

Progress in Computer Science

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**Lecture Notes on
Bucket Algorithms**

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Lecture Notes On Bucket Algorithms

Igor Shparlinski



Lecture Notes On Bucket Algorithms:

Lecture Notes on Bucket Algorithms DEVROYE,2013-11-21 Hashing algorithms scramble data and create pseudo uniform data distributions Bucket algorithms operate on raw untransformed data which are partitioned into groups according to membership In equal sized multidimensional hyperrectangles called cells or buckets The bucket data structure is rather sensitive to the distribution of the data In these lecture notes we attempt to explain the connection between the expected time of various bucket algorithms and the distribution of the data The results are illustrated on standard searching sorting and selection problems as well as on a variety of problems in computational geometry and operations research The notes grew partially from a graduate course on probability theory in computer science I wish to thank Elizabeth Van Gulick for her help with the manuscript and David Avis Hanna Aiyukawa Vasek Chvatal Beatrice Devroye Hossam El Gindy Duncan McCallum Magda McCallum Godfried Toussaint and Sue Whitesides for making the School of Computer Science at McGill University such an enjoyable place The work was supported by NSERC Grant A3456 and by FCAC Grant EQ 1679

INTRODUCTION 1 INTRODUCTION It is not a secret that methods based upon the truncation of data have good expected time performance For example for nice distributions of the data searching is often better done via a hashing data structure instead of via a search tree The speed one observes in practice is due to the fact that the truncation operation is a constant time operation

Lecture Notes on Bucket Algorithms L. Devroye,2014-09-01 *Data Structures and Efficient Algorithms* Burkhard Monien,1992-05-20 Myocarditis and idiopathic dilated cardiomyopathy are being increasingly recognized as important causes of heart disease and heart failure Immunological mechanisms have long been suspected as playing a role in these diseases but direct evidence has been lacking Recently animal models have become available in which myocarditis can be induced either by infection with cardiotropic viruses or by autoimmunization with heart specific antigens This book presents and analyzes the latest information obtained from experimental models relating it to the practical problems of diagnosis and treatment of myocarditis

Analysis of Experimental Algorithms Ilias Kotsireas,Panos Pardalos,Konstantinos E. Parsopoulos,Dimitris Souravlias,Arsenis Tsokas,2019-11-14 This book constitutes the refereed post conference proceedings of the Special Event on the Analysis of Experimental Algorithms SEA2 2019 held in Kalamata Greece in June 2019 The 35 revised full papers presented were carefully reviewed and selected from 45 submissions The papers cover a wide range of topics in both computer science and operations research mathematical programming They focus on the role of experimentation and engineering techniques in the design and evaluation of algorithms data structures and computational optimization methods

Algorithms and Complexity Bozzano G Luisa,2014-06-28 This first part presents chapters on models of computation complexity theory data structures and efficient computation in many recognized sub disciplines of Theoretical Computer Science

Handbook of Computational Geometry J.R. Sack,J. Urrutia,1999-12-13 Computational Geometry is an area that provides solutions to geometric problems which arise in applications including

Geographic Information Systems Robotics and Computer Graphics This Handbook provides an overview of key concepts and results in Computational Geometry It may serve as a reference and study guide to the field Not only the most advanced methods or solutions are described but also many alternate ways of looking at problems and how to solve them

Computer Algebra Handbook Johannes Grabmeier, Erich Kaltofen, Volker Weispfenning, 2012-12-06 Two ideas lie gleaming on the jeweler's velvet The first is the calculus the second the algorithm The calculus and the rich body of mathematical analysis to which it gave rise made modern science possible but it has been the algorithm that has made possible the modern world David Berlinski The Advent of the Algorithm First there was the concept of integers then there were symbols for integers I II III 1 1 1 1 f t t t what might be called a sticks and stones representation I II III IV V Roman numerals 1 2 3 4 5 Arabic numerals etc Then there were other concepts with symbols for them and algorithms sometimes for manipulating the new symbols Then came collections of mathematical knowledge tables of mathematical computations theorems of general results Soon after algorithms came devices that provided assistance for carrying out computations Then mathematical knowledge was organized and structured into several related concepts and symbols logic algebra analysis topology algebraic geometry number theory combinatorics etc This organization and abstraction lead to new algorithms and new fields like universal algebra But always our symbol systems reflected and influenced our thinking our concepts and our algorithms

