COSYNE

WORKSHOPS

Breckenridge CO, Mar 5–6

2018

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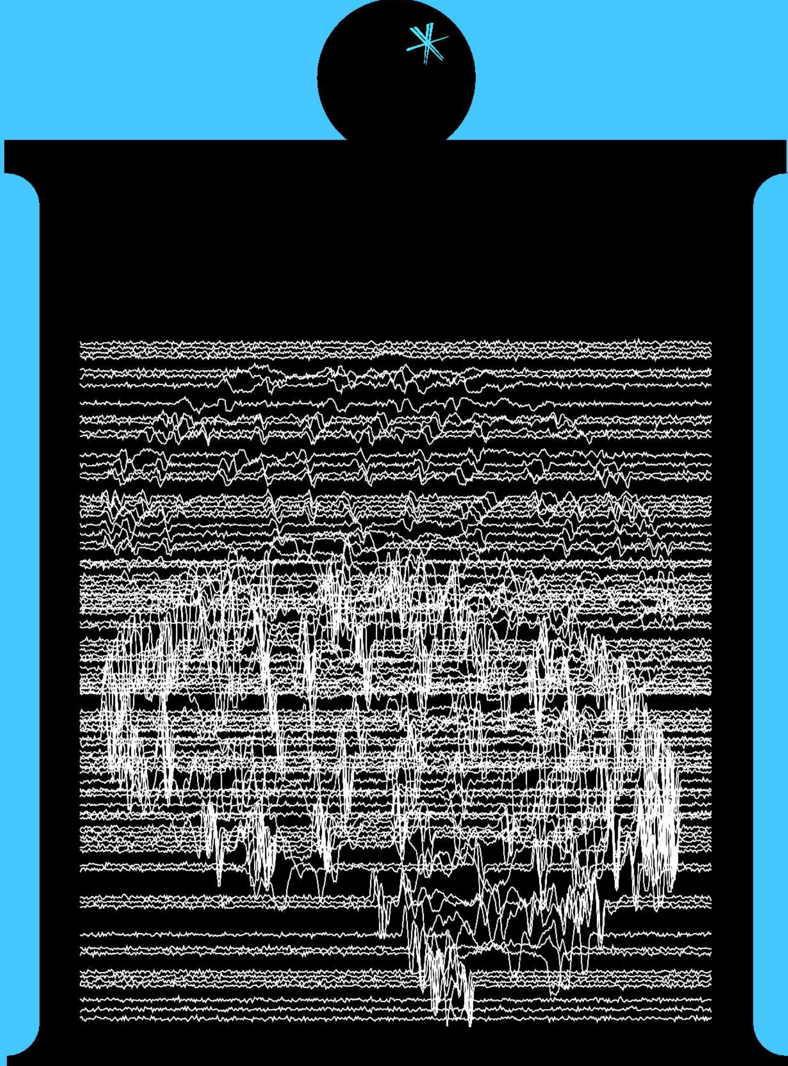

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COSYNE 2018 WORKSHOPS

Breckenridge, CO
March 5–6, 2018

Organizers:
Laura Busse
Ralf Haefner

COSYNE 2018 Workshops

March 5–6, 2018

Breckenridge, Colorado

Monday, March 5, 2018	Organizer(s)	Location
1.1 Concepts, attention, and consciousness in (reinforcement) learning	M Kawato A Cortese	*Colorado Peak 1*
1.2 Hippocampal computations and interactions supporting statistical learning and decision-making	I Ballard	*Colorado Peak 2*
1.3 Computational affective neuroscience: Algorithms for survival	DR Bach RB Rutledge	*Colorado Peak 3*
1.4 Brain-wide neuronal dynamics and inter-area communication: recordings, analysis, and theory – *Day 1*	W Allen AI Jasper I Kauvar J Semedo	*Summit Peaks 6, 7, 8*
1.5 Cortical circuits: functions and models of long-range connections – *Day 1*	DF Albeanu A Kwan S Lee L Petreanu	*Summit Peaks 9, 10*
1.6 RNNs: What are we doing and why? – *Day 1*	A Benucci D Sussillo	*Summit Peaks 11, 12*
1.7 The perturbing approach to understanding the brain	R Engelken M Schottdorf F Wolf	*Breckenridge Peak 14*
1.8 Recent computational advances in neuroengineering: From theory to applications	M Beyeler BW Brunton	*Breckenridge Peak 15*
1.9 Model-based cognition: Hierarchical reasoning and sequential planning – *Day 1*	KJ Miller K Stachenfeld B van Opheusden R Kiani	*Breckenridge Peak 16*

Workshop Co-Chairs	Email
Ralf Haefner, University of Rochester	rhaefne2@ur.rochester.edu
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Map of Breckenridge workshop locations is on page 5 of this booklet.

COSYNE 2018 Workshops

March 5–6, 2018

Breckenridge, Colorado

Tuesday, March 6, 2018	Organizer(s)	Location
2.1 Closed-loop control of neural systems and circuits for scientific discovery	C Rozell G Stanley	*Colorado Peak 1*
2.2 Circuit dynamics in working memory	A Compte K Wimmer	*Colorado Peak 2*
2.3 State-dependent neuromodulation of information processing	A Geana M Nassar	*Colorado Peak 3*
2.4 Brain-wide neuronal dynamics and inter-area communication: recordings, analysis, and theory – *Day 2*	W Allen AI Jasper I Kauvar J Semedo	*Summit Peaks 6, 7, 8*
2.5 Cortical circuits: functions and models of long-range connections – *Day 2*	DF Albeanu A Kwan S Lee L Petreanu	*Summit Peaks 9, 10*
2.6 RNNs: What are we doing and why? – *Day 2*	A Benucci D Sussillo	*Summit Peaks 11, 12*
2.7 Manifold-splaining: What the theorist said to the experimentalist	A Christensen A Calhoun	*Breckenridge Peak 14*
2.8 The multiple facets of synaptic plasticity and learning: Shaping circuits, generating representations, modulating behavior	J Gjorgjieva P Munro	*Breckenridge Peak 15*
2.9 Model-based cognition: Hierarchical reasoning and sequential planning – *Day 2*	KJ Miller K Stachenfeld B van Opheusden R Kiani	*Breckenridge Peak 16*

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Ralf Haefner, University of Rochester	rhaefne2@ur.rochester.edu
Laura Busse, Ludwig-Maximilians-Universität	busse@biologie.uni-muenchen.de

Map of Breckenridge workshop locations is on page 5 of this booklet.

Schedule

Each workshop group will meet in two sessions from ~8–11am and from ~4.30–7.30pm.

Workshop summaries and schedules are available starting on page 6 of this booklet.

Transportation

For all travel discounts available to Cosyne attendees, please visit www.cosyne.org.

Hilton Denver City Center to Breckenridge: Free shuttle provided for registered attendees (first shuttle leaves @ 4pm, last @ 5pm on Sunday, 04 March 2018).

Breckenridge to Denver Airport: Shuttle can be arranged at Breckenridge, or online at: www.coloradomountainexpress.com

Further information about transportation to/from Breckenridge is available at: www.breckenridge.com.

For further information on transportation or other logistics please contact Leslie Weekes (leslie.weekes@cosyne.org).

Discounted workshop rates

For more details on ski rental and lift tickets discounts, please visit www.cosyne.org.

Ski rental discount for Cosyne attendees: 25 % off ski rentals at www.rentskis.com/cosyne.

