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COSYNE 2019 WORKSHOPS

Cascais, Portugal
March 4–5, 2019

Organizers:
Catherine Hartley
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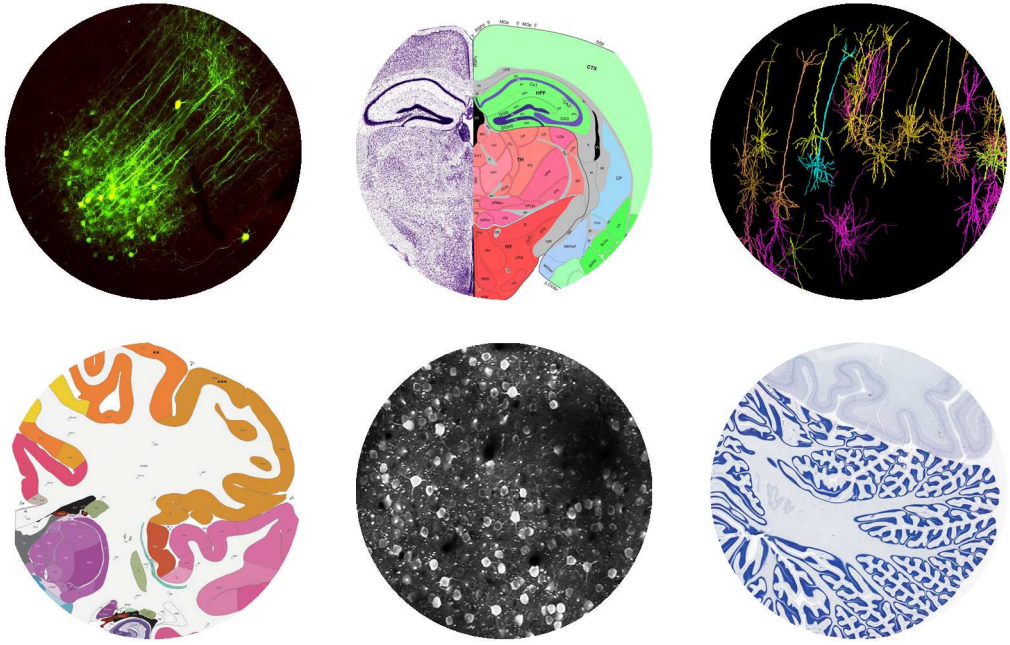

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flashPub

Bernstein Conference
Berlin, Sept 17-20, 2019

Confirmed speakers

Dora Angelaki (USA)
Matthias Bethge (Germany)
Matthew Botvinick (USA)
Nicolas Brunel (USA)
Claudia Clopath (UK)
Hopi Hoekstra (USA)
Gilles Laurent (Germany)
Eve Marder (USA)
Haim Sompolinsky (Israel/ USA)
Gašper Tkačik (Austria)
Nachum Ulanovsky (Israel)

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Call for Workshops
Deadline: March 27, 2019

www.bernstein-conference.de

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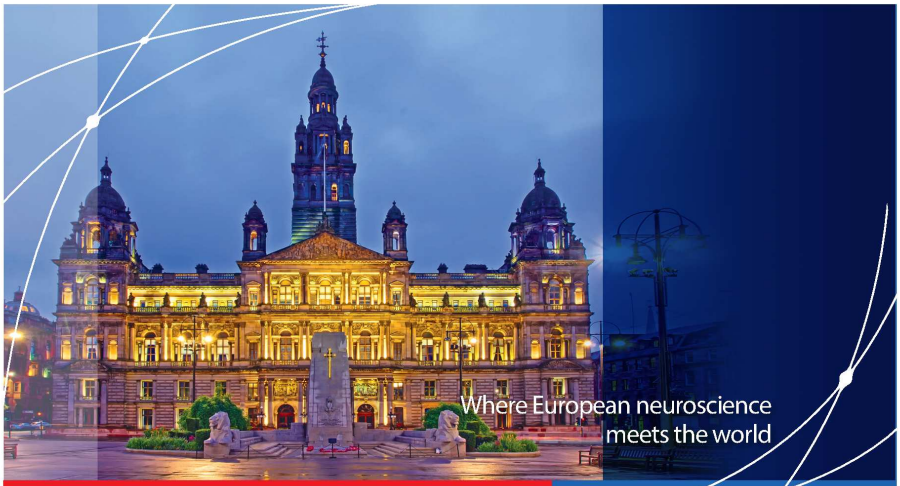
11-15 July 2020 | Glasgow, UK

Organised by the Federation of European Neuroscience Societies (FENS)

Hosted by The British Neuroscience Association (BNA)



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Call for symposium and technical workshop proposals

25 March 2019 - 20 May 2019

The Programme Committee will establish the scientific programme for the FENS Forum 2020 on the basis of proposals from scientists from all over the world and all areas of neuroscience research, including computational neuroscience. There's a theme for everyone!

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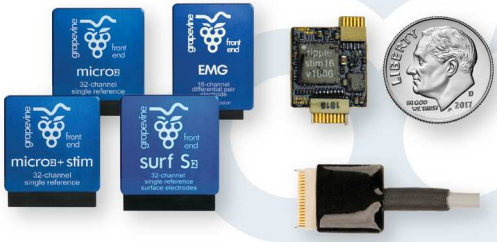

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COSYNE 2019 Workshops

March 4–5, 2019, Cascais, Portugal

Monday, March 4, 2019	Organizer(s)	Location
1.1 Challenges for deep neural network models of visual cognition: from incorporating biological constraints to predicting correlational and causal experimental outcomes	K Jozwik K Kar	*Sala I*
1.2 Data, dynamics, and computation: Using data-driven methods to ground mechanistic theory	JA Menendez L Duncker	*Sala II*
1.3 Continual learning in biological and artificial neural networks	A Saxe C Summerfield C Clopath	*Sala III*
1.4 Retinal circuits for seeing nature	P Berens T Euler	*Sala IV*
1.5 Caus(yn)e: CAUSAL Systems Neuroscience	A Gomez-Marin K Kording	*Sala VI*
1.6 Inhibitory microcircuits: From connectivity to computation and behaviour – *Day 1*	H Barron A Khan, H Bos M Ramaswami K Wilmes A Palmigiano P Znamenskiy	*Sala VII*
1.7 Why spikes? – Understanding the power and constraints of spiking based computation in biological and artificial neuronal networks – *Day 1*	B Grewe IM Park, K Li J Sacramento J Principe JP Pfister	*Sala XII*
1.8 Dopamine updated	J Paton M Walton	*Sala XIII*
1.9 Sleep: Models and experiments on replay, consolidation, and off-line processing – *Day 1*	M Van Rossum S Aton M Zochowski P Lewis	*Sala XV*
1.10 Affective and motivational influences on decision-making	C Raio A Shenhav	*Sala XVI*

Workshop Co-Chairs	Email
Ralf Haefner, University of Rochester	rhaefne2@ur.rochester.edu
Catherine Hartley, New York University	cate@nyu.edu

Map of Cascais workshops locations is on page 5 of this booklet.

COSYNE 2019 Workshops

March 4–5, 2019, Cascais, Portugal

Tuesday, March 5, 2019	Organizer(s)	Location
2.1 Studying visual processing in rodents: where a decade of research has taken us and what is waiting ahead	D Zoccolan A Benucci	*Sala I*
2.2 Quantifying social behaviors: Computational challenges and experimental pitfalls	A Kennedy A Falkner	*Sala II*
2.3 Neural representations and coding under resource limitations	RA da Silveira Y Burak	*Sala III*
2.4 Beyond trial-based choice: Decision-making in naturalistic and temporally extended environments	L Hunt N Kolling	*Sala VI*
2.5 Inhibitory microcircuits: From connectivity to computation and behaviour – *Day 2*	H Barron A Khan, H Bos M Ramaswami K Wilmes A Palmigiano P Znamenskiy	*Sala VII*
2.6 Why spikes? – Understanding the power and constraints of spiking based computation in biological and artificial neuronal networks – *Day 2*	B Grewe IM Park, K Li J Sacramento J Principe JP Pfister	*Sala XII*
2.7 What are your coordinates? Domain-general neural computations underlying coordinate transformations	R Kaplan	*Sala XIII*
2.8 Sleep: Models and experiments on replay, consolidation, and off-line processing – *Day 2*	M Van Rossum S Aton M Zochowski P Lewis	*Sala XV*
2.9 Advances and convergences in 5-HT research *The workshop will continue on 06 March 2019 as: More serotonine: Satellite event at the Champalimaud Centre for the Unknown; see https://goo.gl/Dm2R2a for details.*	R Ligneul G Dolen	*Sala XVI*

Workshop Co-Chairs	Email
Ralf Haefner, University of Rochester	rhaefne2@ur.rochester.edu
Catherine Hartley, New York University	cate@nyu.edu

Map of Cascais workshops locations is on page 5 of this booklet.

Schedule

Each workshop group will meet in two sessions from ~9am–12noon and from ~4pm–7pm.

