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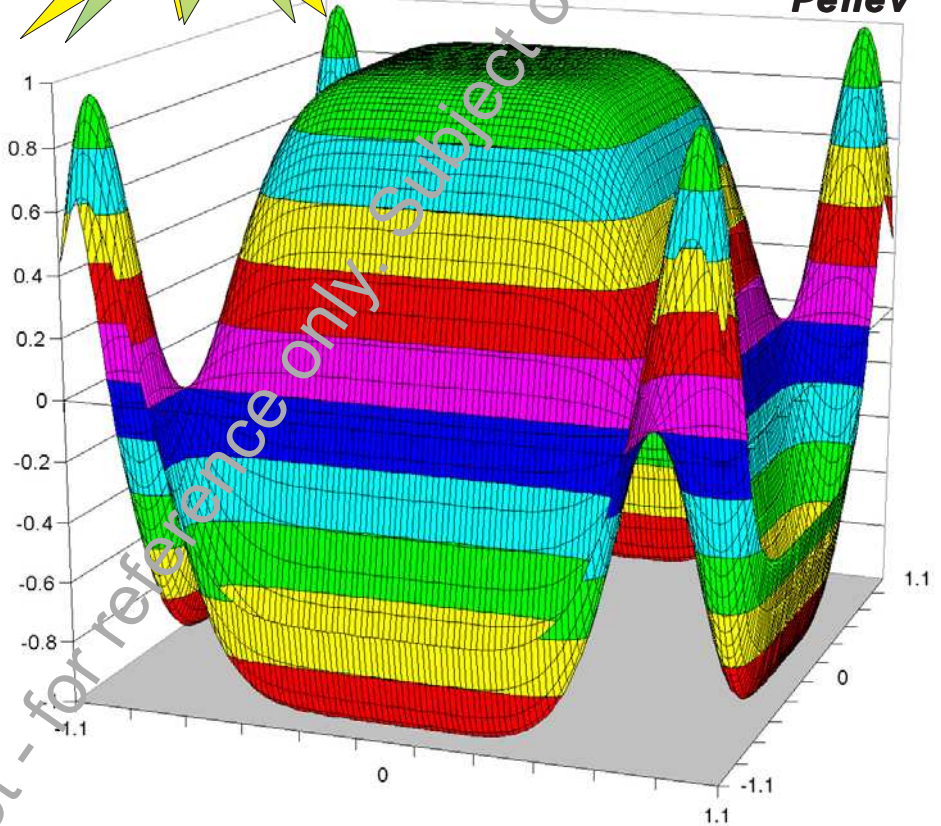
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Free search of real value

or how
to make
computers
think

**Kalin
Penev**



MMVIII

Kalin Penev

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or
how to make computers think**

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MMVIII

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Free Search of real value or how to make computers think

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In memoriam of

my mother
Victoria
Georgieva
Chouroulinkova

my father
Stanoy
Dimitrov
Penev

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With great respect to my grandfather Dimitar Penev, who first showed me the game of the digits.

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If you don't understand it you can learn it,
and may understand it later.

Preface

From the Editor

This book introduces in detail Free Search - a novel advanced method for search and optimisation. It also deals with some essential questions that have been raised in a strong debate following the publication of this method in journal and conference papers. In the light of this debate, Free Search deserves serious attention, as it appears to be superior to other competitive methods in the context of the experimental results obtained. This superiority is not only quantitative in terms of the actual optimal value found but also qualitative in terms of independence from initial conditions and adaptation capabilities in an unknown environment.

The book reviews a wide range of search and optimisation methods – something not be found in most publications in the field, which tend to be more focused and specialised. In addition, the book investigates a number of standard test problems using advanced graphical tools. The main value of this work, however, appears to be in the rich collection of ideas that advance the current stage of knowledge in the area of adaptive heuristic methods for search and optimisation. In this context, the book also contributes to the modelling of the thinking process that is likely to become the subject of extensive research in the near future and the vehicle for building intelligent systems.