Group rates for lift tickets. Use your lift ticket coupon for the following walk up window rates:

Starting on <=04 March	Coupon Adult 1-Day/2-Day/3-Day	$140/$137/$129
	Coupon Child 1-Day/2-Day/3-Day	$92/$90/$79
	First-time, Novice Full Day Adult Group Lesson/+Lift	$104/$143
Starting on >=05 March	Coupon Adult 1-Day/2-Day/3-Day	$151/$151/$144
	Coupon Child 1-Day/2-Day/3-Day	$98/$98/$94
	First-time, Novice Full Day Adult Group Lesson/+Lift	$152/$191

Meals included with registration

Breakfast (Day 1 and Day 2) — Colorado ballroom, Peaks 4 & 5

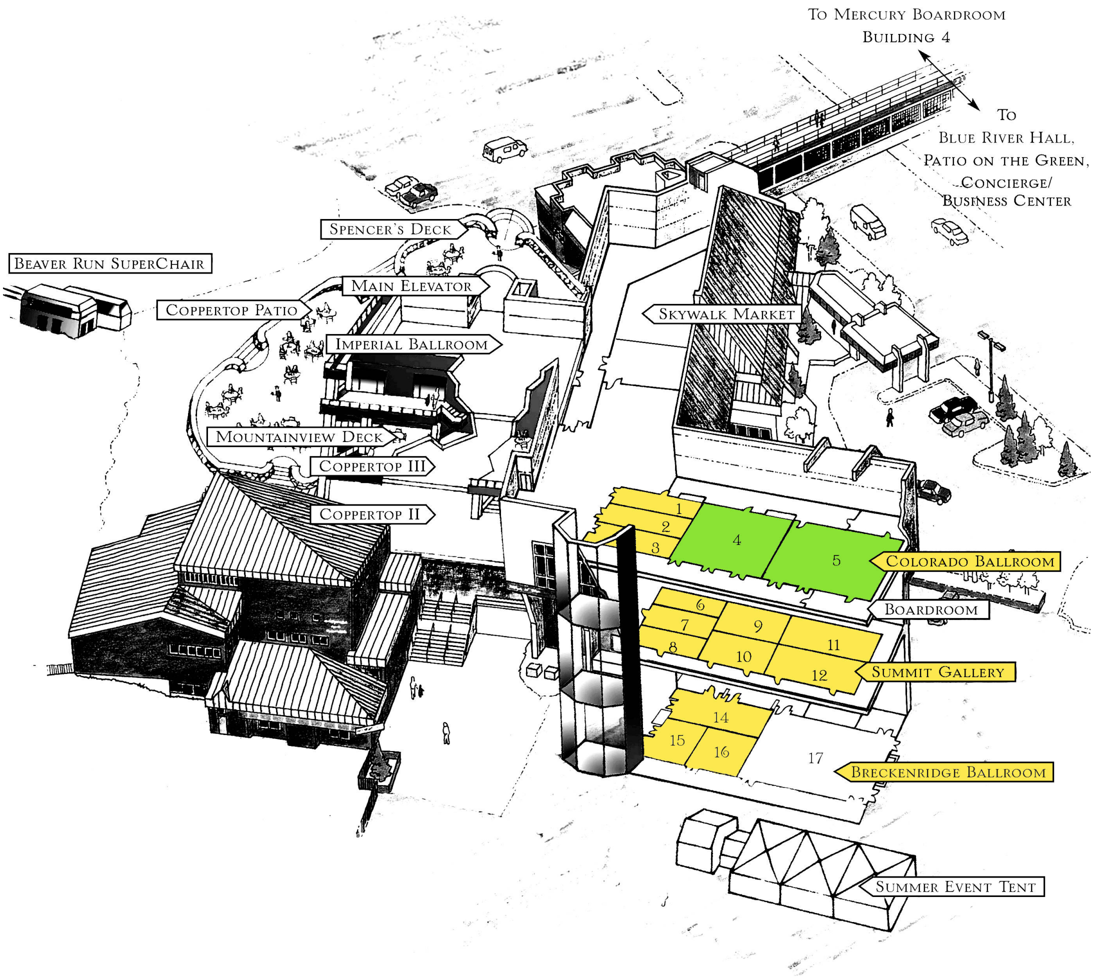
Dinner (Day 2) — Colorado ballroom

Coffee breaks during morning and afternoon sessions

Workshops wi-fi password

Password: *cosyne2018*

Breckenridge workshop locations



1.1 Concepts, attention, and consciousness in (reinforcement) learning

Monday, March 5, 2018

Organizers: Mitsuo Kawato, Aurelio Cortese

The ability to learn is what allows humans and animals alike to exhibit rich, near optimal and highly adaptive behaviors and is one of the key aspects of intelligence. In parallel with basic neuroscience, machine learning has seen spectacular advances in the last few years. But how can the brain learn so efficiently, when it effectively deals with an almost prohibitive number of states, often implicit? Large effort has been directed to this elusive aspect, and we are finally beginning to unravel the functional architecture of this remarkable representational ability. Incremental findings indicate attention, concepts, metacognition and consciousness are all crucial features allowing the brain to reduce dimensionalities and learn from very small samples. Nevertheless, to what extent do they facilitate (reinforcement) learning? What is the neural circuitry involved? More generally, how do they relate to each other? Exploring how these findings can be applied to machine learning will significantly foster artificial intelligence (AI) development, and in turn reveal new ideas and new frameworks for the understanding of the brain.

This workshop will highlight interdisciplinary research in (reinforcement) learning and its relationship to attention, awareness and conceptual knowledge, especially under uncertainty. Furthermore, one of its core aspirations is to bridge the several domains of these studies, spanning from human to animal perspectives, from theoretical and computational to neurophysiological approaches, providing a strong discussion link with AI. We hope this workshop will create the best environment for successful and fruitful discussions, but also potentially for the emergence of new ideas.

1.1 Concepts, attention, and consciousness in (reinforcement) learning

Colorado ballroom, Peak 1

Morning session

08.10–08.20a	Opening remarks, *Mitsuo Kawato*
08.20–08.50a	*Yoshua Bengio,* The consciousness prior
08.50–09.20a	*Megan Peters,* Can access to unconscious representations be learned?
09.20–09.40a	*Coffee break*
09.40–10.10a	*Bradley Love,* Attention as uncertainty-minimising information sampling
10.10–10.40a	*Alicia Izquierdo,* Contributions of rat frontal cortex to value learning under uncertainty
10.40–11.00a	Discussion moderated by Cortese and Kawato

Afternoon session

04.30–05.00p	*Aurelio Cortese,* Graded effects of consciousness in reinforcement learning
05.00–05.30p	*Jacqueline Gottlieb,* Attention and the value of mental actions
05.30–05.50p	*Coffee break*
05.50–06.20p	*Kenji Doya,* Imaging the neural circuit for mental simulation
06.20–07.30p	Discussion moderated by *Cortese* and *Kawato*

1.2 Hippocampal computations and interactions supporting statistical learning and decision-making

Monday, March 5, 2018

Organizer: Ian Ballard

1. What the workshop will address and accomplish

The hippocampus has unique physiological and circuit properties that have long intrigued the computational and systems neuroscience communities. Research over the past five decades has established that this circuit supports episodic memory and spatial navigation, functions for which there are richly developed computational models. Recently, there has been an increased emphasis on hippocampal interactions with striatal and prefrontal circuits involved in reinforcement learning and decision-making.

These observations raise several pressing questions. First, what is the precise role that the hippocampus plays in these processes? Second, what is the nature of representations encoded by the hippocampus and how do they differ from those held in cortical circuits? Third, how can our computational models of learning, decision-making, and memory be expanded and integrated in order to explain these findings?

On these points, significant progress has been made in just the past three years. This workshop will bring together theorists and experimentalists to discuss recent observations about how hippocampal representations can support the functions of other brain systems and discuss how theoretical models can both account for these data and generate new predictions.

2. Why the topic is of interest

Distinguishing the functions and properties of different systems has long been an organizational motif for neuroscience. It is becoming clear that the full suite of decision-making behaviors cannot be explained without understanding the interactions between the hippocampus and striatal and cortical circuits.

3. Who is the targeted group of participants

This workshop is targeted towards researchers who study the neural circuits supporting learning and decision making. In addition, this workshop will appeal to researchers who study functions of the hippocampus as well as those who study statistical and reinforcement learning. The workshop has confirmed participation from theorists, systems neuroscientists and human cognitive neuroscientists who are motivated by shared questions about hippocampal interactions but who rarely have the opportunity to interact.

