COSYNE

Computational and Systems Neuroscience
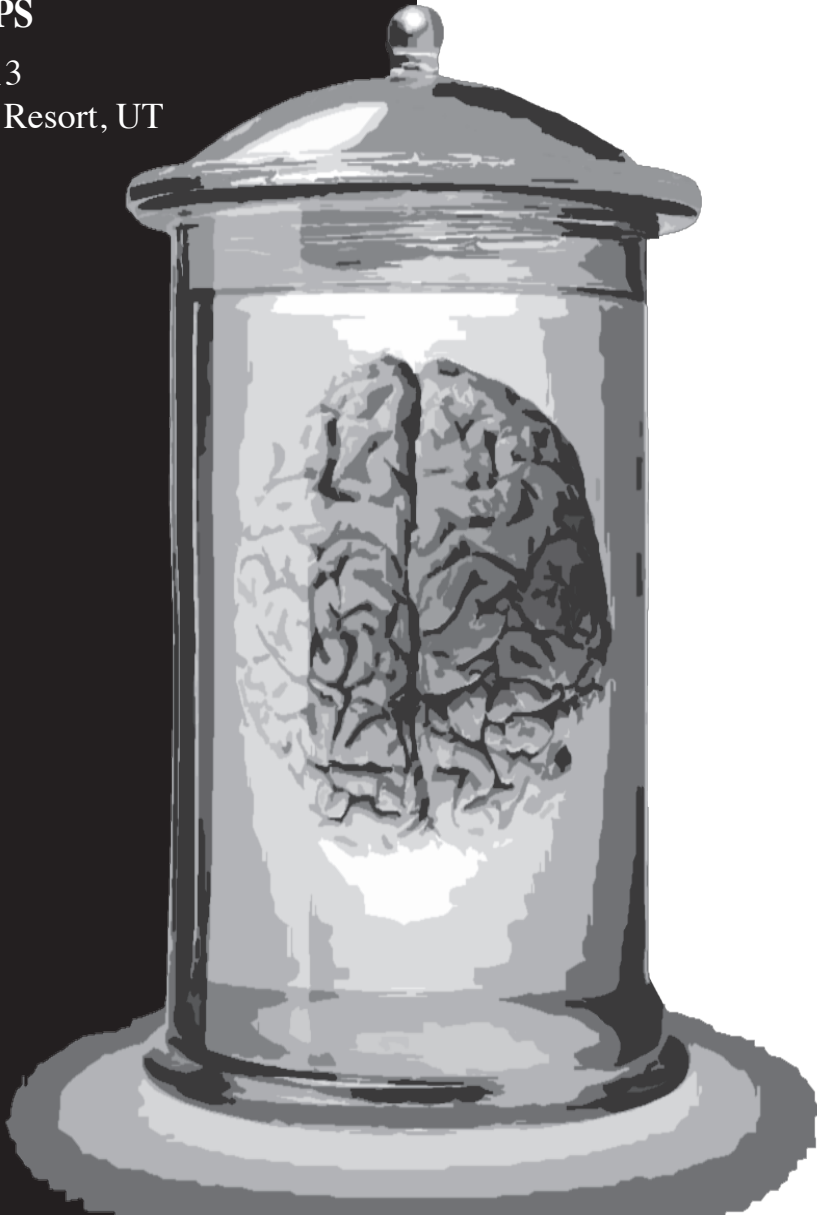
2013

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WORKSHOPS

Mar 4 - 5, 2013
Snowbird Ski Resort, UT

COSYNE 2013 Workshops

March 4 & 5, 2013

Snowbird, Utah

Monday, March 4	Organizer(s)	Location
1. Furry statisticians – how rodents infer the meaningful properties of unreliable environments.	A. Akrami M. Diamond	Superior A
2. Large-scale neuronal simulations – science, languages and platforms.	C. Koch S. Hill	Maybird
3. The awake and anesthetized cortex – similar or different?	F. Frolich	Wasatch B
4. Neural mechanisms for orienting decisions across the animal kingdom.	J. Erlich B. Corneil	Wasatch A
5. Why so many layers and cell types?	R. Bruno	Magpie A
6. Neural mechanisms of foraging decisions	B. Hayden A. Wikenheiser	Superior B
7. A new chapter in the study of functional maps in visual cortex.	I. Nauhaus K. Nielsen	Magpie B

Workshop Co-Chairs	Email	Cell
Jess Cardin, Yale	jess.cardin@yale.edu	267-235-0462
Tatyana Sharpee	sharpee@salk.edu	858-610-7424

Maps of Snowbird are at the end of this booklet (page 33).

COSYNE 2013 Workshops

March 4 & 5, 2012

Snowbird, Utah

Tuesday, March 5	Organizer(s)	Location
1. Reward-based decision making.	M. Laubach J. Roitman	Wasatch A
2. Beyond optogenetics: new approaches for systems neuroscience and towards brain activity mapping	K. Kording	Superior B
3. Dendritic computation in neural circuits	D.J. Strouse B. Ujfalussy T. Branco M. Lengyel	Maybird
4. Understanding the brain by building one: new neuroscience on VLSI hardware	C.M. Niu	Wasatch B
5. Priors in perception, decision-making, and physiology.	J. Gardner H. Nienborg	Superior A
6. Reticular microcircuits: from structure to function	M. Halassa J. Haas	Magpie A
7. A new chapter in the study of functional maps in visual cortex.	I. Nauhaus K. Nielsen	Magpie B

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Schedule

Each workshop group will meet in two sessions from ~8 to 11 am and 4:30 - 7:30 pm.

Workshop summaries and schedules are available starting on page 4 of this booklet.

