COSYNE 2013 Workshops

March 4 & 5, 2013
Snowbird, Utah

<table>
<thead>
<tr>
<th>Monday, March 4</th>
<th>Organizer(s)</th>
<th>Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Furry statisticians – how rodents infer the meaningful properties of unreliable environments.</td>
<td>A. Akrami, M. Diamond</td>
<td>Superior A</td>
</tr>
<tr>
<td>2. Large-scale neuronal simulations – science, languages and platforms.</td>
<td>C. Koch, S. Hill</td>
<td>Maybird</td>
</tr>
<tr>
<td>3. The awake and anesthetized cortex – similar or different?</td>
<td>F. Frolich</td>
<td>Wasatch B</td>
</tr>
<tr>
<td>4. Neural mechanisms for orienting decisions across the animal kingdom.</td>
<td>J. Erlich, B. Corneil</td>
<td>Wasatch A</td>
</tr>
<tr>
<td>5. Why so many layers and cell types?</td>
<td>R. Bruno</td>
<td>Magpie A</td>
</tr>
<tr>
<td>6. Neural mechanisms of foraging decisions</td>
<td>B. Hayden, A. Wikenheiser</td>
<td>Superior B</td>
</tr>
</tbody>
</table>

Workshop Co-Chairs

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

<table>
<thead>
<tr>
<th>Tuesday, March 5</th>
<th>Organizer(s)</th>
<th>Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Reward-based decision making.</td>
<td>M. Laubach J. Roitman</td>
<td>Wasatch A</td>
</tr>
<tr>
<td>2. Beyond optogenetics: new approaches for systems neuroscience and towards brain activity mapping</td>
<td>K. Kording</td>
<td>Superior B</td>
</tr>
<tr>
<td>4. Understanding the brain by building one: new neuroscience on VLSI hardware</td>
<td>C.M. Niu</td>
<td>Wasatch B</td>
</tr>
<tr>
<td>5. Priors in perception, decision-making, and physiology.</td>
<td>J. Gardner H. Nienborg</td>
<td>Superior A</td>
</tr>
<tr>
<td>6. Reticular microcircuits: from structure to function</td>
<td>M. Halassa J. Haas</td>
<td>Magpie A</td>
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</tbody>
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### Workshop Co-Chairs  

| Jess Cardin, Yale | jess.cardin@yale.edu | 267-235-0462 |
| Tatyana Sharpee, Salk | sharpee@salk.edu | 858-610-7424 |

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


10:05 – 10:20am Discussion

10:20 – 10:45am Zachary Mainen. Sources of uncertainty in decision-making.

**Afternoon Session**


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


6:35 – 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 Xyce: 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 higher order 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


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


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 interest 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 Wikenheiser, 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**

<table>
<thead>
<tr>
<th>Time</th>
<th>Speaker(s)</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>8:00 – 8:10am</td>
<td><strong>Introduction</strong></td>
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<tr>
<td>8:10 – 8:40am</td>
<td><strong>Andrew Wikenheiser.</strong> Subjective costs drive a sunk cost-like effect in foraging rats</td>
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<tr>
<td>8:40 – 9:10am</td>
<td><strong>Elisabeth Murray.</strong> Revaluing foraging goals based on current biological needs</td>
<td></td>
</tr>
<tr>
<td>9:10 – 9:40am</td>
<td><strong>Sara Constantino.</strong> Learning the opportunity cost of time in the context of patch-foraging</td>
<td></td>
</tr>
<tr>
<td>9:40 – 9:55am</td>
<td><strong>Coffee break</strong></td>
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</tr>
<tr>
<td>9:55 – 10:25am</td>
<td><strong>John Pearson.</strong> Modeling primate foraging in the lab</td>
<td></td>
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<tr>
<td>10:25 – 10:55am</td>
<td><strong>Stephen Cowen.</strong> Beyond the cost of work: Relationships between physical effort, risk, and reward</td>
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</tbody>
</table>

**Afternoon Session**

<table>
<thead>
<tr>
<th>Time</th>
<th>Speaker(s)</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>4:30 – 5:00pm</td>
<td><strong>Sachin Ranade.</strong> Lessons from an accidental forager: Distinct behavioral correlates of identified interneuron subtypes in mouse anterior cingulate cortex</td>
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</tr>
<tr>
<td>5:00 – 5:30pm</td>
<td><strong>Tommy Blanchard.</strong> Neural basis of diet selection decisions</td>
<td></td>
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<tr>
<td>5:30 – 6:00pm</td>
<td><strong>Coffee break</strong></td>
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<td>6:00 – 6:30pm</td>
<td><strong>Nils Kolling.</strong> A human foraging network? Evidence for the existence of two distinct evaluative networks centred around the dACC and vmPFC from human functional imaging</td>
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<tr>
<td>6:30 – 7:00pm</td>
<td><strong>Michael Platt.</strong> Neural mechanisms of foraging decisions</td>
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<tr>
<td>7:00 – 7:30pm</td>
<td><strong>Discussion</strong></td>
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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. Two-photon 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 extrastriate 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 Häsuser, 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.


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.


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**

<table>
<thead>
<tr>
<th>Time</th>
<th>Speaker</th>
<th>Topic</th>
</tr>
</thead>
<tbody>
<tr>
<td>8:20 – 8:30am</td>
<td><strong>Introduction</strong></td>
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<tr>
<td>8:30 – 9:00am</td>
<td>Bartlett Mel.</td>
<td>The dimensionality of dendritic computation.</td>
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<td>9:00 – 9:30am</td>
<td>Jeff Magee.</td>
<td>Input comparison type computations in cortical networks.</td>
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<td>9:30 – 10:00am</td>
<td><strong>Coffee break</strong></td>
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<tr>
<td>10:00 – 10:30am</td>
<td>Michiel Remme.</td>
<td>Consolidation of synaptic patterns from proximal into distal dendrites of a hippocampal CA1 pyramidal neuron.</td>
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<td>10:30 – 11:00am</td>
<td>Albert Lee.</td>
<td>Cellular mechanisms underlying spatially-tuned firing in the hippocampus.</td>
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**Afternoon Session**

<table>
<thead>
<tr>
<th>Time</th>
<th>Speaker</th>
<th>Topic</th>
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<tbody>
<tr>
<td>4:30 – 5:00pm</td>
<td>Tiago Branco.</td>
<td>Dendritic computations with spatially distributed input.</td>
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<tr>
<td>5:00 – 5:30pm</td>
<td>Walter Senn.</td>
<td>STDP with dendritic spikes: which postsynaptic spike to take?</td>
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<td>5:30 – 6:00pm</td>
<td><strong>Coffee break</strong></td>
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<tr>
<td>6:00 – 6:30pm</td>
<td>Michael Hausser.</td>
<td>Probing the function of dendritic spikes in vivo.</td>
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<tr>
<td>6:30 – 7:00pm</td>
<td>Mate Lengyel.</td>
<td>Computations in recurrent circuits with non-linear dendrites.</td>
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<tr>
<td>7:00 – 7:30pm</td>
<td><strong>Discussion</strong></td>
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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 existing 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 massively parallel 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
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
9:50 – 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
5:40 – 6:10pm Coffee Break and Discussion
6:40 – 6:50pm Discussion
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 Beenakker. Astrocytic control of thalamic oscillations.

6:40 – 7:20pm 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. Two-photon 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 extrastriate 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 B (Downstairs)

Magpie A, Magpie B