  http://www.mauermuseum.de, Friedrichstr. 43-45 (Mitte, H5)

- **Museum für Kommunikation**

  A museum about communication, having its origins in a former postal museum...

  http://www.museumsstiftung.de, Leipziger Straße 16 (Mitte, H5)

- **Musikinstrumenten-Museum**

  Incredible collection of old and contemporary musical instruments. Hear the big Wurlitzer orchestrion play!

  http://www.mim-berlin.de, Tiergartenstr. 1 (Tiergarten, G5)

- **Museum für Gegenwart ('contemporary art')**

  An impressive collection of contemporary art in a beautiful, old train station. The architecture alone is worth a visit, setting a counterpoint to the adjacent new main train station...

  http://www.hamburgerbahnhof.de/text.php?lang=en, Invalidenstraße 50–51 (Mitte, G3)

Food and Fluids

In Berlin, no matter where you are, there is normally a doner kebap, a pizza or one of the more traditional curry 'sausage' places nearby. It is nearly impossible to list all the good restaurants, cozy bistros and relaxed cafés throughout the city.
But if for some reason you are interested in something really special, here is a short list...

- **Anheim**

  An inconspicious, but good restaurant in the vicinity of the 'Friedrichstadtpalast' with innovative recipes – try it!

  http://www.restaurant-anheim.de, Friedrichstr. 134 (Mitte, H3)

- **Mustafas Gemüse Döner**

  If Berlin natives want to eat doner kebap, they go to Mustafas at Mehringdamm. There is no doner like Mustafas doner!

  Mehringdamm 32 (Kreuzberg, H6)

- **Konnopke's Imbiss**

  Reportedly the oldest snack stall of Berlin. If you want to eat 'original German Currywurst', have a look! Below station 'Eberswalder Straße', metro $U2$

  http://konnopke-imbiss.de, Schönhauser Allee 44a (Prenzlauer Berg, I2)

- **Il Casolare**

  Due to some it is the best pizzeria in Berlin. There has to be at least something to it, because during the weekend, especially when the weather is good, the place is crowded.

  Grimmstr. 30 (Kreuzberg, I6)

- **Ishin**

  Ishin is a sushi restaurant near the conference place. The sushi is delicious, as agree all the clients from Asia and Europe.

  http://www.ishin.de, Mittelstraße 24 (Mitte, H4)

- **Café Einstein**

  Located in an old mansion, Café Einstein is a place with the original 'Wiener Caféhaus'-atmosphere. Try a 'Wiener Schnitzel', it is delicious. If the weather is nice, it is a difficult choice between the mansion's garden and the beautiful rooms indoors.

  http://www.cafeeinstein.com, Kurfürstenstraße 58 (Tiergarten, F5)

- **Monsiour Vuong**

  Very popular with Berlin citizens and tourists, this Vietnamese restaurant, or Indochina café as it calls itself, offers a nice atmosphere and tasty food. The restaurant is nearly always crowded and reservations are not possible.

  http://www.monsieurvuong.de, Alte Schönhauser Str. 46 (Mitte, I3)

If there is a queue and you do not want to wait, you can visit...

- **Makotos Japanese Noodle Restaurant**

  . . . which is right in front. There they serve, well, Japanese noodle dishes. But you should try the delicious dumplings as well. Tested and approved by Japanese scientists.

  Alte Schönhauser Straße 13 (Mitte, I3)

- **Unsicht-Bar**

  The name of the restaurant is a pun of words of 'unsichtbar', which means 'invisible' and the word 'Bar', which means, well, 'bar'. It is Germanys first 'Dunkelrestaurant', which means that food is served by blind waiters and waitresses in complete darkness. A unique 'hands-on' experience! Recommended for scientists doing lesion experiments. Reservations obligatory.

  http://www.unsicht-bar-berlin.de, Gormannstr. 14 (Mitte, I3)

- **Weinhaus Rutz**

  If you are looking for a very good restaurant with an excellent collection of wines and are willing to pay for it, have a look at Weinhaus Rutz. Its Michelin Star is well earned. Reservations recommended.

  http://www.rutz-weinbar.de, Chausseestr. 8 (Mitte, H3)

- **Facil**

  According to a famous German restaurant critic the best restaurant in Berlin. It is located in the courtyard of the Mandala hotel. Not Japanese-scientist-approved, though. Reservations recommended.

  http://www.facil.de, Potsdamer Strasse 3 (Mitte, G5)

Or, if you prefer to eat whilst stepping onto a side track of mainstream entertainment...

