Policy-based signatures

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Overview

- New signature primitive
- Signer can only sign messages conforming to policy

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- Practical applications: use for corporations
- Theoretical: unification of existing work

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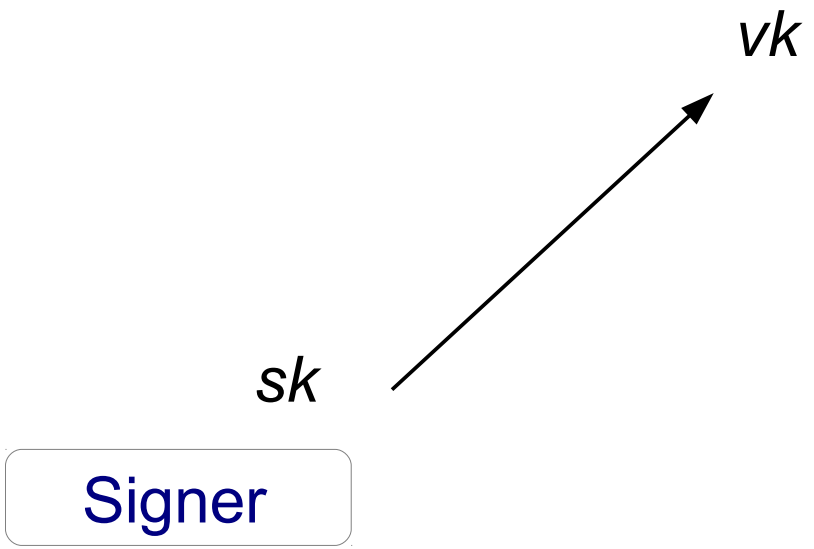

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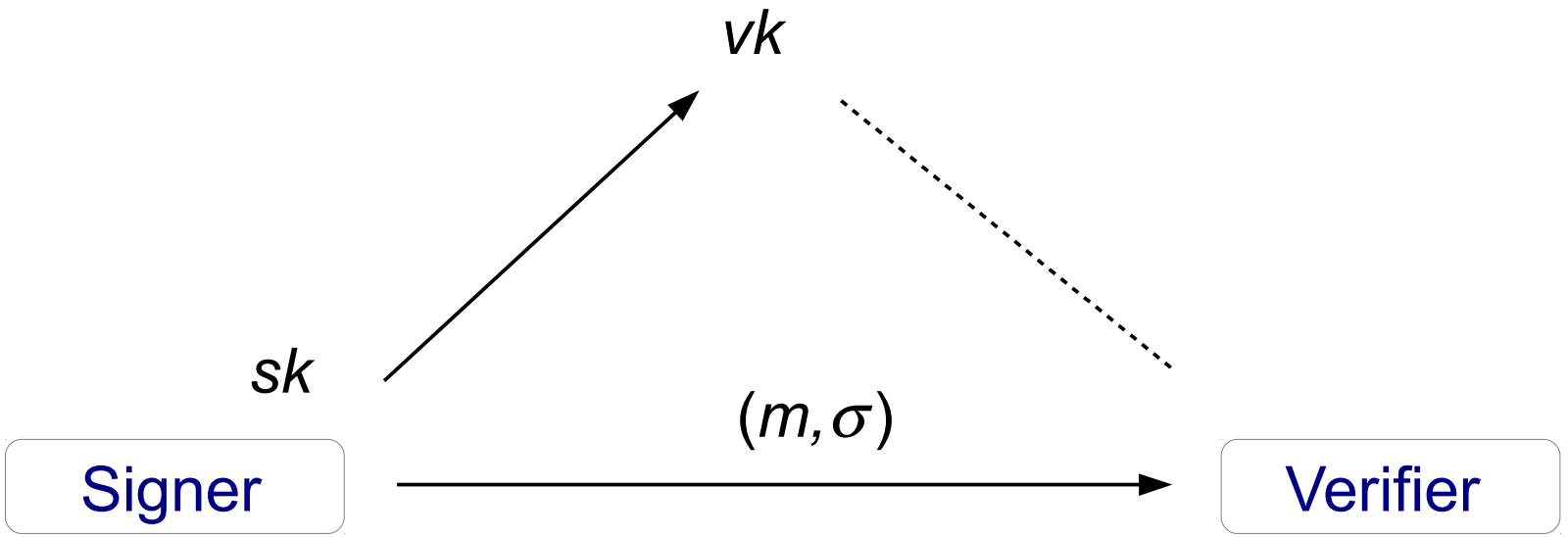
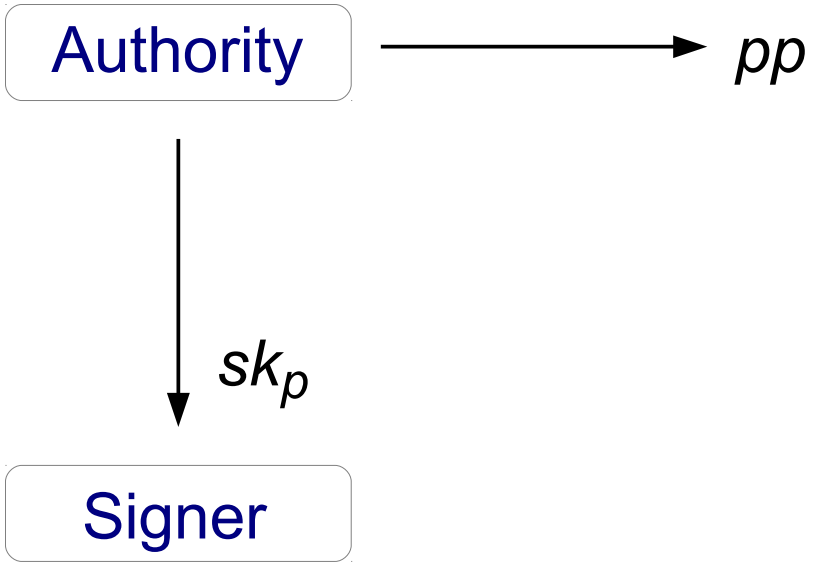


