Non-Interactive Publicly-Verifiable Delegation of Committed Programs

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Problem Setup

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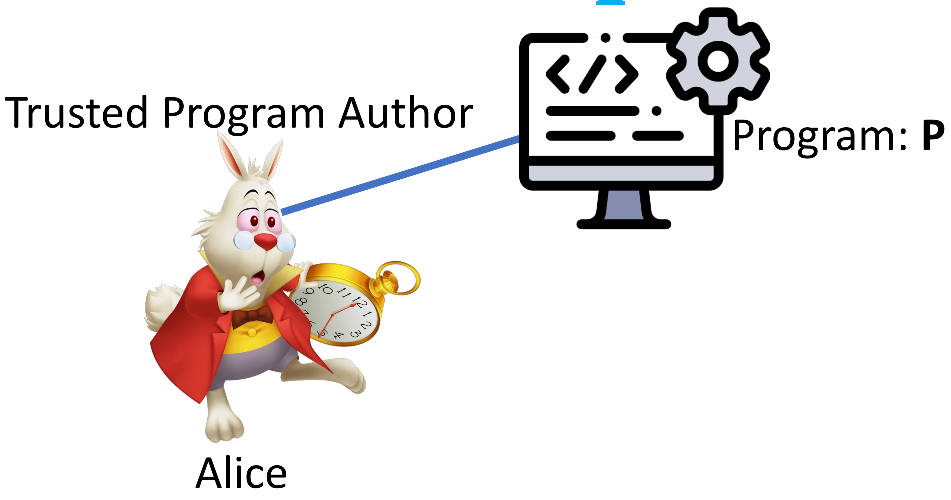

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