# Protean Signature Schemes

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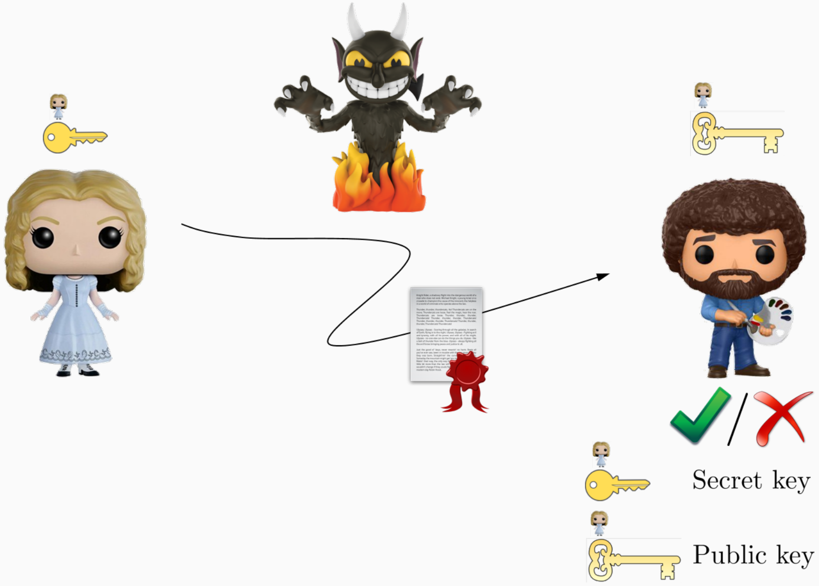
## Digital Signatures



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### Security (EUF-CMA)

- Obtain signatures on arbitrary messages
- Not able to produce valid signature for non-queried message

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Example: Medical documents

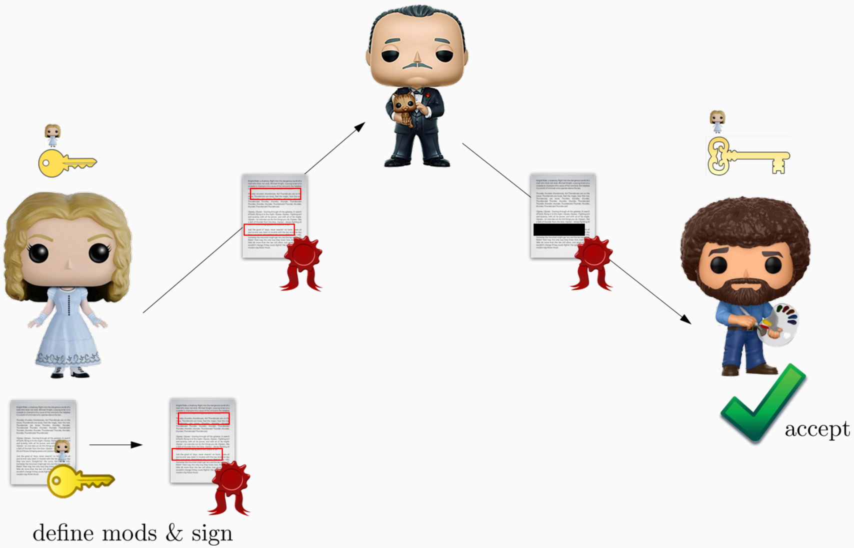
- Anonymization for research/accounting (still want authenticity guarantees)
- Removing exact diagnosis for sick leave

Re-signing after the fact might not be possible (availability, etc.)

