Eidgenössische Technische Hochschule Zürich
Swiss Federal Institute of Technology Zurich

Composite Decentralized Access Control

Petar Tsankov, Srdjan Marinovic,
Mohammad Torabi Dashti, David Basin

Institute of Information Security
ETH Zurich

Example: SweGrid

Goal

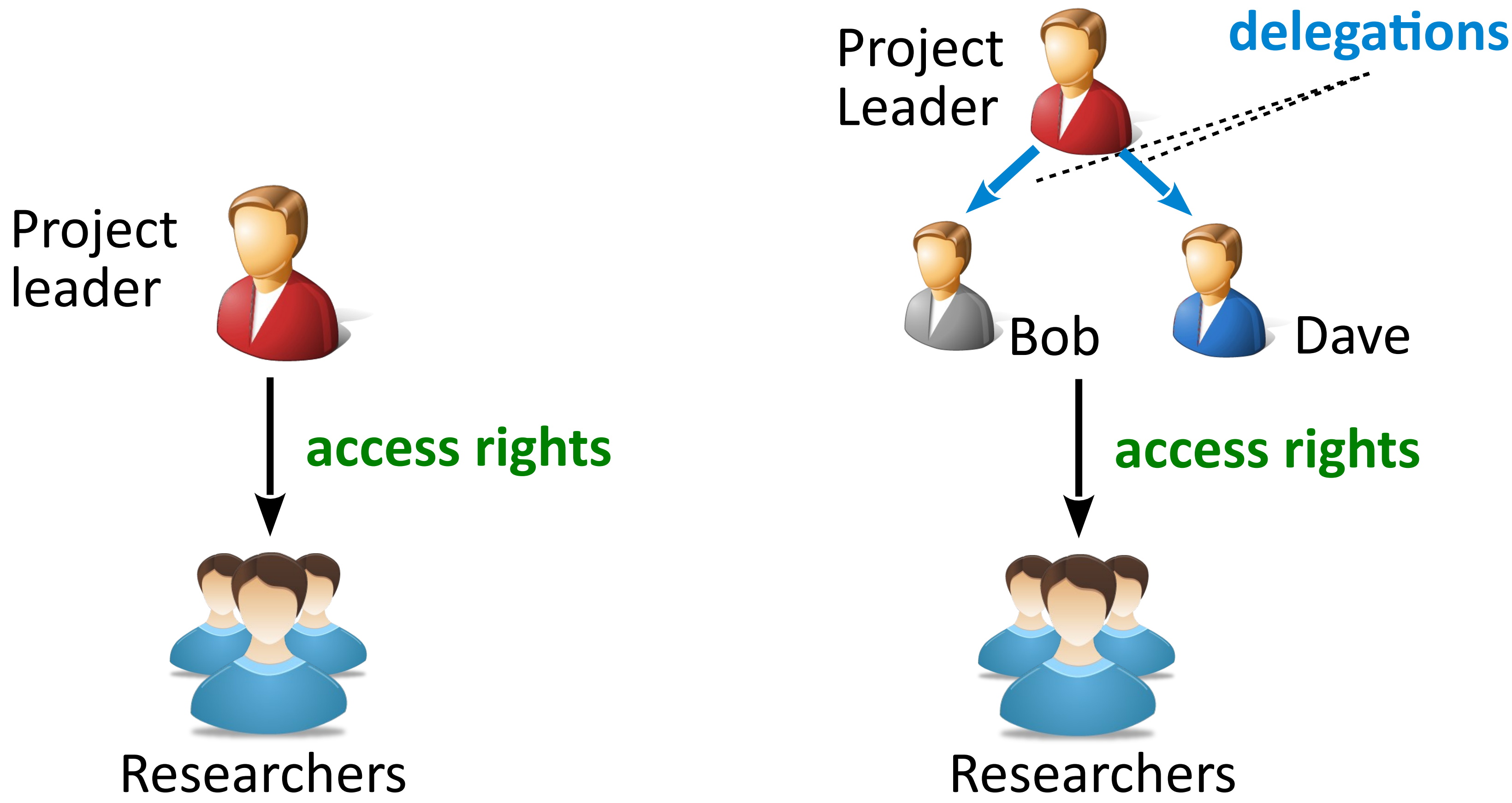
Provides computational and storage resources to researchers

Access Control Requirements

- A project leader **delegates** his authority over resources to principals
- A project leader **composes** the principals' policies (e.g., using permit-override)