- **White Trash**

  In the restaurant and club White Trash a couple of stars are cultivatedly crashed. Even Pink and Mick Jagger have been there after their concerts. Here, the tattooed rocker as well as the Agency's Fuzzi gets his after-work beer as well as spicy chili-cheese burgers.

  http://new.whitetrashfastfood.com, Schönhauser Allee 6-7 (Mitte, I3)

- **Kaffee Burger**

  Dance-Inn since 1890 with an extraordinary history (infamous café, scene bar for theatre makers, Stasi observation position. . .). Now the 'bear is tap-dancing'! Nearly every day you can have some live-music or literature followed by a party.

  http://www.kaffeeburger.de Torstraße 60 (Mitte, I3)

Parties, Beer and Night Life

Night Life Neighbourhoods

In Berlin, there is not just one place where people go to party, but many different zones. Here are a few of the most important ones:

1. **Simon-Dach-Straße (Friedrichshain)**

   In this part of Friedrichshain there are many bars and cafés which are cheap and much frequented by students.

2. **Bergmannstraße (Kreuzberg)**

   Not as cheap as Simon-Dach-Straße and a little bit smaller, but nevertheless a nice neighbourhood.

3. **Oranienstraße, Schlesisches Tor (Kreuzberg)**

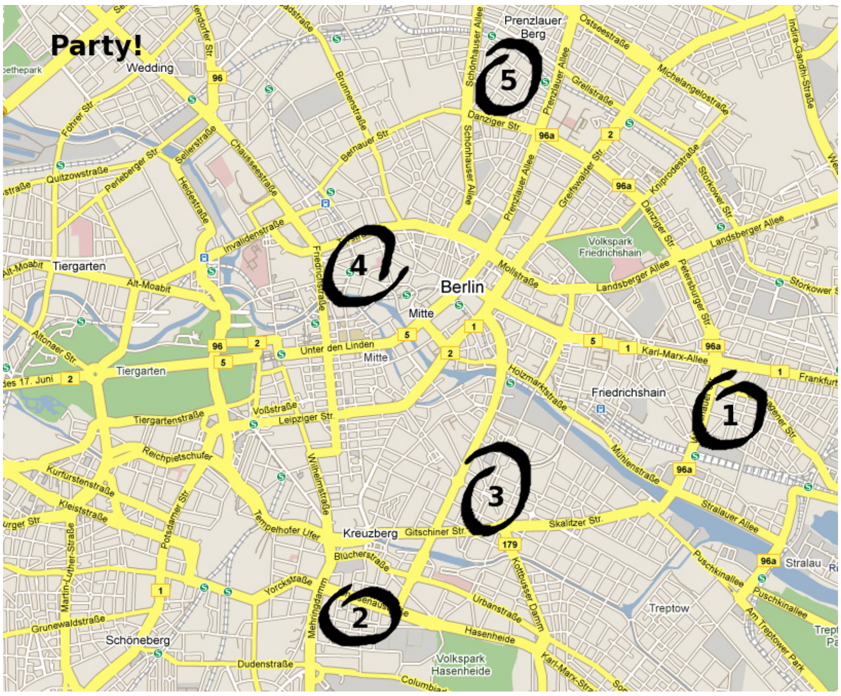
   This is the more left-wing alternative part of Berlin. But don't worry, apart from the first of May ('labour day'), it is a safe place.

4. **Oranienburger Straße (Mitte)**

   In this and and the adjacent streets, located between the train/S-Bahn stations 'Friedrichsstraße' and 'Hackscher Markt', lots of bars attract a lot of tourists. Around Hackscher Markt there is an abundance of small shops for your daytime shopping spree.

