Project Proposal

Introduction to Neural and Cognitive Modelling – CG3.401

Team:

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Project Title: Understand and implement the Striatal Beat Frequency (SBF) Model and explore potential expansions, relations or suggest add-ons pertaining to the scope of the model.

Introduction:

- What is the SBF model?
  1. The Striatal Beat Frequency (SBF) model is a neurobiological model that explains how the brain codes time using neural oscillators and spiny neurons in the basal ganglia. One instance of such models can be found in oscillatory multiplexing of neural population codes for interval timing and working memory.
  2. The model aims to understand how the brain perceives difference and measures time in scales of milliseconds to seconds and the role of basal ganglia (striatum – hence the name) in performing the task.
- Keywords:
  1. **Striatum:** A major part of basal ganglia involved in cognitive processes such as decision making, motor control, reinforcement learning and temporal perception
  2. **Oscillatory Multiplexing:** A neural coding strategy used by the brain to transmit multiple streams of information between different regions parallel
  3. **Neural Population Codes:** A strategy wherein information is represented using a group of neurons rather than relying on a single neuron.

Project Objectives:

- Explore and understand the theory behind the SBF model and the biological processes involved therein
- Implement, experiment with, understand the relations between parameters of and evaluate the model using Python or any other suitable simulation platform

- Suggest potential applications (additional), expand usability to other domains or improvements in the current work. One such potential application has been ideated in the following section.

Applications:

- Interval timing in neuroscience research: this model is widely used to study the ability to perceive and estimate intervals ranging from seconds to minutes
- Parkinson's Disease and other neurodegenerative disorders: PD is known to affect the basal ganglia, having impaired time perception as one of its symptoms, by modelling the time perception deficits in PD patients using SBF we can arrive at therapeutic approaches like deep brain stimulation (DBS) which targets the basal ganglia, also useful for studying time impairments in other neurodegenerative conditions like Huntington's Disease ,and cognitive disorders like Schizophrenia and ADHD.

Introduced Novelty and potential for extended applications:

- While the SBF model offers valuable insight in explaining time perceptions in the wakeful states in current research, it is less directly applicable to the altered experience of time perception in dream-like states such as the inconsistencies of time not matching that of the external world.
- We wish to explore this phenomenon by using several principles of the SBF model (if not sufficient, we wish to extend the project into (in part) other models too)
- Going one step further – the driving ambition behind this novelty idea lies in the usefulness (perceived to us) of studying such a complex reported idea of accelerated or decelerated perception of time and the potential for mimicking it in a wakeful state (if at all, possible).

Suggested References:

1. **Matell and Meck (2004)**: Introduced the core concepts of the SBF model, explaining how the striatum integrates oscillatory cortical inputs.
2. **Buhusi and Meck (2005)**: Review of models for interval timing and temporal processing
3. Recent papers deal more with the applications of the model rather than delving deeper into the basics unlike the seminal or foundational papers afore-mentioned. We might therefore look at the recent papers on the go – especially while building onto the project/expanding it.