Policy-based signatures



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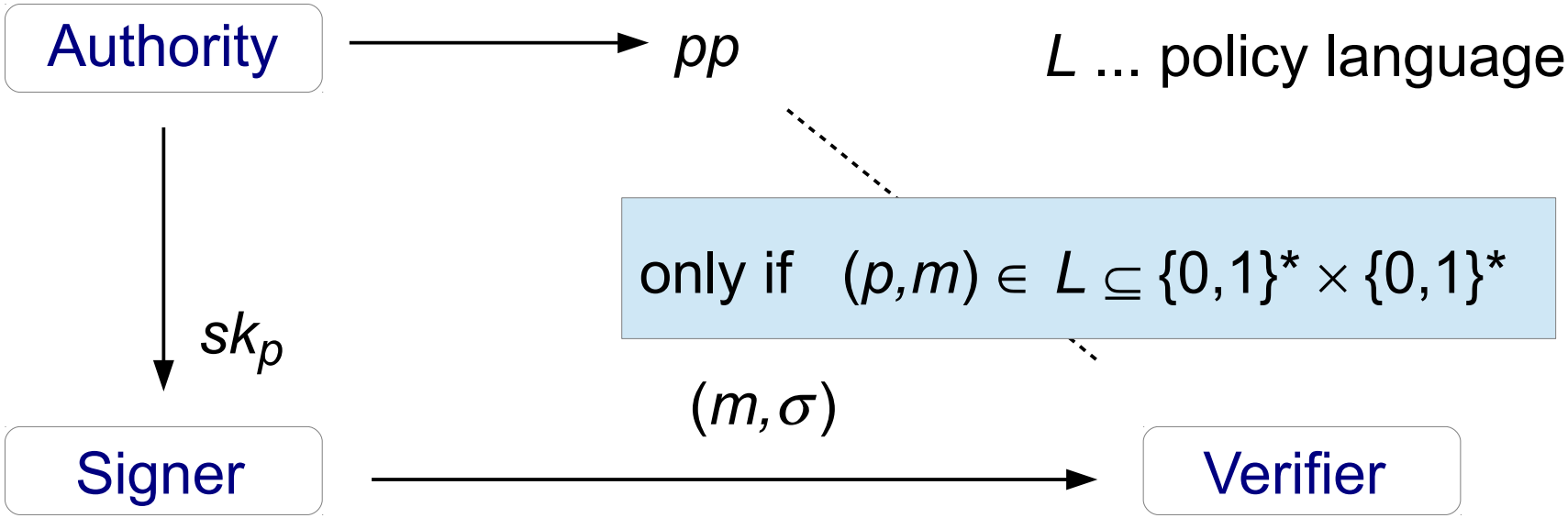

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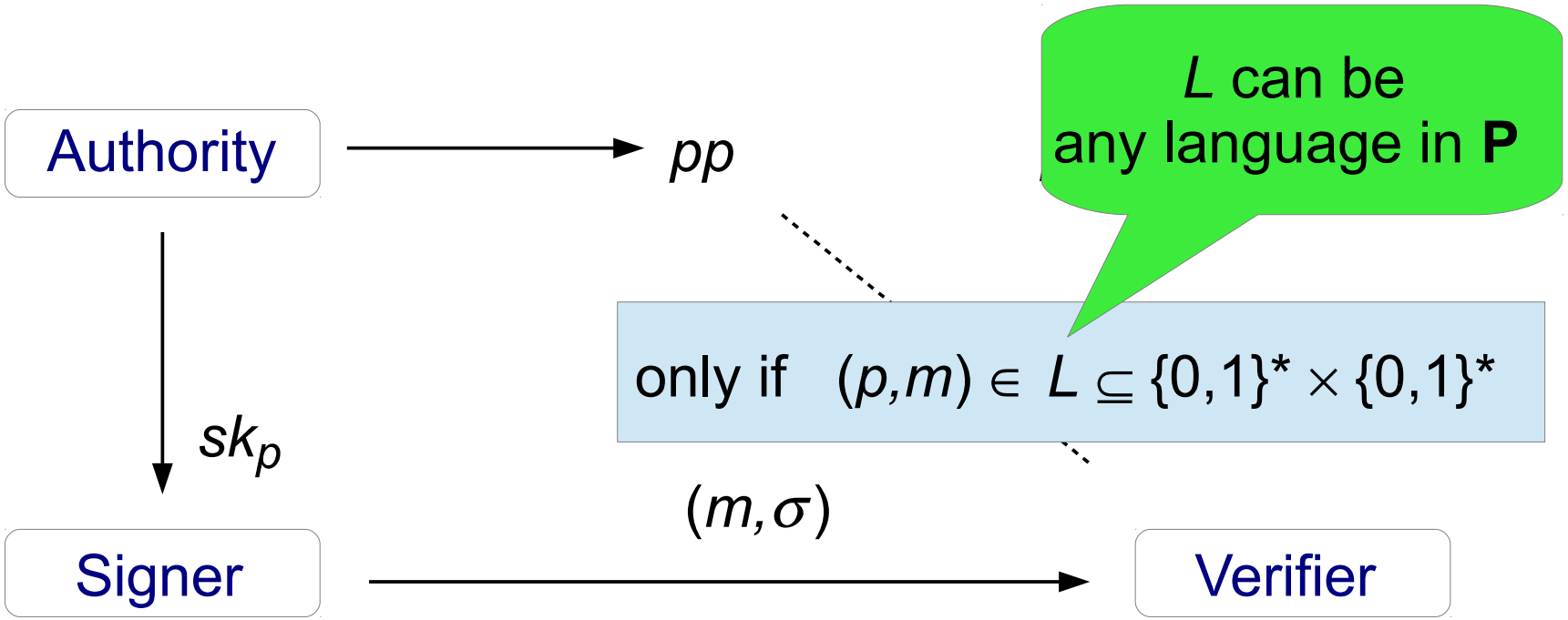