Delegation

Multiple principals can issue access rights



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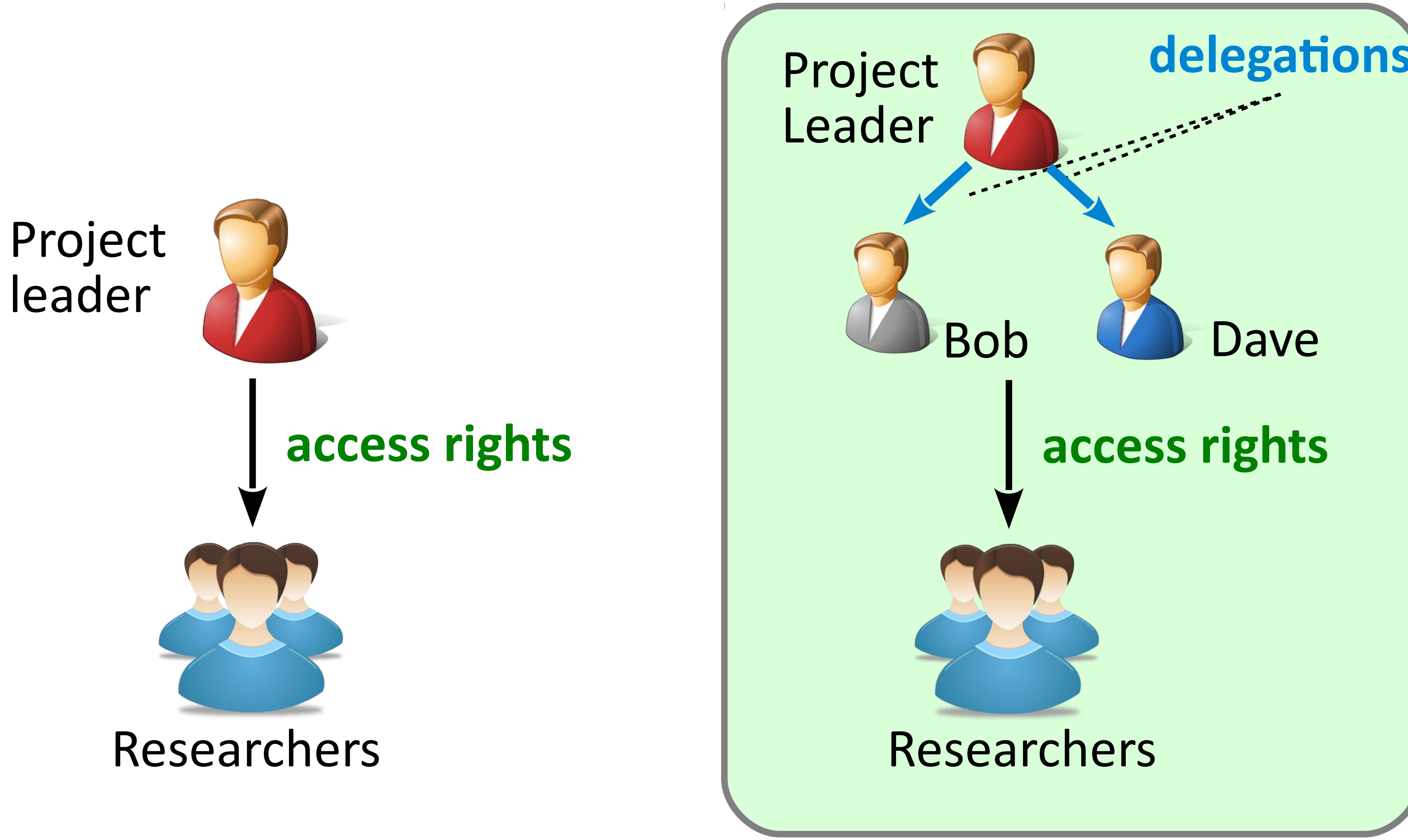
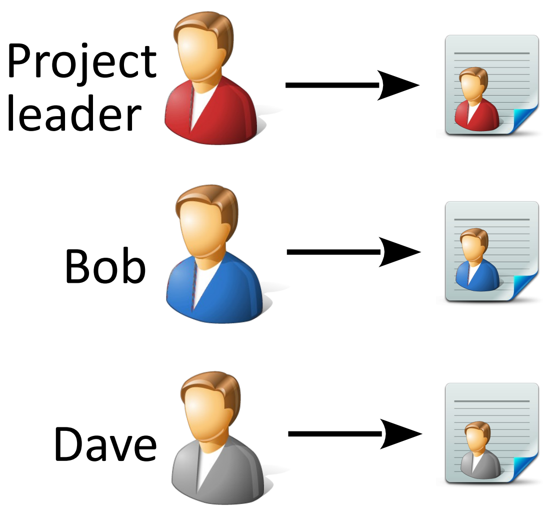


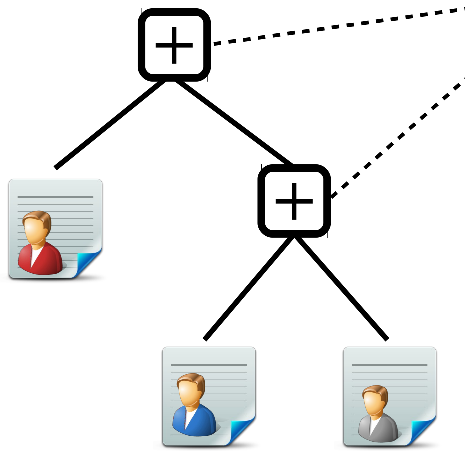
Decentralized Access Control

Composition

Policy decisions in large-scale systems

– Grant, Deny, **Not-applicable**, **Conflict**





Composition operators, e.g.:

- Permit-override
- Deny-override
- Conflict-override

Composition

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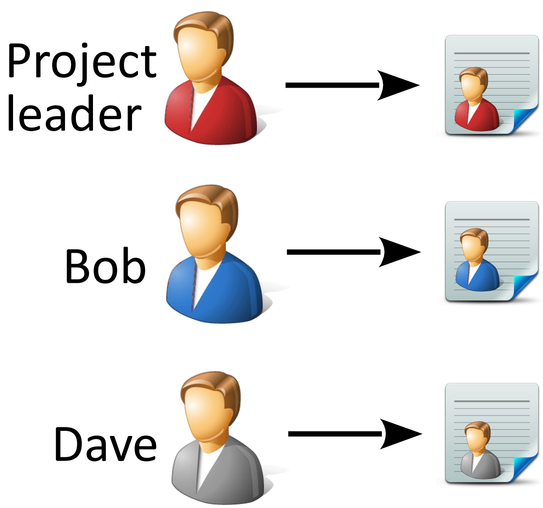