1.2 Hippocampal computations and interactions supporting statistical learning and decision-making

Colorado ballroom, Peak 2

Morning session

08.00–08.20a	*Abigail Novick,* Measuring spontaneous hippocampal contributions to working memory maintenance using drift diffusion modeling
08.20–08.50a	*Michael Mack,* The dynamic formation of hippocampal concept representations during human category learning
08.50–09.20a	*Carien Lansink,* Forming and expressing place-reward associations in the hippocampal-ventral striatal circuitry
09.20–09.35a	*Coffee break*
09.35–09.55a	*Ida Momennejad,* Multi-scale predictive representations in the hippocampus facilitate planning
09.55–10.25a	*Brett Foster,* Sensory reinstatement in human neocortex during episodic memory decisions
10.25–11.00a	Discussion

Afternoon session

04.30–05.00p	*Rutsuko Ito,* Hippocampal contributions to learned approach-avoidance conflict decision making in rodents.
05.00–05.30p	*Deepu Murty,* Contributions of episodic memory to decision making in humans.
05.30–05.50p	*Kim Stachenfeld,* Deriving predictive representations in hippocampus with reinforcement learning theory
05.50–06.05p	*Coffee break*
06.05–06.25p	*Aaron Bornstein,* Continuous accumulation of memory and sensory evidence
06.25–06.45p	*Jingfeng Zhou,* Representation of task structure by the orbitofrontal cortex and hippocampus within an odor sequence task
06.45–07.15p	Discussion

1.3 Computational affective neuroscience: Algorithms for survival

Monday, March 5, 2018

Organizers: Dominik R Bach, Robb B Rutledge

Emotions are believed to play a central role in adaptive behavior across the animal kingdom, but they are conceptualized in many divergent and often imprecise ways. Capturing the essence of emotions with computational methods seems like an oxymoron, and emotions are often even seen as dark irrational forces that inflexibly bias behavior away from rationality.

The field of affective neuroscience has recently started to adopt computational approaches with the aim of formalizing the emergence of emotional phenomena including overt behavior, physiological responses, internal resource allocation, and subjective feelings. This workshop brings together experimental and theoretical neuroscientists to synthesize novel vistas on the topic of computational models of emotions and their relation to adaptive behavior. We will discuss the computational, algorithmic, and implementation-level properties of neural controllers that perform action selection in a wide variety of scenarios relevant to survival, from avoiding predators to finding food, and in both humans and non-human animals.

Talks in this workshop focuses on the computational and neural basis of adaptive behavior under threat of predation, starvation, or innate danger, and on how humans become aware of these emotional processes in the form of subjective feelings. The first part of the workshop covers theoretical and experimental findings from non-human animals using optogenetic, electrophysiological, and optical imaging approaches. The second part of the workshop includes models of human behavior and results from functional neuroimaging. The scope of the workshop also includes pathological emotional experiences relevant to the nascent field of computational psychiatry. With ample time for discussion, we hope to inspire new developments in research and theory to advance this young field.

1.3 Computational affective neuroscience: Algorithms for survival

Colorado ballroom, Peak 3

Morning session

08.00–08.10a	*Dominik Bach,* Overview
08.10–08.40a	*Dominik Bach,* Algorithms for survival: a decision-theoretic view on behavior under threat
08.40–09.10a	*Benjamin Grewe,* Associate or discriminate? Neural ensemble learning in the ancient brain
09.10–09.40a	*Kay Tye,* Dopamine modulates the signal-to-noise of PFC-brainstem neurons to aversive stimuli
09.40–10.00a	*Coffee break*
10.00–10.40a	*Ekaterina Likhtik,* Oscillations in a prefrontal-amygdala circuit pace inhibition during emotion regulation
10.40–11.10a	*Daniel Bush,* Modelling the role of theta oscillations in spatial cognition, navigation, and fear
11.10–11.30a	Morning recap and discussion

Afternoon session

04.30–05.00p	*Catherine Hartley,* Control and the calibration of motivated behavior
05.00–05.30p	*Nils Kolling,* The neural mechanisms underlying behavioral flexibility in complex foraging environments
05.30–06.00p	*June Gruber,* Unpacking positive emotion disturbance in bipolar disorder
06.00–06.30p	*Coffee break*
06.30–07.00p	*Luke Chang,* Dynamic brain representations underlying emotional experience
07.00–07.30p	*Robb Rutledge,* A neurocomputational model for mood instability and reward dysregulation
07.30–08.00p	Workshop recap and discussion

1.4 Brain-wide neuronal dynamics and inter-area communication: Recordings, analysis, and theory–Day 1

Monday, March 5, 2018

Organizers: William Allen, Anna Ivic Jasper, Isaac Kauvar, João Semedo

Many brain functions rely upon coordinated activity across multiple brain areas. Yet, how different brain areas communicate and interact with each other to implement specific computations remains poorly understood. In order to explore these questions, imaging and electrophysiological methods have recently been developed that enable the simultaneous recording of the activity of large numbers of neurons distributed throughout the brains of behaving animals. In conjunction with increasingly detailed brain-wide anatomical information, these types of large-scale recordings promise to yield major insights into how different systems within the brain interact. In parallel, statisticians have started work on new mathematical tools to analyze and interpret these complex experimental data, and theorists have begun to develop network models involving multiple, interconnected brain areas to understand how brains may implement mechanisms such as context-dependent selection and routing of information. The time is thus ripe to bring together experiment and theory to forge a path into the uncharted territory of performing and understanding brain-wide experiments, and to reconcile different experimental observations and network models.

In this workshop, we seek to explore the experimental, analytical, and conceptual challenges that brain-wide recordings present, by bringing together experts in the development and application of optical and electrophysiological recording technologies, experts in the analysis of these high dimensional datasets, and theoretical neuroscientists who are interested in understanding the principles underlying how multiple systems within the brain interact to perform computations and produce behavior

The target audience for this workshop consists of both experimental and theoretical neuroscientists who are interested in understanding the principles underlying how multiple systems within the brain interact to perform computations and produce behavior. We hope to address question such as: “What experimental and computational tools can we use to obtain and interpret simultaneous multi-area recordings of large neuronal populations?”, “What, if anything, distinguishes intra- and inter-area interactions, and what patterns of activity during behavior are local vs global?”, “When and how do brain areas selectively share information, in a context-dependent manner?”. We plan to allocate time for panel discussions after each talk, where speakers and attendees will have a chance to exchange ideas and work to identify some of the immediate challenges in recording and studying multi-area interactions, including the use of new tools to manipulate neuronal activity and interpret large-scale recordings.

1.4 Brain-wide neuronal dynamics and inter-area communication: Recordings, analysis, and theory–Day 1

Summit gallery, Peaks 6, 7, 8

Day 1, organized by William Allen and Isaac Kauvar

The main goals of this session are: To understand the strengths and weaknesses of different recording technologies, and to determine what can be learned from studying multiple parts of the brain simultaneously at different spatial and temporal scales. To discuss the design of experiments that can best leverage a brain-wide perspective.

