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Leveraging low dimensionality and stereotypy in the study of C. elegans behavior

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The roundworm, *C. elegans* is a relatively simple organism with only 300 neurons but can generate complex adaptive behavioral responses to a wide range of sensations including taste, touch, and temperature. One of the grand goals in neuroscience is to understand how neural, genetic, and biochemical circuits produce these behaviors. While a great deal of work has been done on developing tools to perturb and measure circuits underlying sensory behavior, advances in the study of behavior itself has lagged behind. Here I will describe some attempts to close this gap with focus on *C. elegans* locomotion and its response to thermal stimuli. We've developed simple desktop experiments to programmatically stimulate *C. elegans* and quantitatively capture its behavioral response. Using these data we have shown that *C. elegans* moves through a "shape space"that is low dimensional in which four dimensions capture approximately 95% of the variance in body shape. Here I will give two examples of modeling that take advantage of this low dimensionality and stereotypy. In the first we show that stochastic dynamics within this shape space predicts transitions between attractors corresponding to abrupt reversals in crawling direction. With no free parameters, our inferred stochastic dynamical system generates reversal timescales and stereotyped trajectories in close agreement with experimental observations. In the second we model the worm's perception to "thermal pain"allowing us to infer perceived stimulus from careful measurement of the worm's "body language."

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