Transportation

Marriott Downtown to Snowbird: Free shuttle provided for registered attendees (leaves @ 5pm on Sunday, 3-Mar).

Snowbird to Salt Lake City Airport:

Shuttle can also be arranged at Snowbird, or online at:

https://store.snowbird.com/products/index.php?product_category_idx=2.

Further information about transportation to/from Snowbird is available at:

http://www.snowbird.com/about/accessibility.html

For further information on transportation or other logistics please contact Denise Soudan (denise.soudan@rochester.edu).

Lift tickets

Approximate discounted workshop rates
       Snowbird Tram and Chairlifts: $73
       Snowbird Tram & Chairlifts Half Day: $66

Pick up at the Cliff ticket window (level 1 of the Cliff Lodge next to the ski rental shop) or at the ticket window on the top level of the Snowbird Center (the plaza deck).

Meals included with registration

Breakfast (Day 1 and Day 2) - The Cliff Ballroom (7:00-8:30am)

Dinner (Day 2) - The Cliff Ballroom (8:00pm)

Coffee breaks during morning and afternoon sessions

1. Furry statisticians – how rodents infer the meaningful properties of unreliable environments.

Organizers
Athena Akrami, International School for Advanced Studies (ISAS/SISSA)
Matthew Diamond, International School for Advanced Studies (ISAS/SISSA)

A large body of work has shown that humans are able to combine information, coming through one or more sensory modalities, across time, to make accurate perceptual decisions. A surprising discovery in recent years is the sophistication of the statistical inferences made by the rodent brain. This workshop aims to collect an assembly of studies in which rats/mice extract salient features from noisy and unreliable environments to improve their perceptual judgments. These studies strive to explain how the brain does relevant statistics. An issue of particular interest is time scales – the statistical operations can depend on events distributed across milliseconds or many minutes.

In some cases, perceptual system efficiency approaches that of an ideal observer, and does so by carrying out statistical operations in neuronal circuits. There have been several decision theories that put forward possible statistically optimal algorithms by which a subject would perform optimally under uncertain conditions. However, the brain is often treated as a "black box" and the neural underpinning of such algorithms is not fully understood. Recently it has been shown that rodents, with a smaller and simpler brain compared to primates, are able to perform complex tasks whereby they extract salient information from noisy and unreliable stimuli in different modalities e.g. tactile, auditory or olfaction with speed and accuracies comparable to human and monkeys. These works provide a new benchmark to tackle decision making problem as a complete picture, starting from coding (conversion of physical events into neuronal activity), decoding (identification of mechanisms by which the brain carries meaning in its neuronal activity), efficient coding (optimizing the neural code to best match the input statistics) and working memory (memory trace of physical events during a delay period) and finally making a decision. We believe it is of general interest to the field of computational and systems neuroscience to discuss state-of-the-art studies using rodent models for understanding how the brain does statistics and represents probabilities.

Furry statisticians – how rodents infer the meaningful properties of unreliable environments.

Morning Session

8:00 – 8:25am	**Roni Azouz.** Distributed coding in the trigeminal system.
8:25 – 8:40am	**Discussion**
8:40 – 9:05am	**Brice Bathellier.** Prediction of behavioral sound categorization by discrete neocortical population dynamics.
9:05 – 9:20am	**Discussion**
9:20 – 9:40am	**Coffee break**
9:40 – 10:05am	**Ehsan Arabzadeh.** Neural coding and efficiency in rat.
10:05 – 10:20am	**Discussion**
10:20 – 10:45am	**Zachary Mainen.** Sources of uncertainty in decision-making.
10:45 – 11:00am	**Discussion**

Afternoon Session

4:30 – 4:55pm	**Josh Dudman.** Mice infer probabilistic models for timing.
4:55 – 5:10pm	**Discussion**
5:10 – 5:35pm	**Arash Fassihi Zakeri.** Extracting and integrating the statistical structure of tactile stimuli: rats and humans.
5:35 – 5:50pm	**Discussion**
5:50 – 6:10pm	**Coffee break**
6:10 – 6:35pm	**Athena Akrami.** Auditory and tactile working memory in rat and human: Prior competes with recent evidence.
6:35 – 6:50pm	**Discussion**
6:50 – 7:15pm	**Yonatan Loewenstein.** Free operant learning in rats: from synaptic plasticity to behavior.

2. Large-scale neuronal simulations – science, languages, and platforms

Organizers
Christof Koch, California Institute of Technology, Allen Institute for Brain Science
Sean Hill, International Neuroinformatics Coordinating Facility

As neuroscience has developed into a more mature science, large scale efforts have emerged to generate comprehensive genomic, anatomical, electrophysiological and imaging databases under highly standardized and controlled conditions in a few model systems. At the same time, efforts are underway to simulate these systems, following Feynman's dictum "What I cannot create, I do not understand." Such simulation efforts require significant novel efforts to organize these data, generate appropriate sub-cellular, cellular and supra-cellular models, simulate these on various platforms – from desktops to supercomputers and the Cloud – subject the results to sophisticated mathematical sensitivity analyses and manipulate and display a small subset. Our proposed workshop assembles many of the most important projects in this area for an open discussion of common goals, frameworks and standards.

The workshop will present current state-of-the-art tools for simulations of large number of neurons. The workshop goal is to highlight strengths and weaknesses of modern simulation platforms and the type of problems they are best employed to solve and present a summary of the current model description languages used. The primary scientific focus will be on how the current tools can address the questions which arise in simulations of the mammalian cerebral cortex and closely associated structures (e.g., thalamus, hippocampus), what tools are best to use for specific questions, and which type of scientific questions cannot be addressed with the existing tools.

