Thirteenth Annual Computational Neuroscience Meeting
*CNS*2004*

July 18-22, 2004
Baltimore, Maryland

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Photography by Jessica Riescher

Meeting Overview

Sunday, July 18, 2004

8:00 am	Registration: *Calvert Ballroom Foyer*
9.00 am	Welcome and Invited Speaker: *Mary Kennedy*
10:00 am	Oral Session 1:*Ion Channel Dynamics*
10:40 am	Break: *Refreshments provided*
11:10 am	Oral Session 1 (continued)
11:30 am	Oral Session 2: *Morphology and connectivity*
12:30 pm	Lunch break
2.00 pm	Announcements/Oral Session 2 (continued)
2:50 pm	Oral session 3: *Learning*
3:30 pm	Afternoon Break: *Refreshments provided*
4:10 pm	Oral Session 4: *Synaptic plasticity*
5:10 pm	Special Lecture: *Loralyn Mears,* Sun Microsystems
5:40 pm	Dinner break
7.00-11:00 pm	Poster session I: *Calvert Ballroom and Versailles Room* *Cash bar and snacks on Versailles foyer*

Monday, July 19, 2004

8:00 am	Registration: Calvert Ballroom Foyer
9.00 am	Announcements and Invited Speaker: *Terry Sejnowski*
10:00 am	Oral Session 5: *Large scale interactions*
10:40 am	Morning Break: *Refreshments provided*
11:10 am	Oral Session 6: *Network dynamics*
1:00 pm	Lunch break
2:30 pm	CNS-Business meeting
3:00 – 6:30 pm	Poster session II: *Calvert Ballroom and Versailles Room* *Cash bar and snacks on Versailles foyer*
7:00 – 11:00 pm	Banquet: *National Aquarium in Baltimore*

Tuesday, July 20, 2004

8:00 am	Registration: Calvert Ballroom Foyer
9.00 am	Speaker: *Eugene M. Izhikevich*
9:40 am	Oral Session 7: *Visual system*
10:40 am	Morning Break: *Refreshments provided*
11:10 am	Oral Session 8: *Single-neuron and population coding*
12:50 pm	Opportunities for Computational Neuroscience: *Denis Glanzman*
1:10 pm	Lunch break
3:00 pm	Announcements and Invited Speaker: *Miguel Nicolelis*
4:15 pm	Main meeting and workshop announcements
4:15 – 8:00 pm	Poster session III: *Calvert Ballroom and Versailles Room* *Cash bar and snacks on Versailles foyer*
9:00 pm – 12:00 am	CNS*2004 Party: Little Havana

Wednesday/Thursday, July 20/21, 2004

9:00 am – 12:00 pm, 2:00 pm – 5:00 pm Workshops

*THIRTEENTH ANNUAL COMPUTATIONAL NEUROSCIENCE MEETING CNS*2004*

Welcome to CNS*2004! This is the thirteenth annual meeting of an interdisciplinary conference addressing a broad range of research approaches and issues involved in the field of computational neuroscience. These meetings bring together experimental and theoretical neurobiologists along with engineers, computer scientists, physicists and mathematicians interested in the functioning of biological nervous systems. Peer reviewed papers are presented all related to understanding how the nervous systems compute. As in previous years, CNS*2004 will equally emphasize experimental, model-based and more abstract theoretical approaches to understanding neurobiological computation.

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GENERAL INFORMATION

Location: The meeting will be held in the Calvert Ballrom of the Radisson Hotel in Baltimre's Inner Harbor from Sunday, July 18th to Tuesday, July 20th. Workshops will take place in the hotel as well in smaller meeting rooms equipped with audio visual equipment from Thursday, July 22nd to Friday July 23rd. Maps of the Inner Harbor and surrounding areas are included on the following pages along with lists of local activities and restaurants.

Registration: Meeting registration will be open in the foyer of the Calvert Ballroom beginning Saturday, July 17th from 5:00-7:00 pm. From Sunday, July 18th to Wednesday, July 21st the Regisration desk will be open from 8:00 am until 5:00 pm.

Oral Sessions: An LCD projector will be available for all speakers to use and the main meeting room is supplied with a large screen and an ampification system.

Poster Sessions: Posters should be set up before lunch time and removed at the end of the night session to which it is assigned. All three evenings of poster sessions will take place in the Calvert Ballroom and Versailles Room (located on the lobby level). A Cash bar and snacks will be provided at each session.

Lunches, Dinners and sightseeing: In the pages following the abstracts guests will find an array of activites and dining estalishments for them to enjoy. More information can be obtained at the Hotel conceierge desk.

Banquet: The conference banquet will be on Monday, July 19th from 7:00-11:00 pm in the Pier 4 tent of the National Aquarium in Baltimore. Guests will have an opportunity to view the award wining, magical exhibitry and will enjoy a casual dinner complete with a Steel Drum Band on the water.

Workshops: Workshops will take place in the Calvert Salons (Inside the Calvert Ballroom), The Baltimore Theater, and Hannover Suite B. All of these rooms are located inside the hotel for your convenience.

CNS*04 Party: On Tuesday, July 20th at 9:00 pm CNS participants are invited to Little Havana across the Balimore Inner Harbor for our party. From 9:00 until midnight all drafts are $2.00. Transportation to this event will be via water taxi and groups will be lead by the local organizers to the water taxi stop in the Inner Harbor. Those attendees wishing to travel with the group should meet in the lobby of the hotel at 8:30 pm.

Best Presentation Awards: Prizes will be awarded to the best student presentation ($250) and to the best overall presentation ($500). These prizes were generously donated by Elsevier, a corporate sponsor of the meeting. Prizes will be awarded after review by the judging panel: Ernst Niebur (chair), Pamela Abshire, Johnathan Bell, Netta Cohnen, David Horn, Michael Hasselmo.

Sunday, July 18, 2004

SUNDAY, JULY 18, 2004

9.00 am	Welcome by CNS President Christiane Linster Invited Speaker: *Mary Kennedy*	

ORAL SESSION 1 — **Ion Channel Dynamics**

10:00 am	James B. Maciokas, Philip Goodman, John Kenyon, Maria Toledo-Rodriguez, and Henry Markram *Accurate dynamical models of interneuronal GABAergic channel physiologies*	**102**
10:20 am	Gergo Orban, Tamas Kiss and Peter Erdi *Theta-frequency synchronization of hippocampal CA1 populations by hyperpolarization-activated currents*	**103**
10:40 am	**Break: *Refreshments provided***	
11:10 am	Jeremy R. Edgerton, J.E. Hanson and Dieter Jaeger *Effects of dendritic spiking on synaptic integration in globus pallidus neurons*	**104**

ORAL SESSION 2 — **Morphology and connectivity**

11:30 am	Beth L. Chen and Dmitri B. Chklovskii *Why are most neurons in the head?*	**105**
11:50 am	Dmitri B. Chklovskii *Synaptic connectivity and neuronal morphology: two sides of the same coin*	**106**
12:10 pm	Ruggero Scorcioni and Giorgio A. Ascoli *Algorithmic reconstruction of complete axonal arborizations in rat hippocampal neurons*	**107**
12:30 pm	**Lunch break**	
2.00 pm	Announcements	
2:10 pm	Nathaniel N. Urban, Vikrant Kapoor, Jason Castro *Dendritic integration in accessory olfactory bulb mitral cells*	**111**

ORAL SESSION 3 **Learning**

2:50 pm	Robert Kozma, Derek Wong, Walter J Freeman *Learning intentional behavior in the K model of the amygdala and the cortico hyppocampal formation*	**112**
3:10 pm	Yael Niv, Michael Duff and Peter Dayan *Dopamine, uncertainty and TD learning*	**113**
3:30 pm	**Afternoon Break:** ***Refreshments provided***	

ORAL SESSION 4 **Synaptic plasticity**

4:10 pm	Anat Elhalal & David Horn *In-vitro neuronal networks evidence for synaptic plasticity*	**114**
4:30 pm	Erik Fransen Lars Zanden *A synapse which can switch from inhibitory to excitatory and back*	**115**
4:50 pm	Jonathan Rubin Richard Gerkin Guoqiang Bi Carson Chow *Calcium dynamics as a signal for spike-timing dependent plasticity*	**116**
5:10 pm	Loralyn Mears from Sun Microsystems *IT SLICES, IT DICES, AND YES - IT CAN DO BRAIN SURGERY TOO! - An Update on Computation in Neuroscience Today*	**117**
5:40 pm	**Dinner break**	
7.00 pm	**Poster session I**: *Calvert Ballroom and Versailles Room* *Cash bar and snacks on Versailles foyer*	

POSTER SESSION **Visual system 1**

120 (S01)	Timothy Sweeney and Philip Ulinski *Spatial Distribution of Inhibitory Interneurons Expressing Calcium Binding Proteins in Turtle Visual Cortex*
121 (S02)	Peter Kalocsai *Human sensitivity to face statistics computed on V1 similarity*
122 (S03)	Haruka Nishimura, Ko Sakai *The computational model for border-ownership determination consisting of surrounding suppression and facilitation in early vision*
123 (S04)	Mona Mathur and Basabi Bhaumik

Study of spatial frequency selectivity and its spatial organization in the visual cortex through a feedforward model

124 (S05) M.A. Giese, D.A Leopold
Physiologically inspired neural model for the encoding of face spaces

125 (S06) Botond Szatmary, Barnabas Poczos and Andras Lorincz
Finding structure by entropy minimization in coupled reconstruction networks

126 (S07) Axel Etzold, Christian W. Eurich
A direct, interval-based method for reconstructing stimuli from noise-robust tuning curves

127 (S08) Yuguo Yu, Ph.D Tai Sing Lee, Ph.D
Adaptive contrast gain control and information maximization

128 (S09) Guillermo Ortega, Markus Bongard, Enrique Louis, Eduardo Fernandez
Rate synchronization as a deterministic signal in neural spike trains

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POSTER SESSION **Sensory systems**

129 (S10) Evan Haskell Gary J. Rose
Parallel processing of multi-modal information in single neuron computation

130 (S11) Niklas Ludtke, Mark E. Nelson
Electrolocation of prey-like stimuli a detection-theoretic approach

131 (S12) Don H. Johnson Jyotirmai Uppuluri
Finding likely models that describe population responses

132 (S13) Jonathan L House, Rdiger Krahe, Mark E Nelson
Primary afferent responses to naturalistic signals and backgrounds in weakly electric fish

133 (S14) Patrick D. Roberts
Recurrent neural network generates a basis for sensory image cancellation

134 (S15) Kazuhisa Fujita,Yoshiki Kashimori,Takeshi Kambara
Dynamic population coding for detecting the distance and size of an object in electrolocation

135 (S16) Enrico Rossoni, Gareth Leng, Jianfeng Feng
Modeling the milk-ejection reflex

POSTER SESSION **Hippocampus 1**

136 (S17) Alexei V. Samsonovich, Giorgio A. Ascoli
Algorithmic description of hippocampal granule cell dendritic morphology

137 (S18) Duncan E. Donohue and Giorgio A. Ascoli
Morphological noise in a computational model of dendritic branching

138 (S19) Michael E. Hasselmo

Hippocampal and prefrontal cortical mechanisms in goal-directed and memory-guided behavior.

139 (S20) F. Saraga, J.J. Lawrence, J.M. Statland, C.J. McBain and F.K. Skinner
Modeling IM channels in hippocampal CA1 Oriens/Alveus interneurons

140 (S21) M. Stead, G.A. Worrell, and B. Litt
Frequency dependence in the long-range temporal correlation human hippocampus energy fluctuations

141 (S22) Alan H. Bond
Representing episodic memory in a system-level model of the brain

142 (S23) A. Madany Mamlouk, H. Sharp, K. M. L. Menne, U. G. Hofmann, T. Martinetz
Unsupervised spike sorting with ICA and its evaluation using GENESIS simulations

143 (S24) Xiangbao Wu, William B Levy
Increasing CS and US longevity increases the learnable trace interval

144 (S25) David S. Touretzky
Path Integrator Contributions to Hippocampal Map Formation

145 (S26) Ashlie B. Hocking and William B Levy
Computing Conditional Probabilities in a Minimal CA3 Pyramidal Neuron

146 (S27) Maria Markaki, Stelios Orphanoudakis and Panayiota Poirazi
Modelling reduced excitability in aged CA1 neurons as a calcium-dependent process

147 (S28) Pawel Kudela, Piotr J Franaszczuk, Gregory K Bergey
Modeling of intracellular Ca2+ during epileptic seizures

POSTER SESSION **Information coding 1**

148 (S28) Dileep George
Inter-spike-interval coding and computation with integrate and fire neurons

149 (S29) Thomas Hoch, Gregor Wenning and Klaus Obermayer
Correlations in the background activity allow the use of single neuron learning rules in populations

150 (S30) V Del Prete and ACC Coolen
Population dynamics of excitatory and inhibitory spiking neurons quantifying the contribution of spike timing to coding

151 (S31) Andras Lorincz
Is neocortical encoding of sensory information intelligent?

152 (S32) Patrick Crotty and William B Levy
Energy-efficient interspike interval codes

153 (S33) Liam Paninski, Jonathan Pillow, Eero Simoncelli
Comparing integrate-and-fire-like models estimated using intracellular and extracellular data

154 (S34) Thomas Wennekers and Nihat Ay

	Stochastic Interaction in Associative Nets
155 (S35)	Aaron P. Shon Rajesh P. N. Rao *Implementing belief propagation in neural circuits*
156 (S36)	Aurel A. Lazar *Time encoding with integrate-and-fire neurons*

POSTER SESSION **System dynamics**

157 (S37)	Kosuke Hamaguchi Masato Okada Michiko Yamana Kazuyuki Aihara *Stochasticity in localized synfire chain*
158 (S38)	Rubn Moreno-Bote Nstor Parga *Simple model neurons with AMPA and NMDA filters. The role of the synaptic time scales*
159 (S39)	Friedrich T. Sommer Thomas Wennekers *Synfire chains with conductance-based neurons internal timing and coordination with timed input*
160 (S40)	Benjamin Lindner, Jan Benda, and Andre Longtin *Effect of spike-driven feedback on the firing statistics of noisy spike generators*
161 (S41)	Joanna R. Pressley, Todd W. Troyer *A-currents reduce spike synchrony driven by input transients*
162 (S42)	Sean Carver, Tim Kiemel, Herman van der Kooij, John Jeka *Comparing internal models of the dynamics of the visual environment*
163 (S43)	Robert L. Fry *Neural statics and dynamics*

POSTER SESSION **EEG/MEG**

164 (S44)	Yoichi Miyawaki, Masato Okada *Mechanisms of spike inhibition in a cortical network induced by transcranial magnetic stimulation*
165 (S45)	Murielle Hsu David Hsu *A piece-wise harmonic Langevin model of EEG dynamics Theory and application to EEG seizure detection*
166 (S46)	Zoltn Somogyvri, Gbor Borbth, Lszl Zalnyi, Istvn Ulbert, Pter rdi *Electrode-cell distance estimation method, based on spatial potential patterns of spiking cells*
167 (S47)	Freeman, Walter J *Self organized criticality in scale-free neocortical dynamics*
168 (S48)	Yuqiao Gu, Bjrn Wahlund, Hans Liljenstrm, Dietrich von Rosen and Hualou Liang *Analysis of phase shifts in clinical EEG evoked by ECT*

POSTER SESSION **Cellular mechanisms**

169 (S49)	Renaud Jolivet, Alexander Rauch, Hans-Rudolf Lscher, Wulfram Gerstner *Reduced models of neuronal activity have spike timing predictive power*
170 (S50)	WITHDRAWN
171 (S51)	Peter Roper *Frequency-dependent depletion of secretory vesicle pools modulates bursting in vasopressin neurones of the rat supraoptic nucleus*
172 (S52)	Mandana Ahmadi, Timothy J. Lewis, John Rinzel *Bistability in a two-compartment leaky integrate-and-fire neuron*
173 (S53)	Gutkin, B.; Stiefel, K; Sejnowski, T. *Cholinergic modulation of phase response curves of cortical pyramidal neurons.*
174 (S54)	Mathilde Badoual, Michael Rudolph, Zuzanna Piwkowska, Alain Destexhe, Thierry Bal *High discharge variability in neurons driven by current noise*
175 (S55)	Luk Chong Yeung, Harel Z. Shouval and Leon N Cooper *A biophysical model of metaplasticity can account for homeostatic synaptic-scaling*

POSTER SESSION **Thalamus and brainstem**

176 (S56)	Eric Brown, Jeff Moehlis, Mark Gilzenrat, Philip Holmes, Ed Clayton, Gary Aston-Jones, and Jonathan Cohen *A neural mechanism for optimizing task performance*
177 (S57)	C.M. Weaver, R. Baker, and S.L. Wearne *Morphologic contributions to velocity storage neural integration*.
178 (S58)	P. Achard, R. Rodriguez, G. Hilaire *Model of maturation of the respiratory rhythm generator*
179 (S59)	William Lytton, Michael O'Laughlin and Daniel Uhlrich *Paroxysm potentiation synaptic potentiation enhances repetitive epileptiform discharge without enhancing evoked response*
180 (S60)	Marco A. Huertas, Jeffrey R. Groff, Gregory D. Smith *The effect of feedback inhibition on throughput properties of the dLGN/PGN*
181 (S61)	Young-Ah Rho, Jaeseung Jeong, and Kyoung J. Lee *A possible synchronization mechanism of the suprachiasmatic nucleus based on the phase-response curve*
182 (S62)	Netta Cohen *A minimal model for C Elegans forward locomotion*

183 (S63) Z. N. Aldworth A. G. Dimitrov J. P. Miller
Driving neuronal responses using stimulus feedback in the cricket cercal sensory system

184 (S64) Yikun Huang John P. Miller
Phased array processing for spike discrimination

185 (S65) Randall D. Hayes, John H. Byrne, Steven J. Cox and Douglas A. Baxter
Estimation of single-neuron model parameters from spike train data

186 (S66) Victoria Booth, Amitabha Bose
Multistability in inhibitory networks with depressing synapses

187 (S67) Andrey Shilnikov, Ronald L. Calabrese, and Gennady Cymbalyuk
Transition between tonic spiking and bursting in a neuron model

188 (S68) Peter Andras
Neural activity pattern systems

Monday, July 19, 2004

MONDAY, JULY 19, 2004

9.00 am	Announcements	
9:10 am	Invited Talk: Terry Sejnowski, *Spike Time Patterns*	**201**

ORAL SESSION 5 — **Large scale interactions**

10:00 am	Alexander Grushin James A. Reggia *Evolving Processing Speed Asymmetries and Hemispheric Interactions in a Neural Network Model*	**202**
10:20 am	Carol Whitney Michal Lavidor *The Source of Hemifield Asymmetries in Visual Word Recognition*	**203**
10:40 am	**Break: *Refreshments provided***	

ORAL SESSION 6 — **Network Dynamics**

11:10 am	Brent Doiron, Maurice J. Chacron, Benjamin Lindner, Leonard Maler, Andre Longtin and Joseph Bastian *Network Dynamics and Information Transfer of Natural Stimuli in Electric Fish*	**204**
11:50 am	Zuzanna Piwkowska, Michael Rudolph, Mathilde Badoual, Alain Destexhe and Thierry Bal *Recreating active states in vitro with a dynamic clamp protocol*	**205**
12:20 pm	K.D.Harris; P.Bartho; M.B.Zugaro; L.Monconduit; S.Marguet and G.Buzsaki *Disintegration of neocortical cell assemblies under general anesthesia*	**206**
12:30 pm	Scott A. Hill, Melissa A. Borla, Jorge V. Jos, and Donald M. O'Malley *Neurokinematic Modeling of Complex Swimming Patterns of the Larval Zebrafish*	**207**
1:00 pm	**Lunch break**	
2.30 pm	CNS Business Meeting	
3:00-6:30 pm	**Poster session II**: *Calvert Ballroom and Versailles Room*	
7:00 pm	**Banquet at the National Aquarium in Baltimore**	

POSTER SESSION **Olfactory system**

220 (M02) Thomas A. Cleland Praveen Sethupathy
Non-topographical contrast enhancement enables disambiguation of high-dimensional neural representations

221 (M03) Etienne Hughes and Dominique Martinez
Encoding in a network of sparsely connected spiking neurons application to locust olfaction

222 (M04) Jason Castro Vikrant Kapoor Nathan Urban
Analysis of the mitral cell-granule cell reciprocal synapse adaptation and divisive scaling

223 (M05) Orit Kliper, David Horn, Brigitte Quenet
The inertial-DNF Model Spatiotemporal Patterns with Two Time-Scales

224 (M06) Christiane Linster, Silke Sachse, Giovanni Galizia
Olfactory contrast enhancement by functional inhibition in the honeybee antennal lobe

225 (M07) G. Gradwohl and Y. Grossman
A theoretical computer model of cellular modification associated with olfactory learning in the rat piriform cortex

226 (M08) Blejec Andrej
Statistical method for detection of firing rate changes in spontaneously active neurons

227 (M09) Catherine A. Lowry Leslie M. Kay
Oscillatory dynamics of olfactory structures in response to predator and non-predator odors

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POSTER SESSION **Visual system 2**

228 (M10) Rodrigo F. Oliveira, Luciano da Fontoura Costa, Antonio C. Roque
A Possible Mechanism of Curvature Coding in Early Vision

229 (M11) Charles Raliff, Peter Sterling, Vijay Balasubramanian
More dark information in natural scenes requires denser mosaics of OFF ganglion cells

230 (M12) Subramonia Sarma, Yoonsuck Choe
Salience of Orientation-Filter Responses as Suspicious Coincidence in Natural Images

231 (M13) Neil D. B. Bruce
Features That Draw Visual Attention: An Information Theoretic Perspective

232 (M14) Heiko Stemmann, Winrich A. Freiwald, Aurel Wannig, Erich L. Schulzke, and Christian W. Eurich
Encoding of Dynamic Visual Stimuli by Primate Area MT Neurons

233 (M15) Wenxue Wang Bijoy K. Ghosh
Detection of Video Inputs Using the WUNG Model

234 (M16) Maciej T. Lazarewicz, Sandhitsu Das, Leif H. Finkel
Recognition of Temporal Event Sequences by a Network of Cortical Neurons

268 (M49) Clay Campaigne and Philip Ulinski
Temporal Dynamics of Three Populations of Inhibitory Interneurons in Turtle Visual Cortex

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POSTER SESSION **Hippocampus 2**

235 (M17) David W. Sullivan and William B Levy
Activity Affects Trace Conditioning Performance in a Minimal Hippocampal Model

236 (M18) Peter A. Murray and Frances K. Skinner
Reduced Kinetic Schemes of Short-term Synaptic Plasticity in Inhibitory Network Models

237 (M19) Theoden I. Netoff, Jonh A. White
Bridging single cell and network dynamics

238 (M20) W.R. Holmes S. Zeng
Stochastic model of calcium initiated reactions in a dendritic spine

239 (M21) Leslie M. Kay
Performance and olfactory-hippocampal theta band coherence

240 (M22) Zsofia Huhn, Gergo Orban, Mate Lengyel, Peter Erdi
Dendritic spiking accounts for rate and phase coding in a biophysical model of a hippocampal place cell

241 (M23) Theoden I. Netoff, Robert Clewley, Scott Arno, Tara Keck, John A. White
Epilepsy in Small-World Networks

242 (M24) Jonghan Shin, Daesoo Kim, and Hee-Sup Shin
Theta rhythm during passive whole body rotation is absent in phospholipase1 knockout mice

243 (M25) J. Ziburkus J.R. Cressman E. Barreto S.J. Schiff
Dynamical evolution of neuronal interactions during in vitro seizures

244 (M26) Toru Aonishi Hiroyoshi Miyakawa Masashi Inoue Masato Okada
Effect of Dendritic Backpropagating Action Potential on Neural Interaction

245 (M27) Gabor Szirtes, Barnabas Poczos and Andras Lorincz
Neural Kalman-filter

246 (M28) J.A. Gillis; W.P. Luk; L. Zhang; F.K. Skinner
Characterizing in vitro Hippocampal Ripples using Time-Frequency Analysis

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POSTER SESSION **Memory**

248 (M29) Kabaso, D.M., Luebke, J.I., Hof, P.R. and Wearne, S.L. Computational Neurobiology and Imaging Center, Departments Biomathematical

Sciences, Fishberg Research Center for Neurobiology, Center For Behavioral Development, Boston University, Kastor Neurobiology of Aging Laboratories, Mount Sinai School of Medicine, New York. NY. 10029
Modeling Morphologic Contributions to Age-Related Alterations in Neuronal Excitability

249 (M30) Mauktik Kulkarni, Kechen Zhang
A biophysical model of graded persistent activity in a single neuron

250 (M31) John A. Wolf, Jason T. Moyer, Leif H. Finkel
The Role of NMDA Currents in State Transitions of the Medium Spiny Neuron in a Network Model of the Nucleus Accumbens

251 (M32) Jeremy B. Caplan, Mackenzie Glaholt, Terence W. Picton and Anthony R. McIntosh
Unifying memory for associations and lists using cognitive theory, behavioural testing and brain activity

252 (M33) Narihisa Matsumoto, Daisuke Ide, Masataka Watanabe, Masato Okada
Synaptic Depression Enlarges Basin of Attraction

253 (M34) Koki Yamashita, Shoji Tanaka
Parametric study of dopaminergic neuromodulatory effect in a reduced model of the prefrontal cortex

254 (M35) Algis Garliauskas
Estimation of nonlinearities to storage capacity of NN by alternative MFT

255 (M36) Shoji Tanaka
State-dependent alteration of dopamine and glutamate transmission in the prefrontal cortex by psychostimulants

256 (M37) Yoshihisa Kubota, Tara R. Gaertner, John A. Putkey and M. Neal Waxham
A Novel Monte-Carlo Simulation of Molecular Interaction and Diffusion in Postsynaptic Spine

257 (M38) Anders Sandberg, Erik Fransen
An Autocatalytic Model of STDP Timing from Slow Calcium Signals

258 (M39) Tetsuto Minami Toshio Inui
Roles of the prefrontal neurons in delayed matching-to-category task A modeling study

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POSTER SESSION **Information coding 2**

259 (M40) Volker Steuber and R. Angus Silver
Multiplicative gain modulation for linear and non-linear inputs

260 (M41) Sheng Li Si Wu
On the Variability of Cortical Neural Responses A Statistical Interpretation

261 (M42) Dileep George, Friedrich T. Sommer
Computing with Inter-spike Interval Codes in Networks of Integrate and Fire Neurons

262 (M43) Bjrn Naundorf, Theo Geisel, Fred Wolf
Dynamical Response Properties of a Canonical Model for Type-I Membranes

263 (M44) Christopher J. Rozell and Don H. Johnson
Examining methods for estimating mutual information in spiking neural systems

264 (M45) Go Ashida
Signal Size Detection by Noisy Neurons

265 (M46) Gregor Wenning, Thomas Hoch, Klaus Obermayer
The Role of Colored Noise in Pulse Detection, a leaky Integrate-and-Fire Model Study

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POSTER SESSION **Network properties 1**

266 (M47) Kousuke Abe
Existence of stable states of stochastic dynamics in a model of neocortex

267 (M48) Michael Stich and Manuel G. Velarde
Dynamics of a small network of spiking neurons

269 (M50) Thomas P. Trappenberg and Dominic I. Standage
Multi-packet regions in stabilized continuous attractor networks

270 (M51) Christina Ambrosio, Amitabha Bose, Farzan Nadim
The Effect of Modulatory Neuronal Input on Gastric Mill Frequency

271 (M52) Hamish Meffin, Anthony N. Burkitt, David B. Grayden
Dynamically Adjustable Contrast Enhancement from Cortical Background Activity

272 (M53) Gabor Szirtes, Zsolt Palotai and Andras Lorincz
Noise induced structures in STDP networks

273 (M54) David C. Tam, Ph.D.
Motion Detection in Hexagonal Arrays of Insect Ommatidia

274 (M55) Eugene M. Izhikevich, Joseph A. Gally, Gerald M. Edelman
Spike-Timing Patterns in Cortical Neural Networks With Axonal Conduction Delays

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POSTER SESSION **Motor system 1**

275 (M56) M.R.Berends, R. Maex, E. De Schutter
The effect of NMDA receptors on gain modulation in cerebellar granule cells

276 (M57) Yutaka Hirata, Akimasa Yoshikawa, Pablo M. Blazquez, Stephen M. Highstein
Evaluation of the inverse dynamic model in cerebellum during visual-vestibular interactions at different VOR gains in squirrel monkeys

277 (M58) A. Fishbach, S.A. Roy, C. Bastianen, L.E. Miller, J.C. Houk
Discrete Corrective Submovements in the Monkey   Predictive Control under Uncertainty

278 (M59) Joe Graham Victoria Booth Ranu Jung
Modeling Motoneurons after Spinal Cord Injury Persistent Inward Currents and Plateau Potentials

279 (M60) Jeanette Hellgren Kotaleski Dietmar Plenz Kim T Blackwell
The role of background synaptic noise in striatal fast spiking interneurons

280 (M61) Wei Wu, Wilson Truccolo, Maryam Saleh, David Mumford, John P. Donoghue
Movement Direction Decoding using Fast Oscillation in Local Field Potential and Neural Firing during Instructed Delay in a Center-Out Reaching Task

281 (M62) Uri T. Eden Emery N. Brown
Adaptive Decoding of Hand Movement Trajectories from Simulated Spike Train Observations from a Dynamic Ensemble of Motor Cortical Neurons

282 (M63) S. A. Oprisan, and C. C. Canavier
Stability criterion for a two-neuron reciprocally coupled network based on the phase and burst resetting curves

283 (M64) Leonid L. Rubchinsky, Nancy Kopell, Karen A. Sigvardt
Normal and Parkinsonian Control of Motor Programs in Pallidal and Subthalamic Networks of Basal Ganglia

284 (M65) Rafael Rodriguez-Rojas1, Lazaro Alvarez, Rolando Palmero, Raul Macias, Maylen Carballo, Mario Alvarez.
Neural activity changes in Supplementary Motor Area induced by dopaminergic treatment in parkinsonian patients

285 (M66) Amitabha Bose, Timothy J. Lewis, Richard J. A. Wilson
Two-oscillator model of ventilatory rhythmogenesis in the frog

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POSTER SESSION **Robots and silicon neurons**

286 (M67) L. Cozzi, P. D'Angelo, M. Chiappalone, A.N. Ide, A. Novellino, S. Martinoia, V. Sanguineti
Coding and decoding of information in a bi-directional neural interface

287 (M68) WITHDRAWN

288 (M69) D.P. Tsakiris, A. Menciassi, M. Sfakiotakis, G. La Spina and P. Dario
Undulatory locomotion of polychaete annelids mechanics, neural control and robotic prototypes

TUESDAY, JULY 20, 2004

TUESDAY, JULY 20, 2004

9:00 am	Featured Contributed Talk: Eugene M. Izhikevich *Which Model to Use for Cortical Spiking Neurons?*	**301**

ORAL SESSION 7 — **Visual System**

9:40 am	Jim Bednar Post-doc, University of Texas, Austin Judah De Paula PhD student, University of Texas, Austin Risto Miikkulainen Professor, University of Texas, Austin *Self-organization of color opponent receptive fields and laterally connected orientation maps*	**302**
10:00 am	Rama Ratnam, Jozien B. M. Goense *Variance stabilization of spike trains via non-renewal mechanisms – The impact on the speed and reliability of signal detection*	**303**
10:20 am	Ko Sakai and Ogiya Mitsuharu *The Role of Early Vision in the Determination of Depth and Motion from Ambiguous Binocular Information*	**304**
10:40 am	**Break: *Refreshments provided***	

ORAL SESSION 8 — **Single-neuron and population coding**

11:10 am	Peng Xu and Pamela Abshire *Threshold Detection of Intensity Flashes in the Blowfly Photoreceptor by an Ideal Observer*	**305**
11:30 am	Katja Karmeier, Holger G. Krapp, Martin Egelhaaf *Population coding of rapid changes in self-motion by the blowfly visual system*	**306**
11:50 am	A-M. M. Oswald, M.J. Chacron, B. Doiron, J. Bastian, L. Maler *Processing sensory input with bursts and isolated spikes*	**307**
12:10 pm	Rachel M. Berquist, Remus M. Osan & Michael G. Paulin *Prey electric field estimation in dogfish A neuronal population coding model*	**308**
12:30 pm	Lauren M. Jones, Asaf Keller *Temporal coding in whisker primary afferents*	**309**

12:50 pm Denis Glanzman – NIMH
Funding opportunities for Computational Neuroscience

1:10 pm **Lunch Break**

2:30 pm **Invited Speaker:** Miguel Nicolelis
Computing in neural ensembles

3:30 pm **Meeting and workshop announcements**
Christiane Linster, CNS President
Adrienne Fairhall, Workshop Organizer

4:00-8:00 pm **Poster Session III:** *Calvert Ballroom and Versailles Room*
Cash bar and snacks provided.

