The great crossword: Potential for rapid progress in understanding the function of the entire brain

Introduction

- Previous studies focus on particular regions of the brain to understand its functions
- However, the functional decomposition approach [Yamakawa, 21] is also important in that function of a brain region should be allocated from the entire brain function

SCID (Structure-Constrained Interface Decomposition) method [Yamakawa 21]

1. Anatomical structures around the brain region of interest (ROI) are investigated and registered as Brain Information Flow (BIF)
2. A valid ROI and the top-level function (TLF) it performs are determined
3. Possible HCDs (Hypothetical Component Diagrams) are listed and HCDs that are inconsistent with scientific findings are dismissed

In the latter part of problem solving, allocating should rapidly progress

- Allocatable contents for one structure get restricted as the contents are allocated to the peripheral structure
- At the point of the allocating progress, the allocatable contents drastically decreases

Summary

- The functional decomposition approach [Yamakawa, 21] is important in that function of a brain region should be allocated from the entire brain function
- In this approach, as the function allocation proceeds,
  - The constraints on possible function allocation pattern become stronger
  - The allocation problem becomes easier to be solved just like a crossword puzzle

Correspondence between Crossword Puzzle Solving and Designing Reference Architecture of the Brain

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In “Crossfunction” puzzle

- Number of brain region with its function uniquely allocated
- The degree of freedom of allocatable function

Discussion

ROI and TLF is set from the HCDs creator’s own perspective. It causes the problem of integration of HCDs created separately. In this point, we would like to discuss:

1. How should we determine ROI and its TLF?
2. Is it possible to integrate HCD created in a distributed manner (see also: Functional composition problem)?

Functional composition problem

- (Sub)functions of brain regions are determined under the functional decomposition of TLF (e.g. horizontal saccade)
- However, it does not guarantee that the function of a region should be same if allocated by decomposition of the higher function (e.g. “eye movement”, or “visual” attention)

References:

Yamakawa, H.: The whole brain architecture approach: Accelerating the development of artificial general intelligence by referring to the brain, Neural Network, 144, 478–495 (2021)

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