We plan to discuss how better to formalize and standardize model description languages to allow for an easier exchange of models. Based on the discussions of the questions which cannot be easily addressed with current tools, we hope to discuss the desired features and direction for next generation large-scale platforms with which to perform simulation-based research in neuroscience. In addition to the key scientific insights from large-scale simulations, real world experiences developing and simulating large-scale models on these platforms will be shared, as most of such insights cannot be shared via standard peer-reviewed publications.

Each of the three elements which will be discussed - simulation platforms, the model description languages they use and the scientific questions which can be addressed using these platforms to model mammalian cortical structures - are of significant interest to the computational neuroscience community. We believe they have to be discussed together, due to their strong interdependence. Currently, we are experiencing a simultaneous boom of computer power and data glut (Big Data) regarding the structure of the cortex. Yet sharing large models is not easy (due to them often being platform dependent) and comparison of highly complex models is very difficult. We believe the interest in the workshop will be especially high since face-to-face interactions would alleviate some of the communication barriers which are particularly high in large scale modeling. We have invited many of the key players from those groups primarily focused on designing the simulation tools to groups that plan to use them for large scale simulations of cortical structures.

Large-scale neuronal simulations – science, languages, and platforms

Morning Session

8:00 - 8:10am	**Christof Koch**. Introduction
8:10 - 8:25am	**Stefan Mihalas.** Mixing population statistic numerical solutions with population simulations"
8:30 - 8:55am	**Dave Lester**. Supercomputing platforms for Neuron Simulation: The importance of a power-efficient communications architecture"
9:00 - 9:25am	**Markus Diesmann.** TBA.
9:30 - 9:55am	**Abigail Morrison.** TBA.
10:00 - 10:25am	**Joseph Hellerstein.** TBA.
10:30 - 10:55am	**Andrew Davison.** PyNN: a simulator-independent platform for large scale, data-driven neuronal simulations

Afternoon Session

4:30 - 4:55pm	**Wyeth Bair**. iModel.org - an online resource for modeling visual neurophysiology.
5:00 - 5:25pm	**Ted Carnevale.** TBA
5:30 - 5:55pm	**Erik De Schutter.** TBA
6:00 – 6:25pm	**Richard Schiek.** Simulating Neural Systems in Xce: Can electrical circuit simulation techniques benefit computational neuroscience?
6:30 - 6:55pm	**Sean Hill.** Large scale simulation platform for in silico neuroscience.
7:00 - 7:25pm	**Discussion**

3. The awake and anesthetized cortex – similar or different?

Organizer:
Flavio Frolich, University of North Carolina at Chapel Hill

Abstract
Anesthesia has been routinely used in neuroscience research for many decades. The recent shift towards awake in vivo electrophysiology and imaging has raised several controversial questions to be discussed in this workshop: (1) Do the similarities or the differences dominate in the comparison of awake and anesthetized cortical network dynamics? (2) Are there fundamental organizational principles of synaptic excitation and inhibition that are maintained under anesthesia? (3) Do anesthetics mediate their effect on cortex through local action or through modulation of subcortical structures? and (4) Can we use anesthesia to selectively ablate higherorder cortical processing since it suppresses consciousness yet maintains sensory responses? The overall goal of this workshop is to produce a road map for how anesthetized and awake recordings of cortical activity can and should be interpreted. Why is the topic of interest? Systems neuroscience has been recently undergoing a recent shift away from anesthetized recordings towards awake recordings. Understanding the differences and similarities of the awake and anesthetized cortex are therefore crucial for the interpretation of a large body of neuroscience literature and for the design of new research paradigms for the study of cortical information processing. However, little consensus exists on the fundamental questions of how anesthesia alters brain state, network dynamics, and sensory processing. We expect a broad interest in an interdisciplinary workshop that focuses on discussing these contentious questions.

The awake and anesthetized cortex – similar or different?

Morning Session

8:30 – 9:15am	**Nancy Kopell**. Dynamics of anesthesia.
9:15 – 10:00am	**Flavio Frohlich**. Awake versus anesthetized: What is the difference?
10.00 – 10:15am	**Break**
10.15 – 11:00am	**Ayeal Raz**. Pathway specific modulation by anesthetics in auditory cortex.

Afternoon Session

4:00 – 4:45pm	**Bilal Haider**. Excitation and inhibition in awake versus anesthetized mouse V1.
4:45 – 5:30pm	**Axel Hutt**. Extra-synaptic GABAergic inhibition tunes dynamics of neural populations.
5:30 – 5:45pm	**Break**
5:45 – 6:30pm	**Marcello Massimini**. Mechanisms of loss and recovery of consciousness: insight from TMS/EEG studies.
6:30 – 7:15pm	**Emery Brown**. The altered states of arousal induced by anesthetic drugs.

4. Neural mechanisms for orienting decisions across the animal kingdom

Organizers
Jeffrey Erlich, Princeton University
Brian Corneil, University of Western Ontario

Animals are active sensors. They shift their gaze toward interesting and rewarding stimuli and away from uninteresting or unpleasant stimuli. The neural bases of these sensorimotor decision processes have been studied in animals from insects to humans, yet many fundamental questions remain unanswered. The goal of this workshop is to bring together investigators studying diverse model systems to learn from each other and gain insight into neural mechanisms for orienting decisions, and to discuss which mechanisms and circuits are evolutionarily conserved and which are unique specializations.

Some questions that we hope to address: What are the functions of the different elements of the neural circuits for orienting. E.g. What are the distinct roles of parietal and frontal cortex? What role does the superior colliculus (and other subcortical structures) play that is different from cortex (or forebrain)? Are those roles conserved across the animal kingdom? What's special about each animal model that makes it unique (fovea, whiskers, acute hearing) and how does this affect the observed neural signals and comparison with other species?