Morning session

08.00–08.05a	Introduction
08.05–08.30a	*Chi Ren,* Characterizing cell type-specific dynamics of cortex-wide activity during motor learning
08.30–09.05a	*Simon Musall,* Motor events dominate large-scale cortical activity during sensory-guided decision making
09.05–09.25a	*Coffee break*
09.25–09.50a	*Tim Machado,* Large-scale optical interrogation of interconnected brain regions
09.50–10.15a	*Sotiris Masmanidis,* Causally probing neural dynamics with optogenetics and large-scale recording
10:15–10.40a	*Spencer Smith,* TBD
10.40–11.10a	Discussion

Afternoon session

04.30–04.35p	Discussion
04.35–05.00p	*Jason Chung,* A polymer probe-based system for high density, long-lasting electrophysiological recordings across distributed neuronal circuits
05.00–05.25p	*Jerry Chen,* Dissecting long-range cortical networks during behavior
05.25–05.45p	*Coffee break*
05.45–06.10p	*Nick Steinmetz,* Recording the activity of distributed neuronal populations underlying vision, action, and reward across the mouse brain with Neuropixels electrode arrays
06.10–06.35p	*Christine Constantinople,* Orbitofrontal and parietal contributions to computations underlying economic choice in rats
06.35–07.00p	*Josh Siegle,* Performing large-scale recordings at scale
07.00–07.30p	Discussion and closing remarks

1.5 Cortical circuits: Functions and models of long-range connections–Day 1

Monday, March 5, 2018

Organizers: Florin Albeanu, Alex Kwan, Seung-Hee Lee, Leopoldo Petreanu

Cortical function, particularly sensory processing, has been approached typically from the perspective of a sequential hierarchy of feedforward connections. However, in many primary sensory areas (visual, auditory, olfactory, somatosensory, etc.), the ascending inputs are greatly outnumbered by the descending fibers. The recurrent architecture suggests that long-range feedback projections are likely to have important computational functions.

Exciting new studies are beginning to reveal the roles of long-range connections. Experiments are fueled by technological advances in optical and electrophysiological methods, which enable the observation and manipulation of neuronal components from multiple brain regions simultaneously. Moreover, there has been a renewed focus in modeling large-scale cortical networks based on concepts emerging from the machine learning and computational neuroscience communities. These developments lead to new ideas for how long-range connections might contribute to context-dependent processing of task-relevant inputs, predictive coding, attention and perceptual performance, and learning and plasticity during sensory-guided behaviors.

For our workshop, we aim to have a lively discussion between experimental and computational neuroscientists. The talks and discussion periods will focus on questions such as: What is the synaptic organization of the long-range cortical pathways? What types of signals are being encoded and transmitted along the projections? Is there distinct top-down versus bottom-up flow of information? What is the impact of feedback on sensory processing? How may we include the complexity of long-range connections in computational models?

1.5 Cortical circuits: Functions and models of long-range connections–Day 1

Summit gallery, Peaks 9, 10

Morning session

08.00–08.10a	*Florin Albeanu & Leopoldo Petreanu,* Introduction
08.10–08.40a	*Florin Albeanu,* Parallel feedforward and feedback streams in mammalian olfaction
08.45–09.15a	*Mark Andermann,* Amygdala inputs to association cortex signal motivationally relevant outcomes
09.20–09.45a	*Coffee break*
09.45–10.15a	*Peter Latham,* A probabilistic top-down approach for demixing odors
10.20–10.50a	*Kelly Clancy,* Locomotion-dependent remapping of distributed cortico-cortical networks

Afternoon session

04.30–05.00p	*Charles Gilbert,* Circuit dynamics of visual cortex
05.05–05.35p	*Leopoldo Petreanu,* The functional organization of cortical feedback connections in V1
05.40–06.05p	*Coffee break*
06.05p–6.35p	*Hendrikje Nienborg,* Signatures of feedback in visual cortex during perceptual decisions
06.40–07.10p	*Subutai Ahmad,* Could a model of predictive voting explain many long-range connections?
07.10–07.25p	Panel discussion, the organizers

1.6 RNNs: What are we doing and why?–Day 1

Monday, March 5, 2018

Organizers: Andrea Benucci and David Sussillo

The use of recurrent neural networks (RNNs) to model the dynamics of large neuronal populations is becoming increasingly popular. The implicit assumption of those employing the technique is that RNN modeling may bring some advantages relative to more conventional dynamical-system approaches. However, the classes of problems and the level of analysis that might benefit the most from the use of RNNs (e.g. the computational, algorithmic, or implementation level) are currently unclear. In this workshop we will discuss this 'elephant in the room', trying to highlight as concretely as possible the cognitive questions, the behavioral paradigms, and the neural systems that should be targeted for RNNs to reveal their strongest advantages or disadvantages. We also welcome the possibility of negative answers, where specific classes of problems may not be suitable for RNN based techniques. We hope to open up the discussion on whether or not RNNs can provide a unique unifying theoretical framework across diverse neural systems. In conclusion, this workshop will begin a much needed conversation on what we are doing with RNNs and why.

1.6 RNNs: What are we doing and why?–Day 1

Summit gallery, Peaks 11, 12

Morning session

08.15–08.25a	*David Sussillo & Andrea Benucci,* Introduction
08.25–09.00a	*Wolfgang Maas,* New methods for learning in recurrent networks of spiking neurons
09.05–09.40a	*Dan Yamins,* Convolutional recurrent network models of ventral stream neural dynamics
09.40–10.00a	*Coffee break*
10.00–10.35a	*Dean Buonomano,* Using RNNs to understand how the brain tells time
10.40–11.15a	*Claudia Clopath,* Training spiking RNNs

Afternoon session

04.30–05.05p	*Guangyu Robert Yang,* Studying human-level cognition with trained recurrent neural networks
05.10–05.45p	*Byron Yu,* Low-dimensional population activity in recurrent spiking networks
05.45–06.05p	*Coffee break*
06.05–06.40p	*Mehrdad Jazayeri,* Relating sensorimotor timing to brain dynamics: Insights from integrating recurrent neural networks with electrophysiology
06.45–07.20p	*Jonathan Michaels,* Performance-driven recurrent neural networks for complex motor control

1.7 The perturbing approach to understanding the brain

Monday, March 5, 2018

Organizers: Rainer Engelken, Manuel Schottdorf, Fred Wolf

Perturbing neural activity to study circuit function and its link to behavior is a classical paradigm in neuroscience. Novel tools and bidirectional neural circuit interfaces for the first time allow to selectively manipulate and monitor the activity of vast numbers of neurons in behaving animals. These technological advancements promote the perturbation of neural activity with millisecond and single cell precision and allow new approaches to fundamental questions. To fully harness the potential of such tools and approaches, it is vital, to built better theoretical models for the interaction of recurrent circuit dynamics and artificial perturbations, specifically relevant for sensory processing, decision making, fear conditioning and motor control.

The workshop will provide a vibrant platform for exchange between emerging experimental paradigms and theoretical advances to foster progress towards the causal interrogation of circuit function.

The workshop will focus on four main questions:

1. Which stimulation methods and what spatiotemporal stimuli are optimal for manipulating and controlling recurrent cortical dynamics?
2. What can we learn about neural information coding from the susceptibility of neural circuits to artificial perturbations?
3. How can neural activity perturbations change behavior and reveal behaviorally relevant information processing?
4. What are mathematically tractable idealizations that can guide the design of perturbation experiments?

This workshop aims to open novel avenues for the interplay of theory and experiment to catalyze the emergence of a new alliance between the theory of circuits dynamics and perturbation experimental designs.

1.7 The perturbing approach to understanding the brain

Breckenridge ballroom, Peak 14

Morning session

08.00–08.05a	*Fred Wolf,* Welcoming remarks
08.05–08.30a	*Karl Deisseroth,* New tools and techniques for integrative perturbation and readout in neural systems
08.30–08.55a	*Giuseppe Pica,* Identifying features of neural activity that perform perceptual discrimination
08.55–09.20a	*Jeremie Barral,* Synaptic scaling maintains neuronal dynamics and controls the neural code
09.20–09.40a	*Coffee break*
09.40–10.05a	*Manuel Schottdorf,* A synthetic neurobiology approach to visual cortical feature selectivity
10.05–10.30a	*Michael Häusser,* All-optical interrogation of cortical circuits in behaving animals
10.30–11.00a	Discussion

Afternoon session

04.30–04.55p	*Sandro Romani,* Circuit dynamics underlying short–term memory
04.55–5.20p	*Rainer Engelken,* A dynamical systems perspective on perturbations and (optogenetic) activity control
05.20–5.45p	*Thierry Mora,* Closed-loop exploration of retinal sensitivity
05.45–6.15p	*Coffee break*
06.15–6.40p	*Dima Rinberg,* Dissecting relevance of coding feature using spatio-temporal pattern stimulation
06.40–7.05p	*Shy Shoham,* Testing readability of neuronal code features with single neuron precision
07.05–7.30p	Discussion

1.8 Recent computational advances in neuroengineering: From theory to applications

Monday, March 5, 2018

Organizers: Michael Beyeler, Bingni W. Brunton

Neuroengineering is emerging as an interdisciplinary field of research that combines neuroscience, engineering, and data science both for treating neurological and mental disorders as well as for understanding brain function. Relying on quantitative models of information processing in complex neural systems, neural interfaces are being developed that aim to restore sensory function (e.g., via cochlear implants for the deaf, retinal implants for the blind), enable sensorimotor function (e.g., via brain-computer interfaces, BCI), or treat neurological conditions such as depression, Parkinson's disease, epilepsy, and various motor symptoms (e.g., via deep brain stimulation, DBS; electrocorticography, ECoG).

