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"Minimalist Bio-Inspired Strategies for Adaptive Robot Control"

Enabled by rapid advances in underlying technologies, autonomous robots are becoming ever more complex as we try to equip them for the challenges and uncertainties of the real world. This approach has led to some truly remarkable robots, like the advanced humanoids that competed in the recent DARPA Robotics Challenge. However, the complexity of these robots makes them extremely expensive, so it's hard to imagine them being economically viable outside a few niche applications. But could there be another way?

In nature, despite the evolution of highly complex organisms like humans, relatively simple solutions are still just as viable. Insects, worms and bacteria hold their own in the cut-throat game of life and are, by most metrics, more successful than mammals. This talk will describe a body of work that pushes the limits of minimalism in robot control strategies by drawing inspiration from one of the world's simplest multicellular animals, *Caenorhabditis elegans*.

C. elegans is a highly successful free-living nematode worm, about 1mm long, that can be found on most continents living in soil or rotting plant matter. It is also one of the most widely studied model organisms thanks to several useful features including qualitative similarity to higher organisms, relative anatomic simplicity and conduciveness to genetic manipulation. As a result, its anatomy and most of its behaviours have been very well characterised. These behaviours include adaptive serpentine locomotion, goal-directed navigation, learning, threat avoidance, and even rudimentary social behaviour. What is particularly remarkable is that all these behaviours are controlled by a nervous system consisting of only 302 neurons. The fact that the worm must make do with such limited computational resources means that the control strategies underlying its behaviours are simple, elegant and extremely efficient.

The first part of the talk will describe a biologically realistic neural mechanism that was implemented on a physical robot and resulted in robust, snake-like undulatory locomotion which adapts to external constraints. The second part describes ongoing work that uses an abstract model of *C. elegans* chemotaxis to control simulated robots that forage solar energy to recharge their batteries. The governing parameters are optimised using evolutionary algorithms, and the "genotypes" that emerge under different environmental conditions are compared.