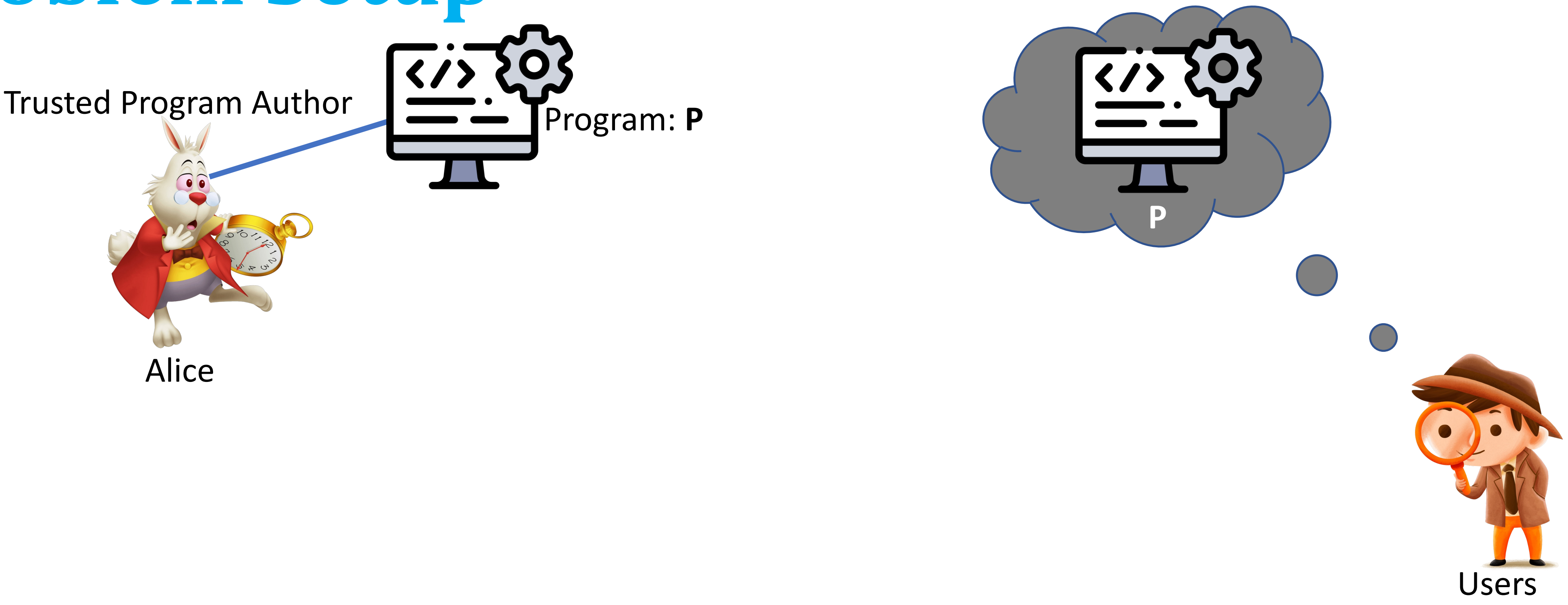

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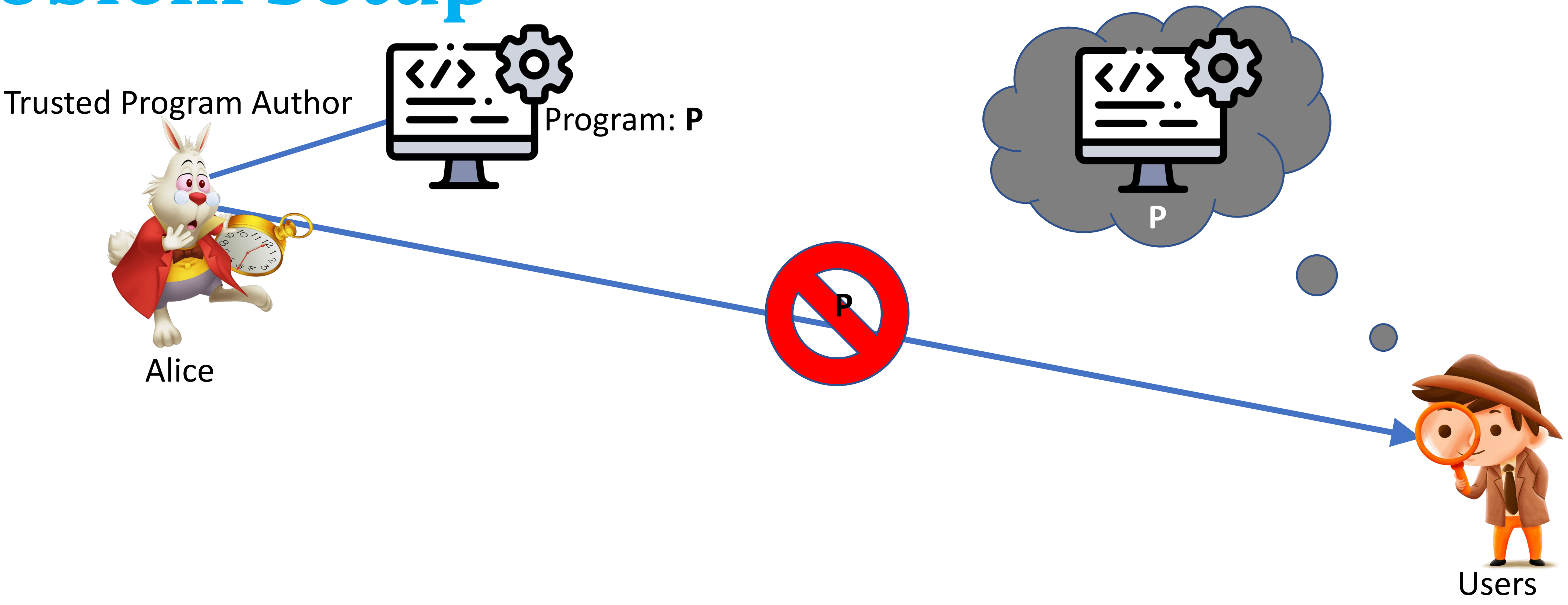