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.

Epic Sana Hotel to Cascais: Free shuttle provided for registered attendees (first shuttle leaves @ 4pm, last @ 5pm on Sunday, 03 March 2019).

Cascais Miragem to Lisbon International Airport: Lisbon International Airport is approximately 30 minutes by car from Cascais.

You can take a Taxi (taxislisboa.com), Uber (uber.com), or a (cabify.com/en), or arrange a transfer with the hotel (paid service). The fare is approximately 40-50€.

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

Discounted workshop rates

Explore Sintra-Guincho on Monday, 04 March 2019
Attendees will have the time to explore Sintra old-town and Guincho Beach. Buses will depart from Hotel Cascais Miragem at 1:00pm and will return at 4:00pm. Not a guided tour, buses will drop-off and pick-up only. This is a free trip. The number of seats is limited to 100 people. Please sign up at https://goo.gl/forms/LrDDuBjdrYVRzoho2.

Guided tours of Cascais-Sintra
Taking U There Tours (www.takinguthere.com). Mention COSYNE 2019 to save 15 %.

Meals included with registration

Lunch (Day 1 and Day 2), boxed lunches will be served outside of the meeting rooms on the lobby and second floor levels.

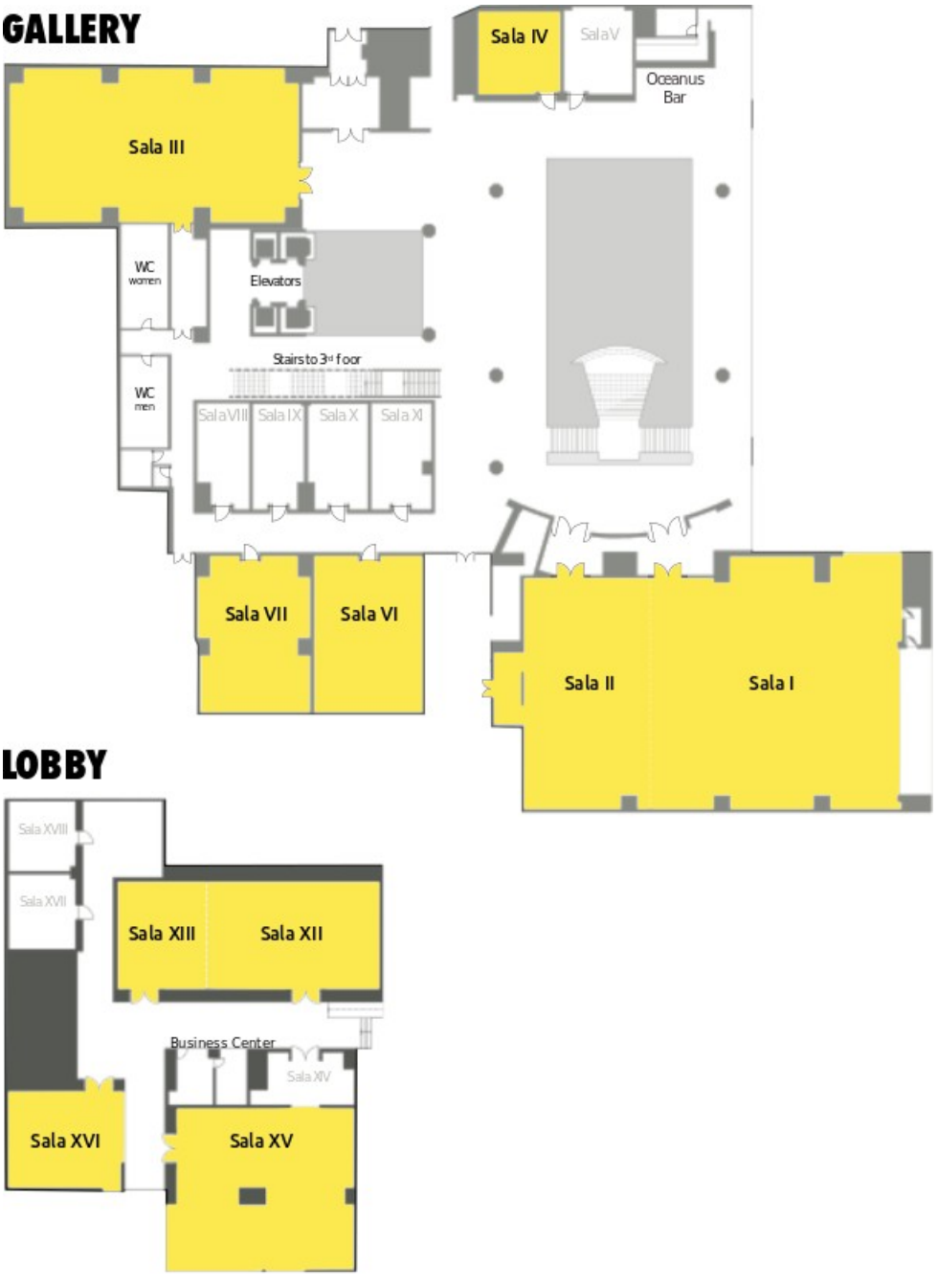
Coffee breaks during morning and afternoon sessions outside of the meeting rooms on the lobby and second floor levels.

Reception dinner on Day 2 will be a heavy reception (standing dinner).

Wi-Fi

Wi-Fi in Miragem is free for guests and registered participants

Cascais workshops locations



1.1 Challenges for deep neural network models of visual cognition: from incorporating biological constraints to predicting correlational and causal experimental outcomes

Monday, March 4, 2019

Organizers: Kamila Jozwik, Kohitij Kar

Workshop goals: Deep convolutional neural networks (DCNNs) have revolutionized the modeling of visual systems. However, despite being good starting points, they do not fully explain brain representations and are not like a brain in many ways. DCNNs differ from the brain with respect to their anatomy, task optimization, learning rules etc. For instance, most DCNNs lack recurrent connections, are supervised learners, and do not have brain-like topography. Therefore, the next generation of models could benefit by incorporating the critical brain-inspired constraints. On the other hand, the model predictions need to be experimentally validated. A common trend is that experimental data collection and modeling are executed somewhat independently, resulting in very little model falsification, and thus — no measurable progress. Our main proposal is that the synergy and collaboration between computational modeling and experiments is critical to achieve success. The approach needs to be a closed loop; models predict experimental outcomes — experimental outcomes falsify models — better models with further experimentally derived constraints are built. We aim to list and discuss the challenges we face and the path forward in establishing this closed loop to solve visual cognition.

Why is it of interest?We are finally at a stage in visual neuroscience, where computational models have progressed beyond toy-data descriptors to real predictive models simulating the one running in our brains. We need to capitalize on this success and start asking the hard questions demanding more stringent empirical tests to falsify current models and build better ones. This workshop sets the stage for both senior and early-career researchers to engage in a very objective discussion on what should be the next steps. The diverse group of invited speakers with varied scientific approaches will ensure challenging and interesting discussions.

Targeted participants: Neuroscientists working with different animal/computational vision models.

1.1 Challenges for deep neural network models of visual cognition: from incorporating biological constraints to predicting correlational and causal experimental outcomes

Sala I

Morning session

09:00–9:15	*Kamila Jozwik and Kohitij Kar (Co-organizers),* Introduction
09:15–9:40	*Nikolaus Kriegeskorte,* Recurrent neural networks: the difficult transition to the right paradigm for understanding vision
09:40–10:05	*Marieke Mur,* Modeling representational dynamics in nonhuman primate high-level visual cortex
10:05–10:30	*Kamila Jozwik,* Different modeling approaches to study visual object representations in humans and monkeys
10:30–10:45	Coffee break
10:45–11:10	*Kalanit Grill-Spector,* The functional neuroanatomy of face perception: From brain measurements to deep neural networks
11:10–11:35	*Eero Simoncelli,* Elucidating and testing hierarchical visual models using model-optimized synthetic stimuli
11:35–12:00	*Arash Afraz,* On the use of deep neural networks in modeling the brain function: A critical analysis

Afternoon session

16:30–16:55	*Winrich Freiwald,* Face recognition: Neural & computational architectures
16:55–17:20	*Kohitij Kar,* Multimodal approaches towards testing current deep neural network models
17:20–17:35	Coffee break
17:35–18:00	*Bart Krekelberg,* Recurrent neural networks to understand and probe information processing in early visual cortex
18:00–18:25	*Gabriel Kreiman,* What do visual neurons really like? Insights from joint computational modeling and neurophysiological experiments
18:25–19:30	Panel discussion

1.2 Data, dynamics, and computation: Using data-driven methods to ground mechanistic theory

Monday, March 4, 2019

Organizer: Jorge Aurelio Menendez, Lea Duncker

Neural circuits operate in a fundamentally dynamic way, and the question of how their intrinsic dynamics can be used for computation is of great interest in modern systems neuroscience. Addressing this question, however, is a fundamentally difficult problem because neither the dynamical rules by which neural circuits evolve in time, nor the computations they perform are directly observable. One approach to inferring the dynamics underlying neural activity is to fit parametric statistical models to large-scale population recordings. While such models have proved useful for characterizing idiosyncratic features of population activity, explicitly linking such features to computation has remained a challenge, since 'data-driven' models are built to learn dynamics that explain variance in the data, rather than dynamics that implement a certain computation. On the other hand, 'task-driven' approaches have focused on analysing networks explicitly built to perform computations relating to a specific task. Classically, this is done either analytically by designing a system of equations implementing a specific solution, or empirically by training an RNN and reverse-engineering its solution. While the link to computation in these networks is readily available, aspects like the uniqueness and biological relevance of their solution remain difficult to test. Hence, 'task-driven' approaches may naturally lack the fidelity to data that is inherent to 'data-driven' approaches.