9:00 pm **CNS Party at Little Havana**

POSTER SESSION **Visual system 3**

320 (T01) Christoph Rasche
Signaling Contours by Retinal Wave Propagation

321 (T02) Timothy Melano and Charles M. Higgins
The Neuronal Basis of Direction Selectivity in Lobula Plate Tangential Cells

322 (T03) Emilio Salinas
A model of target selection based on goal-dependent modulation

323 (T04) Baran Curuklu, Anders Lansner
A Model of the Summation Pools within the Layer 4 (Area 17)

324 (T05) Zuley Rivera-Alvidrez Charles M. Higgins
Contrast Saturation in a Neuronally-Based Model of Elementary Motion Detection

325 (T06) B.A. Siegler, M. Ritchey, J.E. Rubin
Spike-timing dependent plasticity as a mechanism for ocular dominance shift

326 (T07) Ruediger Kupper, Marc-Oliver Gewaltig, Edgar Koerner
Spike-latency codes and the effect of saccades

327 (T08) M. Szabo, R. Almeida, G. Deco, M. Stetter
A neuronal model for the shaping of feature selectivity in IT by visual categorization

328 (T09) Benoit Gaillard Jianfeng Feng
Modelling a Visual Discrimination Task

329 (T10) Nadja Schinkel Klaus R. Pawelzik Udo A. Ernst
Robust integration and detection of noisy contours in a probabilistic neural model

330 (T11) Yoshiki Kashimori, Nobuyuki Suzuki, Kazuhisa Fujita, Meihong Zheng, Takeshi Kambara
A functional role of multiple spatial resolution maps in form perception along the ventral visual pathway

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POSTER SESSION **Auditory system**

331 (T12) Kaushik Ghose & Cynthia F. Moss
The bat's head aim governs flight, simplifying computation during interception

332 (T13) Ruben Tikidji Hamburyan, Sofia Polevaya
Sound-Source Localization by Neural Network Based on Modified Integrate-and Fire Neuron Model with Autopolarization.

333 (T14) Taesu Kim and Soo-Young Lee
Learning self-organized topology-preserving complex speech features at primary auditory cortex

334 (T15) Rajiv Narayan, Kamal Sen
A computational model for discrimination of natural sounds

335 (T16) William Tam and Kechen Zhang
A Recurrent Network Model of Eye-Position Effect on Auditory Receptive Field

336 (T17) Rock Z. Shi and Timothy Horiuchi
Excitation and Inhibition in Bat Azimuthal Echolocation

337 (T18) Ramana Dodla John Rinzel
Phasic, tonic, and mixed mode firing of an auditory neuron model -- bifurcation analysis

338 (T19) Kazuhisa Fujita, ShungQuang Huang, Yoshiki Kashimori, Takeshi Kambara
Neural mechanism of detecting interaural intensity differences in the owl's auditory brainstem for sound location

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POSTER SESSION **Attention**

339 (T20) Hualou Liang, Steven L. Bressler, Robert Desimone, Pascal Fries
Empirical Mode Decomposition – A Method for Analyzing Neural Data

340 (T21) Calin I. Buia, Paul H. E. Tiesinga
Rapid temporal modulation of synchrony in cortical interneuron networks with synaptic depression

341 (T22) Andras Lorincz
Attentional filtering in neocortical areas A top-down model

POSTER SESSION **Speech and language**

342 (T23) Karl Magnus Petersson
ON THE RELEVANCE OF THE NEUROBIOLOGICAL ANALOGUE OF THE FINITE STATE ARCHITECTURE

343 (T24) Peter Grenholm Karl Magnus Petersson
ARTIFICIAL GRAMMAR LEARNING A CASE STUDY OF THE REBER GRAMMAR

344 (T25) Alan H. Bond
A psycholinguistically and neurolinguistically plausible system-level model of natural-language syntax processing

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POSTER SESSION **Network properties 2**

345 (T26) Michael Rudolph and Alain Destexhe
Multi-channel shot noise and characterization of cortical network activity.

346 (T27) Christopher P. Fall, John Rinzel
An Intracellular Ca2+ Subsystem as a Biologically Plausible Source of Intrinsic Bistability in a Network Model of Working Memory

347 (T28) Andreas Knoblauch
Statistical implications of clipped Hebbian learning of cell assemblies.

348 (T29) Michela Chiappalone, Antonio Novellino, Ildiko Vajda, Alessandro Vato, Sergio Martinoia and Jaap van Pelt
Burst detection algorithms for the analysis of spatio-temporal patterns in cortical networks of neurons

349 (T30) Carter Wendelken Lokendra Shastri
Connectionist Mechanisms for Cognitive Control

350 (T31) Jonathan Rubin Amitabha Bose
Localized activity patterns in excitatory neuronal networks

351 (T32) Q.Zou, M.Rudolph, N.Roy, M.Sanchez-Vives, D.Contreras, A.Destexhe
Reconstructing synaptic background activity from conductance measurements in vivo

352 (T33) J. Michael Herrmann, Hecke Schrobsdorff, Theo Geisel
Localized Activations in a Simple Neural Field Model

353 (T34) Charles H. Anderson and Brian Fischer
Large Scale Networks for Contextual Inference, Routing and Motor Control

354 (T35) Ofer Melamed, Gilad Silberberg, Henry Markram, Wulfram Gerstner and Magnus J.E. Richardson
Subthreshold cross-correlations between cortical neurons A reference model with static synapses

355 (T36) M. Kubo, K. Abe, G. Ashida
New Technique for analyzing stationary global activity in neural networks

356 (T37) Jan Karbowski and G.B. Ermentrout
Modeling genetic control of thalamo-cortical connections and area patterning

357 (T38) John Matthew Beggs
Living cortical networks at the critical point may optimize information transmission and storage simultaneously

358 (T39) Mauro Copelli Rodrigo F. Oliveira Antonio Carlos Roque Osame Kinouchi
Signal Compression in the Sensory Periphery

359 (T40) Armen B. Stepanyants, Judith A. Hirsch, Luis M. Martinez, Zoltan F. Kisvarday, Alex S. Ferecsk, and Dmitri B. Chklovskii
Potential connectivity in local cortical circuits

360 (T41) Kenji Morita, Kazuyuki Aihara
A network model with pyramidal cells and GABAergic non-FS cells in the cerebral cortex

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POSTER SESSION **Synchronization and oscillation**

361 (T42) Steve Bellinger
Modeling Astrocyte Communication

362 (T43) Hiroshi Okamoto, Yoshikazu Isomura, Masahiko Takada, Tomoki Fukai
Investigating the time course of single-trial activity of neurons that show gradual increase or decrease in histograms

363 (T44) Kenneth P. Eaton and Craig S. Henriquez
Confounded spikes generated by synchrony within neural tissue models

364 (T45) Paul Tiesinga
Reliability resonance boosts activity in downstream cortical areas

365 (T46) Ho Young Jeong & Boris Gutkin
Study on the role of GABAergic synapses for synchronization

366 (T47) Andrey Shilnikov, Ronald L. Calabrese, and Gennady Cymbalyuk
How a neuron model can demonstrate co-existence of tonic spiking and bursting?

POSTER SESSION **Motor system 2**

367 (T48) Xiuxia Du, Bijoy K. Ghosh
Modeling of the Basal Ganglia Affected by Huntington's Disease

368 (T49) Carmen C. Canavier
The effect of interspike waveform on phase resetting and its impact on the regularity of the firing pattern

369 (T50) Boothe, D.L., Cohen, A.H. Neuro. & Cog. Sci. Program, Univ. of Maryland, College Park, MD, USA
A stochastic neural network model of limbed locomotion

370 (T51) A. Kuznetsov, C Wilson, and N. Kopell
Modeling of the transient firing of the nigral dopamine neuron in vivo and in slices.

371 (T52) Christian Hauptmann, Oleksandr Popovych, Peter Tass
Delayed feedback control of synchronization in locally coupled and stimulated networks

372 (T53) Mark Shelhamer
Phase transition between reactive and predictive eye movements is confirmed with nonlinear prediction and surrogates

373 (T54) Wilsaan M. Joiner Mark Shelhamer
An Investigation of the Relative Stability of Reactive and Predictive Oculomotor Tracking

374 (T55) Alexander Lerchner, John Rinzel
Synaptic Model for Spontaneous Activity in Developing Networks

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POSTER SESSION **Learning and Plasticity**

375 (T56) Naoki Masuda, Kazuyuki Aihara
Encoding Multiple Temporal Waveforms by Neural Population with Spike-time-dependent Plasticity

376 (T57) Chris L. Baker, Aaron P. Shon, Rajesh P.N. Rao
Learning Temporal Clusters with Synaptic Facilitation and Lateral Inhibition

377 (T58) Neel Shah, Luk Chong Yeung, Harel Z. Shouval and Leon N Cooper
A biophysical basis for the inter-spike interaction of Spike-Timing-Dependent Plasticity

378 (T59) Anatoli Gorchetchnikov and Michael E. Hasselmo
A simple rule for spike-timing-dependent plasticity local influence of AHP current

379 (T60) Jean-Pascal Pfister David Barber Wulfram Gerstner
Optimal Spike-Timing Dependent Plasticity for Precise Action Potential Firing

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POSTER SESSION **Synaptic mechanisms and signal transduction**

380 (T61) Joanna Tyrcha and William B Levy
Synaptic Failures and a Gaussian Excitation Distribution

381 (T62) Alain Destexhe and Michael Rudolph
Extracting information from the power spectrum of voltage noise

382 (T63) Thomas Sangrey and William B Levy
Conduction Velocity Costs Energy

383 (T64) Aviv Mezer, Esther Nachliel1 Menachem Gutman and Uri Ashery
Modeling of the exocytotic process by chemical kinetic formalism

384 (T65) Petr Marsalek and Eduard Kuriscak
Cortical microcircuit with adapting synapses

POSTER SESSION **Databases and software**

385 (T66) Kay A. Robbins Igor Grinshpan Kevin Allen David M. Senseman
Synchronized Views for Exploring Populations of Neurons
386 (T67) William Lytton and Michael Hines
No event left behind: adapting variable timestep integration to networks
388 (T69) Thomas Frster, Andreas VM Herz, and Raphael Ritz
NIPClassificator - Toward an evolvable neuroinformatics ontology

WORKSHOPS

The following is a list of workshops scheduled prior to the meeting. Meeting participants are encouraged to propose additional workshops during the meeting.

1) Dynamic clamp, tutorial in developing and using your own programs

2) Cellular and sub-cellular models of excitable cells

3) State-Space models for motor learning and adaptation

4) Theoretical approaches to basal ganglia function

5) Computation of possible functions of neurogenesis in adult hippocampus

6) Reduced Models of Neuronal Excitability and Dynamics of Spike-generation

7) Nonlinear Spatio-temporal Neural Dynamics - Experiments and Theoretical Models

8) Decoding internal representations

PRELIMINARY SCHEDULE
CNS*2004 WORKSHOPS

Wednesday, July 21st

9.00 - 12.00	Reduced Models of Neuronal Excitability and Dynamics of Spike-generation - 1
	Theoretical approaches to basal ganglia function - 1
	Nonlinear Spatio-temporal Neural Dynamics - Experiments and Theoretical Models - 1
	Decoding internal representations - 1
	Computation of possible functions of neurogenesis in adult hippocampus - 1
2.00 - 5.00	Reduced Models of Neuronal Excitability and Dynamics of Spike-generation - 2
	Theoretical approaches to basal ganglia function - 2
	Nonlinear Spatio-temporal Neural Dynamics - Experiments and Theoretical Models - 2
	Decoding internal representations - 2
	Dynamic clamp tutorial

Thursday, July 22nd

9.00 - 12.00	Reduced Models of Neuronal Excitability and Dynamics of Spike-generation - 3
	Theoretical approaches to basal ganglia function - 3
	State-Space models for motor learning and adaptation - 1
	Cellular and sub-cellular models of excitable cells - 1
2.00 - 5.00	Reduced Models of Neuronal Excitability and Dynamics of Spike-generation - 4
	State-Space models for motor learning and adaptation - 2
	Cellular and sub-cellular models of excitable cells - 2

1) Dynamic clamp, tutorial in developing and using your own programs

Organizers: Theoden Netoff (tnetoff@bu.edu) and Alan Dorval

Short description: This is a tutorial to explain how to install, use and develop your own dynamic clamp protocols on a Real-Time Linux operating system. Dynamic clamp is a powerful technique for recording and interacting with neurons in real time. It allows for simulation of conductances in real neurons as well as interactive protocols and simulations of virtual neurons and synaptic connections. We have developed a dynamic clamp based on Real-Time Linux that allows the user to write their own modules, record from neurons and view the data in real time. This workshop will demonstrate the dynamic clamp program, describe its performance capabilities, demonstrate how to install it onto a computer and write new modules in C. This is a tutorial that will take half a day. The last portion of the session will allow people to ask questions about the capabilities and may involve writing some modules and testing them on the dynamic clamp.

2) Cellular and sub-cellular models of excitable cells

Organizer: Pete Roper (proper@helix.nih.gov)

Topics: Synaptic function, gene transcription, spatial dendritic models. Planned to be an informal workshop.

More details can be found here: http://mrb.niddk.nih.gov/proper/cns-workshop.html

Organizers: Peter Roper, Brent Doiron, Arthur Sherman

Workshop Theme:

This workshop is intended as a forum for discussing and understanding realistic models of biological processes. The main foci will be

calcium release, buffering and diffusion, subcellular messenger pathways, gene transcription and regulation, synaptic function, neural coding, paracrine and autocrine neuromodulation, dendritic and spatial models of neuronal function

Speakers:
John H. Byrne (University of Texas at Houston), André Longtin (Université d'Ottawa), Greg Smith (College of William and Mary), Artie, Sherman (NIH) ,Joel Tabak (NIH) ,Brent Doiron (Université d'Ottawa) ,Chris Fall (NYU) ,Victor Matveev (NJIT) ,Yulia Timofeeva (Herriot-Watt University) ,Fernanda Saraga (University of Toronto) ,Tim Lewis (NYU) ,Frances Chance (University of California at Irvine)

3) State-Space models for motor learning and adaptation
Organizers: Joern Diedrichson and Opher Donchin (opher@bme.jhu.edu) and Reza Shadmer
Possible contributors: Kurt Thoroughman, Philip Sabes, Bob Scheidt, Anne Smith, Jean-Jaques Slotine, Roni Paz, Paul Gribble, Steve Scott, Hiroshi Imamizu, Terry Sanger

Short description:
The idea that organisms learn through the development of internal models of their environment has become one of the central paradigms for the study of motor learning. Computational models based on this approach often explicitly represent the state of this internal model as a hidden variable in a dynamical state-space system. This class of models represents an important bridge between behavioral, physiological and computational studies of the motor system, but they are a tool that has only recently gained prominence in the study of the brain and behavior. Thus, there are many questions about how and where they can best be used. This workshop will address those questions.
Some questions concern the structure of the model. Representing an internal model as a hidden variable involves choices and simplifications, and understanding how these choices affect the resulting inferences is of key importance. Second, there are various ideas about the sources of noise in the motor system, and how various sources of noise are best incorporated into a state-space model has yet to be fully explored. Also, learning can involve plasticity of various sorts, and potentially on several time scales. What learning rules should be used in a state space model and what assumptions can be made about the learning signal? The structure of the model also has practical consequences for questions of parameter estimation and tractability of models, and these will also be discussed. Finally, we will outline the insights that can be won by using such a modeling approach. How can models shape and constrain our way of thinking about behavioral experiments? Can models of the hidden state be used to investigate the neural correlates of motor learning?
For more information visit: http://www.bme.jhu.edu/~jdiedric/state_space_workshop/index.htm

4) Theoretical approaches to basal ganglia function

Organizers: **Karen Sigvardt** (kasigvardt@ucdavis.edu) , **Leonid Rubchinsky** (lrubchinsky@ucdavis.edu)

Additional details can be found at http://neuroscience.ucdavis.edu/leo/bg-workshop/index.htm

The basal ganglia are implicated in many functions (and dysfunctions) of the mammalian brain. By the early 90s the amount of experimental data about basal ganglia was rather substantial, which has led, over the past ten years, to considerable interest in theoretical approaches to the analysis of basal ganglia function. Efforts have concentrated on a number of different aspects of basal ganglia function: control of motor programs, reinforcement learning, basal ganglia control of cognition, rhythms in basal ganglia networks etc. Different levels of analysis have been adopted and different types of models used. The aim of this workshop is to bring together researchers who use theoretical approaches in all of these areas. More specifically, we want to concentrate on the following topics: (a) Reinforcement learning, (b) Motor program control, (c) Rhythms in basal ganglia circuits , (d) Dynamics of dopaminergic neurons.

Participants will present their approaches, problems and solutions, will discuss each other's developments, propose new theories, and discuss how somewhat unrelated modeling studies can contribute to a more coherent picture of basal ganglia function. Many questions connect the aforementioned topics and we hope will be discussed during the mini-workshop: how learning affects motor programs control, how dopaminergic neurons contribute to learning processes, what is the relation between control function and rhythms in basal ganglia, how rhythms are modulated by dopaminergic activity, etc. We believe that the community of computational neuroscientists can contribute to the search of the answers to these important questions. The goal of the mini-symposium is to ensure cross-fertilization of different ideologies of mathematical and computational analysis to advance understanding of basic principles of basal ganglia function as well as to gain insights into basal ganglia-associated disorders, such as Parkinson's disease, Huntington's disease, Tourett's syndrome, addiction-related disorders etc.

The following have expressed interest in participating:

Jose L Contreras-Vidal (Department of Kinesiology &Neuroscience & Cognitive Science Program, University of Maryland), Georgi Medvedev (Department of Mathematics, Drexel University), Carmen Canavier (Department of Psychology, University of New Orleans), Jonathan Rubin (Department of Mathematics, University of Pittsburgh), David Terman (Department of Mathematics, Ohio State University), Thomas Boraud, (CNRS, Universite Victor Segalen - Bordeaux 2), Peter Redgrave (Dept. Psychology, University of Sheffield), James Houk (Department of Neuroscience, Northwestern University), Kim Buckwell (George Mason University), Dietmar Plenz (NIH).

5) Computation of possible functions of neurogenesis in adult hippocampus

For more information click here - **www.newneuron.com**

Organizer: J.M. Wojtowicz (martin.wojtowicz@utoronto.ca)
The Goal of this workshop is to bring together scientists who are fascinated by the idea of adult neurogenesis and who wish to employ computational models and techniques to explore the phenomenon. At present many experimental studies implicate hippocampal neurogenesis in numerous physiological functions such as learning, memory, clinical depression, some aspects of aging, etc. but the theoretical framework for such functions is completely missing. On the other hand the modellers do not generally have sufficient knowledge of the phenomenon to make the correct, physiologically valid assumptions. This workshop would likely jump-start collaborative projects to further explore the significance of neurogenesis in the adult brain.

Putative speakers:

1. J.M. Wojtowicz, (Dept. Physiology, University of Toronto, Canada).
Neurogenesis in adult Hippocampus. The dynamics of cell turnover and experimental evidence for a role in learning and memory.

2. R.A. Chambers, (Dept. of Psychiatry, Indiana University). Simulated apoptosis/neurogenesis regulates learning and memory capabilities of adaptive neural networks.

3. S. Becker, (Dept. of Psychology, McMaster University, Hamilton, Canada) A new principle for hippocampal learning taking neurogenesis into account.

4. Participant X, TBA

6) Reduced Models of Neuronal Excitability and Dynamics of Spike-generation.

Organizers: Boris Gutkin (boris@gatsby.ucl.ac.uk) , Eugene Izhikevitch, G. Bard Ermentrout

Detailed program and abstracts can be found here!:
http://www.nbb.cornell.edu/neurobio/linster/cnsorg/workshop.html

2 Day mini-symposium

Neurons are complex dynamical machines that produce their responses, the action potentials, due to concerted synergisitic action of state-dependent currents. While biophysical models strive to reproduce neural behavior taking into account detailed data on the kinetics of the cross-membrane currents, ion concentrations, as well as neural morphology, simplified models attempt to capture the dynamical mechanisms underlying neural activity. While there is a number of classical mathematical techniques by which conductance-based models can be simplified and reduced, recent developments have yielded several new approaches. At the same time a number of new reduced models have appeared (such as QIF, ExpIF) reflecting spike generating mechanisms of cortical neurons. Reduced models of synaptic input have also been developed. In this workshop we shall review these developments and present results based on them. The workshop shall consist of short presentations of research as well as longer tutorial expositions.

This mini-symposium will provide a survey of recent developments both theoretical and experimental.

Issues to be discussed include:

- The types of behavior the Hodgkin-Huxley-type models exhibit.
- The relationship between Hodgkin-Huxley-type models and simpler models.
- Methods of reduction to simpler models.
- Drawbacks and advantages (if any) of the integrate-and-fire models.
- Comparisons of the utility of various models for large-scale simulations of spiking neural networks.
- Experimental corroborations of dynamical mechanisms.

7) Nonlinear Spatio-temporal Neural Dynamics - Experiments and Theoretical Models

Organizers: Peter Andras (University of Newcastle, UK, Peter.Andras@newcastle.ac.uk), Peter Erdi (Hungarian Academy of Sciences & Kalamazoo College, US, perdi@kzoo.edu), Robert Kozma (University of Memphis, TN, US, rkozma@memphis.edu)
Format: mini-symposium with two sessions (morning, afternoon) with 6-8 speakers and thorough discussions.

Description:
The study of nonlinear aspects of neural dynamics increased significantly in recent years. The accessibility of new experimental tools that provide high spatial and temporal resolution recordings of neural function at cellular, circuit and macro level generated a huge amount of new data, which need the application of nonlinear analysis methods. New nonlinear computational models (e.g., pulse-coupled neural networks, spiking neuron models, large scale multi-component statistical simulation models, neuropercolation models and others) were developed in recent years that can be employed to analyze, interpret and explain the available data. The goal of this

workshop is to create a forum for researchers in this exciting research area, to exchange ideas and to discuss recent developments, and also to outline perspectives for future activities.

Topics of interest:
Experimental aspects of spatio-temporal coding; Mechanisms of emergent synchrony in the nervous system; Break down of synchronous behavior and its role in cognitive processing ; Phase transitions and spatio-temporal neurodynamics ; Role of chaos for robust neural processing in noisy environment; Incorporation of neuromodulation into conventional neural models ; Differential equations; Coupled map lattices and cellular automata; Neuropercolations in random graphs; Liquid state machines; Spatio-temporal information processing for: ; Perception; Learning, memory, and reasoning; Motor control, navigation, and decision making ; Communication; Neurological and psychiatric disorders

A paper for a **Special Issue** on the subject topic will be solicited from the participating speakers. Selection of a suitable journal is in progress.

Website: http://www.staff.ncl.ac.uk/peter.andras/cnnd-ws2004.htm

8) Decoding internal representations

Organizers: Shy Shoham (Princeton University, sshoham@princeton.edu) and Ken Harris (Rutgers University, kdharris@andromeda.rutgers.edu)

Format: Informal workshop

Description:
By combining microelectrode array recordings with estimation algorithms, neuroscientists are now able to reconstruct a variety of different percepts and motor commands that are internally represented by the nervous system. Advances in this area will improve our understanding of neural population codes and facilitate the development of neuroprosthetic devices that can directly interface with the nervous system of paralyzed individuals. The purpose of the workshop is to explore current developments in methods and applications of decoding methods in neuroscience. Topics of interest include common themes such as the development of decoding algorithms, the development of hardware and software for real time decoding, potential stumbling blocks and future directions.

Preliminary list of participants: Emery Brown (MGH), Mark Laubach(Yale), Ken Harris(Rutgers), Krishna Shenoy(Stanford), Kechen Zhang(Johns Hopkins), Dawn Taylor (Case Western), Hemant Bakil (Caltech), Doug Weber (Alberta), Remus Osan (Princeton), Mark Lemkuhle (Utah), Shane Guillory (Cyberkinetics)

ABSTRACTS

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Accurate Dynamical Models of Interneuronal GABAergic Channel Physiologies

James B. Maciokas, Philip Goodman, John Kenyon, Maria Toledo-Rodriguez, and Henry Markram
University of California, Davis

Recent experimental results have revealed a large diversity of anatomic, synaptic and membrane physiology within the GABAergic system. By incorporating combinations of parametrically varied M-type, A-type, and calcium-dependent potassium (AHP) channels, we were able to replicate in vitro responses to 1-second current steps ranging from 50 to 350 pA. Our results show the need for subthreshold activating channels to capture the physiological properties of GABAergic cells. Presently underway is a collaboration among the authors to corroborate the proposed channel models using genetic profiles obtained from physiologically characterized interneurons.

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Theta-frequency synchronization of hippocampal CA1 populations by hyperpolarization-activated currents

Gergo Orban, Tamas Kiss, Peter Erdi
KFKI RIPNP of the Hungarian Academy of Sciences

Theta (3-8 Hz) is a major hippocampal electrophysiological activity with distinct firing profiles for hippocampal neuron populations. In our study, we used a three-population network to investigate how timing of neuron population firings emerge. We have shown that the intrahippocampal circuitry is capable of generating coherent theta-frequency oscillation. Furthermore, hyperpolarization-activated current in pyramidal cells, but not in O-LM neurons, was found to play an important role in timing, and synchronization of pyramidal cells. The model was shown to exhibit the same timing relationship found in vivo, supporting the idea that the hippocampus itself contributes significantly to the coherent theta oscillation.

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Effects of dendritic spiking on synaptic integration in globus pallidus neurons

Edgerton, J.R.; Hanson, J.E.; Jaeger, D.
Emory University

We used a realistic compartmental model of GP neurons to investigate synaptic integration in the presence of dendritic spike initiation found in these neurons (Hanson et al., J.Neurosci. 24 329-340, 2004). Versions of the model with and without dendritic spike channels were compared. We find that dendritic spike initiation 1) increases the output spike rate of the model; 2) increases the CV of the output spike pattern; and 3) changes the interaction between inhibition and excitation from an additive to a multiplicative one. These findings indicate that dendritic spike initiation can make a major contribution towards explaining in vivo recordings.

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WHY ARE MOST NEURONS IN THE HEAD?

Beth L. Chen and Dmitri B. Chklovskii
Cold Spring Harbor Laboratory

We pursue the hypothesis that neuronal placement in animals minimizes wiring costs for given functional constraints. Using available C. elegans wiring data, we solve the optimal layout of 280 non-pharyngeal neurons. The solution demonstrates 1. Neurons in the same ganglion cluster together. 2. Neurons follow actual anterior to posterior order. 3. The coordinates of neurons agree with actual positions. Rare neurons show strong deviations from predictions, suggesting existence of other unknown constraints. Our results not only prove the importance of wiring cost minimization in neuronal placement but also spotlight neurons whose function is not captured simply by the wiring diagram.

106

Synaptic connectivity and neuronal morphology two sides of the same coin

Dmitri B. Chklovskii
Cold Spring Harbor Laboratory

Among the cells of the body, neurons stand out by the high number of inter-cell contacts, or synapses, and by the intricate shape of cell processes, or axonal and dendritic arbors. Are these two distinctive neuronal features related? I show that wiring up a neuronal network, such as a cortical column, in the allotted volume requires all the salient features of neuronal morphology the existence of dendrites as well as axons, their branching and the existence of dendritic spines. Therefore, the neuronal morphology is an adaptation that makes high connectivity possible. This teleological argument should help in understanding brain evolution and in inferring synaptic connectivity from the arbor morphology.

107

Algorithmic reconstruction of complete axonal arborizations in rat hippocampal neurons

Scorcioni Ruggero, Ascoli A. Giorgio
Krasnow Institute

Three-dimensional axonal morphologies are not currently available to the neuroscience community in a format suitable for computational modeling. We have designed an algorithm to reconstruct full axonal arborizations based on sets of digitized segments extracted from raw anatomical preparations. We applied this algorithm to eight rat neurons covering the entire synaptic loop of the hippocampal formation (entorhinal cortex, dentate gyrus, CA3, CA1, and subiculum). The algorithm is validated by comparing the reconstructed dendrites of the CA1 cells with those available in several public archives. The eight axonal morphologies are quantitatively analyzed and freely distributed in SWC format (http //www.krasnow.gmu.edu/L-Neuron).

111

Dendritic integration in accessory olfactory bulb mitral cells

Nathaniel N. Urban, Vikrant Kapoor, Jason Castro
Carnegie Mellon University

The accessory olfactory system, including the vomeronasal organ, the accessory olfactory bulb (AOB) and their connections is critical for the generation and control of a variety of chemosensory responses, ranging from neurosteroid signaling, to mating behavior. We have begun to work on understanding AOB circuits focusing on the question of how inputs are integrated by the multitufted mitral cells of the AOB. To this end, we have performed in vitro physiological and optical recordings of the activity of AOB mitral cells, and analyzed detailed compartmental models of these cells to determine the degree to which inputs to different glomeruli are integrated independently.

112

LEARNING INTENTIONAL BEHAVIOR IN THE K-MODEL OF THE AMYGDALA AND THE CORTICO-HYPPOCAMPAL FORMATION

Robert Kozma, Derek Wong, Walter J Freeman
University of Memphis

The interaction between the amygdala and the hippocampal and cortical areas in reptilian brains is studied using the dynamical K model approach. Special emphasis is given to the role of amygdala in decision making as part of the limbic system, under the influence of sensory, orientation, and motivational clues. We introduce a simplified KIV model with positive and negative reinforcement learning in the hippocampus and the cortex. The developed model is implemented in a 2-dimensional computational environment for multi-sensory control of the movement of a simulated animal. The results demonstrate efficient goal-oriented navigation and obstacle avoidance.

113

Dopamine, Uncertainty and TD Learning

Yael Niv, Michael Duff and Peter Dayan
Hebrew University, Jerusalem

Substantial evidence suggests that phasic activities of dopaminergic neurons in the primate midbrain represent a temporal difference error in predictions of future reward. Recently, recordings in a task involving uncertain rewards have been interpreted as contradicting this interpretation, suggesting that dopamine activity represents uncertainty. We reinterpret these data in terms commensurate with the prediction error hypothesis of dopamine, and further study the effects of temporal uncertainty on prediction-error learning. Although robust under representational noise, prediction-error learning is shown to be very sensitive to timing noise, a finding yet to be reconciled with the neurophysiological data.

114

In-vitro neuronal networks evidence for synaptic plasticity

Anat Elhalal & David Horn
Tel Aviv

In vitro neuronal networks are known to fire in Synchronized Bursting Events (SBEs), with characteristic temporal width of 100 ms. We treat these events as the principal data atoms of the network. Applying SVD (or PCA) to the spatial information, i.e. activity of neurons per burst, we demonstrate characteristic changes that take place over time scales of hours. We consider this as evidence for synaptic plasticity. We discover clusters of SBEs in the reduced SVD space, representing behaviour of the experiments at different times. We find two interesting characteristics of SVD analysis of these data which may be helpful to future users of SVD and PCA

115

A synapse which can switch from inhibitory to excitatory and back

Erik Fransen Lars Zanden
Royal Institute of Technology

Co-release of transmitters have recently been observed at synapse terminals and can even be a combination such as glutamate and GABA. A second recent experimental finding is a short-term synaptic plasticity which depends on postsynaptic depolarization releasing dendritic transmitter which affects presynaptic release probability.   In this work we are investigating the functional consequences for a synapse if it had both co-release and conditioning depression. If initially the GABA component is larger than the glutamate component, the synapse has an inhibitory net effect. However, if the postsynaptic cell is conditioned, the GABA component will be suppressed yielding an excitatory synapse.

116

Calcium dynamics as a signal for spike-timing dependent plasticity

Jonathan Rubin Richard Gerkin Guoqiang Bi Carson Chow
University of Pittsburgh

We use computational modeling and experiments to examine the hypothesis that post-synaptic calcium serves as a signal for spike-timing dependent plasticity (STDP). We present a model biochemical detector based on plausible molecular pathways that makes direct use of the calcium time course to reproduce our experimental results for spike pairs, triplets, and quadruplets in hippocampal cultures and that is consistent with classical long-term potentiation/depression. We also present computational evidence that small changes in parameters can significantly affect STDP in any calcium-based detector, possibly accounting for variability in STDP seen across different systems.

117

It slices, It Dices, and Yes, It Can Do Brain Surgery Too! An Update on Computation in Neuroscience Today

Loralyn Mears
Sun Microsystems

Sun Microsystems has developed new technology and formed alliances to bring knowledge management and computational biology solutions to neuroscience. NOVA is a sophisticated, semantic inference, language-independent search engine embedded in a Portal solution based on open-standards. This facilitates automated trolling, harvesting, categorizing, organizing and distribution of data, including invocation of services, based on specified roles, identity and entitlement - helping you determine what you know and what you don't know, but limiting who gets to know. Secure collaboration methodologies coupled with high throughput and high performance computing are advancing the field of neurobiology today. We will introduce both our commercialized and beta-technology and present use-cases including virtual brain surgery at Brigham & Woman's Hospital to brain research ongoing at our academic centers of excellence to highlight how we will be impacting the future of neuroscience.

120 (S01)

Spatial Distribution of Inhibitory Interneurons Expressing Calcium Binding Proteins in Turtle Visual Cortex

Timothy Sweeney and Philip Ulinski
University of Chicago

Visual stimuli evoke waves of electrical activity that propagate across the visual cortex of freshwater turtles and code information about stimuli in visual space. The origination, speed and duration of these waves are controlled, in part, by three populations of inhibitory interneurons. Describing the spatial distribution of these cells is a necessary step in understanding cortical mechanisms. This study uses calcium binding proteins as markers for populations of inhibitory neurons in order to characterize their spatial distributions in the cortex.

