

Preface

This book describes how evolutionary algorithms (EA) such as genetic algorithms (GA) and particle swarm optimization (PSO) can be used for solving multi-objective optimization problems in the area of embedded and VLSI systems design. This book is written primarily for practicing CAD engineers and academic researchers who wish to apply evolutionary techniques and analyze their performance in solving multi-objective optimization problems in VLSI and embedded systems.

Many real engineering problems have multiple objectives, such as minimizing cost, maximizing performance, and maximizing reliability. Being a population-based approach, EA are suitable for solving multi-objective optimization problems. Research has been carried out to ascertain the capabilities of GA and PSO in solving complex and large constrained combinational optimization problems. A reasonable solution to a multi-objective problem is to consider a set of solutions, each of which satisfies the objectives at an acceptable level without being dominated by any other solution. Graph theoretic approaches and integer/linear programming have been used to solve problems in embedded and VLSI system design. GA and PSO may prove to be a general purpose heuristic method for solving a wider class of engineering and scientific problems.

Organization of the Book

This book provides an introduction to multi-objective optimization using meta-heuristic algorithms: GA and PSO and their application to problems like hardware/software partitioning in embedded systems, circuit partitioning in VLSI, design of operational amplifiers in analog VLSI, design space exploration in high level synthesis, delay fault testing in VLSI testing, and scheduling in heterogeneous distributed systems. It is shown how in each case the various aspects of the EA, namely its representation, and operators like crossover, mutation, etc., can be separately formulated to solve these problems.

The content of this book is divided into 9 chapters, and each chapter focuses on one aspect or application of EA to multi-objective optimization. Each of the chapters deals with experimental results as well as an analysis of the problem at hand.

Chapter 1 provides an introduction to multi-objective GA and PSO algorithms. The terminology of GA and PSO is introduced and its operators are discussed. Also, the variants of GA and PSO and their hybrids with hill climbing are explained.

Chapter 2 addresses the problem of hardware/software partitioning in embedded systems. It discusses how multi-objective EA can be applied to hardware/software partitioning.

Chapter 3 focuses on the problem of circuit partitioning in VLSI. It describes how the chromosome is represented in GA for the problem of circuit partitioning.

Chapter 4 explains how the design of operational amplifiers in analog VLSI can be represented as multi-objective optimization problem and how GA can be applied to solve the design of operational amplifiers.

Chapter 5 describes how multi-objective EA can be applied to the problem of design space exploration in high-level synthesis of VLSI.

Chapter 6 presents the design space exploration of datapath (architecture) in high level synthesis (HLS) for computation intensive applications.

Chapter 7 elaborates evolutionary algorithm driven high level synthesis design flow: Algorithm to RTL.

Chapter 8 deals with delay fault testing in VLSI testing. It describes how the problem of delay fault testing can be formulated as a multi-objective problem and delineates experimental results for the various crossover operators.

Chapter 9 explores how the scheduling in heterogeneous distributed system can be formulated as a multi-objective problem and the applicability of EA to the problem. Experimental results are provided for four variants of multi-objective GA and PSO.

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