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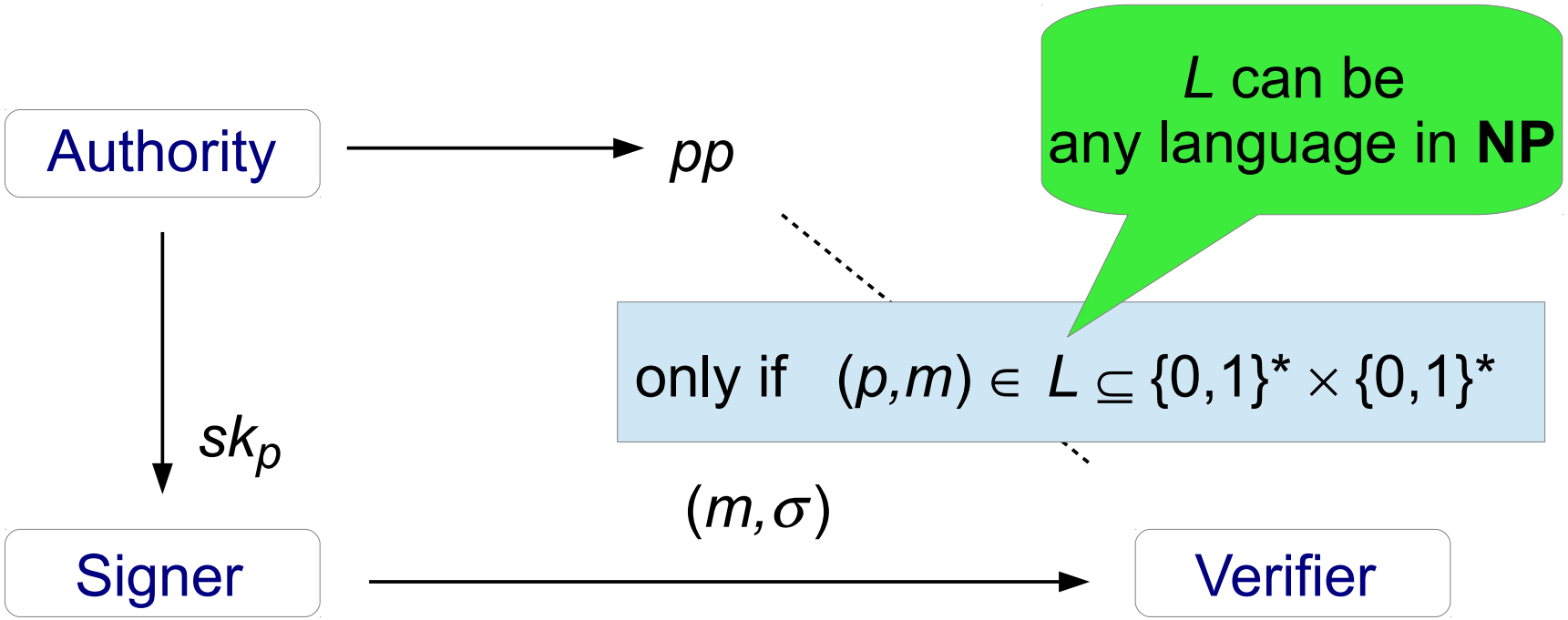

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- Privacy:
  - The signature hides the policy
  - Signatures under same key are unlinkable

Related work

- Functional signatures (Boyle, Goldwasser, Ivan [BGI13]):
  - Key sk_f allows signing messages in range of f
  - Interpret f as policy: $(f,m) \in L \;:\Leftrightarrow\; \exists\, w : f(w) = m$

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  - Policy languages in **P**, succinctness condition
- Delegatable functional signatures (Backes, Meiser, Schröder [BMS13]):
  - Signatures verified w.r.t. signer's public key

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- Attribute-based signatures [MPR11]:
  - Keys issued for set of attributes $\{a_1, a_2, \ldots, a_n\}$
  - Signing w.r.t. predicate φ, possible iff $\varphi(a_1, a_2, \ldots, a_n) = 1$

Motivation for PBS

Practical motivation

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- Employees get signing keys enabling signing
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  - Verification w.r.t. policies $\text{CEO} \vee (\text{board member} \wedge \text{manager})$

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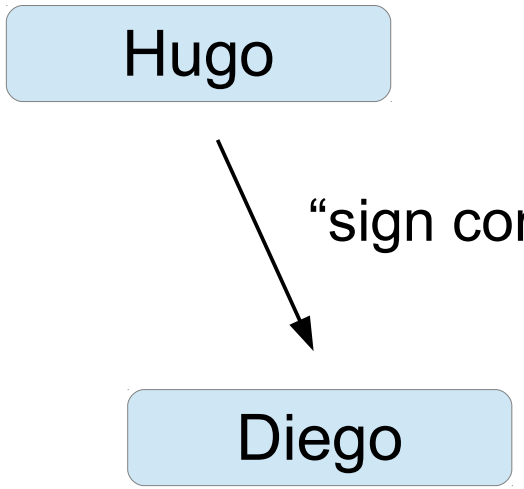

