CIS 4360: Computer Security Fundamentals

Digital Signature

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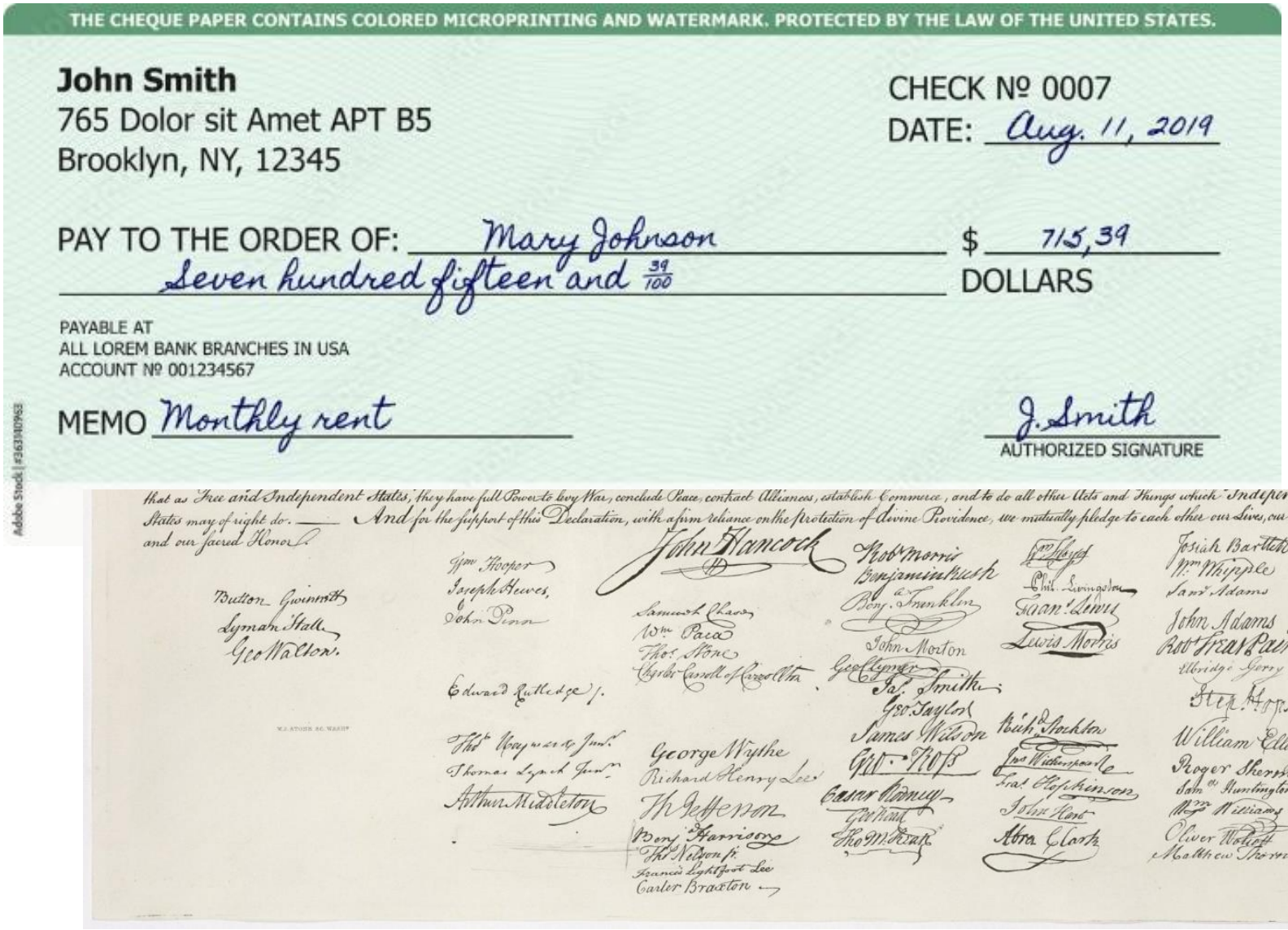
The slides are loosely based on those of Prof. Mihir Bellare, UC San Diego.

