public-key cryptography

slides
bit.ly/cs161-disc

feedback
bit.ly/extended-feedback

~~hack~~ mitigation of the day

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- Google introduces client-side encryption to Gmail and Calendar

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SERVICE	DATA THAT'S CLIENT-SIDE ENCRYPTED	DATA THAT'S *NOT* CLIENT-SIDE ENCRYPTED
Google Drive	• Files created with Google Docs Editors (documents, spreadsheets, presentations) • Uploaded files, like PDFs and Microsoft Office files	• File title • File metadata, such as owner, creator, and last-modified time • Drive labels (also called Drive metadata) • Linked content that's outside of Docs or Drive (for example, a YouTube video linked from a Google document) • User preferences, such as Docs header styles
Gmail	• Email body, including inline images • Attached files **Note:** Attaching client-side encrypted Drive files isn't yet supported	• Email header, including subject, timestamps, and recipients lists
Google Calendar	• Event description • Attached Drive files (if CSE for Drive is turned on) • Meet audio and video streams (if CSE for Meet is turned on)	Any content other than the event description, attachments, and Meet data, such as: • Event title • Event starting and ending times • Attendees list • Booked rooms • Join by phone numbers • Link for Meet
Google Meet	• Audio streams • Video streams (including screen sharing)	• Any data other than audio and video streams

general questions, concerns, etc.

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  - private key
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- no longer need to assume alice and bob share key
- much slower than symmetric-key cryptography
  - relies on number theory calculations

el gamal

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- Bob: private key b and public key $B = g^b \bmod p$

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- Alice: random r and computes $R = g^r \bmod p$
- Alice sends $C1 = R$, $C2 = M \times B^r \bmod p$
- Bob: $C2 \times C1^{-b} = M \times B^r \times R^{-b} = M \times g^{br} \times g^{-br} = M \bmod p$

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has access to Bob's
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Bob

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RSA - encrypt

message

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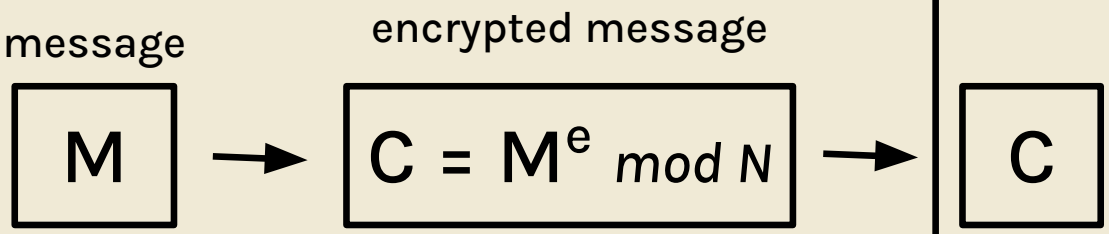

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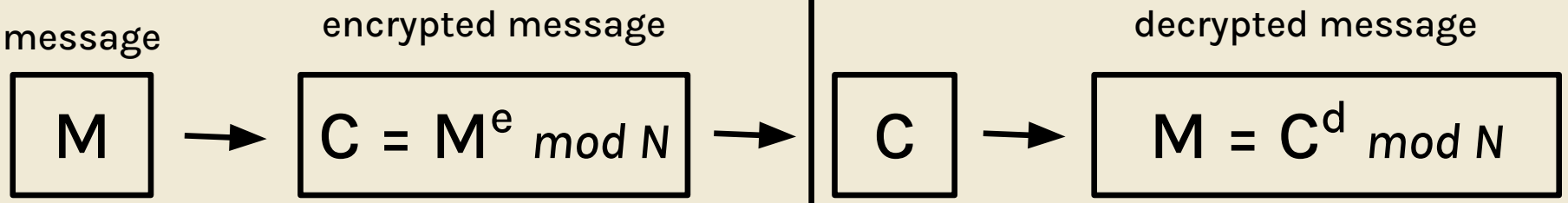