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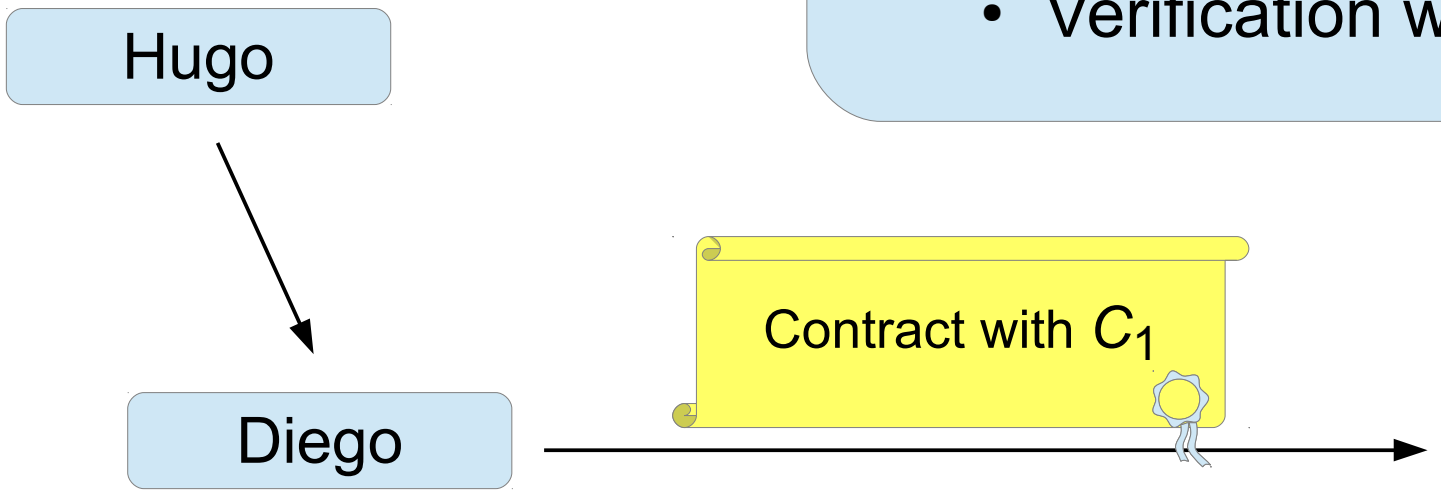

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- Unification of existing notions for signatures with privacy:

  (Anonymous) proxy signatures [MUO96, FP08]

  Ring signatures, mesh signatures [RST01, Boy07]

  Attribute-based signatures [MPR11]

  Anonymous credentials [CL01, BCKL08]

  Group signatures [Cv91]

Definition of PBS

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  We allow any language in **NP**, defined by policy checker

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m conforms to policy *p*

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- Algorithms:

  $\mathrm{Setup}(1^\lambda) \rightarrow (pp, msk)$

  $\mathrm{KeyGen}(msk, p) \rightarrow sk_p$

  $\mathrm{Sign}(sk_p, m, w) \rightarrow \sigma$

  $\mathrm{Verify}(pp, m, \sigma) \rightarrow b$

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  should not be able to create signature on new m^*

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- Extractability $\Rightarrow$ unforgeability

  is efficiently decidable

Constructions of PBS

Construction I

- Generic construction (à la [BMW03])

  based on - signatures

  - IND-CPA encryption

  - NIZK proofs for any policy language in **NP**

Construction II

- Concrete construction

  based on - structure-preserving signatures [AFG+10]

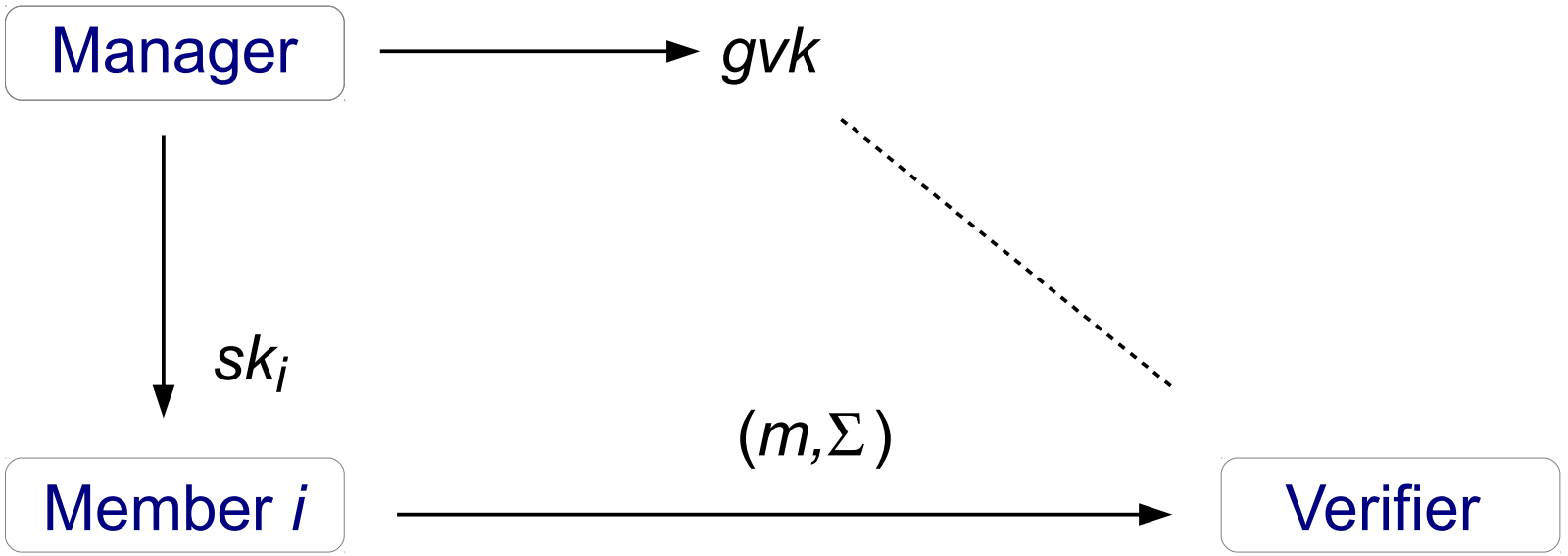
  - Groth-Sahai proofs [GS08]

  for policy languages over **pairing groups**

  (policies define pairing-product equations)