Agenda

1. **High-level Overview**

2. Building Signature Scheme

The Need For Signing Is Ubiquitous



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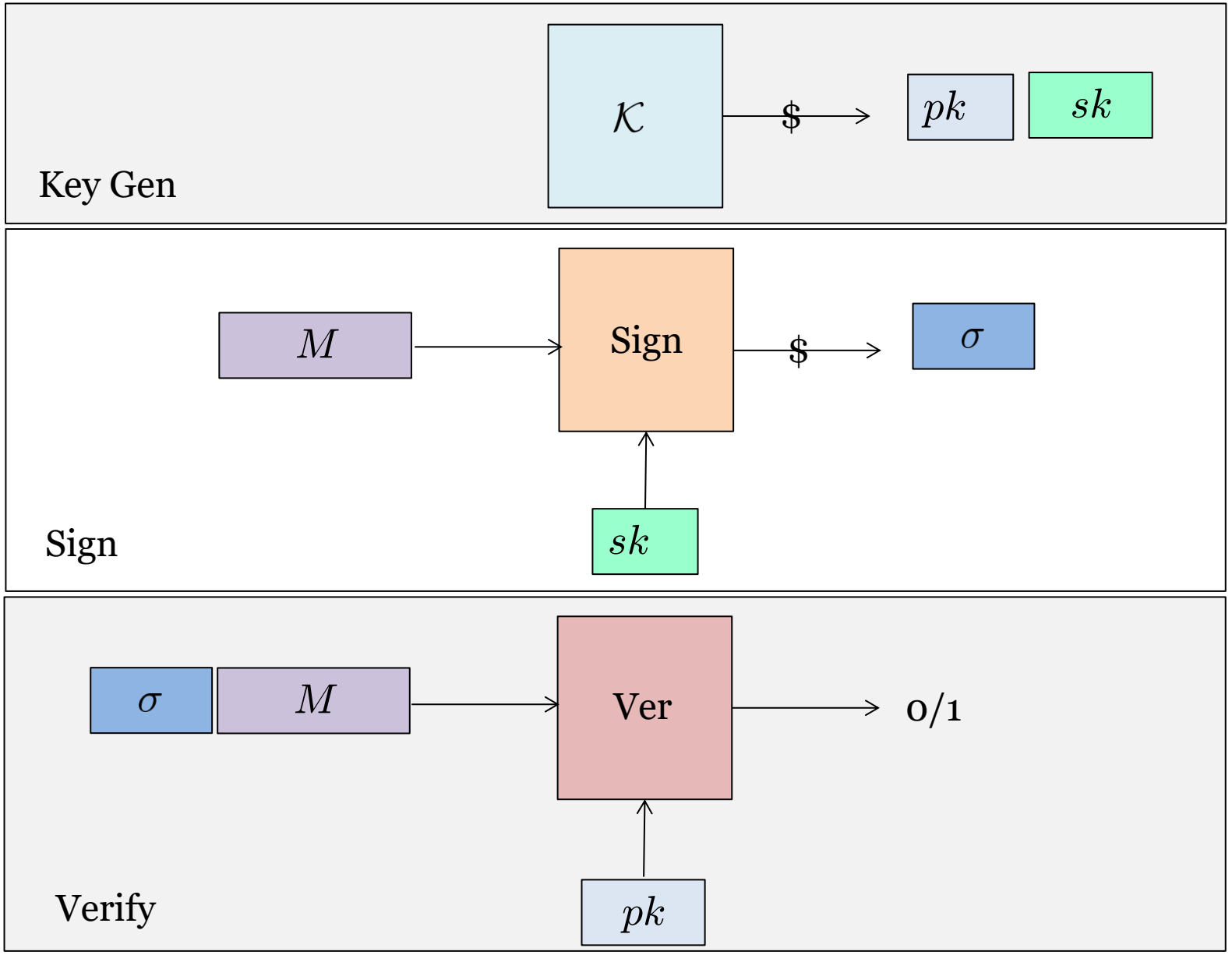
How To Sign Electronically?