## Controlled Modification of Signed Messages

Will look at two common schemes: redactable and sanitizable signatures

## Redactable Signatures (RSS)



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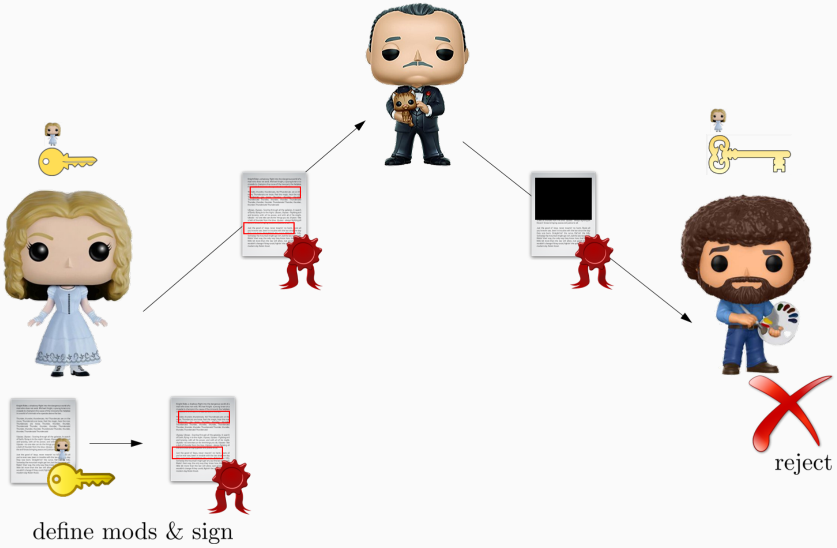

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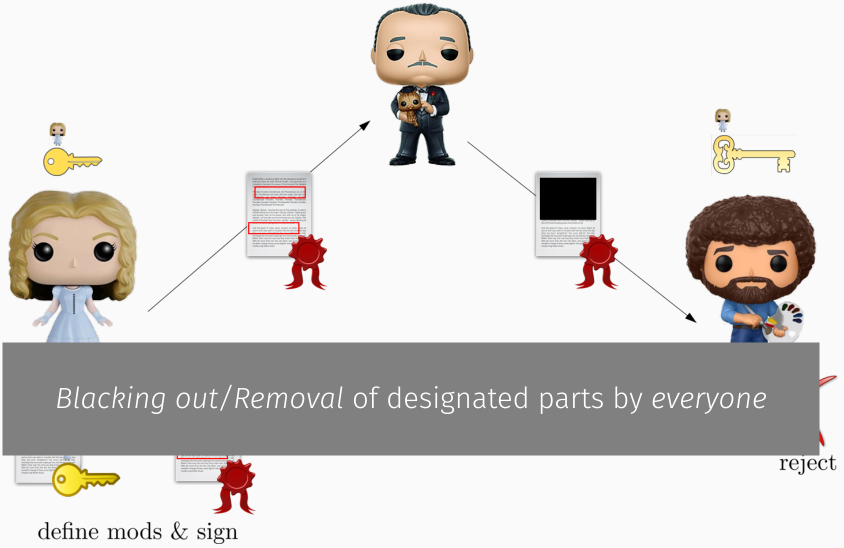

*Blacking out*/*Removal* of designated parts by *everyone*

## Redactable Signatures (RSS)

### Security properties

- Unforgeability
    - In EUF-CMA sense: cannot come up with valid signature for a message not “derivable” from signed ones
- Privacy
    - Redacted signatures leaks no information about redacted parts
- Transparancy (optional)
    - Not visible if redaction happened or not
- Unlinkability

## Redactable Signatures (RSS)

Originally proposed in [SBZ, ICISC'01] and [JMSW, CT-RSA'02]

Various ad-hoc constructions for different message representations (linear, sets, trees)

Generic construction from EUF-CMA secure signatures and *indistinguishable* accumulators [DPSS, ICISC'15]