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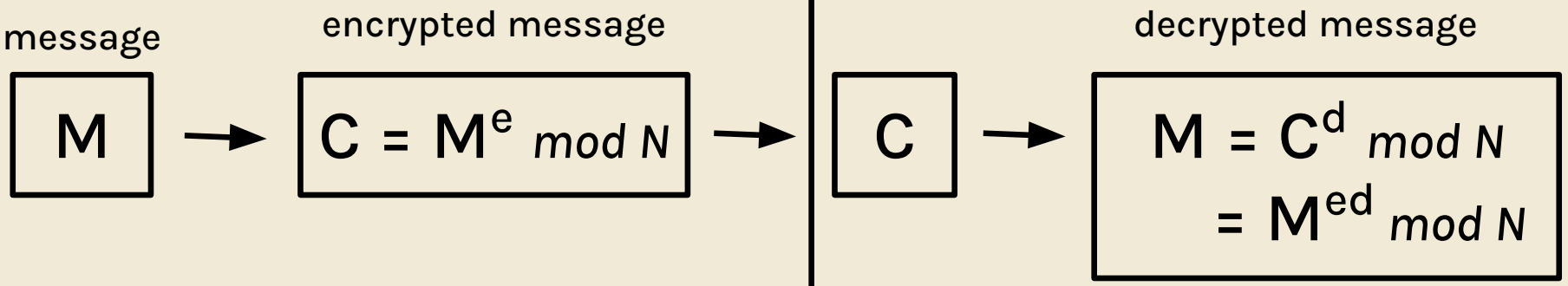

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  - no! what if mallory gives alice her public key instead of bob's?

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- **trust anchor:** a root of trust—implicit trust

trust-on-first-use

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- used by SSH

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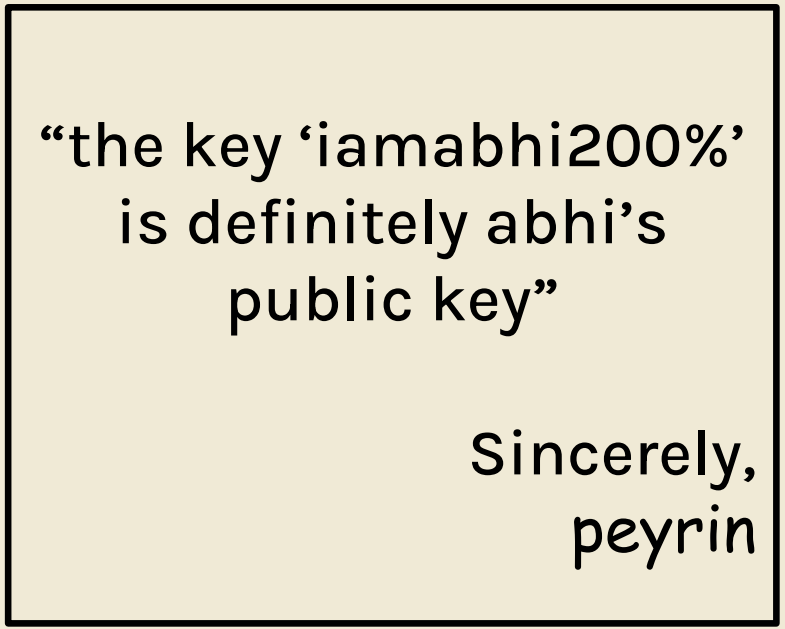

