An Iterative Neural Network Based Approach to Automated IFT-20 Sensory Neuron Identification in Caenorhabditis elegans

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Determining neuronal identity in imaging data is an essential task in neuroscience, facilitating the comparison of neuronal activity across organisms. Cross-organism comparison, in turn, enables a wide variety of research including whole-brain analysis of functional networks and linking the activity of specific neurons to observable behavior, environmental stimuli, and even neurological diseases such as Parkinson’s or Alzheimer's. The recent development of three-dimensional, pan-neuronal imaging with single-cell resolution within Caenorhabditis elegans has brought neuron identification, tracking, and activity monitoring all within reach. Neuroscience research progress is, however, impeded by the labor-intensive and error-prone manual neuron identification process. The principal barrier to automated high-accuracy identification is that in adult C. elegans, the position of neuronal cell bodies is not stereotyped. This limits state-of-the-art identification systems to under 65% accuracy. Alternate techniques leveraging multi-colored fluorescent reporters are able to slightly improve accuracy, but negatively impact the health and behavior of the organism due to excessive genetic modification. In this study, I propose an alternative neuron identification technique using only single-color fluorescent images. My machine learning based classifier design, inspired by the manual annotation procedures that humans employ, incorporates a unique iterative multi-stage neural network architecture as well as novel position and appearance-based features. The design labels IFT-20 sensory neurons in C. elegans with over 90% accuracy.

Awards Won:
Fourth Award of $500
Association for the Advancement of Artificial Intelligence: Honorable Mention (do not read aloud). Winners receive a student level membership. Information is included separately in the SAO Portal.
Association for the Advancement of Artificial Intelligence: AAAI Student Memberships for each finalist that is part of the 1st, 2nd, and 3rd Prize Winning projects and 5 Honorable Mention winning projects (up to 3 students per project) (in-kind award / part of the 1st-3rd prize)