SANKET NEWSLETTER

Signaling And Neurophysiology Knowledge-resource for Experiments and Theory

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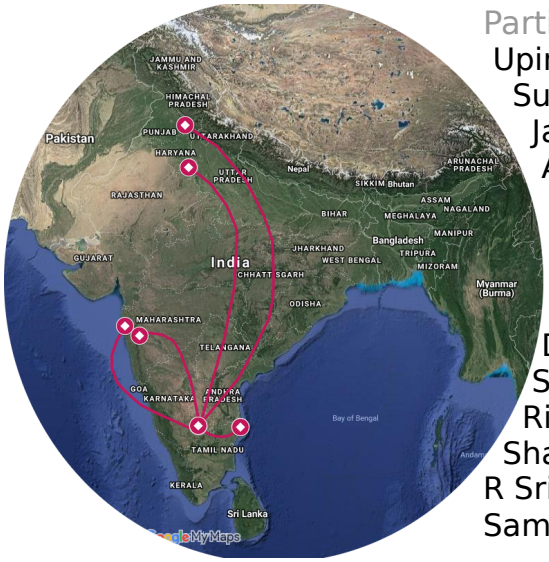
Highlights...

- FindSimInterface website is up and running
- "Metaplasticity in autism" from Bhupesh Vaidya from Dr. James Clement's lab lab
- "Developing computational models at systems level with medical and engineering applications"
  - Prof Srinivas Chakravarthy



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General Consortium News

The CAMP school 2019 is starting next week.

The "FindSimInterface" website is up and running with 18 FindSim experiments which is curated and is availiable for plug and play.

These experiments are taken from published papers which are tested against the model of biochemical signaling which is designed to be embedded in a single-compartment neuronal spine to match the result.

We have divided FindSim experiments to Curated and Non-curated set.

- Curated list contains FindSim experiments which have been cross-checked and verified by the team.
- Non-Curated list which needs a thorough curation.

Update on project

"Metaplasticity in Autism" on going project done by Phd student Bhupesh from Dr. James Clement's lab.

The human brain is made up of 86 billion neurons which communicate with each other and the other non-neuronal cells called glia. Connection and communication between these neurons occur at the synapses which is responsible for learning and memory. It is governed by the phenomenon of synaptic plasticity which results in changes in synaptic strength by pre-and post-synaptic mechanisms.

Metaplasticity is a higher order of synaptic plasticity which is the plasticity of the synaptic plasticity. It broadly includes all the processes that lead to any biochemical or physiological alteration in the neuron's ability to induce and maintain synaptic plasticity.

Several mechanisms have been proposed to explain metaplasticity depending on the location and the type of synapse or pre- and post-synaptic receptors. To date, there are no reports stating the direct involvement of metaplasticity in any gene mutations implicated in intellectual disability (ID) and Autism Spectrum Disorders (ASD). However, it has been proposed that memory deficits in ID and ASD may be due to an inability to undergo metaplasticity during various developmental stages. It has also been demonstrated that hippocampal metaplasticity is important for the formation of temporal associative memories and these mechanisms are linked to cognitive deficits in Alzheimer's disease.
Another study which showed the motor evoked potential in the human volunteers provided preliminary evidence that metaplastic mechanisms might be involved in the pathology of ID/ ASD.
Though, studies done to investigate the effect of metaplasticity in animal models are limited, owing to its role in the maintenance of LTP and LTD, which are electrophysiological readouts of memory, it is speculated that it might be responsible for the cognitive deficits seen in patients with ID/ ASD. However, more detailed studies need to be done to establish the possible involvement of metaplasticity so that better therapeutic strategies could be designed for the treatment of ID/ ASD

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Work from particitpating labs

The Computational Neuroscience (CNS) lab IIT, Madras led by Prof V. Srinivasa Chakravarthy aims at developing computational models at systems level with medical and engineering applications.

Modeling the Basal ganglia (BG):

His lab has developed a general BG model that explains a wide range of motor functions and some cognitive functions of this circuit in healthy controls and Parkinson's disease conditions.
These findings were summarized in the book "Computational Neuroscience models of the Basal Ganglia" published by Springer 2018.