The presented experimental results seem to be better than the results available in the search and optimisation literature. They also raise fundamental questions about the nature and the capabilities of Free Search. Conceptual analysis discusses the original ideas implemented in this novel method as well as how they affect its performance and relate to existing knowledge and theory in heuristic, evolutionary and bio-inspired computational methods.

This work explores the suitability of the Free Search method for unknown constrained optimisation problems, in what way the new concepts lead to better performance and how they impact on the optimisation process. It examines how Free Search features such as uncertainty, individualism and abilities for own decision making facilitate global exploration and local search. The ability to deal successfully with hard tests, similar to real-word problems, can be a good indicator for reliability of search methods. In this context, the stable and robust behaviour of Free Search indicates that it can support and

benefit significantly optimisation of a wide range of problems in business, finance, engineering, design and science.

The book is aimed primarily at undergraduate and postgraduate students as well as researchers in academia and industry who have special interest in search and optimisation methods, evolutionary and adaptive computing, and advanced process modelling. However, it is written in a flexible style that combines the features of a specialised research monograph and a general purpose textbook. This makes the book also suitable for reading by less specialised audience with general interest in cognitive science and artificial intelligence.

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Abbreviations

ACO - Ant Colony Optimisation

ASA - Adaptive Simulated Annealing

BGA - Breeder Genetic Algorithm

CMA ES - Covariance Matrix Adaptation Evolution Strategy

DE - Differential Evolution

ES - Evolution Strategy

EA - Evolutionary Algorithms

EP - Evolutionary Programming

FS - Free Search

GA - Genetic Algorithm

GA BLX α - Genetic Algorithm Blend Crossover α

GP - Genetic Programming

MSHC – Multi Start Hill Clumber

PAS - Pure Adaptive Search

PSO - Particle Swarm Optimisation

PBIL - Population Based Incremental Learning

RTS - Reactive Tabu Search

SA - Simulated Annealing

vmCOGA -variable mutation Cluster Oriented Genetic Algorithm

TS - Tabu Search

Chapter 1. Introduction

This book is dedicated to adaptive methods for search and optimisation and some nonconventional understanding of computers abilities.

This chapter briefly introduces some population-based evolutionary algorithms. It states accepted definitions of terms and notions used in the study.

1.1. Role of search and optimisation methods in the modern world

Mathematical optimisation deals with the problem of finding (or approximating) a point that gives an optimal (minimal or maximal) value to some function (called objective function), subject to some additional conditions (called constraints) [Censor 2000].

Many problems in various scientific and technological fields, such as engineering, physics, chemistry, economics, business, finance, and operations research, can be classified as optimisation problems and thereby benefit from and contribute to the knowledge of mathematical optimisation.

In this area numerical analysis, computational methods, and other branches of mathematics, as well as the study of practical applications, interact each with other and promote an understanding and ability to solve concrete problems [Censor 2000].

Complex problems, which cannot be described and solved by analytical, deterministic rules, are a subject of heuristic optimisation methods. A development of heuristic optimisation concepts and algorithms is a research challenge for modern Computer Science. Problems, which involve global optimisation over continuous spaces, are ubiquitous throughout the scientific community [Storn and Price 1995]. "Still, no algorithm can solve evidently a general, smooth global optimisation problem with certainty in finite time therefore stochastic methods are of eminent importance in global optimisation." [Guus and Boender, 1995]

This study is grounded on the idea to try to improve the process of search, for example, by adaptive modification of the values of strategy parameters during the run of the algorithm.

"It is possible to do this by using heuristic rules, by taking feedback from the current state of the search, or by employing some self-adaptive mechanism" [Hinterding et al.,1997].

A general objective of investigation is improvement of the heuristic methods for search and optimisation.

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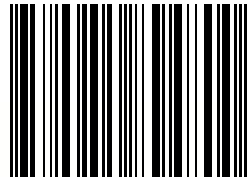
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