The goal of this workshop is to facilitate a conversation between 'data-driven' and 'task-driven' strategies to studying dynamical systems models of the brain, in order to highlight how each can contribute to the other. How can data-driven approaches help constrain network models of computation? Conversely, how can we use insights from network models to design better statistical models? Drawing such connections will help to constrain and refine our modelling choices, deepen the way we interpret results, and ultimately lead to a better understanding of computation through neural dynamics.

1.2 Data, dynamics, and computation: Using data-driven methods to ground mechanistic theory

Sala II

Morning session

09:00–09:10	*Jorge A. Menendez & Lea Duncker,* Introduction & welcome
09:10–09:35	*Pedro Goncalves,* Statistical inference for mechanistic models of neural dynamics
09.35–10:00	*Joana Soldado Magraner,* Inferring and interpreting neural dynamics during contextual decision making
10:00–10:25	*João Semedo,* Low-dimensional interactions between cortical areas
10:25–10:45	Coffee break
10:45–11:10	*Scott Linderman,* Using computational theory to constrain state space models of neural data
11:10–11:35	*Matt Golub,* Constraining RNNs to find dynamical solutions that look like the brain
11:35–12:00	*Claudia Clopath,* Using recurrent network modelling to better understand hippocampal function

Afternoon session

04:30–04:55	*Guillaume Hennequin,* Control-theoretic methods for understanding neural circuits
04:55–05:20	*Christian Machens,* TBC
05:20–05:45	Coffee break
05:45–06:10	*Francesca Mastrogiuseppe,* Shaping slow activity manifolds with low-rank recurrent networks
06:10–06:35	*Omri Barak,* Searching for constraints in task-driven models
06:35–07:30	Discussion (lead by Maneesh Sahani)

1.3 Continual learning in biological and artificial neural networks

Monday, March 4, 2019

Organizers: Andrew Saxe, Christopher Summerfield, Claudia Clopath

Biological agents continue to learn across their lifespan. However, building artificial systems that exhibit continual learning remains one of the most pressing unsolved problems in current artificial intelligence research. Biological brains have evolved mechanisms for learning over multiple timescales in order to structure neural representations efficiently, and modular memory systems for consolidation and allocation of neural resources. These allow animals to avoid overwriting old knowledge during new learning ("catastrophic forgetting"), a phenomenon that severely limits the behavioural repertoire of current artificial agents.

Our workshop will compare approaches to understanding continual learning in biological and artificial systems, with a view to both identifying candidate mechanisms from biology that may be useful in AI research, and feeding back new results from machine learning to help understand how continual learning is implemented in neural systems. We have invited cognitive scientists, neuroscientists, and AI researchers to speak on the same platform, with the goal of tackling the problem of continual learning at multiple levels, from whole-brain systems and behaviour in humans, to cellular and synaptic mechanisms in animal models, to the algorithms and architectures of contemporary deep learning systems.

Our diverse speaker list includes

(i) cognitive scientists whose primary focus is the study of human behaviour, with a focus on category learning, task-level control and memory systems (Cohen, Summerfield),

(ii) experimental neuroscientists using diverse techniques including 2-photon imaging in rodents, single-cell recordings in nonhuman primates, and brain stimulation/functional neuroimaging in humans (Tolias, Barron, Murthy, Kastner),

(iii) theoretical neuroscientists modelling learning and consolidation at the synaptic level in biological systems (Clopath, Senn) and

(iv) researchers building state of the art machine learning systems, with approaches that meet the challenge of catastrophic forgetting in deep networks (Hadsell, Kirkpatrick, Zenke, Saxe).

1.3 Continual learning in biological and artificial neural networks

Sala III

Morning session

9:00–9:25	*Helen Barron,* Avoiding catastrophic interference: mechanisms for stable memory storage and integration
9:25–9:50	*Friedemann Zenke,* Continual learning through synaptic intelligence
9:50–10:15	*Christopher Summerfield,* Comparing continual learning in minds and machines
10:15–10:45	Coffee break
10:45–11:10	*Claudia Clopath,* Continual reinforcement learning with complex synapses
11:10–11:35	*David Kastner,* Higher order feature learning following expansion of possibilities during a spatial learning task in rats
11:35–12:00	*Walter Senn,* Synaptic consolidation enabling fast learning without catastrophic forgetting

Afternoon session

16:30–16:55	*Andreas Tolias,* Generative replay through feedback connections as a general strategy for continual learning
16:55–17:20	*James Kirkpatrick,* Overcoming catastrophic forgetting in neural networks through Elastic Weight Consolidation
17:20–17:45	*Andrew Saxe,* Dynamics of continual learning in neural networks: what causes catastrophic interference?
17:45–18:10	Coffee break
18:10–18:35	*Sebastian Musslick,* On the Rational Boundedness of Cognitive Control: Independent vs. Interactive Parallelism
18:35–19:00	*Raia Hadsell,* A Scalable Framework for Continual Learning
19:00–19:45	Panel Discussion, Continual learning: integrating theory and experiment

1.4 Retinal circuits for seeing nature

Monday, March 4, 2019

Organizers: Philipp Berens, Thomas Euler

Animals use vision to navigate vastly different environments. Consequently, an animal's eyes are exquisitely adapted to gathering the information needed for survival and procreation from the animal's distinct environments. Key adaptations to the visual statistics are already deeply rooted in the structure and function of the visual system. However, comparative studies necessary to elucidate these adaptations require detailed knowledge on circuit structure and function across large parts of the network, or indeed across species. Recent studies started to reveal the extent of retinal adaptations to their species-specific input statistics, highlighting a fact that has been mostly ignored so far: That retinal circuits can strongly differ across the retinal surface and in addition are not necessarily identical even between closely related species. Instead, retinas are surprisingly well-matched to the local statistics of each animal's natural visual world, and within a species, these statistics can be vastly different across the visual field. These developments have also sparked a new wave of studies probing retinal organization in the context of its function when facing natural, rather than artificial input. We will discuss the latest developments in retinal research with emphasis on species differences, retinal asymmetries and whether current theories such as long-held notions in efficient coding are enough to explain the observed adaptations. It is targeted at attendees with an interest in vision and the importance of environmental adaptations.

1.4 Retinal circuits for seeing nature

Sala IV

Morning session

09:00–09:20	*Philipp Berens & Thomas Euler,* Introduction
09:20–09:50	*Stephane Deny,* The emergence of multiple retinal cell types through efficient coding of natural movies
09:50–10:20	*Katrin Franke,* Chromatic processing in the mouse retina
10:20–10:40	Coffee break
10:40–11:10	*Takeshi Yotsimatsu,* Functional recordings at the first synaptic layer of the visual system in vivo
11:10–11:40	*Wei Wei,* Noise resilience of motion detection in the retina
11:40–12:00	Discussion

Afternoon session

04:30–05:00	*Petri Ala Laurila,* Visual adaptations for seeing in the dark
05:00–05:30	*Stephanie Palmer,* Quantifying motion statistics in different natural scenes
05:30–05:50	Coffee break
05:50–06:20	*Olivier Marre,* Models and mechanisms of surround modulation
06:20–06:50	*Marion Silies,* A luminance sensitive pathway enables motion detection in dim light
06:50–07:30	Final discussion

1.5 Caus(yn)e: CAUSAL Systems Neuroscience

Monday, March 4, 2019

Organizers: Alex Gomez-Marin, Konrad Kording

(1) What the workshop will address and accomplish: The workshop will bring a community into the Cosyne fold that is not traditionally represented, scientists that focus on causality. That includes philosophy, the statistics of causality, neurophenomenology, and mechanistic approaches, amongst others. The workshop will thus get these diverse scientists to discuss such entangled neuroscience topics. At the same time, the workshop will help scientists in the Cosyne community with an interest in causality develop bridges into that field.

(2) Why the topic is of interest: Most of the real questions in neuroscience are of a causal nature. We ask how neurons affect one another. We ask how brain areas affect one another. And we ask how neurons affect behavior. All these questions suffer from several conceptual and technical caveats: from conflating intervention with understanding, to the so-called confounding problem (the measured signals can be affected by other, unmeasured, signals making it hard to identify how the signals relate to one another). Development in statistics, econometrics, and philosophy are starting to give us better ways of thinking of these issues. We need these techniques in neuroscience to make progress at many if not most of our questions.