Lots of apps to digitize signatures

Problem: A digitized signature is easily copied → forgery

Digital Signature Scheme: Syntax



Digital Signature versus MAC

MAC

- Verifier needs to share a secret key with signer

- Verifier can impersonate signer

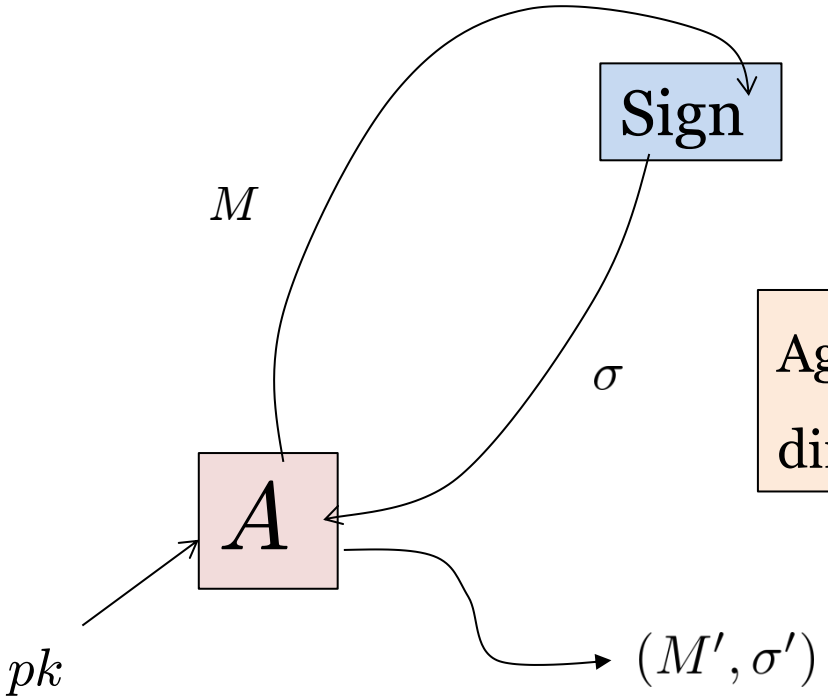
Digital Signature

- Verifier needs no secret

- Verifier cannot impersonate signer

Digital Signature: Unforgeability Security

- Similar to MAC security
- **Difference**: The adversary is given the public key



Again, digital signature doesn't directly thwart replay attack.

Agenda

1. High-level Overview

2. Building Signature Scheme

A Bad Scheme: Plain RSA Signature

Key generation: Like RSA encryption

Sign:

- To sign a message, “decrypt” it:

Verify:

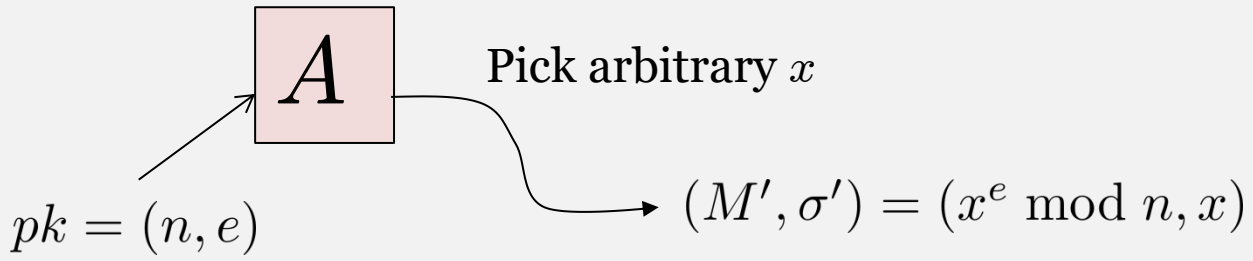
- To verify a signature, “encrypt” it and compare with the message

