A Public-Key Cryptosystem with
Worst-Case/Average-Case Equivalence

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Abstract

We present a probabilistic public key cryptosystem which is secure unless the worst case of the following lattice problem can be solved in polynomial time: "Find the shortest nonzero vector in an n dimensional lattice L where the shortest vector v is unique in the sense that any other vector whose length is at most $n^c \|v\|$ is parallel to v."

1   Introduction

The *unique shortest vector problem (u-SVP)* is to find the shortest nonzero vector in an n dimensional lattice L where the shortest vector v is unique in the sense that any other vector whose length is at most $n^c \|v\|$ is parallel to v. We present a public key cryptosystem generator with the property that if a random instance of the cryptosystem can be broken, that is, if for a random instance the probability that an encryption of a zero can be distinguished from an encryption of a one (without the private key) in polynomial time is at least $\frac{1}{2} + n^{-c_1}$ for some absolute constant $c_1 > 0$, then the worst-case unique shortest vector problem has probabilistic polynomial time solution. The unique shortest vector problem is one of the three famous problems listed in [1]. There, a random method is given to generate hard instances of a particular lattice problem so that if it has a polynomial time solution then all of the three worst-case problems (including the unique-shortest vector problem) has a polynomial time solution. To our knowledge, this is the only public key cryptosystem with the property that to break a random instance is as hard as to solve the worst-case instance of the problem on which the system is based.

Our approach also yields a conceptually simple and extremely natural pseudo-random generator.

Outline of the Construction Very roughly speaking, an instance of the cryptosystem is a collection of *hidden hyper-*

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planes, which form the private key, together with a method of generating a point guaranteed to be near one of the hyperplanes in the collection, which forms the public key. The public key is chosen so as not to reveal the collection of hyperplanes – indeed, any ability, given the public key, to discover the collection implies the ability to solve the worst-case unique shortest vector problem. We fix a large n-dimensional cube $Q \in \mathbb{R}^n$. Encryption is bit-by-bit: zero is encrypted by using the public key to find a random vector $v \in Q$ near one of the hyperplanes – the ciphertext is v; one is encrypted by choosing a random vector u uniformly from Q – the ciphertext is simply u. Decryption of a ciphertext x is performed using the private key to determine the distance of x to the nearest hidden hyperplane. If this distance is sufficiently small, then x is decrypted as zero; otherwise x is decrypted as one. There is a small (but polynomial) probability of an error in decryption: an encryption of one may be decrypted as zero.

We present three separate cryptosystems; the third is the system just described. The first has the most compact public key; its correctness depends on the hardness of random instances of a certain subset of instances of the unique shortest vector problem. The second has a less compact public key, but its correctness depends only on the hardness of random instances of the unique shortest vector problem (that is, we are no longer restricted to a subset). The third has the least compact public key. However, its correctness relies only on the hardness of the worst-case unique shortest vector problem.

In the first two constructions the hyperplanes are obtained by regarding the unique shortest vector u in lattice Λ as a linear functional inducing the collection of hyperplanes $H_i = \{v \mid u \cdot v = i\}$ for each $i \in \mathbb{Z}$. The private key is a basis for H_0. Every point in $L = \Lambda^*$ (the dual of Λ) is on one of the H_i. The public key is a random basis for L, together with an additional parameter R. In these schemes, a point near a hyperplane (an encryption of zero) is obtained by choosing a random point in L and perturbing it slightly (using R). In the third construction we omit the lattice: u is chosen uniformly at random from the unit n-dimensional ball and the H_i are defined exactly as above. The public key is a collection of random points, themselves near the H_i. A point near a hyperplane is obtained by summing a random subset of the published points.

Several proofs have been omitted from these proceedings for lack of space. Full proofs are available through the Electronic Colloquium on Computational Complexity [2].