Neural mechanisms for orienting decisions across the animal kingdom

Morning Session

8:20 – 8:30am   **Introduction**

8:30 – 9:15am   **Brian Corneil**. Not just saccades: lessons learned about the oculomotor system from recording neck muscle activity in human and non-human primates.

9:15 – 10:00am   **Shreesh Mysore**. Stimulus selection for gaze and spatial attention: Neural building blocks.

10:00 – 10:45am   **Gidon Felsen**. Subcortical contributions to orienting decisions in rodents.

Afternoon Session

4:30 – 5:15pm   **Chris Harvey**. Neuronal circuit dynamics in the mouse posterior parietal cortex during virtual navigation.

5:15 – 6:00pm   **Jeffrey Erlich**. Distinct contributions of rat frontal and parietal cortex to accumulation of evidence for orienting decisions.

6:00 – 6:45pm   **Alex Huk**. Temporal dynamics of sensorimotor integration in the primate dorsal stream.

6:45 – 7:30pm   **Discussion**

5. Why so many layers and cell types?

Organizer:
Randy Bruno, Columbia University

Theoreticians and experimentalists often approach the neocortex as a collection of homogenous and interchangeable "units". Neocortex has been known for over a century, however, to possess six distinct layers. The cells of each layer differ from those of other layers in terms of 1) their sources of synaptic inputs, 2) the morphological and biophysical properties that govern how the cells can respond to those inputs, and 3) the downstream layers and brain regions to which they output. Nevertheless, we still have a poor understanding of the functional roles of cortical layers and a computational explanation of what a cortical column does.

In only the last few years, there has been an explosion of research into these questions. This has been due to the emergence and spread of techniques that allow detailed cellular/laminar analyses *in vivo*, such as optogenetic manipulation of specific layers and cell types, the morphological recovery of recorded neurons by juxtasomal and whole-cell recording, new single-axon and tract tracing methods, two-photon microscopy of large neuronal populations, and multi-channel array recordings. Many of the ensuing results have called for a rethinking of conventional models of and beliefs regarding cortical function.

This workshop will bring together a number of experimentalists who are actively working on this issue in a diversity of neocortical systems (somatosensory, visual, auditory, and motor cortex) but should be of great interested to theorists. While our experimental understanding of neural diversity is increasing, our theoretical understanding is still limited. This workshop is a call-to-arms for theorists, as well as an update on the latest experimental results.

Why so many layers and cell types?

Morning Session

8:15 – 8:30am	**Introduction**
8:30 – 9:00am	**Dan O'Connor**. Cortical layer 4 coding for active object localization revealed using illusory touch.
9:00 – 9:30am	**Alison Barth**. Receptive field properties define discrete cellular networks in somatosensory cortex.
9:30 – 10:00am	**Coffee Break**
10:00 – 10:30am	**Randy Bruno.** The neocortical circuit is two circuits.
10:30 – 11:00am	**Anthony Zador.** Who you talking to? Routing messages in the cortex.

Afternoon Session

4:30 – 5:00pm	**Hillel Adesnik.** Mechanisms of layer and cell-type specific representations of sensory space.
5:00 – 5:30pm	**Tomoki Fukai.** Neural representations of behavior in different layers of motor cortex.
6:00 – 6:30pm	Coffee Break
5:30 – 6:00pm	**Georg Keller.** Functional diversification in layer 2/3 of mouse visual cortex during behavior.
6:30 – 7:00pm	**Matthew Larkum.** Active dendritic processes embedded in a laminar structure.
7:00 – 7:30pm	**Discussion**

6. Neural mechanisms of foraging decisions

Organizers:
Ben Hayden, University of Rochester
Andrew Wlkenheiser, University of Minnesota

Abstract

Searching for food is a naturally motivated behavior that has shaped animals' bodies and minds through evolutionary time. Inspired by microeconomic theory, behavioral ecologists have developed a formal framework, known as foraging theory, for predicting optimal decisions in foraging contexts. Recently, neuroscientists interested in decision-making have begun to import ideas from foraging theory to motivate selection of problems and interpretation of data. This foraging-centric approach provides a complement to economic approaches to understanding behavior and brain activity, one that is directly driven by biological findings, that dovetails with evolutionary theory, and is equally rigorous.

This workshop brings together researchers broadly interested in understanding the neural computations that subserve cost-benefit decision making in foraging and foraging-like contexts. Our aim is to integrate theoretical and experimental approaches to studying foraging behavior with recent advances in our understanding of the brain mechanisms underlying reward processing and other forms of decision-making. Because "neuro foraging" is a new, interdisciplinary field, we hope that this workshop will serve as a coming-out party for us and will ultimately spark new collaborations, idea sharing, and interdisciplinarity among like-minded scientists. The confirmed speakers include both established investigators and scientists in early career stages; we hope this dynamic will encourage future collaborations and facilitate networking to help grow this emerging field.