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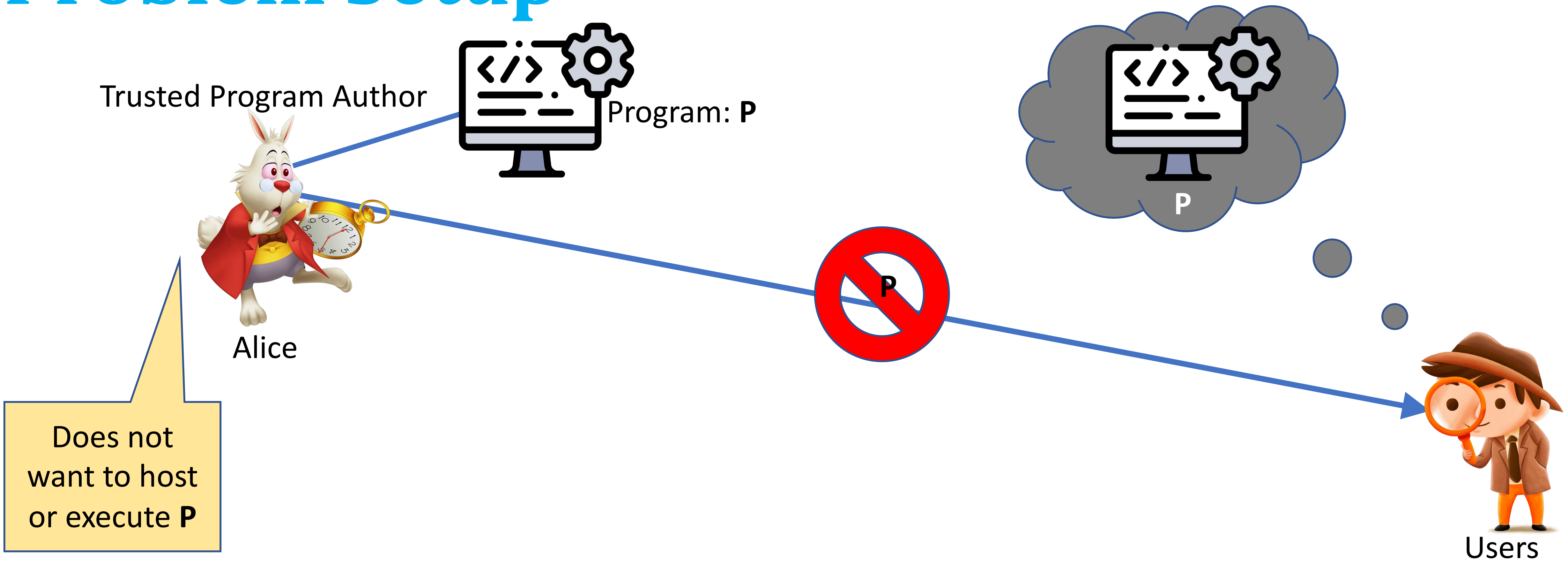

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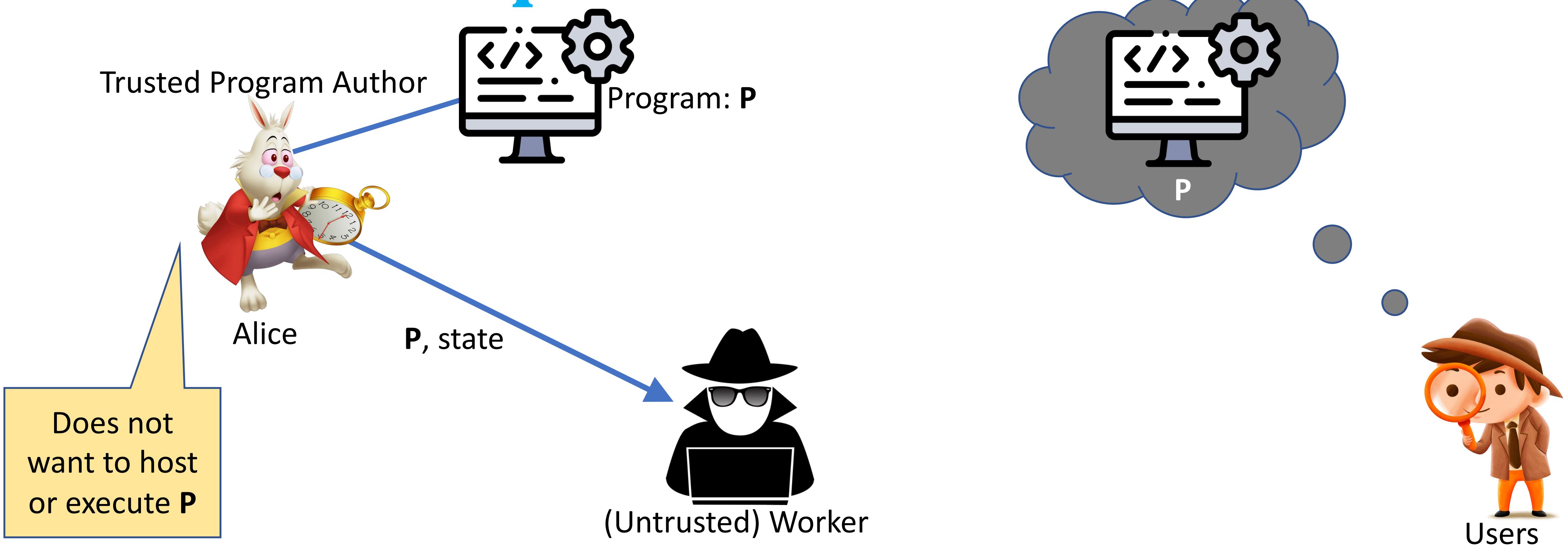