121 (S02)

Human sensitivity to face statistics computed on V1 similarity

Peter Kalocsai
UCLA

In a biologically motivated recognition system we represent face images as convolution values with a set of multiscale and multiorientation Gabor wavelets (a simple model of V1). Based on their discriminative power on recognition tasks various face images were reconstructed from the Gabor wavelet representation to test whether the computed statistics had any psychophysical relevance. The result of our experiments indicate that human performance is sensitive to statistical information derived from our recognition system. The study provides evidence that higher face recognition areas, such as FFA in humans, potentially not only preserve, but also compute upon earlier V1 similarity space.

122 (S03)

The computational model for border-ownership determination consisting of surrounding suppression and facilitation in early vision

Haruka Nishimura, Ko Sakai
University of Tsukuba

We have proposed the computational model for border-ownership (BO) determination based on the contrast configurations within a certain range that extends beyond the classical receptive field (CRF). In this paper, we adopt two crucial functions of the surrounding modulation reported by the recent physiological studies; (1) changes in functional connection depending on the amplitude of contrast, and (2) a variety of surrounding suppression/facilitation depending on the orientation and retinotopic position of surrounding stimuli relative to the CRF. Simulation results show that the model reproduces the major characteristics of BO selective neurons

123 (S04)

Study of spatial frequency selectivity and its spatial organization in the visual cortex through a feedforward model

Mona Mathur and Basabi Bhaumik
Indian Institute of Technology, Delhi

A purely feedforward model has been shown to produce realistic simple cell receptive fields that show smooth transitions between subregions and fade off gradually at the boundaries [2]. Here we show that the modeled cells also capture a wide range of spatial frequency properties of cortical cells. The shape and size of the subregions in the receptive field is found to be an important parameter in determining the frequency selectivity of the cell. The spatial frequency maps obtained through the model show a continuous distribution of spatial frequency preference across the modeled cortex and pinwheels co-localize with the extrima of the spatial frequency domains.

124 (S05)

Physiologically inspired neural model for the encoding of face spaces

M.A. Giese, D.A Leopold
Tuebingen

Due to the lack of electrophysiological data the neural basis of the encoding of faces is largely unclear. We present a model for the neural encoding of face spaces that is based on new electrophysiological results. It reproduces important properties of the physiological data and shows that faces might be encoded exploiting a \em norm-based rather than an \em example-based neural representation. This implies that the encoding exploits an internal representation of an average (norm) face that might be derived by averaging over the previous stimulus history.

125 (S06)

Finding structure by entropy minimization in coupled reconstruction networks

Botond Szatmary, Barnabas Poczos and Andras Lorincz
Eotvos Lorand University

There is psychological and physiological evidence for components-based representations in the brain. We present a special architecture of coupled parallel working reconstruction subnetworks that can learn components of input and extract the structure of these components. Each subnetwork directly minimizes the reconstruction error and indirectly minimizes the entropy of the internal representation via a novel tuning method, which effectively reduces the search space by changing the learning rate dynamically and increasing the escape probability from local minima. Revealing the structure of the input improves when competitive spiking and indirect minimization of the entropy of spike rate are applied together.

126 (S07)

A direct, interval-based method for reconstructing stimuli from noise-robust tuning curves

Axel Etzold, Christian W. Eurich
University of Bremen

We present a new method for reconstructing stimuli from a tuning curve, completing a tuning curve estimation method published earlier. Stimuli are reconstructed by dividing the stimulus space into intervals and providing boundaries for the probabilities with which they contain a given stimulus. The endpoints of these intervals are calculated as zeros of polynomials of high degree using the efficient direct method of Dixon polynomial resultants. Repeated measurements refine the decomposition, allowing for more accurate statements about the associated probabilities. Our method employs no special assumptions about the noise distribution, removing tractability problems of Bayesian or Maximum Likelihood estimation.

127 (S08)

Adaptive contrast gain control and information maximization

Yuguo Yu, Ph.D Tai Sing Lee, Ph.D
Carnegie Mellon University

Contrast gain control is an ubiquitous phenomenon in biological systems. While the static nonlinearities (e.g., saturation and threshold) of neurons can explain a number of contrast gain control phenomena [1-2], the theoretical connection between information maximization and contrast gain control is not completely clear. In this paper, we report that for a neuron with fixed threshold and saturation, information maximization dictates that the gain of the neuronal transfer function and the variance of the input signals should obey an inverse power law. This suggests that in addition to the effect due to static nonlinearity, an additional rescaling of the amplitude gain of the transfer function is needed to achieve information maximization.

128 (S09)

Rate synchronization as a deterministic signal in neural spike trains

ortega, guillermo bongard, markus louis, enrique fernandez, eduardo
Universidad de Buenos Aires

We introduce a simple method to analyze recorded spike trains in sensory neurons that allows to reveal deterministic aspects of spiking dynamics. In particular, events with an associated firing rate f_r, are defined whenever two successive spikes on a given cell \alpha occur at times t_i^\alpha and t_i-1^\alpha such that (f_r+\Delta)^-1<\vert_i^\alpha-t_i-1^\alpha \vert <(f_r-\Delta f_r)^-1, for a given \Delta f_r. We then look for synchronization of those events on different cells. Our results show that synchronized events are sharply correlated with stimuli. The method is used to analyze experimental time series obtained on retinal ganglion cells and synthetic time series.

129 (S10)

Parallel Processing of Multi-Modal Information in Single Neuron Computation

Evan Haskell Gary J. Rose
University of Utah

How neurons integrate integrate encodings of different types of information is a fundamental issue in understanding neuronal computation. While parrallel processing of information in neuronal circuits is well accepted; the question of parallel processing at the level of compartments within individual neurons has received relatively little attention. Many neurons perform parallel processing of multiple types of information in order to make a behaviorally relevant response. Some neurons in the dorsal torus semicircularis of the weakly electric fish receive differentiated inputs encoding low and high temporal frequency fluctuations of a self generated electric field. Low temporal frequency information can be further accentuated by parallel processing within the cell, possibly involving active conductances that operate predominately on spine compartments, short term plasticity, or segregation of synaptic input.

130 (S11)

Electrolocation of prey-like stimuli a detection-theoretic approach

Niklas Ludtke, Mark E. Nelson
University of Illinois

Sensory systems are adapted to the statistical structure of their natural environment. Neural filtering properties at the early stages of sensory processing should be matched to the spatiotemporal structure of natural stimuli. Using the electro-sensation in weakly electric fish as a model system, we argue that an integrate-and-fire neuron can realize a good approximation of a Bayesian likelihood ratio detector. Moreover, the approximation can be modelled as a lower bound of the likelihood ratio in terms of Jensen's inequality, which helps explain the high detection performance for a very low signal to noise ratio (SNR < 0 db). The model also explains the sharply limited range of detection and characterizes the spatial structure of the receptive field of the detector.

131 (S12)

Finding Likely Models that Describe Population Responses

Don H. Johnson Jyotirmai Uppuluri
Rice University
Analyzing the spike response of a neural population will be plagued by a lack of data unless some knowledge of the interrelationships among the individual neural discharge patterns places the available data in context. Unfortunately, determining that context---a model---is precisely what the data analysis must produce. We describe here a new approach to population data analysis that turns the usual data analysis procedure around Instead of measuring response statistics, such as discharge rates and correlation coefficients, and then finding a single model from them, we find all statistical models consistent with the data. We use an objective information theoretic criterion for determining appropriate models. Our approach generalizes maximum likelihood techniques for estimating model parameters.

132 (S13)

Primary Afferent Responses to Naturalistic Signals and Backgrounds in Weakly Electric Fish

Jonathan L House, Rdiger Krahe, Mark E Nelson
University of Illinois, Urbana-Champaign

Sensory systems are specialized for selectively extracting information from the environment that is relevant to an animals behavioral goals, while suppressing background noise that tends to obscure behaviorally important signals. Considering the amazing ability of many sensory systems to extract weak signals from background noise, it is expected that sensory filtering mechanisms should be adapted to the statistical properties of natural sensory stimuli. Understanding the functional consequences of sensory filtering can best be assessed using stimuli consistent with the characteristics of the natural environment.

133 (S14)

Recurrent Neural Network Generates a Basis for Sensory Image Cancellation

Patrick D. Roberts
Oregon Health & Science University

This study investigates the temporal dynamics of recurrent layers and their relevance to storage of temporal information. A recurrent layer is shown to generate a dynamical basis that allows cancellation of predictable sensory images via and adaptive mechanism based on spike-timing dependent plasticity.

134 (S15)

Dynamic population coding for detecting the distance and size of an object in electrolocation

Kazuhisa Fujita,Yoshiki Kashimori,Takeshi Kambara
University of Electro Communications

To clarify the neural mechanism of dynamic population coding in electrolocation carried out by electrosensory system of a weakly electric fish, we developed a model of fish body to describe numerically the spatiotemporal patterns of electric field around the body, and neural network models of electrosensory lateral-line lobe(ELL) and torus semicircularis(TS). The spatiotemporal features of electric field relevant to distance and size of objects are encoded into the spatial distribution and timing of burst spikes of ELL neurons. The information is represented more definitely as the area and timing of the synchronized firing pattern of TS neuron population.

135 (S16)

Modeling the milk-ejection reflex

Enrico Rossoni, Gareth Leng, Jianfeng Feng
University of Sussex

We present a model of the bursting behavior observed during lactation in hypothalamic magnocellular neurons releasing the hormone oxytocin (OT). The OT system is modeled as a network of Integrate-and-Fire neurons interacting through dendritic release of OT. Each neuron receives a stochastic synaptic input which is responsible for a tonic background activity, and a suckling-related input which triggers accumulation of a releasable pool of OT in the dendrites (priming). Dendritic priming allows spike-dependent release to occur, thereby switching on communication among neurons. As a result, a synchronised bursting activity is produced in the network, resembling that observed in vivo.

136 (S17)

Algorithmic Description of Hippocampal Granule Cell Dendritic Morphology

Alexei V. Samsonovich, Giorgio A. Ascoli
George Mason University

Recent efforts in computational neuroanatomy have aimed at accurately reproducing all relevant statistical details of dendritic morphology with stochastic models based on local rules and parameters measured from real neurons. Here we present a solution of this problem for dentate gyrus granule cells based on a hidden Markov algorithm. The correctness of the model is supported by the statistical agreement between distributions of emergent parameters measured from population of traced and virtual neurons. The algorithm relies on two local hidden variables, one of which might be associated with dendritic microtubules, and another may represent the time of development.

137 (S18)

Morphological Noise in a Computational Model of Dendritic Branching.

Duncan E. Donohue and Giorgio A. Ascoli
George Mason University

We present a computational model of dendritic branching in which several parameters are measured from reconstructed CA1 pyramidal cells, grouped by the corresponding branch diameter, and resampled to create virtual neurons. This model greatly improves over previous studies in which parameters were not grouped by diameter. Further improvement was obtained by separating the distal dendrites in the apical tree. We also investigated the effects of measurement error in the model by systematically adjusting the variability of the parameter distributions. We found the model to be particularly sensible to key parameters (e.g. taper rate) at variability ranges near the experimental values.

138 (S19)

Hippocampal and prefrontal cortical mechanisms in goal-directed and memory-guided behavior.

Michael E. Hasselmo
Boston University

Mechanisms of memory-guided behavior were analyzed in a simulation of the hippocampus and prefrontal cortex which guided movements of a virtual rat in a virtual delayed spatial alternation task, in which correct turning response depended upon the previous episode. At the choice point, both possible episodes were retrieved in entorhianl cortex and temporal context from dentate gyrus and region CA3 allowed selection of one episode in CA1. Episodic retrieval allowed selection of correct goal-directed movement by prefrontal cortex circuits. Network activity replicates current source density during theta rhythm, as well as theta phase precession and context sensitivity of place cells.

139 (S20)

Modeling IM Channels in Hippocampal CA1 Oriens/Alveus Interneurons

F. Saraga, J.J. Lawrence, J.M. Statland, C.J. McBain and F.K. Skinner
University of Toronto

Recent experimental work suggests that a muscarinic sensitive potassium current, IM, is a component of the sustained outward current in hippocampal oriens/alveus (O/A) interneurons. This channel plays a key role in controlling membrane excitability and can be modulated by a variety of neurotransmitters, hormones and second messengers. We use voltage clamp experimental data to characterize the kinetics of this channel and incorporate it into a single compartment model. Using multi-compartment models based on reconstructed O/A interneuron morphologies we determine what possible channel distributions of IM in the soma and dendrites match the experimental data.

140 (S21)

Frequency dependence in the long-range temporal correlation human hippocampus energy fluctuations

M. Stead, G.A. Worrell, and B. Litt
Mayo Clinic

Spontaneous energy fluctuations in human hippocampal EEG show prominent amplitude and temporal variability. Here we show hippocampal energy fluctuations often exhibit long-range temporal correlations with power-law scaling. During these epochs we find that the energy fluctuations exhibit LRTC over a broad frequency range (0.5- 100 Hz) with greater persistence of the correlations in the 0.5-30 Hz range compared to 30-100 Hz. The correlation in hippocampal energy fluctuations is characterized by a bias for energy fluctuations to be followed by similar magnitude fluctuations over all energy scales, i.e. large begets large and small begets small.

141 (S22)

Representing episodic memory in a system-level model of the brain

Alan H. Bond
California Institute of Technology

We discuss the problem of finding neuroscientific and psychologically plausible representations of the memories of events and episodes. In order to do this we need to take into account the neuroanatomical connectivity between the cortex and the hippocampal complex, and also the cognitive psychology of episodic memory. We then need to develop a model of the cortex and hippocampal complex and to find representations of events that are consistent with biological information-processing constraints. We conclude that events and episodes can be represented by certain codes which are stored in associative memories. Indexing at the top-level of chunking uses timing information.

142 (S23)

Unsupervised spike sorting with ICA and its evaluation using GENESIS simulations

A. Madany Mamlouk, H. Sharp, K. M. L. Menne, U. G. Hofmann, T. Martinetz
University of Luebeck

Data acquisition for multisite neuron recordings still requires two main problems to be solved - the reliable detection of spikes and the sorting of these spikes back to their originating neurons. Approaches and solutions for both problems are difficult to evaluate quantitatively, due to a lack of knowledge about the truth behind the experimental data. Biologically realistic simulations allow to overcome this fundamental problem and to control all the processes which lead to the measured data. Within this framework the quantitative evaluation of the performance of data analysis methods becomes possible. In this paper the potential of Independent Component Analysis (ICA) for spike sorting and detection is studied. A biologically realistic simulation of hippocampal CA3 is used to get a measure of quality and usability of ICA to solve the neural cocktail party problem. The results are promising.

143 (S24)

Increasing CS and US longevity increases the learnable trace interval

Xiangbao Wu, William B Levy
University of Virginia Health System

It has been hypothesized that increasing CS longevity affects performance on trace conditioning. Using a hippocampal model, we find that increasing CS and US longevity increases learnable trace interval. As a matter of fact, over a modest range, maximal learnable trace interval is approximately a linear function of CS/US longevity.

144 (S25)

Path Integrator Contributions to Hippocampal Map Formation

David S. Touretzky
Carnegie Mellon University

Skaggs and McNaughton's (1998) experiment in which rats shuttled between two visually identical boxes provided a clear demonstration of stable partial remapping in hippocampal place cells. Any satisfactory theory of hippocampal map formation must account for both the degree of remapping and the stability of the partially remapped state. We suggest that a weak path integrator is reponsible for the remapping observed in this experiment, but the PI also helps to stabilize the remapped state. These ideas are tested in a computer simulation.

145 (S26)

Computing Conditional Probabilities in a Minimal CA3 Pyramidal Neuron

Ashlie B. Hocking and William B Levy
University of Virginia Health System

The CA3 region of the hippocampus seems to be a sequence predicting recoder; thus each CA3 neuron must compute something that approximates conditional probabilities which forecast its own firing. Here we compare a sensibly derived neural network model, based on local conditional probabilities to an existing model of CA3. Due to the divisive inhibition used in the existing model, the excitation equations of the two models are similar and interesting analogies are highlighted. In addition to their similarities, both models demonstrate deficiencies, but in differing aspects of their behavior.

146 (S27)

Modelling reduced excitability in aged CA1 neurons as a calcium-dependent process

Maria Markaki, Stelios Orphanoudakis and Panayiota Poirazi
FORTH

We use a multicompartmental model of a CA1 pyramidal cell to study changes in hippocampal excitability that result from aging induced alterations in calcium-dependent membrane mechanisms. Based on experimental predictions, the model incorporates N- and L-type calcium channels which are respectively coupled to slow and fast afterhyperpolarization potassium channels. N-type channels show calcium-dependent inactivation (CDI), while L-type channels display two opposing forms of autoregulatory feedback calcium-dependent facilitation (CDF) and calcium-dependent inactivation (CDI). Model parameters are calibrated using in vitro data from physiological studies. Computer simulations reproduce the experimentally observed decreased excitability of aged CA1 cells which results from increased calcium influx, subsequently larger postburst afterhyperpolarization and enhanced spike frequency adaptation. We find that aging induced alterations in CA1 excitability can be explained by a simple coupling mechanism that links L-type calcium channels with sAHP current.

147 (S28)

Modeling of intracellular Ca2+ during epileptic seizures

Pawel Kudela, Piotr J Franaszczuk, Gregory K Bergey
Johns Hopkins University

Considerable experimental evidence indicates that changes in cellular Ca2+ homeostatic mechanisms may be associated with changes in neuronal excitability and epileptogenesis. In these studies we look into various intracellular Ca2+ processes and investigate how they may influence the dynamics of repetitive bursting activities in simulated neuronal networks. Our results show that the process of Ca2+ clearance in neurons is an important factor influencing the dynamics of simulated bursting activity. Slow reduction in the rate of Ca2+ clearance produces changes in patterns of simulated EEG similar to those observed in ictal EEG recorded from humans. Synaptic potentiation produced by raised intracellular Ca2+ may be responsible for the late irregular bursting in both simulated EEG and in human EEG prior to seizure termination.

148 (S28)

Inter-spike-interval Coding and Computation with Integrate and Fire Neurons

Dileep George
Stanford University

It is well known that neurons communicate using spikes. However, it is not known how information is encoded in the spikes that travel from one neuron to another. Any information encoding mechanism using spikes should also account for computations done by the neurons. This paper to introduces Inter-spike Interval (ISI) coding as a viable coding and computational mechanism in neural networks with Integrate and Fire neurons. Moreover, the ISI coding and computation as suggested by this paper could account for part of the observed variability of cortical spike trains.

149 (S29)

Correlations in the background activity allow the use of single neuron learning rules in populations

Thomas Hoch, Gregor Wenning and Klaus Obermayer
Technical University of Berlin

Single neuron learning rules have received a lot of attention in recent years. In the central nervous system of higher animals single neurons rarely matter, and information is likely to be coded by populations of cells. Thus the question arises, if single neuron learning rules remain valid. In this paper we investigate the effect of correlations in the background activity on the information transmission properties of populations of neurons. We show that correlations in the background activity not only decrease information transmission but also immediately reduce the optimal noise level to that of the single neuron. As a consequence of this, single neuron learning rules remain valid in the context of population coding.

150 (S30)

Population dynamics of excitatory and inhibitory spiking neurons quantifying the contribution of spike timing to coding

V Del Prete and ACC Coolen
king's college london

In a recent work we have introduced an effective neuron model aiming at bridging the simplified description of integrate and fire neurons and the complex dynamics of conductance based models. Our effective formulation allows us to define a measure of multiple neurons temporal patterns characterizing the dynamics. Here we extend the previous study to analyze the dynamics of two interconnected populations, the first of excitatory, directionally selective, and the second of inhibitory cells, in presence of directional input stimuli. In a mean field approximation we can estimate qualitatively the contribution of spike timing to the information about the directional stimuli.

151 (S31)

Is neocortical encoding of sensory information intelligent?

Andras Lorincz
Eotvos Lorand University

The theory of computational complexity is used to underpin a recent model of neocortical sensory processing. It is argued that the theory of computational complexity points to generative networks and that these networks resolve the homunculus fallacy. Computational simulations illustrate the idea.

152 (S32)

Energy-Efficient Interspike Interval Codes

Patrick Crotty and William B Levy
University of Virginia Health System

We study the energy efficiency of interspike interval (ISI) neural codes. Assuming that nature maximizes the amount of information transmitted per metabolic energy cost produces a firing frequency which maximizes the energy/information ratio. Fairly simple assumptions about and parameterizations of the signal and jitter noise distributions lead to ISI codes that are at least as efficient as discrete binary and frequency codes.

153 (S33)

Comparing integrate-and-fire-like models estimated using intracellular and extracellular data

Liam Paninski, Jonathan Pillow, Eero Simoncelli
NYU

We have recently developed a method for estimating integrate-and-fire-like stimulus encoding models that can be used even when only extracellular spike train data (no intracellular voltage record) is available. Here we apply this method to responses recorded \it in vitro, allowing a direct comparison of model fits given extracellular versus intracellular data. Both models are able to capture the behavior of these cells under dynamic stimulus conditions to a high degree of temporal precision, although we observe significant differences in the stochastic behavior of the two models.

154 (S34)

Stochastic Interaction in Associative Nets

Thomas Wennekers and Nihat Ay
University of Plymouth

Spatio-temporal correlations in spike trains of simultaneously recorded cortical neurons have been a matter of intensive research during the last years. Information theoretic measures for spatial" and temporal stochastic interaction" can characterize spike correlations on a mathematical base. In the present work we calculate these interaction measures for associative networks that have been proposed as models for cortical gamma-oscillations and precisely repetiting spike patterns (synfire chains).

155 (S35)

Implementing belief propagation in neural circuits

Aaron P. Shon Rajesh P. N. Rao
University of Washington

There is growing evidence that neural circuits may employ statistical algorithms for inference and learning. Many such algorithms can be derived from independence diagrams (graphical models) showing causal relationships between random variables. A general algorithm for inference in graphical models is belief propagation, where nodes in a graphical model determine values for random variables by combining observed values with messages passed between neighboring nodes. We propose that synaptic connections between neurons in cortex directly correspond to causal dependencies in an underlying graphical model. Our results suggest a new probabilistic framework for computation in the neocortex.

156 (S36)

Time Encoding with Integrate-and-Fire Neurons

Aurel A. Lazar
Columbia University

Time encoding is a mechanism of mapping amplitude information into a time sequence. We show that time encoding with integrate-and-fire neurons provides, under natural conditions, an invertible representation of information, i.e., a sensory stimulus can be recovered from its multidimensional spike train representation loss-free.

157 (S37)

Stochasticity in Localized Synfire Chain

Kosuke Hamaguchi Masato Okada Michiko Yamana Kazuyuki Aihara
RIKEN

We report on the stochastic evolutions of firing states through feedforward neural networks with Mexican-Hat type connectivity (the MH network). The variance in connectivity, which depends on the pre-synaptic neuron, generates common noisy input to post-synaptic neurons. We develop a theory to describe the stochastic evolution of the localized synfire chain driven by a common noisy input. The development of a firing state through neural layers does not converge to a certain fixed point but keeps on fluctuating. Stationary firing states except for a non-firing state are lost, but an almost stationary distribution of firing state is observed.

158 (S38)

Simple model neurons with AMPA and NMDA filters. The role of the synaptic time scales

Rubn Moreno-Bote Nstor Parga
Universidad Autonoma de Madrid

Cortical neurons receive inputs that are filtered by a variety of synaptic types with very different time constants. We study the response properties of a leaky integrate-and-fire (LIF) model neuron in the presence of both fast AMPA and slow NMDA filters and find an analytical formula valid when the membrane time constant \tau_m of the neuron is short. When the NMDA/AMPA abundances are similar to those found in cortex, the neuron mainly responds to particular large fluctuations in its inputs. These results suggest that NMDA filters play a crucial role in shaping the neuron response in cortex.

159 (S39)

Synfire chains with conductance-based neurons internal timing and coordination with timed input

Friedrich T. Sommer Thomas Wennekers
Redwood Neuroscience Institute

Synfire chain models store and retrieve hetero-associative sequences of firing patterns, thereby explaining basic aspects of the neuronal processing of temporal information. Existing models were based on McCulloch-Pitts or integrate \& fire neurons and therefore neglect most physiological properties of real neurons. Here, we study a model with conductance-based neurons and both, hetero- and auto-associative couplings which support synfire vs.~attractor activity, respectively. We show that the speed of synfire recall is influenced by slow neuronal variables and is sensitive to the ratio between auto- and heteroassociative synapses while quite insensitive to background activity. We then propose a bidirectional synfire model where the duration of states in a synfire chain is variable and can be coordinated by a timed but otherwise unspecific external signal.

160 (S40)

Effect of spike-driven feedback on the firing statistics of noisy spike generators

Benjamin Lindner, Jan Benda, and Andre Longtin
University of Ottawa

We consider a general dynamical neuron model with noise and inhibitory feedback driven by its spikes (e.g. voltage-gated adaptation currents). Such feedback reduces the spike rate and can lead to negative ISI correlations. If certain characteristics of the neuron without feedback are known, the firing statistics in presence of a weak feedback can be inferred. For a white noise driven leaky integrate-and-fire model with current feedback, analytical results for mean, variance, ISI correlation coefficient, and spike train power spectrum display a good agreement with simulation results. This provides analytical insight into firing characteristics of stochastic neurons with adaptation or feedback.

161 (S41)

A-Currents Reduce Spike Synchrony Driven by Input Transients

Joanna R. Pressley, Todd W. Troyer
University of Maryland

Neural populations can be driven to spike synchronously by sudden increases in external input. The degree of synchrony depends on a number of factors. For leaky integrate-and-fire (LIF) neurons firing in the regular spiking regime, the rate of depolarization decreases as threshold is approached. The increased likelihood of being near threshold translates into an increased likelihood of spiking (synchrony) just after an input transient. A-type potassium channels (a hyperpolarizing current activated near threshold) can counteract this effect, reducing population synchrony in a simple LIF model.

162 (S42)

Comparing Internal Models of the Dynamics of the Visual Environment

Sean Carver, Tim Kiemel, Herman van der Kooij, John Jeka
Univesity of Maryland

We compare four models of the human postural control system. Three include internal models which assume the environmental dynamics to be, respectively, a random walk and a general first and second order linear stochastic process. The fourth model does not predict environmental dynamics. We compare the behavior of the four models to the behavior of the human postural control system based on the gain and phase of postural sway with respect to a sinusoidal stimulus as a function of the amplitude and frequency of that stimulus. We find that the model that makes no predictions best matches the data.

163 (S43)

Neural Statics and Dynamics

Robert L. Fry
Johns Hopkins University

Abstract. A theory of cybernetic systems was previously proposed as a quantitative basis for neural computation. This theory dictates the architectural aspects of a single-neuron system including its operation, adaptation, and most importantly, its computational objective. The present paper completes prior work by formalizing the Hamiltonian for the single-neuron system and by providing an expression for its partition function. Besides explaining previous work, new findings suggest the presence of a computational temperature T above which the system must operate to avoid freezing, upon which useful computation becomes impossible. T serves at least two important functions (1) it provides a computational degree of freedom to the neuron enabling the realization of probabilistic Bayesian decisioning, and (2) it can be varied by the neuron so as to maximize its throughput capacity in the presence of measurement noise.

164 (S44)

Mechanisms of spike inhibition in a cortical network induced by transcranial magnetic stimulation

Yoichi Miyawaki, Masato Okada
RIKEN

We propose mechanisms of neural interference induced by transcranial magnetic stimulation (TMS). TMS is widely used as a powerful and unique experimental tool to stimulate the human brain noinvasively, which typically induces inhibitory effect on the cortical functions. However, the fundamental mechanism of TMS-induced suppression is still unclear. In this paper, we computationally demonstrate that TMS induces sustained spike inhibition in a conductance-based network model without the ion channel which is necessary for spike inhibition in an isolated single neuron, suggesting that each individual neuron is not necessarily suppressed by TMS; rather, a collapse of excitatory and inhibitory input balance in the cortical network is crucial for TMS-induced suppression.

165 (S45)

A piece-wise harmonic Langevin model of EEG dynamics   Theory and application to EEG seizure detection

Murielle Hsu David Hsu
University of Wisconsin, Madison

Electroencephalogram (EEG) dynamics results from the motion of charged particles in the brain. By invoking the laws of classical physics, we show that EEG dynamics obeys, at short enough times, a piece-wise harmonic Langevin equation characterized by an effective mass matrix, a piece-wise harmonic potential energy surface, a friction and random force matrix. In analyzing a sample seizure, we find with seizure onset a marked increase in frequency of encounters with inflection points on the potential energy surface, and a subtle increase in the potential energy contribution to the total force.

166 (S46)

Electrode-cell distance estimation method, based on spatial potential patterns of spiking cells

Zoltn Somogyvri, Gbor Borbth, Lszl Zalnyi, Istvn Ulbert, Pter rdi
Hungarian Academy of Science, RIPNP

A new principle for cell-electrode distance estimation was presented, based on extracellular spatial potential patterns of spikes, measured by linear multi micro electrodes. This new method required a reliable model of spiking cells' current source density distribution. Thus, properties of the extracellular potential patterns were discussed - referring to problems with monopole, and other point source models. Instead of point source models, a new model was set up and circumstances of its validity were determined. Finally the precision of the new distance estimation method was examined on simulated data and was applied on in vivo measurements from cat's neocortex.

167 (S47)

Self Organized Criticality in Scale-Free Neocortical Dynamics

Freeman, Walter J
California

Analysis of high spatiotemporal resolution rabbit EEG reveals spatial patterns in amplitude and phase modulation of gamma carrier waves that serve to classify discriminative CS+/- trials. Paleocortex exemplified by olfactory EEG has one AM-PM pattern at a time that forms by an input-dependent state transition. Neocortex shows multiple overlapping AM-PM patterns before and during presentation of CSs. Modeling suggests that neocortex is stabilized in a scale-free state of self-organized criticality, enabling cooperative domains to form virtually instantaneously by state transitions ranging in size from a few hypercolumns to an entire hemisphere. This mechanism is proposed to explain Gestalt formation.

168 (S48)

Analysis of Phase Shifts in Clinical EEG Evoked by ECT

Yuqiao Gu, Bjrn Wahlund, Hans Liljenstrm, Dietrich von Rosen and Hualou Liang
SLU

We propose a new strategy to study the phase shifts of Electroencephalography (EEG) after electroconvulsive therapy (ECT) to patients with major depression (ECT EEG). We divide each ECT EEG time series into four phases and calculate the power spectrum and coherence of left and right prefrontal EEGs for each phase. Previously we have qualitatively demonstrated certain ECT EEG dynamical patterns by using a neo-cortical neural network model. Now we quantitatively analyze the dynamical phase shift of the ECT EEG data. Our results are suggestive for a deeper understanding of the ECT EEG patterns and for building more realistic cortical models.

169 (S49)

Reduced models of neuronal activity have spike timing predictive power

Renaud Jolivet, Alexander Rauch, Hans-Rudolf Lscher, Wulfram Gerstner
Swiss Federal Institute of Technology Lausanne

We demonstrate that a single-variable generalized integrate-and-fire model can quantitatively capture the dynamics of real cortical neurons. Contrary to classic integrate-and-fire models, here, parameters depend on the time elapsed since the last spike (Spike Response Model). We present a technique for systematically and numerically optimizing parameters in the Spike Response Model (SRM) based on intracellular recordings of the target neuron. To quantitatively test the predictive power of the SRM, we compare predicted spike trains to those in the target neuron when they are driven by identical randomly fluctuating input. This technique is tested on data simulated with a single-compartment Hodgkin-Huxley model first and then applied to intracellular in-vitro recordings of rat pyramidal cells. For random current input, the SRM reproduces 70%-80% of the spikes of the target neuron (with temporal precision of plus or minus 2ms) over a wide range of firing frequencies. For random conductance injection, up to 75% of spikes are coincident. This method is suitable both for systematic numerical model reduction and for construction of equivalent simple phenomological models of real neurons.

170 (S50)

Withdrawn

171 (S51)

Frequency-dependent depletion of secretory vesicle pools modulates bursting in vasopressin neurones of the rat supraoptic nucleus

Peter Roper
NIDDK - NIH

When stimulated, vasopressin neurones discharge lengthy, repeating bursts of action potentials. An increase in the stimulus strength causes both a lengthening of the bursts' active phase and an increase in the intra-burst firing frequency. Here we extend our earlier model \citeRoper2004 for phasic bursting at a constant stimulus. We show that an increase in burst length could be due to a reduction of the co-secretion of an inhibitory factor, dynorphin, and we propose this to be caused by a frequency dependent depletion of the pool of secretory vesicles.

172 (S52)

Bistability in a Two-Compartment Leaky Integrate-and-Fire Neuron

Mandana Ahmadi, Timothy J. Lewis, John Rinzel
NORDITA

We have carried out an analytical and numerical study to explore the effects of adding a passive compartment to a point neuron spiking model. The enhanced neuron model consists of two coupled compartments, idealizing cable-like properties. The soma-like compartment has leaky integrate-and-fire (LIF) dynamics while the dendrite-like compartment is passive. Our analysis shows that the dynamics of such a two-compartment model can produce different behavior than those of a simple LIF neuron. The two-compartment model also exhibited various additional behaviors over that of a single-compartment LIF model input resistance that can vary with cable-like parameters while leakage conductance is fixed, a non-zero minimum firing frequency, and bistability between firing and non-firing states.

