Take two: Integrating neuronal perspectives for richer results

July 21 2021, by Carnegie Mellon University, Department Of Biomedical Engineering

Carnegie Mellon University researchers have identified a way to bridge two neuronal approaches traditionally used in isolation, resulting in a richer understanding of neuronal activity. Credit: Melissa Neely

Every brain function, from standing up to deciding what to have for dinner, involves neurons interacting. Studies focused on neuronal interactions extend across domains in neuroscience, primarily using the approaches of spike count correlation or dimensionality reduction. Pioneering research from Carnegie Mellon University has identified a way to bridge these approaches, resulting in a richer understanding of neuronal activity.

Neurons use electrical and chemical signals to relay information throughout the body, and we each have billions of them. Understanding how neurons interact with each other is important, because these correlations influence learning, decision-making, motor control and many other functions of life.

Historically, two approaches have been used to study interactions among neurons: spike count correlation and dimensionality reduction. Spike count correlation describes pairs of neurons, whereas dimensionality reduction is applied to a population of neurons. While both the pairwise and population methods are equally valid and scientifically sound, efforts to relate the two approaches have been sparse, until now. This is the novelty of collaborative research, recently published in *Neuron*.

"What we are providing through this study is a common language and way to navigate between two approaches," says Matt Smith, an associate professor of biomedical engineering and the Neuroscience Institute. "Essentially, scientists have been speaking different dialects of the same language when it comes to neuronal research. What we've been able to show is that they're speaking the same language, and they can communicate with each other."

To build a bridge between the two approaches, the group established concrete mathematical and empirical relationships between pairwise correlation and metrics of population-wide covariability based on dimensionality reduction. Their results provide a cautionary tale that using a single statistic on its own yields a one-sided description. A fuller, more interpretable description of interactions between neurons can be gleaned by considering a range of metrics, from both approaches.

Akash Umakantha, a graduate student with the Neuroscience Institute at Carnegie Mellon University and co-first author of the paper, alongside Carnegie Mellon graduates Rudina Morina and Benjamin Cowley, uses an analogy to help explain this work and its impact.

"There are different ways of viewing the world and different ways to explain the activity of neurons in the brain," points out Umakantha. "Let's replace neurons with friends in a social network setting. In this scenario, one approach to better understanding your network would be to look at groups of two people for trends or commonalities. Another approach could be to look at everyone together. Both are equally valid, it's just that there are different ways of capturing what is going on. Leveraging the understanding from multiple vantage points, and connecting them, ultimately broadens our perspective."

In the big picture, these concepts offer broad implications and relevance to people in different neuroscience domains, who have different ways of characterizing what is going on in the brain.

"Bridging these approaches could foster more collaboration and ways to move ideas across neuroscience domains, so that we are not entrenched in one way of thinking about something," says Byron Yu, professor of biomedical engineering and electrical and computer engineering. "A better cross-fertilization of ideas ultimately benefits everyone."

More information: *Neuron* (2021).
doi.org/10.1016/j.neuron.2021.06.028

Provided by Carnegie Mellon University, Department of Biomedical Engineering