Neural mechanisms of foraging decisions

Morning Session

8:00 – 8:10am   **Introduction**

8:10 – 8:40am   **Andrew Wikenheiser**. Subjective costs drive a sunk cost-like effect in foraging rats

8:40 – 9:10am   **Elisabeth Murray**. Revaluing foraging goals based on current biological needs

9:10 – 9:40am   **Sara Constantino**. Learning the opportunity cost of time in the context of patch-foraging

9:40 – 9:55am   **Coffee break**

9:55 – 10:25am   **John Pearson**. Modeling primate foraging in the lab

10:25 – 10:55am   **Stephen Cowen**. Beyond the cost of work: Relationships between physical effort, risk, and reward

Afternoon Session

4:30 – 5:00pm   **Sachin Ranade**. Lessons from an accidental forager: Distinct behavioral correlates of identified interneuron subtypes in mouse anterior cingulate cortex

5:00 – 5:30pm   **Tommy Blanchard**. Neural basis of diet selection decisions

5:30 – 6:00pm   **Coffee break**

6:00 – 6:30pm   **Nils Kolling**. A human foraging network? Evidence for the existence of two distinct evaluative networks centred around the dACC and vmPFC from human functional imaging

6:30 – 7:00pm   **Michael Platt**. Neural mechanisms of foraging decisions

7:00 – 7:30pm   **Discussion**

7. A new chapter in the study of functional maps in visual cortex

Organizers:
Ian Nauhaus, Salk Institute
Kristina Nielsen, Johns Hopkins University

The functional organization of visual cortex has been passionately studied ever since Hubel and Wiesel first identified orientation and ocular dominance columns in V1. The energy put forth in this area of research has been justified by the significance that feature maps may hold in helping us understand the function of neocortex. For example, feature maps are likely relevant to cortical coding capacity, cortical circuits, and cortical development. Although the decades of research on cortical maps have provided many useful insights, the most important questions remain unanswered. Luckily, new techniques have been developed to allow the field to dig deeper. Twophoton microscopy and circuit tracing technology now allows us to image feature maps at the level of cell bodies and their corresponding dendritic/axonal processes. Furthermore, new theoretical models are in the works to help guide these future experiments. The proposed workshop will bring together both experimentalists and theoreticians, and will provide a platform for important discussions on how to best propagate this field of research into a new era. The recently published and unpublished work by our speakers sheds light on cortical maps from multiple angles. The workshop will start with work from groups that use two-photon imaging to characterize the joint-representation of different stimulus features within the micro-architecture of V1 (Conway et al., 2010; Kara and Boyd, 2009; Nauhaus et. al., 2012; Nielsen et. al., 2012). Some of the follow-up talks will then address how columns of neuronal tuning are established by the thalamo-cortical circuit (Jin et al., 2011; Paik and Ringach, 2011), whereas others will discuss how the maps may be constructed via self-organizing principles of the cortex during development (Li et al., 2008; Kaschube et al., 2010). Next, there will be a discussion on how tuning of classical and extra-classical receptive field properties is shaped by the local circuits within V1 maps (Levy et al., 2012; Hashemi-Nezhad and Lyon, 2012). A natural extension of this topic is work on how maps get transformed after V1 in extriastriate cortex (Lu et al., 2010). Finally, our workshop will address how the columnar architecture of large mammals may scale down to the level of the rodent architecture (Smith and Häusser, 2010). The unique perspectives from these different groups will undoubtedly result in lively discussion.

A new chapter in the study of functional maps in visual cortex

Day 1

Morning Session

8:00 am – 8:40 am   **Ian Nauhaus**. Spatial tiling by V1 receptive fields.

8:50 am – 9:30 am   **Jose Manuel-Alonso**. Functional organization of ON and OFF pathways in visual cortex.

9:40 am – 10:20 am   **Spencer Smith**. Dense mapping reveals wiring and computational principles for mouse V1.

10:30 am – 10:50 am   **Bartlett Mel**. How to form a 'multimap' in visual cortex.

Afternoon Session

4:30 pm – 5:00 pm   **Se-Bum Paik**. Development of early visual cortex maps.

5:10 pm – 5:50 pm   **Fred Wolf**. Learning to be disorganized - the Evolutionary Origin of Interspersed and Columnar Visual Cortex Architectures.

6:00 pm – 6:30 pm   **Wyeth Bair**. How do maps constrain physiologically plausible circuits in V1?

6:40 pm – 7:10 pm   **Anna Roe**. What does functional organization offer? Views from visual and somatosensory cortex.

1. Reward-based decision making.

Organizers:
Mark Laubach, Yale University
Jaime Roitman, University of Illinois

Behavior is often guided by external variables (i.e. the size or likelihood of reward) as well as internal biases (i.e. preference, motivational state). These variables drive the activity of neurons in a variety of interconnected cortical regions to ultimately compute a decision. Failure to engage in adaptive decision-making can adversely impact our finances and health, and is broadly implicated in many disorders - such as gambling, substance abuse, obesity, and affective disorders. The goal of the workshop is to examine the processes that underlie the formation of associations between environmental cues that predict reward, the behaviors directed at obtaining them, and the internal biases that affect choices. Circuits that include prefrontal cortex, striatum, and the systems that modulate them (e.g. dopaminergic inputs from the substantia nigra/ventral tegmental area) have been implicated in learning stimulus-outcome and stimulus-response associations, as well as the maintenance of adaptive or maladaptive goal-directed behaviors subsequent to learning. Speakers in this workshop will integrate results obtained from a variety of approaches that combine measurements of reward-based decisions with in vivo electrophysiology, electrochemistry and pharmacology in rodent and primate models, combined with computational modeling of this neural circuitry.

Talks will be 20 min each, with 5 min for discussion. A general discussion will be held at the end of the evening session, and will be motivated by statements from each speaker about what they believe is *the* major open question about the neural basis of reward-based decision-making.

Reward-based decision making.

Morning Session – Corticostriatal systems

8:00 – 8:25am   **Mark Laubach**. Building a decision context with corticostriatal circuits.

8:30 – 8:55am   **Anne Collins**. Creating and generalizing task-set structure in corticostriatal circuits.

9:00 – 9:25am   **Mark Walton**. What, if any, role does phasic mesolimbic dopamine transmission play in cost-benefit decision making?