Despite the rapid progress in the field, these technologies share a number of open computational challenges. On the one hand, for stimulating devices, predicting neural activity in response to artificial stimulation and finding optimal stimulation patterns (encoding problem) requires a deep theoretical knowledge of the underlying neurophysiology and interactions with device technology. On the other hand, for devices used in closed loop, reading out neural activity and decoding high-dimensional activity patterns demands rapid, online algorithms and state-of-the-art machine learning (decoding problem).

The goal of this workshop is to share ideas on fundamental principles and recent advances in neuroengineering applications in order to: 1) identify common computational challenges in designing neural interfaces that can interact meaningfully with complex neural systems; 2) discuss how computational theory can inform best practices and drive innovation in both scientific and clinical real-world applications; and 3) promote the use of shared computational tools, software, and resources across domains.

1.8 Recent computational advances in neuroengineering: From theory to applications

Breckenridge ballroom, Peak 15

Morning session

08.25–08.30a	*Michael Beyeler & Bingni Brunton,* Opening remarks
08.30–08.55a	*Caleb Kemere,* Investigating irregularly patterned deep brain stimulation signal design using biophysical models
08.55–09.20a	*Nir Grossman,* Noninvasive DBS via temporally interfering electric fields
09.20–09.45a	*Coffee break*
09.45–10.10a	*Nishal Shah,* Real time optimization of visual coding for artificial retina
10.10–10.35a	*Michael Beyeler,* Optimizing stimulation protocols for prosthetic vision based on retinal anatomy
10.35–11.00a	*Shreya Saxena,* Performance limitations in sensorimotor control: Tradeoffs between neural computing and accuracy while tracking fast movements

Afternoon session

04.30–04.55p	*Maryam Shanechi,* Multiscale, high-rate, and control-theoretic brain-machine interface design
04.55–05.20p	*Cynthia Chestek,* Neural interfaces for controlling finger movements
05.20–05.45p	*Aaron Batista,* Harnessing low-dimensional spaces to improve BCI performance
05.45–06.05p	*Coffee break*
06.05–06.30p	*Bingni Brunton,* Multimodal deep learning for natural human neural recordings and video
06.30–06.55p	*Joshua Jacobs,* Direct electrical stimulation of the human entorhinal region and hippocampus impairs memory
06.55–07.20p	*Edward Chang,* Sparse coding of ECoG signals identifies interpretable components for speech control in human sensorimotor cortex

1.9 Model-based cognition: Hierarchical reasoning and sequential planning–Day 1

Monday, March 5, 2018

Organizers: Kevin J. Miller, Kim Stachenfeld, Bas van Opheusden, Roozbeh Kiani

Decision making in a complex natural environment requires humans and animals to construct internal models of the world around them. These internal models support a wide variety of flexible behaviors, ranging from relatively simple learning procedures (e.g. outcome revaluation) to decision-making in complex, elaborately structured domains (e.g. games like chess). Although there is a growing consensus that humans and animals rely on models of their environment for goal-oriented behavior, it has proven challenging to draft theories and design experiments to study model-based reasoning and planning in the brain.

Consequently, many questions remain about the mechanisms by which models of the environment are built, revised, and deployed during decision-making behaviors which our workshop will seek to address.

A guiding principle of our workshop will be to consider decision-making in natural environments as a hierarchy of inference processes that generate a sequence of actions or action plans to attain a goal. In this hierarchical framework, a high-level strategy guides lower-level choices, and the outcome of those choices informs the strategy. Choosing a good strategy requires an internal model of the world that is rarely explicitly known and must therefore be inferred from past experience. A complete understanding of this framework must answer how models of the environment are learned, how suitable decision strategies are selected and executed based on such models, how these strategies guide ongoing choices, and how these processes adapt to improve performance in dynamic environments.

Our workshop builds on this framework and aims to provide new avenues to overcome existing challenges. We will identify points of connection across various perspectives from animal physiology, human neuroscience, and machine learning, and we will provide a forum for discussing recent advances in the field and their theoretical and conceptual implications.

1.9 Model-based cognition: Hierarchical reasoning and sequential planning–Day 1

Breckenridge ballroom, Peak 16

Morning session

08.00–08.10a	*Kevin Miller,* Introductory remarks
08.10–08.40a	*Josh Gold,* A bias-variance trade-off in human inference
08.40–09.10a	*Marco Wittmann,* Multiple time-linked reward representations in anterior cingulate cortex
09.10–09.40a	*Roozbeh Kiani,* Hierarchical decisions about choice and change of strategy
09.40–10.00a	*Coffee break*
10.00–10.30a	*Alireza Soltani,* Model adoption through hierarchical decision making and learning
10.30–11.00a	*Ben Hayden,* Transformation of options to choices in economic choice

Afternoon session

04.30–05.00p	*Sam Gershman,* What is the model in model-based reinforcement learning?
05.00–05.30p	*Jessica Hamrick,* Metareasoning and mental simulation in humans and artificial agents
05.30–05.45p	*Coffee break*
05.45–06.15p	*Thomas Akam,* Studying model-based cognition in rodents using multi-step decision tasks
06.15–06.45p	*Geoffrey Schoenbaum,* Dopamine neurons respond to errors in the prediction of sensory features of expected rewards
06.45–07.30p	Discussion

2.1 Closed-loop control of neural systems and circuits for scientific discovery

Tuesday, March 6, 2018

Organizers: Christopher Rozell, Garrett Stanley

With the advent of new technologies for interfacing with neural systems, there are exciting opportunities emerging that enable us to manipulate neural systems and circuits while simultaneously monitoring their activity. These new sensing and actuation strategies hold the promise of more powerful techniques for functionally dissecting complex neural circuits to uncover their operating principles and potentially develop novel clinical therapies. With a common goal of neural control, a variety of researchers ranging from theorists to experimentalists are currently developing techniques for estimating system states from recorded data and making real-time updates to stimulation.

This topic is particularly timely because of the confluence of technological advances in recording, stimulation, and algorithms that enable closed-loop stimulation studies in circuits, and for increasing government and private support for research in these and related areas. Such closed-loop techniques will enable an entirely new class of experimental manipulations that promise new insight into circuit function in health as well as disease. Given that the first papers using closed-loop stimulation of neural circuits have only recently appeared in the literature and there is finally a critical mass of people working on these exciting problems, now is the perfect time to bring a community together around this emerging area.

The overarching goal of this workshop is to foster a discussion to illuminate a set of community research goals to accelerate the impact of closed-loop stimulation techniques in neuroscience. This workshop will provide a venue for researchers building the components of these closed-loop stimulation systems and researchers using these tools for scientific discovery and clinical treatments. Specifically, the target audience includes neuroscience researchers who are using (or want to be using) closed-loop stimulation of neural circuits in scientific studies or treatment for disorders, computational neuroscientists developing the foundations for analysis and design of algorithms necessary for closed-loop control (include modeling and state estimation), and neuroengineering researchers building elements of experimental systems (interfaces, algorithms and hardware).

