Usage Report for Fiscal Year 2023

Project Title: The neural mechanism of vision and memory in the human brain and network analysis of fruit fly connectome

Name:

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1. Background and purpose of the project, relationship of the project with other projects

In the current project, we aim to investigate the role of prefrontal cortex (PFC) in visual perception using neuroimaging and tools from machine learning models such as deep convolutional neural networks and generative adversarial networks. In addition, we aim to study the fruit fly brain connectome using network analysis. The PFC has been found to be critical for conscious perception and high-level cognition (such as cognitive control, planning). The dysfunction of it has also been implicated in a variety of psychiatric disorders, most notably in schizophrenia. Cracking the computational codes employed by the PFC will be an important step towards understanding how the brain works. Finally, understanding the network structure of the fruit fly brain would also enable us to know more about the human brain network.

2. Specific usage status of the system and calculation method

In FY 2023, we primarily used Hokusai for two lines of work :

2.1 Identifying the images that will activate PFC within individuals [PFC-DNN project]

For this project, we used Hokusai for: storing the data/DNN models, extracting activations from DNNs, building regression models, running permutation tests and conducting additional analyses to identify the most PFC-activating images. Since last FY, we have expanded the project to a new fMRI dataset. .

2.2 Investigating how the PFC contributes to visual illusion in the visual periphery [PFC-peripheral vision project]

For this project, we used Hokusai for running permutation tests.

Collectively, these two projects used ~1,096,000 hours on bwmpc and ~14690 hours on gwacsl (for manipulating large matrices).

3. Result

3.1 PFC-DNN project

We found that there more substantial individual differences across individuals in terms of which images tend to activate their PFC compared to those that tend to activate the visual regions.

4. Conclusion

Collectively, the results above highlight the critical role of PFC in visual perception, a previously underappreciated aspect of PFC functioning.

5. Schedule and prospect for the future

For the PFC-DNN project, we are moving onto collecting fMRI data at RIKEN to further validate our findings. We already presented these findings internally within RIKEN several times and will present them at international conferences in 2024.

6. If no job was executed, specify the reason.

Not applicable.

Fiscal Year 2023 List of Publications Resulting from the Use of the supercomputer

[Oral presentation]

Lin, Q. & Lau H. (July 2023) Individual Differences in Prefrontal Coding of Visual Features. Invited talk given at RIKEN AIP.

Lin, Q. & Lau H. (October 2023) Individual Differences in Prefrontal Coding of Visual Features. RIKEN CBS Young Investigator Seminar.

Lin, Q. & Lau H. (November 2023) Individual Differences in Prefrontal Coding of Visual Features. RIKEN CBS Retreat.