

Kaveh Sheibani, PhD

# Fuzzy Greedy Search in Combinatorial Optimisation

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INSTITUTE FOR OPERATIONAL RESEARCH,  
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## Preface

The idea of reporting my research work within this monograph came to light during the viva voce examination of my PhD thesis entitled “Fuzzy Greedy Evaluation in Search, Optimisation and Learning” in London Metropolitan University, UK. This original research work, which culminated in 2005, formed the basis of emerging a new approximation method for hard combinatorial optimisation problems.

In recent years, there has been a growth of interest in the development of systematic search methods for solving problems in operational research and artificial intelligence. Metaheuristics that are employed as strategies in optimisation are a fairly young research field. They are approaches that organise an interaction between solution improvement procedures and higher-level tactics in order to create a process capable of escaping from premature local optima and performing a robust search of a solution space. A metaheuristic can be viewed as a generic approach, for a type of hard optimisation problem. It is applicable to a wide set of different optimisation problems, with relatively few modifications needed to apply it to a specific problem. A much newer area of research is the hybridisation of metaheuristics. It has become evident that a skilled combination of general ideas from different metaheuristics can provide an efficient performance and high flexibility.

The use of search techniques on a solution space are central to the design of metaheuristics. Indeed, adopting a robust search technique significantly improves the overall performance. In this monograph, we introduce a new idea for the integration of approaches for hard combinatorial optimisation problems. The proposed methodology evaluates objects in a way that combines fuzzy reasoning with a greedy mechanism. In other words, we exploit a fuzzy solution space (fuzzy set) using greedy methods. Our methodology also attempts to adapt its knowledge from previous experiments, thereby improving the exploration of the promising areas of the search space. The effectiveness and efficiency of this so-called fuzzy greedy evaluation concept are investigated within search, optimisation and learning systems for hard combinatorial optimisation problems.

For this purpose, the travelling salesman problem (TSP) and the flow-shop scheduling problem (FSP) have been selected for investigation as two

of the most widely studied problems in the field of combinatorial optimisation. In this context, we have developed a hybrid metaheuristic, which is a combination of a genetic algorithm (GA) and greedy randomised adaptive search procedures (GRASP), for the TSP, a heuristic for the FSP, and a hybrid GA for the FSP. Computational experiments gave very promising results. These were competitive with the results obtained by other researchers. In addition, the heuristic for the FSP problem gave results that were, in general, superior to those obtained by the well-known NEH heuristic, which has dominated the field for many years.

This monograph consists of 6 chapters. Chapter 1 covers a basic introduction and a review and classification of metaheuristics in the solution of combinatorial optimisation problems. Chapter 2 deals with the main foundation of the text. This includes a description of the theory and mathematics of the proposed fuzzy greedy evaluation concept. Chapter 3 overviews GA and GRASP metaheuristics. Chapters 4 to 6 demonstrate, through computational experiments, the efficiency of the proposed concept in the development of approaches for the specific combinatorial optimisation problems TSP and FSP. The text contains an extensive bibliography, which covers many relevant books and significant papers. Appendix A provides a short introduction to relevant graph theory. Appendix B illustrates a simple fuzzy greedy evaluation algorithm in C++ code. A glossary of key concepts and a glossary of mathematical symbols appear after the Appendices to help the reader to quickly find the meaning of a concept or a symbol.

I am very grateful to all those who have helped with the writing and production of this monograph. I should like to express my gratitude to Ben Atkinson for his advice and assistance throughout this research.

**Kaveh Sheibani**  
November 2007, Tehran

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