Solving Traveling Salesman Problem By Using Improved Ant

One of the simplest, but still NP-hard, routing problems is the Traveling Salesman Problem (TSP). In the TSP, one is given a set of cities and a way of measuring the distance between cities. One has to find the shortest tour that visits all cities exactly once and returns back to the starting city. In state-of-the-art algorithms, they all assume that a complete graph is given as an input. However, for very large graphs, generating all edges in a complete graph, which corresponds to finding shortest paths for all city pairs, could be time-consuming. This is definitely a major obstacle for some real-life applications, especially when the tour needs to be generated in real-time. The objective, in this thesis, is to find a near-optimal TSP tour with a reduced set of edges in the complete graph. In particular, the following problems are investigated: which subset of edges can be produced in a shorter time comparing to the time for generating the complete graph? Is there a subset of edges in the complete graph that results in a better near-optimal tour than other sets? With a non-complete graph, which improvement algorithms work better? In this thesis, we study six algorithms to generate subsets of edges in a complete graph. To evaluate the proposed algorithms, extensive experiments are conducted with the well-known TSP data in a TSP library. In these experiments, we evaluate these algorithms in terms of tour quality, time and scalability.

This book and its companion volume, LNCS vol. 8794 and 8795 constitute the proceedings of the 5th International Conference on Swarm Intelligence, ICSI 2014, held in Hefei, China in October 2014. The 107 revised full papers presented were carefully reviewed and selected from 198 submissions. The papers are organized in 18 cohesive sections, 3 special sessions and one competitive session covering all major topics of swarm intelligence research and development such as novel swarm-based search methods; novel optimization algorithm; particle swarm optimization; ant colony optimization for travelling salesman problem; artificial bee colony algorithms; artificial immune system; evolutionary algorithms; neural networks and fuzzy methods; hybrid methods; multi-objective optimization; multi-agent systems; evolutionary clustering algorithms; classification methods; GPU-based methods; scheduling and path planning; wireless sensor networks; power system optimization; swarm intelligence in image and video processing; applications of swarm intelligence to management problems; swarm intelligence for real-world application.

This book is written above all for artificial intelligence directors and engineers with some experience in the field. For instance, you may be an AI executive who has no technical background or an AI engineer who has implemented several projects in the past. This book was written with you in mind. The practical tips and insight will make you more productive with regard to idea development, and more prosperous in terms of communication with other professionals. Sharing my experience in building machine learning products, I have aimed to describe sophisticated concepts in simple terms. I hope you enjoy reading this book. This book helps you: identify use-cases where AI creates value, learn fundamentals in simple words, prevent mistakes to build an AI solution, learn best practices and increase efficiency, gain insight to build innovative solutions, manage development risks and save money.

The idea behind TSP was conceived by Austrian mathematician Karl Menger in mid 1930s who invited the research community to consider a problem from the everyday life from a mathematical point of view. A traveling salesman has to visit exactly once each one of a list of m cities and then return to the home city. He knows the cost of traveling from any city i to any other city j. Thus, which is the tour of least possible cost the salesman can take? In this book the problem of finding algorithmic technique leading to good/optimal solutions for TSP (or for some other strictly related problems) is considered. TSP is a very attractive problem for the research community because it arises as a natural subproblem in many applications concerning the every day life. Indeed, each application, in which an optimal ordering of a number of items has to be chosen in a way that the total cost of a solution is determined by adding up the costs arising from two successively items, can be modelled as a TSP instance. Thus, studying TSP can never be considered as an abstract research with no real importance.

The purpose of this book is to collect contributions that deal with the use of nature inspired metaheuristics for solving multi-objective combinatorial optimization problems. Such a collection intends to provide an overview of the state-of-the-art developments in this field, with the aim of motivating more researchers in operations research, engineering, and computer science, to do research in this area. As such, this book is expected to become a valuable reference for those wishing to do research on the use of nature inspired metaheuristics for solving multi-objective combinatorial optimization problems.

Bio-inspired computational algorithms are always hot research topics in artificial intelligence communities. Biology is a bewildering source of inspiration for the design of intelligent artifacts that are capable of efficient and autonomous operation in unknown and changing environments. It is difficult to resist the fascination of creating artifacts that display elements of lifelike intelligence, thus needing techniques for control, optimization, prediction, security, design, and so on. Bio-Inspired Computational Algorithms and Their Applications is a compendium that addresses this need. It integrates contrasting techniques of genetic algorithms, artificial immune systems, particle swarm optimization, and hybrid models to solve many real-world problems. The works presented in this book give insights into the creation of innovative improvements over algorithm performance, potential applications on various practical tasks, and combination of different techniques. The book provides a reference to researchers, practitioners, and students in both artificial intelligence and engineering communities, forming a foundation for the development of the field.