9:30 – 9:55am   **Coffee Break & Discussion**

10:00 – 10:25am   **Ben Hayden**. Circuitry for risky decision making.

10:30 – 10:55am   **Jamie Roitman**. Neural signals in reward-guided approach and restraint.

Afternoon session – Orbitofrontal cortex and Discussion

4:30 – 4:55pm   **Jon Wallis**. Functional organization of orbitofrontal cortex

5:00 – 5:25pm   **Camillo Padoa-Schioppa**. Neuronal origins of choice variability in economic decisions

5:30 – 5:55pm   **Coffee Break & Discussion**

6:00 – 6:25pm   **Adam Kepecs**. Separate and integrated representation of reward and confidence in orbitofrontal cortex

6:30 – 6:55pm   **Robert Wilson**. Orbitofrontal cortex as a cognitive map of task space

7:00 – 7:30pm   **Discussion**

2. Beyond optogenetics: new approaches for systems neuroscience and towards brain activity mapping

Organizer:
Konrad Kording, Northwestern University

Optogenetics is having an impact on many if not most areas of systems neuroscience. However, there are many techniques that are currently being developed that promise to lead to new waves of progress. The workshop aims at bringing together scientists who work on developing, enabling and exploiting new technologies. It will focus on techniques that involve molecular engineering. Importantly, a lot of time will be reserved to discuss problems, opportunities and solutions for the underlying developments; there are likely many synergies between different approaches being designed at the moment. Cosyne has always been a place for the exchange of ideas between computational and systems neuroscientists and the workshop will enable the discussion of many ideas that are not yet mainstream.

Beyond optogenetics: new approaches for systems neuroscience and towards brain activity mapping

Morning Session

8:00 – 8:05am	**Konrad Kording**. New techniques – new data – new computational problems – new insights into systems neuroscience
8:10 – 8:40am	**Ed Boyden**. Tools for an integrative understanding of neural computations
8:45 – 9:15am	**Josh Vogelstein**. Beyond little neuroscience
9:15 – 9:50am	**Coffee Break & Discussion**
9:50 – 10:20am	**Vincent Pieribone**. Recording neuronal activity with fluorescent protein-based voltage probes
10:25 – 10:55am	**Jeff Lichtman**. TBA

Afternoon Session

4:25 – 4:55pm	**Tony Zador**. Sequencing the connectome.
5:00 – 5:30pm	**Adam Marblestone**. Molecular ticker-tapes.
5:30 – 6:05pm	**Coffee Break & Discussion**
6:05 – 6:35pm	**Loren Looger**. In vivo imaging of calcium and glutamate
6:40 – 7:30pm	**Summary & Discussion**

3. Dendritic computation in neural circuits

Organizers:
DJ Strouse, Princeton University
B Ujfalussy, University of Cambridge
T Branco, MRC Laboratory of Molecular Biology
M Lengyel, University of Cambridge

This workshop will concentrate on the role that dendritic processing plays in circuit computations. While there is now plenty of evidence, both experimental and computational, that dendrites of single neurons are capable of local nonlinear processing, the role this type of processing plays in behaviorally relevant computations at the network level has only recently begun to be elucidated. We aim to bring together leading experimentalists and theorists in the field to discuss and consolidate current ideas, focusing in particular on increased interaction between theory and experiment, as well as to discuss important future directions of research. We believe this workshop will provide a valuable forum for integrating research across multiple levels - from subcellular to behavioral - for both theorists and experimentalists.

Dendritic computation in neural circuits

Morning Session

8:20 – 8:30am	**Introduction**
8:30 – 9:00am	**Bartlett Mel**. The dimensionality of dendritic computation.
9:00 – 9:30am	**Jeff Magee**. Input comparison type computations in cortical networks.
9:30 –10:00am	**Coffee break**
10:00 – 10:30am	**Michiel Remme**. Consolidation of synaptic patterns from proximal into distal dendrites of a hippocampal CA1 pyramidal neuron.
10:30 – 11:00am	**Albert Lee**. Cellular mechanisms underlying spatially-tuned firing in the hippocampus.

Afternoon Session

4:30 – 5:00pm	**Tiago Branco**. Dendritic computations with spatially distributed input.
5:00 – 5:30pm	**Walter Senn**. STDP with dendritic spikes: which postsynaptic spike to take?
5:30 – 6:00pm	**Coffee break**
6:00 – 6:30pm	**Michael Hausser**. Probing the function of dendritic spikes in vivo.
6:30 – 7:00pm	**Mate Lengyel**. Computations in recurrent circuits with non-linear dendrites.
7:00 – 7:30pm	**Discussion**