5. **Helmholtzplatz (Prenzlauer Berg)**

   A little bit more quiet. Prenzlauer Berg is said to have the highest birth rate in Germany, but nevertheless there are not only young mothers in the cafés and restaurants. At least not during nighttime.



Especially recommended clubs

- **Berghain**

  Not a zone, but the world's best techno club (according to DJ Mag). It is located in a former power plant in Friedrichshain and is infamous for its selective door policy. E.g., wear a shirt and you are out. It is as well not recommendable to try to enter as a group.

  http://www.berghain.de, Am Wriezener Bahnhof (Kreuzberg/Friedrichshain)

- **Weekend**

  The week-end is not only located at the end of the week, but also on the roof of an office building at Alexanderplatz. It is only open if the weather is nice – but if the weather is nice you can party with an incredible view of Berlin by night.

  http://www.week-end-berlin.de, Alexanderplatz 5 (Mitte, I4/K3)

- **Watergate**

  The Club is very popular. It is located directly at the river Spree and has a huge glass window towards the waterfront, giving it a great atmosphere.

  http://www.water-gate.de, Falckensteinstr. 49 (Kreuzberg/Friedrichshain)

Biergärten

What is a trip to Germany without visiting a traditional German Biergarten ('beer garden'), and having a beer and traditional German/Austrian food under the shade of chestnut trees? You have two possibilities to share this experience: (1) Ask a local for directions to go to 'Bayern' (not recommended to mention this word in the captial of ancient Prussia), or (2) Go to one of the most beautiful Biergärten in Berlin, as e.g.

- **PraterGarten**

  Since 1837 you can sit down and relax in the oldest Biergarten of Berlin which has a quite eventful past.

  http://www.pratergarten.de, Kastanienallee 7-9 (Prenzlauer Berg)

- **Schleusenkrug**

  Located at an old watergate at the 'Landwehrkanal' (a channel) next to the Zoo and the big central Park Tiergarten, this Biergarten does not let you notice that you are in a big city.

  http://www.schleusenkrug.de, Müller-Breslau-Straße (Tiergarten, E4/E5)

- **Schönbrunn**

  This Biergarten is located in the beautiful park 'Friedrichshain'. It also has a restaurant which is renowned for its delicious Austrian food

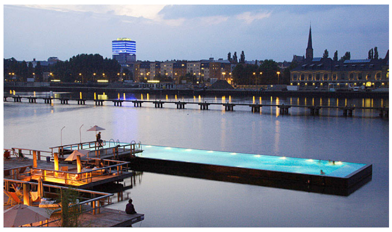
  http://www.schoenbrunn.net, Am Friedrichshain 8 (Prenzlauer Berg)

By the way, the local beer delicacy is the 'Berliner Weiße mit Schuß' (to be ordered in green – with Waldmeister – or in red – with Himbeere –). Try it, if you dare...

Other Places of Touristic Interest in And Around Berlin...

Swimming and Fishing

- **Badeschiff/Arena**



The 'Badeschiff' (swimming boat or boat for swimming, both are correct) allows you to swim in the river Spree without actually touching the water flowing through German's capital: It is an old transport boat, located on the Spree river, which is filled with crystal-clear water, making it to a funny outdoors pool for a relaxed summer evening. Moreover, it is near the area termed the 'Arena', which hosts big concerts and nice bars.

http://www.arena-berlin.de Eichenstraße near Spree river, take metro $U1$ to station 'Schlesisches Tor' plus a 10-minute walk. Alternatively, use the S-Bahn lines $S8$, $S85$, $S9$, $S42$, $S41$, station 'Treptower Park' plus a 5-minute walk.