This thesis presents an evolutionary algorithm (EA) to efficiently solve large instances of the time dependent travelling salesman problem (TDTSP). In this approach, the path the salesman

must follow is structured as an ordered list of cities. The path may optionally have two kinds of constraints. Precedence constraints specify that a specific city must be visited before another specific city. "Time windows" specify the time at which specific cities must be visited. This work demonstrate that EAs are more effective than traditional methods, such as linear or dynamic programming, for solving general TDTSPs of up to 50 cities. This thesis also describes an improved dynamic programming heuristic that produces better solutions in less CPU time on TDTSPs of up to 400 cities.

Stochastic local search (SLS) algorithms are among the most prominent and successful techniques for solving computationally difficult problems. Offering a systematic treatment of SLS algorithms, this book examines the general concepts and specific instances of SLS algorithms and considers their development, analysis and application.

This book brings together leading research from engineers and practitioners interested in the technical advances, business and industrial applications of intelligent systems. AIAI 2007 is focused on providing insights on how AI can be implemented in real world applications. Topics covered in this volume include: Theoretical Advances in AI; Intelligent Internet Systems: Emerging Technologies and Applications; Intelligent Systems in Electronic Healthcare; AI in Business and Finance.

Sharpen your coding skills by exploring established computer science problems! Classic Computer Science Problems in Java challenges you with time-tested scenarios and algorithms. Summary Sharpen your coding skills by exploring established computer science problems! Classic Computer Science Problems in Java challenges you with time-tested scenarios and algorithms. You'll work through a series of exercises based in computer science fundamentals that are designed to improve your software development abilities, improve your understanding of artificial intelligence, and even prepare you to ace an interview. As you work through examples in search, clustering, graphs, and more, you'll remember important things you've forgotten and discover classic solutions to your "new" problems! Purchase of the print book includes a free eBook in PDF, Kindle, and ePub formats from Manning Publications. About the technology Whatever software development problem you're facing, odds are someone has already uncovered a solution. This book collects the most useful solutions devised, guiding you through a variety of challenges and tried-and-true problem-solving techniques. The principles and algorithms presented here are guaranteed to save you countless hours in project after project. About the book Classic Computer Science Problems in Java is a master class in computer programming designed around 55 exercises that have been used in computer science classrooms for years. You'll work through hands-on examples as you explore core algorithms, constraint problems, AI applications, and much more. What's inside Recursion, memoization, and bit manipulation Search, graph, and genetic algorithms Constraint-satisfaction problems K-means clustering, neural networks, and adversarial search About the reader For intermediate Java programmers. About the author David Kopec is an assistant professor of Computer Science and Innovation at Champlain College in Burlington, Vermont. Table of Contents 1 Small problems 2 Search problems 3 Constraint-satisfaction problems 4 Graph problems 5 Genetic algorithms 6 K-means clustering 7 Fairly simple neural networks 8 Adversarial search 9 Miscellaneous problems 10 Interview with Brian Goetz

This book presents the latest findings on one of the most intensely investigated subjects in computational mathematics--the traveling salesman problem. It sounds simple enough: given a set of cities and the cost of travel between each pair of them, the problem challenges you to find the cheapest route by which to visit all the cities and return home to where you began. Though seemingly modest, this exercise has inspired studies by mathematicians, chemists, and physicists. Teachers use it in the classroom. It has practical applications in genetics, telecommunications, and neuroscience. The authors of this book are the same pioneers who for nearly two decades have led the investigation into the traveling salesman problem. They have derived solutions to almost eighty-six thousand cities, yet a general solution to the problem has yet to be discovered. Here they describe the method and computer code they used to solve a broad range of large-scale problems, and along the way they demonstrate the interplay of applied mathematics with increasingly powerful computing platforms. They also give the fascinating history of the problem--how it developed, and why it continues to intrigue us.

Still today I am receiving requests for reprints of the book, but unfortunately it is out of print. Therefore, since the book still seems to receive some attention, I p- posed to Springer Verlag to provide a free online edition. I am very happy that Springer agreed. Except for the correction of some typographical errors, the online edition is just a copy of the printed version, no updates have been made. In particular, Table 13.1 gives the status of TSPLIB at the time of publishing the book. For accessing TSPLIB the link http://www.iwr.uni-heidelberg.de/iwr/comopt/software/TSPLIB95/ should be used instead of following the procedure described in Chapter 13. Heidelberg, January 2001 Gerhard Reinelt Preface More than ?fteen years ago, I was faced with the following problem in an assignment for a class in computer science. A brewery had to deliver beer to ?ve stores, and the task was to write a computer program for determining the shortest route for the truck driver to visit all stores and return to the brewery. All my attemps to ?nd a reasonable algorithm failed, I could not help enumerating all possible routes and then select the best one.

