

Title

Abandoning Objective Abandoning Objectives: Evolution Through
Through the Search for Novelty Alone

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Introduction

- ▶ Discusses algorithms used for evolutionary computation (EC).
- ▶ Previous approaches primarily used objective functions.
 - ▶ Example: Chinese finger trap
 - ▶ Problem: Only finds local optima (deception)
- ▶ New Idea: Search for novelty instead.
 - ▶ Completely ignores the objective
- ▶ How can we use these approaches to model evolution?
- ▶ Main idea: The objective function isn't as perfect as we used to think, sometimes novelty functions work better.



Figure 1: Chinese Finger Trap

Background

- ▶ Deception – when lower-order building blocks are combined and don't lead to a global optimum.
 - ▶ Multi-Objective Evolutionary Algorithms can sometimes fight deception by training against multiple objectives.
 - ▶ Incremental evolution of objective functions can also help
 - ▶ Implies the need to track the “stepping stones” that lead to the objective
- ▶ Selection pressure restricts the scope and direction of search
- ▶ NeuroEvolution of Augmenting Topologies (NEAT)
 - ▶ Evolves artificial neural networks
 - ▶ Complexifies the network over generations

The Search for Novelty

- ▶ Learning method is rewarded finding instances that are significantly different from any found before
- ▶ Biped locomotion example:
 - ▶ Novelty function would reward falling in new ways (maybe eventually walking)
 - ▶ Objective function would reward falling the furthest
- ▶ Novelty search is different from exhaustive search
 - ▶ Domain typically limits the variety of behaviors
 - ▶ Since NEAT starts simple and complexifies, it is much better than random.

Novelty Search Algorithm

- ▶ Replace objective function with novelty function in NEAT
- ▶ Characterize how far new result is from all previous results
 - ▶ Average distance to k -nearest neighbors
- ▶ Still needs to check distance to objective to know when to stop

Experiment 1

► point

Biped Experiment

- ▶ A more challenging problem than the Maze Problem
- ▶ Robot needs to walk as far as possible in given time
 - ▶ 6 DOF – pitch and roll in each hip, pitch in knee
- ▶ Novelty metric: each second, sample the offset of the center of mass
- ▶ Average distance traveled for:
 - ▶ Objective Function: 2.88 meters
 - ▶ Novelty Function: 4.04 meters
- ▶ The novelty function produced models that were significantly less complex
- ▶ Video

Discussion/Conclusion

- ▶ point