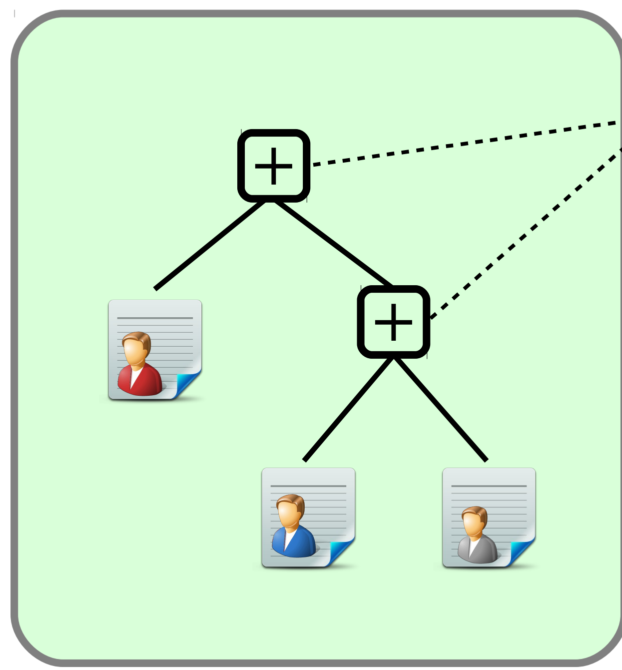

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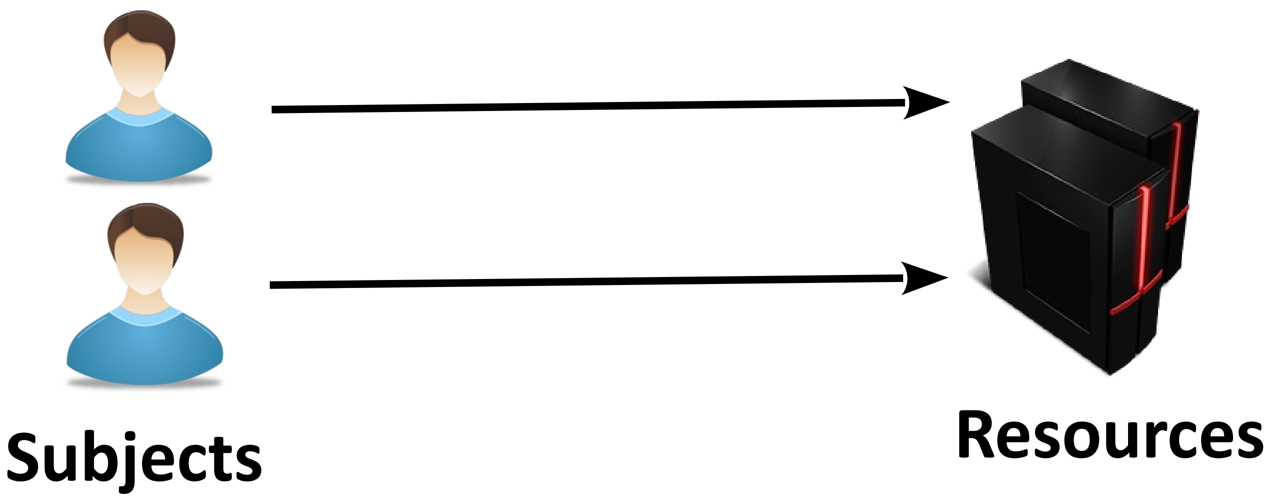
Composite Access Control

System Model



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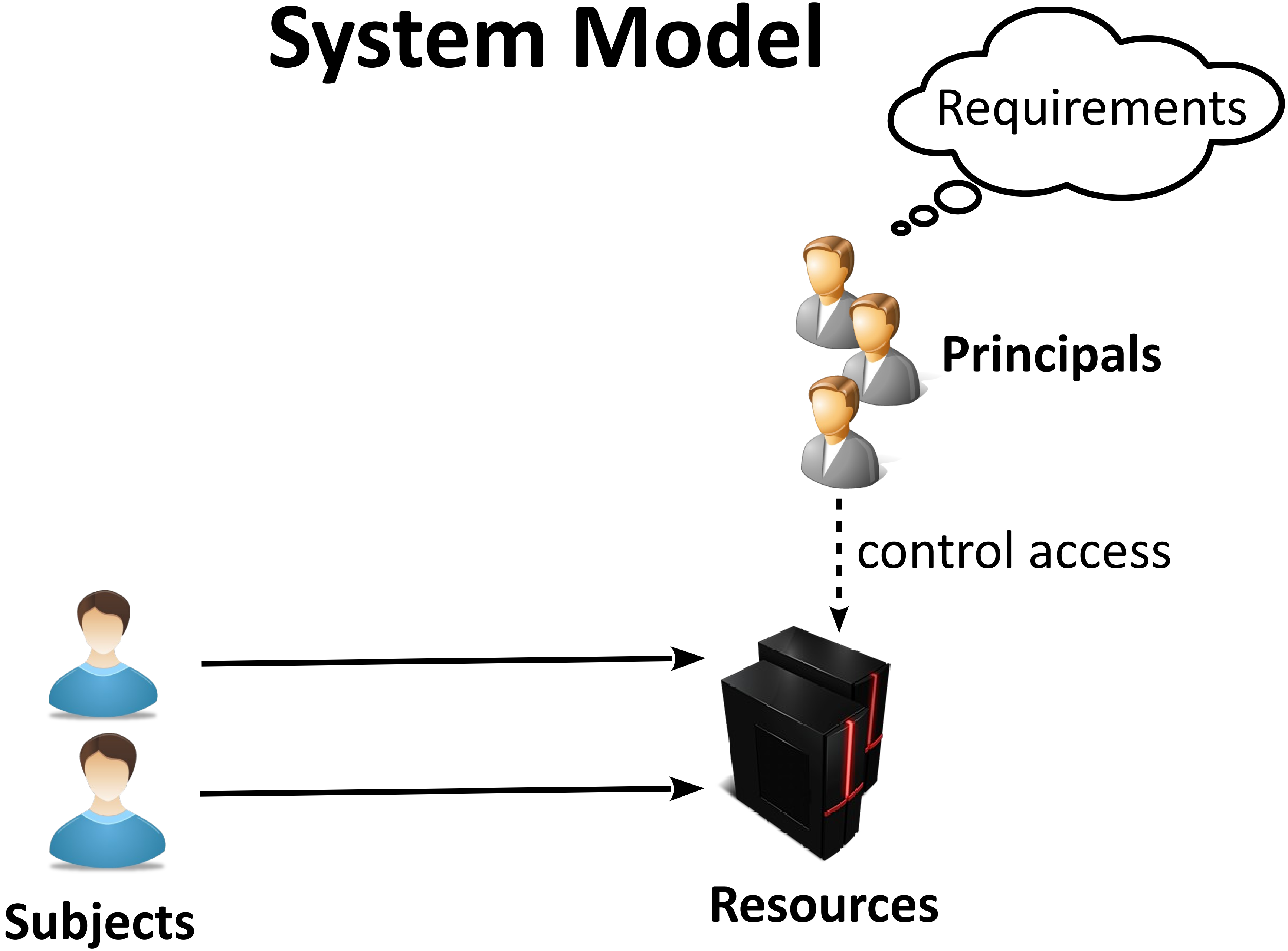