"This book explores the recent steps forward for smart applications in sustainability"--

What is the shortest possible route for a traveling salesman seeking to visit each city on a list exactly once and return to his city of origin? It sounds simple enough, yet the traveling salesman problem is one of the most intensely studied puzzles in applied mathematics—and it has defied solution to this day. In this book, William Cook takes readers on a mathematical excursion, picking up the salesman's trail in the 1800s when Irish mathematician W. R. Hamilton first defined the problem, and venturing to the furthest limits of today's state-of-the-art attempts to solve it. He also explores its many important applications, from genome sequencing and designing computer processors to arranging music and hunting for planets. In Pursuit of the Traveling Salesman travels to the very threshold of our understanding about the nature of complexity, and challenges you yourself to discover the solution to this captivating mathematical problem.

The Traveling Salesman Problem (TSP) is widely considered one of the most intensively studied problems in computational mathematics and operations research. Since its inception, it has become the poster child for computational complexity research. A number of problems have been transformed to a TSP problem and its application base now

extends into scheduling, manufacturing, routing, and logistics. With the advent of high-performance computing and advanced meta-heuristics such as GPU programming and swarm-based algorithms, the TSP problem is positioned firmly as the go-to problem for the development of the next generation of high-performance intelligent heuristics. This book looks to leverage some of these new paradigms for both students and researchers in this field.

This book is a collection of current research in the application of evolutionary algorithms and other optimal algorithms to solving the TSP problem. It brings together researchers with applications in Artificial Immune Systems, Genetic Algorithms, Neural Networks and Differential Evolution Algorithm. Hybrid systems, like Fuzzy Maps, Chaotic Maps and Parallelized TSP are also presented. Most importantly, this book presents both theoretical as well as practical applications of TSP, which will be a vital tool for researchers and graduate entry students in the field of applied Mathematics, Computing Science and Engineering.

Annotation This book constitutes the refereed proceedings of the 7th International Workshop on Hybrid Metaheuristics, HM 2010, held in Vienna, Austria, in October 2010.The 14 revised full papers presented were carefully reviewed and selected from 29 submissions.

In recent years, the need for a review of the state of the art in Combinatorial Optimization has been felt by many scientists and researchers in the field. The opportunity of achieving this aim was offered by the Deputy Secretary General of the International Centre of Mechanical Sciences, Professor A. Marzollo, who invited the contributors of this volume to Udine for a Workshop. During the meeting the participants discussed their results and their ideas on the future developments of the various facets of this expanding area of applied mathematics. The success of the Workshop and the encouragement of the participants suggested that I collect the main contributions in the present volume. It is my hope that it may both give a sound background to people entering this fascinating area of study and stimulate further research in the field. The Editor Sergio Rinaldi LIST OF CONTRIBUTORS BARTHES, J. P. : Departement d'informatique et de Mathematiques Appli quees - Universite de Technologie de Compiegne - 60200 Compiegne, France. LAWLER, E. L. : Dept. of Electrical Engineering and Computer Science - University of California at Berkeley - U. S. A. LUCCIO, F. : Universita di Pisa - Pisa - Italy. MAFFIOLI, F. : Istituto di Elettrotecnica ed Elettronica e Centro di Telecomuni cazioni Spaziali of C. N. R. - Politecnico di Milano - Milano - Italy. MARTELLI, A. : Istituto di Elaborazione dell'Informazione del C. N. R. - Via S. Maria, 46 - Pisa - Italy.

This well-written textbook on combinatorial optimization puts special emphasis on theoretical results and algorithms with provably good performance, in contrast to heuristics. The book contains complete (but concise) proofs, as well as many deep results, some of which have not appeared in any previous books.

The Traveling Salesman Problem (TSP) has already been solved in the semi-optimal manners using the numbers of different methods. Among them, genetic algorithms (GA) are pre-dominating. This paper presents a new approach to solve this problem using the Simplified Bi-directional Associative Memory (sBAM), a type of Artificial Neural Network. To get a comparative idea of its performance, the same problem has been solved using a genetic algorithm. In this paper, performance has been analyzed of a TSP by Genetic Algorithm (GA) and sBAM. Finally we proved that sBAM provide real time highly faster nearly optimal solutions than the genetic algorithm.

