

# 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 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