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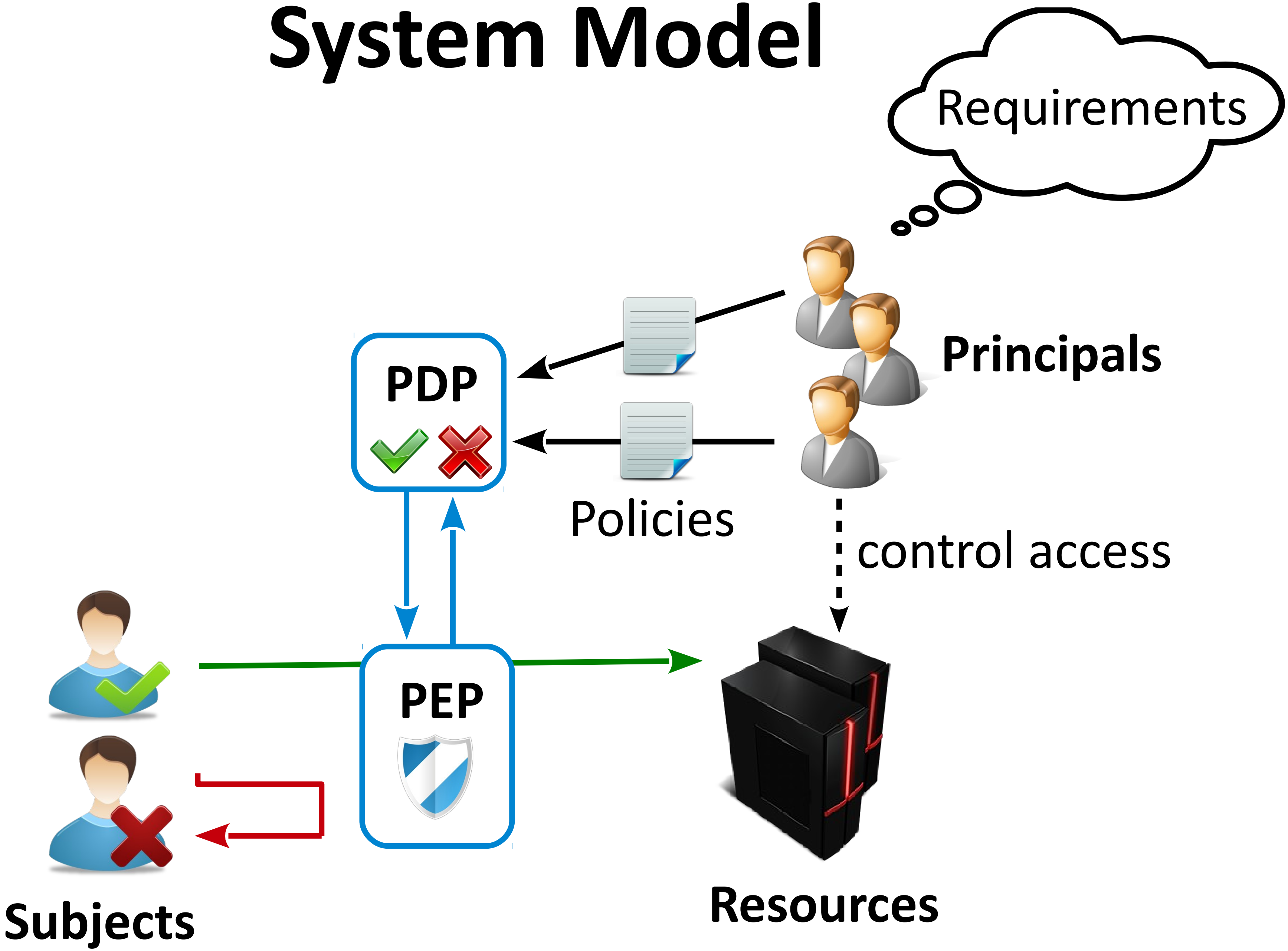

Related Work

Systems and standards	
Formal foundations	

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	Delegation
Systems and standards	SecPAL for Grid KeyNote PDP (RFC 2704)
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	Delegation	Composition
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Related Work

	Delegation	Composition	Delegation + Composition
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How to Build Access Control Systems

Specify Policy

- Formal semantics
- Support for delegation
- Support for composition

Verify Policy

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Construct PDP

- Efficient evaluation algorithm

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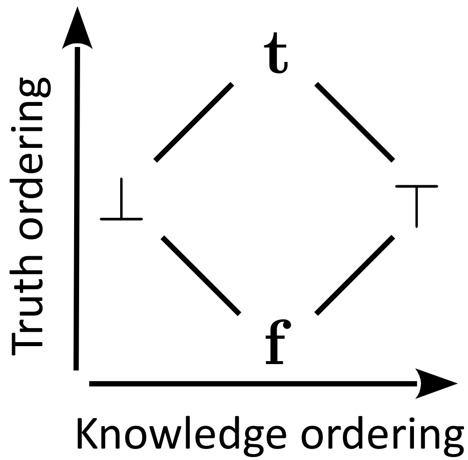
Belnap Logic



(stratified) Datalog

(Program)	$P ::= \vec{r}$
(rule)	$r ::= a \leftarrow \vec{l}$
(literal)	$l ::= a \mid \neg a$
(atom)	a

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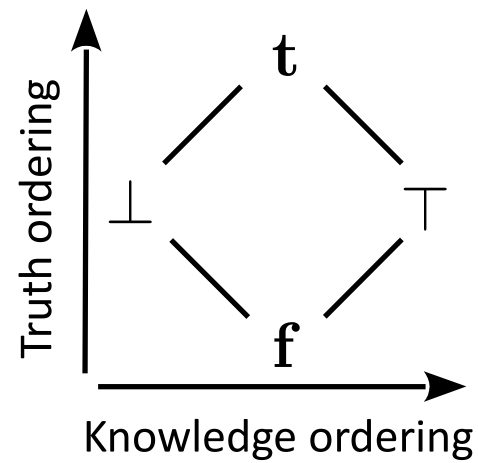

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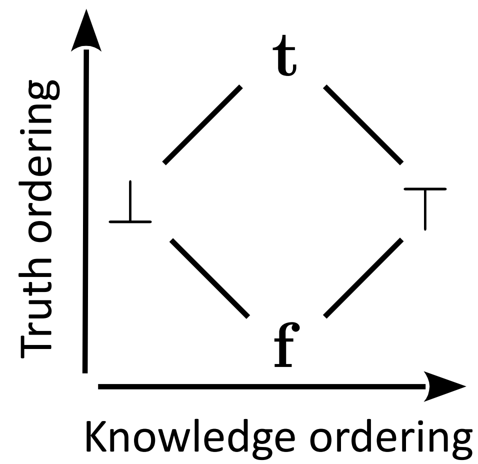