(3) Targeted group of participants: Anyone interested in causality. That will directly include all perturbative neuroscientists (tms, tdcs, electrical stimulation, and optogenetics). It is also directly relevant for all neuroscientists doing model based analysis of neural data. From “raw” experimentalists to “pure” theoretically minded researchers, this workshop should be useful for a broad range of cosyne participants.

1.5 Caus(yn)e: CAUSAL Systems Neuroscience

Sala VI

Morning session

09:00–09:40	*Alex Gomez-Marin & Konrad Kording,* Why "why" matters (and when it doesn't)
09:40–10:20	*Motojiro Yoshihara,* Necessity and sufficiency
10:20–10:40	Coffee break
10:40–11:20	*Esther Florin,* Granger causality
11:20–12:00	*Lena Kästner,* Classifying experiments: Manipulation, intervention, interaction

Afternoon session

04:30–05:10	*Romain Brette,* Coding and the Causal Structure of the Brain
05:10–05:50	G*iuseppe Longo,* The differential method in biology
05:50–06:10	Coffee break
06:10–06:50	*Ehud Ahissar,* Circular causality in perception
06:50–07:30	Final discussion, Causality — Neuroscientists' Holy Grail?

1.6 Inhibitory microcircuits: From connectivity to computation and behaviour – Day 1

Monday, March 4, 2019

Organizers: Helen Barron, Adil Khan, Mani Ramaswami, Katharina Wilmes, Hannah Bos, Agostina Palmigiano, Petr Znamenskiy

Inhibitory neurons constitute a minority of cells in the cortex but provide a disproportionate fraction of synaptic input to excitatory cells. However, their role in shaping the response properties and plasticity of local circuits is not fully understood. Recent years have witnessed a development of experimental techniques both for cell-type specific in-vivo manipulation and recordings in mice, and for the measurement of fMRI and GABA concentration in humans. At the same time, theoretical work has made advances in exploring the network versatility arising from interneuron diversity and connectivity. As a result, experimental findings are increasingly guided by theoretical hypotheses while novel theoretical analyses are more closely informed by experiments. This ongoing dialogue between theory and experiment is revealing a more nuanced view of the computational roles served by different interneuron classes in the cortex. This workshop will address the functional role of inhibitory subtypes and their modulation during behaviour with respect to neural coding and representations. In particular, it will address how inhibition contributes to

1) recurrent amplification, shaping and routing of feedforward inputs by cortical circuits,

2) efficient and predictive coding, and

3) experience-dependent plasticity of cortical circuits during learning and memory.

By bridging insights across species and brain areas, and by integrating theoretical and experimental work, this workshop aims to bring together a diverse community of researchers.

1.6 Inhibitory microcircuits: From connectivity to computation and behaviour – Day 1

Sala VII

Morning session

09:00–09:10	Co-chairs, Overview
09:10–09:40	*Yashar Ahmadian,* When do networks balance E and I?
09:40–10:10	*Andrea Hasenstaub,* Different functional roles of interneuron types in mouse and human auditory cortex
10:10–10:30	Coffee break
10:30–11:00	*Henning Sprekeler,* Amplifying the somato-dendritic redistribution of inhibition by an interplay of three interneuron types
11:00–11:30	*Hannah Bos,* Arousal unlocks interneuron heterogeneity in olfactory codes
11:30–12:00	Co-chairs + speakers + audience, Discussion

Afternoon session

16:30–17:00	*Hillel Adesnik,* Inhibitory circuits for contextual modulation in the visual cortex
17:00–17:30	*Xiao-Jing Wang,* A macroscopic gradient of synaptic inhibition across the cortex
17:30–18:00	*Michael Long,* Inhibition and motor sequences
18:00–18:20	Coffee break
18:20–18:50	*Gianluigi Mongillo,* Inhibitory connectivity defines the realm of excitatory plasticity
18:50–19:20	*Katharina A Wilmes,* Interneuron circuit structure for top-down guided plasticity of sensory representations
19:20–19:30	Co-chairs + speakers + audience, Discussion

1.7 Why spikes? – Understanding the power and constraints of spiking based computation in biological and artificial neuronal networks – Day 1

Monday, March 4, 2019

Organizers: Benjamin Grewe, Il Memming Park, Joao Sacramento, Jose Principe, Kan Li, Jean-Pascal Pfister

Within the last decade the use of deep artificial neuronal networks (ANNs) has revolutionized thousands of machine-learning and data-science applications. Similar to biological neuronal networks, hierarchical multi-layer ANNs are able to discover intricate structure in high-dimensional data (e.g. image classification or speech recognition), but with the major distinction that training and testing is performed in analog neural networks. In contrast, most biological neuronal systems (except in smaller systems such as C. Elegans) communicate digitally via spikes. Although, several theoretical studies have attempted to train biologically realistic spiking neuronal networks to solve challenging machine-learning tasks, the success of these spiking neural networks has been very limited. This substantial difference in performance (ANNs vs. spiking networks) points to a major knowledge gap in the field of theoretical/systems neuroscience (spiking neural networks) and computer science (analog neural networks). Addressing this gap we aim to illuminate the benefits and constraints of spike based computation in biological and artificial neuronal networks. We will start by elaborating the potential constraints in biological hardware that may have led to spiking networks in the brain (such as energy constraints), followed by a critical discussion on the usefulness of spiking neuronal networks to solve challenging machine learning tasks.

To involve all related research fields the workshop will include theoretical- and systems neuroscientists as well as machine learning experts and neuromorphic engineers. While the computational reasoning behind biological spiking will be of high interest to many neuroscientists, it will also be beneficial for machine learning experts and neuromorphic engineers as a source of inspiration in their quest to design better neuronal network algorithms and neuromorphic systems.

What will the workshop address?The main goal of this workshop is to discuss the benefits and difficulties that arise when neuronal networks compute information with spiking signals. By discussing fundamental concepts of neural spiking, we aim to bridge a major gap that currently exists between the theoretical neuroscience and neuromorphic research community (spiking networks) and the field of computers science (analog ANNs) that recently revolutionized thousands of machine-learning applications. Further, the workshop aims to identify future experimental, theoretical and engineering work that will be necessary to fully understand and utilize the computational benefits (if there are any) of spiking neuronal networks.

...workshop description continues on p. 36

1.7 Why spikes? – Understanding the power and constraints of spiking based computation in biological and artificial neuronal networks – Day 1

Sala XII

Morning session

08:30–08:40	Introduction
08:40–09:10	*Benjamin Grewe,* Biological hardware constraints that could have made spiking necessary.
09:10–90:40	*Peter Latham,* Spikes: Good for communication in biological tissue over long distances, but not helpful for understanding how the brain works
09:40–10:10	*Biswa Sengupta,* Energy efficiency in the nervous system might be suitable for this audience
10:10–10:30	Coffee break
10:30–11:00	*Julia Harris,* Energy consumption and signalling in the white and grey matter
11:00–11:30	*José C. Príncipe,* Computation with spikes in the time domain: advantages and challenges

Afternoon session

16:00–16:10	Introduction
16:10–16:40	*Simon Thorpe,* Speeding up neural processing; Spike-based codes for fast visual processing; Multilayer spiking neural networks
16:40–17:10	*Jean-Pascal Pfister,* What are the consequences of the spiking bottleneck?
17:10–17:10	*Richard Naud,* Temporal codes for multiplexing
17:40–18:00	Coffee break
18:00–18:30	*Dongsung Huh,* Exploring the space of spike-based computations
18:30–19:00	*Uygar Sümbül,* Criteria for evaluating biologically plausible learners

1.8 Dopamine updated

Monday, March 4, 2019

Organizers: Joe Paton, Mark Walton

Over the last two decades, the notion that the activity of midbrain dopamine (DA) neurons represents the signed difference between expected and experienced reward – a reward prediction error (RPE) – broadcast widely across the brain to be used for learning, has proven hugely influential throughout neuroscience. This idea has shaped disciplines afield as well, from economics to psychiatry. Indeed, the RPE theory of dopamine function is one of the most celebrated examples of potential explanatory power of combining experimental data with theoretical models. Yet, in spite of its lasting significance, there have been persistent questions about whether the theory fully captures the function of dopamine transmission. In particular, there have been questions about whether DA activity is not simply a teaching signal but can also promote action. Moreover, there is increasing evidence for diversity of molecular features, anatomical connections, and coding across DA neurons. This raises important questions not only in narrow terms about how to reconcile a unified RPE theory of dopamine with such neuronal heterogeneity, but also whether it can be possible to ascribe a single computationally defined role for a particular neurotransmitter.The aim of the workshop is to bring together experimentalists and theoreticians working at different levels of analysis to debate these issues. In particular, we would hope to address key questions in the field such as: What are the appropriate levels of description to describe the neurotransmitter function; Can the RPE hypothesis be reconciled with emerging data describing heterogeneity in the signals encoded across different dopamine neurons; What is the evidence for conserved dopaminergic function between invertebrates and vertebrates; How does the choice of behavioral paradigm potentially influence DA responses.Given the proposed central importance of DAergic signalling for theories of behavioral control, we would expect broad interest from across the experimental and theory Cosyne community.