The Traveling Salesman Problem is central to the area of Combinatorial Optimization, and it is through this problem that many of the most important developments in the area have been made. This book focuses on essential ideas; through them it illustrates all the concepts and techniques of combinatorial optimization concisely but comprehensively. The extensive reference list and numerous exercises direct the reader towards related fields, and give results. Each of the twelve chapters in this volume is concerned with a specific aspect of the Traveling Salesman Problem, and is written by an authority on that aspect. It is hoped, that the book will serve as a state-of-the-art survey of the Traveling Salesman problem which will encourage further investigations, and that it will also be useful for its comprehensive coverage of the techniques of combinatorial optimization.

Over two parts, this book examines the meaning of complexity in the context of systems both social and natural. Chapters cover such topics as the traveling salesman problem, models of opinion dynamics creation, a universal theory for knowledge formation in children, the evaluation of landscape organization and dynamics through information entropy indicators, and studying the performance of wind farms using artificial neural networks. We hope that this book will be useful to an audience interested in the different problems and approaches that are used within the theory of complexity

A brilliant treatment of a knotty problem in computing. This volume contains chapters written by reputable researchers and provides the state of the art in theory and algorithms for the traveling salesman problem (TSP). The book covers all important areas of study on TSP, including polyhedral theory for symmetric and asymmetric TSP, branch and bound, and branch and cut algorithms, probabilistic aspects of TSP, and includes a thorough computational analysis of heuristic and metaheuristic algorithms.

This book constitutes the refereed proceedings of the 11th International Conference on Parallel Problem Solving from Nature - PPSN XI, held in Kraków, Poland, in September 2010. The 131 revised full papers were carefully reviewed and selected from 232 submissions. The conference covers a wide range of topics, from evolutionary computation to swarm intelligence, from bio-inspired computing to real world applications. Machine learning and mathematical games supported by evolutionary algorithms as well as memetic, agent-oriented systems are also represented.

Harness the power of Scala to program Spark and analyze tonnes of data in the blink of an eye! About This Book Learn Scala's sophisticated type system that combines Functional Programming and object-oriented concepts Work on a wide array of applications, from simple batch jobs to stream processing and machine learning Explore the most common as well as some complex use-cases to perform large-scale data analysis with Spark Who This Book Is For Anyone who wishes to learn how to perform data analysis by harnessing the power of Spark will find this book extremely useful. No knowledge of Spark or Scala is assumed, although prior programming experience (especially with other JVM languages) will be useful to pick up concepts quicker. What You Will Learn Understand object-oriented & functional programming concepts of Scala In-depth understanding of Scala collection APIs Work with RDD and DataFrame to learn Spark's core abstractions Analysing structured and unstructured data using SparkSQL and GraphX Scalable and fault-tolerant streaming application development using Spark structured streaming Learn machine-learning best practices for classification, regression, dimensionality reduction, and recommendation system to build predictive models with widely used algorithms in Spark MLlib & ML Build clustering models to cluster a vast amount of data Understand

tuning, debugging, and monitoring Spark applications Deploy Spark applications on real clusters in Standalone, Mesos, and YARN In Detail Scala has been observing wide adoption over the past few years, especially in the field of data science and analytics. Spark, built on Scala, has gained a lot of recognition and is being used widely in productions. Thus, if you want to leverage the power of Scala and Spark to make sense of big data, this book is for you. The first part introduces you to Scala, helping you understand the object-oriented and functional programming concepts needed for Spark application development. It then moves on to Spark to cover the basic abstractions using RDD and DataFrame. This will help you develop scalable and fault-tolerant streaming applications by analyzing structured and unstructured data using SparkSQL, GraphX, and Spark structured streaming. Finally, the book moves on to some advanced topics, such as monitoring, configuration, debugging, testing, and deployment. You will also learn how to develop Spark applications using SparkR and PySpark APIs, interactive data analytics using Zeppelin, and in-memory data processing with Alluxio. By the end of this book, you will have a thorough understanding of Spark, and you will be able to perform full-stack data analytics with a feel that no amount of data is too big. Style and approach Filled with practical examples and use cases, this book will hot only help you get up and running with Spark, but will also take you farther down the road to becoming a data scientist. Neural Networks presents concepts of neural-network models and techniques of parallel distributed processing in a three-step approach: - A brief overview of the neural structure of the brain and the history of neural-network modeling introduces to associative memory, preceptrons, feature-sensitive networks, learning strategies, and practical applications. - The second part covers subjects like statistical physics of spin glasses, the mean-field theory of the Hopfield model, and the "space of interactions" approach to the storage capacity of neural networks. - The final part discusses nine programs with practical demonstrations of neural-network models. The software and source code in C are on a 3 1/2" MS-DOS diskette can be run with Microsoft, Borland, Turbo-C, or compatible compilers.

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