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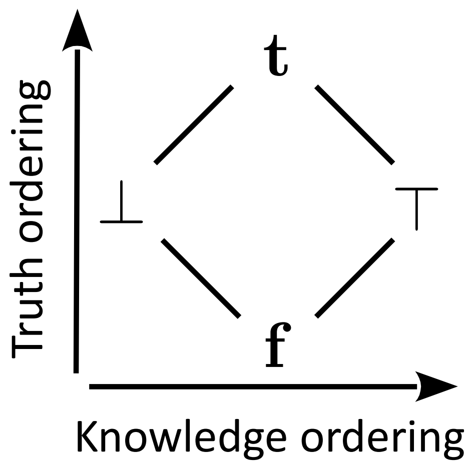

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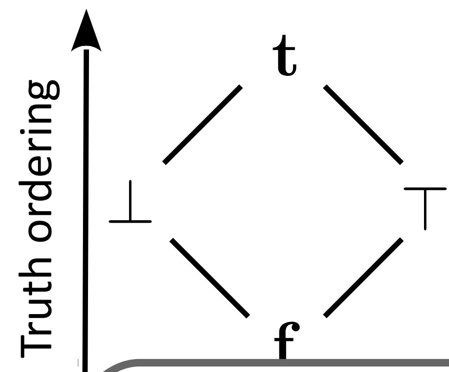

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Semantics

Extend stratified Datalog to four-valued fixed-point semantics

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BelLog Examples

Transitive delegatic $eq)@Y, delegate(Y)@X$

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Conflict-override $eq)[\top \mapsto polC(Req)]$

Other idioms?

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Policy Analysis

Does the policy meet its requirements?

Policy

Requirements

Policy Analysis

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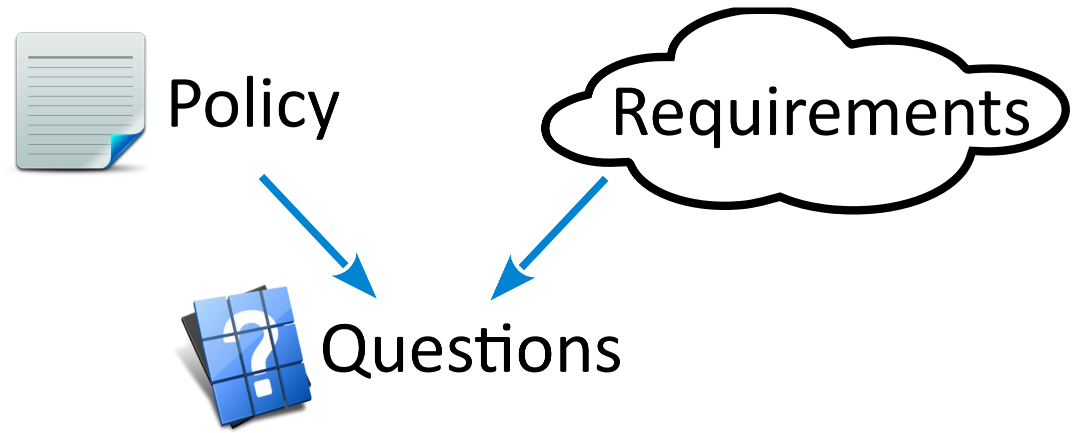

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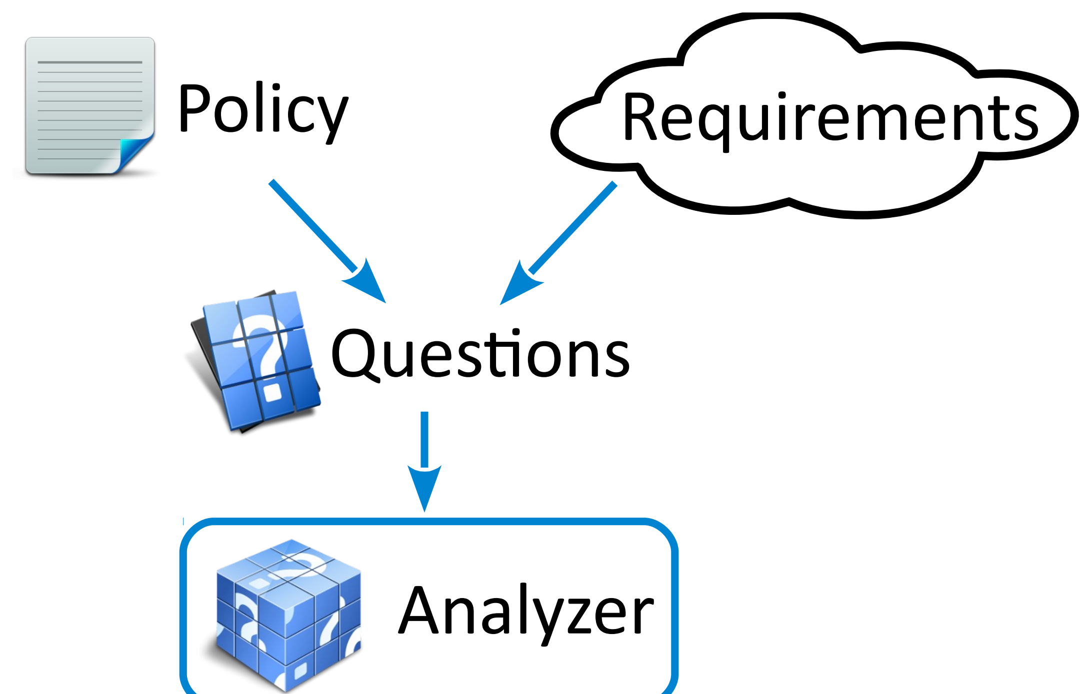