1.8 Dopamine updated

Sala XIII

Morning session

09:00–09:20	*Mark Walton and Joe Paton,* Co-organizers, Introduction
09:20–09:45	*Talia Lerner,* Distinct information carried by dopamine subcircuits
09:45–10:10	*Mitsuko Watabe-Uchida,* Separate dopamine systems reinforce choice along value and threat axes
10:10–10:35	*Zeb Kurth-Nelson,* A distributional code for value in dopamine-based reinforcement learning
10:35–10:50	Coffee break
10:50–11:15	*Joaquim Alves da Silva,* Dopamine neuron activity before action initiation gates and invigorates future movements
11:15–11:40	*Nathaniel Daw,* Reconciling dopaminergic response heterogeneity with prediction error models
11:40–12:00	Panel Discussion

Lunch (Location TBA, and visit to Paula Rego Museum for casual interaction)

Afternoon session

16:30–16:55	*Rafal Bogacz,* Dopamine as a prediction error in active inference
16:55–17:20	*Arif Hamid,* Waves organize dopamine transients into compartmentalized decision signals
17:20–17:45	*Johannes Felsenberg,* Dopamine-driven memory formation and extinction in Drosophila
17:45–17:55	Coffee break
17:55–18:20	*Masayuki Matsumoto,* Nigrostriatal dopamine signal regulates response inhibition in macaque monkeys
18:20–18:45	*Bill Stauffer,* Value and learning signals in dopamine neurons
18:45–19:10	*Angela Langdon,* Model-based predictions for dopamine
19:10–19:30	Panel Discussion/Wrap-up

1.9 Sleep: Models and experiments on replay, consolidation, and off-line processing – Day 1

Monday, March 4, 2019

Organizers: Mark Van Rossum, Sara Aton, Michal Zochowski, Penny Lewis

Since ancient history it has been realized that sleep is essential for a healthy life, but the neuroscience of sleep has long remained a mystery. In recent years there has been a true revolution in the study of sleep through investigation of its links to memory. Strikingly, 2411 of the 6951 total PubMed publications on sleep and memory are from the last 5 years. A number of parallel developments underpin this surge of interest: Large scale recording techniques and closed-loop feedback have revealed intricate aspects of sleep replay in memory consolidation. Meanwhile in human studies, findings in memory reactivation and replay boosting are revealing the role of sleep phases and already leading to a first generation of devices being marketed to improve sleep and memory. Finally, machine learning is increasingly interested in the performance gain from off-line processing occurring during sleep, while computational modellers are seeking to integrate disparate experimental findings. As exciting as these developments are, dialogue between disciplines has been wanting.

This workshop ambitiously tries to bring together researchers from experimental and computational neuroscience, AI researchers, and even a device engineer to explore the state-of-the-art in their subfields. The speakers have agreed to gear their talks towards a wide audience so that researchers outside the field will also benefit from this workshop.Specific questions that we have asked the speakers to debate are:

How are memories transformed during the sleep consolidation process?

How do sleep processes influences various brain areas?

How does sleep protect and or sharpen memories (e.g. the sleep homeostasis hypothesis)?

How can sleep rehearsal be used to improve computational Reinforcement Learning?

What is the role of REM vs SWS sleep for various forms of memory?

How does neural network dynamics change during sleep?

1.9 Sleep: Models and experiments on replay, consolidation, and off-line processing – Day 1

Sala XV

Morning session

09:10–09:25	TBC, Introduction
09:25–09:50	*Sara Aton,* Roles of oscillations and hippocampal ensembles in sleep-dependent memory consolidation
09:50–10:15	*Mark Blumberg,* Sleep promotes activity-dependent plasticity in the developing motor cortex
10:15–10:45	Coffee break
10:45–11:10	*Kamran Diba,* Hippocampal replay during sleep and wake
11:10–11:35	*Maxim Bazhenov,* Can sleep protect memories from catastrophic forgetting?
11:35–12:00	*Terrence Sejnowski,* The maturation of sleep spindles in the developing human cortex

Afternoon session

13:30–13:55	*Sean Hill,* Large-scale computational models and the exploration of sleep, plasticity and synaptic homeostasis
13:55–14:20	*Victoria Booth,* Modeling sleep-wake regulation: REM sleep mechanisms and dynamics
14:20–14:45	*Lisa Genzel,* Sleep for systems consolidation, from rats to humans
14:50–15:10	Coffee break
15:10–15:35	*Marcos Frank,* Sleep promotes bidirectional cortical plasticity in vivo
15:35–16:00	*Julie Seibt,* State-dependent synaptic plasticity: spotlight on dendrites
16:00–16:25	*Gianlugi Mongillo,* Synaptic volatility, inhibitory plasticity and the synaptic trace theory of memory

1.10 Affective and motivational influences on decision-making

Monday, March 4, 2019

Organizers: Candace Raio, Amitai Shenhav

As we navigate throughout our daily lives, we are constantly faced with the challenge of evaluating potential choice options and deciding which will yield the best outcome. Such decisions require us to weigh the potential rewards for different course of action against their attendant costs. A growing body of theoretical and empirical research suggests that this cost-benefit analysis interacts heavily with affective and motivational processes. As a result, a wide range of psychiatric disorders, including most mood and anxiety disorders, impact one's ability to evaluate potential costs and benefits and to subsequently make optimal decisions. To understand the process by which people weigh the costs and benefits of a decision, and how this process is impacted by dynamic changes in affect and motivation, it is critical to understand how affect shapes our estimate of potential rewards; how motivation influences our ability to make decisions; and how affective and motivational processes converge to determine real-world choice.

This workshop will bring together a set of talks on the ways in which affective and motivational processes inform and are influenced by decisions. Our speakers will present cutting-edge research into the neural and computational mechanisms of decision-making, across a variety of animal models (humans, non-human primates, rodents) and methodologies (e.g., electrophysiology, optogenetics, pharmacology, and functional neuroimaging).

Talks in this workshop will cover

(1) the relationship between affect and reward processing;

(2) the relationship between motivation and decision-making; and the influence of motivational and affective circuitry on

(3) impulsive choice and

(4) foraging/explore-exploit decisions.

We aim to bridge theoretical perspectives and empirical findings across fields of cognitive, affective, and decision neuroscience, laying the groundwork for more integrative and interdisciplinary research across these communities moving forward.

1.10 Affective and motivational influences on decision-making

Sala XVI

Morning session

09:00–09:05	Introduction
09:00–09:25	*Peter Rudebeck,* The influence of temporally extended affective states on reward processing
09:25–09:50	*Amitai Shenhav,* Neurally dissociable influences of choice set value on behavior and affect
09:50–10:15	*Melissa Malvaez,* Cortical–amygdala circuitry in reward learning and decision–making
10:15–10:45	Coffee break
10:45–11:10	*Candace Raio,* Exposure to stress modulates the subjective cost of control
11:10–11:35	*Roshan Cools,* Catecholaminergic modulation of cognitive control costs
11:35–12:00	*Mathias Pessiglione,* The role of executive control and fatigue in decision–making

Afternoon session

04:30–04:55	*Christian Ruff,* How arousal influences preferential and exploratory choice behavior
04:55–05:20	*Tali Sharot,* Valence–dependent information seeking in the human brain
05:20–05:45	*Michael Yoo,* What can we learn from naturalistic dynamic foraging tasks?
05:45–06:10	Coffee break
06:10–06:45	*Rafael Polania,* Self–control and decision–making: motivation, skill, and attention
06:45–07:10	*Sara Morrison,* Investigating the influence of Pavlovian conditioned approach on decision–making
07:10–07:30	*Candace Raio & Amitai Shenhav,* General discussion & Closing remarks

2.1 Studying visual processing in rodents: where a decade of research has taken us and what is waiting ahead

Tuesday, March 5, 2019

Organizers: Davide Zoccolan, Andrea Benucci

Recent years have witnessed a surge in the use of rodents as animal models to study visual functions. One reason is the availability of increasingly powerful experimental approaches (e.g., optogenetics and two-photon imaging) for the dissection of the underlying neural circuits. Another reason is that the functional architecture of the rodent visual system has important similarities with that of larger mammals, both at the sub-cortical and cortical level. For example, functional and anatomical evidence suggests that visual information is streamed in ventral-like and dorsal-like pathways, together with a complexification of the processed features along the hierarchy. These across-species preserved architectures suggest fundamental commonalities in the underlying computations. A third, important reason is the accessibility of rodent models to joint studies of visual perception and higher-level cognitive processes that rely on visual information, such as the vision-to-action link, and the development of cognitive maps to guide critical behaviors (e.g., spatial navigation).