- **Zoo/Aquarium**

Near 'Bahnhof Zoo' you will find the zoo which gave this train station its name. Being not as big as other aquariums in CNS history, the aquarium of the Berlin zoo is remarkable for its many fine displays, located in a historic building. There's the possibility to buy tickets for the zoo or the aquarium only. If you want to co-visit some of the many fine police stations in Berlin, don't forget to ask one of the guards for fresh sushi!

http://www.aquarium-berlin.de/en.html, http://www.zoo-berlin.de/en.html, Budapester Str. 32 (Charlottenburg/Tiergarten, E5)

...and not that obvious sights

- **Hohenschönhausen**

Since 1994 the site of the former remand prison of the 'Stasi' (DDR - Ministerium für Staatssicherheit/ministry for state security of the GDR)- has been a memorial. There are impressive guided tours by former inmates, though in English only Saturdays.

http://www.stiftung-hsh.de, Genslerstraße 66 (Hohenschönhausen)

- **Jewish Museum**

The exhibition offers a round trip through 2000 years of Jewish history and Jewish-German history since medieval times. The museum was built by Daniel Libeskind and has a unique unity of architecture and content.

http://www.juedisches-museum-berlin.de, Lindenstr. 9 (Kreuzberg, H5/H6)

- **Sony Center at Potsdamer Platz**

The building complex houses cinemas, bars, shops, offices and the like. It is a quite impressive sight especially by night. Then you can enjoy the cyberpunk atmosphere, created by the illuminated roof in the courtyard.

http://www.sonycenter.de, Potsdamer Straße 4 (Tiergarten, G5)

- **KaDeWe**

  The 'Kaufhaus des Westens' ('department store of the West') is an over a hundred years old luxury department store, after Harrods the second largest in Europe. Besides lots of small shops and beautiful architecture it offers a tremendous food department.

  http://www.kadewe.de, Tauentzienstr. 21-24 (Charlottenburg, E5)

- **Berlin Central Station/Ice Cream**

  If you are flying to Berlin, you do not pass through Berlin Central Station. A pity – the new central station is either an interesting piece of architecture or a not-really-inspired monumental brick made of glass and steel (depending on whom you ask). Have a look and decide for yourself which three superlatives you want to attribute to it!

  The gem inside this building is a very good ice cream parlor directly at the southern entrance on the street level – really delicious!

  http://www.hbf-berlin.de/site/berlin_hauptbahnhof/en/start.html (G3)

- **Tacheles**

  Being once the massive entrance facade of the Friedrichstadt-Passage built in 1907, the ancient department store was subject to a slow collapse and breakup after World War II. Shortly after the Wall came down, artists repopulated the ruin during the 1990's, and by now this famous building hosts a variety of performing and fine arts. In the vicinity, there are many small places for having dinner and enjoying a relaxed summer evening

  http://www.tacheles.de, Oranienburger Str. 54 (Mitte, H3)

Around Berlin (for more info, enter 'Germany' in Google...)

- **Potsdam**

  Potstam, the capital of the federal state Brandenburg, is the former residence of the Prussian kings. The kings are gone, but their beautiful palaces and parks remain and they alone would make Potsdam worth a trip, not even speaking about places like the historic city center or important museums. You can reach Potsdam with a S-Bahn or a RE ('Regionalbahn', regional train), from e.g. Hauptbahnhof in 40 respectively 25 minutes. Note that you will need an 'ABC' ticket.
- **Spreewald** – One of the most popular holiday destinations in Brandenburg
- **Mecklenburgische Seenplatte**

  A mixture of Canadian woods & lakes with sand from the Californian coast, topped with southern French coniferous forest and interspersed with Rotkäppchen-like villages
- **Wannsee and Pfauninsel** – ...where (some) Berliner go during the weekend to relax
- **Frankfurt/Oder, Slubice**

  If you are interested in a vist to Poland, the shortest trip you can do is taking a regional train to Frankfurt (Oder). There you can cross the river 'Oder' by foot. Frankfurt (Oder) hosts the Viadrina European University, dedicated to intercultural exchange, especially between Germany and Poland.
- More information on day trips in and around Berlin:

  http://www.visitberlin.de/deutsch/sightseeing/d_si_umland.php
- Tourist infos for Brandenburg, the federal state surrounding Berlin:

  http://www.brandenburg-tourism.com

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