173 (S53)

Cholinergic modulation of phase response curves of cortical pyramidal neurons.

Gutkin, B.; Stiefel, K; Sejnowski, T.
Gatsby Computational Neuroscience Unit

When a periodically firing neurons is perturbed the spike is either advanced or delayed. The spike-time shift is the Phase Response Curve (PRC). Theory shows that neurons with strong spike frequency adaptation (SPA) should show type-II (biphasic) PRCs while non-adapting neurons have type-I (strictly positive). We tested the hypothesis that the PRC shape and/or type can be changed by acetylcholine modulating the SPA currents. We recorded from layer II/III pyramidal neurons in mouse visual cortex. Via current injection we depolarized the neurons above threshold and injected brief current pulses at random times during the inter-spike interval to determine the PRC. This was repeated after bath application of 20M of carbachol. Cholinergic neuromodulation transformed the phase-reset curve from type II to type I. Since the PRC shape has implications for neuronal synchronization behavior, such modulation can change the global behavior of cortical networks.

174 (S54)

High discharge variability in neurons driven by current noise

Mathilde Badoual, Michael Rudolph, Zuzanna Piwkowska, Alain Destexhe, Thierry Bal
Institut Alfred Fessard UNIC

Cortical neurons in vivo show a highly irregular spontaneous discharge activity, characterized by a Poisson statistics and coefficient of variation around unity. In modelling studies it was found that this irregularity is a consequence of the high-conductance state caused by the ongoing activity in the cortical network. Here, we investigate to which extend this high discharge variability can be reproduced in vitro using current noise injection. In agreement with numerical studies, we found that equalizing the noise time constant with the membrane time constant may lead to an irregular discharge activity which, however, departs from Poisson statistics.

175 (S55)

A Biophysical Model of Metaplasticity Can Account for Homeostatic Synaptic-Scaling

Luk Chong Yeung, Harel Z. Shouval and Leon N Cooper
Brown University

Synaptic scaling has been described as a non-Hebbian, activity-dependent plasticity mechanism that globally adjusts the synaptic gain of a given neuron in response to changes in its firing activity (Turrigiano et al. 1998, Desai et al. 1998). It has been proposed that synaptic scaling is reminiscent of the sliding-threshold hypothesis of the BCM theory (Bienenstock et al. 1982, Frgnac 1998) and could act to maintain cortical stability and homeostasis in vivo; however, its mechanistic basis remains unexplained. We show that a biophysical model of BCM-type metaplasticity can account for the experimentally observed synaptic scaling, suggesting that these two phenomena C scaling and metaplasticity C could share a common underlying physiological mechanism.

176 (S56)

A neural mechanism for optimizing task performance

Eric Brown, Jeff Moehlis, Mark Gilzenrat, Philip Holmes, Ed Clayton, Gary Aston-Jones, and Jonathan Cohen
Princeton University

Recent brain recordings suggest a link between different firing patterns in the brainstem nucleus locus coeruleus (LC) and different levels of performance in simple cognitive tasks. Starting from the dynamics of single spiking neurons, I will describe mathematical models for these firing patterns and possible mechanisms for the observed transitions between them. Then, in an extension of previous work, I will discuss a possible role for the LC in optimizing speed and accuracy in decision tasks, via release of neuromodulators which dynamically adjust the sensitivity (i.e. gain) of neural populations.

177 (S57)

Morphologic contributions to velocity storage neural integration.

C.M. Weaver, R. Baker, and S.L. Wearne
Mount Sinai School of Medicine

Neurons comprising the velocity storage neural integrator (VSNI) perform a leaky mathematical integration of their inputs. Lacking accurate 3D morphologic representations of their constituent neurons, current network models of vestibular integrators neglect cellular and morphologic mechanisms that could contribute to persistent activity. We present a biophysically plausible model of an electrophysiologically characterized, 3D manually reconstructed neuron from goldfish Area II, a region shown to be necessary, possibly sufficient, for velocity storage. The model reproduces subthreshold electrophysiological responses and firing characteristics recorded in Area II. We demonstrate that morphology is an essential determinant of the response dynamics of the modeled neurons.

178 (S58)

Model of maturation of the respiratory rhythm generator

P. Achard, R. Rodriguez, G. Hilaire
CNRS

Rodent respiratory generator stabilises its rhythm between embryonical day 16 (E16) and birth. Pacemaker neurons are observed just before birth but don't seem to be necessary to generate rhythm. A simple GENESIS simulation, using single compartment neurons with three ionic channels and noise, is able to solve the pacemaker/network dilemna. The effects on rhythm frequency and stability of the evolution of several parameters are studied. Bimodal interspike intervals are seen in weakly connected networks. A model where pacemaker apparition is mainly driven by epigenetic factors is proposed.

179 (S59)

Paroxysm potentiation synaptic potentiation enhances repetitive epileptiform discharge without enhancing evoked response

William Lytton, Michael O'Laughlin and Daniel Uhlrich
SUNY Downstate

We have explored a rat model of the human photoparoxysmal response (PPR), a high amplitude epileptiform response to repetitive strobing. This rat PPR is acquired and is likely to involve potentiation at multiple sites in the circuit. The thalamocortical synapse is known to show long-term potentiation and is likely to be one of the sites involved. However, in our preparation, spike amplitude increased substantially in the late PPR without increasing in the first response cycle,

suggesting no augmentation at this site. We performed network simulations to explore this paradox. We found that mild increases in synaptic strength at the thalamocortical synapses did not significantly alter response to single stimulation but nonetheless produced substantial amplitude augmentation during an epileptiform oscillation.

180 (S60)

The effect of feedback inhibition on throughput properties of the dLGN/PGN

Marco A. Huertas, Jeffrey R. Groff, Gregory D. Smith
College of William and Mary

The effect of feedback inhibition from thalamic reticular (RE) cells on retinogeniculate transmission by thalamocortical (TC) neurons of the dLGN is analyzed using a minimal integrate-and-fire-or-burst (IFB) network model. The network includes spatially non-local synaptic coupling, alpha-function postsynaptic conductances, and a gamma process representation of spontaneous or visually-driven retinal ganglion cell activity. Potassium leakage conductances control the neuromodulatory state of the network and can eliminate rhythmic bursting in the presence of spontaneous input (i.e., wake the network). During oscillatory full-field stimulation the response of the aroused network depends on average input rate, contrast level, and temporal frequency of modulation.

181 (S61)

A possible synchronization mechanism of the suprachiasmatic nucleus based on the phase-response curve

Young-Ah Rho, Jaeseung Jeong, and Kyoung J. Lee
Korea University

The suprachiasmatic nucleus (SCN), the master biological clock in mammals, consists of multiple, single-cell oscillators (i.e. clock cells) with widely dispersed periods. The mechanism underlying synchronization and entrainment of the clock cells is an important issue in nonlinear dynamics as well as Chronobiology. Recently, we have shown that the neurotransmitter - aminobutyric acid (GABA) mediated cell-to-cell interaction is essential for the clock cell synchronization [1]. Following this observation, we develop a novel model of the SCN o a population of non-identical oscillators responding slowly to GABA in a phase-dependent manner. This model successfully reproduces the two key properties of the SCN self-organized synchronization and entrainment to external stimuli. Therefore, we propose that the phase-dependent, slow responses of clock cells to GABAergic inputs can be the basis of the SCN synchronization and entrainment.

182 (S62)

A minimal model for C Elegans forward locomotion

Netta Cohen
University of Leeds, UK

We study a minimal model of the neural control for C Elegans forward locomotion. The model relies on graded potential neurons, and lacks any synaptic inhibition. Rather, sustained undulations are shown to propagate down the worm in a robust manner, with a simple circuit of gap junctions and capacitive delays. Antiphase oscillations are achieved, not by means of central pattern generators, but rather via feedback from stretch receptors along the body. Computer optimisation was used to seek working parameters. In this talk, we present the model, simulations thereof and possible implications for the neurobiology of the C Elegans locomotion system.

183 (S63)

Driving Neuronal Responses Using Stimulus Feedback in the Cricket Cercal Sensory System

Z. N. Aldworth A. G. Dimitrov J. P. Miller
Montana State University

We investigate the extent to which we can control potentially distinct neuronal responses by presenting stimulus features designed to elicit a stereotypical temporal pattern of spikes. We find that in instances where we insert the stimulus features we significantly alter the ratio of response patterns in comparison to the ratio of the same response patterns in a control experiment.

184 (S64)

Phased Array Processing for Spike Discrimination

Yikun Huang John P. Miller
Montana State University

We present a phased array technique for discrimination of neuronal spikes from multi-channel recordings. We evaluated this new approach using simulated data. This approach enables discrimination of simulated spikes from multiple simultaneously-active neurons with a high degree of reliability and robustness even in situations where there is heavy spike waveform superposition on the recording channels and the signal-to-noise ratio is less than 1.

185 (S65)

Estimation of Single-Neuron Model Parameters from Spike Train Data

Randall D. Hayes, John H. Byrne, Steven J. Cox and Douglas A. Baxter
The University of Texas-Houston Medical School

Estimating parameters for models of neurons requires a quantitative comparison between the model output and empirical data. The present study compares three error functions voltage-time-series (VTS), cumulative-voltage-integrals (CVI), and phase-histograms (PH). In two test cases, predefined models were used to produce target data and to compare the efficacy of the three error functions when they were used to recover the target data. In a third example, empirical data were used to parametrize a model. VTS was found to be inferior, whereas as CVI and PH were similar and effective. Reliable parameters were derived from analyzing as few as two datasets.

186 (S66)

Multistability in inhibitory networks with depressing synapses

Victoria Booth, Amitabha Bose
New Jersey Institute of Technology

A network of mutually coupled neurons is considered. Synapses between the neurons are inhibitory and display short-term depression. Multistability of solutions is demonstrated. Implications for temporal coding are discussed.

187 (S67)

Transition between tonic spiking and bursting in a neuron model

Andrey Shilnikov, Ronald L. Calabrese, and Gennady Cymbalyuk
Georgia State University

Tonically spiking as well as bursting neurons are frequently observed in electrophysiological experiments. The theory of slow-fast dynamical systems can describe basic scenarios of how these regimes of activity can be generated and transitions between them can be made. Here we demonstrate that a bifurcation of a codimension one can explain a transition between tonic spiking behavior and bursting behavior. The bifurcation of a saddle-node periodic orbit with non-central homoclinics is underlying the phenomena of bi-stability observed in a Hodgkin-Huxley type neuron model. This model can exhibit two coexisting types of oscillations tonic spiking and bursting.

188 (S68)

Neural activity pattern systems

Peter Andras
University of Newcastle

Understanding how neural systems work needs appropriate models. Here we propose a model that describes neural systems in terms of abstract communication systems. We indicate how to apply the proposed framework to the analysis of real neural systems.

201

Spike Time Patterns

Terry Sejnowski

When a cortical neuron is repeatedly injected with the same fluctuating current stimulus (frozen noise) the timing of the spikes is highly precise from trial to trial. However, the spike time patterns are not unique. Multiple coexisting spike pattersn were discovered in pyramidal cells recorded from rat prefrontal cortex in vitro, in data obtained in vivo from the middle temporal area of the monkey and from the cat lateral geniculate nucleus. These spikes time patterns may reflect different dynamical states of the thalamortical network.

202

Evolving Processing Speed Asymmetries and Hemispheric Interactions in a Neural Network Model

Alexander Grushin James A. Reggia
University of Maryland

Substantial experimental data suggests that the cerebral hemispheres have different processing speeds, and that this may contribute to hemispheric specialization. Here, we use evolutionary computation models to examine whether asymmetric hemispheric processing speeds and lateralization can emerge in neural networks from the need to respond quickly to stimuli and/or to minimize energy consumption. Simulated neuroevolution produced networks with left-right asymmetric processing speeds whenever fitness depended on energy minimization, but not on quickness of response. The results also provide support for a recent hypothesis that subcortical cross-midline interactions are inhibitory/competitive.

203

The Source of Hemifield Asymmetries in Visual Word Recognition

Carol Whitney Michal Lavidor
University of Maryland

Left/right visual field asymmetries have been observed for the lexical-decision task with respect to the effects of string length and orthographic neighborhood size. Based on precise predictions arising from a computational model of letter-position encoding, we demonstrate that the visual field asymmetries can be reversed. These experimental results show that the asymmetries do not arise from hemisphere-specific methods of lexical access, but rather result from differing activation patterns at the sub-lexical level.

204

Network Dynamics and Information Transfer of Natural Stimuli in Electric Fish

Brent Doiron, Maurice J. Chacron, Benjamin Lindner, Leonard Maler, Andre Longtin, Joseph Bastian
University of Ottawa

The neural architecture and spatiotemporal tuning of sensory systems are optimized to code naturalistic environments. Weakly electric fish use an electric sense to navigate their surroundings, hunt prey, and communicate with other fish. We show that electrosensory feedback dynamics support distinct network behavior in response to distinct natural stimuli. In addition, the receptive field structure optimizes information transfer when the spatiotemporal signatures of inputs match naturalistic stimuli. Thus, we give a concrete example of a neural system that uses coding strategies, which are appropriate for stimuli ensembles that they routinely code.

205

Recreating active states in vitro with a dynamic clamp protocol

Zuzanna Piwkowska, Michael Rudolph, Mathilde Badoual, Alain Destexhe, Thierry Bal
UNIC

In neocortical neurons, network activity is responsible for an intense barrage of synaptic inputs, which maintains the membrane in a high-conductance state. Here we propose a method for recreating specific high-conductance states intracellularly. This method makes use of the estimation of the mean and variance of excitatory and inhibitory conductances based on intracellular recordings, and of the injection of appropriate stochastic conductances in in vitro slice preparations using the dynamic clamp protocol. The approach could be used to evaluate the modulation of neuronal responses by specific network states.

206

Disintegration of neocortical cell assemblies under general anesthesia

K.D.Harris; P.Bartho; M.B.Zugaro; L.Monconduit; S.Marguet; G.Buzsaki
Rutgers University

Cognitive functions arise from the activity of neuronal populations. We contrasted population patterns in wakefulness, REM, and anesthesia, to determine if different cognitive states were reflected at the spike-train level. During waking or REM sleep, spike trains showed an irregular structure. Peer prediction analysis (Harris et al, Nature 2003) suggested this irregularity resulted from an underlying cell assembly organization. Under anesthesia, however, spike trains were often oscillatory (5-20Hz). No global oscillation was detected, suggesting that the oscillations were generated by cell-specific mechanisms. We suggest that impaired neuronal coordination under anesthesia mirrors the absence of cognitive activity in the anesthetized animal.

207

Neurokinematic Modeling of Complex Swimming Patterns of the Larval Zebrafish

Scott A. Hill, Melissa A. Borla, Jorge V. Jos, Donald M. O'Malley
Northeastern University

Larval zebrafish exhibit a variety of complex undulatory swimming patterns. This repertoire is controlled by the 300 neurons projecting from brain into spinal cord. Understanding how descending control signals shape the output of spinal circuits, however, is nontrivial. We have therefore developed a segmental oscillator model (using NEURON) to investigate this system. We found that adjusting the strength of NMDA and glycinergic synapses enabled the generation of oscillation (tail-beat) frequencies over the range exhibited in different larval swim patterns. In addition, we developed a simple kinematic model to imitate the more complex axial kinematics used during prey capture.

220 (M02)

Non-topographical contrast enhancement enables disambiguation of high-dimensional neural representations

Thomas A. Cleland Praveen Sethupathy
Cornell University

The topographical mapping of stimulus spaces is a common principle of neural organization, facilitating contrast enhancement mechanisms such as center-surround lateral inhibition. Because this form of contrast enhancement relies upon mutual inhibition among similarly-tuned neurons, its intrinsic topology must match the underlying topology of the sensory map upon which it acts. In the olfactory system, contrast enhancement sharpens odor representations, which map onto a high-dimensional sensory space; however, no known neural mechanism is capable of mediating contrast enhancement in more than two dimensions. We demonstrate a novel mechanism, non-topographical contrast enhancement (NTCE), enabling arbitrarily high-dimensional contrast enhancement by olfactory bulbar circuitry.

221 (M03)

Encoding in a network of sparsely connected spiking neurons application to locust olfaction

HUGUES Etienne, MARTINEZ Dominique
LORIA

Experiments in the locust antennal lobe have revealed that during odor stimulation an oscillation appears together with an odor-specific transient synchronization of the projecting excitatory cells. In order to investigate this behavior, we consider a network of sparsely connected excitatory and inhibitory spiking neurons with noisy stimulus input. For sufficiently strong inhibition, its activity oscillates and, for stronger inhibition, the equally-inhibited excitatory cells fire in distinguishable and precise time windows. The implications for the encoding and decoding of stimuli are then discussed.

222 (M04)

Analysis of the mitral cell-granule cell reciprocal synapse adaptation and divisive scaling

Jason Castro Vikrant Kapoor Nathan Urban
University of Pittsburgh

There is currently much interest in the computational aspects of mammalian olfactory bulb function. Due to its unique synaptic structure and the unusual excitability of its projection cells, much remains unknown about how its physiology creates the dynamics to implement pattern recognition and discrimination. One of the bulb's more remarkable abilities is its capacity for self inhibition, which is mediated through bidirectional dendrodendritic synapses between mitral cells and granule cells. In the present study, we present a biophysically plausible reduced model of this reciprocal interaction, and examine its effects on spike dynamics. We conclude with a demonstration that plasticity of this interaction may serve as a divisive scaling factor of the mitral cell FI curve.

223 (M05)

The inertial-DNF Model Spatiotemporal Patterns with Two Time-Scales

Orit Kliper, David Horn, Brigitte Quenet
Tel-Aviv University

We introduce the inertial-DNF (iDNF) model, an expansion of the Dynamic Neural Filter (DNF) model, as a model that generates spatiotemporal patterns similar to those observed in the Locust Antennal-Lobes (ALs). The DNF model, which was described in previous works, includes one temporal scale defining the discrete dynamics inherent to the model. It lacks a second, slow, temporal scale that exists in the biological spatiotemporal data, where one finds slow temporal patterns in the behavior of individual neurons in response to odor. Using the iDNF, we examine mechanisms that lead to temporal ordered spatiotemporal patterns, similar to those observed in the experimental data. We conclude that the second temporal scale is crucial for the creation of temporal order within the evolving spatiotemporal pattern.

224 (M06)

Olfactory contrast enhancement by functional inhibition in the honeybee antennal lobe

Christiane Linster, Silke Sachse, Giovanni Galizia
Cornell University

In recent years, research in olfaction has considerably increased our understanding of the representation of high dimensional olfactory space in essentially two-dimensional neural networks. While a number of researcher project's have shown the importance of inter-bulbar and inter-lobar inhibitory networks for the shaping and processing of olfactory information, it is not clear how exactly these inhibitory networks are organized in order to provide optimal filtering and contrast enhancement capabilities. Using a computational model of the honeybee antennal lobe, we here show that among other possibilities, a functionally inhibitory network, in which glomeruli inhibit each other proportionally to the similarity in their olfactory response profiles best reproduces the experimentally observed input-output function.

225 (M07)

A theoretical computer model of cellular modification associated with olfactory learning in the rat piriform cortex

G. Gradwohl and Y. Grossman
Ben- Gurion University

Learning associated cellular modifications were previously studied experimentally in the rat piriform cortex after operand conditioning. The action potential AHP in trained rats was reduced and paradoxically depressed EPSP amplitude more effectively than in "pseudotrained" and "naive" rats (control groups). The aim of the computer model was to explain this paradox by simulating the AHP amplitude reduction. Moving the synaptic input distally from the soma enhanced EPSP depression by the AHP conductance. Hence, the learning process could be simulated by a jump from the control curve to any curve representing decreased AHP amplitude with an additional distally shifted EPSP input.

226 (M08)

Statistical method for detection of firing rate changes in spontaneously active neurons

Blejec Andrej
National Institute of Biology

We present a simple statistical method for detection and identification of firing rate changes in spontaneously active neurons. Spontaneously active neurons (such as olfactory neurons) can be, in response to stimulation, either excited or suppressed and thus increase or decrease the spike firing rate. The described method, here called Cumulative Slope Analysis, is based on the detection of changes in slope of cumulative spike time distribution and efficiently detects excitations and suppressions. Using the simulated spike trains we examined the methods Type I error and power in relation to recorded number of spikes, response strength and duration.

227 (M09)

Oscillatory dynamics of olfactory structures in response to predator and non-predator odors

Catherine A. Lowry Leslie M. Kay
University of Chicago

Examination of the functional roles of oscillatory activity in mammalian olfactory systems is necessary to understanding the processing of olfactory information. In this study, male rats were implanted with electrodes in the olfactory bulb (OB) and exposed to a panel of odors in while local field potential was recorded in an enclosed chamber. Odors included natural and synthetic predator odors, conspecific urines, food odors, and several monomolecular chemicals. Oscillatory activity in the theta, beta, and high gamma frequency bands in the OB during exposure and habituation to these varied odorants is characterized and related to spontaneous odor-elicited behavioral states.

228 (M10)

A Possible Mechanism of Curvature Coding in Early Vision

Rodrigo F. Oliveira, Luciano da Fontoura Costa, Antonio C. Roque
USP

This paper addresses the issue of curvature coding in the mammalian visual system. Considering the successful account of cortical neurons as detectors of features of visual stimuli like orientation, spatial frequency among others, we discuss the role of curvature in visual processes, review some previous investigations on curvature and present a possible biologically plausible model of curvature detection. This model requires only orientation selective neurons (simple cells) and short-range connections, both known and well documented features of the mammalian primary visual cortex. The dependence of the model on different parameters is explored and discussed.

229 (M11)

More dark information in natural scenes requires denser mosaics of OFF ganglion cells

Charles Raliff, Peter Sterling, Vijay Balasubramanian
University of Pennsylvania

The structure and receptive field properties of retinal ganglion cells should reflect statistical properties of the visual world. OFF ganglion cells (which process dark regions in a scene) are smaller and more densely distributed than ON ganglion cells (which process bright regions). Measuring from photographs of natural scenes, we find an excess of dark patches over light patches over a range of spatial scales. This suggests a need for more OFF cells than ON cells. We also quantify the redundancy of information in natural scenes and in ON and OFF channels separately.

230 (M12)

Salience of Orientation-Filter Responses as Suspicious Coincidence in Natural Images

Subramonia Sarma, Yoonsuck Choe
Texas A&M University

Visual cortical neurons have receptive fields resembling oriented bandpass filters, and their response distributions on natural images are non-Gaussian. Inspired by this, we previously showed that comparing the response distribution to a normal distribution with the same variance gives a good thresholding criterion for detecting salient levels of edginess in images. However, the question why the comparison to a normal distribution can be so effective was not fully answered. In this paper, we approach this issue under the general framework of suspicious coincidence proposed by Barlow. It turns out that salience defined our way can be understood as a deviation from the unsuspicious baseline. Further, we show that the response threshold directly calculated from the white-noise based distribution closely matches that of humans, providing further support for the analysis.

231 (M13)

Features That Draw Visual Attention   An Information Theoretic Perspective

Neil D. B. Bruce
York University

A novel image operator is proposed for the purpose of predicting the focus of visual attention in arbitrary natural scenes based on local statistics. The proposed method is based on the hypothetical premise that attention proceeds by way of sampling a scene in a manner that maximizes the information acquired from the scene. A tractable means of computing the joint likelihood of local statistics in a low-dimensional space is presented and shown to have a close relationship to the representation of retinal image stimulus existing in the primary visual cortex of primates.

232 (M14)

Encoding of Dynamic Visual Stimuli by Primate Area MT Neurons

Heiko Stemmann, Winrich A. Freiwald, Aurel Wannig, Erich L. Schulzke, Christian W. Eurich
Bremen University

Neural tuning properties are known to be adaptive on various time scales and are probably optimized to represent real-world stimuli. Here we study directional tuning in MT neurons in awake monkeys during presentation of motion stimuli with two different dynamical behaviors a random sequence of movement directions and a random walk. Most MT neurons with significant direction tuning show characteristic tuning differences in the two stimulus conditions whereas neurons un-tuned in either condition do not significantly change their statistical properties. We suggest that MT neurons undergo a rapid adaptation to stimulus statistics, thus allowing for an optimal signal processing.

233 (M15)

Detection of Video Inputs Using the WUNG Model

Wenxue Wang Bijoy K. Ghosh
Washington University

The visual cortex of a freshwater turtle, when stimulated by a pattern of light, produces waves of activity that have been recorded experimentally and simulated using a model cortex. It is believed that these activity waves encode features of the visual scene, viz. position and velocity of targets. The goal of this paper is to test detectability of video inputs using the activity pattern in the modified noise model cortex containing subpial cells. We consider five natural video scenes and represent them using sparse, over-complete set of basis functions. The associated coefficients are KL-decomposed to provide appropriate inputs to the cortex. Finally, the cortical response has been displayed as a spatiotemporal signal. The paper concludes with detection of the natural visual inputs using the noise WUNG model.

234 (M16)

Recognition of Temporal Event Sequences by a Network of Cortical Neurons

Maciej T. Lazarewicz, Sandhitsu Das, Leif H. Finkel
University of Pennsylvania

Recognition of ordered sequences of temporal events is central to many perceptual recognition tasks, from speech detection to analysis of biological motion. We describe a simple cortical network capable of recognizing event sequences through a process of encoding followed by detection. The network is composed of regular spiking and fast spiking neurons, with minimal connectivity. Ordered sequences of inputs occurring over tens-to-hundreds of milliseconds, are time-compressed by the network into tightly clustered spike outputs occurring over a few milliseconds. We investigate the ability of the network to accurately encode the input pattern, in the presence or absence of noise. We show that information about relative input timings are preserved in the output interspike intervals.

235 (M17)

Activity Affects Trace Conditioning Performance in a Minimal Hippocampal Model

David W. Sullivan and William B Levy
University of Virginia Health System

Using a minimal hippocampal model, previous studies simulating trace conditioning have reproduced the empirically observed learnable trace interval and reproduced the number of training trials required for learning. However, these earlier studies did not address the effects of parameterization on performance. Here, we demonstrate a robust effect of average activity on trace conditioning performance.

236 (M18)

Reduced Kinetic Schemes of Short-term Synaptic Plasticity in Inhibitory Network Models

Peter A. Murray and Frances K. Skinner
University of Toronto

GABAergic, inhibitory interneurons are critical controllers of brain rhythms. Short-term synaptic plasticity affects neuronal network dynamics that give rise to these rhythms. We incorporated a three-state phenomenological kinetic scheme that describes synaptic depression into inhibitory network simulations. We developed a protocol to fit the phenomenological scheme to a more complex six-state kinetic scheme. We are able to capture the network dynamics using our reduced" simpler scheme as compared with using the more complex scheme. Using such simpler schemes, we will be able to explore the effects of short-term depressions as described by more complex kinetic schemes on network dynamics.

237 (M19)

Bridging single cell and network dynamics

Theoden I. Netoff, Jonh A. White
Boston University

The dynamics of networks can be predicted from the dynamics of the neurons and their connections. To better understand the dynamics of small networks of neurons, we measure the dynamics of stellate cells in the entorhinal cortex, estimated with a spike time response curve (STRC), and then couple them thorough a dynamic clamp. Using our dynamical description of the neurons, we can simulate the network and compare it to the network of real neurons. We find that the STRC can capture the essential dynamics of the neurons and can successfully simulate the network behaviors.

238 (M20)

Stochastic model of calcium initiated reactions in a dendritic spine

W.R. Holmes S. Zeng
Ohio University

Both experimental and theoretical studies suggest that calcium-calmodulin dependent kinase II (CaMKII) can act as a bistable switch because of its autophosphorylation properties. However, these studies either do not use physiological calcium signals or do not consider the switch-like behavior within the context of an actual dendritic spine. We have developed a model that includes stochastic NMDA channel openings to provide calcium entry to a spine. Calcium diffusion and reaction with calmodulin and subsequent activation of CaMKII are all modeled stochastically. We find that CaMKII activation can be highly sensitive to stochastic variations and small changes in the number of NMDA receptors, even for moderately low frequency stimulation.

239 (M21)

Performance and olfactory-hippocampal theta band coherence

Leslie M. Kay
University of Chicago

We show significant coherence between olfactory bulb (OB) and hippocampal (HPC) theta oscillations during odor sniffing at the sniffing frequency (7-12 Hz). Coherence magnitude is positively correlated with performance in short trial blocks lasting about 10 minutes and is dependent on the two odor condition. During odor sniffing entorhinal theta coherence with OB and HPC is dramatically decreased. During contingency reversal training, initial reversal of the former CS- to CS+ (one odor condition) produces a negative correlation between OB-HPC coherence and performance, while subsequent performance of the new two odor task in the same session produces a strong positive correlation.

240 (M22)

Dendritic spiking accounts for rate and phase coding in a biophysical model of a hippocampal place cell

Zsofia Huhn, Gergo Orban, Mate Lengyel, Peter Erdi
KFKI R.I.P.N.P., Hungarian Academy of Sciences

Hippocampal place cells provide prototypical examples of neurons firing jointly phase and rate coded spike trains. We propose a biophysical mechanism accounting for the generation of place cell firing at the single neuron level. An interplay between external theta-modulated excitation impinging the dendrite and intrinsic dendritic spiking as well as between frequency modulated dendritic spiking and periodic somatic hyperpolarization was a key element of the model. Through these interactions robust phase and rate coded firing emerged in the model place cell, reproducing salient experimentally observed properties of place cell firing.

241 (M23)

Epilepsy in Small-World Networks

Theoden I. Netoff, Robert Clewley, Scott Arno, Tara Keck, John A. White
Boston University

In hippocampal slice models of epilepsy, two behaviors are seen short bursts of electrical activity lasting 100 ms, and seizure-like electrical activity lasting seconds. The bursts originate from the CA3 region, where there is a high degree of recurrent excitatory connections. Seizures originate from CA1 where there are fewer recurrent connections (if the connections between CA3 and CA1 are cut). We simulated networks of excitatory neurons, connected in a ring having small-world network connectivity. By changing physiological and network parameters, we induced normal, seizing, and bursting behaviors. A simple mathematical description explains how parameter changes cause transitions between these behaviors.

242 (M24)

Theta rhythm during passive whole body rotation is absent in phospholipase1 knockout mice

Jonghan Shin, Daesoo Kim, and Hee-Sup Shin
Korea Institute of Science & Technology

To clarify issues related to mechanisms underlying theta generation and functional significance, we investigated the interrelationship between behavioral states and theta rhythms in phospholipase C-1 knockout mice. Here we show that 1) theta rhythm from PLC1-/- mice was generated during wheel running but the power of theta rhythm was reduced compared to wild littermates; and 2) PLC1-/- mice did not show theta rhythm during passive whole body rotation while wild littermates generate theta rhythm during passive rotation. We will discuss how theta rhythm absent during passive whole body rotation in phospholipase1 knockout mice can be related to spatial disorientation behavior.

243 (M25)

Dynamical evolution of neuronal interactions during in vitro seizures

J. Ziburkus J.R. Cressman E. Barreto S.J. Schiff
george mason universtiy

We describe neuronal interaction and synchrony levels in both the subthreshold (synaptic currents) and suprathreshold (spiking) events among pyramidal-pyramidal, pyramidal-interneuron, and interneuron-interneuron cell pairs during in vitro 4-aminopyridine seizures. Simultaneous dual and triple whole-cell patch clamps were performed in rat hippocampal CA1 slices. Cell classes were identified by membrane firing properties and biocytin morphology. We found that synchronization during seizures can be qualitatively different when calculated from synaptic currents (cell inputs) versus spike correlations (cell outputs). Furthermore, the interactions between different neuronal types in seizures were complex and cannot, e.g., be simply described or modeled by an increase in synchrony.

244 (M26)

Effect of Dendritic Backpropagating Action Potential on Neural Interaction

Toru Aonishi Hiroyoshi Miyakawa Masashi Inoue Masato Okada
RIKEN

We elucidate the effect of dendritic backpropagating action potentials on neural interactions. First, we reduce a solvable oscillator model with passive dendrites to phase description. We show that backpropagating action potentials change the stability structure of the system from monostable to bistable. Next, we obtain phase response curves of a model hippocampal pyramidal neuron with realistic morphology and electroresponsiveness by running a compartmental simulator NEURON. We demonstrate that this realistic model also has such bistability; furthermore, A-type K channels in the dendrite facilitate the bistability.

245 (M27)

Neural Kalman-filter

Gabor Szirtes, Barnabas Poczos and Andras Lorincz
Eotvos Lorand University

Anticipating future events is a crucial function of the central nervous system and can be modelled by Kalman-filter like mechanisms which are optimal for predicting linear dynamical systems. Connectionist representation of such mechanisms with Hebbian learning rules has not yet been derived. We show that the recursive prediction error method offers a solution that can be mapped onto the entorhinal-hippocampal loop in a biologically plausible way. Model predictions are provided.