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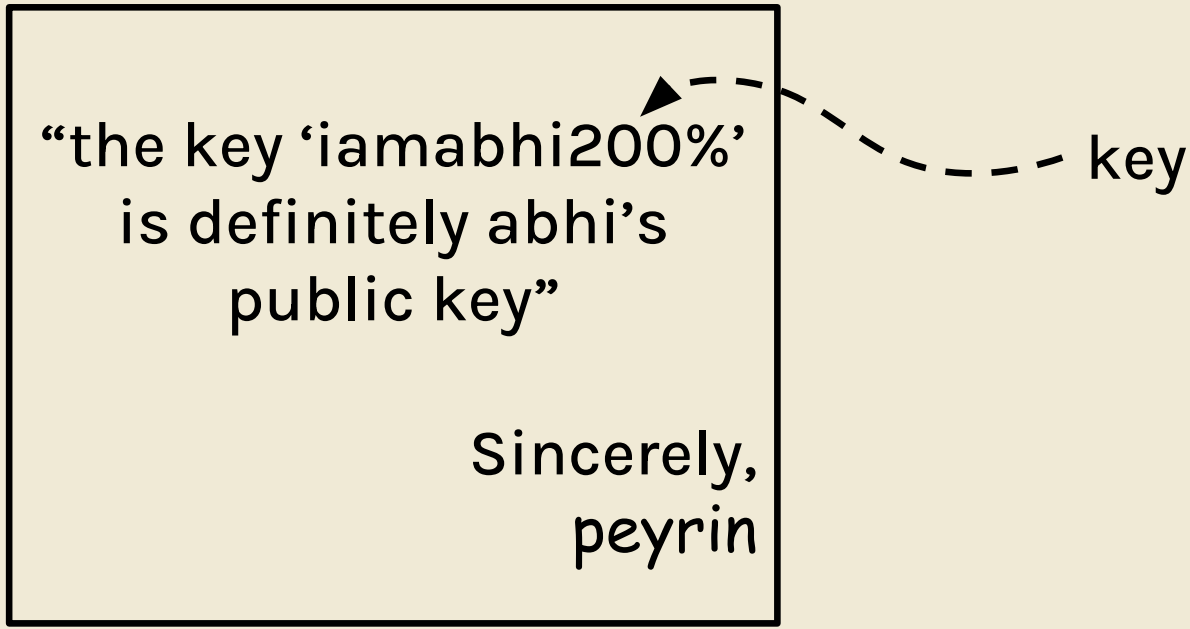

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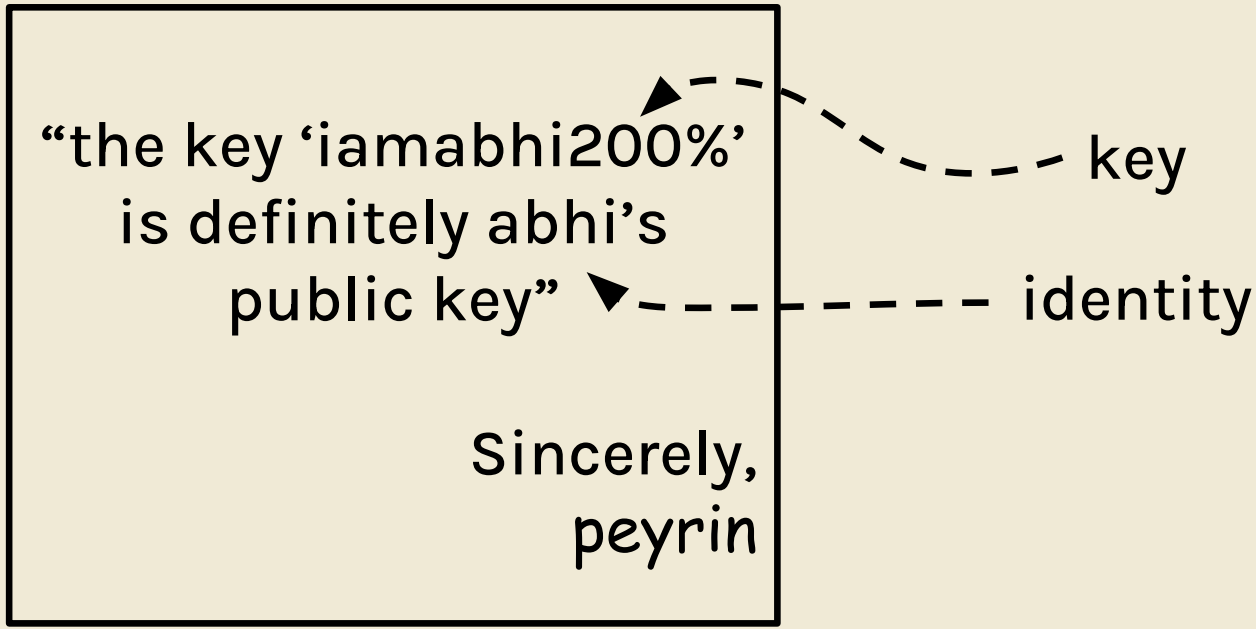

