

# Sexual Selection through Mate Choice in Evolutionary Computation

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# Outline

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Sexual Selection in Evolutionary Computation

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# 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?

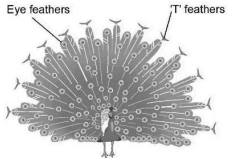


Fig. 116.—Skeleton of the "Black Elk" (Cervus nigrescens).  
From Thomas, 1891.

Some traits add nothing to survivability

- ▶ They must bring evolutionary advantage

# Sexual Selection

## 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

# Sexual Selection in Evolutionary Computation

## 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

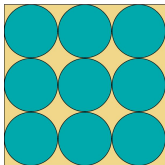
Reproductive success is determined by attractiveness

Feedback loop

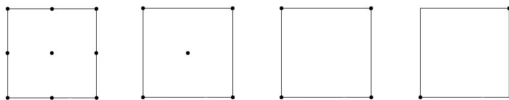
- ▶ Traits giving evolutionary advantage cause preferences to evolve accordingly
- ▶ Preferences giving evolutionary advantage cause traits to evolve accordingly

# 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

Two approaches

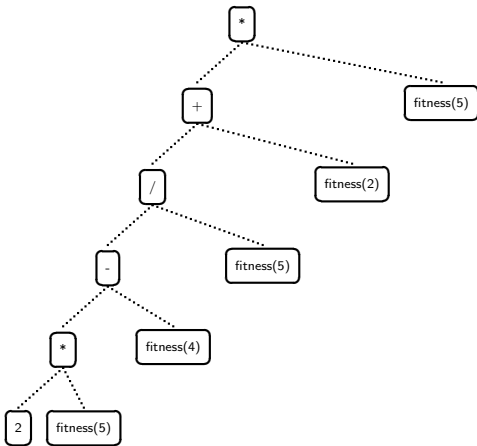
Genetic algorithms

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

$$MatingFitness^{mc} = \sum_{k=2}^n w_k^p F_k^{mc}$$

# Previous Work

## Genetic programming



# Future work

## Five main tasks

- ▶ Continuously review the literature
- ▶ Develop of 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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