

Computational Modeling of Odor-Associated Avoidance in Fruit Flies Using Cybernetic

Automata

Abstract

To study memory and decision-making, it is essential to understand how animals learn from their environment. Insects such as the fruit fly (*Drosophila melanogaster*) have been widely used to explore the neural and behavioral mechanisms of classical conditioning. However, replicating these learning processes with a machine learning model-based experiment allows testing hypotheses that would be difficult to examine experimentally. This project focuses on validating a cybernetic automata model—a system that learns and adapts through feedback, mimicking natural intelligence based on cognitive science—by demonstrating that it can reproduce behavioral patterns in fruit flies. In this context, CS1 (Conditioned Stimulus 1) and CS2 (Conditioned Stimulus 2) represent attractive odors to the fly, while UCS (Unconditioned Stimulus) refers to an electric shock. The model encodes innate avoidance of the electric shock and learns to associate it with either or both odors over repeated trials, replicating experimental protocols in behavioral neuroscience. Using this simulation, I tested populations of virtual fruit flies and found that the model exhibits avoidance patterns for CS1 and CS2 odors similar to those reported in biological experiments.