Primitives from PBS

CCA-secure group signatures



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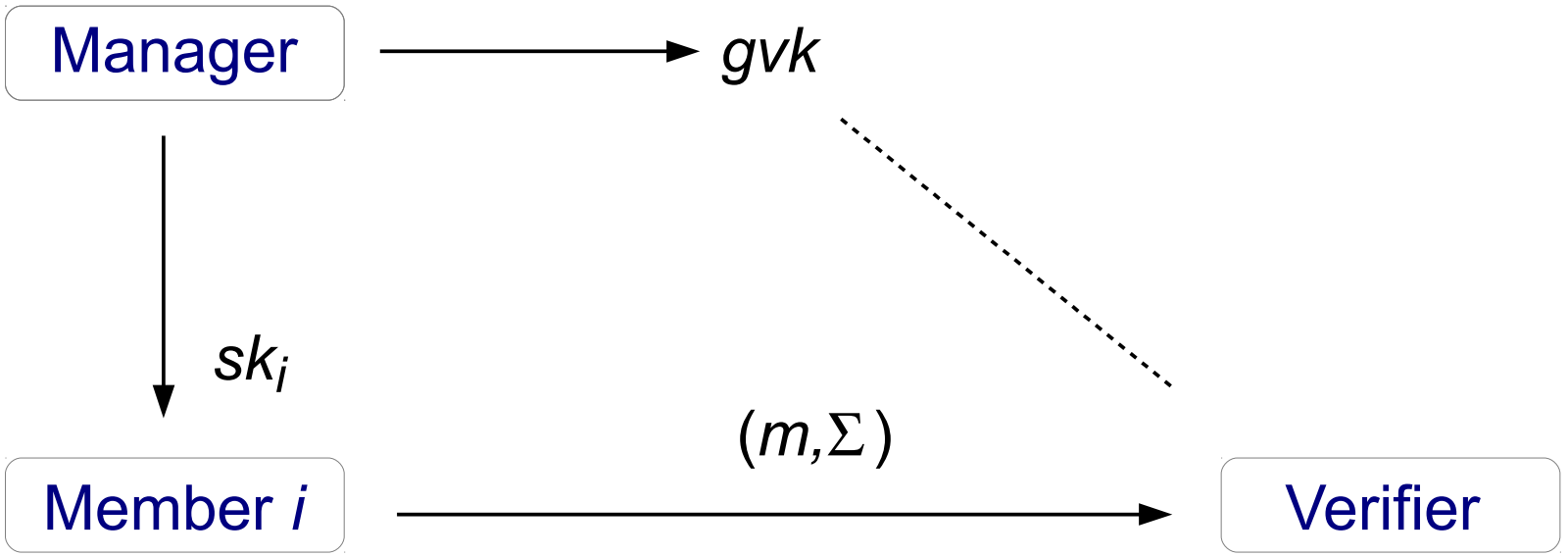

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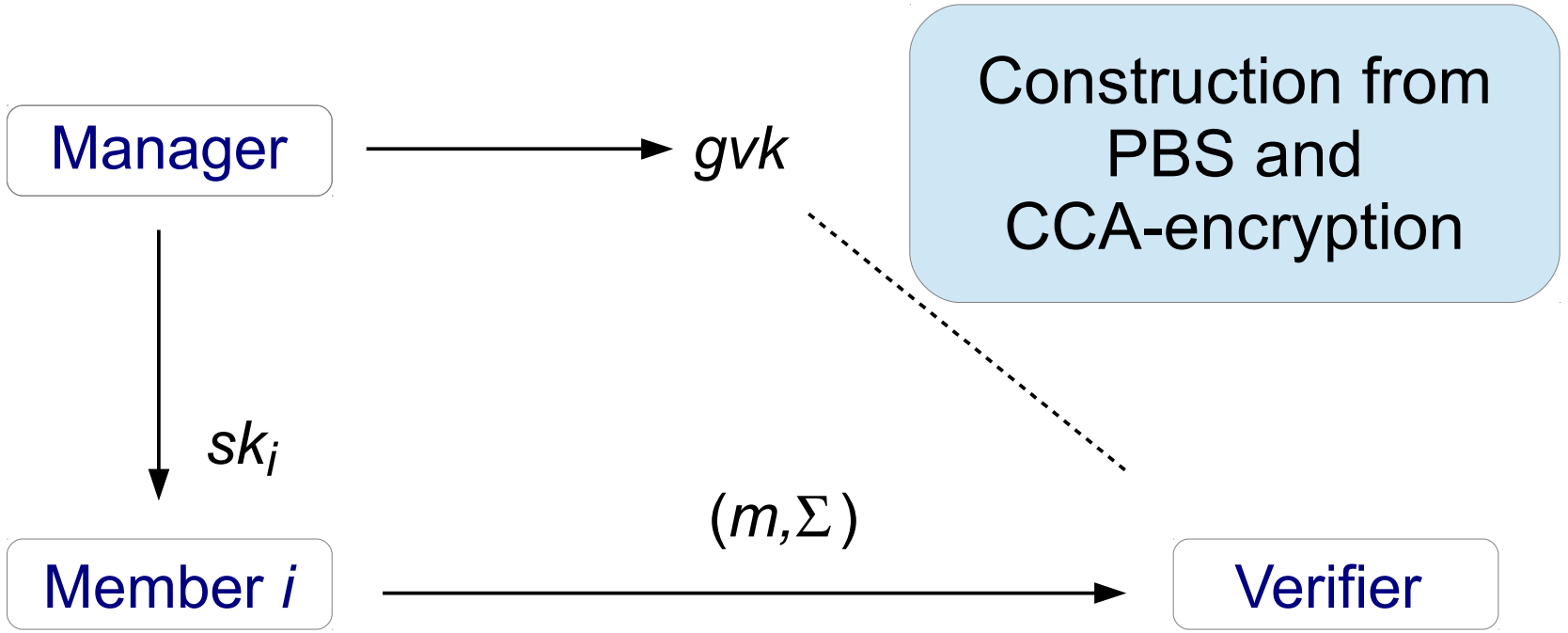