Issues with Plain RSA Signature

- **Feasibility**: Can sign only short messages

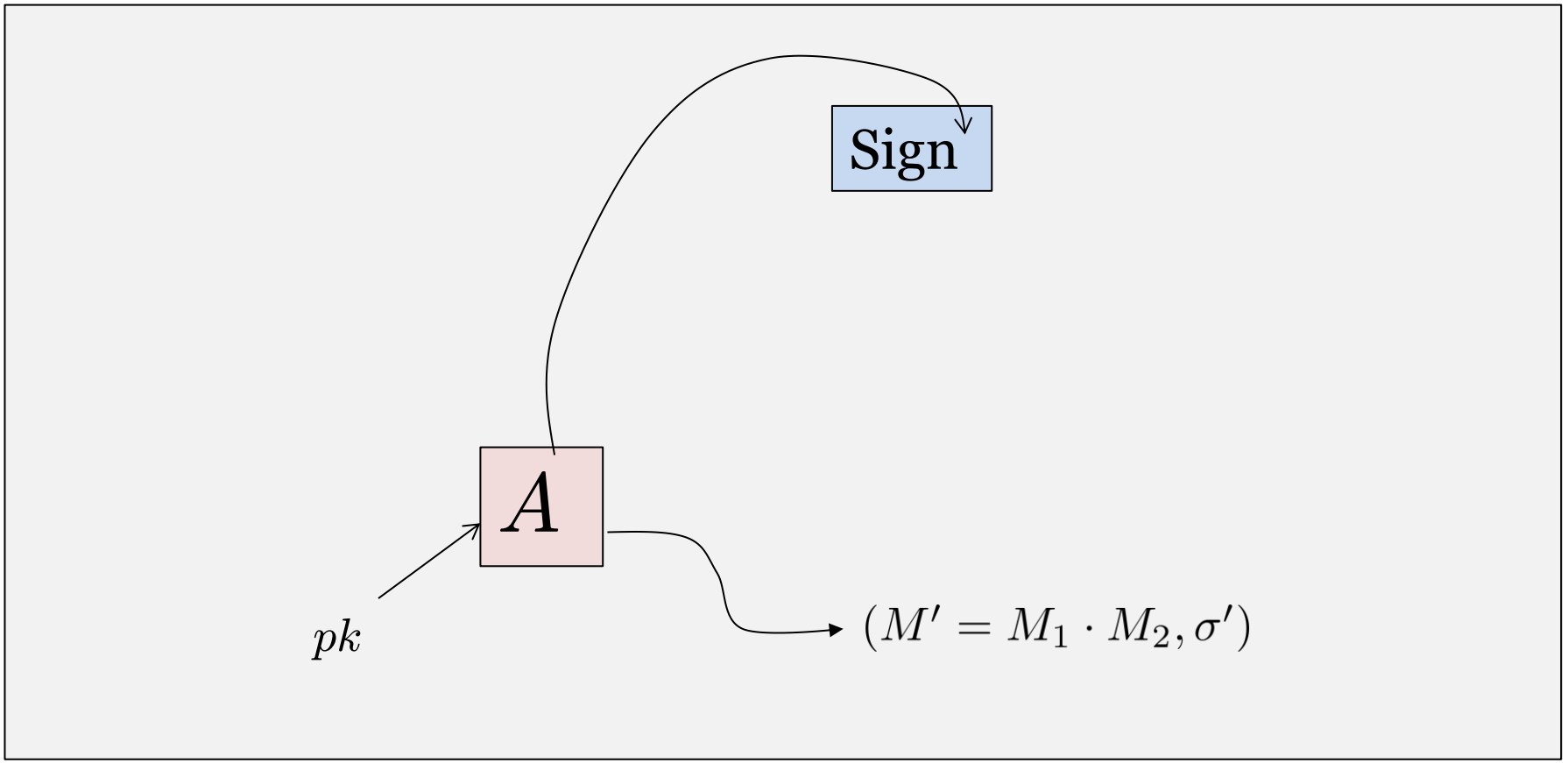
- **Security**: Can easily break unforgeability security

No sign query needed!