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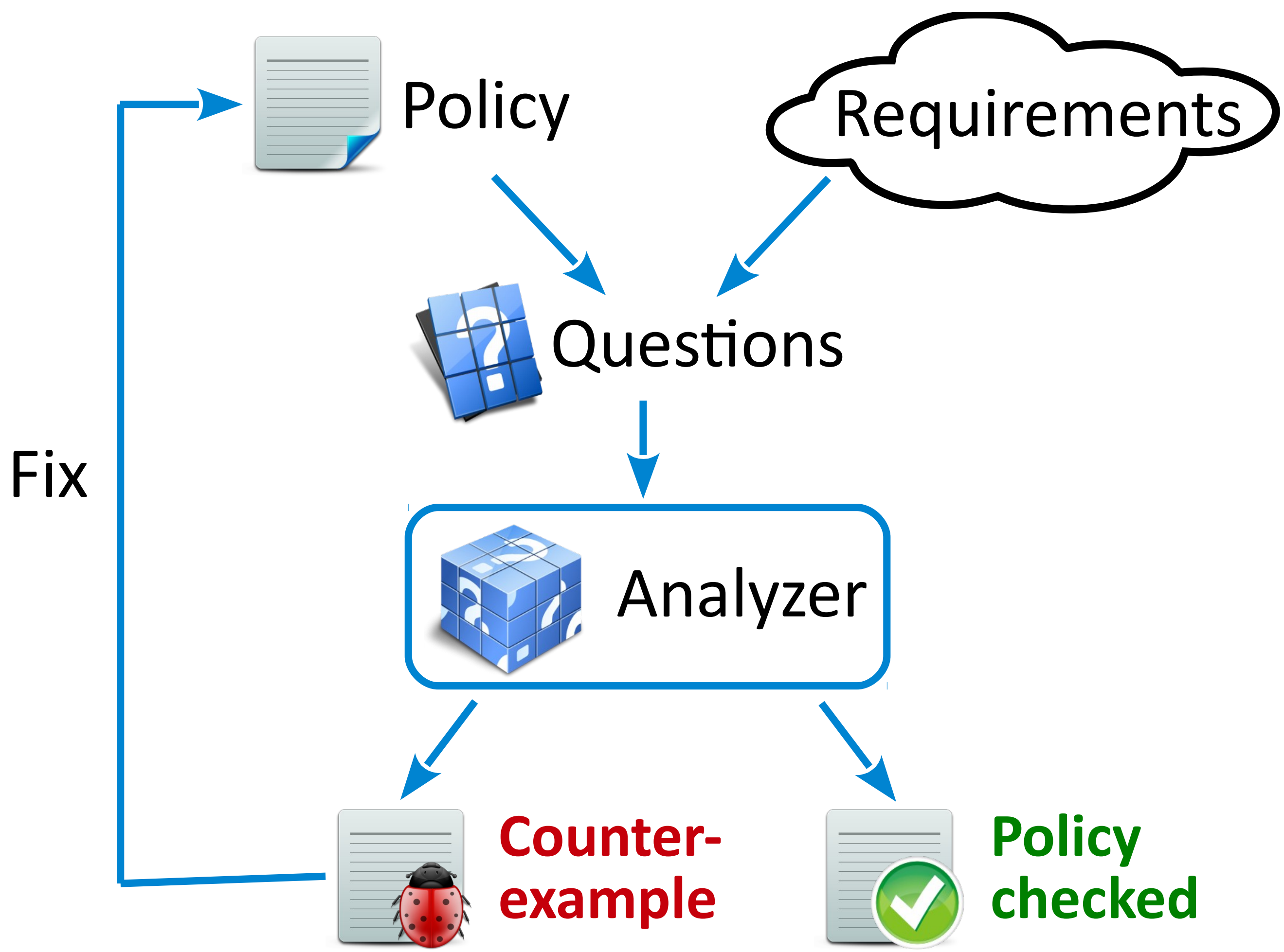

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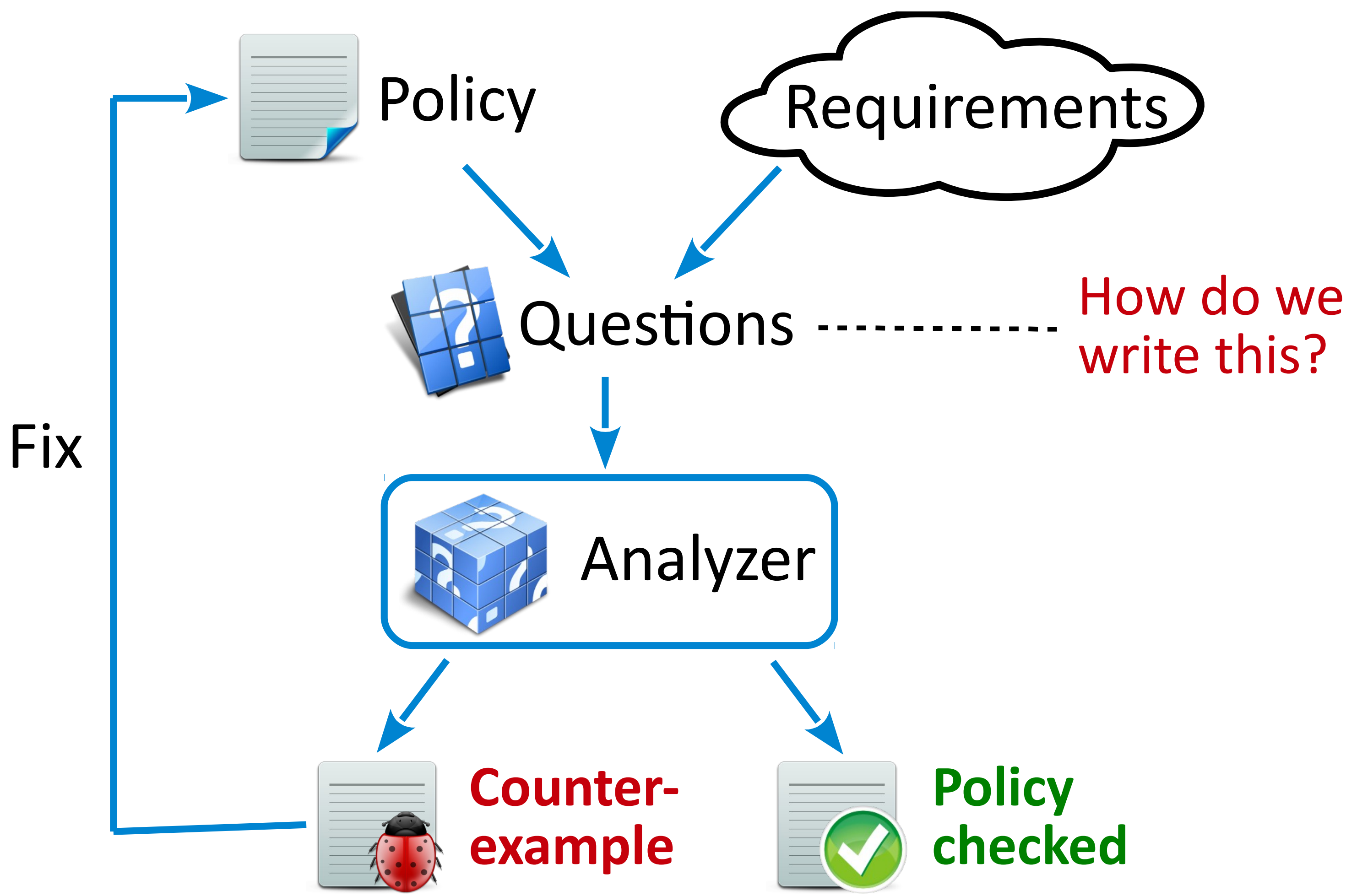

