Automatic generation of controllers for embodied legged organisms: A pareto evolutionary multi-objective approach

Abstract

In this paper, we investigate the use of a self-adaptive Pareto evolutionary multi-objective optimization (EMO) approach for evolving the controllers of virtual embodied organisms. The objective of this paper is to demonstrate the trade-off between quality of solutions and computational cost. We show empirically that evolving controllers using the proposed algorithm incurs significantly less computational cost when compared to a self-adaptive weighted sum EMO algorithm, a self-adaptive single-objective evolutionary algorithm (EA) and a hand-tuned Pareto EMO algorithm. The main contribution of the self-adaptive Pareto EMO approach is its ability to produce sufficiently good controllers with different locomotion capabilities in a single run, thereby reducing the evolutionary computational cost and allowing the designer to explore the space of good solutions simultaneously. Our results also show that self-adaptation was found to be highly beneficial in reducing redundancy when compared against the other algorithms. Moreover, it was also shown that genetic diversity was being maintained naturally by virtue of the system's inherent multi-objectivity.