Assessing Anatomical Connectivity in Motor Cortex

Trung Le
Advisor: Steven M. Chase
Center for the Neural Basis of Cognition, Carnegie Mellon University

Motivation

- A neural network's computation is determined by its connectivity.
- However, anatomical connectivity is difficult to identify in extracellular recordings, since experiments usually do not last long enough to gather sufficient amounts of neural data.
- Here we leverage chronic multielectrode array recordings and techniques for tracking neurons over days to analyze anatomical connectivity in the motor cortex of Rhesus macaques.

Method

- Two monkeys were trained to perform a 2D center-out cursor movement task using a brain-computer interface.
- Spiking trains of neurons were recorded while monkey performed the task. Activities of a subset of neurons were used to push the cursor [1]. We call these neurons "direct units", and the rest "indirect units".
- Cross-correlogram (CCG) are constructed for each unit pair [2].
- Units are tracked between two consecutive days by investigating waveforms and pairwise cross-correlograms [2].

Analyses

- Probability of connection for pairs of different types implies that direct units are more likely to have anatomical connections among themselves.
- Connections are not randomly distributed among pairs:
  - Probability of having connections varies among direct and indirect cells.
- Future works include:
  - Building rigorous scan test to assess certainty of pairs having connection from looking at CCG.
  - Evaluate how angular difference in preferred directions of a pair of neurons correlates with its chance to be anatomically connected.

Discussion

- Anatomical connectivity can be observed with sufficiently large neural data collected in long term experiment.
- Probability of having connections varies among direct and indirect cells.
- Future works include:
  - Building rigorous scan test to assess certainty of pairs having connection from looking at CCG.
  - Evaluate how angular difference in preferred directions of a pair of neurons correlates with its chance to be anatomically connected.

Acknowledgment

The author would like to express his sincere gratitude to Dr. Steven Chase, Xiao Zhou, Lindsay Bahureksa, and Saddhana Ravikumar for their dedicated guidance during the research. Special thanks also to CNBC and NIH for supporting this research program.

References