Sorting Hosam M. Mahmoud, 2011-10-14 A cutting edge look at the emerging distributional theory of sorting Research on distributions associated with sorting algorithms has grown dramatically over the last few decades spawning many exact and limiting distributions of complexity measures for many sorting algorithms Yet much of this information has been scattered in disparate and highly specialized sources throughout the literature In *Sorting A Distribution Theory* leading authority Hosam Mahmoud compiles consolidates and clarifies the large volume of available research providing a much needed comprehensive treatment of the entire emerging distributional theory of sorting Mahmoud carefully constructs a logical framework for the analysis of all standard sorting algorithms focusing on the development of the probability distributions associated with the algorithms as well as other issues in probability theory such as measures of concentration and rates of convergence With an emphasis on narrative rather than technical explanations this exceptionally well written book makes new results easily accessible to a broad spectrum of readers including computer professionals scientists mathematicians and engineers *Sorting A Distribution Theory* Contains introductory material on complete and partial sorting Explains insertion sort quick sort and merge sort among other methods Offers verbal descriptions of the mechanics of the algorithms as well as the necessary code Illustrates the distribution theory of sorting using a broad array of both classical and modern techniques Features a variety of end of chapter exercises

Automata Theory and its Applications Bakhadyr Khoussainov, Anil Nerode, 2012-12-06 The theory of finite automata on finite strings infinite strings and trees has had a distinguished history First automata were introduced to represent idealized switching circuits augmented by unit

delays This was the period of Shannon McCullouch and Pitts and Howard Aiken ending about 1950 Then in the 1950s there was the work of Kleene on representable events of Myhill and Nerode on finite coset congruence relations on strings of Rabin and Scott on power set automata In the 1960s there was the work of Btichi on automata on infinite strings and the second order theory of one successor then Rabin s 1968 result on automata on infinite trees and the second order theory of two successors The latter was a mystery until the introduction of forgetful determinacy games by Gurevich and Harrington in 1982 Each of these developments has successful and prospective applications in computer science They should all be part of every computer scientist s toolbox Suppose that we take a computer scientist s point of view One can think of finite automata as the mathematical representation of programs that run using fixed finite resources Then Btichi s SIS can be thought of as a theory of programs which run forever like operating systems or banking systems and are deterministic Finally Rabin s S2S is a theory of programs which run forever and are nondeterministic Indeed many questions of verification can be decided in the decidable theories of these automata

INTELLIGENCE FOR NONLINEAR DYNAMICS AND SYNCHRONISATION

Abdelhamid Bouchachia,2010-09-01 Over the past years the appropriateness of Computational Intelligence CI techniques in modeling and optimization tasks pertaining to complex nonlinear dynamic systems has become indubitable as attested by a large number of studies reporting on the successful application of CI models in nonlinear science for example adaptive control signal processing medical diagnostic pattern formation living systems etc This volume summarizes the state of the art of CI in the context of nonlinear dynamic systems and synchronization Aiming at fostering new breakthroughs the chapters in the book focus on theoretical experimental and computational aspects of recent advances in nonlinear science intertwined with computational intelligence techniques In addition all the chapters have a tutorial oriented structure

Cryptographic

Applications of Analytic Number Theory Igor Shparlinski,2013-03-07 The book introduces new techniques that imply rigorous lower bounds on the complexity of some number theoretic and cryptographic problems It also establishes certain attractive pseudorandom properties of various cryptographic primitives These methods and techniques are based on bounds of character sums and numbers of solutions of some polynomial equations over finite fields and residue rings Other number theoretic techniques such as sieve methods and lattice reduction algorithms are used as well The book also contains a number of open problems and proposals for further research The emphasis is on obtaining unconditional rigorously proved statements The bright side of this approach is that the results do not depend on any assumptions or conjectures On the downside the results are much weaker than those which are widely believed to be true We obtain several lower bounds exponential in terms of $\log p$ on the degrees and orders of polynomials algebraic functions Boolean functions linear recurrence sequences coinciding with values of the discrete logarithm modulo a prime p at sufficiently many points the number of points can be as small as $p^{1/2}$ These functions are considered over the residue ring modulo p and over the residue ring modulo an arbitrary divisor d of $p-1$ The case of $d=2$ is of special interest since it corresponds to the

representation of the rightmost bit of the discrete logarithm and defines whether the argument is a quadratic residue

