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Introduction to Security Reduction

- Security proofs are essential to public-key cryptography
- Illustrates important notions in security reductions
- Suitable for researchers and graduate students engaged with public-key cryptography

This monograph illustrates important notions in security reductions and essential techniques in security reductions for group-based cryptosystems. Using digital signatures and encryption as examples, the authors explain how to program correct security reductions for those cryptographic primitives. Various schemes are selected and re-proven in this book to demonstrate and exemplify correct security reductions. This book is suitable for researchers and graduate students engaged with public-key cryptography.

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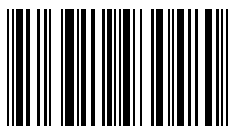
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Preface

Security reduction is a very popular approach for proving security in public-key cryptography. With security reduction, roughly speaking, we can show that breaking a proposed scheme is as difficult as solving a mathematical hard problem. However, how to program a correct security reduction using an adversary’s adaptive attack is rather complicated. The reason is that there is no universal security reduction for all proposed schemes.

Security reductions given in cryptographic research papers are often hard for beginners to fully comprehend. To aid the beginners, some cryptography textbooks have illustrated how to correctly program security reductions with simpler examples. However, security reductions mentioned in research papers and previous textbooks are usually for specific schemes. The difference in security reductions for different schemes leads to confusion for the beginners. There is a need for a book that systematically introduces how to correctly program a security reduction for a cryptosystem, not for a specific scheme. With this in mind, we wrote this book, which we hope will help the reader understand how to correctly program a security reduction.

The contents of this book, especially the foundations of security reductions, are based on our understanding and experience. The reader might find that the explanations of concepts are slightly different from those in other sources, because we have added some “condiments” to help the reader understand these concepts. For example, in a security reduction, the adversary is not a black-box adversary but a malicious adversary who has unbounded computational power.

We thought this book would be completed within one year, but we underestimated its difficulty. It has taken more than four years to complete the writing of this book. There must still be errors that have not yet been found. We welcome any comments and suggestions.

University of Wollongong, Australia

Fuchun Guo, Willy Susilo, and Yi Mu
May 2018

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