Theory and Applications of Bio-inspired Algorithms

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Markus Wagner

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Thesis advisors:
Associate Prof. Frank Neumann
Prof. Zbigniew Michalewicz

Markus Wagner

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Abstract

Evolutionary algorithms, which form a sub-class of bio-inspired algorithms, mimic some fundamental aspects of the neo-Darwinian evolutionary process. They simultaneously search with a *population* of candidate solutions and associate an objective score as a fitness value for each one. The algorithms then select among the population to favour those solutions that are more fit. The next generation (i.e. a new population) consists of replicates of the fitter solutions that have been *genetically mutated and crossed over* in a biological metaphor: the decision variables were perturbed such that they inherit characters of their *parents*, as well as change in random ways.

For the past decades, the algorithms' success has led to strongly practical-oriented interests. Although the theory of them is far behind the knowledge gained from experiments, there are theoretical investigations about some of their properties. This thesis spans theoretical investigations, theory-motivated algorithm engineering, and also the real-world application of evolutionary algorithms.

First, we analyse different algorithms that work with solutions of variable length. We show theoretically and experimentally that certain design choices can have drastic impacts on the ability of an algorithm to find optimal solutions.

Second, motivated by recent theoretical investigations, we design a framework for solving problems with conflicting objectives. We demonstrate that it can efficiently handle problems with many such objectives, which most existing algorithms have difficulties dealing with.

Finally, we consider the problem of maximising the energy yield of wind farms. Our problem-specific algorithm achieves higher quality results than existing approaches, and it allows for an optimisation within minutes or hours instead of days or weeks.

Contents

Listing of Figures

List of Tables

List of Algorithms

Statement of Originality

I certify that this work contains no material which has been accepted for the award of any other degree or diploma in any university or other tertiary institution and, to the best of my knowledge and belief, contains no material previously published or written by another person, except where due reference has been made in the text. In addition, I certify that no part of this work will, in the future, be used in a submission for any other degree or diploma in any university or other tertiary institution without the prior approval of the University of Adelaide and where applicable, any partner institution responsible for the joint-award of this degree.

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To my loving parents, and my beloved family.

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