Exercise: Forging Plain RSA For Targeted Msg

Goal: The forged message must be a **specific** one

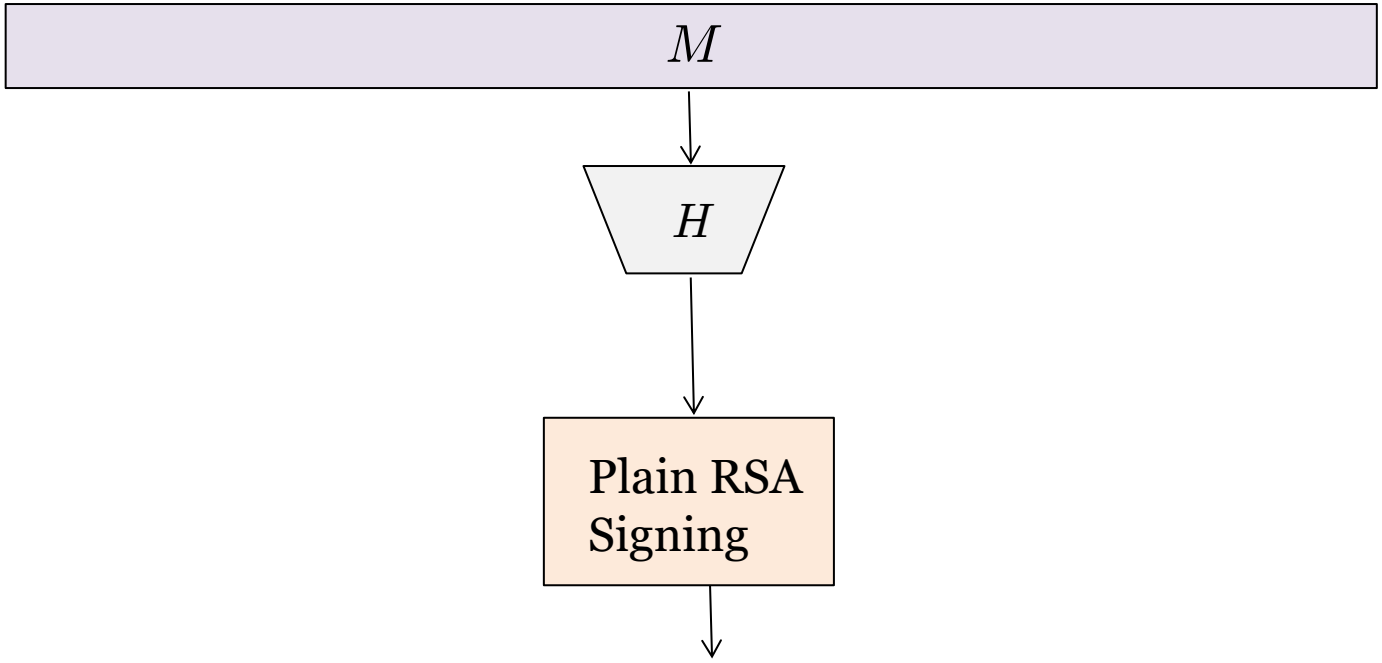


Hash-then-Sign Paradigm

Plain RSA Signature → Full Domain Hash (FDH)

Key generation: Like Plain RSA

Sign: To sign message M



Question: How to verify?