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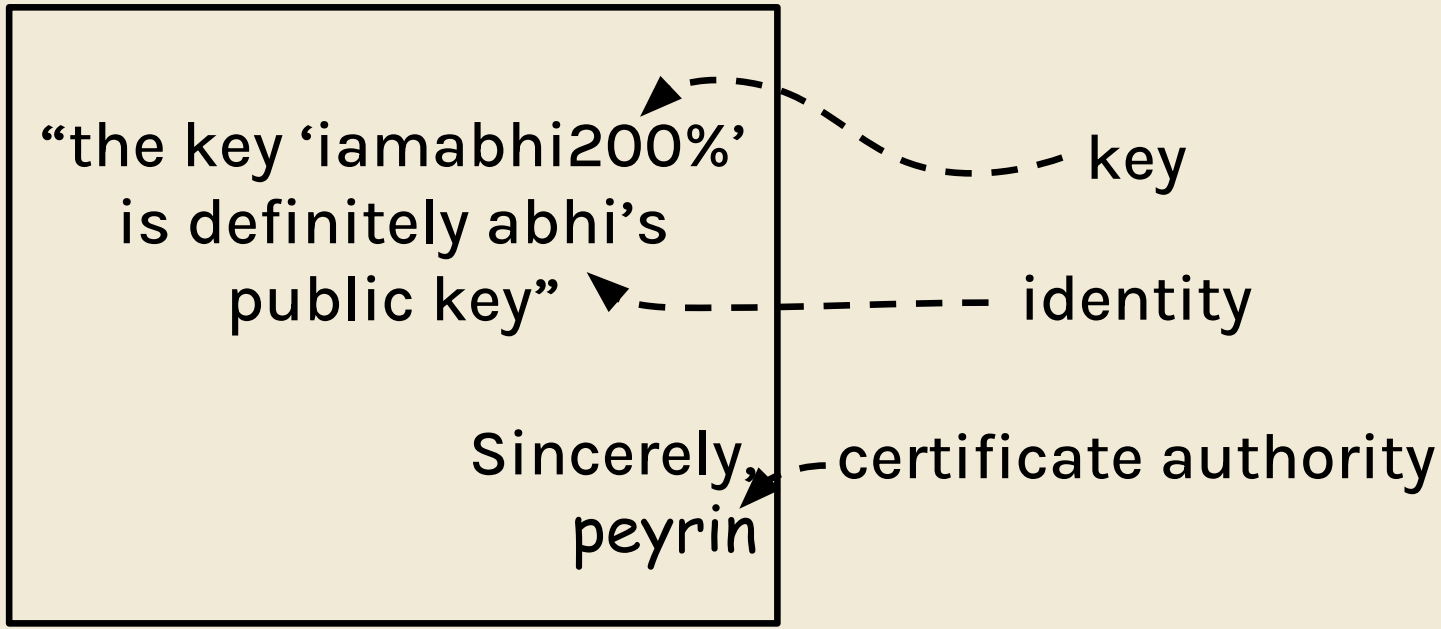

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- if we trust EvanBot and he sends {"Bob's public key is *PK*$_B$"}$_{SK_E^{-1}}$, we trust this certificate

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    - the TD won't sign keys unless the owner is verified

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    - single point of failure: if directory is compromised, can't trust anyone

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  - hierarchical trust: a root CA signs other CAs, and they can certificates as well