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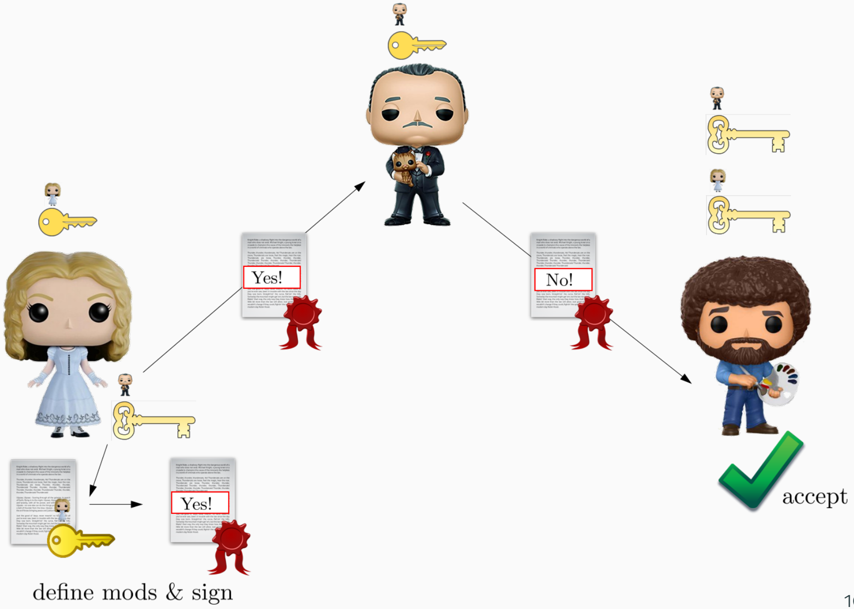
- Compute $\mathsf{acc}_m$ and use $\Sigma$ to sign $\mathsf{acc}_m$
- As redactable signature provide signature of $\Sigma$ and $\{\mathsf{wit}_{m_i}\}$

## Sanitizable Signatures (SSS)



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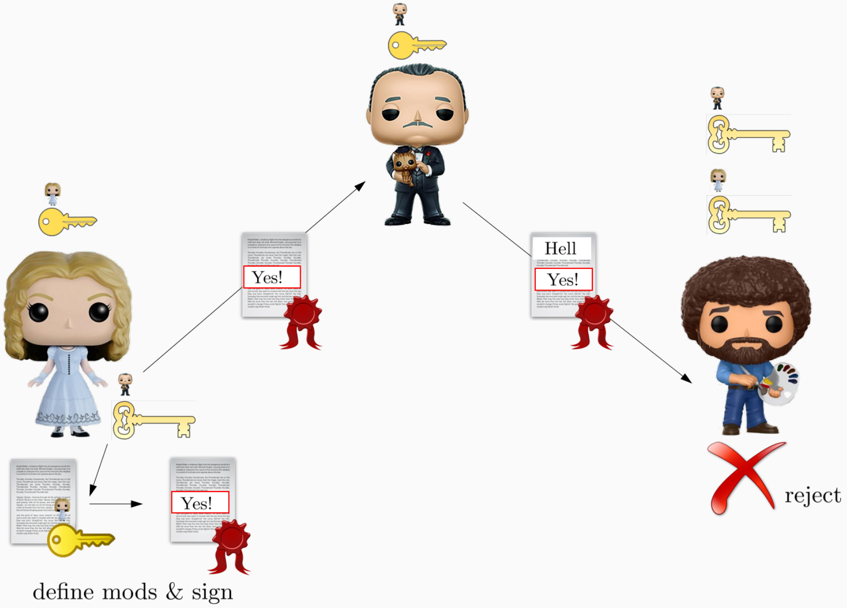

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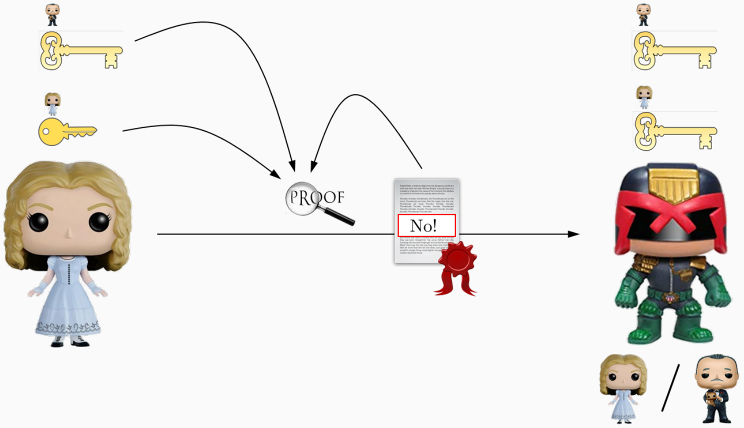