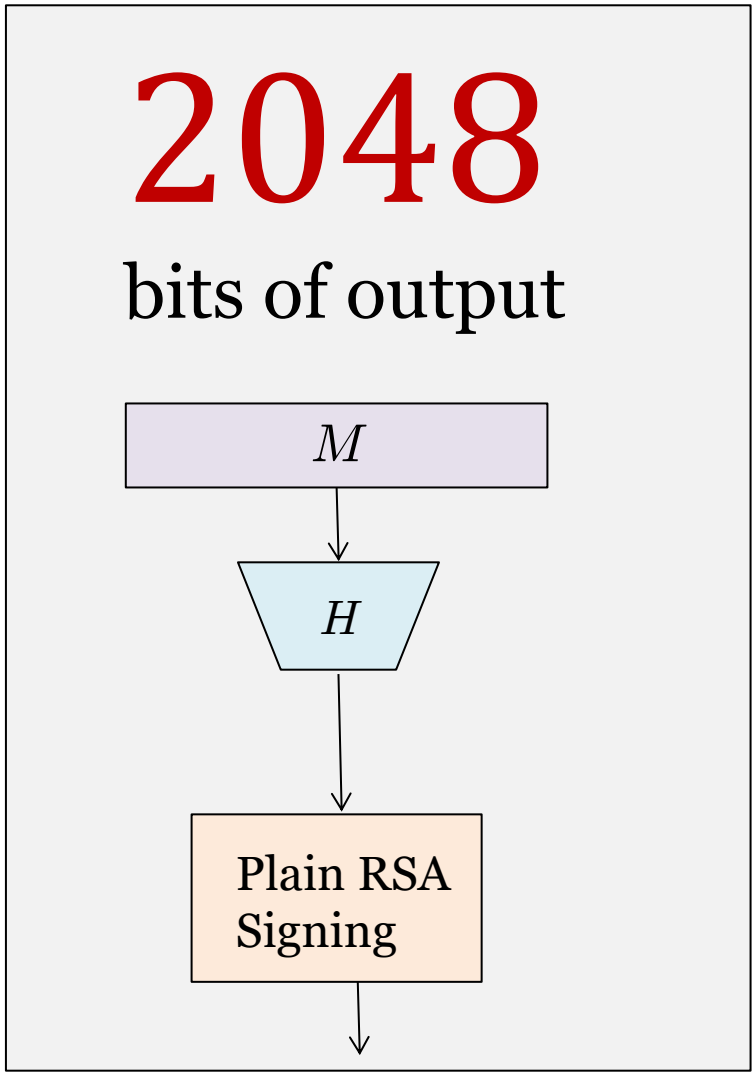
Security Requirement for Hash Function

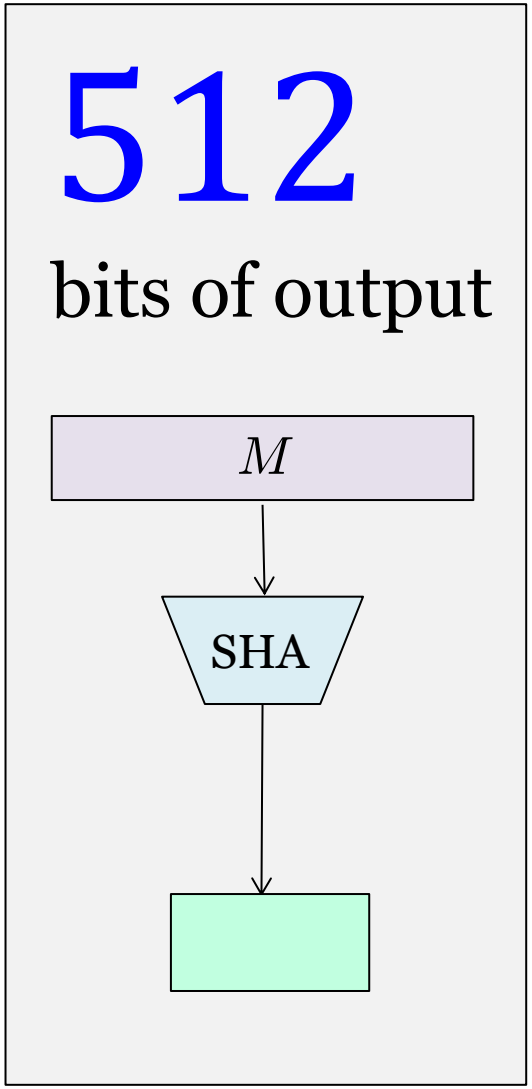
What intuition suggests: Hash must be collision-resistant

If $H(M) = H(M')$ then M and M' have the same signature

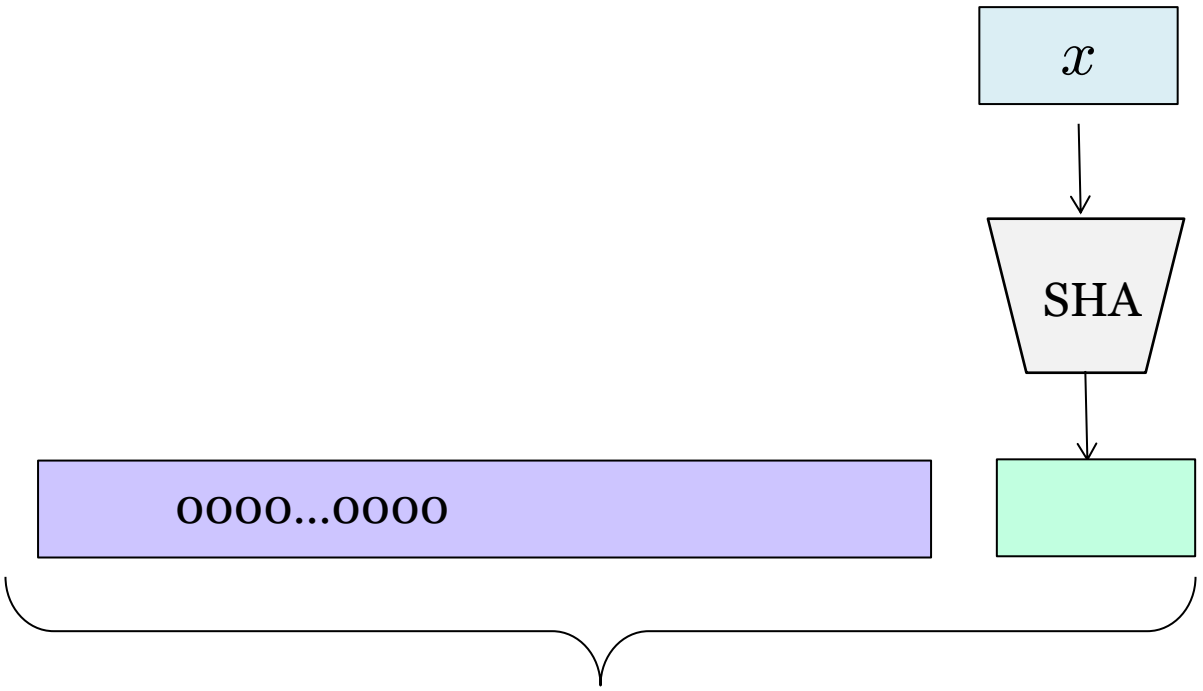
What proof requires: Hash is modeled as a random oracle