2.1 Closed-loop control of neural systems and circuits for scientific discovery

Colorado ballroom, Peak 1

Morning session

08.00–08.15a	Introduction and opening remarks by organizers and BRAIN Initiative representatives
08.15–08.40a	*Maryam Shanechi,* Dynamic modeling of brain network response to stimulation: A computational framework with binary-noise modulated waveforms
08.40–09.05a	*Memming Park,* Myopic control of neural dynamics
09.05–09.35a	*Coffee break*
09.35–10.00a	*Danielle Bassett,* Perturbation and control of human brain networks
10.00–10.25a	*Hillel Adesnik,* Precise control of neural ensemble activity with multiphoton holographic optogenetics
10.25–11.00a	*Garrett Stanley,* Closed-loop optogenetic control in vivo: Tracking dynamics and states (Act I)

Afternoon session

04.30–04.55p	*Jeanne Paz,* Optogenetic closed loop control of thalamocortical seizures in animal models of genetic and acquired epilepsies
04.55–05.20p	*Christopher Rozell,* Closed-loop optogenetic control in vivo: Tracking dynamics and states (Act II)
05.20–05.50p	*Coffee break*
05.50–06.15p	*ShiNung Ching,* Controlling the meaning of spikes. Strategies for extrinsic manipulation of neural information processing
06.15–06.40p	*Chethan Pandarinath,* LFADS: A deep learning method to infer latent states and dynamics from neural population activity
06.40–07.30p	Panel discussion and concluding remarks

2.2 Circuit dynamics in working memory

Tuesday, March 6, 2018

Organizers: Albert Compte, Klaus Wimmer

In recent years, experimental advances have facilitated the validation of competing network models of how stimulus representations are autonomously maintained in brain circuits, in the absence of the triggering external sensory information. Such circuit dynamics are thought to underlie processes such as working memory or spatial orientation in darkness (head-direction system). Multi-electrode recordings, imaging methods, and optical and magnetic perturbation methods, combined with advanced multidimensional analyses, have opened the possibility to validate experimentally computational concepts such as attractor dynamics, synaptic memories, or dynamical codes. In this workshop we propose to bring together some of the latest advancements in this line of research. Presentations will include reports of experimental evidence in support of various computational models of working memory, and computational developments to enlarge or specify the realm of mechanistic alternatives to be tested experimentally.

2.2 Circuit dynamics in working memory

Colorado ballroom, Peak 2

Morning session

08.00–08.10a	Introduction
08.10–08.40a	*Eelke Spaak,* Stable yet dynamic coding and rapid synaptic plasticity during working memory maintenance
08.40–09.10a	*John Murray,* Are working memory representations stable (enough)? Testing circuit models with spike trains from monkey prefrontal cortex
09.10–09.40a	*Klaus Wimmer,* Persistent neurons drive stable population-level working memory representations
09.40–10.00a	*Coffee break*
10.00–10.30a	*Athena Akrami,* Parametric working memory and its multiple timescales
10.30–11.00a	*Gianluigi Mongillo,* Does the cortex operate in a “glassy phase”? A hypothesis for the origin of the wide spectrum of relaxation timescales of the cortical dynamics.

Afternoon session

04.30–05.00p	*Joni Wallis,* Prefrontal neurons and working memory control processes
05.00–05.30p	*Mikael Lundqvist,* Gamma and beta events as correlates of volitional control of WM
05.30–05.50p	*Coffee break*
05.50–06.20p	*Paul Bays,* A neural resource model of visual working memory
06.20–06.50p	*Vivek Jayaraman,* The circuit basis of persistent heading representation: What throwing the fly kitchen sink at the problem has taught us so far
06.50–07.20p	Discussion

2.3 State-dependent neuromodulation of information processing

Tuesday, March 6, 2018

Organizers: Andra Geana, Matt Nassar

Computational neuroscience and artificial intelligence communities have made tremendous headway over the past decade toward understanding how neural networks can self organize to process information to solve complex tasks. However, to date, the best artificial information processing systems lack the flexibility typical of human and animal behavior. We propose that a key missing ingredient in these artificial systems is the ability to rapidly modulate information processing in accordance with changes to internal state, which themselves are often driven by changes in environmental imperatives.

An organism's behavioral state has an important effect on the integration of incoming sensory information: different arousal levels or different goals, for instance, can change the flow of information through neural circuitry to emphasize aspects of the sensory world that are most relevant to the selection of future behaviors. This process can make efficient use of cortical circuitry by allowing a single circuit to perform multiple computations that can be selected from according to behavioral state. In this workshop we will explore how and why aspects of behavioral state impact the processing of relevant information for the express purpose of putting the organism back in the neural network.

Our aim is to bring together a diverse group of researchers who study this problem through various tools at various levels, in order to facilitate an integrative, multi-level understanding of state-dependent information modulation. Our speakers' respective areas of expertise focus on describing the differential neural dynamics that code for state, linking state-dependent neural activity to accessible measures such as pupil diameter, and establishing a computational framework to provide a normative theoretical account of state-modulated information processing. Furthermore, most talks will be given by non-faculty members–i.e. postdocs and graduate students. We believe that this focus on the first authors, rather than the last, will encourage fresh perspectives and provide a welcome forum for new voices.

2.3 State-dependent neuromodulation of information processing

Colorado ballroom, Peak 3

Morning session

08.30–09.00a	*Introduction + Matt Nassar,* A latent state neural model of learning rate adjustment in dynamic environments
09.05–09.30a	*Jacob Reimer,* Fast brain state fluctuations in mouse V1
09.35–10.00a	*Coffee break*
10.05–10.20a	*Gary Kane,* Stimulating the locus coeruleus-norepinephrine system causes task disengagement
10.20–10.45a	*Guangyu Robert Yang,* Flexible information routing in the brain with a disinhibitory circuit motif

Afternoon session

04.00–04.25p	*Jane Keung,* Suboptimal evidence accumulation explained by dynamic divisive normalization
04.30–04.55p	*Renata Batista-Brito,* Developmental dysfunction of VIP interneurons impairs cortical circuits
05.15–05.40p	*James Howard,* Identity prediction errors in the human midbrain update reward-identity expectations in the orbitofrontal cortex
05.45–06.10p	*Angela Langdon,* Reward prediction and learning: What is the computation?
06.15–06.40p	*Andra Geana,* Adaptive information-seeking in a complex learning environment predicts reward-independent changes in behavior
06.45–07.00p	Conclusions

2.4 Brain-wide neuronal dynamics and inter-area communication: Recordings, analysis, and theory–Day 2

Tuesday, March 6, 2018

Organizers: William Allen, Anna Ivic Jasper, Isaac Kauvar, João Semedo

Many brain functions rely upon coordinated activity across multiple brain areas. Yet, how different brain areas communicate and interact with each other to implement specific computations remains poorly understood. In order to explore these questions, imaging and electrophysiological methods have recently been developed that enable the simultaneous recording of the activity of large numbers of neurons distributed throughout the brains of behaving animals. In conjunction with increasingly detailed brain-wide anatomical information, these types of large-scale recordings promise to yield major insights into how different systems within the brain interact. In parallel, statisticians have started work on new mathematical tools to analyze and interpret these complex experimental data, and theorists have begun to develop network models involving multiple, interconnected brain areas to understand how brains may implement mechanisms such as context-dependent selection and routing of information. The time is thus ripe to bring together experiment and theory to forge a path into the uncharted territory of performing and understanding brain-wide experiments, and to reconcile different experimental observations and network models.

In this workshop, we seek to explore the experimental, analytical, and conceptual challenges that brain-wide recordings present, by bringing together experts in the development and application of optical and electrophysiological recording technologies, experts in the analysis of these high dimensional datasets, and theoretical neuroscientists who are interested in understanding the principles underlying how multiple systems within the brain interact to perform computations and produce behavior

The target audience for this workshop consists of both experimental and theoretical neuroscientists who are interested in understanding the principles underlying how multiple systems within the brain interact to perform computations and produce behavior. We hope to address question such as: “What experimental and computational tools can we use to obtain and interpret simultaneous multi-area recordings of large neuronal populations?”, “What, if anything, distinguishes intra- and inter-area interactions, and what patterns of activity during behavior are local vs global?”, “When and how do brain areas selectively share information, in a context-dependent manner?”. We plan to allocate time for panel discussions after each talk, where speakers and attendees will have a chance to exchange ideas and work to identify some of the immediate challenges in recording and studying multi-area interactions, including the use of new tools to manipulate neuronal activity and interpret large-scale recordings.

