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Jan Camenisch (Eds.)

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International Conference on the Theory
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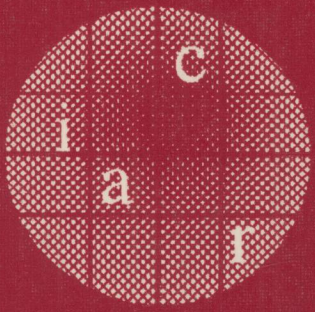
Interlaken, Switzerland, May 2004, Proceedings



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Volume Editors

Christian Cachin
Jan Camenisch
IBM Zurich Research Laboratory
Säumerstrasse 4, CH-8803 Rüschlikon, Switzerland
E-mail: {cca,jca}@zurich.ibm.com

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Preface

These are the proceedings of Eurocrypt 2004, the 23rd Annual Eurocrypt Conference. The conference was organized by members of the IBM Zurich Research Laboratory in cooperation with IACR, the International Association for Cryptologic Research.

The conference received a record number of 206 submissions, out of which the program committee selected 36 for presentation at the conference (three papers were withdrawn by the authors shortly after submission). These proceedings contain revised versions of the accepted papers. These revisions have not been checked for correctness, and the authors bear full responsibility for the contents of their papers.

The conference program also featured two invited talks. The first one was the 2004 IACR Distinguished Lecture given by Whitfield Diffie. The second invited talk was by Ivan Damgård who presented "Paradigms for Multiparty Computation." The traditional rump session with short informal talks on recent results was chaired by Arjen Lenstra.

The reviewing process was a challenging task, and many good submissions had to be rejected. Each paper was reviewed independently by at least three members of the program committee, and papers co-authored by a member of the program committee were reviewed by at least six (other) members. The individual reviewing phase was followed by profound and sometimes lively discussions about the papers, which contributed a lot to the quality of the final selection. Extensive comments were sent to the authors in most cases. At the end, the comments and electronic discussion notes filled more than 32,000 lines of text! We would like to thank the members of the program committee for their hard work over the course of several months; it was a pleasure for us to work with them and to benefit from their knowledge and insight. We are also very grateful to the external reviewers who contributed with their expertise to the selection process. Their work is highly appreciated.

The submission of all papers was done using the electronic submission software written by Chanathip Namprempre with modifications by Andre Adelsbach. During the review process, the program committee was mainly communicating using the Web-based review software developed by Bart Preneel, Wim Moreau, and Joris Claessens. We would like to thank Roger Zimmermann for his help with installing and running the software locally, and for solving many other problems, not the least of which was the assembly of these proceedings. The final decisions were made at a meeting in Rüschlikon at the IBM Zurich Research Laboratory. Helga Steimann helped us with the organization and also made sure there was enough coffee and food available so that we could concentrate on the papers and were not distracted by empty stomachs. Thanks a lot!

We are grateful to Endre Bangerter, Martin Hirt, Reto Strobl, and Roger Zimmermann for their help with the local arrangements of the conference.

Eurocrypt 2004 was supported by the IBM Zurich Research Laboratory, Crypto AG, Omnisec, MediaCrypt, HP, Microsoft Research, and Swiss International Air Lines.

Our most important thanks go to our families for bearing with us through this busy period, for their support, and for their love.

Last but not least, we thank all the authors from all over the world who submitted papers. It is due to them and their work that the conference took place.

February 2004 Christian Cachin and Jan Camenisch

EUROCRYPT 2004

May 2–6, 2004, Interlaken, Switzerland

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Efficient Private Matching and Set Intersection

Michael J. Freedman[1]*, Kobbi Nissim[2]**, and Benny Pinkas[3]

[1] New York University
(mfreed@cs.nyu.edu)
[2] Microsoft Research SVC
(kobbi@microsoft.com)
[3] HP Labs
(benny.pinkas@hp.com)

Abstract. We consider the problem of computing the intersection of private datasets of two parties, where the datasets contain lists of elements taken from a large domain. This problem has many applications for online collaboration. We present protocols, based on the use of homomorphic encryption and balanced hashing, for both semi-honest and malicious environments. For lists of length k, we obtain $O(k)$ communication overhead and $O(k \ln \ln k)$ computation. The protocol for the semi-honest environment is secure in the standard model, while the protocol for the malicious environment is secure in the random oracle model. We also consider the problem of approximating the size of the intersection, show a linear lower-bound for the communication overhead of solving this problem, and provide a suitable secure protocol. Lastly, we investigate other variants of the matching problem, including extending the protocol to the multi-party setting as well as considering the problem of approximate matching.

1 Introduction

This work considers several two-party set-intersection problems and presents corresponding secure protocols. Our protocols enable two parties that each hold a set of inputs – drawn from a *large* domain – to jointly calculate the intersection of their inputs, without leaking any additional information. The set-intersection primitive is quite useful as it is extensively used in computations over databases, *e.g.*, for data mining where the data is vertically partitioned between parties (namely, each party has different attributes referring to the same subjects).

One could envision the usage of efficient set-intersection protocols for online recommendation services, online dating services, medical databases, and many other applications. We are already beginning to see the deployment of such applications using either trusted third parties or plain insecure communication.

* Research partially done while the author was visiting HP Labs.
** Research done while the author was at NEC Labs.

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Contributions. We study private two-party computation of set intersection, which we also denote as *private matching* (PM):

- Protocols for computing private matching, based on homomorphic encryption and balanced allocations: (i) a protocol secure against semi-honest adversaries; and (ii) a protocol, in the random oracle model, secure against malicious adversaries.[4] Their overhead for input lists of length k is $O(k)$ communication and $O(k \ln \ln k)$ computation, with small constant factors. These protocols are more efficient than previous solutions to this problem.
- Variants of the private matching protocol that (i) compute the intersection *size*, (ii) decide whether the intersection size is greater than a threshold, or (iii) compute some other function of the intersection set.
- We consider private approximation protocols for the intersection size (similar to the private approximation of the Hamming distance by [10]). A simple reduction from the communication lower-bound on disjointness shows that this problem cannot have a sublinear *worst-case* communication overhead. We show a sampling-based private approximation protocol that achieves instance-optimal communication.
- We extend the protocol for set intersection to a multi-party setting.
- We introduce the problem of secure approximate (or "fuzzy") matching and search, and we present protocols for several simple instances.

2 Background and Related Work

Private equality tests (PET). A simpler form of private matching is where each of the two datasets has a single element from a domain of size N. A circuit computing this function has $O(\log N)$ gates, and therefore can be securely evaluated with this overhead. Specialized protocols for this function were also suggested in [9, 18, 17], and they essentially have the same overhead. A solution in [3] provides fairness in addition to security.

A circuit-based solution for computing PM of datasets of length k requires $O(k^2 \log N)$ communication and $O(k \log N)$ oblivious transfers. Another trivial construction compares all combinations of items from the two datasets using k^2 instantiations of a PET protocol (which itself has $O(\log N)$ overhead). The computation of this comparison can be reduced to $O(k \log N)$, while retaining the $O(k^2 \log N)$ communication overhead [18]. There are additional constructions that solve the private matching problem at the cost of only $O(k)$ exponentiations [12, 8]. However, these constructions were only analyzed in the random oracle model, against semi-honest parties.

Disjointness and set intersection. Protocols for computing (or deciding) the intersection of two sets have been researched both in the general context of communication complexity and in the context of secure protocols. Much attention has been given to evaluating the communication complexity of the disjointness problem, where the two parties in the protocol hold subsets a and b of

[4] For malicious clients, we present a protocol that is secure in the standard model.