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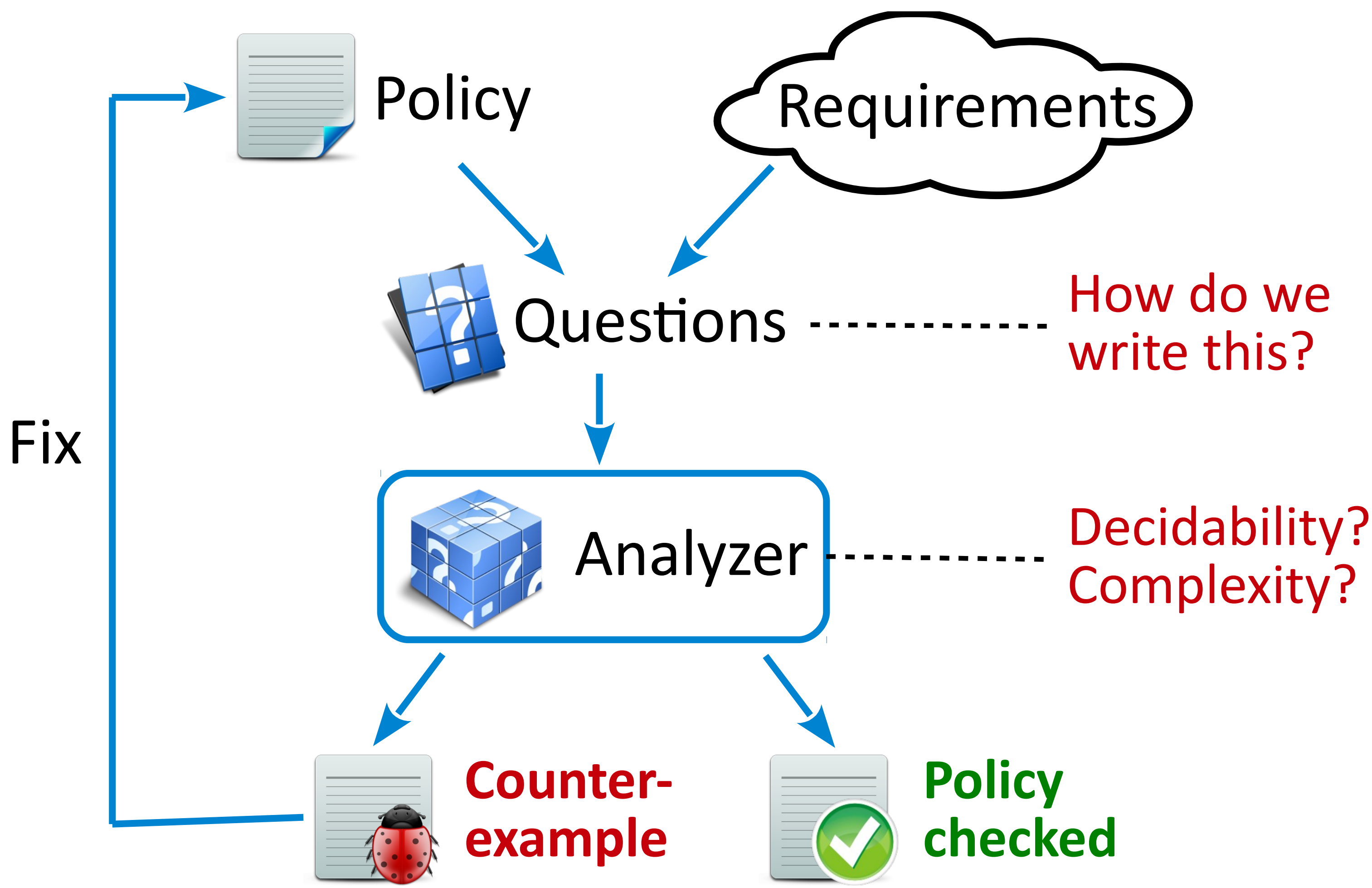

Analysis Questions

Syntax

(question) $(c \Rightarrow P_1 \preceq P_2)$

(condition) $c ::= a(X) = \mathbf{t} \mid \exists X.\ c \mid \neg c \mid \cdots$

– Is policy **P2** more permissive than **P1** for all inputs that satisfy the condition **c**?

