

Behavioral analysis of a “swimming neuron” with deep learning

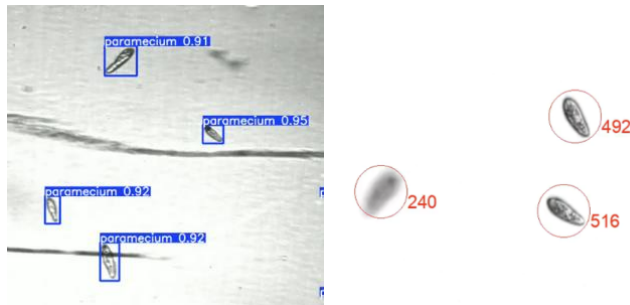
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More details: <http://romainbrette.fr/neuroscience-of-a-swimming-neuron/>

Paramecium is a unicellular organism that swims in fresh water by beating thousands of cilia. When it is stimulated (mechanically, chemically, optically, thermally...), it often swims backward then turns and swims forward again. This “avoiding reaction” is triggered by a calcium-based action potential. For this reason, some authors have called *Paramecium* a “swimming neuron” (Brette, 2021; Elices et al., 2023). *Paramecium* can adapt to changing environments and learn.

To study *Paramecium*, we perform detailed observations of behavior in various conditions. This means extracting precise individual trajectories from microscopy movies, despite collisions between individuals or with obstacles. We also want to extract 3D position as well as 3D orientations. We have started to use deep learning to localize paramecia (left) and to estimate the vertical position from the microscopy image (right):



The next challenges we want to tackle are:

- 1) Improving tracking for long-term recordings. We make recordings over several hours, where paramecia can cross or collide. The challenge is to preserve the correct identity of paramecia over long periods. Ideally, the algorithms should be able to run in real time (at least 10 Hz).
- 2) Extract the 3D orientation of paramecia. To this end, our idea is to train a network to predict the future trajectory. In this way, we can associate an expected motion vector to an image, which should correspond to its orientation.

The student will develop algorithms to address these challenges, using large databases of video recordings.

Brette R (2021) Integrative Neuroscience of Paramecium, a “Swimming Neuron.” eNeuro 8:ENEURO.0018-21.2021.

Elices I, Kulkarni A, Escoubet N, Pontani L-L, Prevost AM, Brette R (2023) An electrophysiological and kinematic model of Paramecium, the “swimming neuron.” PLoS Comp Biol