In this workshop, we will discuss the functional properties of the rodent visual system that can best highlight key computations shared with larger mammals. We aim to make the point of what has been achieved so far, after about a decade of work with this model organisms, and to define a roadmap for future work that maximally leverages on rodent-specific technologies. Importantly, we will welcome a discussion on the use of modeling approaches that build from the preserved architectures to provide an implementation-level description of visual function. For instance, self-organizing principles (e.g., sparse/efficient coding and unsupervised temporal learning) have long been proposed as the key computations shaping the tuning of cortical visual neurons in primates, but without any strong empirical validation yet. We will discuss how the application of these computational principles to rodent vision could causally test model predictions via the extensive set of perturbative technologies available for rodents.

2.1 Studying visual processing in rodents: where a decade of research has taken us and what is waiting ahead

Sala I

Morning session

09:00–09:10	*Davide Zoccolan & Andrea Benucci,* Introduction & Welcome
09:10–09:30	*Cris Niell,* Vision and action in the mouse
09:30–09:50	*Aman Saleem,* Vision during locomotion and navigation
09:50–10:10	*Nicholas J. Priebe,* Studying active vision in mice
10:10–10:30	Coffee break
10:30–10:50	*Michael Stryker,* Visual processing and locomotion
10:50–11:10	*Samuel Solomon,* Adaptive processing in mouse visual cortex
11:10–12:00	Discussion

Afternoon session

16:30–16:50	*Andreas Burkhalter,* Modular organization of mouse visual cortex
16:50–17:10	*Shawn Olsen,* Large-scale activity mapping of the corticothalamic visual system in mice
17:10–17:30	*Laurenz Wiskott,* Slowness and predictability for vision and navigation
17:30–17:50	Coffee break
17:50–18:10	*Hans Op De Beeck,* The KISS principle in rodent object vision: A comparison with primate and convolutional neural networks
18:10–18:30	*Davide Zoccolan,* Unsupervised temporal learning underlies the development of complex cells in rat primary visual cortex
18:30–19:30	Discussion

2.2 Quantifying social behaviors: Computational challenges and experimental pitfalls

Tuesday, March 5, 2019

Organizers: Ann Kennedy, Annegret Falkner

Social behaviors, which include dyadic and group interactions, are evolutionarily ancient and vital to survival. Recently, modern neuroscience has experienced a flood of fresh interest in the neural mechanisms underlying social behaviors, owing to a proliferation of technologies for recording from and manipulating neural circuits in freely behaving animals, as well as the emergence of high-throughput tools to automate detection and quantification of animal behavior.As a result, the study of social behavior has a bit of a “wild west” feel to it, and the time is ripe for a bit of reigning in. This includes addressing both small scale questions (How can experimentalists maximally benefit from new tools for tracking behavior?), and the very large (What kinds of “high level” models of social behavior yield testable predictions?)

The analysis of social behavior also has several properties that make it uniquely difficult:

1) The multiple moving bodies problem. How do we best quantify the animal’s sensory space when we cannot control the input?

2) The experience problem. How can we best arrive at a complete quantitative description of the impact of previous experiences (social, sexual, agonistic) on brain and behavior?

3) The movement variability problem. How do we quantify a behavior when no two instantiations of it are identical?

4) The timescale problem. How do we determine the appropriate timescale to measure a behavior, when a behavior itself might last a few milliseconds, but its effects on body, brain, and endocrinological system might last for days?

The goal of this workshop is to foster fresh discussion of social neuroscience—its goals, its knowns, and its unknowns—by bringing together experimentalists and computational neuroscientists within the field, with theoretical and experimental neuroscientists who are more generally interested in information processing, decision-making, group interactions, and goal-directed behavior.

2.2 Quantifying social behaviors: Computational challenges and experimental pitfalls

Sala II

Morning session

09:00–09:10	*Annegret Falkner,* Welcome and introduction: What's right and wrong about the ways we are quantifying social behavior
09:10–09:35	*Gordon Berman,* Why two is tough: conceptual challenges (and some potential solutions) in measuring social behavior
09:35–10:00	*Ioana Carcea,* Spontaneous interactions for the social transmission of maternal behavior in mice
10:00–10:25	*John Cunningham,* Automated analysis of spontaneous interactions in a persistent social environment
10:25–10:45	Coffee break
10:45–11:10	*Scott Linderman,* Hierarchical recurrent models of neural activity and natural behavior
11:10–11:35	*Christian Broberger,* Capitalizing on natural differences to provide the network rules underlying social behaviour
11:35–12:00	*Oren Forkosh,* Identity domains in complex behavior: from personality to well-being

Afternoon session

04:30–04:55	*Mackenzie Mathis,* Pose estimation for social animals using DeepLabCut
04:55–05:20	*Adam Calhoun,* Identifying the internal states that shape sensorimotor integration during natural behavior
05:20–05:40	Coffee break
05:45–06:10	*Ann Kennedy,* Hypothalamic representations of internal state and behavior
06:10–06:35	*Ilana Witten,* Distinct reference frames for social space in two descending projections from PFC
06:35–07:00	*Bob Datta,* Motion Sequencing for solitary and social behaviors
07:00–07:30	Group discussion led by Ann and Annegret

2.3 Neural representations and coding under resource limitations

Tuesday, March 5, 2019

Organizers: Rava Azeredo da Silveira, Yoram Burak

The brain represents and manipulates huge amounts of information resulting from sensory inputs, memory, and internal computations whose outputs are relayed and transformed across brain regions. But brain activity comes with an energetic cost, and is subject to biophysical limitations. Historically, the notion of 'efficient coding'–that the brain uses optimal coding strategies given its limited resources– has motivated a number of important advances in the field, in particular in examining early sensory coding.With the explosive progress in experimental technology over the past two decades, we can now probe neural representations in larger and targeted populations of neurons, in diverse brain areas, and in behaving animals. This opens the door to examining the efficient coding hypothesis much more broadly than has been done in the past, and to relate it not only to neural activity but also to behavior. The goal of our proposed workshop is to consider efficient neural representations and coding in the brain beyond the confines of early sensory systems: in the context of brain areas involved in higher cerebral functions, in relation to analyzes of large-scale neural recordings, and in terms of its implications for behavior and cognition.

To achieve this goal, we propose to bring together researchers that study diverse aspects of efficient coding:

•from mathematical models to data analysis;

•from the study of neural representations to that of cognition and behavior;

•from mechanistic approaches to effective and normative ones.

The workshop will serve to establish bridges between existing models, while identifying conceptual differences, and to examine how mechanistic approaches can contribute to normative ones and vice versa. The target audience of the workshop includes cognitive scientists as well as researchers working at the neural level. The topics discussed will engage both theoreticians and experimentalists interested in normative frameworks of brain organization and function.

2.3 Neural representations and coding under resource limitations

Sala III

Morning session

09:00–09:25	*Eero Simoncelli,* Coding efficiency and prior embedding in neural populations
09:25–09:50	*Zhaoping Li,* Predictions and experimental tests of efficient coding theory in stereo vision
09:50–10:15	*Memming Park,* Bayesian efficient coding for early visual neurons
10:15–10:45	Coffee break
10:45–11:10	*Rafael Polania,* Efficient coding of subjective value
11:10–11:35	*Chris Summerfield,* How context modulates perceptual, cognitive and economic decisions
11:35–12:00	*Noga Zaslavsky,* Efficient coding and language evolution: The case of color naming

Afternoon session

04:30–04:55	*Tatyana Sharpee,* Implications of resource limitations for cell type diversity
04:55–05:20	*Remi Monasson,* Environmental adaptation of olfactory receptor distributions
05:20–05:45	*Balasz Ujfalussy,* Robust and efficient coding with grid cells
05:45–06:15	Coffee break
06:15–06:40	*Matthew Chalk,* Inferring the function of a resource constrained neural network
06:40–07:05	*Ann Hermundstad,* Adaptive sensory coding for dynamically balancing speed, performance, and resource use
07:05–07:30	*Wei Ji Ma,* Efficient coding, resource rationality, and rational inattention: clarifying connections

2.4 Beyond trial-based choice: Decision-making in naturalistic and temporally extended environments

Tuesday, March 5, 2019

Organizers: Laurence Hunt, Nils Kolling

Decision-making research has traditionally been modelled around repeated choices between a limited number of options, simultaneously presented to the agent. By contrast, decisions in natural environments take place in temporally extended sequential environments: they involve planning, information search, and choice between multiple alternatives. Such decisions may take place in environments with long temporal autocorrelations, and may be made over far longer timescales than those typically studied experimentally.In this workshop, we address the benefits (and challenges) of moving from trial-based choice towards studying decision making in such naturalistic, temporally extended environments. An interdisciplinary approach to this topic is particularly timely.

Recent advances in our understanding of (a) ecological decision-making in real-world environments, (b) how artificial agents could solve high dimensional planning, and (c) how best to analyse temporally extended neural data, could all strongly influence the nascent field of ecological decision neuroscience.