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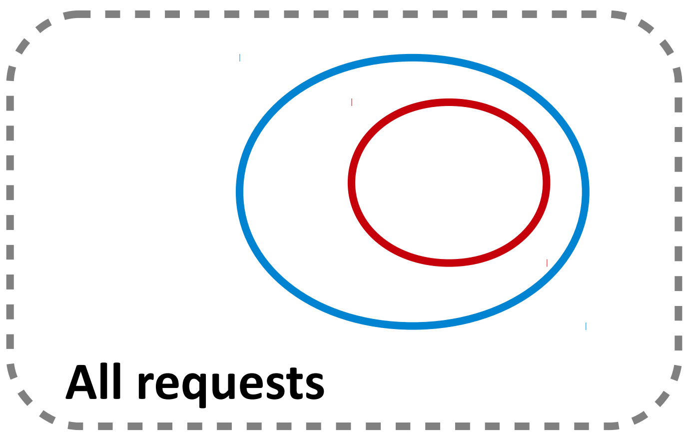

Requests granted by **P1**

Requests granted by **P2**

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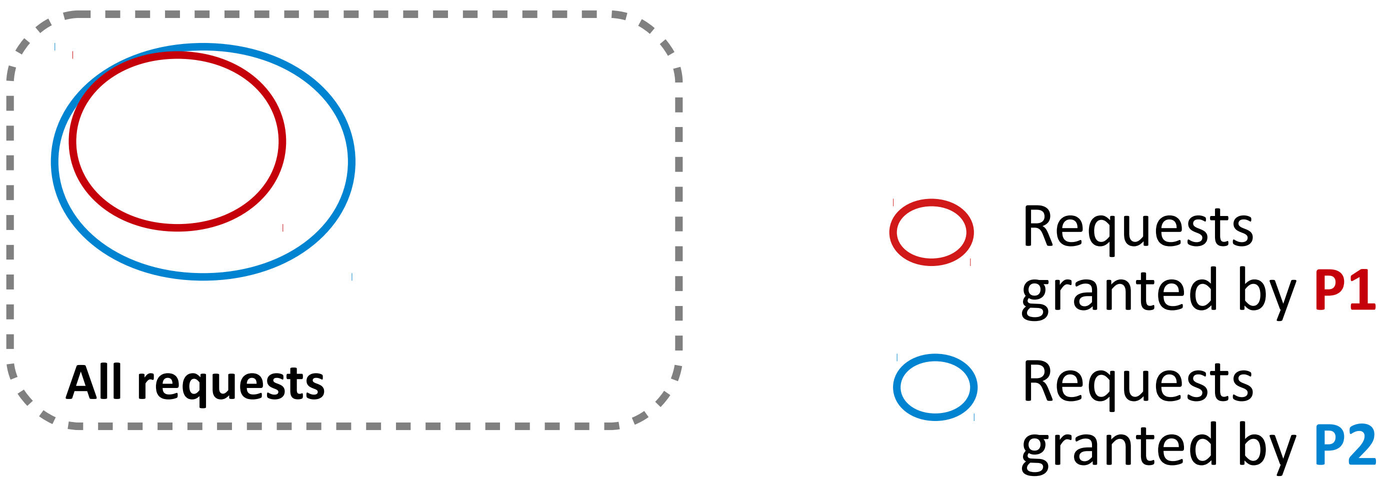

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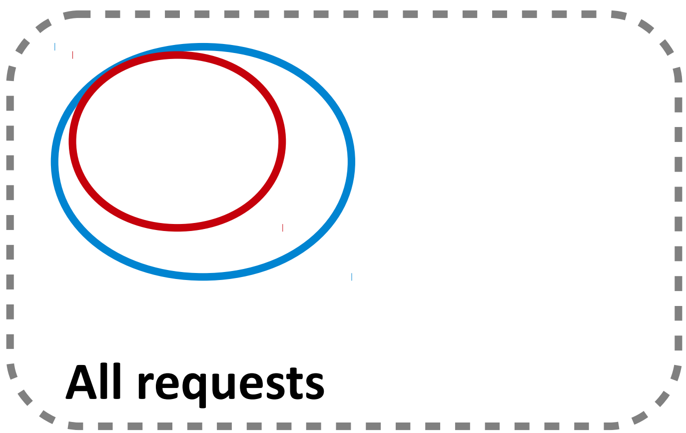
For a given input:

Check for all inputs that satisfy the condition



Example: Analysis Question

Policy

P

Requirement

If the requester is a project leader, then grant access.

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Analysis Question

$$leader(Sub) \Rightarrow P \preceq \{pol(Sub) \leftarrow \mathbf{t}\}$$

Analysis

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Theorem 1
Policy containment is **undecidable**

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Theorem 2
Policy containment for **unary-input policies*** is in **CO-NEXP-COMPLETE**

*Unary-input policies

– Example: $pol(Sub, Obj) \leftarrow leader(Sub), pub(Obj)$

Analysis

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Policy containment is **undecidable**

Theorem 2
Policy containment for **unary-input policies*** is in **CO-NEXP-COMPLETE**

Theorem 3
Policy containment for **a finite universe** is in **CO-NP-COMPLETE**

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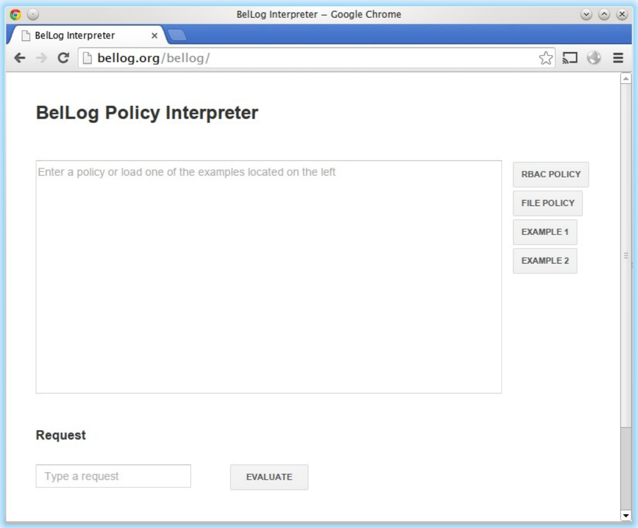
Constructing PDPs

Theorem 4
Policy entailment is in **PTIME**

Policy Interpreter

http://bellog.org



GitHub

https://github.com/ptsankov/bellog/

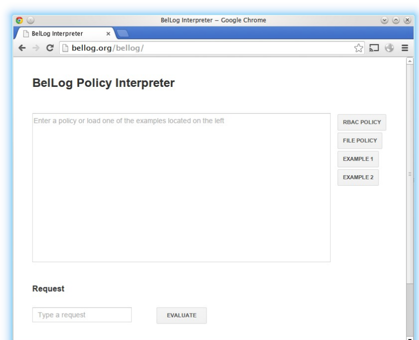
Limitations

- Analysis of administrative changes
- Analysis complexity and tool support
- Usability

BelLog Contributions

A foundation for composite decentralized access control

Policy analysis framework



BelLog PDP
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