Usage Report for Fiscal Year 2022

Project Title:

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

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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 human brain network.

2. Specific usage status of the system and calculation method

In FY 2022, we primarily used Hokusai for two lines of work :

2.1 Predicting how the PFC will respond to novel images using deep neural networks (DNN) [PFC-DNN project]

For this project, we used Hokusai for: storing the data/DNN models, extracting activations from DNNs, building regression models and running permutation tests.

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 ~1,500,000 hours on bwmpc and ~7000 hours on gwacsl (for manipulating large matrices).

3. Result

3.1 PFC-DNN project

We found that we can indeed predict how a human observer's PFC will respond to a new image by just identifying the relevant features in the image without actually measuring their brain activity.

3.2 PFC peripheral vision project

We found that PFC activity predicts whether a participant experiences a visual illusion in the periphery.

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 the next stage of generating images to maximally engage the PFC using generative neural networks. We expect to have results worthy of publication in 6 months.

For the PFC peripheral vision project, we will use the cluster for additional permutations tests to establish the statistical reliability of our results.

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

N/A