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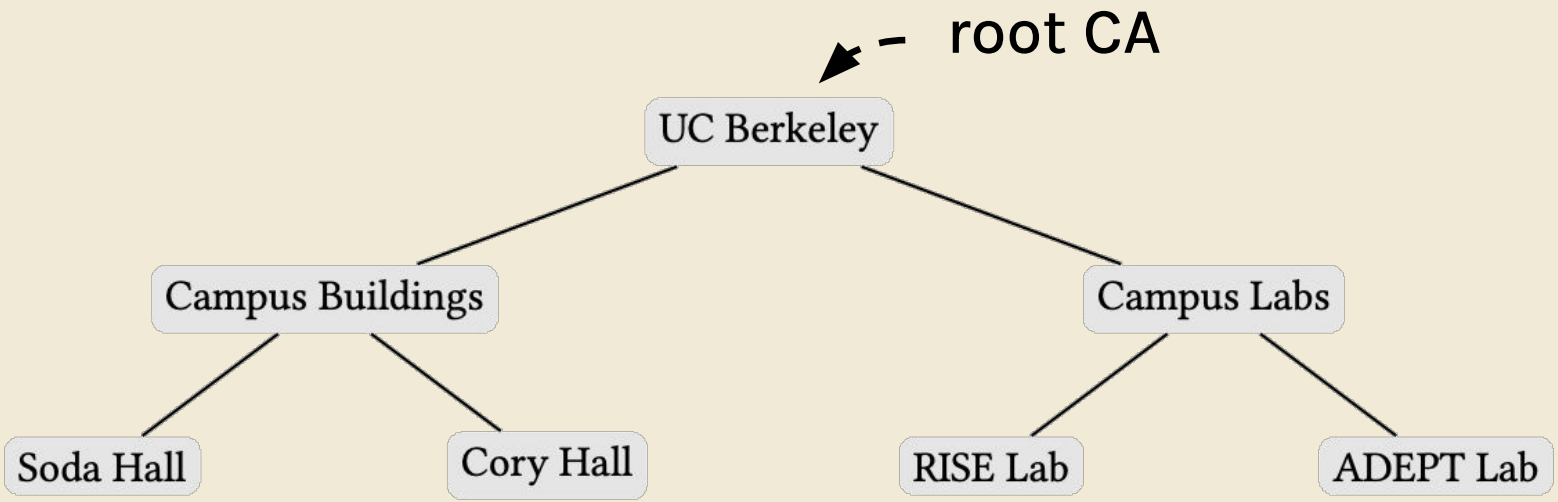

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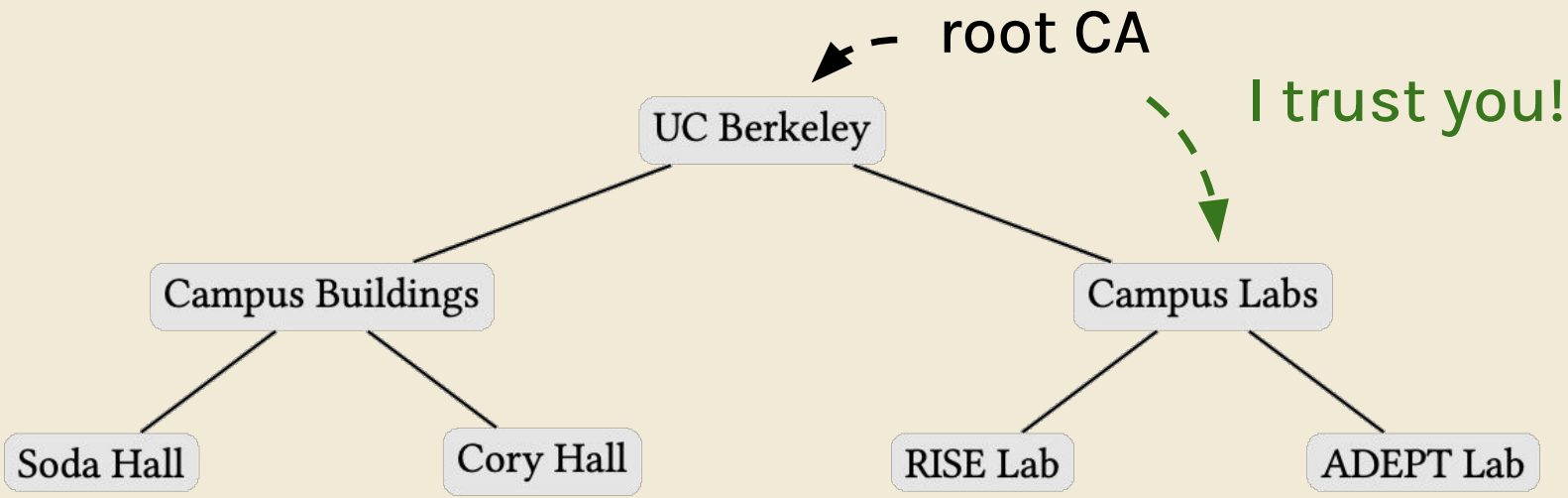