246 (M28)

Characterizing in vitro Hippocampal Ripples using Time-Frequency Analysis

J.A. Gillis; W.P. Luk; L. Zhang; F.K. Skinner
University of Toronto

We analyze in vitro hippocampal activity exhibiting drug induced ripple-like rhythms using time-frequency distributions. The different tradeoffs between time-frequency resolution, interference, and range are examined with reference to the suitability of each for use in analyzing ripple data. An unbiased approach is taken to characterizing ripple rhythms uniquely by determining the parameter choices in which its behaviour is most distinct from baseline activity. Mixture distribution analysis of the two components generated from correlating frequency behaviour allows a clear method for determining the distinctiveness of ripple-like rhythms given a particular parameter choice. These parameters thus serve to characterize hippocampal ripples.

248 (M29)

Modeling Morphologic Contributions to Age-Related Alterations in Neuronal Excitability

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Normal brain aging in primates is characterized by a progressive decline in working memory, mediated largely by the prefrontal cortex (PFC). Morphometric studies have shown significant age-related decreases in the extent of dendritic arborization and spine densities in pyramidal neurons from layer III macaque monkey PFC. Recent electrophysiological studies in pyramidal neurons of similar origin show increased action potential firing rates with age. Using compartment models from 3D reconstructed, electrophysiologically characterized layer III pyramidal neurons from young and aged monkeys, we demonstrate how altered dendritic branching, tapering and spine densities may account for the observed increases in neuronal excitability.

249 (M30)

A biophysical model of graded persistent activity in a single neuron

Mauktik Kulkarni, Kechen Zhang
Johns Hopkins University

Neurons in various brain regions demonstrate graded persistent activity. This phenomenon may involve single neurons, as suggested by a recent electrophysiological study of entorhinal cortical neurons that exhibited graded persistent activity after blocking all synaptic transmissions. This activity appears to depend on a particular calcium-dependent non-specific cationic channel. Single neuron models of persistent activity have been studied by modeling calcium wavefronts1 or by hysteresis in the cationic current activation2. We propose a Hodgkin-Huxley type model, based on high-threshold calcium channels and calcium-dependent non-specific cationic channels, that exhibits sustained firing activity controllable by transient external input. Figure 1 shows the response of the model to depolarizing and hyperpolarizing external current pulses of various magnitudes. The dynamics of influx and decay of intracellular calcium allow its concentration to act as a short-term memory that integrates the external input.

250 (M31)

The Role of NMDA Currents in State Transitions of the Medium Spiny Neuron in a Network Model of the Nucleus Accumbens

John A. Wolf, Jason T. Moyer, Leif H. Finkel
University of Pennsylvania

The Nucleus Accumbens (NAcb) integrates information from a wide range of glutamatergic afferent inputs, including the prefrontal cortex, hippocampus and amygdala. One of the glutamatergic receptors, the NMDA channel, has been implicated in the non-linearity of the current-voltage relationship in these cells under certain input conditions. In order to examine the relationship of the different glutamatergic receptors to the membrane response, we modeled the AMPA, GABA and NMDA receptors in the Medium Spiny (MSP) cells and their afferent input. The model demonstrates that the NMDA current is capable of sustaining certain membrane states and contributes to the non-linearity of the membrane response to input.

251 (M32)

Unifying memory for associations and lists using cognitive theory, behavioural testing and brain activity

Jeremy B. Caplan, Mackenzie Glaholt, Terence W. Picton and Anthony R. McIntosh
Baycrest Centre

Behavioural, physiological and connectionist models of paired associates learning (PAL) and serial learning (SL) comprise two classes those that treat PAL and SL memory as distinct and those that unify them within a common theoretical framework. We evaluate and constrain these two cases. Using behavioural models and simulations, we show how one can implement both tasks with identical mechanisms and nonetheless reproduce behavioural dissociations. We provide further support for predictions of these unifying models with cued recall behaviour for word pairs and triples. Finally, electroencephalographic recordings reveal common mechanisms as well as some different cognitive processes correlated with test accuracy.

252 (M33)

Synaptic Depression Enlarges Basin of Attraction

Narihisa Matsumoto, Daisuke Ide, Masataka Watanabe, Masato Okada
RIKEN Brain Science Institute

Neurophysiological experiments show that synaptic depression controls a gain for presynaptic inputs. However, it remains a controversial issue what are functional roles of this gain control. We propose that one of the functional roles is to enlarge basins of attraction. To verify this, we employ an associative memory model. An activity control is requisite for the stable retrieval of sparse patterns. We investigate a storage capacity and the basins of attraction. Consequently, the basins of attraction are enlarged while the storage capacity does not change. Thus, the synaptic depression might incorporate the activity control mechanism.

253 (M34)

Parametric study of dopaminergic neuromodulatory effect in a reduced model of the prefrontal cortex

Koki Yamashita, Shoji Tanaka
Sophia University

A reduced model is constructed to explore the essential nature of dopaminergic modulation in the prefrontal cortex. The model network comprises excitatory and inhibitory units. It includes potentiation of the excitatory transmission and prolongation of the time constant of the inhibitory unit as the dopaminergic effect. Results indicate that the tonic activity of the model units shows an inverted U-shape property. Additional parametric analysis has shown that blocking the dopaminergic effects eliminates this property. In conclusion, the reduced model provides a theoretical explanation of the mechanisms for the inverted U-shaped modulation in the prefrontal cortex via D1 receptor activation.   Keywords Dopamine; Inverted U-shape property; prefrontal cortex; Working memory

254 (M35)

Estimation of nonlinearities to storage capacity of nn by alternative mft

Algis Garliauskas
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ESTIMATION OF NONLINEARITIES TO STORAGE CAPACITY OF NN BY ALTERNATIVE MFT Algis Garliauskas Institute of Mathematics & Informatics Akademijos 4, 2600, Vilnius, Lithuania E-mail galgis@ktl.mii.lt In the paper, the more realistic neuronal soma and synaptic nonlinear relations and an alternative mean field theory (MFT) approach relevant for strongly interconnected systems as a cortical matter are considered. The general procedure of averaging of the quenched random states in the fully-connected networks for MFT, as usually, is based on the Boltzmann Machine learning. But this approach requires an unrealistically large number of samples to provide a reliable performance. We suppose an alternative MFT with instead of stochastic nature of search a solution a set of large number equations with deterministic features. Of course, this alternative theory will not be strictly valid for infinite number of elements. Another property of generalization is an inclusion of the additional member in the effective Hamiltonian allowing to improve the stochastic hill-climbing search of the solution not dropping into local minimum of the energy function. Especially, we pay an attention to increasing of neural networks retrieval capability transforming the replica-symmetry model by including of different nonlinear elements. Some results of experimental modeling as well as the wide discussion of neural systems storage capacity are presented.

255 (M36)

State-dependent alteration of dopamine and glutamate transmission in the prefrontal cortex by psychostimulants

Shoji Tanaka
Sophia University

In spite of accumulating evidence for dopaminergic contribution to cognitive functions, the mechanism how cortical dopamine (DA) level is controlled is still obscure. To investigate the mechanisms of intracortical DA level control, this article investigates the dynamics of the prefronto-mesoprefrontal system under the influence of DA. The fundamental assumption of this model is closed-loop circuitry between the prefrontal cortex (PFC) and midbrain DA nuclei. This study suggests that the system forms a regulator with peculiar characteristics. These characteristics would be responsible for differential responses to psychostimulants and may be critically relevant to negative symptoms and cognitive deficits in schizophrenia.

256 (M37)

A Novel Monte-Carlo Simulation of Molecular Interaction and Diffusion in Postsynaptic Spine

Yoshihisa Kubota, Tara R. Gaertner, John A. Putkey and M. Neal Waxham
University of Texas Medical School

We developed a new Monte Carlo simulator incorporating molecular interactions and diffusion of Ca^{2+} signaling molecules in dendritic spines. The simulator is based on two well-established

Monte Carlo approaches, namely the Kopelman algorithm and the Kinetic Monte Carlo algorithm. This paper describes the simulator in detail and compares it against ODE models of classical enzyme kinetics. We then explore anomalous diffusion and molecular interactions of CaM molecules in the dendrite. The simulations suggest that the CaM-binding protein RC3 plays a significant role in determining spatio-temporal dynamics of CaM-target interaction during Ca2+ oscillations.

257 (M38)

An Autocatalytic Model of STDP Timing from Slow Calcium Signals

Anders Sandberg, Erik Fransen
Royal Institute of Technology

Spike timing dependent plasticity (STDP) shows a sharp temporal transition between potentiation and depression despite a slow timecourse of calcium concentration. We show how autocatalytic amplification of initial concentration differences can enable a high degree of temporal selectivity despite having a longer time constant than the time difference measured, and produce the sharp STDP weight change curve. This simple model is robust to parameter changes, noise and details of the model. The model predicts the location of the maximum and minimum for STDP at \pm10 milliseconds from coincidence.

258 (M39)

Roles of the prefrontal neurons in delayed matching-to-category task A modeling study

Tetsuto Minami Toshio Inui
NICT

In understanding the environment around us, we do not perceive our exact sensory input as is. Instead, we divide the world into meaningful groups or categories. This categorization function is fundamental to cognitive processes. Such categories are processed in brain areas such as the inferior temporal cortex (ITC) and prefrontal cortex (PFC). To clarify the fundamental neuronal mechanisms involved in category information, we simulated the delayed matching-to-category task in Freedman et al. (2001) and showed that category selectivity in the PFC reflected the interaction between the selectivity of complex stimuli in the ITC and task-dependency in the motor area.

259 (M40)

Multiplicative gain modulation for linear and non-linear inputs

Volker Steuber and R. Angus Silver
University College London

Multiplicative gain modulations alter the sensitivity of a neuron to changes in its inputs. Although such gain modulations are thought to play an important role for neuronal information processing, the mechanisms by which they occur are not fully understood. It has been suggested that gain can be modulated by balanced changes in background excitation and inhibition, or by excitation and inhibition alone if the mapping between input and subthreshold voltage is non-linear. Here we show that multiplicative gain changes can also occur in the presence of linear inputs and constant noise and investigate the effect of different non-linearities.

260 (M41)

On the Variability of Cortical Neural Responses A Statistical Interpretation

Sheng Li Si Wu
University of Sussex

Neural responses in the cerebral cortex exhibit tremendous variability. Understanding the origin and the functional meaning of this variability is of critical importance for our understanding of neural coding. The present study investigates the neural response variability from the view of statistical inference. We show that high variability can also arise due to the inferential sensitivity in neural coding. More precisely, it is the overlap between neuronal receptive fields that account for this sensitivity. The overlapping, however, is unavoidable due to that the neural estimator needs to extract the smooth structure of stimulus. This view is support by the simulation on the encoding of nature images.

261 (M42)

Computing with Inter-spike Interval Codes in Networks of Integrate and Fire Neurons

Dileep George, Friedrich T. Sommer
Stanford University

Information encoding in spikes and computations performed by spiking neurons are two sides of the same coin and should be consistent with each other. This study uses this consistency requirement to derive some new results for Inter-spike Interval (ISI) coding in networks of Integrate and Fire (IF) neurons. Our analysis shows that such a model can carry out useful computations and that it does also account for variability in spike timing as observed in cortical neurons. Our general result is that IF type neurons, though highly non-linear, perform a simple linear weighted sum operation of ISI coded quantities. Further we can derive bounds on the variation of ISIs that occur in the model although the neurons are deterministic. We also derive useful estimates of the maximum processing speed in a hierarchical network

262 (M43)

Dynamical Response Properties of a Canonical Model for Type-I Membranes

Bjrn Naundorf, Theo Geisel, Fred Wolf
Max-Planck Institute fuer Stroemungsforschung

We study a canonical model of type-I membranes subject to a correlated fluctuating input currents. We present a semi-analytical approach for calculating the response of this neuron model to time dependent inputs both in the input current and the noise amplitude using a novel sparse matrix representation of the systems Fokker-Planck operator. It turns out, that the maximum stimulation frequency which can be transmitted through this model neuron is approximately given by the stationary firing rate. Our results agree well with the behavior of a conductance-based model-neuron but are in qualitative disagreement with key response properties of leaky integrate-and-fire neurons.

263 (M44)

Examining methods for estimating mutual information in spiking neural systems

Christopher J. Rozell and Don H. Johnson
Rice University

Mutual information enjoys wide use in the computational neuroscience community for analyzing spiking neural systems. Its direct calculation is difficult because estimating the joint stimulus-response distribution requires a prohibitive amount of data. Consequently, several techniques have appeared for bounding mutual information that rely on less data. We examine two upper bound techniques and find that they are either unreliable or introduce strong assumptions about the neural code. We also examine two lower bounds, showing that they can be very loose and possibly bear little relation to the mutual information's actual value.

264 (M45)

Signal Size Detection by Noisy Neurons

Go ASHIDA
Kyoto University

Signal transmission ability of stochastic model neurons is examined. Neurons with finite number of Markov ion channels are modeled and their input-output relationship are recorded. Based on the formulae obtained, reconstruction of unknown inputs from the output sequence of a neuronal population is carried out. The back-estimation shows a very good agreement with the actual input, and then it is concluded that a stochastic neuronal population can detect not only the signal timing but also the signal size.

265 (M46)

The Role of Colored Noise in Pulse Detection, a leaky Integrate-and-Fire Model Study

Gregor Wenning, Thomas Hoch, Klaus Obermayer
TU Berlin

The membrane potential of a typical cortical neuron is strongly fluctuating as a consequence of many intrinsically noisy inputs. Measurements and modeling studies suggest that this noise is colored, i.e. correlated in time. Neural information transmission and processing is based upon transient inputs. In this modeling study we investigate the detection of transient inputs, modeled as pulses, in a leaky-integrate-and-fire neuron subject to colored noise. We find that (colored) noise facillitates the detection of weak pulses. Given a certain variance of the membrane potential colored noise makes pulse detection more robust, for any pulse intensity, compared to white noise.

266 (M47)

Existence of stable states of stochastic dynamics in a model of neocortex

Kousuke Abe

We investigate stochastic dynamics of a spatially structured model of neocortex, which consists of numerous spiking neurons, both excitatory and inhibitory, interacting through a large number of synaptic connections. Analyzing sub-threshold voltage activity and recurrent input, we show the existence of stable basins of the dynamics which are independent of trials but dependent on the intensity of the Poisson external input and the connection structures of the network. Correspondences to experiments using voltage sensitive dye imaging are also discussed.

267 (M48)

Dynamics of a small network of spiking neurons

Michael Stich and Manuel G. Velarde
Universidad Complutense de Madrid

We investigate the dynamics of a small network of spiking neurons and present numerical results for different neuron models. The structure of the network is motivied by models of Central Pattern Generators and contains excitatory and inhibitory connections among the neurons. Our focus lies on the dependence of the temporal dynamics of a given output neuron on the input of the network. The effect of noise on the behavior of the system is discussed.

268 (M49)

Temporal Dynamics of Three Populations of Inhibitory Interneurons in Turtle Visual Cortex

Clay Campaigne and Philip Ulinski
University of Chicago

Visual stimuli evoke waves of electrical activity that propagate across the visual cortex of freshwater turtles. The experimental methods used to demonstrate these waves measure the activity of populations of pyramidal cells. However, turtle visual cortex contains at least three populations of inhibitory interneurons. This study uses a large-scale model to characterize the time course of activity in subpial, stellate, and horizontal cells. Their activities are consistent with the hypothesis that subpial cells are involved in feedforward inhibition of pyramidal cells, horizontal cells mediate feedback inhibition and stellate cells are involved in both feedforward and feedback inhibition.

269 (M50)

Multi-packet regions in stabilized continuous attractor networks

Thomas P. Trappenberg and Dominic I. Standage
Dalhousie University

Continuous attractor neural networks are recurrent networks with center-surround interaction profiles which are common ingredients in many neuroscientific models. The basic CANN model is often augmented with mechanisms reflecting activity-dependent cellular nonlinearities. In this paper, we study the balance between global competition and the stabilizing effects of cellular nonlinearities, and derive the transitions between regions in the network parameter space with different numbers of stable activity packets.

270 (M51)

The Effect of Modulatory Neuronal Input on Gastric Mill Frequency

Christina Ambrosio, Amitabha Bose, Farzan Nadim
New Jersey Institute of Technology

We study the crustacean stomatogastric nervous system to gain insight in the interaction of oscillators of different intrinsic frequencies. We show how fast inhibition from the pyloric network interacts with a slow modulatory input to control the frequency of the gastric mill rhythm. We deduce that the timing of the pyloric input is crucial in determining what affect it will have on the frequency of the gastric network. Over one set of timings, the modulatory input and the pyloric input work together to determine the frequency and over another set of timings, the affect of the pyloric input is mitigated by the modulatory input.

271 (M52)

Dynamically Adjustable Contrast Enhancement from Cortical Background Activity

Hamish Meffin, Anthony N. Burkitt, David B. Grayden
Bionic Ear Institute

An experimentally supported model of cortical background activity is used to investigate the role of such activity in neural gain control. The model demonstrates the feasibility of a scheme for contrast enhancement where by the overall intensity of an input pattern adjusts the dynamic range of a neuron such that it remains sensitive to contrast over a wide range of overall intensities.

272 (M53)

Noise induced structures in STDP networks

Gabor Szirtes, Zsolt Palotai and Andras Lorincz
Eotvos Lorand University

In this paper we study the emergent structures in networks with spike-timing dependent synaptic plasticity that are subject to external noise. We show that scale-free small-worlds can emerge in such noise driven Hebbian networks. This may explain the interplay between noise and Hebbian plasticity. We also argue that this model can be seen as a unification of the Watts-Strogatz and preferential attachment models of scale-free small-worlds.

273 (M54)

Motion Detection in Hexagonal Arrays of Insect Ommatidia

David C. Tam, Ph.D.
University of North Texas

The photodetecting elements of the insect compound eyes (ommatidia) are often arranged in hexagonal arrays. We will show this hexagonal arrangement provides a computational efficient symmetric geometry for visual signal processing without needing for high-level processing. The geometric symmetry also allows additional computational efficiency for not only detecting visual gradients, but also movement velocity of visual objects. We proposed a computational model of a simplified circuitry for efficient processing of visual signals by neighboring cells that can be used to detect both visual gradients and motion detection with a flight escape reflex circuitry using a trigger threshold for critical motion velocity detection.

274 (M55)

Spike-Timing Patterns in Cortical Neural Networks With Axonal Conduction Delays

Eugene M. Izhikevich, Joseph A. Gally, Gerald M. Edelman

In the mammalian neocortex, pyramidal neurons often project to distant regions resulting in axonal conduction delays of tens of milliseconds. Synchronous spiking of such neurons may not be effective to fire a postsynaptic cell, since the spikes might arrive to the postsynaptic cell at drastically different times. To excite the cell, the presynaptic neurons must fire with certain spike-timing patterns determined by the delays. Simulating a network of neocortical neurons with conduction delays and STDP, we found that spiking neurons spontaneously self-organized into groups and fire such repetitive spike-timing patterns with a millisecond precision. We found more groups than neurons.

275 (M56)

The effect of NMDA receptors on gain modulation in cerebellar granule cells

M.R.Berends, R. Maex, E. De Schutter
University of Antwerp

The bandwidth for divisive gain modulation by shunting inhibition in cerebellar granule cells is restricted by NMDA-receptor mediated currents. The amount of modulation of high frequency mossy fiber rates is significantly reduced. This effect is mainly caused by the increased current flow into the cell, and not due to a reduced variability in the input current

276 (M57)

Evaluation of the inverse dynamic model in cerebellum during visual-vestibular interactions at different VOR gains in squirrel monkeys

Yutaka Hirata, Akimasa Yoshikawa, Pablo M. Blazquez, Stephen M. Highstein
Chubu University

Generality of the cerebellar inverse dynamic model (IDM) theory was evaluated in oculomotor control in squirrel monkeys. Flocculus Purkinje cell firing patterns recorded during visual, vestibular and their interaction paradigms at various VOR gains were reconstructed by the IDM consisting of the linear combination of eye position, velocity, and acceleration. The IDM could successfully reconstruct more than 72 % of the firing patterns of 138 cells, but with different sets of parameters for different paradigms and different VOR gains. This result suggests that the output of the flocculus relates to motor output, but not the motor command per se.

277 (M58)

Discrete Corrective Submovements in the Monkey   Predictive Control under Uncertainty

A. Fishbach, S.A. Roy, C. Bastianen, L.E. Miller, J.C. Houk
Northwestern University

Two macaque monkeys were trained to turn a knob rapidly and accurately to align a cursor to a target that was randomly perturbed at movement onset. Decomposing the movements into primary plus one or more corrective submovements, often overlapping the primary, demonstrates that under uncertainty the monkeys tend to initially undershoot the target. The latency of the ensuing corrective submovement, which often started before the primary movement ended, was correlated with the expected error of the primary movement. These findings support a stochastic predictive control mechanism and set the stage for single unit studies of predictive control in the monkey.

278 (M59)

Modeling Motoneurons after Spinal Cord Injury Persistent Inward Currents and Plateau Potentials

Joe Graham Victoria Booth Ranu Jung
Arizona Biodesign Institute, ASU

A single-compartment conductance-based computational model to mimic the behavior of rat tail motoneurons after acute and chronic spinal cord injury (SCI) was developed. The model includes a calcium dependent potassium current, IK(Ca), that contributes to afterhyperpolarizations. In the chronic SCI model, the presence of sodium and calcium persistent inward currents (PICs) causes plateau potentials resulting in prolonged self-sustained firing. The interaction between the calcium PIC and IK(Ca) affects the magnitude and duration of plateau potentials as well as the hysteresis seen during injected current ramps. The model responses mimic experimental observations and may explain the spasticity observed after chronic SCI.

279 (M60)

The role of background synaptic noise in striatal fast spiking interneurons

Jeanette Hellgren Kotaleski Dietmar Plenz Kim T Blackwell
Royal Institute of Technology

Striatal fast spiking (FS) interneurons provide inhibition to each other as well as to medium spiny projection (SP) neurons. They exhibit Up-states synchronuously with SP neurons, and receive both GABAergic and AMPA synaptic input during both Up- and Down-states. The synaptic input during Down-states can be considered as noise and might affect signal detection. We investigate what role this background noise might play for Up-state firing in FS neurons. We investigate this in a 127 compartments FS model neuron, with Na, KDr and KA conductances, and activated through AMPA and GABA synapses. The model neuron is well constrained by experimental data.

280 (M61)

Movement Direction Decoding using Fast Oscillation in Local Field Potential and Neural Firing during Instructed Delay in a Center-Out Reaching Task

Wei Wu, Wilson Truccolo, Maryam Saleh, David Mumford, John P. Donoghue
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We explore the fast oscillation (15-33Hz) of Local Field Potential (LFP) and firing patterns of single units in motor cortex with respect to a monkey's hand-movement direction. Our work examined, during the instructed delay period, various approaches to couple the LFP and firing rates to the encoding of movement direction by counting the number of spikes per unit time within different phases of fast oscillation of the LFP. We found that the coupled rates within certain phases have higher (though not statistically significant) decoding accuracy than the rates over the whole instructed delay period which was reported in previous work.

281 (M62)

Adaptive Decoding of Hand Movement Trajectories from Simulated Spike Train Observations from a Dynamic Ensemble of Motor Cortical Neurons

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Harvard-MIT

One of the many challenges in long-term decoding from chronically implanted electrodes involves tracking changes in the firing properties of the neural ensemble while simultaneously reconstructing the desired signal [1]. We offer an approach to dealing with this problem based on adaptive point process filtering. In particular, we construct a lock-step adaptive filter built upon stochastic models for a) the receptive field parameters of individual neurons within the ensemble, b) the biological signal to be reconstructed, and c) the instantaneous likelihood of firing in each neuron given the current state of a) and b). We assess the ability of this filter to maintain a good representation of movement information in a simulated ensemble of primary motor neurons tuned to hand kinematics.

282 (M63)

Stability criterion for a two-neuron reciprocally coupled network based on the phase and burst resetting curves

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Experimental and theoretical studies have shown that the amount of phase resetting produced in a neural oscillator by a synaptic input depends not only on the stimulus timing (phase), but also on its intensity and duration. To eliminate the influence of the stimulus intensity on the amount of the phase resetting we studied only strong synaptic couplings. We defined the burst resetting curve (BRC) as the change in burst duration in response to an input at various phases in the open loop condition. We combined the newly defined BRC with the phase resetting curve (PRC) to derive a stability criterion for a two-neuron network of bursting neurons.

283 (M64)

Normal and Parkinsonian Control of Motor Programs in Pallidal and Subthalamic Networks of Basal Ganglia

Leonid L. Rubchinsky, Nancy Kopell, Karen A. Sigvardt
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Modeling of the Basal Ganglia (BG) role in motor control requires a study of how BG networks respond to cortical input to influence thalamocortical circuits responsible for motor control. This report presents biophysically-based model of BG motor control circuitry. Our model is constructed within an experimentally motivated theory in which the BG are hypothesized to facilitate the motor programs to be executed, and inhibit motor programs that may interfere with the ongoing movement. The model network consists of subthalamic and pallidal neural assemblies, with inputs from cortex and striatum, which correspond to the desired motor program and the unwanted motor programs. The modeling allowed for the identification of those biologically-relevant modifications of the network (both in cellular properties and circuitry), that can be responsible for the slowness of movement in Parkinsons disease.

284 (M65)

Neural activity changes in Supplementary Motor Area induced by dopaminergic treatment in parkinsonian patients

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International Centre for Neurological Restoration

In this research we study the neural activity changes in Supplementary Motor Area in patients with Parkinsons disease using fMRI. We studied the effect of DOPA medication. The correlation with motor improvement was also tested. Statistical parametric mapping was used to detect differences in the cortical activity when is compared with both normal pattern and after DOPA supply. Patients show abnormal activation intensities in SMA, normalized after DOPA medication. Improvement in clinical outcome correlated with increase in fMRI signal, particularly with improvement of hypokinesia. The study indicates that cardinal symptoms in PD are associated with inappropriate underactivity in SMA.

285 (M66)

Two-oscillator model of ventilatory rhythmogenesis in the frog

Amitabha Bose, Timothy J. Lewis, Richard J. A. Wilson
New Jersey Institute of Technology

Frogs produce two distinct yet highly coordinated ventilatory behaviors, buccal and lung. Lung ventilation occurs in short episodes, interspersed with periods of buccal ventilation. Recent data suggests that two brainstem oscillators are involved in generating these behaviours, one primarily responsible for buccal ventilation, the other for lung. Here we use a modeling approach to demonstrate that the episodic pattern of lung ventilation might be an emergent property of the coupling between the oscillators, and may not require a perturbing input from another, as yet unidentified but previously postulated, neuronal oscillator.

286 (M67)

Coding and decoding of information in a bi-directional neural interface

L. Cozzi, P. D'Angelo, M. Chiappalone, A.N. Ide, A. Novellino, S. Martinoia, V. Sanguineti
University of Genova

We report on an experiment in which a population of rat cortical neurons, cultured on a micro-electrode array, was connected bi-directionally to a mobile robot. Bi-directional communication between a neural population and an external device requires to translate time-varying signals into spatio-temporal patterns of neural activity, and back. Here describe the experimental set-up and the computational modules of the neural interface, and describe our work of characterization of the 'transfer function' of the neural preparation, as it emerges from closed-loop experiments.

287 (M68)

WITHDRAWN

288 (M69)

Undulatory locomotion of polychaete annelids mechanics, neural control and robotic prototypes

D.P. Tsakiris, A. Menciassi, M. Sfakiotakis, G. La Spina and P. Dario
Foundation for Research and Technology - Hellas

The undulatory locomotion of polychaete annelid worms is studied as a biological paradigm of a versatile body morphology and effective motion control, adaptable to a large variety of unstructured and tortuous environmental conditions (water, sand, mud, sediment, etc.). Computational models of this type of locomotion have been developed, based on the Lagrangian dynamics of the system, on resistive models of its interaction with the environment and on neural control using central pattern generators. Simulation studies demonstrate the possibility to generate undulatory gaits, which are characterized by essential features of polychaete locomotion, based on these models. A lightweight robotic prototype has been developed, whose undulatory actuation achieves propulsion on sand.

301

Which Model to Use for Cortical Spiking Neurons?

Eugene M. Izhikevich

We review the biological plausibility and computational efficiency of eleven most useful and widely used models of spiking and bursting neurons. Our goal is to identify a model that is most applicable to large-scale simulations of cortical neural networks. We discuss why the integrate-and-fire neuron, being the simplest and the most efficient spiking model, is not appropriate for simulations and should be avoided by all means. Finally, we discuss some reasonable alternatives.

302

Self-organization of color opponent receptive fields and laterally connected orientation maps

Jim Bednar Post-doc, University of Texas, Austin Judah De Paula PhD student, University of Texas, Austin Risto Miikkulainen Professor, University of Texas, Austin
University of Texas at Austin

Long-range lateral connections in the primary visual cortex (V1) are known to link neurons with similar orientation preferences, but it is not yet known how color-selective cells are connected. Using a self-organizing model of V1 with natural color image input, we show that realistic color-selective receptive fields, color maps, and orientation maps develop. Connections between orientation-selective cells match previous experimental results, and the model predicts that color-selective cells will primarily connect to other cells with similar chromatic preferences. These findings suggest that a single self-organizing system may underlie the development of orientation selectivity, color selectivity, and lateral connectivity.

303

Variance stabilization of spike trains via non-renewal mechanisms The impact on the speed and reliability of signal detection

Rama Ratnam, Jozien B. M. Goense
University of Illinois at Urbana-Champaign

Detecting a signal in a noisy background is important to sensory processing. The properties of the input affect the ability of a neuron to detect a signal. A neural spike train that exhibits anti-correlations in the interspike interval sequence, was compared to a renewal spike train without correlations. Anti-correlations enable a neuron to detect changes in input quickly and reliably, even when the integration time is varied over a large range. For renewal input, performance is poor, and is sensitive to integration time. Anti-correlations stabilize the variance of the detector's membrane potential, keeping it roughly constant over multiple time scales. This mechanism allows the nervous system to detect signals robustly, independent of membrane characteristics.

304

The Role of Early Vision in the Determination of Depth and Motion from Ambiguous Binocular Information

Ko Sakai and Ogiya Mitsuharu
University of Tsukuba

The visual system can determine motion and depth from ambiguous information contained in images projected onto both retinas over space and time. The key to the way the system overcomes such ambiguity lies in dependency among multiple cuessuch as spatial displacement over time, binocular disparity, and interocular time delaywhich might be established based on prior knowledge or experience. We conducted a psychophysical investigation of whether a single ambiguous cue (specifically, interocular time delay) permits depth discrimination and motion perception. Data from this investigation are consistent with the predictions derived from the response profiles of V1 neurons, which show interdependency in their responses to each cue, indicating that spatial and temporal information is jointly encoded in early vision.

305

Threshold Detection of Intensity Flashes in the Blowfly Photoreceptor by an Ideal Observer

Peng Xu and Pamela Abshire
University of Maryland

Detection of intensity flashes in the blowfly photoreceptor is limited by photon noise in the input signal as well as noise contributed by transduction components within the photoreceptor. Our analysis uses an optimal observer and a model of blowfly phototransduction to compute the threshold for detection of intensity flashes as background intensity varies. We find that detection threshold increases with background light intensity according to a power function, that the threshold for low light levels is limited mainly by the photon noise, and that the threshold at high light levels is limited mainly by the channel noise.

306

Population coding of rapid changes in self-motion by the blowfly visual system

Katja Karmeier, Holger G. Krapp, Martin Egelhaaf
Bielefeld University

We demonstrate how the accuracy of a population code depends on integration time. Our analysis is based on a population of optic flow processing interneurons in the fly encoding the animals rotations around horizontally aligned body axes with graded potential changes. We obtain from electrophysiological experiments parameters for modelling the neurons responses. By applying a Bayesian Estimator we show that integration of neuronal activities over 1 ms is sufficient to decode the rotation axis with high accuracy. Short integration times are important since flies show rapid flight manoeuvres and do not have much time to decode neuronal responses.

307

Processing sensory input with bursts and isolated spikes

A-M. M. Oswald, M.J. Chacron, B. Doiron, J. Bastian, L. Maler
University of Ottawa

Although burst firing is commonly observed, a direct relationship between burst dynamics and sensory information transfer has not been established. We employ in vivo, in vitro and modeling approaches to investigate electrosensory pyramidal cell responses to mimics of behaviorally relevant sensory input. We find that, within a given spike train, backpropagation-dependent bursts signal low frequency events while isolated spikes simultaneously code for high frequency components. In addition, burst dynamics are essential for feature detection but are not required for stimulus estimation. Thus, burst and spike dynamics segregate a single spike train into two parallel and complementary streams for information transfer.

308

Prey electric field estimation in dogfish   A neuronal population coding model

Rachel M. Berquist, Remus M. Osan & Michael G. Paulin
University of Minnesota, Duluth

We have approximated the natural dynamics of primary electrosensory inputs to the electric sense of a swimming dogfish using a realistic three-dimensional graphical and computational model of the animal&8216;s array of electrosensory canals and innervating neurons responding to nearby prey. We use this to test a neural network hypothesis of electrosensory-mediated prey localization in sharks. Employing an idea from population coding we show how dynamical neural inputs from hundreds of directionally sensitive electrosensory organs can be integrated by a population of decision-making neurons to reliably estimate the strength and direction of the prey electric field during realistic predator-prey scenarios.