2.4 Brain-wide neuronal dynamics and inter-area communication: Recordings, analysis, and theory–Day 2

Summit gallery, Peaks 6, 7, 8

Day 2, organized by Anna Ivic Jasper and João Semedo

The main goals of this session are: To learn about different approaches for analyzing and interpreting these high dimensional datasets, and how these analyses may guide recordings and hypotheses concerning inter-area interaction. Foment discussion about, and try to reconcile, the different mechanisms that have been proposed on how the brain selectively propagates information between neuronal networks in different brain areas.

Morning session

08.00–08.05a	Introduction
08.05–08.45a	*João Semedo,* Cortical areas interact through a communication subspace
08.45–09.25a	*Joel Zylberberg,* Propagation of visual information from the retina to the cortex
09.25–09.40a	*Coffee break*
09.40–10.20a	*Farran Briggs,* Inter-areal communication and circuit connectivity: advantages, challenges, and assumptions
10.20–11.00a	*James Fitzgerald,* Understanding whole-brain sensorimotor circuits underlying zebrafish behavior

Afternoon session

04.30–05.10p	*Brent Doiron,* Internally generated variability and the propagation of information across brain areas
05.10–05.50p	*Bijan Pesaran,* Neural coherence during coordination and decision making–correlations and causation
05.50–06.05p	*Coffee break*
06.05–06.45p	*Agostina Palmigiano,* Flexible information routing
06.45–07.25p	*Mark Churchland,* Division of labor between the hemispheres during movement generation
07.25–07.30p	Closing remarks

2.5 Cortical circuits: Functions and models of long-range connections–Day 2

Tuesday, March 6, 2018

Organizers: Florin Albeanu, Alex Kwan, Seung-Hee Lee, Leopoldo Petreanu

Cortical function, particularly sensory processing, has been approached typically from the perspective of a sequential hierarchy of feedforward connections. However, in many primary sensory areas (visual, auditory, olfactory, somatosensory, etc.), the ascending inputs are greatly outnumbered by the descending fibers. The recurrent architecture suggests that long-range feedback projections are likely to have important computational functions.

Exciting new studies are beginning to reveal the roles of long-range connections. Experiments are fueled by technological advances in optical and electrophysiological methods, which enable the observation and manipulation of neuronal components from multiple brain regions simultaneously. Moreover, there has been a renewed focus in modeling large-scale cortical networks based on concepts emerging from the machine learning and computational neuroscience communities. These developments lead to new ideas for how long-range connections might contribute to context-dependent processing of task-relevant inputs, predictive coding, attention and perceptual performance, and learning and plasticity during sensory-guided behaviors.

For our workshop, we aim to have a lively discussion between experimental and computational neuroscientists. The talks and discussion periods will focus on questions such as: What is the synaptic organization of the long-range cortical pathways? What types of signals are being encoded and transmitted along the projections? Is there distinct top-down versus bottom-up flow of information? What is the impact of feedback on sensory processing? How may we include the complexity of long-range connections in computational models?

2.5 Cortical circuits: Functions and models of long-range connections–Day 2

Summit gallery, Peaks 9, 10

Morning session

08.00–08.10a	*Alex Kwan,* Introduction
08.10–08.40a	Wankun Li, Adult born neurons facilitate olfactory bulb pattern separation during task engagement
08.45–09.15a	*Robert Froemke,* Plasticity in ‘real life’
09.20–09.45a	*Coffee break*
09.45–10.15a	*Georg Keller,* Predictive coding and mismatch signals in the visual cortex
10.20–10.50a	*Alex Kwan,* Cortical circuits for flexible sensorimotor decisions

Afternoon session

04.30–05.00p	*Seung-Hee Lee,* Audiovisual integration in the posterior parietal cortex: role of inhibition
05.05–05.35p	*Dan O’Connor,* A non-canonical feedback circuit for rapid interactions between somatosensory cortices
05.40–06.05p	*Coffee break*
06.05–06.35p	*David Schneider,* A sensory motor interface for learning and predicting self-generated sounds
06.40–07.10p	*Takashi Sato,* Streamlined sensory-motor communication in the reciprocal connectivity of cerebral cortex
07.10–07.25p	Panel discussion and closing remarks, the organizers

2.6 RNNs: What are we doing and why?–Day 2

Tuesday, March 6, 2018

Organizers: Andrea Benucci and David Sussillo

The use of recurrent neural networks (RNNs) to model the dynamics of large neuronal populations is becoming increasingly popular. The implicit assumption of those employing the technique is that RNN modeling may bring some advantages relative to more conventional dynamical-system approaches. However, the classes of problems and the level of analysis that might benefit the most from the use of RNNs (e.g. the computational, algorithmic, or implementation level) are currently unclear. In this workshop we will discuss this ‘elephant in the room’, trying to highlight as concretely as possible the cognitive questions, the behavioral paradigms, and the neural systems that should be targeted for RNNs to reveal their strongest advantages or disadvantages. We also welcome the possibility of negative answers, where specific classes of problems may not be suitable for RNN based techniques. We hope to open up the discussion on whether or not RNNs can provide a unique unifying theoretical framework across diverse neural systems. In conclusion, this workshop will begin a much needed conversation on what we are doing with RNNs and why.

2.6 RNNs: What are we doing and why?–Day 2

Summit gallery, Peaks 11, 12

Morning session

08.15–08.25a	*David Sussillo & Andrea Benucci,* Introduction
08.25–09.00a	*Larry Abbott,* Untangling in recurrent networks and motor cortices
09.05–09.40a	*Ken Miller,* Recurrent networks for spatial processing, normalization and gain modulation
09.40–10.00a	*Coffee break*
10.00–10.35a	*Maneesh Sahani,* Describing non-linear latent dynamics
10.40–11.15a	*Surya Ganguli,* TBD

Afternoon session

04.15–04.50p	*Omri Barak,* Towards a theory of trained recurrent neural networks
04.55–05.30p	*Valerio Mante,* Inferring neural dynamics from trial-by-trial variability in population responses
05.30–05.50p	*Coffee break*
05.50–06.25p	*Nikolaus Kriegeskorte,* Recurrent convolutional neural networks: A better model of biological object recognition
06.30–07.05p	*Srdjan Ostojic,* Linking connectivity, dynamics and computations in low-rank recurrent neural networks
07.05–07.30p	Concluding remarks

2.7 Manifold-splaining: What the theorist said to the experimentalist

Tuesday, March 6, 2018

Organizers: Amy Christensen, Adam Calhoun

It seems non-controversial amongst those in the Cosyne community that a synergy of theoretical and experimental approaches is integral to the advancement of systems neuroscience. E.g. the Cosyne18 call for workshops states: “the overarching goal of all workshops should be the integration of empirical and theoretical approaches”. However, despite this community enthusiasm for collaboration, many challenges remain when it comes to day-to-day application of theoretical neuroscience to experimental data.

While our speakers will approach this topic from a variety of perspectives, we will take a particularly deep dive into a popular contemporary topic: neural manifolds. From this example, we will frame the more general question of “what counts as a theory, what’s pure computational reductionism, and does the distinction even matter if the goal is to understand the brain”. Our target audience members are Cosyne attendees who are invested in how the future of theory driven neuroscience research will unfold, or anyone that is dying to know “Is a manifold a meaningful theory of the mind??”.

To facilitate this discussion we are proposing a workshop with presenters from a variety of backgrounds: theorists, experimentalists, experimentalists turned theorists, etc., and a variety of career stages, from graduate students and postdoctoral scholars, to junior and senior professors. Our workshop will prioritize audience participation and discussion, and will hopefully contribute to clarifying the conceptual framework in which theoretical and experimental neuroscience can together enhance our understanding of the brain.