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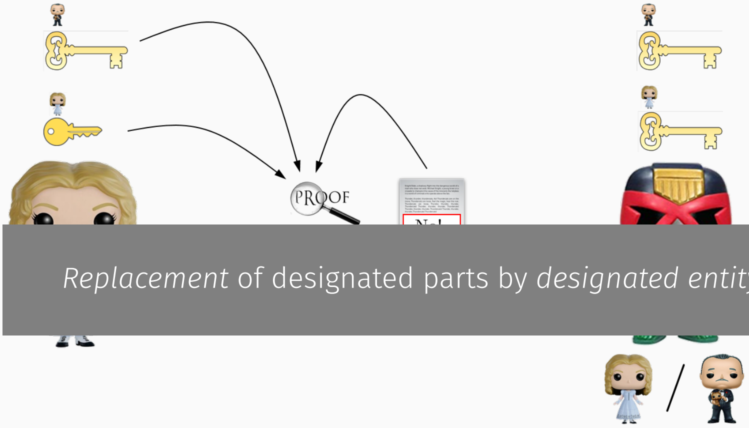

*Replacement* of designated parts by *designated entity*

## Sanitizable Signatures (SSS)

### Security properties

- Unforgeability
- Immutability
  - In EUF-CMA sense: Sanitizer cannot come up with valid signature for a message not “derivable” from signed ones
- Privacy
- Signer/Sanitizer accountability
  - Signer/sanitizer cannot blame the other party for having produced a signature
- Transparancy (optional)
- Invisibility (optional)
  - Signature does not leak which parts are sanitizable
- Unlinkability

## Sanitizable Signatures (SSS)

Originally proposed in [ACMT, ESORICS'05] and rigorous security model [BFFLP+, PKC'09]

Various constructions with different properties and sanitizing restrictions, e.g., limit sanitizing to defined set

Generic construction from EUF-CMA secure signatures and *chameleon hash functions* [BFFLP+, PKC'09]

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As sanitizable signature provide signature of $\Sigma$ and $r$

## Merging the Functionalities

Provide a primitive that supports removal and editing at the same time

Generalize RSS and SSS into a single primitive having all desired properties of RSS and SSS

Motivating example (k-anonymization):

- Removal of attributes
- Generalization of attributes

## Using Existing Approaches?

We could use SSS to mimic the functionality of RSS

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Ideally have efficient construction providing all properties

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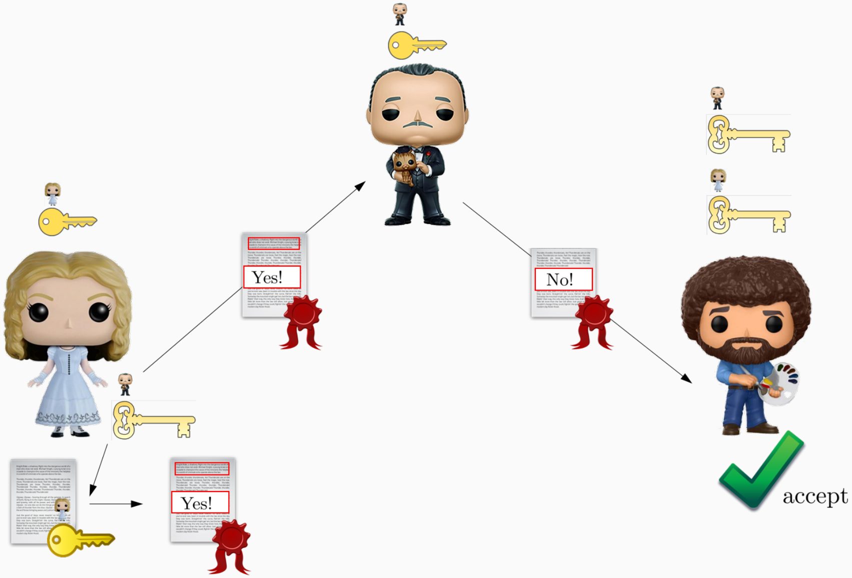