309

Temporal coding in whisker primary afferents

Lauren M. Jones, Asaf Keller
University of Maryland, Baltimore

The ability of rats to use their whiskers to perform fine tactile discrimination rivals that of humans using their fingertips. Rats perform these discriminations rapidly and accurately while palpating the environment with their whiskers. This suggests that whisker-derived inputs produce a robust and reliable code in the whisker-trigeminal system. Here we show that whisker primary afferent neurons respond with highly reproducible temporal spike patterns to transient stimuli. We demonstrate that a single response train recorded from an individual neuron can reliably encode complex whisker deflection patterns, and that encoding is improved by combining responses from cells with opposite directional preferences.

320 (T01)

Signaling Contours by Retinal Wave Propagation

Christoph Rasche
Notre Dame

We describe a neuromorphic retina that signals a luminance edge as a spike. In a fast process, the luminance profile of the receptor layer determines the membrane potential of the ganglion cells and their individual, adjustable spiking thresholds. In a slower process, a wave-propagation process, the charge of ganglion cells with high membrane potential will propagate toward neighboring cells with low membrane potential and low spiking threshold, thus signaling the edge as a spike. Following that, the signaled edge (or contour) actively propagates across the retinal map. The retinal signal can be used for a contour-integration or a contour- propagation approach.

321 (T02)

The Neuronal Basis of Direction Selectivity in Lobula Plate Tangential Cells

Timothy Melano and Charles M. Higgins
University of Arizona

Using a neuronally-based computational model of the fly's visual elementary motion detection (EMD) system, the effects of picrotoxin, a GABA receptor antagonist, were modeled to investigate the role of various GABAergic cells in direction selectivity. By comparing the results of our simulation of an anatomically correct model to previously published electrophysiological results, this study supports the hypothesis that EMD outputs integrated into tangential cells are weakly directional, although the tangential cells themselves respond to moving stimuli in a strongly directional manner.

322 (T03)

A model of target selection based on goal-dependent modulation

Emilio Salinas
Wake Forest University School of Medicine

When contemplating a crowded scene, gaze can be directed toward a large number of potential target items, whose presence is signalled by the responses of visual neurons. However, the current target may change every moment, so how can these sensory responses direct eye movements? Here I show that, if additional information encoding the current goal is combined nonlinearly with the sensory activity, then the oculomotor command needed to foveate the current target can be easily read out by downstream neurons. This is illustrated with a model network that solves a target-selection task. The goal-dependent modulation controls the network's functional connectivity, allowing it to locate different objects under different circumstances.

323 (T04)

A Model of the Summation Pools within the Layer 4 (Area 17)

Baran Curuklu, Anders Lansner
Malardalen University

We propose a developmental model of the summation pools within the layer 4. The model is based on the modular structure of the neocortex and captures some of the known properties of layer 4. Connections between the orientation minicolumns are developed during exposure to visual input. Excitatory local connections are dense and biased towards the iso-orientation domain. Excitatory long-range connections are sparse and target all orientation domains equally. Inhibition is local. The summation pools are elongated along the orientation axis. These summation pools can facilitate weak LGN input and explain improved visibility as an effect of enlargement of a stimulus.

324 (T05)

Contrast Saturation in a Neuronally-Based Model of Elementary Motion Detection

Zuley Rivera-Alvidrez Charles M. Higgins
University of Arizona

The Hassenstein-Reichardt (HR) correlation model is commonly used to model elementary motion detection in the fly. Recently, a neuronally-based computational model was proposed, which unlike the HR model, is based on identified neurons. The response of both models increases as the square of contrast, although the response of insect neurons saturates at high contrasts. We introduce a saturating nonlinearity into the neuronally-based model in order to produce contrast saturation and discuss the neuronal implications of these elements. Furthermore, we show that features of the contrast sensitivity of movement-detecting neurons are predicted by the modified model.

325 (T06)

Spike-timing dependent plasticity as a mechanism for ocular dominance shift

B.A. Siegler, M. Ritchey, J.E. Rubin
University of Pittsburgh

Spike-timing dependent plasticity has been implicated in visual cortex modification. We created a model of ocular dominance shift based on STDP rules and compared it to experimental results. Although STDP proved to be a powerful means of ocular dominance shift in our model, we found that it was unable to account for more subtle effects of monocular deprivation.

326 (T07)

Spike-latency codes and the effect of saccades

Ruediger Kupper, Marc-Oliver Gewaltig, Edgar Koerner
Honda Research Institute Europe GmbH

Input enters the visual system structured by saccades. The exact timing of spikes produced is believed to be interpreted in terms of latency or spike rank. Spike-time based simulations often cover only a few spike waves. This disregards the continuous character of visual processing. We demonstrate that in an extended simulation, a spike latency code is lost after short time, and needs to be explicitly reestablished. We suggest and implement several biologically relevant strategies of how to do this. We conclude that relaxation of neurons is an effective way of setting temporal reference frames for spike-time processing.

327 (T08)

A neuronal model for the shaping of feature selectivity in IT by visual categorization

M. Szabo, R. Almeida, G. Deco, M. Stetter
Siemens AG

Neurophysiology results have shown that learning a visual categorization task shapes the selectivity of inferiotemporal cortex neurons to task-relevant features of the stimuli. In this work we propose a biologically realistic meanfield neuronal model of a two layer network to explain these experimental results. We show that the enhancement of feature selectivity in one layer of the model can emerge due to input coming from another layer, corresponding to a region encoding stimulus category, possibly in prefrontal cortex. Further, we explore the behavior of the network in function of the weights of the connections between its two layers.

328 (T09)

Modelling a Visual Discrimination Task

Benoit Gaillard Jianfeng Feng
University of Sussex

We study the performance of a spiking network model based on Integrate and Fire neurons when performing a benchmark discrimination task. The task consists of determining the direction of moving dots in a noisy context. By varying the synaptic parameters of the Integrate and Fire neurons, we illustrate the counter-intuitive importance of the second order statistics (input noise) in improving the discrimination accuracy of the model. Surprisingly we found that measuring the firing rate of a population of neurons considerably enhances the discrimination accuracy as well, in comparison with the firing rate of a single neuron.

329 (T10)

Robust integration and detection of noisy contours in a probabilistic neural model

Nadja Schinkel Klaus R. Pawelzik Udo A. Ernst
University of Bremen

Contour integration is an important step in the process of image segmentation and gestalt perception. Experimental evidence with monkeys and humans demonstrates that this specific computation is performed very fast and in a highly efficient manner, even if contours are jittered, partially occluded, or reduced in luminance. In this contribution, we investigate algorithms and strategies for a reliable detection of contours, which are subjected to various plausible neuronal and environmental constraints, as e.g. synaptic noise or imperfect knowledge about the exact orientation of an edge at some position in a stimulus display. It is shown that under most conditions there exists a range of tuning widths for orientation-specific neurons in the visual cortex which yields an optimum in contour detection performance. In particular, the performance can increase when the information of the orientation of the contour elements becomes more uncertain.

330 (T11)

A functional role of multiple spatial resolution maps in form perception along the ventral visual pathway

Yoshiki Kashimori, Nobuyuki Suzuki, Kazuhisa Fujita, Meihong Zheng, Takeshi Kambara
Univ. of Electro-Communications

We present a functional model of form pathway in visual cortex based on the idea of predictive recognition, in which the prediction for input image is compared with the feedforward signals from retina. Three kinds of spatial resolution maps of V1 and V4, broad, middle, and fine resolution maps, are effectively used to achieve the form perception. The prediction is generated by the feedforward signals of main neurons in broader resolution maps of V1 and V4, and then is compared with the feedback signals of main neurons in fine map of V4. We propose here the functional roles of the three kinds of spatial resolution maps in predictive recognition of object form.

331 (T12)

The bat's head aim governs flight, simplifying computation during interception

Kaushik Ghose & Cynthia F. Moss
University of Maryland College Park

We studied the head-directing behavior of echolocating bats as they intercepted insect prey on the wing. We found that the angle between the bat's head and body at a given instant is proportional to its turn rate 80ms into the future. The bat centers its head on its prey during interception. We propose that these strategies simplify the computations required by the bat to guide its flight to the target.

332 (T13)

Sound-Source Localization by Neural Network Based on Modified Integrate-and Fire Neuron Model with Autopolarization.

Ruben Tikidji Hamburyan, Sofia Polevaya
Rostov State University

A neural-network model based on the modified "Integrate and Fire" neuron (MIFN) [10, 11] with autopolarization to simulate a sound localization at dichotic stimulation is presented. The model consists of two groups of MIFNs, which receive excitatory and inhibitory synapses from the corresponding input elements, making the each MINF like the real E-I neurons [3, 4]. It has been shown that the model can detect a short (up to 40ms) Interaural Time Difference (ITD) by a relation of spikes number between neuron groups. Model prediction about possible erroneous sound location received by analytical study was confirmed in psychophysical experiments at qualitative level.

333 (T14)

Learning self-organized topology-preserving complex speech features at primary auditory cortex

Taesu Kim and Soo-Young Lee
KAIST

By applying independent component analysis (ICA) algorithm to auditory signals a computational model was developed for the speech feature extraction at the primary auditory cortex. Unlike the other ICA-based features with simple frequency selectivity at the basilar membrane and inner-hair-cells the learnt features represent complex signal characteristics at the primary auditory cortex such as onset/offset and frequency modulation in time. Also, the topology is preserved with the help of neighborhood coupling during the self-organization. The extracted complex features demonstrated good performance for the robust discrimination of speech phonemes.

334 (T15)

A computational model for discrimination of natural sounds

Rajiv Narayan, Kamal Sen
Boston University

We investigate the neural discrimination of natural sounds using a computational model based on Spectral-temporal Receptive Fields (STRFs) obtained from neurons in the songbird analog of the auditory cortex. The discriminability of spike trains for different songs is quantified using a spike distance metric that is sensitive to temporal variations in neural firing. We find a significant improvement in song discriminability when the dynamics of neural firing are taken into account.

We use the model and the dynamic measure of discriminability to characterize how the reliability and speed of discrimination depends on parameters of the STRF.

335 (T16)

A Recurrent Network Model of Eye-Position Effect on Auditory Receptive Field

William Tam and Kechen Zhang
Johns Hopkins University

Visual and auditory systems use different reference frames to code stimuli early vision is eye-centered, while early audition is head-centered. To direct saccade towards an auditory target, auditory signals have to be transformed into eye-centered coordinates in the superior colliculus (SC), where auditory receptive fields (RF) can indeed be shifted with the eyes. We propose a recurrent network model with separate excitatory and inhibitory neuronal populations for combining the incoming signals using the approximate multiplicative property of the network. The model may provide a robust and biologically more realistic computational mechanism for the eye-position effects.

336 (T17)

Excitation and Inhibition in Bat Azimuthal Echolocation

Rock Z. Shi and Timothy Horiuchi
University of Maryland

Bats use interaural level differences (ILD) as their primary cue for azimuthal echolocation. ILD information is processed in the bats brainstem through cells that receive excitation from one ear and inhibition from the other ear (called EI cells). In this paper, we model bats three ILD processing centers - the lateral superior olive (LSO), the dorsal nucleus of the lateral lemniscus (DNLL) and the inferior colliculus (IC), with a three layer feedforward spiking neural network. We also present a very large scale integrated (VLSI) circuit based neuromorphic system that mimics ILD processing in the bat LSO.

337 (T18)

Phasic, tonic, and mixed mode firing of an auditory neuron model -- bifurcation analysis

Ramana Dodla John Rinzel
New York University

Temporal processing, such as coincidence detection, on sub-msec time scales by auditory brain stem neurons is enhanced by a low-threshold potassium current (IKLT). IKLT also helps to make the neurons (e.g. in the medial superior olive, MSO) fire phasically rather than tonically. In response to a step of current (Iapp) MSO cells typically fire a single spike at stimulus onset but not tonically for the maintained current or for a slow ramp of Iapp. We have studied the response properties of an HH-like model that incorporates an IKLT. The model shows phasic behavior over a large range of parameters. But for reduced IKLT strength tonic firing is elicited by an adequate step of Iapp. Curiously, the model does not fire if Iapp is very slowly ramped through this entire range of Iapp. The behavior is explained by using bifurcation theory the rest state is stable for all Iapp but there is a coexistent limit cycle for some Iapp range. This mixed mode behavior leads to spike patterns that appear bursty (with high CV) when the model is driven periodically in the presence of noise.

338 (T19)

Neural mechanism of detecting interaural intensity differences in the owl's auditory brainstem for sound location

Kazuhisa Fujita, ShungQuang Huang, Yoshiki Kashimori, Takeshi Kambara
University of Electro Communications

In order to clarify the neural mechanism of detection of the interaural intensity difference(IID), we presented a neural model of a pair of VLVp units (the first site of binaural convergence of intensity information). We proposed that each value of IID is represented as a neuronal position of a firing zone gap which is generated in ICc shell by combining output of right VLVp with that of left VLVp. Based on this gap coding scheme, we clarified the functional role of the mutual inhibitory connections between R- and L- VLVp and of bilateral inhibitory projection from VLVp pair to ICc shell.

339 (T20)

Empirical Mode Decomposition A Method for Analyzing Neural Data

Hualou Liang, Steven L. Bressler, Robert Desimone, Pascal Fries
The University of Texas at Houston

Almost all measurements in neurobiology are stochastic and nonstationary. Conventional methods to use these measurements to provide a meaningful and precise description of complex neurobiological phenomenon are insufficient. Here, we report on the use of Huangs data-driven Empirical Mode Decomposition (EMD) method (Huang et al. 1998a) to study neuronal activity in visual cortical area V4 of macaque monkeys performing a visual spatial attention task (Fries et al. 2001). We found that Local Field Potentials were resolved by the EMD into the sum of a set of intrinsic components with different degrees of oscillatory content. High-frequency components were identified as gamma band (35-90 Hz) oscillations, whereas low-frequency components in single-trial recordings contributed to the average visual evoked potential (AVEP). We also discovered that the magnitude of time-varying gamma activity was enhanced when monkeys attended to a visual stimulus as compared to when they were not attending to the same stimulus. These results support the idea that the magnitude of gamma activity reflects the modulation of V4 neurons by visual spatial attention. The EMD, coupled with instantaneous frequency analysis, may prove to be a vital technique for the analysis of neural data.

340 (T21)

Rapid temporal modulation of synchrony in cortical interneuron networks with synaptic depression

Calin I. Buia, Paul H. E. Tiesinga
University of North Carolina at Chapel Hill

The synchrony of neurons in extrastriate visual cortex is modulated by selective attention even when there are only small changes in firing rate. We used Hodgkin-Huxley type models of cortical neurons to investigate the mechanism by which the degree of synchrony can be modulated independently of changes in firing rates. The synchrony of local networks of model cortical interneurons interacting through inhibitory synapses with synaptic depression was modulated on a fast time scale by selectively activating a fraction of the interneurons. The activated interneurons became rapidly synchronized without changing significantly the firing rate of other neurons.

341 (T22)

Attentional filtering in neocortical areas A top-down model

Andras Lorincz
Eotvos Lorand University

Two comparator based rate code models -- a reconstruction network model and a control model -- are merged. The role of bottom-up filtering is information maximization and noise filtering, whereas top-down control paves the way' of context based information prediction that we consider as attentional filtering. Falsifying prediction of the model has gained experimental support recently.

342 (T23)

On the relevance of the neurobiological analogue of the finite state architecture

Karl Magnus Petersson
University of Nijmegen

In the present paper, we present two simple arguments for the potential relevance of the neurobiological analogue of the finite state architecture. One within the classical cognitive framework, based on the assumption that the brain is finite with respect to its memory organization, and the second within non-classical framework, based on the assumption that the brain sustains some level of 'realistic' noise and/or does not utilize infinite precision processing. These assumptions seem necessary requirements for physically realizable information processing systems. In addition we briefly review the classical cognitive framework based on Church-Turing computability and some recent non-classical approaches based on analog information processing in dynamical systems. We frame this discussion broadly in the context of recent suggestions that neurobiological and functional brain architectural constraints may have important implications for the processing architecture of the brain.

343 (T24)

Artificial grammar learning a case study of the reber grammar

Peter Grenholm Karl Magnus Petersson
University of Nijmegen

It has been suggested that language processing is an example of the infinite use of finite means. A simple formal model of this idea is represented by the finite state grammars. Artificial grammar learning has been used to study aspects of natural language processing in humans. Recent FMRI studies indicate that language related brain regions are engaged in artificial grammar processing.

In the present study we investigate the Reber grammar by means of simple formal analysis and network simulations. We also outline a method for describing network dynamics and suggest that statistical frequency based and rule-based artificial grammar learning in important ways can be viewed as complementary in the case of the Reber grammar and similar artificial grammars.

344 (T25)

A psycholinguistically and neurolinguistically plausible system-level model of natural-language syntax processing

Alan H. Bond
California Institute of Technology

We describe a psycholinguistically and neurolinguistically plausible model of natural-language processing by the human brain. This model is based on the work of Gerard Kempen and coworkers at Leiden and Nijmegen who have developed computational models of language generation and of language recognition. We show how to use our own brain modeling approach to develop a neurolinguistically plausible model based on the Kempen psycholinguistic model. Our model is implemented as a set of intercommunicating brain modules that run in parallel. These brain modules have the same structure and control regime as other nonlinguistic brain modules. They approximately correspond to Broca's and temporal lobe areas.

345 (T26)

Multi-channel shot noise and characterization of cortical network activity.

Michael Rudolph and Alain Destexhe
CNRS, UPR-2191

Neurons in cerebral cortex are characterized by a stochastic subthreshold membrane potential (Vm) activity, which originates from the ongoing and irregular activity of neurons in the cortical network. Here, propose a way of characterizing this network activity by using the notion of shot noise applied to pulse-based kinetic models of synaptic conductances. We link the statistical characterization of synaptic conductances in terms of their mean and variance to the activity in the network, in particular the average firing rate of presynaptic neurons and their temporal correlation, thus providing a possible method for characterizing cortical network activity from intracellularly-recorded Vm activity.

346 (T27)

An Intracellular Ca^{2+} Subsystem as a Biologically Plausible Source of Intrinsic Bistability in a Network Model of Working Memory

Christopher P. Fall, John Rinzel

We explore a network model of working memory in an integrodifferential form similar to those proposed by Amari. The model incorporates an intracellular Ca2+ subsystem whose dynamics depend upon the level of the second messenger [IP3]. This Ca2+ subsystem endows individual units with intrinsic bistability for a range of [IP3]. This full network sustains [IP3]-dependent persistent (bump) activity in response to a brief transient stimulus. The dynamics of network activation suggest that the time scales of second messenger activity relative to initiation of persistent firing deserves further exploration.

347 (T28)

Statistical implications of clipped Hebbian learning of cell assemblies.

Andreas Knoblauch
University of Ulm

Although cell assemblies have been postulated by Donald Hebb almost half a century ago, so far they have not yet been proven (or disproven) to occur in the real brain. This is mainly because of immense difficulties in recording simultaneously from a large number of single neurons with high spatial and temporal resolution. In this study I suggest an alternative approach to test the structure of a local cortical network. After repeated stimulation of a large neuron number, the test just requires the evaluation of statistical properties of the postsynaptic potentials recorded from a single cell. Using a simple binary network model and applying clipped Hebbian learning, it is shown that the variance in the postsynaptic potentials grows with the square of the stimulation strength if the synapses have been generated by Hebbian learning of many overlapping cell assemblies, but only linearly for independent random synapses. This result bears implications both for analysis of associative memory and the verification of the assembly hypothesis in neurophysiological experiments.

348 (T29)

Burst detection algorithms for the analysis of spatio-temporal patterns in cortical networks of neurons

Michela Chiappalone, Antonio Novellino, Ildiko Vajda, Alessandro Vato, Sergio Martinoia and Jaap van Pelt
University of Genova

Cortical neurons extracted from the developing Central Nervous System are spontaneously active and, after a few days in culture, display a typical electrophysiological pattern ranging from stochastic spiking to organized bursting. Using microelectrode arrays (MEA), on which dissociated cultures can be grown for long-term measurements, we recorded the electrophysiological activity of cortical networks during development, in order to monitor their responses at different stages of the maturation process. Employing new algorithms for burst analysis and statistical procedures we were able to extract relevant parameters useful for describing the neural dynamics changes at different stages of the developmental process.

349 (T30)

Connectionist Mechanisms for Cognitive Control

Carter Wendelken Lokendra Shastri
Center for Mind and Brain, UC-Davis

An understanding of cognitive control is crucial for understanding high-level cognition and delineating the functional role of prefrontal cortex in supporting complex cognitive operations. In this paper, we approach the problem of cognitive control by examining the control needs of

SHRUTI, a neurally plausible and cognitively motivated model of inference and decision-making. It is shown that processing via spreading activation has a number of limitations with respect to inference and decision-making, and specific forms of controlled processing is required to overcome these limitations. We propose a set of primitive, neurally plausible control mechanisms, including monitoring, filtering, selection, maintenance, organization, and manipulation, describe connectionist implementations of these primitive mechanisms, and demonstrate the use of several of these primitives in a complex control process.

350 (T31)

Localized activity patterns in excitatory neuronal networks

Jonathan Rubin Amitabha Bose
University of Pittsburgh

Localized activity bumps have been investigated in a variety of spatially distributed neuronal network models featuring both excitatory and inhibitory coupling. Here we elucidate a mechanism by which a neuronal network with purely excitatory synaptic coupling, and no sustained input, exhibits sustained, localized activity. Bump formation ensues from an initial transient synchrony of a localized group of cells, which promotes recruitment, followed by desynchronization of firing with the active group, which curtails recruitment yet maintains activity. We explain why bump size is sensitive to initial conditions and parameters in this network and examine the effect of synaptic depression on bumps.

351 (T32)

Reconstructing synaptic background activity from conductance measurements in vivo

Q.Zou, M.Rudolph, N.Roy, M.Sanchez-Vives, D.Contreras, A.Destexhe
UNIC

To reconstruct synaptic background activity, we combined computational models with intracellular recordings in vivo. A new conductance analysis method applied to intracellular recordings in the somatosensory cortex of anesthetized rats revealed mirror changes of excitation and inhibition during the up and down states of slow waves, but concerted changes in conductance variances. We then used these measurements to constrain the patterns of random release at excitatory and inhibitory synapses in computational models. We show that measurements of the mean and variance of conductances are sufficient constraints to design models fully consistent with in vivo recordings.

352 (T33)

Localized Activations in a Simple Neural Field Model

J. Michael Herrmann, Hecke Schrobsdorff, Theo Geisel
Universitaet Goettingen

A quarter of a century ago Amari has presented a comprehensive and very elegant solution of the one-dimensional neural field equation. In the two-dimensional case analytical results on localized solutions are available under the assumption of rotational invariance, although numerical evidence indicates that no other stable solution exist. We present analytic results for a special case of an interaction function, which partially justifies the implicit assumption of circular solutions and allows to discuss the possibility of non-generic deviations from circularity.

353 (T34)

Large Scale Networks for Contextual Inference, Routing and Motor Control

Charles H. Anderson and Brian Fischer
Wash. Univ. Sch. of Medicine

The question of how neurons multiply is an important, but unresolved problem in neuroscience. Motivated by the problems of contextual inference, dynamic routing of information, and nonlinear control of motor systems, we feel the more important question is how networks of large ensembles of neurons multiply many pairs of numbers and sum the result; the computation of bilinear forms. Using the framework described in (Eliasmith and Anderson 2003), we show that bilinear forms can be computed in networks with hidden layers" of neurobiologically realistic neurons, which can be far more efficient than digital systems and artificial neural networks.

354 (T35)

Subthreshold cross-correlations between cortical neurons A reference model with static synapses

Ofer Melamed, Gilad Silberberg, Henry Markram, Wulfram Gerstner and Magnus J.E. Richardson
EPFL

The structure of cross-correlations between subthreshold potentials of neocortical neurons was recently examined. Characteristic features included broad widths and significant peak advances. It was suggested that dynamic synapses shape these cross-correlations. Here a reference model is developed comprising leaky integrators with static synapses. Subthreshold correlations are derived analytically for two different forms of synaptic input steady drive and population bursts. For the latter case the model captures the widths seen in experiment. However, the model could not account for the peak advance. It is concluded that models with static synapses lack the necessary biological details for describing these cortical dynamics.

355 (T36)

New Technique for analyzing stationary global activity in neural networks

M. Kubo, K. Abe, G. Ashida
Kyoto university

To investigate the origin of spontaneous activity in the neuronal population dynamics and the mechanisms that keep it stable, we explore a new technique and methods for analyzing stationary global activity in large networks of integrate-and-fire neurons. Our technique is based on the diffusion approximation theory and probabilistic models. Under a given condition on the balance of excitation and inhibition, we find that stationary global activity deeply depends on major sources of inherent neuronal noise background synaptic activity from other areas, thermal agitation, and ion channel stochasticity. In the case without this neuronal noise, population activity is exceedingly unstable even if we choose almost perfect balanced parameter regime by

intention. We conclude that neuronal population, by making effective use of own neuronal noise, keep self-sustaining stable states.

356 (T37)

Modeling genetic control of thalamo-cortical connections and area patterning

Jan Karbowski and G.B. Ermentrout
California Institute of Technology

There has been growing experimental evidence that the emergence and development of cortical areas is controlled by both epigenetic and genetic factors. This paper presents a theoretical model that explicitly considers the genetic factors and that is able to explain several recent experiments on cortical area regulation involving transcription factors Emx2 and Pax6, fibroblast growth factor FGF8, and cortical ablation. The model consists of the dynamics of thalamo-cortical connections modulated by signaling molecules that are regulated genetically or extrinsically. The model can make predictions and provides a basic mathematical framework for the early development of the thalamo-cortical connections and area patterning.

357 (T38)

Living cortical networks at the critical point may optimize information transmission and storage simultaneously

John Matthew Beggs
Indiana University

Previous work showed that cultured cortical networks recorded on 60 channel microelectrode arrays displayed many stable attractors, and operated at the critical point where they had a power law distribution of neuronal avalanche sizes. To examine the implications of the critical point on information transmission and storage, network simulations were tuned through subcritical, critical and supercritical regimes. Simulations showed that both information transmission and the number of significant attractors were maximized simultaneously, and that this occurred only at the critical point. These results suggest that living cortical networks self-organize to the critical point to optimize both information transmission and storage.

358 (T39)

Signal Compression in the Sensory Periphery

Mauro Copelli Rodrigo F. Oliveira Antonio Carlos Roque Osame Kinouchi
Universidade Federal de Pernambuco

In this contribution we address the issue of signal compression in the peripheral nervous system. We propose a simple mechanism by which the narrow dynamical range observed experimentally in isolated sensory neurons, translates into a wide dynamical range as a result of the collective phenomenon of self-limited amplification. The mechanism is illustrated by means of different models in which excitable elements are coupled by lateral excitatory connections. The models are based on recent experimental findings that gap junctions are present in the sensory periphery.

359 (T40)

Potential connectivity in local cortical circuits

Armen B. Stepanyants, Judith A. Hirsch, Luis M. Martinez, Zoltan F. Kisvarday, Alex S. Ferecsk, and Dmitri B. Chklovskii
Cold Spring Harbor Laboratory

Synaptic connectivity among cortical neurons may vary with time due to the growth and retraction of dendritic spines. This suggests that the invariant description of cortical circuits should be formulated on a level of more stable features of connectivity, i.e. the layout of axonal and dendritic branches. To describe this layout we use potential synapses, locations in neuropil where an axon of one neuron is present within few micrometers from a dendrite of another. Potential synapse is a requirement for a physiological synapse. We developed a method which allows us to determine potential connectivity maps for excitatory and inhibitory neurons.

360 (T41)

A network model with pyramidal cells and GABAergic non-FS cells in the cerebral cortex

Kenji Morita, Kazuyuki Aihara
University of Tokyo

Recent experiments revealed two classes of GABAergic interneurons in the cerebral cortex, fast spiking (FS) cells and non-FS cells. There are increasing evidences that these two classes of GABAergic cells are electrophysiologically, anatomically, and functionally distinct. We propose a neural network model of pyramidal cells and non-FS cells by describing dendritic local inhibition, which is the anatomical hallmark of the non-FS cells. Our model is shown to have several distinctive properties, such as highly specific pattern discrimination and convergence to "I don't know" states, which could not be achieved by the conventional competitive neural networks with FS-mediated somatic inhibitions.

361 (T42)

Modeling Astrocyte Communication

Steve Bellinger
Arizona State University

Calcium wave oscillations are utilized by astrocytes as a method of cellular communication. These waves are dependent on both an intracellular, gap-junction pathway involving [Ca++]i and [IP3]i and an extracellular pathway involving [ATP]o and [Glu]o. Our goal was to incorporate the extracellular pathway into a preexisting mathematical model of the intracellular pathway. The model showed that during an [IP3]i stimulated calcium wave, [ATP]o controls the amplitude while [Glu]o controls the duration of the wave. Also, our model implicated purinergic, PLCB and PLCG activating receptors as potential drug targets to modify glutamate release by astrocytes which may effect neural plasticity.

362 (T43)

Investigating the time course of single-trial activity of neurons that show gradual increase or decrease in histograms

Hiroshi Okamoto, Yoshikazu Isomura, Masahiko Takada, Tomoki Fukai
Fuji Xerox Co., Ltd.

Go/No-go task related activities of some neurons in the monkey anterior cingulate cortex gradually increase or decrease with time at a nearly constant rate, as demonstrated in histograms (ex. PSTHs) (Isomura et al., 2003). We devised an analysis method to investigate the time course of neuronal activity during a single-trial. Results of application of this method to Isomura et al.fs data indicate that the neurons are bimodal, residing in the high- or low-firing state; the timing of transition from one to the other uniformly fluctuates across trials. We also put forward a computational model that can account for such single-trial neuronal activity.

363 (T44)

Confounded spikes generated by synchrony within neural tissue models

Kenneth P. Eaton and Craig S. Henriquez
Duke University

Spike-sorting often requires subjective interpretation of the waveforms to resolve the underlying neural activity. Often, multiple waveforms are detected at one site and interpreted as arising from multiple neurons. Because uncovering the relationship between the spike and the underlying intracellular activity is not tractable in vivo, a computer model of 128 multi-compartment neurons sharing common inputs was used to explore how synchronous firing impacts both the morphology and classification of the spikes. The results suggest that near-synchronous conditions yield multiple waveforms that could lead to missed spikes and a confounded interpretation of the number of neurons contributing to the recording.

364 (T45)

Reliability resonance boosts activity in downstream cortical areas

Paul Tiesinga
University of North Carolina

The reproducibility of neural responses to an identical stimulus across different presentations (trials) has been studied extensively. The responses across different trials can sometimes be interpreted as the response of an ensemble of similar neurons to a single stimulus presentation. How does the reliability of the activity of neural ensembles affect information transmission between different cortical areas? We find using model simulations that weak temporal modulations in the power of gamma-frequency oscillations in a given cortical area can strongly affect firing rate responses downstream by way of reliability in spite of rather modest changes in firing rate in the originating area.

365 (T46)

Study on the role of GABAergic synapses for synchronization

Ho Young Jeong & Boris Gutkin
Univ. College London

GABAergic synapses play an important role in the control of neural activity as well as the formation of neural circuitry. In particular, the reversal potential of GABAergic synapses can change significantly during development along with the intrinsic neuronal properties. In this report, we study the influence of such synaptic changes on synchrony in neural circuits. We use phase reduction methods to study the stability of synchrony. Numerical simulations of a conductance-based model based on the analysis exhibit the various firing conditions. We also extend the analysis to large globally coupled neuronal networks.

366 (T47)

How a neuron model can demonstrate co-existence of tonic spiking and bursting?

Andrey Shilnikov, Ronald L. Calabrese, and Gennady Cymbalyuk
Georgia State University

Tonically spiking as well as bursting neurons are frequently observed in electrophysiological experiments. The theory of slow-fast dynamical systems can describe basic scenarios of how these regimes of activity can be generated and transitions between them can be made. Here we demonstrate that a bifurcation of a codimension one can explain a transition between tonic spiking behavior and bursting behavior. The bifurcation of a saddle-node periodic orbit with non-central homoclinics is behind the phenomena of bi-stability observed in a Hodgkin-Huxley type neuron model. This model can exhibit two coexisting types of oscillations tonic spiking and bursting.

367 (T48)

Modelling of the Basal Ganglia Affected by Huntington's Disease

Xiuxia Du, Bijoy K. Ghosh
Washington University in St. Louis

Huntington's Disease (HD) is an autosomal dominant neurodegenerative disorder. The disease is due to a single gene which expresses huntingtin. Normal genes have less than 29 copies of the CAG trinucleotide repeat within each gene and mutant genes have an expanded number of CAG repeats. The disease affects initially the striatum and extends to other brain regions in later stages of the disease. A variety of the cellular processes are affected by the mutant gene and the cellular mechanism that links the mutation with the disease is to be found. This paper attempts to integrate hypothesis and experimental results into an integrated NEURON simulation framework, aiming to obtain a comprehensive understanding of the disease pathogenesis. The affected cellular processes that are considered include synaptic transmission, dendrite morphology change, transcription, and calcium signalling.