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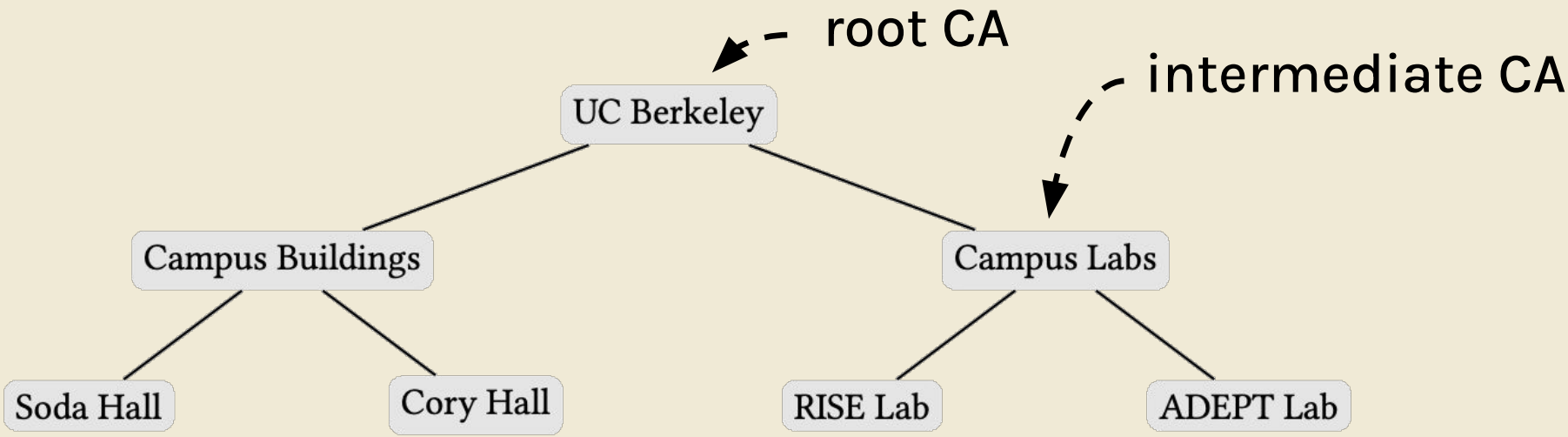

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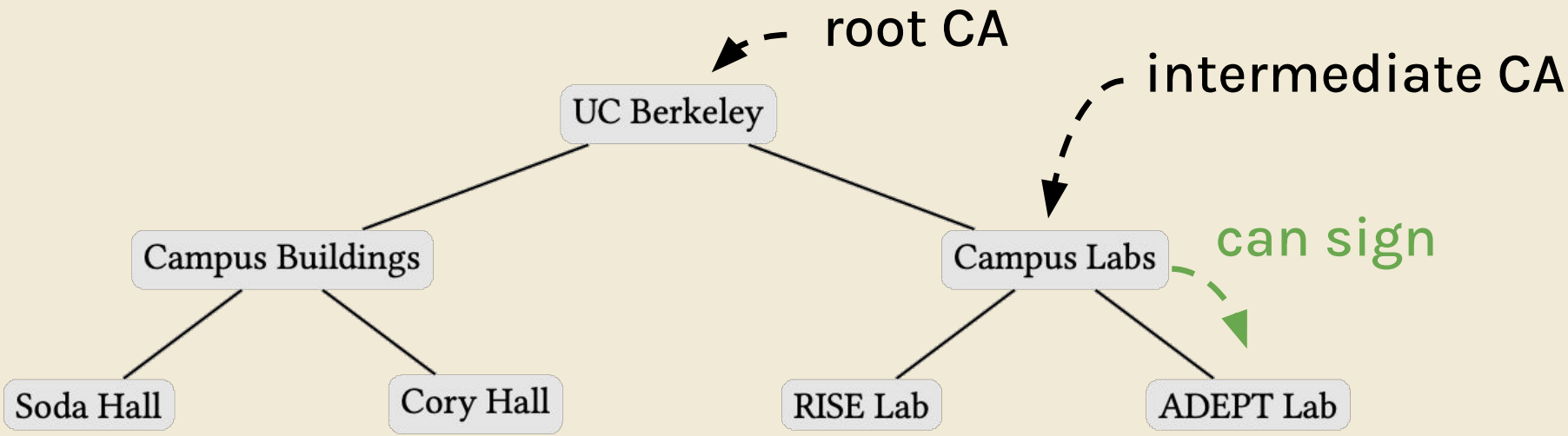

