5 amazing visuals show how the male fruit fly’s brain map is advancing neuroscience

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A years-long project by HHMI Janelia, Google Research, and collaborators has built the first complete brain map for a male fruit fly, a key model organism in science.

For the first time, scientists have mapped every single neural connection in the brain and central nervous system of an adult male fruit fly. In this years-long project by HHMI Janelia Research Campus, Google Research, and collaborators from the scientific community, this map of the male fruit fly brain includes a record-breaking more than 166,000 neurons. It’s a big step in advancing neuroscience experiments on this key model organism.

AI is making it possible for scientists and researchers to exponentially scale projects in the field of connectomics, which precisely reconstruct the connections between brain cells. This new complete brain map, a first for a male fruit fly, builds on the earlier release of a complete female fruit fly brain map, and promises to be a foundational resource for neuroscience for years to come.

Today, we’re sharing five images from the project.

1. A record-breaking map: charting more neurons than ever before

This image shows selected neurons in the male fruit fly’s brain and ventral nerve cord, which is analogous to a spinal cord.

Like humans, flies do most of their sensing using organs located on their heads, including two huge compound eyes and a retractable proboscis that extends to detect smell and ingest liquid food. Neurons in these sensing organs detect external information and pass the signal through pathways that eventually reach the motor neurons that control movement.

2. Brain + nerve cord: Connecting sensing to actions using AI

When seen from above, the fruit fly’s massive eyes and central brain stand out. They connect via a thick cord of nerves to the body, where motor neurons control behavior. This map was created by taking thin sections of a fruit fly brain and body, imaging each slice, and then using computers and AI to combine millions of 2D images to create 3D neural shapes. Knowing the structure of the brain allows neuroscientists to understand the mechanisms behind brain function.

3. Inside the black box: Visualizing almost 11,700 types of neurons

This video shows some of the 11,691 types of neuron cells in the male fruit fly’s central nervous system, which includes the brain and ventral nerve cord. Neurons can be categorized by size, shape, function, gene expression, or other factors. This visualization begins with neurons at the core of the brain and body. It then gradually moves to outer layers and, finally, to neurons at the extremities.

Computing and AI helped human experts classify more than 166,000 neurons.

4. Vive la différence: Brain differences between male and female fruit flies

While most neurons in male and fruit females are the same, or isomorphic, a minority are sex-specific. A third category of neurons are “dimorphic,” existing in both males and females but connecting to different neighboring neurons. These neighbors may be isomorphic, the same in both male and female, or sex-specific, or even dimorphic themselves. This video shows one example, for the neural type AOTU012 (blue) that plays a role in processing sensory and taste inputs. While paired AOTU012 neurons exist in both male (left) and female (right) fruit fly brains, the AOTU012 connect to both similar (green) and different (red, orange and yellow) neurons in male and female fruit flies.

5. Fly see, fly do: Connecting stimulus to motion

The new brain map of the male fruit fly includes visual-motor pathways. These connect the visual neurons, which help the fly detect its environment, to motor neurons, which help it move in response. This video shows an example of such a pathway, going from the R1-R6 visual neurons (purple) to the DNg13 motor neuron (green). In between are several intermediate steps, including the male-specific LoVP92, named for the so-called “love spot,” that plays a role in courtship behavior.

Three companion studies also released today apply the new brain map to studying visual systems, taste, and social behavior. Read more about this groundbreaking project, and about our ongoing efforts to map full vertebrate brains, on the Neural Mapping website and in the Google Research Blog post.

https://blog.google/innovation-and-ai/technology/research/male-fruit-fly-brain-map