368 (T49)

The effect of interspike waveform on phase resetting and its impact on the regularity of the firing pattern

Carmen C. Canavier
University of New Orleans

We simulated the response of Type I pacemakers with different waveforms to noisy inputs, and these simulations suggest a mechanism by which the firing pattern of dopamine neurons can be modulated to be more variable in the presence of a constant level of background noise. An increase in the slope of the membrane potential between spikes at constant frequency imparts resistance to phase resetting in response to stochastically-time inputs that would otherwise deregularize the firing pattern. In addition, we showed that the phenomenology of phase resetting is quite different for subthreshold versus suprathreshold excitatory perturbations.

369 (T50)

A stochastic neural network model of limbed locomotion

Boothe, D.L., Cohen, A.H. Neuro. & Cog. Sci. Program, Univ. of Maryland, College Park, MD, USA
University of Maryland, College Park

The current structure of the central pattern generator (CPG) underlying limbed locomotion in mammals remains poorly understood. Adding a stochastic component to a simulated CPG creates model outputs possessing variability. Neural network models with variable outputs are amenable to the application of statistical analysis. This statistical analysis can be identical to that performed on the biological system. Individual neural network models possess specific correlation structures. These correlation structures can be observed by determining correlation coefficients between burst lengths and off times of simulated outputs.

370 (T51)

Modeling of the transient firing of the nigral dopamine neuron in vivo and in slices.

A. Kuznetsov, C Wilson, and N. Kopell
Boston University

The dopaminergic neuron ordinarily will not fire faster than about 10 Hz when depolarized in slices. In vivo, much higher rates are briefly attained, for example after an unexpected reward. Using a physiologically based coupled oscillators model, we suggest a mechanism by which a burst may occur in vivo, but not in slices. We propose two ways of obtaining a transitional burst after release from a state of low somatic Ca concentration (somatic hyperpolarization). Both ways are based on forcing of the whole system by distal compartments. We show that geometric features of the dendrite, such as branching and presence of long thin dendritic parts, enforce the high-frequency transient. Thus, a firing pattern depends on the dendrite geometric features, and slicing, reducing the number of fast compartments, may prevent the burst firing.

371 (T52)

Delayed feedback control of synchronization in locally coupled and stimulated networks

Christian Hauptmann, Oleksandr Popovych, Peter Tass
Research Center Juelich

The measured and delayed neuronal activity is administered as a stimulation at different sites within a network of neurons. Due to local coupling and decaying stimulation a completely desynchronized state results. Phase oscillator models as well as microscopic models are used to show that unlikely to previously presented methods, this novel approach is robust against variations of model parameters, does not require time consuming calibration and contains a self-organized demand control of the stimulation strengths. It is suggested that the novel technique is used for deep brain stimulation in patients suffering from Parkinson's disease or essential tremor.

372 (T53)

Phase transition between reactive and predictive eye movements is confirmed with nonlinear prediction and surrogates

Mark Shelhamer
Johns Hopkins University School of Medicine

We previously demonstrated that there is an abrupt (rather than smooth) transition between reactive and predictive modes of eye-movement tracking of target lights (a phase transition). We also found evidence that the sequence of eye movements in the reactive mode was independent, while those in the predictive mode were correlated and possibly formed a random fractal sequence. Here we confirm this finding by quantifying the rate of decay of nonlinear forecasting when applied to these data, and develop an extension to small data sets using surrogate data.

373 (T54)

An Investigation of the Relative Stability of Reactive and Predictive Oculomotor Tracking

Wilsaan M. Joiner Mark Shelhamer
Johns Hopkins University

Previously we demonstrated a phase transition between reactive and predictive eye tracking of alternating targets. At the slowest pacing, subjects made a reactive eye movement after the target moved. As the pacing frequency increased, there was an abrupt transition to a predictive response at higher frequencies. When pacing decreased in frequency, a phase transition again occurred, but this transition point was different. This hysteresis suggests that the tracking system has two stable behavioral modes reactive and predictive. Here we present preliminary data regarding the relative stability of these behaviors as the pacing of the targets are abruptly altered or perturbed.

374 (T55)

Synaptic Model for Spontaneous Activity in Developing Networks

Alexander Lerchner, John Rinzel
Technical University of Denmark

Spontaneous rhythmic activity is an almost universal phenomenon in developing neural networks. The activity in these hyperexcitable networks is comprised of recurring "episodes" consisting of "cycles" of high activity that alternate with "silent phases" with little or no activity. We introduce a new model of synaptic dynamics that takes into account that only a fraction of the vesicles stored in a synapse is readily available for release. We show that our model can reproduce spontaneous rhythmic activity with the same general features as observed in experiments, including a positive correlation between episode length and length of the preceding silent phase.

375 (T56)

Encoding Multiple Temporal Waveforms by Neural Population with Spike-time-dependent Plasticity

Naoki Masuda, Kazuyuki Aihara
RIKEN Brain Science Institute

Spike-time-dependent plasticity (STDP) supports the importance of spike timing and provides a mechanism for cluster formation, which may be relevant to the binding problem. We present numerical results on a feedforward network with two input sources and possible plastic feedback. Without feedback coupling, each downstream neuron encodes one of the two inputs independently. With fixed uniform feedback, global synchrony is induced. With symmetric STDP learning, two synchronous clusters stably coexist, both for excitatory population or inhibitory population. However, synchronous clusters cannot form with asymmetric STDP learning. Our results suggest different functional roles of symmetric and asymmetric STDP learning.

376 (T57)

Learning Temporal Clusters with Synaptic Facilitation and Lateral Inhibition

Chris L. Baker, Aaron P. Shon, Rajesh P.N. Rao
University of Washington

Short-term synaptic plasticity has been proposed as a way for cortical neurons to process temporal information. We present a model network that uses short-term plasticity to implement a temporal clustering algorithm. The model's facilitory synapses learn temporal signals drawn from mixtures of nonlinear processes. Units in the model correspond to populations of cortical pyramidal cells arranged in columns; each column consists of neurons with similar spatio-temporal receptive fields. Clustering is based on mutual inhibition similar to Kohonen's SOM's. A generalized expectation maximization (GEM) algorithm, guaranteed to increase model likelihood with each iteration, learns the synaptic parameters.

377 (T58)

A biophysical basis for the inter-spike interaction of Spike-Timing-Dependent Plasticity

Neel Shah, Luk Chong Yeung, Harel Z. Shouval and Leon N Cooper
Brown University

Experiments involving Spike-Timing Dependent Plasiticy (STDP) are often performed under artificial conditions, where one pre and one postsynaptic spike is delivered systematically at various time lags, and the corresponding change in synaptic strength is mapped onto the learning curve. However, the manner in which STDP generalizes for more complex temporal patterns of spikes is unknown. It has been shown that the effects of STDP from different spike pairs do not add independent or linearly. Here, we show that the previously proposed Calcium-Dependent Plasticity Model can reproduce this result if short-term depression and spike adaptation are taken into account. This suggests that, for realistic spike-trains, the canonical form of STDP is insufficient to account for the observed plasticity and complex cellular and synaptic biophysics must be considered.

378 (T59)

A simple rule for spike-timing-dependent plasticity local influence of AHP current

Anatoli Gorchetchnikov and Michael E. Hasselmo
Boston University

A classical Hebbian learning rule was adapted to produce spike-timing-dependent plasticity. The shape of the plasticity curve for this rule is shown to depend on local mechanisms such as the strength and length of afterhyperpolarization of the postsynaptic cell. The suggested rule can serve as a good approximation for the network models that use simplified dynamics of the membrane currents.

379 (T60)

Optimal Spike-Timing Dependent Plasticity for Precise Action Potential Firing

Jean-Pascal Pfister David Barber Wulfram Gerstner
EPFL

Synaptic connections can adapt so that the postsynaptic neuron generates an action potential at a desired firing time defined by the onset of a temporally inaccurate fuzzy teaching signal. We use a modelling framework to show that the optimal strategy of weight adaptation results in a two-phase learning window similar to that of Spike-Timing Dependent Plasticity (STDP). The temporal form of the optimal potentiation window reflects the time course of an excitatory postsynaptic potential. The duration of the optimal depression window reflects the duration of the teaching input.

380 (T61)

Synaptic Failures and a Gaussian Excitation Distribution

Joanna Tyrcha and William B Levy
University of Virginia Health System

The energetic efficiency of an axon depends on its average firing rate [5]. We hypothesize that the failure process of quantal synaptic transmission moves a neuron's input excitation distribution closer to a gaussian, which then helps a neuron more precisely achieve an energetically desirable firing rate. If there are many statistically independent inputs per neuron, excitation is binomial and well approximated by a gaussian distribution. Quantal failures are unnecessary but are essentially harmless. Such statistical independence is, however, too simplistic. To reflect statistical dependence among the inputs, we consider mixture distributions. Generally, mixture distributions are a distributional class that can be far from gaussian even though the individual component distributions themselves are gaussian, or nearly so. Here we show that quantal synaptic failures can move the kurtosis and skewness of mixture distributions towards gaussian values.

381 (T62)

Extracting information from the power spectrum of voltage noise

Alain Destexhe and Michael Rudolph
CNRS

We outline an approximation for obtaining an analytic expression of the power spectral density (PSD) of the membrane potential (Vm) in neurons subject to synaptic noise. In high-conductance states, there is a remarkable agreement between this approximation and PSDs computed numerically. This analytic expression can be used to predict how the PSD depends on the exact kinetic model for synaptic currents, as well as on the values of the rate constants. This approach can therefore yield methods to estimate the characteristics of the kinetics of individual synaptic conductances from the analysis of the Vm activity in intracellular recordings in vivo.

382 (T63)

Conduction Velocity Costs Energy

Thomas Sangrey and William B Levy
University of Virginia Health System

Hodgkin's 1975 hypothesis that the squid axon is optimized for maximum conduction velocity is flawed by its approximate value and the prohibitive energetic expense of his prediction. By considering the importance of metabolic demands placed on neurophysiological function, we investigate the metabolic cost of conduction velocity. In two separate parameterizations involving the manipulation of ion channel density and the Nernst battery strength, we find that the metabolic cost for velocity is significant and must be considered as energy expenditure in brain.

383 (T64)

Modeling of the exocytotic process by chemical kinetic formalism

Aviv Mezer, Esther Nachliel1 Menachem Gutman and Uri Ashery
Tel-Aviv University

The exocytotic process in neuroendocrine cells consists of a sequence of reactions between well-defined proteins. In the present study the interactions between the synaptic proteins were transformed into differential rate equations and exocytosis was described as dynamics of interactions between the proteins. The model can perfectly reconstruct the kinetic of exocytosis, the calcium dependent priming and fusion processes and the effects of genetic manipulation of synaptic proteins. The model suggests that fusion occur from two parallel pathways and assigns precise synaptic protein complexes to the two pathways. This model provides an excellent platform to predict and quantify the effects of protein manipulation on exocytosis.

384 (T65)

Cortical microcircuit with adapting synapses

Petr Marsalek and Eduard Kuriscak

Input and output firing frequencies of neocortical cells can range in two orders of magnitude. We studied, what parameters are important in a model of a neocortical network. The model maintains activities reported in experimental literature. Our aim is to show what is the contribution of more complex synapses. These synapses are dynamic - they have several state variables and at least two time constants with different orders of magnitude. We study the response of the network to modeled stimulation and we also study relation of the LTP/LTD phenomena to the state variables of the synapses.

385 (T66)

Synchronized Views for Exploring Populations of Neurons

Kay A. Robbins   Igor Grinshpan Kevin Allen   David M. Senseman
University of Texas at San Antonio

Davis (Data Viewing System) is a general-purpose data viewer designed for the simultaneous display of a large number of dynamic data sets. Davis was inspired by the need to explore computational models of the cerebral cortex. These systems are distinguished by complex dynamic elements interconnected in irregular patterns. Neuroscientists study the detailed behavior of individual elements and how these elements interact to achieve cortical function. This paper describes Davis and its use in cortical visualization. Davis is written in Java and can be run from a browser or as a standalone application. Users must provide an XML description of their data, which Davis uses for its menus, browsing and visualization. Davis visualizations can be applied to any collection of space-time data sets, and the Davis infrastructure allows visualizations to be added easily.

386 (T67)

No event left behind adapting variable timestep integration to networks

William Lytton and Michael Hines
SUNY Downstate

Realistic neural networks involve the co-existence of stiff, coupled, continuous differential equations arising from the integrations of individual neurons, with the discrete events with delays used for modeling synaptic connections. We present here an integration method, the local variable time step method (\lvardt) that utilizes separate variable step integrators for individual neurons in the network. Cells which are undergoing excitation tend to have small time steps and cells which are at rest with little synaptic input tend to have large time steps. A synaptic input to a cell causes re-initialization of only that cell's integrator without affecting the integration of other cells. Realistic neural networks involve the co-existence of stiff, coupled, continuous differential equations arising from the integrations of individual neurons, with the discrete events with delays used for modeling synaptic connections. We present here an integration method, the local variable time step method (\lvardt) that utilizes separate variable step integrators for individual neurons in the network. Cells which are undergoing excitation tend to have small time steps and cells which are at rest with little synaptic input tend to have large time steps. A synaptic input to a cell causes re-initialization of only that cell's integrator without affecting the integration of other cells. Realistic neural networks involve the co-existence of stiff, coupled, continuous differential equations arising from the integrations of individual neurons, with the discrete events with delays used for modeling synaptic connections. We present here an integration method, the local variable time step method (\lvardt) that utilizes separate variable step integrators for individual neurons in the network. Cells which are undergoing excitation tend to have small time steps and cells which are at rest with little synaptic input tend to have large time steps. A synaptic input to a cell causes re-initialization of only that cell's integrator without affecting the integration of other cells.

388 (T69)

NIPClassificator - Toward an evolvable neuroinformatics ontology

Thomas Frster, Andreas VM Herz, and Raphael Ritz
Humboldt-Universitaet Berlin

The Neuroinformatics Portal Pilot (NIP; http //www.neuroinf.de) is part of a larger effort to promote the exchange of neuroscience data, data-analysis tools, and modeling software. We develop the basic infrastructure needed for an optimal utilization of the many available resources on the web. Conceptual and technical problems have to be solved before the portal can serve the community in a most efficient way. Nevertheless the portal is operational already while still being further developed. In this contribution, we describe the design and planned usage of NIP's classification system.

REVIEWERS

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Van Drongelen, Wim
Vanpelt, Jaap
Victor, Jonathan
Wehr, Michael
Willshaw, David
Wilson, Charlie
Yamamoto, Kenji

BALTIMORE CITY GUIDE

BALTIMORE ATTRACTIONS

Arundel Mills Mall and Crayola Works - The Creativity Studio and Store
7000 Arundel Mills Circle
Hanover MD, 21076
Phone: 410-799-0400
Fax: 410-799-3360
Website: http://www.crayolaworks.com
Every visit to Crayola Works takes you on a magical journey into a world of color and creativity. It's a place where imagination knows no bounds... where artistic self-expression is the special every day!

Babe Ruth Birthplace and Museum
216 Emory Street
Baltimore MD, 21230
Phone: 410-727-1539
Fax: 410-727-1652
Website: http://www.baberuthmuseum.com
A national historic site, the museum is the birthplace of Babe Ruth; it's also the museum of Baltimore's Colts and Orioles, and Johnny Unitas. See rare artifacts, photos, videos and more. Located two blocks from Camden Yards.

Baltimore Museum of Art
10 Art Museum Drive
Baltimore, MD 21218
Phone: 410-396-7100
Website: www.artbma.org

Baltimore Museum of Industry
1415 Key Highway
Inner Harbor South
Baltimore MD, 21230
Phone: 410-727-4808
Fax: 410-727-4869
Website: http://www.thebmi.org
The museum that works! Visit re-created workshops, explore industry from days past, see the 1906 Steam Tug Baltimore -- a national historic landmark. Hands-on activities for kids, family theater productions, outdoor pavilion, free parking.

Baltimore Public Works Museum
751 Eastern Avenue
Pier 7 of the Inner Harbor
Baltimore MD, 21202
Phone: 410-396-5565
Fax: 410-545-6781
Explore the dynamic interrelationships of public works and urban life. Learn about the history of Baltimore's public works and the fascinating technology behind clean drinking water, recycling, tunnels and more!

Baltimore Zoo
Druid Hill Park
Baltimore MD, 21217
Phone: 410-396-7102
Fax: 410-396-6464
Website: http://www.baltimorezoo.org
Baltimore's wildest attraction! The zoo is home to more than 2,000 exotic mammals, birds and reptiles amid a wooded, 180-acre setting. Group rates and rental facilities are available.

Berrywine Plantations/Linganore Winecellars
13601 Glissans Mill Road
Mt. Airy MD, 21771
Phone: 410-795-6432
Fax: 301-829-1970
Estate vintages, grape, fruit and honey wines will entice you to this spectacular setting in the Linganore Viticultural area. Outdoor music fests, weekend events and picnics add to the fun.

Evergreen House
4545 N. Charles Street
Baltimore MD, 21210
Phone: 410-516-0341
Fax: 410-516-0864
Website: http://www.jhu.edu/historichouses
Evergreen House, a 48-room Italianate mansion on 26 acres offers guided tours of the home and its magnificent art collections while its carriage house and gardens are available for receptions, meetings, banquets and picnics.

Fells Point Maritime Museum
1724 Thames Street
Baltimore MD, 21231
Phone: 410-732-0278
Fax: NONE
Fell's Point produced the world's fastest ships and some of the Chesapeake's most colorful characters. Learn their stories at this waterfront museum.

Harborplace and the Gallery at Harborplace
200 E. Pratt Street
Baltimore MD, 21202
Phone: 410-332-4191
Fax: 410-547-7317
Website: http://www.harborplace.com
The heart of Baltimore's renowned Inner Harbor, Harborplace and The Gallery feature a mix of 101 unique shops, 16 sit-down restaurants and 40 diverse eateries, as well as live entertainment on the waterfront.

Ladew Topiary Gardens
3535 Jarrettsville Pike
Monkton MD, 21111
Phone: 410-557-9466
Fax: 410-557-7763
The most outstanding topiary garden in America features 15 thematic flower gardens on 22 acres. The historic manor house, built over three centuries, includes the famous oval library. Nature walk, cafe, gift shop and Carriage Museum.

Maryland Science Center
601 Light Street
Baltimore MD, 21230
Phone: 410-545-5927
Fax: 410-545-5973
Website: http://www.mdsci.org
One of Baltimore's premier locations for family entertainment. Located at the famed Inner Harbor, we offer three full floors of hands-on exhibits, IMAX films, planetarium shows, kids' room, observatory, Science Store and a new café.

Medieval Times Dinner & Tournament at Arundel Mills Mall
7000 Arundel Mills Circle
Hanover MD, 21076
Phone: 443-755-0011
Fax: 443-755-0033
Website: http://www.medievaltimes.com
Feast on a four-course meal while watching spectacular pageantry, exquisite horsemanship and an authentic medieval jousting tournament. An unforgettable evening for the entire family.

National Aquarium in Baltimore
Pier 3
501 E. Pratt Street
Baltimore MD, 21202
Phone: 410-576-3800
Fax: 410-576-8641
Website: http://www.aqua.org
Dive in for an unforgettable journey under the sea. Stunning exhibits and more than 11,000 aquatic animals make this Inner Harbor destination Baltimore's most popular attraction. Express entry available when you purchase tickets online at www.aqua.org.

Passport: Voyages of Discovery
Pier IV Building
621 E. Pratt Street, Suite 110
Baltimore MD, 21202
Phone: 410-468-0700
Fax: 410-468-0109
Website: http://www.passportvoyages.com
SEE, HEAR, FEEL and RIDE American history and experience the ocean in a new way at the first United States location of Passport: Voyages of Discovery. Combining film, motion seats and special effects, audiences become immersed in the adventure.

Port Discovery, the Kid-Powered Museum
35 Market Place
Baltimore MD, 21202
Phone: 410-727-8120
Fax: 410-727-3042
Website: http://www.portdiscovery.org
Voted Top Five Children's Museum in the U.S. (Child Magazine, Feb. 2002), Port Discovery, the Kid-Powered Museum offers ever-changing, interactive exhibits and programs for kids ages 2-12.

Power Plant Live!
34 Market Place
Baltimore MD, 21202
Phone: 410-727-LIVE
Fax: 410-659-9491
Website: http://www.powerplantlive.com
Baltimore's premier dining and entertainment district, located adjacent to Baltimore's Inner Harbor. This exciting new development features entertainment, restaurants and nightclubs -- all spilling out into a common plaza with outdoor seating.

Pride of Baltimore, Inc.
World Trade Center
401 E. Pratt Street, Suite 222
Baltimore MD, 21202
Phone: 410-539-1151
Fax: 410-539-1190
Website: http://www.prideofbaltimore.org
Pride of Baltimore II, a representative of an 1812-era Baltimore Clipper, promotes economic trade and tourism for Maryland and Baltimore city. When in home Chesapeake Bay waters, she provides public day sails and is available for group sails/receptions.

Ride the Ducks of Baltimore
25 Light Street
3rd Floor
Baltimore MD, 21202
Phone: 410-727-DUCK
Fax: 410-727-8659
Website: http://www.baltimoreducks.com
Take a Baltimore adventure aboard an amphibious duck! See the city from both land and sea as the expedition takes you through historic sites and neighborhoods, then plunges into the Inner Harbor for a water tour!

World Trade Center
401 E. Pratt Street, 27th Floor
Baltimore MD, 21202
Phone: 410-837-VIEW
Fax: 410-837-0845

Start your visit to Baltimore with a breathtaking view of the city's skyline and beyond from the world's tallest pentagonal building, designed by I.M. Pei. Top of the World offers a 360-degree view of the horizon.

Walters Art Museum
600 N. Charles Street
Baltimore MD, 21201
Phone: 410-547-9000
Fax: 410-727-7591
Experience 55 centuries of art at the Walters. Featuring Egyptian mummies, medieval armors, illustrated manuscripts, Asian art and European masterpieces. Admission includes audio tour and Saturday children's activities. A must-see during any visit to Baltimore!

Day trips outside of Baltimore:
Washington DC, Smithsonian Institute
Historic Annapolis, the Capitol of Maryland

BALTIMORE RESTAURANTS

100 Great Places to Eat Listed Alphabetically

Afghan Kabab
37 S. Charles Street
Suite C
Baltimore MD, 21201
Phone: 410-727-5511
Fax: 410-727-0511

Afghan Kabab is the best quality and fastest carryout Afghan cuisine in the city. Located at the corner of Lombard and Charles, across from the Legg Mason Bldg. We are only one block from the Baltimore Convention Center.

Akbar
823 N. Charles Street
Baltimore MD, 21201
Phone: 410-539-0944
Fax: 410-539-0308
Website: http://www.akbar-restaurant.com

An elegantly decorated restaurant, with authentic Indian cuisine, featuring tandoori lamb, chicken, seafood and a wide variety of vegetable dishes.

Aldo's Ristorante Italiano
306 S. High Street
Baltimore MD, 21202
Phone: 410-727-0700
Fax: 410-625-3700
Website: http://www.aldositaly.com

Award-winning chef/owner Aldo Vitale's eponymous restaurant has garnered both national and international attention for its sophisticated, uncomplicated style of Southern-influenced, regional Italian cuisine, featuring seasonal ingredients. 'Baltimore's Premier Italian Restaurant.'

Alonso's
415 W. Cold Spring Lane
Baltimore MD, 21210
Phone: 410-235-3433
Fax: 410-889-3833
Website: http://www.alonsos.com

Your neighborhood bar and package goods store. Home of the best hamburgers since 1931.

Amicci's
231 S. High Street
Baltimore MD, 21202
Phone: 410-528-1096
Fax: 410-685-6259

Discover what residents of Baltimore and Little Italy have known for years -- 'Freshly prepared seafood, chicken and pasta doesn't have to be expensive, just good!'

Attman's Authentic New York Delicatessen
1019 E. Lombard Street
Baltimore MD, 21202
Phone: 410-563-2666
Fax: 410-563-0222

Attman's is the best place to bring your appetite. Delicious New York style hot corned beef, hot New York pastrami, bagels and lox, smoked fish, potato knishes, meat knishes, matzo ball soup and homemade potato latke.

Asahi Sushi
629 S. Broadway
Baltimore, MD
410-534-4255

Babalu Grill
32 Market Place
Baltimore MD, 21202
Phone: 410-234-9898
Fax: 410-234-8028
Website: http://www.serioussteaks.com

Named one of the top 50 Latin restaurants in the United States by Hispanic Magazine, Babalu Grill features authentic Cuban cuisine from family recipes and a fun, exciting atmosphere. Enjoy authentic mojitas and lively Latin music. Valet parking available.

Bandaloops
1024 S. Charles Street
Baltimore MD, 21230
Phone: 410-727-1355
Fax: 410-727-8398

Serving casual contemporary creative cuisine in a friendly neighborhood atmosphere. With our list of daily specials, you'll never grow tired of our menu.

Bertha's
734 S. Broadway
Baltimore MD, 21231
Phone: 410-327-5795
Fax: 410-732-1548

Mussels, ales, jazz and Scottish teas.

Bistro 300
Hyatt Regency Baltimore
300 Light Street
Baltimore MD, 21202
Phone: 410-605-2839
Fax: 410-605-2870

Bistro 300 offers casual dining with a daily service of breakfast buffets; a lunch buffet Monday through Friday; and evening dining that includes a wide array of martinis and local microbrews. Brunch on Sundays.

Blue Agave Restaurante Y Tequileria
1032 Light Street
Baltimore MD, 21230
Phone: 410-576-3938
Fax: 410-576-5134

Casual upscale restaurant, serving traditional, regional Mexican cuisine. Over 80 tequilas of 100% agave. Critically acclaimed hot spot by Baltimore Magazine, Baltimore Sun, City Paper, Zagat's 2002, Restaurant News, Amtrak's Arrive Magazine. Reservations suggested.

Blue Sea Grill
614 Water Street
Baltimore MD, 21202
Phone: 410-837-7300
Fax: 410-837-7200
Website: http://www.serioussteaks.com

A welcome addition to Baltimore's Restaurant Row, the mid-Atlantic's premier seafood experience features an elegant raw bar, daily delivered fresh fish and an extensive wine list with a wait staff trained to cater to your pleasure.

Bo Brooks at Lighthouse Point
2780-A Lighthouse Point
Baltimore MD, 21224
Phone: 410-558-0202
Fax: 410-558-1102

'Baltimore's Best' crab house at Baltimore's best location. Casual fine dining on the water in Canton. Full seafood menu with steaks, salads and chicken. Indoor and outdoor dining. Banquet facilities available. Eat in or take out.

Boccaccio Restaurant
925 Eastern Avenue
Baltimore MD, 21202
Phone: 410-234-1322
Fax: 410-727-6318

Owner and chef Giovanni Rigato specializes in Northern Italian cuisine and Mediterranean seafood. Ambiance lends itself to an atmosphere of friendliness and fine dining. Extensive wine selection. Major credit cards accepted.

Brass Elephant
924 N. Charles Street
Baltimore MD, 21201
Phone: 410-547-8480
Fax: 410-783-2933
Website: http://www.brasselephant.com

Step back to the Victorian era. Lavish appointments of hand-carved teakwood, sculpted marble and intricately detailed brass complement our classically prepared American and continental cuisine and nationally acclaimed wine list.

Brewer's Art
1106 N. Charles Street
Baltimore, MD
410-547-9310

Brightons
Harbor Court Hotel
550 Light Street
Baltimore MD, 21202
Phone: 410-234-0550
Fax: 410-659-5925

Brightons...classic American cuisine, better than you've ever had it before. Informal elegance. Private alcove table with harbor view. Breakfast, lunch, afternoon tea and dinner. Complimentary valet parking.

Cactus Willie's, Steak Buffet & Bakery
7940 Eastern Ave.
Baltimore MD, 21224
Phone: 410-233-8600
Fax: 410-233-0108
Website: http://www.cactuswillies.com

Cactus Willie's is an all-you-can-eat buffet featuring an open flame grill where steaks and chicken breasts are cooked to order. Serving stations feature ribs, shrimp, vegetables, salads, desserts and unlimited beverages.

Cafe Bombay
114 E. Lombard Street
Baltimore MD, 21202
Phone: 410-539-2233
Fax: 410-788-1371
Website: http://www.bombaygrill.com

Cafe Bombay, the first Indian restaurant featuring a full line of both Northern and Southern cuisine! One block from major attractions, hotels and the Inner Harbor. Casual yet elegant, the ideal luncheon and dinner place!

Cafe di Roma
413 S. High Street
Baltimore MD, 21202
Phone: 410-685-1151
Fax: 410-685-1153

Cafe Hon
1002 W. 36th Street
Baltimore MD, 21211
Phone: 410-243-1133
Fax: 410-243-6461
Website: http://www.cafehon.com

Baltimore's hon style featured in the NY Times. Much Better than Mom's Meatloaf, full bar and special event catering, hon. Experience real Baltimore home-style cooking in the heart of happening Hampden.

Café Promenade
Baltimore Marriott Inner Harbor
110 S. Eutaw Street
Baltimore MD, 21201
Phone: 410-962-0202
Fax: 410-625-7832

For casual breakfast, lunch or dinner featuring a daily breakfast buffet and a weekday luncheon buffet. Ideally located in the Marriott Inner Harbor across from Oriole Park at Pratt and Eutaw streets.

California Pizza Kitchen
Pratt Street Pavilion
201 E. Pratt Street
Baltimore MD, 21202
Phone: 410-783-9339
Fax: 410-783-4706

CPK is the leader in authentic California-style cuisine and is known for menu items that draw inspiration from today's broad cultural influences. CPK provides a range of creative dishes, from signature hearth-baked pizzas to innovative salads, pastas, soups and sandwiches.

Capitol City Brewing Company
301 S. Light Street
#93 Light Street Pavilion
Baltimore MD, 21202
Phone: 410-539-7468
Fax: 410-539-5909
Website: http://www.capcitybrew.com

Fine American food served alongside award-winning microbrews on the waterfront in Baltimore's downtown scenic Inner Harbor.

Charleston
1000 Lancaster Street
Baltimore MD, 21202
Phone: 410-332-7373
Fax: 410-332-8425

Bon Appetit touted Charleston as 'the city's finest restaurant' (04/01), and Robert Parker of The Wine Advocate lauded Charleston as 'Baltimore's uncontested world-class dining destination' (12/00). Chef Cindy Wolf's signature cuisine is complemented by an award-winning wine list.

Chiapparelli's Restaurant
237 S. High Street
Baltimore MD, 21202
Phone: 410-837-0309
Fax: 410-783-7985
Website: http://www.chiapparellis.com

Chiapparelli's is one of Little Italy's best-known and best-loved restaurants. The menu includes homemade pasta, seafood, veal dishes and our famous house salad. Banquet facilities and valet parking available.

Ciao Bella Restaurant
236 S. High Street
Baltimore MD, 21202
Phone: 410-685-7733
Fax: 410-625-4847

Quaint, casually elegant restaurant in the heart of Little Italy specializing in delicious fresh seafood, veal and pasta. For your convenience, we also have valet parking. Reservations recommended.

City Lights Seafood Restaurant
Harborplace
301 Light Street
Baltimore MD, 21202
Phone: 410-244-8811
Fax: 410-244-8815
Website: http://www.citylightsseafood.com

Experience the Baltimore traditions of fresh seafood, good friends and harbor-side dining at City Lights. Only a four-minute walk from the Baltimore Convention Center via elevated skywalks.

Corks
1026 S. Charles Street
Baltimore MD, 21230
Phone: 410-752-3810
Fax: 410-752-0408

Chef owner Jerry Pellegrino creates exciting eclectic nouvelle cuisine in historic Federal Hill. Private dining facilities available in cozy enclosed patio setting. Outstanding vintage wine selection. Distinctive dining, elegant surroundings and attentive service.

Crabby Dick's Restaurant
606 S. Broadway
Baltimore MD, 21231
Phone: 410-327-7900
Fax: 410-327-0749

Baltimore Style home cooking, hot and juicy crabs. Full menu including burgers, pasta, steaks and seafood. Family Friendly, locally owned and operated in historic Fells Point. Visit our Web site at www.crabby-dicks.com / http://www.crabby-dicks.com.

Dalesio's of Little Italy
829 Eastern Avenue
Baltimore MD, 21202
Phone: 410-539-1965
Fax: 410-576-8749

A softly lit townhouse, known best for its fine Italian, seafood and spa cuisine. A tradition of excellence that stands apart from the others in Baltimore's Little Italy.

Della Notte Ristorante
801 Eastern Avenue
Baltimore MD, 21202
Phone: 410-837-5500
Fax: 410-837-2600
Website: http://www.dellanotte.com

Innovative and traditional Italian cuisine featuring the finest pasta, veal, beef, lamb, poultry and seafood. 'Award of Excellence': Distinguished Restaurants of North America; 'Best of Award of Excellence': the Wine Spectator. Live entertainment nightly. Free parking and shuttle service.

Eight East
Tremont Suite Hotel
8 E. Pleasant Street
Baltimore MD, 21202
Phone: 410-576-1200
Fax: 410-244-1154

Eight East Restaurant is famous for its authentic Maryland crab cakes. We serve lunch Monday-Friday with daily wonderful specials. Dinner is served seven days a week from 5:00 - 7:00 p.m. Menu: Seafood, steaks and pasta.