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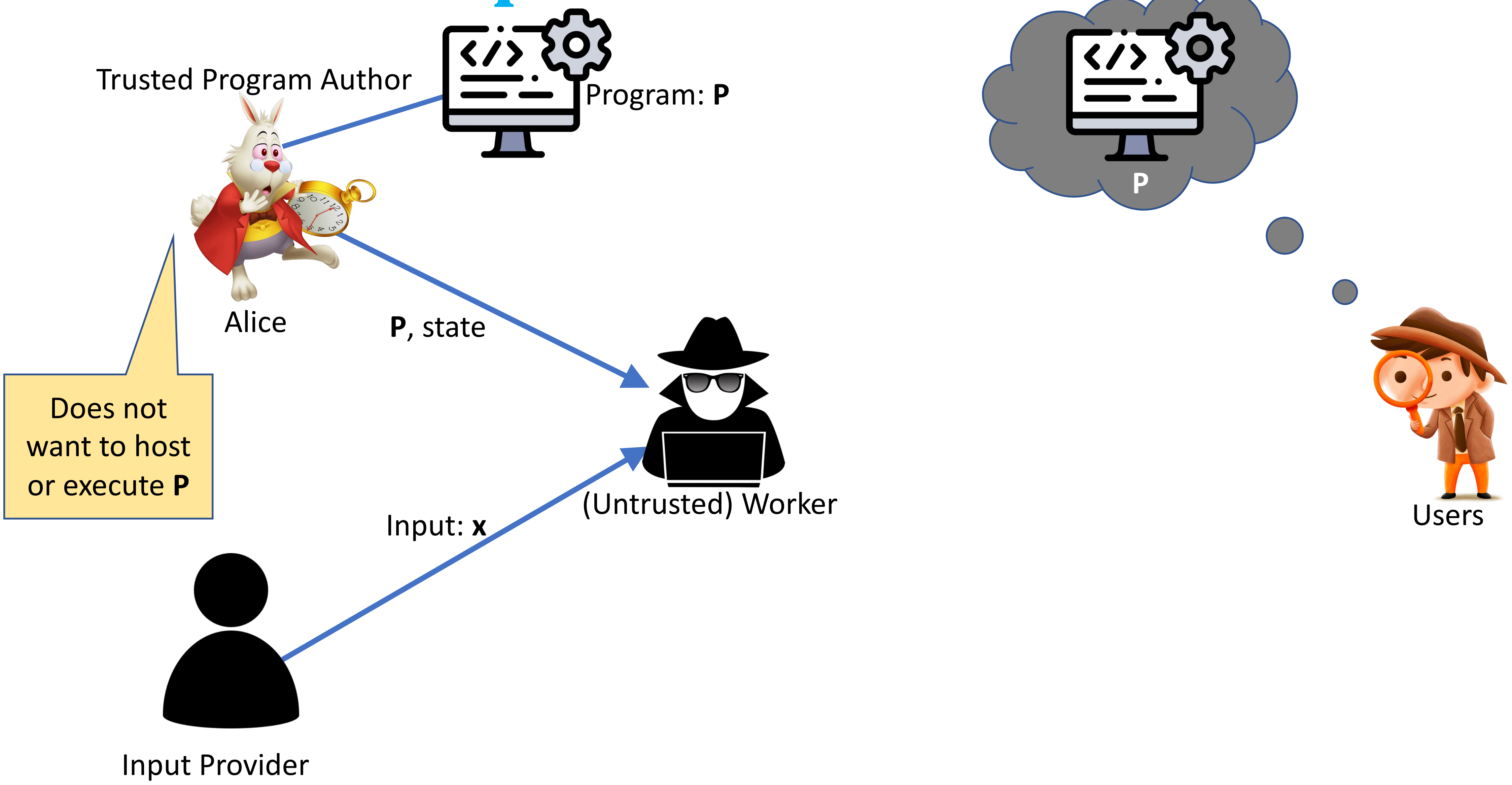

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