Proceedings Of The Ninth Annual Acm Symposium On Theyry Of Computing

Robert Kudelić

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Proceedings of the Ninth Annual ACM Symposium on Theory of Computing John E. Hopcroft,1977 STOC '77: Proceedings of the Ninth Annual ACM Symposium on Theory of Computing , *Proceedings of the Ninth Annual Structure in Complexity Theory Conference* IEEE Computer Society. Technical Committee on Mathematical Foundations of Computing,1994 Proceedings of the Thirty-ninth Annual ACM Symposium on Theory of Computing ACM Special Interest Group for Algorithms and Computation Theory,2007 **STOC '97** ,1997 **Proceedings of the Ninth Annual ACM Symposium on Theory of Computing** ACM SIGACT,1977 Proceedings of the Thirtieth Annual ACM Symposium on Theory of Computing ,1998 **Alasdair Urquhart on Nonclassical and Algebraic Logic and Complexity of Proofs** Ivo Düntsch,Edwin Mares,2021-09-24 This book is dedicated to the work of Alasdair Urquhart The book starts out with an introduction to and an overview of Urquhart s work and an autobiographical essay by Urquhart This introductory section is followed by papers on algebraic logic and lattice theory papers on the complexity of proofs and papers on philosophical logic and history of logic The final section of the book contains a response to the papers by Urquhart Alasdair Urquhart has made extremely important contributions to a variety of fields in logic He produced some of the earliest work on the semantics of relevant logic He provided the undecidability of the logics R of relevant implication and E of relevant entailment as well as some of their close neighbors He proved that interpolation fails in some of those systems Urquhart has done very important work in complexity theory both about the complexity of proofs in classical and some nonclassical logics In pure algebra he has produced a representation theorem for lattices and some rather beautiful duality theorems In addition he has done important work in the history of logic especially on Bertrand Russell including editing Volume four of Russell s Collected Papers **Handbook of Scheduling** Joseph Y-T. Leung,2004-04-27 Researchers in management industrial engineering operations and computer science have intensely studied scheduling for more than 50 years resulting in an astounding body of knowledge in this field Handbook of Scheduling Algorithms Models and Performance Analysis the first handbook on scheduling provides full coverage of the most recent and advanced topics on the subject It assembles researchers from all relevant disciplines in order to facilitate cross fertilization and create new scheduling insights The book comprises six major parts each of which breaks down into smaller chapters Part I introduces materials and notation with tutorials on complexity theory and algorithms for the minimization of makespan total completion time dual objectives maximum lateness the number of late jobs and total tardiness Part II is devoted to classical scheduling problems Part III explores scheduling models that originate in computer science operations research and management science Part IV examines scheduling problems that arise in real time systems focusing on meeting hard deadline constraints while maximizing machine utilization Part V discusses stochastic scheduling and queueing networks highlighting jobs that are not deterministic Part VI covers applications discussing scheduling problems in airline process and transportation industries as well as in hospitals and educational

institutions   Encyclopedia of Cryptography, Security and Privacy Sushil Jajodia,Pierangela Samarati,Moti Yung,2025-01-10 A rich stream of papers and many good books have been written on cryptography security and privacy but most of them assume a scholarly reader who has the time to start at the beginning and work his way through the entire text The goal of Encyclopedia of Cryptography Security and Privacy Third Edition is to make important notions of cryptography security and privacy accessible to readers who have an interest in a particular concept related to these areas but who lack the time to study one of the many books in these areas The third edition is intended as a replacement of Encyclopedia of Cryptography and Security Second Edition that was edited by Henk van Tilborg and Sushil Jajodia and published by Springer in 2011 The goal of the third edition is to enhance on the earlier edition in several important and interesting ways First entries in the second edition have been updated when needed to keep pace with the advancement of state of the art Second as noticeable already from the title of the encyclopedia coverage has been expanded with special emphasis to the area of privacy Third considering the fast pace at which information and communication technology is evolving and has evolved drastically since the last edition entries have been expanded to provide comprehensive view and include coverage of several newer topics   *Cyber Security in India* Sandeep Kumar Shukla,Manindra Agrawal,2020-03-17 This book of directions focuses on cyber security research education and training in India and work in this domain within the Indian Institute of Technology Kanpur IIT Kanpur s Computer Science and Engineering Department established an Interdisciplinary Center for Cyber Security and Cyber Defense of Critical Infrastructures C3I Center in 2016 with funding from the Science and Engineering Research Board SERB and other funding agencies The work at the center focuses on smart grid security manufacturing and other industrial control system security network web and data security cryptography and penetration techniques The founders are involved with various Indian government agencies including the Reserve Bank of India National Critical Information Infrastructure Protection Center UIDAI CCTNS under home ministry Ministry of IT and Electronics and Department of Science Technology The center also testifies to the parliamentary standing committee on cyber security and has been working with the National Cyber Security Coordinator s office in India Providing glimpses of the work done at IIT Kanpur and including perspectives from other Indian institutes where work on cyber security is starting to take shape the book is a valuable resource for researchers and professionals as well as educationists and policymakers   Feedback Arc Set Robert Kudelić,2022-10-10 The main aim of the book is to give a review of all relevant information regarding a well known and important problem of Feedback Arc Set FAS This review naturally also includes a history of the problem as well as specific algorithms To this point such a work does not exist There are sources where one can find incomplete and perhaps untrustworthy information With this book information about FAS can be found easily in one place formulation description theoretical background applications algorithms etc Such a compendium will be of help to people involved in research but also to people that want to quickly acquaint themselves with the problem and need reliable information Thus research