A Gap of Demand and Supply





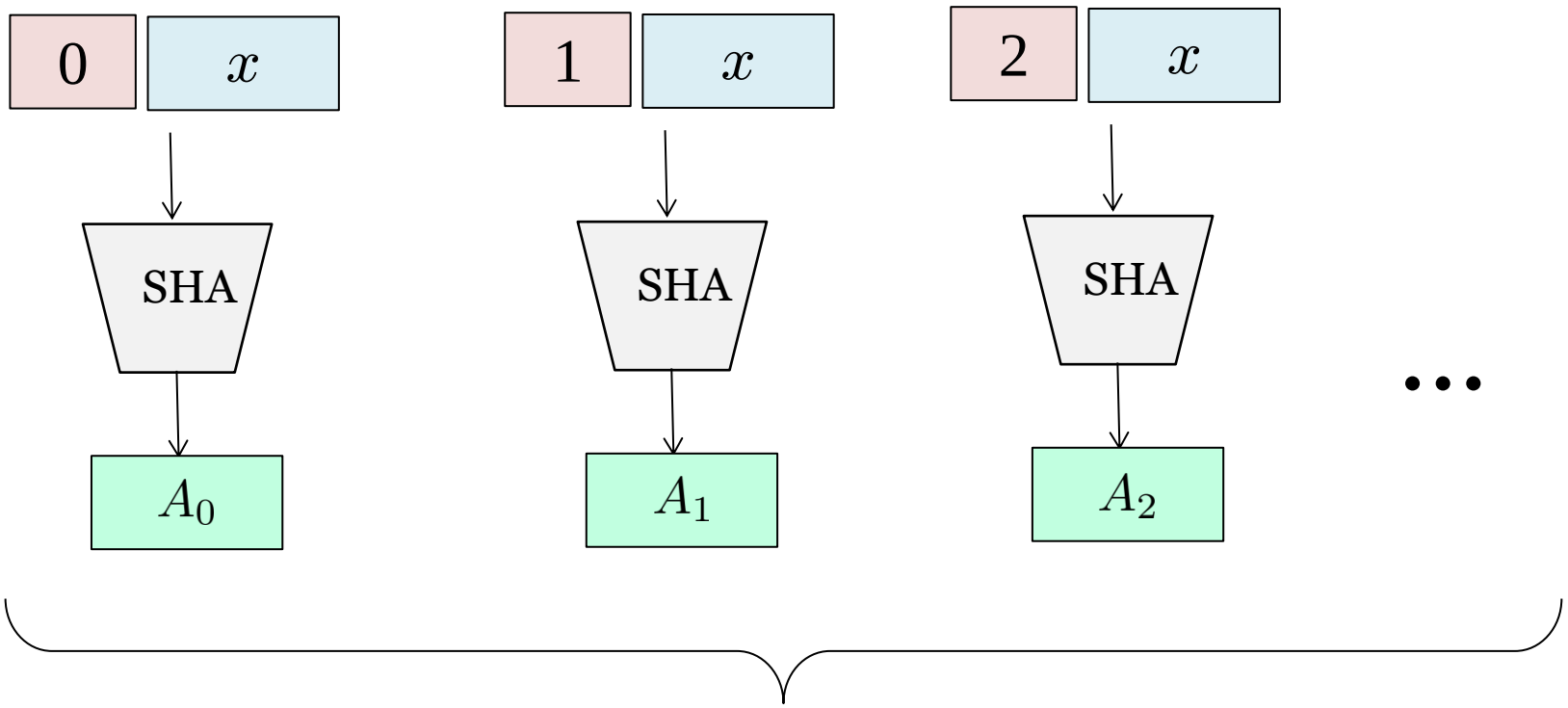
A Common Wrong Way to Hash



2048-bit string Y, viewed as a number in $\mathbb{Z}_N$

Broken by Desmedt and Odlyzko in 1985

How to Hash Properly



Use the first $m = \lceil \log_2(N) \rceil$ bits and take mod N

Hashing in PKCS#1