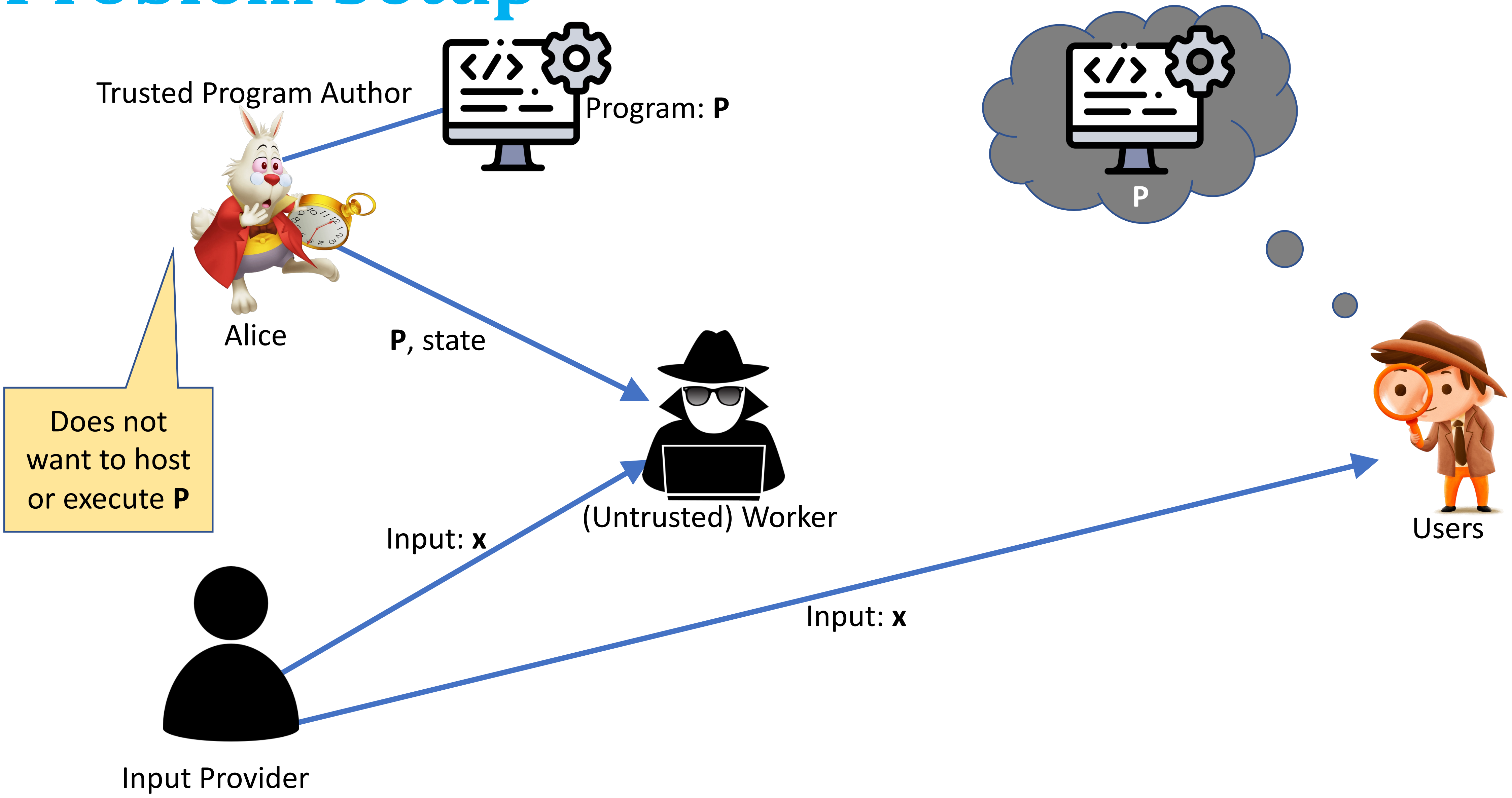

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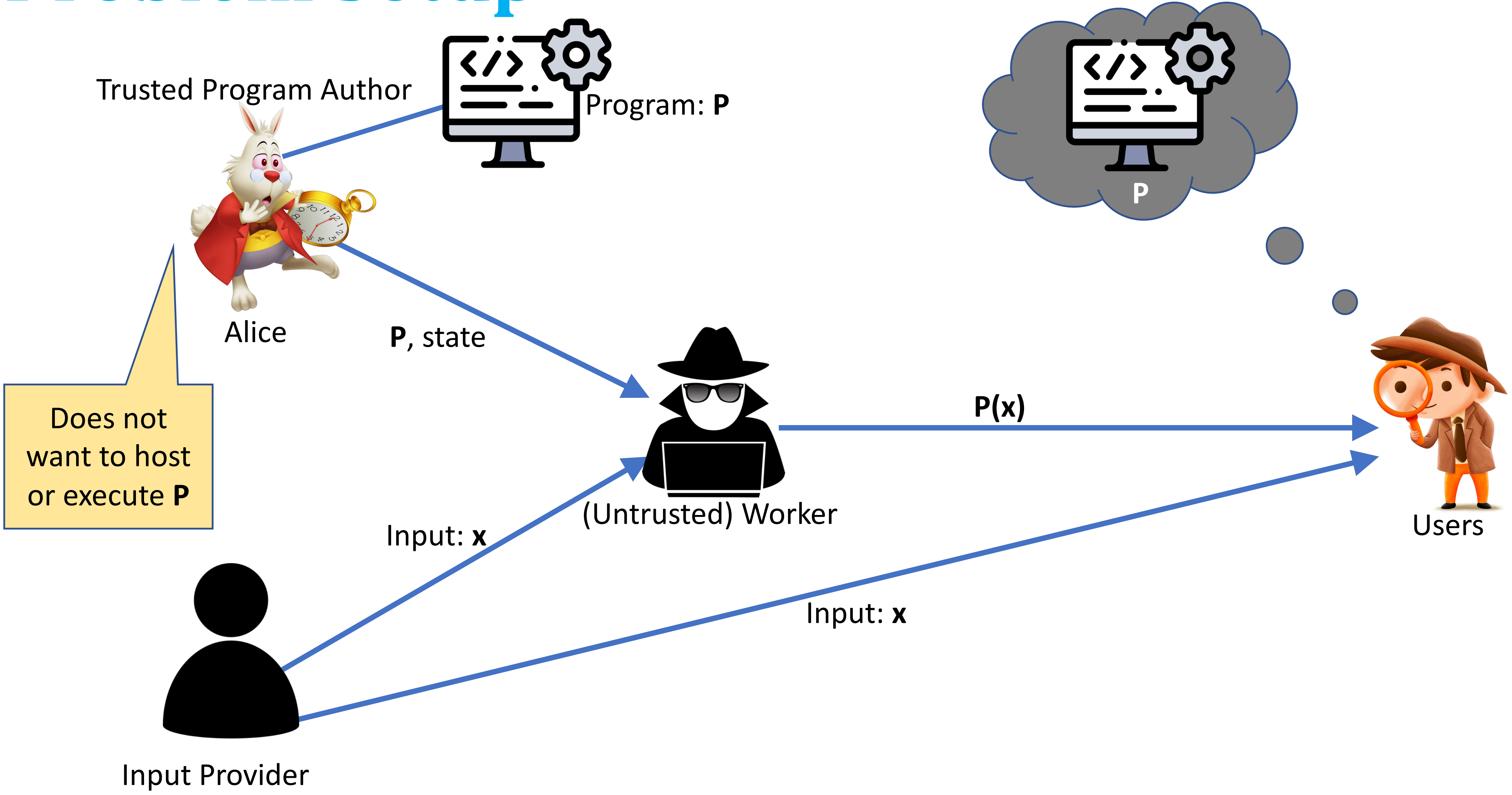

