Computational Methods for Tracking, Quantitative Assessment, and Visualization of *C. elegans* Locomotory Behavior

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Abstract

The nematode Caenorhabditis elegans provides a unique opportunity to interrogate the neural basis of behavior at single neuron resolution. In *C. elegans*, neural circuits that control behaviors can be formulated based on its complete neural connection map, and easily assessed by applying advanced genetic tools that allow for modulation in the activity of specific neurons. Importantly, *C. elegans* exhibits several elaborate behaviors that can be empirically quantified and analyzed, thus providing a means to assess the contribution of specific neural circuits to behavioral output. Particularly, locomotory behavior can be recorded and analyzed with computational and mathematical tools. We built a robust single worm-tracking system, which is based on the open-source Java programming language, and an analysis system, which implements path-related algorithms. Our tracking system was designed to accommodate worms that explore a large area with frequent turns and reversals at high speeds. As a proof of principle, we used our tracker to record the movements of wild-type and other mutant type *C. elegans* and implemented mathematical models to explore how wild-type *C. elegans* change locomotory behavior is different with other mutant type over a long period of time under different food conditions. We found that the movement behavior of tph-1 mutants that lack an enzyme responsible for serotonin biosynthesis is similar to that of wild-type *C. elegans* off food. Also, we found that AIB mutant animal which interneuron plays critical roles in the processing of sensory information has dissimilar movement behavior with other mutant type.