professional work and learning can proceed in a more streamlined and faster way   Randomization, Approximation, and Combinatorial Optimization. Algorithms and Techniques Dorit Hochbaum,Klaus Jansen,Jose D.P. Rolim,Alistair Sinclair,1999-07-28 This book constitutes the refereed proceedings of the Third International Workshop on Randomization and Approximation Techniques in Computer Science RANDOM 99 held jointly with the Second International Workshop on Approximation Algorithms for Combinatorial Optimization Problems APPROX 99 in Berkeley California in August 1999 The volume presents 24 revised full papers selected from 44 submissions and four invited contributions The papers present a wealth of new results and document the state of the art in the areas covered by the workshop   *Systems Approach Applications for Developments in Information Technology* Stowell, Frank,2012-05-31 The intricate fields of information systems and information technology consist of innumerable interrelated facets from hardware to software and creators to end users All systems inevitably encounter errors or problems and as new solutions are found and created in today s complex world of technology it is essential to look at systems as complete entities when searching for solutions and answers Systems Approach Applications for Developments in Information Technology addresses the essential need to look at systems as a complete unit through using systems approach in the field of IT This complete reference is designed for all information technology professionals to better understand their current jobs and future goals through the pivotal idea of systems approach as applied in software engineering systems engineering and complex systems   *Mathematical Theory and Computational Practice* Klaus Ambos-Spies,Benedikt Löwe,Wolfgang Merkle,2009-07-15 This book constitutes the proceedings of the 5th Conference on Computability in Europe CiE 2009 held in Heidelberg Germany during July 19 24 2009 The 34 papers presented together with 17 invited lectures were carefully reviewed and selected from 100 submissions The aims of the conference is to advance our theoretical understanding of what can and cannot be computed by any means of computation It is the largest international meeting focused on computability theoretic issues   Post-Quantum Cryptography Daniel J. Bernstein,Johannes Buchmann,Erik Dahmen,2009-02-01 Quantum computers will break today s most popular public key cryptographic systems including RSA DSA and ECDSA This book introduces the reader to the next generation of cryptographic algorithms the systems that resist quantum computer attacks in particular post quantum public key encryption systems and post quantum public key signature systems Leading experts have joined forces for the first time to explain the state of the art in quantum computing hash based cryptography code based cryptography lattice based cryptography and multivariate cryptography Mathematical foundations and implementation issues are included This book is an essential resource for students and researchers who want to contribute to the field of post quantum cryptography   *Current Trends in Theoretical Computer Science* Gheorghe P?un,2004 This book is based on columns and tutorials published in the Bulletin of the European Association for Theoretical Computer Science EATCS during the period 2000OCo2003 It presents many of the most active current research lines in theoretical computer science The material appears in two volumes OC Algorithms

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