Specifically, recent work from ecology (MacIver) provides theoretical insights into which environments benefit planning behaviours, whose neural substrates are observed in empirical data from rodents (Redish), macaques (Hunt), and humans (Scholl, Daw). Work from artificial intelligence (Stachenfeld, Daw) provides insight into neural mechanisms for planning, which can then be compared to neural data from hippocampus and prefrontal cortex (Hunt, Redish, Procyk, Scholl). Work from statistics (Russo) opens up completely new ways to approach neural data in temporally extended and more unconstrained ecological behaviours, such as sequential search in high dimensional environments (Daw, Scholl) or foraging (Redish).

Our workshop will thus bring together theoreticians using diverse approaches with empiricists studying different types of neural data, across multiple species. The resulting dialogue will surely lead to more successful strategic long-term decisions about the future direction of the field.

2.4 Beyond trial-based choice: Decision-making in naturalistic and temporally extended environments

Sala VI

Morning session

09:00–09:05	Introduction
09:05–09:40	*Malcolm MacIver,* Terrestrial sensory ecology provides a selective benefit to planning
09:40–10:15	*Kimberly Stachenfeld,* Structured representation learning and the hippocampus
10:15–10:40	Coffee break
10:40–11:15	*Eleonora Russo,* Cell assembly detection: unsupervised assessment of the temporal scales and activity patterns of task relevant information encoding
11:15–11:50	*Jacqueline Scholl,* Sequential choice, prospection and insight - neural mechanisms and clinical relevance
11:50–12:00	Summary

Afternoon session

04:30–04:35	Introduction
04:35–05:10	*Emmanuel Procyk,* Trial-to-trial information integration and the regulation of exploratory behaviours by the midcingulate cortex
05:10–05:45	*David Redish,* Stay/go foraging and T-maze choice access different decision making processes
05:45–06:05	Coffee break
06:05–06:50	*Nathaniel Daw,* Rational planning by prioritized memory access
06:40–07:15	*Laurence Hunt,* Where to look next? Information search and choice in humans and other primates
07:15–07:45	General discussion

2.5 Inhibitory microcircuits: From connectivity to computation and behaviour – Day 2

Tuesday, March 5, 2019

Organizers: Helen Barron, Adil Khan, Mani Ramaswami, Katharina Wilmes, Hannah Bos, Agostina Palmigiano, Petr Znamenskiy

Inhibitory neurons constitute a minority of cells in the cortex but provide a disproportionate fraction of synaptic input to excitatory cells. However, their role in shaping the response properties and plasticity of local circuits is not fully understood. Recent years have witnessed a development of experimental techniques both for cell-type specific in-vivo manipulation and recordings in mice, and for the measurement of fMRI and GABA concentration in humans. At the same time, theoretical work has made advances in exploring the network versatility arising from interneuron diversity and connectivity. As a result, experimental findings are increasingly guided by theoretical hypotheses while novel theoretical analyses are more closely informed by experiments. This ongoing dialogue between theory and experiment is revealing a more nuanced view of the computational roles served by different interneuron classes in the cortex. This workshop will address the functional role of inhibitory subtypes and their modulation during behaviour with respect to neural coding and representations. In particular, it will address how inhibition contributes to

1) recurrent amplification, shaping and routing of feedforward inputs by cortical circuits,

2) efficient and predictive coding, and

3) experience-dependent plasticity of cortical circuits during learning and memory.

By bridging insights across species and brain areas, and by integrating theoretical and experimental work, this workshop aims to bring together a diverse community of researchers.

2.5 Inhibitory microcircuits: From connectivity to computation and behaviour – Day 2

Sala VII

Morning session

09:00–09:10	Co-chairs, Overview
09:10–09:40	*Anne Marie Oswald,* A role for disinhibition in ensemble formation
09:40–10:10	*Mani Ramaswami,* Inhibitory potentiation in adaptive filtering and behavioral habituation
10:10–10:30	Coffee break
10:30–11:00	*Adil Khan,* Selectivity and interactions of interneurons during learning and attention switching
11:00–11:30	*Helen Barron,* Inhibitory engrams in human neocortex ensure stable memory storage
11:30–12:00	Co-chairs + speakers + audience, Discussion

Afternoon session

16:30–17:00	*Quentin Chevy,* Surprise, surprise: a VIP neuron-mediated cortical circuit for reinforcement learning
17:00–17:30	*Guillaume Hennequin,* Detailed inhibition and the neural control of movement
17:30–18:00	*Baranidharan Raman,* Encoding sensory information with dynamically switching neural ensembles
18:00–18:20	Coffee break
18:20–18:50	*Charlotte Stagg,* The role of inhibition in motor learning and plasticity in humans
18:50–19:20	*Petr Znamenskiy,* A microcircuit for functionally specific inhibition in visual cortex
19:20–19:30	Co-chairs + speakers + audience, Discussion

2.6 Why spikes? – Understanding the power and constraints of spiking based computation in biological and artificial neuronal networks – Day 2

Tuesday, March 5, 2019

Organizers: Benjamin Grewe, Il Memming Park, Joao Sacramento, Jose Principe, Kan Li, Jean-Pascal Pfister

… continued from p. 18

To discuss the usefulness of biological network spiking and the potential benefits for machine-learning/neuromorphic applications we will focus on the four main questions that we will discuss across four sessions spread across two days:

T1. Why do most biological neurons spike? Are there any constraints of the biological hardware that have made spiking necessary? Why do simple biological systems (e.g., C. Elegans) do not use spikes?

T2. For spiking neural networks – What are the computational benefits (if any) in computing and learning with spikes? In which scenarios are spiking systems better?

T3. How can we efficiently train recurrent or deep spiking neuronal networks? How can we implement gradient-descent error backpropgation in multilayer spiking networks?

T4. What are the benefits of implementing spiking neuronal networks in neuromorphic hardware? What will be the neural hardware of the future? – Neuromorphic spiking systems or GPU-like streaming processors with integrated memory.

Why is this topic timely? Although new neuromorphic spiking hardware platforms such True North or Intel's Loihi chip now allow to simulate ~200,000 spiking neurons in real time, applications to make use of spiking neural networks have been very limited. One reason for this could be that spiking neuronal networks seem to have failed keeping up with current deep learning approaches that are revolutionizing machine-learning. This raises the inevitable question if spiking is at all a useful concept for 'in silicon' neural computation and if spiking primarily emerged due to constraints of the biological hardware.

Why is this topic of interest? This topic is of substantial interest not only to systems and theoretical neuroscience researchers who aim at a more detailed understanding of event based computation in large neural networks, but also to machine learning scientists and neuromorphic engineers who strive to understand spiking neuronal networks in the brain with the ultimate goal to improve training and learning procedures in artificial neural networks and neuromorphic systems.

Who is the target audience? The target audiences for this workshop are all neuronal network researchers who are interested in constraints, benefits and problems that arise when information is computed via spikes. These include theoretical and systems neuroscientists as well as computer scientists (deep learning) and neuromorphic engineers. In addition, our workshop will be of interest to a broad spectrum of young and early career researchers who are interested in the big question if spiking networks will be play a major role in future machine-learning as well as in neural hardware development.

2.6 Why spikes? – Understanding the power and constraints of spiking based computation in biological and artificial neuronal networks – Day 2

Sala XII

Morning session

09:00–09:10	Introduction
09:10–09:40	*Wulfram Gerstner,* Learning with spikes: Old models and recent results
09:40–10:10	*Friedemann Zenke,* Computation in spiking neural networks: Opportunities and challenges
10:10–10:40	*Robert Legenstein,* Optimizing recurrent spiking neural networks with backpropagation through time
10:40–11:00	Coffee break
11:00–11:30	*Jordan Guerguiev,* Learning feedback pathways for credit assignment using spike-based discontinuities
11:30–12:00	*Walter Senn,* Why spikes? - To correctly assign credits
12:00–12:30	*Shih-Chii Liu,* Optimizing spiking deep neural networks for classification

Afternoon session

16:00–16:10	Introduction
16:10–16:40	*Kan Li,* Learning with spike trains in reproducing kernel Hilbert space
16:40–17:10	*Mike Davies,* A Matter of scale: Computational principles applicable to neuromorphic chips and biological neurons
16:40–17:10	*Giacomo Indiveri,* Spike-based communication and processing in neuromorphic cognitive agents
17:40–18:00	Coffee break
18:00–19:00	Panel Discussion, *Pfister, Grewe, Davies, Indiveri, Thorpe, Park, Sümbül, Legenstein*

2.7 What are your coordinates? Domain-general neural computations underlying coordinate transformations

Tuesday, March 5, 2019

Organizers: Raphael Kaplan

Spatial information is neuronally encoded in different coordinate systems/reference frames (e.g., world-centered, eye-centered, hand-centered). Investigating how different coordinates are transformed to generate a particular action has led to significant advances in our understanding of basic brain function. More recently, the concept of coordinate transformations is serving as a useful proxy for understanding many non-explicitly spatial behaviors, such as decision-making and social cognition. For example, the use of world-centered spatial coordinates during navigation may also be used when transforming abstract, metrically coded variables, like inferring the personal preferences of other people.

