CNS*2024 Natal

TYPE - KEYNOTE • JULY 20 • SATURDAY

K Keynote

JULY 20 • SATURDAY

5:30pm – 6:30pm K **Welcome and Keynote #1: Suzana Herculano-Houzel, "Intelligence as flexibility: What life gains with a pallium"** Jacarandá

Speakers: Leonid Rubchinsky

Neurons are the computational units of brains, and in principle, the more the neurons in a circuit, the more computationally capable that circuit will be. Indeed, that is the most obvious feature that sets the human brain apart from all others: it is the one with by far the most cortical, or pallial, neurons. Given the associative connectivity of the pallium, it endows the brain with flexible behavior, which, the speaker will argue, is the best current working definition of intelligence. Indeed, despite their entirely different brain sizes, corvids and great apes have comparable cognition and numbers of associative neurons in the pallium.

However, while it seems intuitive from the Darwinian adaptationist point of view that life should evolve towards ever more capable brains, with ever more neurons, the vast majority of vertebrate animals have very few pallial neurons, even fewer of which are purely associative – and yet, they do just fine, which is a strong argument against any need or requirement for more brain neurons in any species. Instead, this lecture will argue that brain evolution has been a matter of balance between opportunity and constraints, rather than of finding computational solutions to problems. Circuits, like brains, do not *need* to be optimized; they just have to *work* – and if opportunities and constraints *allow* for a pallium, then long, complex and flexible, intelligent life ensues, in proportion to the number of neurons afforded in the pallium.

K Keynote

JULY 21 • SUNDAY

9:10am – 10:10am K **Announcements and Keynote #2: Claudia Clopath, "A Memory's Journey"** Jacarandá

Speakers: Thomas R. Knösche

Episodic memories are encoded by experience-activated neuronal ensembles that remain necessary and sufficient for recall. However, the temporal evolution of memory engrams after initial encoding is unclear. In this study, we employed computational and experimental approaches to examine how the neural composition and selectivity of engrams change with memory consolidation. Our spiking neural network model yielded testable predictions: memories transition from unselective to selective as neurons drop out of and drop into engrams; inhibitory activity during recall is essential for memory selectivity; and inhibitory synaptic plasticity during memory consolidation is critical for engrams to become selective. Using activity-dependent labeling, longitudinal calcium imaging and a combination of optogenetic and chemogenetic manipulations in mouse dentate gyrus, we conducted contextual fear conditioning experiments that supported our model’s predictions. Our results reveal that memory engrams are dynamic and that changes in engram composition mediated by inhibitory plasticity are crucial for the emergence of memory selectivity.

K Keynote

JULY 22 • MONDAY

9:10am – 10:10am K **Announcements and Keynote #3: Andre Longtin, "Adaptive design in sensory and memory systems"** Jacarandá

Speakers: André Longtin, Gennady Cymbalyuk

Neural fatigue, and recovery from this fatigue, is a negative feedback mechanism that endows an organism with a large array of information coding capabilities. This talk will present novel adaptive computations in the central and peripheral nervous system beyond the well-documented ability to signal input changes. I will first set the stage by contrasting current or threshold adaptation. Then I will show how adaptation causes spike train patterning that enables the detection of stimuli too weak to change the mean rate. It also leads to optimal transmission to neurons with similar synaptic time scale. Adaptation reduces noise in certain frequency bands and thus enhanced information transmission for time-varying signals. The reason is the regularization of spike trains by adaptation via noise-shaping. In its power-law variety, adaptation leads to a speed-invariant estimation of stimulus distance. I will then discuss the impact of adaptation on sensory system design, wherein supra-threshold encoding of small stimuli is followed by subthreshold encoding (stochastic resonance). It will explain a machine-learning-and-dynamics-based inference method to infer adaptation and connectivity parameters from microscopic neural data. Adaptation also appears in more central circuits such as hippocampus where it has very long time scales. Such adaptation can be used to represent time intervals between events. Finally, in a recurrent network inspired by dentate gyrus circuitry, our theory reveals a state of quasi-criticality that enables a novel dual encoding strategy that is possibly relevant for pattern separation: rate coding for moderate-to-large stimuli and pattern coding for weak stimuli.

K Keynote

JULY 23 • TUESDAY

2:00pm – 3:20pm K **Keynote #4: Mauro Copelli, "Brain criticality and cortical states"** Jacarandá

Speakers: Mauricio Girardi-Schappo

The presumed proximity to a critical point is believed to endow the brain with scale-invariant statistics, which are thought to confer various functional advantages in terms of information processing, storage, and transmission capabilities. In this talk, I will present a personal review of this idea, known as the critical brain hypothesis, which is now two decades old. The role of very simple and not-so-simple computational models in addressing pressing questions in the field will be discussed. Specifically, we will investigate to what extent these ideas can contribute to the understanding of cortical

states by comparing model results with the analysis of spiking data from the urethane-anesthetized rat’s primary visual cortex.