2.7 Manifold-splaining: What the theorist said to the experimentalist

Breckenridge ballroom, Peak 14

Morning session

08.00–08.05a	*Amy Christensen,* Introduction
08.05–08.35a	*Andrew Pruszynski,* Testable models teeter between trivial and profound - an example with machine learning and the tactile periphery
08.40–09.00a	*Chen Yan,* Circuitry dynamic deficits in a mouse model of Alzheimer's disease.
09.00–09.20a	*Coffee break*
09.20–09.40a	*Grace Lindsey,* Synthesizing experimental data with circuit models
09.45–10.15a	*Stephanie Palmer,* New ideas in dimensionality reduction: Adding relevant information
10.20–10.40a	*Jonathan Michaels,* WHAT'S IN THE BOX? - interpretable neural nets for movement control
10.45–11.15a	*Jonathan Pillow,* New tools for finding manifolds underlying simultaneously recorded spike trains

Afternoon session

04.30–04.40p	*Adam Calhoun,* MANIFOLDS
04.45–05.05p	*Carsen Stringer,* The high-dimensional geometry of cortical population responses
05.10–05.30p	*Juan Gallego,* Neural manifolds: Mere correlations or a window into cortical processing?
05.35–05.45p	*Coffee break*
05.45–06.05p	*SueYeon Chung,* Neural object manifolds: How to characterize their geometries, and why it matters
06.10–06.40p	*Konrad Kording,* Infinitely confounded
06.45–07.15p	*Blake Richards,* Manifolds and the structure of cognition. Why experimentalists should search for low-dimensional manifolds in their data
07.20–07.30p	Workshop conclusions, final questions and discussions

2.8 The multiple facets of synaptic plasticity and learning: Shaping circuits, generating representations, modulating behavior

Tuesday, March 6, 2018

Organizers: Julijana Gjorgjieva, Paul Munro

Activity dependent synaptic plasticity is considered to underlie learning and formation of new memories in a variety of different environments. This process was originally dissected at the level of single synapses, which allowed us to generate quantitative relationships between patterns of neural activity at presynaptic and postsynaptic neurons and the observed temporal evolution of synaptic strength. This has allowed us to make significant progress in characterizing learning rule like Spike-Timing-Dependent Plasticity and to make powerful theoretical predictions about the role of these rules in generating input selectivity, mostly in feedforward networks with well-defined presynaptic and postsynaptic neurons. However, several challenges remain: how can we understand synaptic plasticity in recurrent circuits, how does plasticity at electrical synapses differ from that at chemical synapses, how does plasticity at excitatory and inhibitory synapses interact, how is plasticity modulated during behavior by powerful modulators which can fundamentally change the underlying learning rules? In the present workshop, we bring together experimentalists and theorists to address these questions at several different levels, ranging from dendrites, to single neurons, to circuits and behavior. With the development of novel recording techniques that give us access to circuits operating in vivo where we can practically watch animals learn, and the establishment of novel theoretical methods that allow us to characterize how local circuit changes influence circuit output at large, we are now in the unique position to study the multiple facets of activity dependent plasticity – not just as a mechanism that characterizes synaptic strength at the single synapse, but as a framework that underlies large scale circuit formation, generation of sensory representations and modulation of behavior.

We have invited an exciting list of international speakers ranging from theorists to experimentalists who study these different aspects of activity dependent plasticity. The goal of the workshop is not only to discuss recent advances, but also to bridge levels and trigger new hypotheses about the potential of neural circuits to change in so many ways due to ongoing activity of its component neurons through activity dependent plasticity.

Abstracts and more information can be found at:

http://cns.wzw.tum.de/index.php?id=cosyne

2.8 The multiple facets of synaptic plasticity and learning: Shaping circuits, generating representations, modulating behavior

Breckenridge ballroom, Peak 15

Morning session

08.00–08.10a	Introduction
08.10–08.40a	*Yoram Burak,* How high-order synaptic interactions shape the global structure of recurrent neural circuits
08.40–09.10a	*Julie Haas,* Activity rules of electrical synapse plasticity, and impact on thalamic relay
09.10–09.25a	*Coffee break*
09.25–09.55a	*Gabriel Ocker,* Stability and selectivity in spike time-dependent plasticity
09.55–10.25a	*Claudia Clopath,* Plasticity in dendrites
10.25–10.55a	*Kishore Kuchibhotla,* Dissociating task acquisition from expression during learning reveals latent knowledge

Afternoon session

04.30–05.00p	*Ben Donsung Huh,* Gradient descent for spiking neural networks
05.00–05.30p	*Julijana Gjorgjieva,* Spontaneous activity drives plasticity in the developing cortex
05.30–06.00p	*Johannes Letzkus,* Learning-related plasticity of inhibition and disinhibition in neocortical layer 1
06.00–06.15p	*Coffee break*
06.15–06.45p	*Maria Geffen,* Excitatory-inhibitory circuits in auditory processing
06.45–07.15p	*Henning Sprekeler,* Inhibitory plasticity: A tale of specificity
07.15–07.45p	Discussion

2.9 Model-based cognition: Hierarchical reasoning and sequential planning–Day 2

Tuesday, March 6, 2018

Organizers: Kevin J. Miller, Kim Stachenfeld, Bas van Opheusden, Roozbeh Kiani

Decision making in a complex natural environment requires humans and animals to construct internal models of the world around them. These internal models support a wide variety of flexible behaviors, ranging from relatively simple learning procedures (e.g. outcome revaluation) to decision-making in complex, elaborately structured domains (e.g. games like chess). Although there is a growing consensus that humans and animals rely on models of their environment for goal-oriented behavior, it has proven challenging to draft theories and design experiments to study model-based reasoning and planning in the brain.

Consequently, many questions remain about the mechanisms by which models of the environment are built, revised, and deployed during decision-making behaviors which our workshop will seek to address.

A guiding principle of our workshop will be to consider decision-making in natural environments as a hierarchy of inference processes that generate a sequence of actions or action plans to attain a goal. In this hierarchical framework, a high-level strategy guides lower-level choices, and the outcome of those choices informs the strategy. Choosing a good strategy requires an internal model of the world that is rarely explicitly known and must therefore be inferred from past experience. A complete understanding of this framework must answer how models of the environment are learned, how suitable decision strategies are selected and executed based on such models, how these strategies guide ongoing choices, and how these processes adapt to improve performance in dynamic environments.

Our workshop builds on this framework and aims to provide new avenues to overcome existing challenges. We will identify points of connection across various perspectives from animal physiology, human neuroscience, and machine learning, and we will provide a forum for discussing recent advances in the field and their theoretical and conceptual implications.

2.9 Model-based cognition: Hierarchical reasoning and sequential planning–Day 2

Breckenridge ballroom, Peak 16

Morning session

08.00–08.10a	*Kimberly Stachenfeld,* Introductory remarks
08.10–08.40a	*Bruno Averbeck,* Bayesian and reinforcement learning models of reversal learning
08.40–09.10a	*Rani Moran,* Interaction between model-based and model-free systems in human reinforcement learning
09.10–09.40a	*Hyojung Seo,* Timing and decision-making in the prefrontal cortex
09.40–10.00a	*Coffee break*
10.00–10.30a	*Stephanie Groman,* Model-free and model-based influences in addiction-like behaviors in rats
10.30–11.00a	*Xiaohong Wan,* Neural systems for decision-making and metacognition

Afternoon session

04.30–05.00p	*Matthijs van der Meer,* Reward revaluation biases hippocampal sequence content away from the preferred outcome
05.00–05.30p	*David Reichert,* Deep reinforcement learning with imagination-augmented agents
05.30–05.45p	*Coffee break*
05.45–06.15p	*Bas van Opheusden,* Expertise in sequential decision-making relies on attention and tree search
06.15–06.45p	*David Foster,* Hippocampal sequences and learning
06.45–07.30p	Discussion