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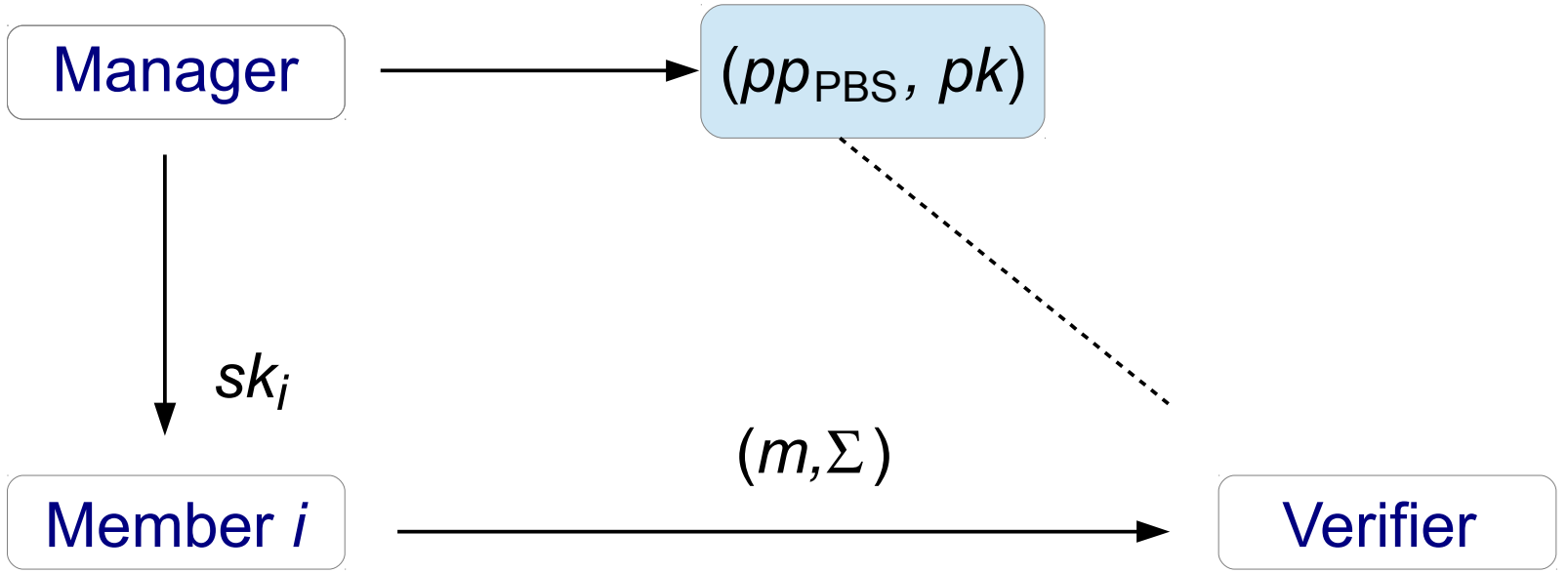

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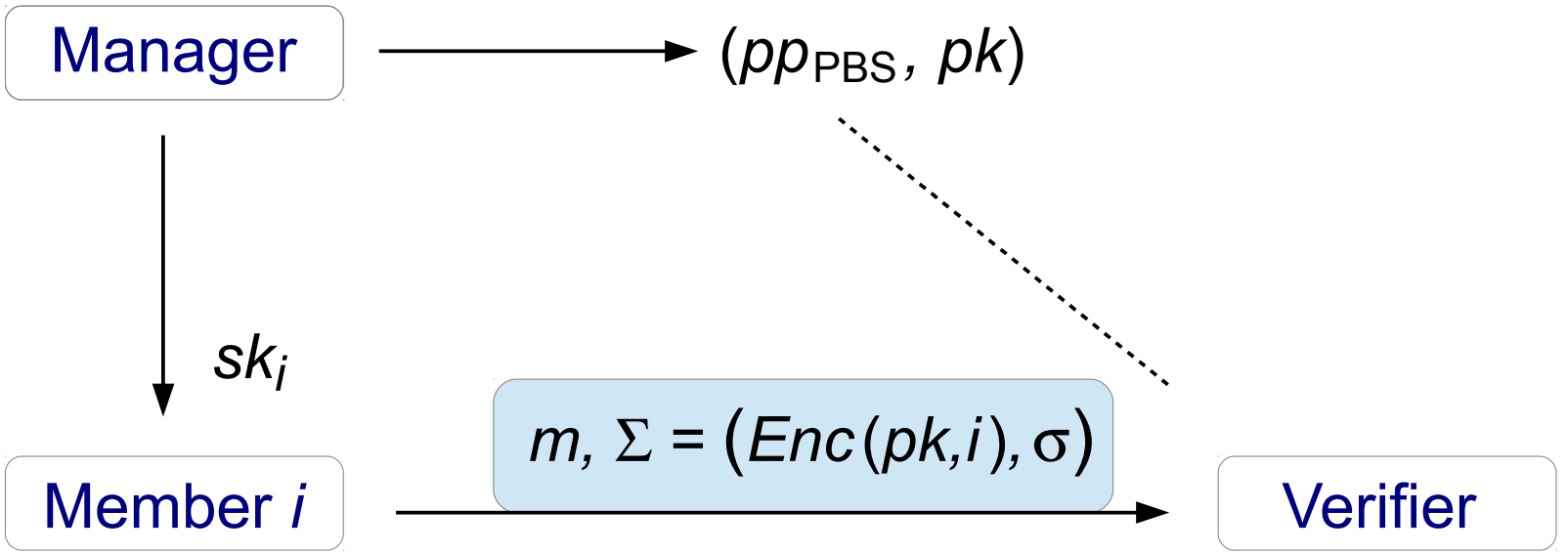