Number Theoretic Methods in Cryptography Igor Shparlinski, 2012-12-06 The book introduces new techniques which imply rigorous lower bounds on the complexity of some number theoretic and cryptographic problems These methods and techniques are based on bounds of character sums and numbers of solutions of some polynomial equations over finite fields and residue rings It also contains a number of open problems and proposals for further research We obtain several lower bounds exponential in terms of $\log p$ on the degrees and orders of polynomials algebraic functions Boolean functions linear recurring sequences coinciding with values of the discrete logarithm modulo a prime p at sufficiently many points the number of points can be as small as $p^{1/2}$ He These functions are considered over the residue ring modulo p and over the residue ring modulo an arbitrary divisor d of $p-1$ The case of $d=2$ is of special interest since it corresponds to the representation of the right most bit of the discrete logarithm and defines whether the argument is a quadratic residue We also obtain non trivial upper bounds on the degree sensitivity and Fourier coefficients of Boolean functions on bits of x deciding whether x is a quadratic residue These results are used to obtain lower bounds on the parallel arithmetic and Boolean complexity of computing the discrete logarithm For example we prove that any unbounded fan in Boolean circuit of sublogarithmic depth computing the discrete logarithm modulo p must be of superpolynomial size Learning and

Geometry: Computational Approaches David Kueker, Carl Smith, 2012-12-06 The field of computational learning theory arose out of the desire to formally understand the process of learning As potential applications to artificial intelligence became apparent the new field grew rapidly The learning of geometric objects became a natural area of study The possibility of using learning techniques to compensate for unsolvability provided an attraction for individuals with an immediate need to solve such difficult problems Researchers at the Center for Night Vision were interested in solving the problem of interpreting data produced by a variety of sensors Current vision techniques which have a strong geometric component can be used to extract features However these techniques fall short of useful recognition of the sensed objects One potential solution is to incorporate learning techniques into the geometric manipulation of sensor data As a first step toward realizing such a solution the Systems Research Center at the University of Maryland in conjunction with the Center for Night Vision hosted a Workshop on Learning and Geometry in January of 1991 Scholars in both fields came together to learn about each others field and to look for common ground with the ultimate goal of providing a new model of learning from geometrical examples that would be useful in computer vision The papers in the volume are a partial record of that meeting **Mass**

Transportation Problems Svetlozar T. Rachev, Ludger Rüschendorf, 2006-05-17 The first comprehensive account of the theory of mass transportation problems and its applications In Volume I the authors systematically develop the theory with emphasis on the Monge Kantorovich mass transportation and the Kantorovich Rubinstein mass transshipment problems They then discuss a variety of different approaches towards solving these problems and exploit the rich interrelations to several

mathematical sciences from functional analysis to probability theory and mathematical economics The second volume is devoted to applications of the above problems to topics in applied probability theory of moments and distributions with given marginals queueing theory risk theory of probability metrics and its applications to various fields among them general limit theorems for Gaussian and non Gaussian limiting laws stochastic differential equations and algorithms and rounding problems Useful to graduates and researchers in theoretical and applied probability operations research computer science and mathematical economics the prerequisites for this book are graduate level probability theory and real and functional analysis

Graph-Based Proof Procedures for Horn Clauses RAATZ,2013-11-21 The origins of this monograph lie in my Ph D dissertation of 1987 at the University of Pennsylvania which was concerned with proof procedures for the Horn clause subset of logic The rise of logic programming has made this an important area of study All Prologs are based on a variant of resolution and inherit various properties related to this proof method This monograph studies the paradigm of logic programming in the context of graph based proof procedures which are unrelated to resolution The monograph is not a general introduction to logic programming although it is self contained with respect to the mathematics used It should appeal to the computer scientist or mathematician interested in the general area we now call computational logic A large part of the monograph is devoted to detailed proofs that the methods we present are sound and complete which in the context of the logic programming means that the operational and denotational semantics agree

