The Connectome Project - 2020

Brain And Cognitive Society
Indian Institute of Technology, Kanpur

INTRODUCTION

One of the most complex and least understood organs in the body is the brain. We do know its main components which are primarily neurons which are connected to each other via synapses. However, the wonder of the brain not lies in what a single neuron can do but based on what the brain achieves as a result of collaboration of thousands of neurons in networks.

A connectome is a structural and functional map of the brain. On a expansive and huge scale, developing a human connectome will be the next big thing in the medical industry, diagnosing various diseases, behavioural and mental and in the (data) analysis of the plethora of data our brains collect every waking and sleeping second - a complete new way to look at neuroscience.

This project seeks to understand the what the connectome is and develop the modern tools required to study it. Through this project, we have looked at various the biological organization of neurons and the higher structures they form. We have looked into various neuroimaging techniques that are involved. We also looked into the auditory system in humans; the visual system in insects, and in more detail the olfactory system in Drosophila.

We have modelled the Drosophila olfactory system (Mittal et al.) and have tried to show that identification of odors need not be a feature that is learnt.

OBJECTIVE

a) To explore the emerging field of connectomics.
b) To learn about the various techniques used in modern Neuroscience.
c) To confirm that MBON responses were stereotyped in a modified (and unreal) network with identical connections between PNs and KCs across individuals
d) To verify that stereotypy was not seen in the MBON response if the PN responses in the two individuals were made non-stereotypic
e) Analyze the real network with non-stereotypic PN-KC connections and stereotypic PN responses across individuals

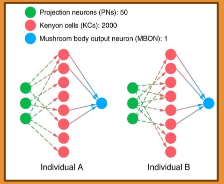

Fig: This is the proposed model for the simulation. There are 50 Projection Neurons (PN). 2000 Kenyon Cells (KC) and one output MBON Cell

RESULTS

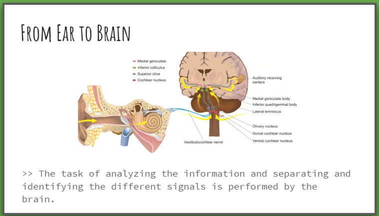

Fig: A slide from one of the presentations made discussing the route taken by information as it travels from the outer ear and is tranced into neural signals by the cochlea in the inner ear. Followed by the route taken to the temporal lobe via the midbrain

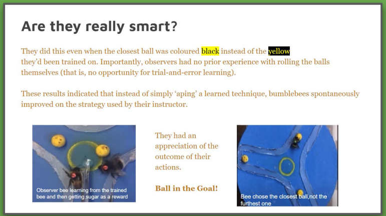

Fig: A slide from one of the presentations made discussing the various ways in which bumble bees discriminate targets based on the contrasting colours and various patterns.

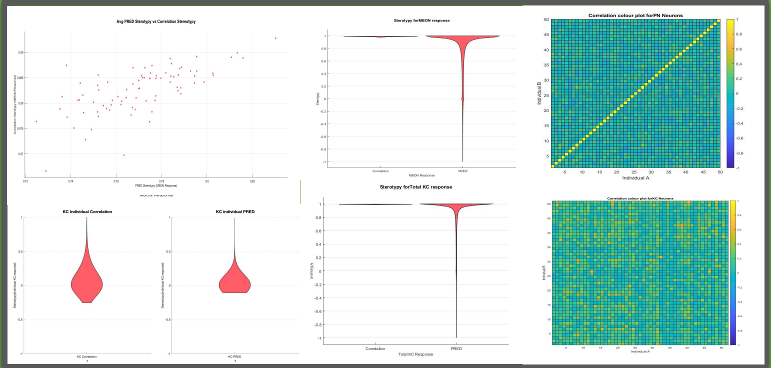

Fig: Even with the random connections, the MBON showed a surprisingly high stereotypy: correlation stereotypy was 0.98 and PRED stereotypy was 0.80 , with both metrics behaving similarly (Pearson correlation, r = 0.57). These values are higher than experimentally measured values of stereotypy probably because biological and experimental noise reduces stereotypy. For more details, please find more details on the github repository.

METHODS

Literature Reviews:	Understanding the concept of the connectome.
Two layer ANNs:	Understanding models of networks.
Presentation:	The Insect Visual System.
Presentation:	The Human Auditory System.
Flow Chart:	Neural Maps and Wiring Diagrams.
Course:	Fundamentals of Neuroimaging.
Course:	Academic Information Search.
Presentation:	The Drosophila Olfactory System.
Course:	Learning basics of MATLAB.
Coding:	Running simulation of Drosophila Olfactory System

REFERENCES

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