4. Understanding the brain by building one: new neuroscience on VLSI hardware

Organizer:
C. Minos Niu, USC

"What I cannot create, I do not understand." -- Richard Feynman
Ever since the years of Sir Sherrington, almost a century of neuroscientific research has seen tremendous breakthroughs that unveiled gradually how our brain works. With all those feats earned by experimentation both in vitro and in vivo, however, we are probably still tens of years away from mapping out all neural circuitries, their interplays and functionalities. When passionately expecting more neuroscience findings to come, we believe that electronic technologies can enable a fundamentally innovative way of understanding neural mechanisms, in addition to merely providing the instrumentation for experiments. By creating an electronic hardware system that evaluates bio-realistic neural models, it becomes possible to verify and identify neural mechanisms with an abundance of details instantenously accessible. We will use this workshop to share our experiences of using of Very-Large-Scale Integration (VLSI) technology when verifying exisiting theories of brain mechanisms. We will also introduce how to use real-time VLSI neural emulations for generating testable hypotheses for neuroscience experiments. It is also expected that the technical advancing will enable innovations in information processing. The panelists intend to paint a general picture of VLSI neural emulation by introducing their diversified projects. Dr. Kwabena Boahen will describe Neurogrid, an iPad-sized special-purpose computer developed at Stanford that simulates a million cortical neurons with billions of synaptic connections in real-time. Terence Sanger, MD PhD will introduce a framework of using spiking neural network on Field Programmable Gate Arrays (FPGA) to study the long-term progression of child movement disorders, exemplified by child dystonia. Dr. Steve Furber will introduce the SpiNNaker project, which aims to build a million 32-bit ARM processor cores into a massivelyparallel computer optimized for modelling up to a billion spiking neurons in biological real-time. Dr. Gert Cauwenberghs will introduce the HiAER-IFAT (hierarchical address-event routing integrate-and-fire array transceiver) project aiming at a general-purpose multi-scale neural emulation platform interfacing analog chips, implementing continuous-time conductance-based membrane dynamics with digital programmable and reconfigurable systems, implementing axonal and synaptic connectivity. Dr. Chris Eliasmith will describe methods for constructing large-scale spiking neural models of complex behaviors, such as solving the Tower of Hanoi and completing a general intelligences test (Raven's Progressive Matrices). Dr. Karlheinz Meier will describe the concept, design and operation of an accelerated, highly configurable neuromorphic substrate implementing 50 Million plastic synapses on an 8 inch silicon wafer developed in the European FACETS / BrainScaleS projects. Dr. C. Minos Niu will share the progress of building physiologically-realistic proprioceptive pathways using FPGA, and demonstrating its closed-loop behavior that mimics both able and pathological human movements.

Understanding the brain by building one: new neuroscience on VLSI hardware

Morning Session

8:00 – 8:45am   **Karlheinz Meier**. A universal neuromorphic computing engine – results and plans.

8:45 – 9:30am   **Kwabena Boahen**. How neurogrid works.

9:30 – 10:00am   **Coffee break**

10:00 – 10:45am   **Chris Eliasmith**. How to build a brain.

10:45 – 11:30pm   **C. Minos Niu**. How far are we from a spinal cord on chip.

Afternoon Session

4:30 – 5:15pm   **Emre Neftci**. Hierarchical event-based reconfigurable neuromorphic systems.

5:15 – 6:00pm   **Terence Sanger**. Likelihood calculus: a mathematical framework for spike-based feedback control.

6:00 – 6:45pm   **Steve Furber**. SpiNNaker: a spiking neural network architecture.

6:45 – 7:30pm   **Discussion**

5. Priors in perception, decision-making and physiology

Organizers:
Justin Gardner, Riken
Hendrikje Nienborg, Tubigen

Biases in behavior are a nuisance. Any experimentalist will tell you that behavioral biases are a serious frustration when conducting experiments, be they human or animal. Subjects may exhibit an idiosyncratic bias for one of multiple equally likely options - like preferring to choose the first interval in a 2AFC task or more often the option on the left. Or they may exhibit more subtle biases like switching choices after an error, regardless of the stimuli presented on the current trial. These biases can severely hamper the ability of an experimentalist to measure desired behavioral quantities accurately and often much effort goes into designing experiments to avoid or train away such biases. Theoretic considerations, however, have begun to place biases in a more normative framework. Biases may reflect long-term knowledge that an organism has acquired - while non-optimal for the task at hand, they may be the "right" thing to do in a broader behavioral context. In a Bayesian view, when sensory evidence is weak or equivocal, biasing choices towards more likely options represents optimal inference. Idiosyncratic biases may thus be viewed as possible adaptations to the natural statistics of the world. That is, biases may be thought of as reflecting prior information. Understanding how priors affect behavior and perception, how they are implemented in the brain and how they interact with sensory information are a key, as yet poorly understood, component of our understanding of the neural mechanisms subserving sensory decision making.

This workshop aims to bring together theorists with animal and human experimentalists who are working to explore and understand priors, their effect on behavior and their neural basis. What is a prior? Over what time scales can priors be manipulated and learned? For example, if an experimenter changes the statistics of presentation of different trial types does that represent a different type of prior than ones that are learned over much longer exposure to the statistics of the world? How and when do priors affect perception? Do they change the way an object is perceived or simply the response that a subject makes? What is the time course of action of a prior in behavioral tasks? How do signals representing priors exhibit changes with uncertainty or across time? Are priors a form of top-down cognitive signal or can they be represented in a bottom-up fashion in the basic functioning of sensory circuitry? This workshop will gather together various experimentalists and theoreticians working on these problems to discuss answers to these questions.

Priors in perception, decision-making and physiology

Morning Session

8:30 – 8:40am	**Introduction**
8:40 – 9:10am	**Adrienne Fairhall.** TBA.
9:10 – 9:20am	**Discussion**
9:20 – 9:50am	**Matteo Carandini.** Adaptation to stimulus statistics in visual cortex.
9:50 – 10:20am	**Coffee Break and Discussion**
10:20 – 10:50am	**Anne Churchland.** Multisensory decisions are corrupted by misguided priors.
11:50 – 11:00am	**Discussion**

Afternoon Session

4:30 – 5:00pm	**Eero Simoncelli.** TBA.
5:00 – 5:10pm	**Discussion**
5:10 – 5:40pm	**Justin Gardner.** Cortical mechanisms for improving human visual perception with prior information.
5:40 – 6:10pm	**Coffee Break and Discussion**
6:10 – 6:40pm	**Hendrikje Nienborg.** Visual responses reflect a changing prior.
6:40 – 6:50pm	**Discussion**
6:50 – 7:20pm	**Mike Shadlen.** Believing and time: A dynamic neural representation of a static prior.
7:20 – 7:30pm	**Discussion**