We will explore common–and sometimes distinct–computations guiding coordinate transformations across species and diverse areas of investigation, ranging from perception to social behavior. To highlight the diversity of behaviors that utilize coordinate transforms, presentations will be grouped into three areas: sensation and perception, hippocampal coding of space, and coordinate transformations in learning and decision-making. By understanding commonalities across these diverse behaviors, we hope to gain a better understanding of potential domain-general neural computations guiding coordinate transformations.

We aim to have a lively discussion among a diverse group of computational and systems neuroscientists studying related questions involving coordinate transformations, but that typically do not have the opportunity to interact. More specifically, the discussion will focus on three key questions.

First, do the same neural computations underlie coordinate transforms across brain regions and behaviors?

Second, are there truly allocentric/world-centered reference frames, or are all coordinate systems self-referenced in some way?

And finally, do non-spatial coordinate transformations really exist?

2.7 What are your coordinates? Domain-general neural computations underlying coordinate transformations

Sala XIII

Morning session

09:00–09:30	*Chair Intro + Flavia Filimon,* Are all spatial reference frames egocentric in some way?
09:30–09:55	*Jonathan Whitlock,* Dense egocentric coding along the rat parieto–frontal pathway
09:55–10:20	*Jenni Groh,* Evolution of reference frames along visual and auditory pathways
10:20–10:40	Coffee break
10:40–11:15	*Andrej Bicanski,* Computational models of coordinate transformations in spatial memory and navigation
11:15–11:40	*Sylvia Wirth,* From visual representation of space to schemas in the primate hippocampus
11:40–12:05	*Christian Doeller,* Transforming perceptual coordinates to memory
12:05–12:15	Discussion

Afternoon session

04:30–04:55	*Beth Buffalo,* Maps vs sequences in the primate hippocampus
04:55–05:20	*Kari Hoffman,* Goal–oriented paths in real and memory space in primates
05:20–05:40	Coffee break
05:40–06:05	*Raphael Kaplan,* Relating hippocampal–entorhinal coordinate transformations to social learning
06:05–06:30	*Liora Las,* Bat hippocampus – beyond self localization
06:30–06:55	*Jesse Geerts + Neil Burgess,* How allocentric versus egocentric codes give the appearance of incidental versus reinforcement learning.
06:55–07:25	Discussion

2.8 Sleep: Models and experiments on replay, consolidation, and off-line processing – Day 2

Tuesday, March 5, 2019

Organizers: Mark Van Rossum, Sara Aton, Michal Zochowski, Penny Lewis

Since ancient history it has been realized that sleep is essential for a healthy life, but the neuroscience of sleep has long remained a mystery. In recent years there has been a true revolution in the study of sleep through investigation of its links to memory. Strikingly, 2411 of the 6951 total PubMed publications on sleep and memory are from the last 5 years. A number of parallel developments underpin this surge of interest: Large scale recording techniques and closed-loop feedback have revealed intricate aspects of sleep replay in memory consolidation. Meanwhile in human studies, findings in memory reactivation and replay boosting are revealing the role of sleep phases and already leading to a first generation of devices being marketed to improve sleep and memory. Finally, machine learning is increasingly interested in the performance gain from off-line processing occurring during sleep, while computational modellers are seeking to integrate disparate experimental findings. As exciting as these developments are, dialogue between disciplines has been wanting.

This workshop ambitiously tries to bring together researchers from experimental and computational neuroscience, AI researchers, and even a device engineer to explore the state-of-the-art in their subfields. The speakers have agreed to gear their talks towards a wide audience so that researchers outside the field will also benefit from this workshop.Specific questions that we have asked the speakers to debate are:

How are memories transformed during the sleep consolidation process?

How do sleep processes influences various brain areas?

How does sleep protect and or sharpen memories (e.g. the sleep homeostasis hypothesis)?

How can sleep rehearsal be used to improve computational Reinforcement Learning?

What is the role of REM vs SWS sleep for various forms of memory?

How does neural network dynamics change during sleep?

2.8 Sleep: Models and experiments on replay, consolidation, and off-line processing – Day 2

Sala XV

Morning session

09:00–09:25	*Michael Fauth,* Self-organized reactivation maintains and reinforces memories stored in Hebbian cell assemblies despite synaptic turnover
09:25–09:50	*Niels Niethard,* Plasticity during sleep is linked to specific regulation of cortical circuit activity
09:50–10:15	*Umberto Olcese,* Neuron-level information transfer in sleep and wakefulness
10:15–10:45	Coffee break
10:45–11:10	*David Ha,* World models and replay for reinforcement learning
11:10–11:35	*Tomoki Fukai,* Implications of symmetric STDP, replay and inhibitory engrams in sequence learning
11:35–12:00	*Tatiana Engel,* Spatiotemporal dynamics of cortical states during selective attention

Afternoon session

13:30–13:55	*Michal Zochowski,* Understanding dynamical mechanisms of memory consolidation during sleep
13:55–14:20	*Igor Timofeev,* Sleep slow wave activities potentiate cortical network and contribute to memory formation
14:20–14:45	*Ariana Maffei,* Circuit mechanisms for learning in the insular cortex
14:50–15:15	*Danielle Bassett,* Using synthetic and empirical network architectures to infer principles of efficient, high dimensional encoding of static representations and dynamic systems in whole-brain circuits
15:15–15:35	Coffee break
15:35–16:00	*Anna Schapiro,* Empirical and neural network modeling investigations into sleep-dependent consolidation of structured information
16:00–16:25	*Viola Priesemann,* Network dynamics from wakefulness to deep sleep
16:25–16:30	Closing remarks

2.9 Advances and convergences in 5-HT research

Tuesday, March 5, 2019

Organizers: Romain Ligneul, Gul Dolen

The serotonin (5-HT) system is one of the most complex and ubiquitous neurotransmitter systems. It is also one of the most important targets for the treatment of depression, anxiety, panic and obsessive-compulsive disorders, amongst others.

Decades of pharmacological experiments have demonstrated that agonists or antagonists of 5-HT receptors can modulate a very wide array of cognitive processes, from the most simple sensory inputs and motor outputs to the most ethereal forms of consciousness. Yet, until the emergence of genetically-encoded molecular tools to track, image and manipulate the serotonin system, very little was known about its neuroanatomy, its development, and the causes and effects of endogenous 5-HT signals.

Opsins, calcium indicators, chimeric receptors and release sensors have recently revolutionized the field in many ways. The 5-HT community has for example discovered that transient 5-HT signals can influence on behavior at short time scales, contribute directly to associative learning, shape perceptual processes and regulate social behaviors in unique ways. Moreover, it became clear that early life events can have a profound impact on the development of the 5-HT system with long-lasting behavioral consequences. Consequently, the 5-HT system now appears as a dynamic “toolbox” shaped by experience, which in turn controls numerous downstream networks and plasticity pathways.

Given the advances made by the field in the last years, bringing researchers together shall promote the pursuit of cohesive and synergistic researches in the near future.

What are the key principles influencing the development of the 5-HT system?

What are the key computational principles governing the firing of 5-HT neurons?

How do serotonin interact with other neurotransmitters to influence behaviors?

How to articulate the affective and cognitive dimensions of serotonin?

What are the most promising serotonergic perspectives for pharmacopsychiatry?

The workshop will continue on 06 March 2019 as:

More serotonine: Satellite event at the Champalimaud Centre for the Unknown, see https://goo.gl/Dm2R2a for details.

2.9 Advances and convergences in 5-HT research

Sala XVI

Morning session

09:05	*Jing Ren,* Functional neuroanatomy of the Dorsal Raphe Nucleus
09:30	*David J Linden,* Regeneration of serotonin axons in the adult brain
09:55	*Patricia Gaspar,* Regulation of 5-HT signaling across development–from maternal behavior to adult phenotypes
10:20	*Nicolas Guttierez,* Development of the mPFC-DRN pathway and its functional consequences
10:45	Coffee break
10:55	*Raffaella Tonini,* Input-specific serotonergic modulation of striatal synaptic plasticity
11:20	*Massimo Pasqualetti,* The control of neuronal wiring by serotonin
11:45	*Roshan Cools,* 5-HT and adaptive control: genetic and pharmacological studies

Afternoon session

16:20	*Sangyu Xu,* Serotonin Regulation of Inter-temporal Choice
16:45	*Kenji Doya,* Patience and beyond
17:10	*Jeremiah Cohen,* Serotonergic neurons modulate dynamic decision making
17:35	Coffee break
17:45	*Peter Dayan,* The long and the short of 5-HT stimulation: optogenetic activation of dorsal raphe serotonergic neurons changes the learning rate for rewards
18:10	*Zach Mainen,* Serotonin from priors to behavior
18:35	*Hendrikje Nienborg,* Serotonergic control of V1 neurons
19:00	*Katrin Preller,* 5HT1A/2A agonists and cognition in humans-pharmaco-fMRI studies in psychedelic-induced states