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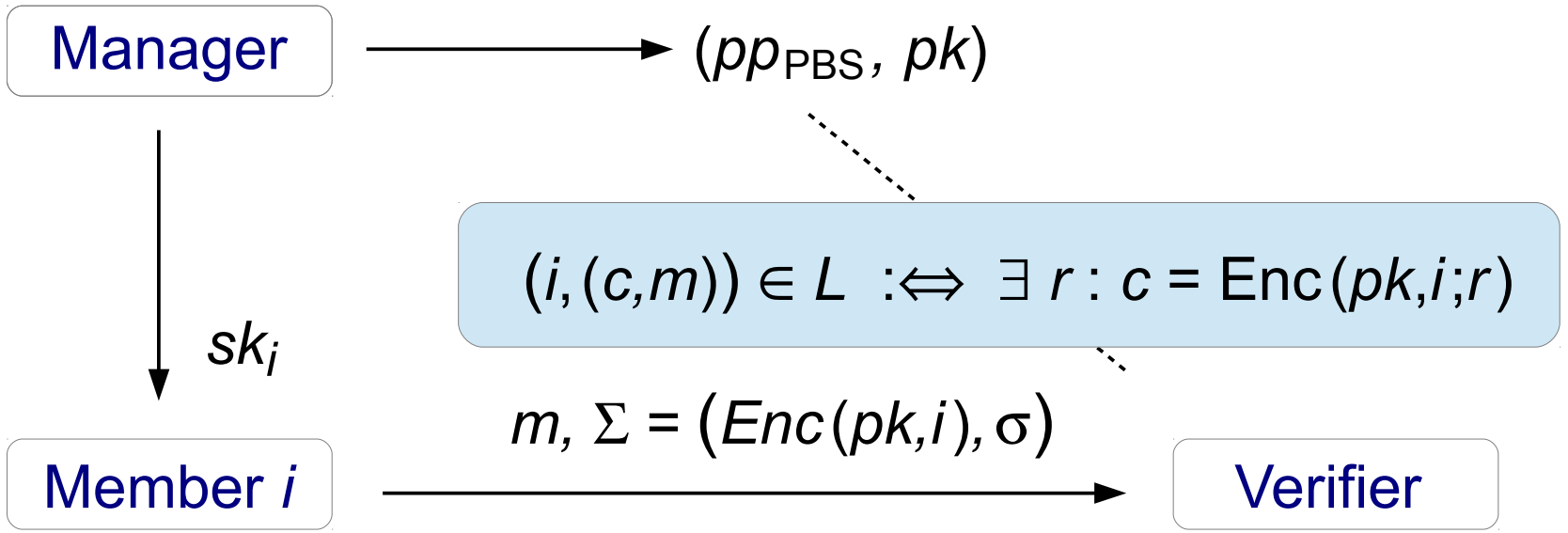

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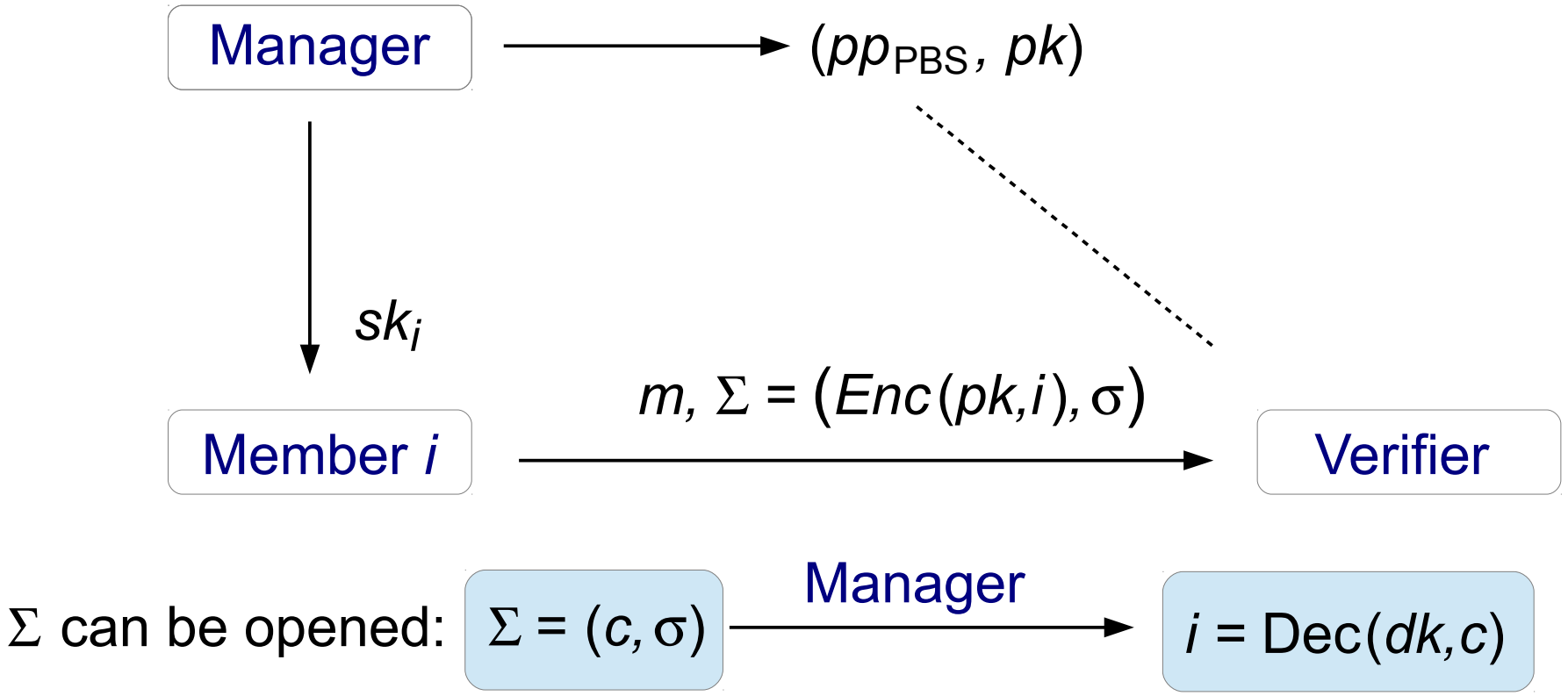

