Medical Xpress

Neuroscientists use statistical model to draft fantasy teams of neurons

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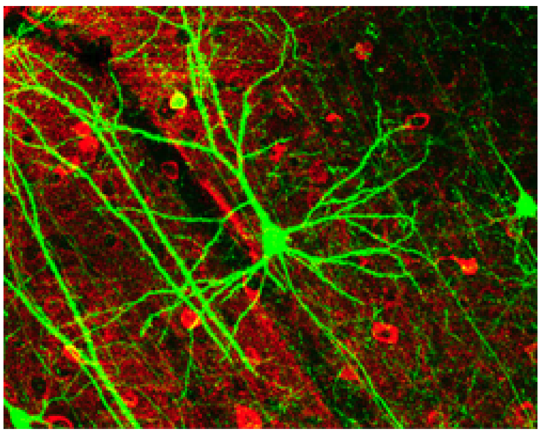

Image: PLoS Biology via Wikipedia

This past weekend teams from the National Football League used statistics like height, weight and speed to draft the best college players, and in a few weeks, armchair enthusiasts will use similar measures to select players for their own fantasy football teams. Neuroscientists at Carnegie Mellon University are taking a similar approach to compile "dream teams" of neurons using a statistics-based method that can evaluate the fitness of individual neurons.

After assembling the teams, a computer simulation pitted the groups of neurons against one another in a playoff-style format to find out which population was the best. Researchers analyzed the winning teams to see what types of neurons made the most successful squads.

The results were published in the early online edition of the *Proceedings of the National Academy of Sciences* the week of April 29.

"We wanted to know what team of neurons would be most likely to perform best in response to a variety of stimuli," said Nathan Urban, the Dr. Frederick A. Schwertz Distinguished Professor of Life Sciences and head of the Department of Biological Sciences at Carnegie Mellon.

The human brain contains more than 100 billion neurons that work together in smaller groups to complete certain tasks like processing an odor, or seeing a color. Previous work by Urban's lab found that no two neurons are exactly alike and that diverse teams of neurons were better able to determine a stimulus than teams of similar neurons.

"The next step in our work was to figure out how to assemble the best possible population of neurons in order to complete a task," said Urban, who is also a member of the joint Carnegie Mellon/University of Pittsburgh Center for the Neural Basis of Cognition (CNBC).

However, using existing methods, scouting for the best team of neurons was a seemingly daunting task. It would be impossible for scientists to determine how each of the billions of neurons in the brain would individually respond to a multitude of stimuli. Urban and Shreejoy Tripathy, the article's lead author and graduate student in the CNBC's Program in Neural Computation, solved this problem using a statistical modeling approach, known as generalized linear models (GLMs), to analyze the cell-to-cell variability. Urban and Tripathy found that by applying this approach they were able to accurately reproduce the behavior of individual neurons in a computer, allowing them to gather statistics on each single cell.

Then, much like in fantasy football, the computer model used the statistics to put together thousands of teams of neurons. The teams competed against one another in a computer simulation to see which were able to most accurately recreate a stimulus delivered to the team of neurons. In the end researchers identified a small set of teams that they could study to see what characteristics made those populations successful.

They found that the winning teams of neurons were diverse but not as diverse as they would be if they were selected at random from the general population of neurons. The most successful sets contained a heterogeneous group of neurons that were flexible and able to respond well to a variety of stimuli.

"You can't have a football team made up of only linebackers. You need linebackers and tight ends, a quarterback and a kicker. But, the players can't just be random people off of the street; they all need to be good athletes. And you need to draft for positions, not just the best player available. If your best player is a quarterback—you don't take another quarterback with your first pick," Urban said. "It's the same with neurons. To make the most effective grouping of neurons, you need a diverse bunch that also happens to be more robust and flexible than your average neuron."

Urban believes that GLMs can be used to further understand the importance of neuronal diversity. He plans to use the models to predict how alterations in the variability of neurons' responses, which can be caused by learning or disease, impact function.

More information: Intermediate intrinsic diversity enhances neural population coding, *PNAS*, www.pnas.org/cgi/doi/10.1073/pnas.1221214110

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