ESPN Zone
Power Plant
601 E. Pratt Street
Baltimore MD, 21202
Phone: 410-685-3776
Fax: 410-244-8222

The ESPN Zone is a sports-themed dining and entertainment experience in Baltimore's Inner Harbor. The Studio Grill, Screening Room and the Sports Arena are ideal for private events and group functions.

Eurasian Harbor
Pier 5 Hotel at the Inner Harbor
711 Eastern Avenue
Baltimore MD, 21202
Phone: 410-230-9992
Fax: 410-230-9993
Website: http://www.serioussteaks.com

Our chefs have married the finest of European and Asian culture to create an unexpected, exotic blend of tastes -- all in a single dish. Come early for one of our award-winning drinks. They are as delicious as our sushi and sashimi. Valet parking is available.

Fleming's Prime Steakhouse and Wine Bar
720 Aliceanna Street
Baltimore MD, 21202
Phone: 410-332-1666
Fax: 410-332-0436

Experience classic steakhouse dining at the nationally acclaimed Fleming's Prime Steakhouse and Wine Bar featuring 100 fine wines by the glass. For a truly memorable evening for larger groups, two private dining rooms are available for 20-70 guests.

Geckos
2318 Fleet Street
Baltimore MD, 21224
Phone: 410-732-1961
Fax: 410-534-0838

Serving fine Southwestern cuisine in a cool casual atmosphere featuring salsa sensations -- chicken and sweet potato quesadilla, enchiladas and nightly specials seven days a week. On Sunday try our champagne brunch from 11:30 a.m.-3:00 p.m.

George's on Mt. Vernon Square
Peabody Court Hotel
101 W. Monument Street
Baltimore MD, 21201
Phone: 410-727-1314
Fax: 410-789-3312

'Casual dining room of Baltimore's fanciest boutique hotel.' Fine wines and casual dining. Georges' eclectic wine menu features 25 different wines that are available by the glass. Breakfast, lunch and dinner available.

Germano's Trattoria
300 S. High Street
Baltimore MD, 21202
Phone: 410-752-4515
Fax: 410-625-6472
Website: http://www.germanostrattoria.com

Authentic Tuscan cuisine. Three dining rooms, attractively decorated with turn-of-the-century artwork. Groups up to 150. Valet parking. Complimentary transport to and from hotels. Full-service and off-premise catering.

Hampton's
Harbor Court Hotel
550 Light Street
Baltimore MD, 21202
Phone: 410-234-0550
Fax: 410-659-5925

Hampton's...New American cuisine. European service. Harbor views. Overstuffed chairs. Table privacy. Classic Edwardian interiors. Award-winning wine list. One of America's Top 50 Restaurants by Conde Naste Traveler magazine.

Hard Rock Cafe
The Power Plant/The Inner Harbor
601 E. Pratt Street
Baltimore MD, 21202
Phone: 410-347-7625
Fax: 410-576-2334

Legendary parties since 1971. Hard Rock Cafe located in the Power Plant features down-home American food seasoned with a healthy dose of rock 'n' roll. Cool memorabilia and merchandise. For private parties, contact our party professionals.

Helmand Restaurant
806 N. Charles Street
Baltimore MD, 21201
Phone: 410-752-0311
Fax: 410-442-2682

The first Afghan restaurant in Baltimore, inexpensively priced with a reasonable wine list, includes kebabs and vegetarian dishes. Chosen top restaurant by Baltimore Sun, City Paper and Baltimore Magazine.

Ikaros Restaurant
4805 Eastern Avenue
Baltimore MD, 21224
Phone: 410-633-3750
Fax: 410-633-7881

Greek restaurant also serving American foods. Specializing in high-quality, large quantity foods at value prices. Established 1969.

Ixia Restaurant Bar Lounge
518 N. Charles Street
Baltimore MD, 21201
Phone: 410-727-1800
Fax: 410-727-1887

Progressive fine dining establishment with cocktail lounge and bar. Some American cuisine with Pacific Rim and Mediterranean influences. Open seven days a week, Wednesday - Saturday, 11 a.m. - 2 a.m.; Sunday - Tuesday, 11 a.m. - midnight; and happy hour 4-7 p.m. weekdays.

J. Paul's Dining Saloon
301 Light Street
Harborplace
Baltimore MD, 21202
Phone: 410-659-1889
Fax: 410-659-1997
Website: http://www.capitalrestaurants.com

J. Paul's is a classic version of a turn-of-the-century American saloon designed to meet the tastes of today.

James Joyce Irish Pub & Restaurant
616 S. President Street
Baltimore MD, 21202
Phone: 410-727-5107
Fax: 410-727-8615

'The Home of Irish Hospitality.' Built in Ireland and shipped to Baltimore's Inner Harbor, this authentic Irish pub serves American Irish cuisine. Open daily 11:00 a.m. - 2:00 a.m. Live music every Tuesday - Saturday at 9:00 p.m. No cover.

Jimmy’s Famous Seafood
2526 Holabird Avenue
Dundalk, MD
410-633-4040

A true Baltimore Crab House!

Kali's Court
1606 Thames Street
Fells Point MD, 21231
Phone: 410-276-4700
Fax: 410-276-2420

Kawasaki Japanese Seafood Restaurant
413 N. Charles Street
Baltimore MD, 21201
Phone: 410-659-7600
Fax: 410-625-0607

Japanese cuisine at its best, served in a comfortable atmosphere. Sushi bar. Entrees include beef, pork and chicken dishes. Validated parking -- Franklin Garage. Lunch, Monday - Friday. Dinner, Monday - Saturday.

Kobe Teppan & Sushi
1023 N. Charles Street
Baltimore MD, 21202
Phone: 410-685-0780
Fax: NONE

Featuring tableside food preparation. Watch entertaining chefs chop, cook and create fresh, delicious meals before your eyes. Kobe Sushi follows old and new trends, using the freshest fish for their seafood and sushi dishes.

L.P. Steamers
1100 E. Fort Avenue
Baltimore MD, 21230
Phone: 410-576-9294
Fax: 410-576-0591

L.P. Steamers -- top crab house -- voted Baltimore Magazine's, 'Best Seafood,' Sun Papers and New York Times. Casual, local, friendly; steamed crabs. Seven days a week. Catering available, large or small.

La Scala Ristorante Italiano
1012 Eastern Avenue
Baltimore MD, 21202
Phone: 410-783-9209
Fax: 410-783-5949

Located in historic Little Italy, our menu offers a variety of classic pasta, veal, chicken and seafood dishes; innovative daily specialties; and tempting homemade desserts. Complimentary van service available to all downtown hotels. Private parties and catering available.

La Tavola Ristorante Italiano
248 Albemarle Street
Baltimore MD, 21202
Phone: 410-685-1859
Fax: 410-685-1891
Website: http://www.la-tavola.com

Three-time award winner 'Best Italian Restaurant' (1997, 1998 and 2000) offers an extensive and reasonably priced selection of fresh homemade pastas, fresh seafood delivered daily and a variety of veal entrees. Private rooms available for small or large groups.

Legal Sea Foods, Inc.
100 E. Pratt Street
Baltimore MD, 21202
Phone: 410-332-7360
Fax: 410-332-8009

For over 50 years Legal Seafood has served the freshest seafood possible. Freshness is something that cannot be told, it must be tasted. Private dining available with various menu options; outside seating for your pleasure.

Little Havana
1325 Key Highway
Baltimore, MD
410-837-5716

Loco Hombre
413 W. Cold Spring Lane
Baltimore MD, 21210
Phone: 410-889-2233
Fax: 410-889-3833
Website: http://www.locohombre.com

The best Mexican food north of the Rio Grande. Loco Hombre features an eclectic menu of the most traditional Mexican dishes to a host of delicious, innovative, gourmet specials.

Louisiana Restaurant
1708 Aliceanna Street
Baltimore MD, 21231
Phone: 410-327-2610
Fax: 410-529-6286

Fine dining in historic Fell's Point. Voted Baltimore's Best New Restaurant and Best Hot Spot in 2000. Classic French cooking with a Southern flair. Extensive wine list and valet parking. Private meeting rooms available.

M & S Grill
201 E. Pratt Street
Baltimore MD, 21202
Phone: 410-547-9333
Fax: 410-547-8383

Max's at Camden Yards
300 W. Pratt Street
Baltimore MD, 21201
Phone: 410-234-8100
Fax: 410-332-4101

Great American fare in a pub setting located in downtown Baltimore, across from the famed Oriole Park at Camden Yards and the newly renovated Baltimore Convention Center. Open for lunch, dinner and late-night snacks.

McCormick & Schmick's Seafood Restaurant
711 Eastern Avenue
Baltimore MD, 21202
Phone: 410-234-1300
Fax: 410-659-7388

McCormick and Schmick's Seafood Restaurant at Pier V in Baltimore's Inner Harbor reflects a commitment to culinary excellence by showcasing a rich bounty of seafood specialties from the Pacific Northwest, Atlantic Seaboard and Chesapeake Bay.

Michener's Restaurant
Sheraton International Hotel
7032 Elm Road
Baltimore MD, 21240
Phone: 410-859-3300
Fax: 410-859-0565

Located at the Sheraton BWI, offering New American cuisine in a relaxing atmosphere.

Mondo Bondo
30 Market Place
Baltimore, MD
410-244-8080

Morton's of Chicago
300 S. Charles Street
Baltimore MD, 21201
Phone: 410-547-8255
Fax: 410-547-8244

America's premier steakhouse features U.S.D.A. prime aged beef and fresh seafood. Classic decor provides the perfect atmosphere for business or celebration. Private dining is available in our boardrooms. Inquire about luncheons.

Mother's Federal Hill Grille
1113 S. Charles Street
Baltimore MD, 21230
Phone: 410-244-8686
Fax: 410-783-1122
Website: http://www.mothersgrille.com

This neighborhood restaurant is in the heart of historic Federal Hill. It serves lunch and dinner seven days a week and breakfast on Saturday/Sunday. Specializing in seafood and fresh fish. Free parking. Groups and buses welcome.

Mt. Vernon Stable & Saloon
909 N. Charles Street
Baltimore MD, 21201
Phone: 410-685-7427
Fax: 410-244-7040

We specialize in baby back ribs imported from Denmark, along with barbeque chicken, hamburgers, Tex-Mex entrees and daily specials. Downstairs bar open until 2 a.m. daily.

Obrycki's Crab House and Seafood Restaurant
P.O. Box 38218
1727 E. Pratt Street
Baltimore MD, 21231-1817
Phone: 410-732-6399
Fax: 410-522-4637

World-renowned crab house and seafood restaurant located just minutes from downtown Baltimore. Favored by locals and visitors alike, Obrycki's specializes in Maryland seafood, steamed crabs and fun dining.

Paolo's Ristorante
Inner Harbor - Light Street Pavilion
Baltimore MD, 21202
Phone: 410/539-7060

It's a toss-up which is more attractive - the Northern Italian dishes, the harbor view, or the clientele at this popular restaurant and watering hole. Paolo's offers pasta dishes with an American flare, grilled meats, unique wood-fired pizzas, sumptuous salads, excellent wine selections and fabulous desserts.

Phillips Harborplace Restaurant
301 Light Street
Inner Harbor - Light Street Pavilion
Baltimore MD, 21202
Phone: 410-685-6600
Fax: 410-685-0512

Phillips Seafood Restaurant overlooking Baltimore's Inner Harbor is a Maryland tradition. Our award-winning cuisine and friendly atmosphere offer an unforgettable experience. Sample recipes featuring fresh Chesapeake Bay seafood. Banquet facilities, crab feasts and seafood buffet.

Pier 4 Kitchen + Bar
The Pier 4 Building
621 E. Pratt Street
Baltimore MD, 21202
Phone: 410-659-1200
Fax: NONE

Pier 4 Kitchen + Bar specializes in fresh seafood along with great views of Baltimore harbor. It has a 'big city' atmosphere showcasing an oyster bar and a bustling open kitchen. Private space available.

Pisces

Pisces
Hyatt Regency Baltimore
300 Light Street
Baltimore MD, 21202
Phone: 410-605-2835
Fax: 410-605-2870

The Champagne Jazz Brunch offers the sounds of piano while enjoying complimentary champagne. Brunch selections include a complete raw bar, gourmet salads, fresh fruit, and imported and domestic cheeses, along with a variety of bakery items, berries and sinfully rich desserts.

Plaza Deli
Tremont Plaza Hotel
222 St. Paul Place
Baltimore MD, 21202
Phone: 410-528-8800
Fax: 410-685-5273

New York style gourmet deli featuring homemade sandwiches, soups and salads. Open seven days until 10:00 p.m. Free delivery. Catering and gift baskets are our specialty.

Porter's Pub & Grille
1032 Riverside Avenue
Baltimore MD, 21230
Phone: 410-539-1999
Fax: 410-783-1754

Historic Porters Pub & Grille in Federal Hill is the perfect place to take a break from the crowds of the Inner Harbor. It’s equally welcoming to families or fans wanting to catch the ballgame.

Power Plant / The Cordish Company
601 E. Pratt Street
The Power Plant, 6th Floor
Baltimore MD, 21202
Phone: 410-752-5444
Fax: 410-659-9491

The Power Plant, located on Baltimore's Inner Harbor, is the country's pre-eminent entertainment complex. Featuring Hard Rock Café, Barnes & Noble, Gold's Gym, ESPN Zone, Passport Voyages, Chipotle, Power Dogs, and Pier 4 Kitchen + Bar. It's the perfect downtown destination.

Purple Orchid
729 E. Pratt Street
Baltimore MD, 21202
Phone: 410-837-0080
Fax: 410-837-2813

Spicy fillet of tuna with sesame sauce, crispy duck a la orange, jumbo lump crab cake, lamb chops, and Kobe Beef Diane. Winner of Wine Spectator Award / Culinary Salon Gold Awards / Award of Excellence.

Red Maple
930 N. Charles Street
Baltimore MD, 21201
Phone: 410-547-0149
Fax: 443-524-1995
Website: http://www.930redmaple.com

Opened in December 2001, Red Maple has set a new standard for the modern dinner-lounge experience found here in Baltimore and far beyond. New Asian tapas, cocktails, down tempo DJs and late-night lounging.

Rick's Café Americain
2903 O'Donnell Street
Canton, MD
410-675-1880

Roy's of Baltimore
720-B Aliceanna Street
Baltimore MD, 21202
Phone: 410-659-0099
Fax: 410-659-0075

Roy's, featuring Hawaiian fusion cuisine! Menu offers bold Asian spices, European sauces and fresh ingredients with an emphasis on fresh seafood. Banquet space available. Reservations recommended.

Rusty Scupper Restaurant
402 Key Highway
Baltimore MD, 21230
Phone: 410-727-3678
Fax: 410-234-1084
Website: http://www.selectrestaurants.com

American cuisine with emphasis on fresh seafood, beef and pasta. Panoramic view of Baltimore's Inner Harbor. Lunch, dinner and Sunday brunch. Banquet and meeting facilities. Reservations suggested. Groups welcome. Call Kathy Atterbury for parties of 10 or more.

Ruth's Chris Steak House
600 Water Street
Baltimore MD, 21202
Phone: 410-783-0033
Fax: 410-783-0049
Website: http://www.serioussteaks.com

Ruth's Chris Steak House serves hand-cut, never frozen, U.S.D.A. prime beef, fresh seafood -- including live Maine lobster -- in an atmosphere of casual elegance. Exceptional service. Outstanding wine list. Valet parking is always available.

Sabatino's Italian Restaurant
901 Fawn Street
Baltimore MD, 21202
Phone: 410-727-2667
Fax: 410-837-6540
Website: http://www.sabatinos.com

Traditional homestyle Italian cuisine in a casual setting. Baltimore's People's Choice: Best Italian Restaurant 1997. We invite you to dine with us. Complimentary transportation to and from hotels. Lunch, dinner and late-night dining daily.

Saffron
802 N. Charles Street
Baltimore MD, 21201
Phone: 410-528-1616
Fax: 410-528-1310

Baltimore's newest eclectic, fusion style restaurant. Hints of Asian, enveloped in 'World Inspirations' -- with French and European influences. Highly publicized for its most unique menu, extravagant wine list and fantastic décor. Fine dining at its finest!

Samos
600 Oldham Street
Highlandtown, MD
410-675-5392

In the heart of Greektown. BYOB.

Shula's Steakhouse
101 W. Fayette Street
Baltimore MD, 21201
Phone: 410-385-6604
Fax: 410-244-6584
Website: http://www.donshula.com

One of North America's top 10 steak houses. Exceptional steaks, fresh seafood and four-pound live Maine lobster. Don Shula's Hall of Fame Lounge: featuring premium cigars, martinis and cordials. Shula's elegance is available for banquets.

Soigné
554 E. Fort Avenue
Baltimore, MD
410-659-9898

Sotto Sopra, Inc.
405 N. Charles Street
Baltimore MD, 21201
Phone: 410-625-0534
Fax: 410-625-2642
Website: http://www.sottosoprainc.com

Contemporary Italian restaurant set in the famous Charles Street corridor. We boast a casual, yet aristocratic atmosphere. Our new and inventive dishes make us one of the top 10 dining establishments in the Baltimore area.

Ten-O-Six
1006 Light Street
Baltimore MD, 21230
Phone: 410-528-2146
Fax: NONE

Selected as a 'Best Restaurant In Baltimore' 2000-2003, Baltimore Magazine. Zagat Award of Distinction. 'Food was breathtakingly presented' -- Susan Fradkin, City Paper, May 1999. 'I'd like to nominate as the best spring roll ever created' -- Elizabeth Large, Baltimore Sun, March 1999.

Tex Mex Grill
201 E. Pratt Street
Baltimore MD, 21202
Phone: 410-783-2970
Fax: 410-783-9521

Casual Tex-Mex dining in a relaxing Southwest atmosphere enhanced by the sweeping vistas of the Inner Harbor. Specializing in fajitas, ribs, burritos. Try our Lone Star beef and our Texas-size margaritas.

Thai Arroy
1019 Light Street
Baltimore, MD
410-385-8587

The Black Olive
814 S. Bond Street
Baltimore MD, 21231
Phone: 410-276-7141
Fax: 410-276-7143
Website: http://www.theblackolive.com

Experience classic Mediterranean Greek whole-grilled seafood. Voted Best Overall Restaurant, City Paper, 1998; Best Seafood, Baltimore Magazine, 1998; and Zagat's Best Seafood, 1999. Intimate private dining room and distinctive service in beautiful Fell's Point.

The Point Restaurant
at the Admiral Fell Inn
814 South Broadway
Historic Fell's Point
Baltimore MD, 21231
Phone: 410-558-0929
Fax: 410-558-1013

Overlooking the Square in Historic Fell's Point. Relaxed neighborhood pub atmosphere, imaginative casual fare, a variety of local microbrews and imports, and wines by the glass. Lunch and dinner daily; Sunday buffet brunch.

The Prime Rib, Inc.
1101 N. Calvert Street
Baltimore MD, 21202
Phone: 410-539-1804
Fax: 410-837-0244

Svelte, sleek, sophisticated and noted for its perfect martinis, slabs of juicy prime rib, giant veal chops, crab imperial and crab cakes. Referred to as Baltimore's 21 Club. Serving dinner every evening. Piano and bass nightly.

Thir-Tea-First Street Cafe & Tea Room
414 E. 31st Street
Baltimore MD, 21218
Phone: 410-889-7112
Fax: NONE

Quaint atmosphere/Victorian setting. Enjoy everything from afternoon or high tea to elegant dining. Breakfast, lunch and tea is served daily, Tuesday - Friday, 10 a.m. - 6 p.m. Dinner by reservation only, Tuesday - Sunday. Home of 'Saturday brunch,' 10 a.m. - 3 p.m.

Tio Pepe Restaurant
10 E. Franklin Street
Baltimore MD, 21202-2241
Phone: 410-539-4675
Fax: 410-837-7288

Heralded as one of Baltimore's most popular restaurants, we are dedicated to offering authentic Spanish cuisine such as paella, fillet of sole with bananas and many other Spanish favorites.

Tradewinds Restaurant and Lounge
Best Western Hotel & Conf. Ctr.
5625 O'Donnell Street
Baltimore MD, 21224
Phone: 410-633-9500
Fax: 410-633-2812

Moderate prices and a relaxed atmosphere make Tradewinds the perfect break from your travels. Seafood and steaks are just part of the picture ... we also have pastas, salads and great desserts.

Tug's Restaurant
Tremont Plaza Hotel
222 St. Paul Place
Baltimore MD, 21202
Phone: 410-244-7300
Fax: 410-685-4215

Tug's Restaurant and Bar specializes in fresh seafood, steaks and fabulous overstuffed sandwiches at reasonable prices. Perfect for families, couples or individuals. Open weekdays 6:30 a.m. - midnight, and weekends 7:30 a.m. - midnight.

Uncle Lee's Harbor Restaurant
44 South Street
Baltimore MD, 21202
Phone: 410-727-6666
Fax: 410-625-1425

Fine Chinese restaurant located one block from the Inner Harbor. Dine-in or carryout. We specialize in a tasty variety of your favorite Chinese dishes!

Vespa
1117 S Charles Street
Baltimore, MD
410-385-0355

Wharf Rat - Camden Yards
206 W. Pratt Street
Baltimore MD, 21201
Phone: 410-244-8900
Fax: 410-659-1676

A friendly English-style pub with full-service dining and an exhibition brewery. Twelve of our own Oliver Ales and several guest draughts offered. Special tastings and tours daily until 7:00 p.m.

Windows Restaurant at Renaissance Harborplace Hotel
Renaissance Harborplace Hotel
202 E. Pratt Street
Baltimore MD, 21202
Phone: 410-685-VIEW
Fax: 410-783-9676

Spectacular view overlooking the Inner Harbor, Windows is an all-day dining restaurant featuring award-winning dishes. Perfect for power breakfasts, business luncheons and romantic dinners. Private dining room available for up to 12 people.

Ze Mean Bean Cafe
1739 Fleet Street
Baltimore MD, 21231
Phone: 410-675-5999
Fax: 410-732-2632

Eclectic Fell's Point bistro serving American and traditional Eastern European cuisine, incredible homemade desserts and specialty coffees. Jazz Brunch Sundays, Slavic Night Thursdays and our acclaimed wine dinner on the third Wednesday each month.

BALTIMORE RESTAURANTS
Listed by Cuisine

Afghan
Afghan Kabab
Helmand Restaurant

American
Alonso's
Bandaloops
Bistro 300
Brewer's Art
Brighton's
Cactus Willie's
Café Hon
Café Promenade
California Pizza Kitchen,
Capitol City Brewing Co.
Eight East
ESPN Zone
Fleming's
George's on Mt. Vernon Sq.
Hampton's
Hard Rock Café
J. Paul's
M&S Grill
Max's at Camden Yards
Morton's of Chicago
Mt. Vernon Stable
Porter's
Power Plant Live
Rick's American Café
Ruth's Chris
Shula's
The Point Restaurant
The Prime Rib
Tradewinds
Tug's Restaurant
Wharf Rat at Camden Yards
Window's Restaurant

American Mediterranean
Ixia Restaurant Bar

Asian Fusion
Eurasian Harbor
Purple Orchid
Red Maple
Soigne

Caribbean
Mondo Bondo

Chinese
Uncle Lee's

Continental
Brass Elephant

Crab House
Crabby Dicks
Jimmy's Famous Seafood,
Obrycki's

Cuban
Babalu Grill
Little Havana

Deli
Attman's
Plaza Deli

Eclectic Nouvelle
Corks

Greek
Ikaros Restaurant
Samos
The Black Olive
Ze Mean Bean

Hawaiian Fusion
Roy's

Indian
Akbar
Café Bombay

Irish
James Joyce Irish Pub

Italian
Aldo's Ristorante Italiano
Amicci's
Boccaccio
Café di Roma
Chipparalli's
Ciao Bella
Daliesio's
Della Notte
Germano's Trattoria
La Scala Ristorante
La Tavola Ristorante
Paolo's
Sabatino's,
Sotto Sopra
Vespa

Japanese
Kawasaki
Kobe Teppan

Mexican
Blue Agave
Gecko's
Loco Hombre
Tex Mex Grill

Seafood
Bertha's
Blue Sea Grill
Bo Brooks
City Lights Seafood
Kali's Court
Legal Sea Foods
LP Steamers
McCormick and Schmick's,
Mother's
Phillips
Pier 4 Kitchen and Bar,
Pisces
Rusty Scupper

Southern
Charleston

Southern French Louisiana

Spanish
Tio Pepe Restaurant

Sushi
Asahi

Thai
Ten O Six
Thai Arroy

Vegetarian
Liquid Earth

Baltimore Restaurants
Listed by Neighborhood

Camden Yards
Max's at Camden Yards
Wharf Rat at Camden Yards

Canton
Bo Brooks
Gecko's
Rick's American Café
Tradewinds

City Center
Afghan Kabab
Attman's
Blue Sea Grill
Café Bombay
Shula's
Tex Mex Grill
Tio Pepe Restaurant

Dundalk
Jimmy's Famous Seafood

Federal Hill
Bandaloops
Blue Agave
Corks
Little Havana
LP Steamers
Mother's
Porter's
Soigne
Ten O Six
Thai Arroy
Vespa

Fell's Point
Asahi
Bertha's
Cactus Willie's
Crabby Dicks
Kali's Court
Liquid Earth
Louisiana
Obrycki's
The Black Olive
The Point Restaurant
Ze Mean Bean

Greektown
Ikaros Restaurant
Samos

Hamden
Café Hon

Harbor East
Charleston
Fleming's
James Joyce Irish Pub
Roy's

Inner Harbor
Babalu Grill
Bistro 300
Brighton's
Café Promenade
California Pizza Kitchen
Capitol City Brewing Co.
City Lights Seafood
ESPN Zone
Eurasian Harbor
Hampton's
Hard Rock Café
J. Paul's
Legal Sea Foods
McCormick and Schmick's
Mondo Bondo
M&S Grill
Morton's of Chicago
Paolo's
Pier 4 Kitchen and Bar
Pisces
Phillips
Power Plant Live
Purple Orchid
Rusty Scupper
Ruth's Chris
Uncle Lee's
Window's Restaurant

Little Italy
Aldo's Ristorante Italiano
Amicci's
Boccaccio
Café di Roma
Chipparalli's
Ciao Bella
Daliesio's
Della Notte
Germano's Trattoria
La Scala Ristorante
La Tavola Ristorante
Sabatino's,

Mount Vernon
Akbar
Brass Elephant
Brewer's Art
Eight East
George's on Mt. Vernon Sq
Helmand Restaurant
Ixia Restaurant Bar
Kawasaki
Kobe Teppan
Mt. Vernon Stable
Plaza Deli
Red Maple
Sotto Sopra
The Prime Rib
Tug's Restaurant

Roland Park
Alonso's
Loco Hombre

WATER TAXI AND BALTIMORE CITY MAP

Parking Directions and Baltimore City Map

AIRPORT TRANSPORTATION

SuperShuttle 410-859-0800

Transportation is provided by the BWI SuperShuttleExpress. The shuttle leaves BWI every half hour. Departures from the Radisson Plaza Hotel, 10 minutes after and 20 minutes before the hour between 6:10 am and 11:40 pm.*

Cost: $11.00 one-way
$17.00 round-trip (can only be purchased at airport)

Airport taxi service to or from the Radisson runs approximately $21.00.

TAXI SERVICE

Yellow Cab 410-685-1212

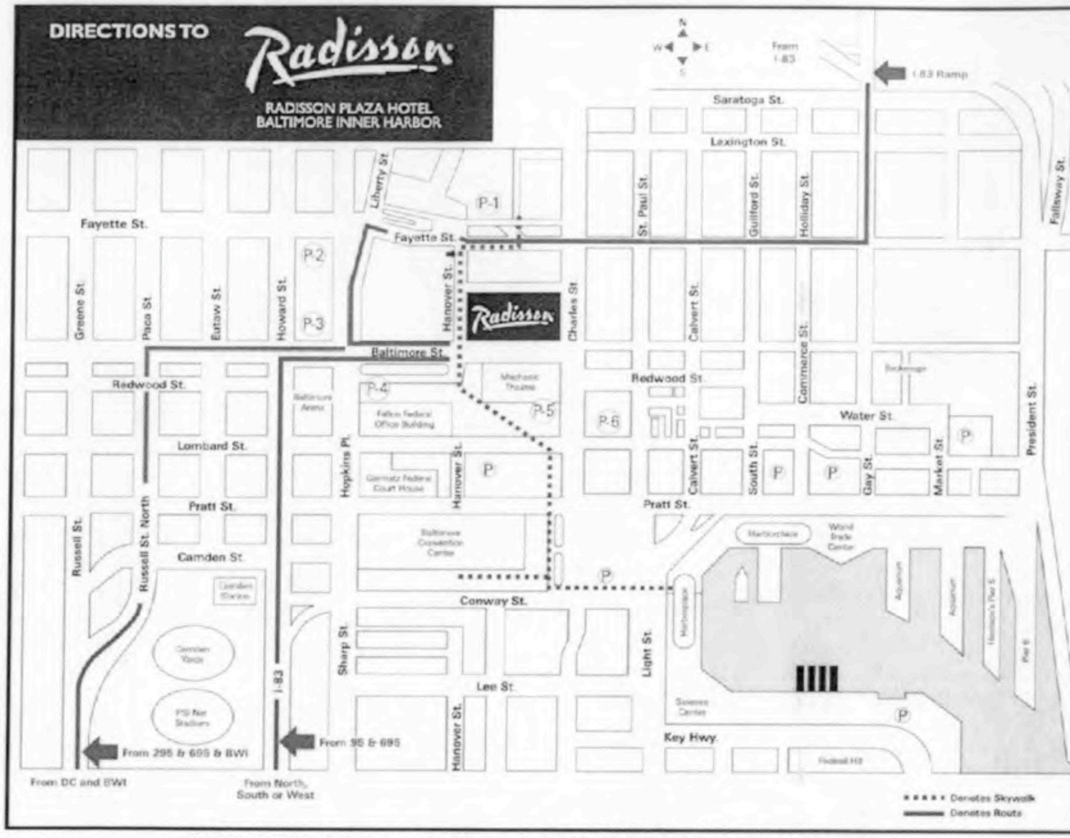
A cab service is just steps away from the front door, or a bellman can hail one for you. Services are available departing the Radisson between 5:40 am through 10:10 pm and from the airport between 5:45 am and 11:15 pm.

The following are approximate fares from the Radisson to various locations.

Inner Harbor	$3.00
Little Italy	$4.00
Fells Point	$5.50
Lexington Market	$3.00
Convention Center	$3.00
Johns Hopkins University	$7.50
Towson University	$12.00
University of Maryland Hospital	$4.00

If you have a large group that requires transportation, our concierge staff will be happy to arrange a charter bus, trolley or an ample number of taxis.

* Monday - Saturday. See concierge for Sunday schedule. Prices subject to change.



20 West Baltimore Street (410) 539-8400 or (888) 466-4644

FROM THE NORTH OR SOUTH:

Follow I-95 to exit 53 (I-395 North). I-395 North will become Howard Street. Follow Howard Street to Baltimore Street, turn right onto Baltimore Street. Follow 2 blocks to Hanover Street, turn left onto Hanover Street. Hotel is on the right.

FROM DOWNTOWN WASHINGTON D.C., BWI AIRPORT:

Follow I-295 North to Baltimore. Once inside the city limits I-295 will become Russell Street. When Russell Street crosses Pratt Street it becomes Paca Street. Turn right onto Baltimore Street, follow to Hanover Street and turn left. Hotel is on your right.

FROM THE WEST:

Take I-70 East to I-695 South (marked Glen Burnie). Follow I-695 to I-95 North. Follow I-95 North to exit 53 (I-395 North). I-395 North will become Howard Street. Follow Howard Street to Baltimore Street and turn right. Follow Baltimore Street 2 blocks to Hanover Street and turn left. Hotel is on your right.

FROM I-83 (YORK, HARRISBURG, SOUTH CENTRAL PENNSYLVANIA)

Follow I-83 South to the end and turn right on Fayette Street. Go 9 blocks to Liberty Street and turn left. Make next left onto Baltimore Street and next left at Hanover Street. Hotel is on your right.

PARKING LEDGEND

P-1. Edison Garage
Located on Fayette Street directly behind the hotel.
410-659-5824
Daily rate is $13.00 weekdays. Flat rate of $7.00 after 4:00 pm weekdays and on weekends. Open 24 Hours.

P-2. Arrow Garage
213 W. Fayette Street
410-727-1583
Daily Rate is $9.00 weekdays. Open 6:30 am – 8:00 pm Closed on weekends.

P-3. Arrow Garage
210 W. Baltimore Street
410-727-6660
Daily rate is $9.00 weekdays and weekends. Open 24 hours.

P-4. Allright Baltimore Parking
Located at 109 Liberty and Baltimore Streets at Hopkins Plaza
410-685-2700
Daily rate is $11.00. Monday-Saturday. Open 8:00 am – 12:00 am. Open Sundays only for special events.

HOTEL VALET PARKING
The Radisson Hotel offers valet parking for $21.00 and day parking for $18.00 per day. There is an extra charge for in/out privileges.

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