Evolutionary multi-objective optimization for automatic synthesis of artificial neural network robot controllers

Abstract

This paper investigates the use of a multi-objective approach for evolving artificial neural networks that act as controllers for the legged locomotion of a quadrupedal robot simulated in a 3-dimensional, physics-based environment. The Pareto-frontier Differential Evolution (PDE) algorithm is used to generate a Pareto optimal set of artificial neural networks that optimize the conflicting objectives of maximizing locomotion behavior and minimizing neural network complexity. In this study, insights are provided on how the controller generates the emergent walking behavior in the creature by analyzing the evolved artificial neural networks in operation. A comparison between Pareto optimal controllers showed that ANNs with varying numbers of hidden units resulted in noticeably different locomotion behaviors. It was also found that a much higher level of sensory-motor coordination was present in the best evolved controller.