define mods & sign

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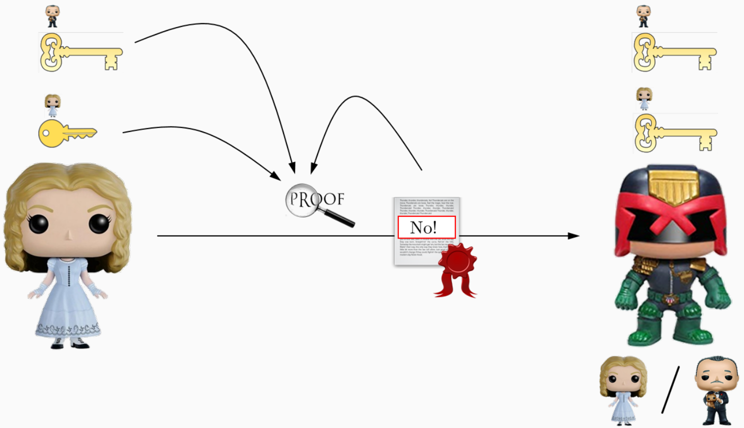

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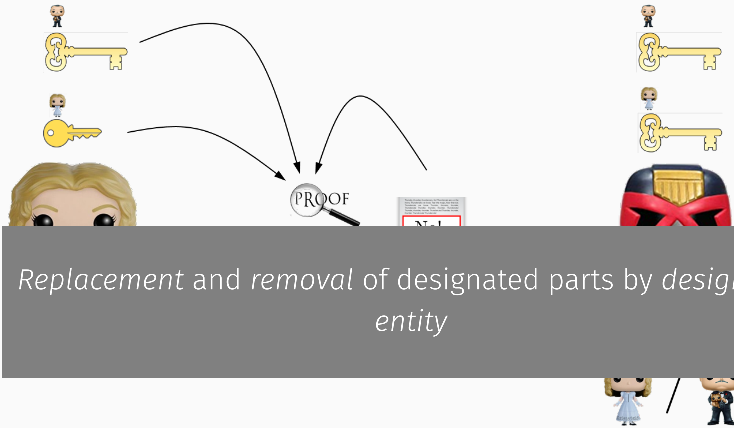

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## Protean Signature Schemes (PSS)

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## Sketch of Construction (Ingredients)

We provide a black-box construction of a protean signature scheme

Ingredients

- A secure sanitizable signature scheme (SSS)
- A secure redactable signature scheme (RSS)
- A CCA2 secure labeled public key encryption scheme
    - Only required if RSS provides auxiliary redaction information RED
    - RED typically makes redactions more efficient

## Sketch of Construction (Keys)

Signer keys (keys from SSS and RSS)

- $\mathsf{sk}_{\mathsf{sig}} \leftarrow (\mathsf{sk}_{\mathsf{sig}}^{\mathsf{SSS}}, \mathsf{sk}^{\mathsf{RSS}})$
- $\mathsf{pk}_{\mathsf{sig}} \leftarrow (\mathsf{pk}_{\mathsf{sig}}^{\mathsf{SSS}}, \mathsf{pk}^{\mathsf{RSS}})$

Sanitizer keys (keys from SSS)

- $\mathsf{sk}_{\mathsf{san}} \leftarrow \mathsf{sk}_{\mathsf{san}}^{\mathsf{SSS}}$
- $\mathsf{pk}_{\mathsf{san}} \leftarrow \mathsf{pk}_{\mathsf{san}}^{\mathsf{SSS}}$

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Inner SSS

$\boxed{\underbrace{(m_1, \tau, \tau_1, \mathsf{pk}_{\mathsf{sig}}, \mathsf{pk}_{\mathsf{san}})}_{\sigma_1^{\mathsf{SSS}}}}$ $\boxed{\underbrace{(m_2, \tau, \tau_2, \mathsf{pk}_{\mathsf{sig}}, \mathsf{pk}_{\mathsf{san}})}_{\sigma_2^{\mathsf{SSS}}}}$ $\boxed{\underbrace{(m_3, \tau, \tau_3, \mathsf{pk}_{\mathsf{sig}}, \mathsf{pk}_{\mathsf{san}})}_{\sigma_3^{\mathsf{SSS}}}}$

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Outer SSS

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Unlinkability: Seems hard to achieve with our construction paradigm

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- We generalize RSS and SSS into protean signatures (PSS)
- PSS provide all features and strong privacy guarantees
- We provide a generic construction based on RSS and SSS (and labeled PKE)

## Thank you! Questions?

@drl3c7er

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