6. Thalamic reticular microcircuits: from structure to function

Organizers:
Michael Halassa, Harvard/MIT
Julie Haas, UCSD

The thalamic reticular nucleus (TRN) is a critical gate for thalamo-cortical communication. This GABAergic neuronal shell surrounding the thalamus is involved in sensory processing and attentional/state regulation. We are inviting experts in the field to discuss recent advances in anatomical, physiological and computational understanding of TRN circuitry. Given the rapid rise of studies involving thalamic regulation of cortical function and higher cognition, a Workshop discussing the major inhibitory regulator of cortico-thalamic interchange seems both highly significant and timely. This Workshop will appeal not only to thalamic physiologists and cortical modelers, but also to anyone interested in cortical physiology and the role of thalamus in regulating cortical function.

Thalamic reticular microcircuits: from structure to function

Morning session (*TRN: from neurons to local microcircuits*)

8:00 – 8:10am	**Introduction**
8:10 – 8:50am	**Scott Cruikshank**. TBA.
8:50 – 9:30am	**Carole Landisman**. Electrical synapses in thalamic circuitry: function and modulation.
9:30 – 10:10am	**Nathalie Leresche**. T-type calcium channel dependent plasticity at GABAergic intrathalamic synapses.
10:10 – 10:50am	**Jeanne Paz**. Dynamic interaction between cortical and thalamic inputs onto reticular thalamic neurons revealed by dual-wavelength optogenetics.
10:50 – 11:30am	**Judith Hirsch**. TBA.

Afternoon session: (*TRN: from local microcircuits to large scale networks*)

4:30 – 4:40pm	**Introduction**
4:40 – 5:20pm	**Maxim Bazhenov**. Role of thalamic reticular microcircuits in controlling sleep oscillations.
5:20 – 6:00pm	**Igor Timofeev**. How does the thalamic gate work?
6:00 – 6:40pm	**Mark Beenhakker**. Astrocytic control of thalamic oscillations.
6:40 – 6:20pm	**Basilis Zikopoulos**. Circuits for attention to emotions through the thalamic reticular nucleus.
7:20 – 7:45pm	**Discussion**. Future conceptual and experimental approaches.

7. A new chapter in the study of functional maps in visual cortex

Organizers:
Ian Nauhaus, Salk Institute
Kristina Nielsen, Johns Hopkins University

The functional organization of visual cortex has been passionately studied ever since Hubel and Wiesel first identified orientation and ocular dominance columns in V1. The energy put forth in this area of research has been justified by the significance that feature maps may hold in helping us understand the function of neocortex. For example, feature maps are likely relevant to cortical coding capacity, cortical circuits, and cortical development. Although the decades of research on cortical maps have provided many useful insights, the most important questions remain unanswered. Luckily, new techniques have been developed to allow the field to dig deeper. Twophoton microscopy and circuit tracing technology now allows us to image feature maps at the level of cell bodies and their corresponding dendritic/axonal processes. Furthermore, new theoretical models are in the works to help guide these future experiments. The proposed workshop will bring together both experimentalists and theoreticians, and will provide a platform for important discussions on how to best propagate this field of research into a new era. The recently published and unpublished work by our speakers sheds light on cortical maps from multiple angles. The workshop will start with work from groups that use two-photon imaging to characterize the joint-representation of different stimulus features within the micro-architecture of V1 (Conway et al., 2010; Kara and Boyd, 2009; Nauhaus et. al., 2012; Nielsen et. al., 2012). Some of the follow-up talks will then address how columns of neuronal tuning are established by the thalamo-cortical circuit (Jin et al., 2011; Paik and Ringach, 2011), whereas others will discuss how the maps may be constructed via self-organizing principles of the cortex during development (Li et al., 2008; Kaschube et al., 2010). Next, there will be a discussion on how tuning of classical and extra-classical receptive field properties is shaped by the local circuits within V1 maps (Levy et al., 2012; Hashemi-Nezhad and Lyon, 2012). A natural extension of this topic is work on how maps get transformed after V1 in extriastriate cortex (Lu et al., 2010). Finally, our workshop will address how the columnar architecture of large mammals may scale down to the level of the rodent architecture (Smith and Häusser, 2010). The unique perspectives from these different groups will undoubtedly result in lively discussion.

A new chapter in the study of functional maps in visual cortex

Day 2

Morning session

8:00 – 8:40am	**Kristina Nielsen**. Organization of V1 revisited - Taking a closer look at feature maps.
8:50 – 9:25am	**Soumya Chatterjee**. Micromaps in blobs: the architecture of color in V1.
9:35 –10:15am	**Prakash Kara**. Synaptic, cell body, and vascular maps of binocular integration.

Afternoon session

4:30 – 5:00pm	**David Fitzpatrick**. Building cortical circuits with experience: Insights from visual cortex.
5:10 –5:50pm	**Taro Toyoizumi**. A theory of the transition to critical period plasticity.
6:00 – 6:30pm	**David Lyon**. Revealing connectivity patterns of inputs to inhibitory neurons in relation to the V1 orientation preference map: combining intrinsic signal optical imaging with cell-type specific tracing using viral vectors.
6:40 – 7:15pm	**Marina Garrett**. Functional and structural mapping of mouse visual cortical areas.

The Cliff Lodge - Level C (Upstairs)

Wasatch A, Wasatch B, Superior A, Superior B, Maybird

The Cliff Lodge - Level 8 (Downstairs)
Magpie A, Magpie B