Recently lab began, a line of models to investigate the hypothesis that metabolic deficiency is the root cause of the loss of cells in Substantia Nigra pars compacta. The models could explain Parkinson's related changes at molecular and network levels.

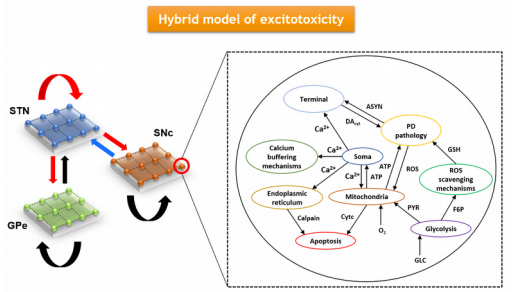

Figure 1: Modeling the effects of metabolic deficiency at network and subcellular level in SNc.

Hippocampus and spatial navigation:-

His lab has developed a general model that can explain a wide variety of observations related to hippocampal spatial cells in both 2D and 3D navigation Soman et al, Nature Communications, 2018.

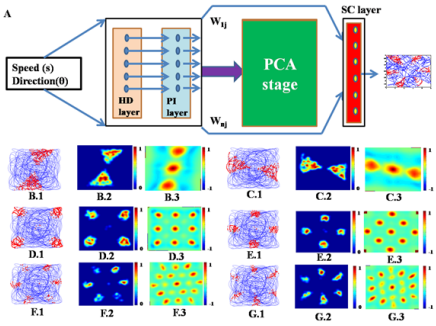

Figure 2: Modeling emergence of grid cells in 2D navigation.

In collaboration with the company Continental Automotive his lab is seeking to apply these ideas to a brain-inspired navigational system for automobiles.

Modeling Stroke:-

Graduate students in his lab are currently developing a model of stroke of upper extremity. Working as a part of a consortium that brings together clinical experts and industry, they are combining neuroimaging with modeling to develop a comprehensive patient-specific models of stroke, which can further be used for designing rehabilitation protocols.

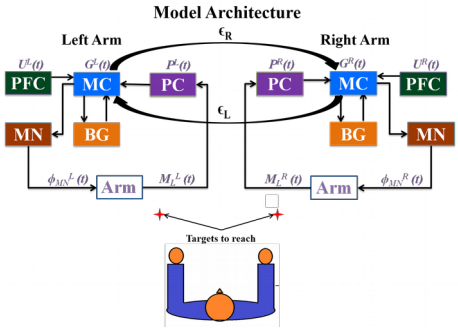

Figure 3: A computational model of bimanual reaching in hemiparetic stroke.

Modeling neurovascular coupling:-

The CNS lab proposed that in neurovascular coupling energy demand generated by neural activity must be met by energy supply delivered by the glio-vascular network. In theoretical investigation, this hypothesis leads to a plethora of radical biological possibilities including plasticity in glio-vascular "connections", stimulus-dependent adaptation of glial-neuron ratio, etc. This line of work suggests that brain's computations are not performed by neurons alone, but jointly by the neuro-glio-vascular network, a notion that attributes exciting information processing functions to cerebral microvasculature.

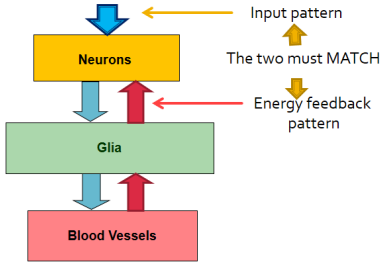

Figure 4: The proposed Matching Principle in neurovascular coupling.

The CNS lab has recently published a book titled "Demystifying the brain – a computational approach" published by Springer. The book seeks to present the modern computational perspective of the brain to a biologist without equations, and to an engineer without resorting to excessive neurobiological jargon.Prof Chakravarthy says, "We await the day when computational models are not "accessories" but founding pillars of neuroscience research."