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- CPA-secure public-key encryption
- combining the above [Sah99]: CCA-secure encryption

  thus PBS $\Rightarrow$ group signatures

Delegatable PBS

Re-delegation

- Delegatable PBS
  - holding sk_p, derive $sk_{p'}$ for subpolicy p'
- Reflects hierarchies in organizations

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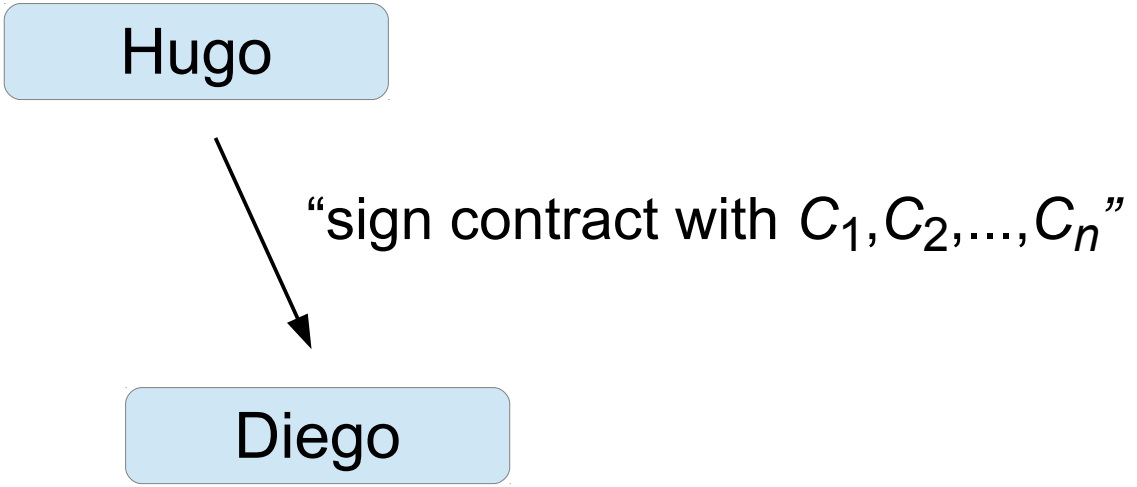

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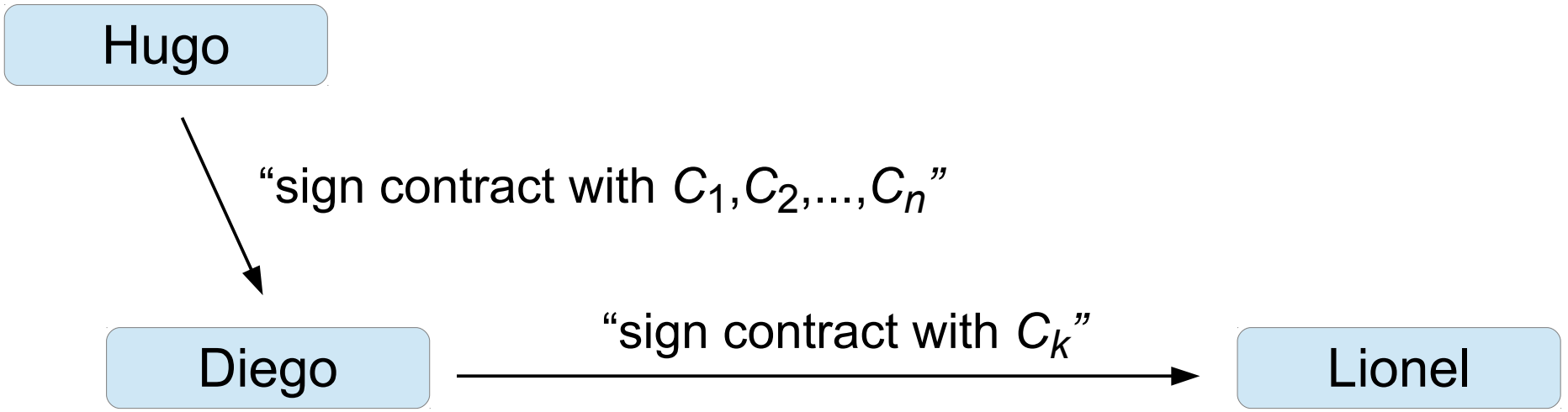

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    - Definition
    - Constructions
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Open problems / future work

- Practical schemes for specific policy languages

Thank you