Logical Methods John N. Crossley,Jeffrey B. Remmel,Richard Shore,Moss E. Sweedler,1994-01-26 The twenty six papers in this volume reflect the wide and still expanding range of Anil Nerode s work A conference on Logical Methods was held in honor of Nerode s sixtieth birthday 4 June 1992 at the Mathematical Sciences Institute Cornell University 1 3 June 1992 Some of the conference papers are here but others are from students co workers and other colleagues The intention of the conference was to look forward and to see the directions currently being pursued in the development of work by or with Nerode Here is a brief summary of the contents of this book We give a retrospective view of Nerode s work A number of specific areas are readily discerned recursive equivalence types recursive algebra and model theory the theory of Turing degrees and r e sets polynomial time computability and computer science Nerode began with automata theory and has also taken a keen interest in the history of mathematics All these areas are represented The one area missing is Nerode s applied mathematical work relating to the environment Kozen s paper builds on Nerode s early work on automata Recursive equivalence types are covered by Dekker and Barback the latter using directly a fundamental metatheorem of Nerode Recursive algebra is treated by Ge Richards group representations Recursive model theory is the subject of papers by Hird Moses and Khoussainov Dadajanov while a combinatorial problem in recursive model theory is discussed in Cherlin Martin s paper Cenzer presents a paper on recursive dynamics

A Proof Theory for General Unification W. Snyder,2012-12-06 In this monograph we study two generalizations of standard unification E unification and higher order unification using an abstract approach orig inated by Herbrand and

developed in the case of standard first order unification by Martelli and Montanari The formalism presents the unification computation as a set of non deterministic transformation rules for converting a set of equations to be unified into an explicit representation of a unifier if such exists This provides an abstract and mathematically elegant means of analysing the properties of unification in various settings by providing a clean separation of the logical issues from the specification of procedural information and amounts to a set of inference rules for unification hence the title of this book We derive the set of transformations for general E unification and higher order unification from an analysis of the sense in which terms are the same after application of a unifying substitution In both cases this results in a simple extension of the set of basic transformations given by Herbrand Martelli Montanari for standard unification and shows clearly the basic relationships of the fundamental operations necessary in each case and thus the underlying structure of the most important classes of term unification problems

Automata, Languages and Programming Andrzej Lingas,Rolf Karlsson,1993-06-23 The International Colloquium on Automata Languages and Programming ICALP is an annual conference series sponsored by the European Association for Theoretical Computer Science EATCS It is intended to cover all important areas of theoretical computer science such as computability automata formal languages term rewriting analysis of algorithms computational geometry computational complexity symbolic and algebraic computation cryptography data types and data structures theory of databases and knowledge bases semantics of programming languages program specification transformation and verification foundations of logicprogramming theory of logical design and layout parallel and distributed computation theory of concurrency and theory of robotics This volume contains the proceedings of ICALP 93 held at LundUniversity Sweden in July 1993 It includes five invited papers and 51 contributed papers selected from 151 submissions

Advances in Database Systems J. Paredaens,L. Tenenbaum,2014-05-04 Advanced information technology is pervasive in any kind of human activity science business finance management and others and this is particularly true for database systems Both database theory and database applications constitute a very important part of the state of the art of computer science Meanwhile there is some discrepancy between different aspects of database activity Theoreticians are sometimes not much aware of the real needs of business and industry software specialists not always have the time or the opportunity to get acquainted with the most recent theoretical ideas and trends as well as with advanced prototypes arising from these ideas potential users often do not have the possibility of evaluating the theoretical foundations and the potential practical impact of different commercial products So the main goal of the course was to put together people involved in different aspects of database activity and to promote active exchange of ideas among them

Feasible Mathematics S.R. Buss,P.J. Scott,2013-03-07 A so called effective algorithm may require arbitrarily large finite amounts of time and space resources and hence may not be practical in the real world A feasible algorithm is one which only requires a limited amount of space and or time for execution the general idea is that a feasible algorithm is one which may be practical on today s or at least tomorrow

s computers There is no definitive analogue of Church's thesis giving a mathematical definition of feasibility however the most widely studied mathematical model of feasible computability is polynomial time computability Feasible Mathematics includes both the study of feasible computation from a mathematical and logical point of view and the reworking of traditional mathematics from the point of view of feasible computation The diversity of Feasible Mathematics is illustrated by the contents of this volume which includes papers on weak fragments of arithmetic on higher type functionals on bounded linear logic on sub recursive definitions of complexity classes on finite model theory on models of feasible computation for real numbers on vector spaces and on recursion theory The vWorkshop on Feasible Mathematics was sponsored by the Mathematical Sciences Institute and was held at Cornell University June 26-28 1989

Whispering the Strategies of Language: An Emotional Quest through **Lecture Notes On Bucket Algorithms**

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