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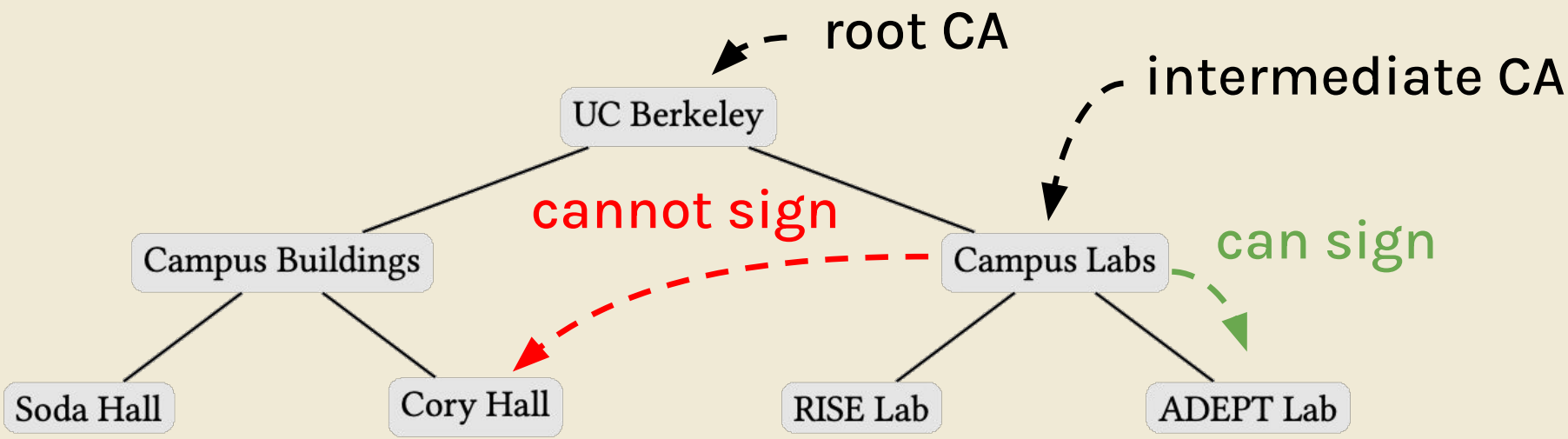

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hashing—a review

- H(M): M is an arbitrary length message
  - output: fixed length n-bit hash
  - $\{0, 1\}^* \rightarrow \{0, 1\}^n$
- “look” random
- fast
- **one-way:** hard to find x given a y such that H(x) = y
- **collision-resistant:** hard to find $x \neq x'$ s.t. H(x) = H(x’)

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- rainbow tables: an algorithm to make brute-forcing easier

brute-forcing passwords

how hard is it to brute force a 10-bit password?

password = “1011010100”

hash = H(“1011010100”) = 158912

brute-forcing passwords

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only guessing 1 or 0 for 10 bits, 2 options

for each of 10 bits, 2 * 2 * 2 …. * 2 = 2^{10}

guesses and then hashing each guess

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- password hashes are designed to be slow
  - why?
  - guessing the wrong password should waste time
  - users can’t tell the difference between 0.001 and 0.1 second hashes, attackers computing thousands of hashes can

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  - defense: salted passwords, slow hashes, strong passwords

worksheet

(on 161 website)

feedback

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