Sexual Selection through Mate Choice in Evolutionary Computation

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Outline

Introduction

Sexual Selection

Sexual Selection in Evolutionary Computation

Previous Work

Future work

Questions
Introduction

Darwin’s theory of Natural Selection

- Competition within or between species affecting its individuals relative rate of survival
- 1859 - *On the Origin of Species through Natural Selection*

Darwin’s theory of Sexual Selection

- Competition within species affecting its individuals relative rate of reproduction
- 1871 - *The Descent of Man and Selection in Relation to Sex*
Introduction

Why the need of a second theory?

Some traits add nothing to survivability

- They must bring evolutionary advantage
Synthesis

- Natural Selection causes the adaption of species to their environment
- Sexual Selection causes the adaption of each sex in relation to the other
  - Individuals struggle for access to those of the opposing sex
  - The feedback loop between female mating preferences and male ornaments guides evolution

Failing does not mean death but few or no offspring
Sexual Selection

The road to acceptance

- Sexual Selection remained in the shadows for nearly 100 years
- Discussion was relaunched in the 1970s by Fisher and Zahavi
- The theory has reached high acceptance across many research fields

In Evolutionary Computation

- Traditional approaches rely on reproduction of the fittest rather than reproduction of the sexiest
- Sexual Selection has yet to find its place
Sexual Selection in Evolutionary Computation

Motivation

- Sexual Selection has proven to have a great importance in evolutionary theory

Scope

- Male Competition vs. Female Mate Choice
- Rules for modeling Mate Choice:
  - Individuals choose their mating partners
  - Mating preferences are heritable
  - Introduces its own selection pressure
  - It’s subject to selection pressure itself
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Working Hypothesis

- Sexual Selection through Mate Choice may be used to enhance the performance of Evolutionary Algorithms on various contexts

Research questions

- What are good design choices?
- How does it influence the behaviour of Evolutionary Algorithms?
- Is there any relation with natural behaviours and theorems?
Previous Work

1: parent1 = parent_selection(pop)
2: candidates = mating_candidates_selection(pop)
3: evaluate_mating_candidates(parent1,candidates)
4: parent2 = select_best(candidates)

Figure: Parent selection through Mate Choice

Reproductive success is determined by attractiveness

Feedback loop

- Traits giving evolutionary advantage cause preferences to evolve accordingly
- Preferences giving evolutionary advantage cause traits to evolve accordingly
Previous Work

Circle Packing in Squares

Figure: Optimal packing of 9 circles in a square

Figure: Representation of optimal packing of 9 circles in a square and possible fitness indicators
Previous Work

Two approaches

Genetic algorithms

- Preferences encoded as an array of weights
- Weights evolve as a second chromosome

\[ MatingFitness^{mc} = \sum_{k=2}^{n} w^p_k F_{k}^{mc} \]
Previous Work

Genetic programming

```
fitness(5)

+   fitness(2)
   /  
  -   fitness(5)
   /   
  *   fitness(4)
   /   
  2   fitness(5)
```
Future work

Five main tasks

- Continuously review the literature
- Develop a framework
  - Support different design choices
  - Apply to Morse Clusters Optimization
- Tackle a test set of hard optimization problems
  - Assess the performance of the approaches
  - Gather information regarding behaviour
  - Study the effects of Mate Choice
- Gradually adapt the framework toward its generalization
- Disseminate the results
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