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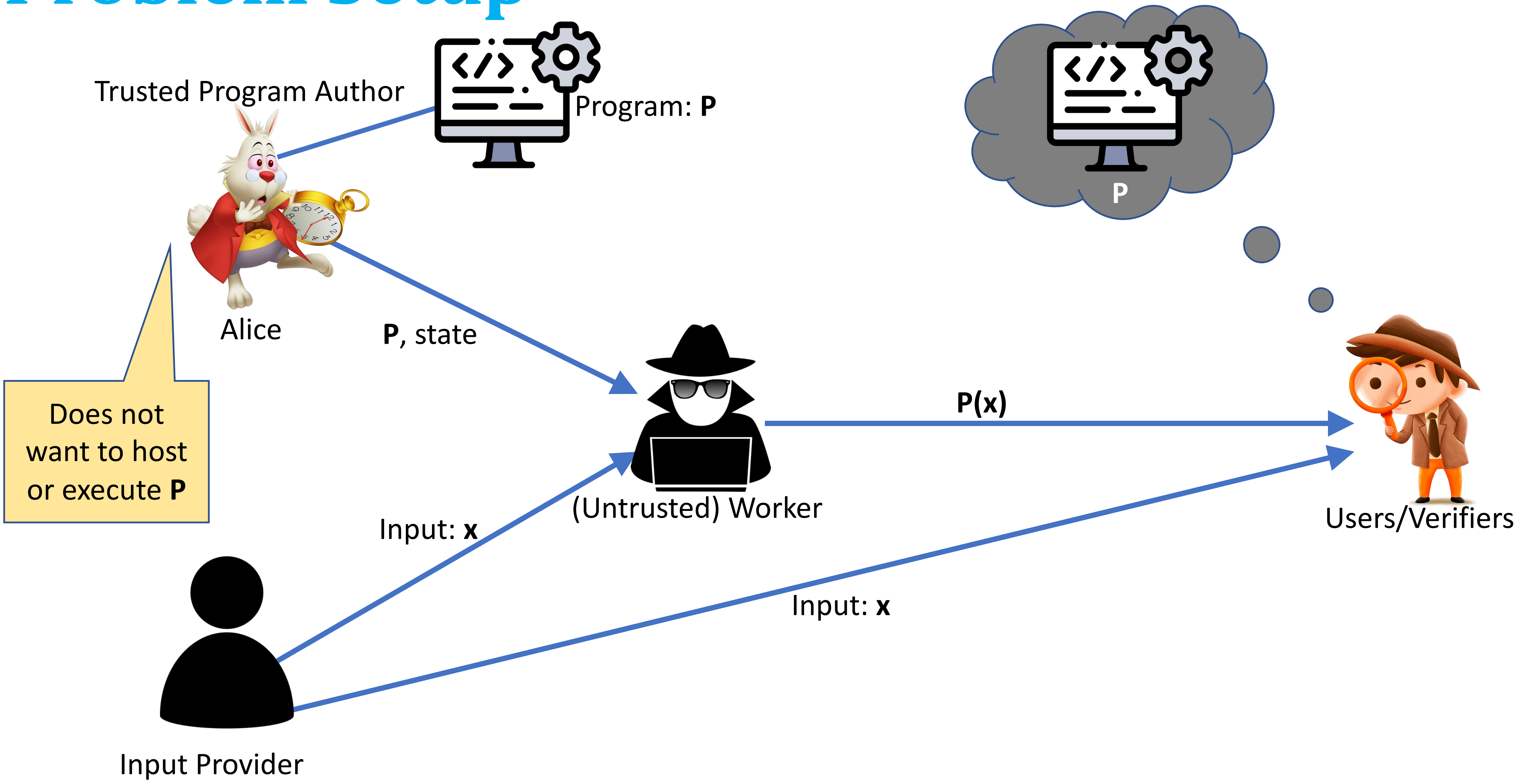

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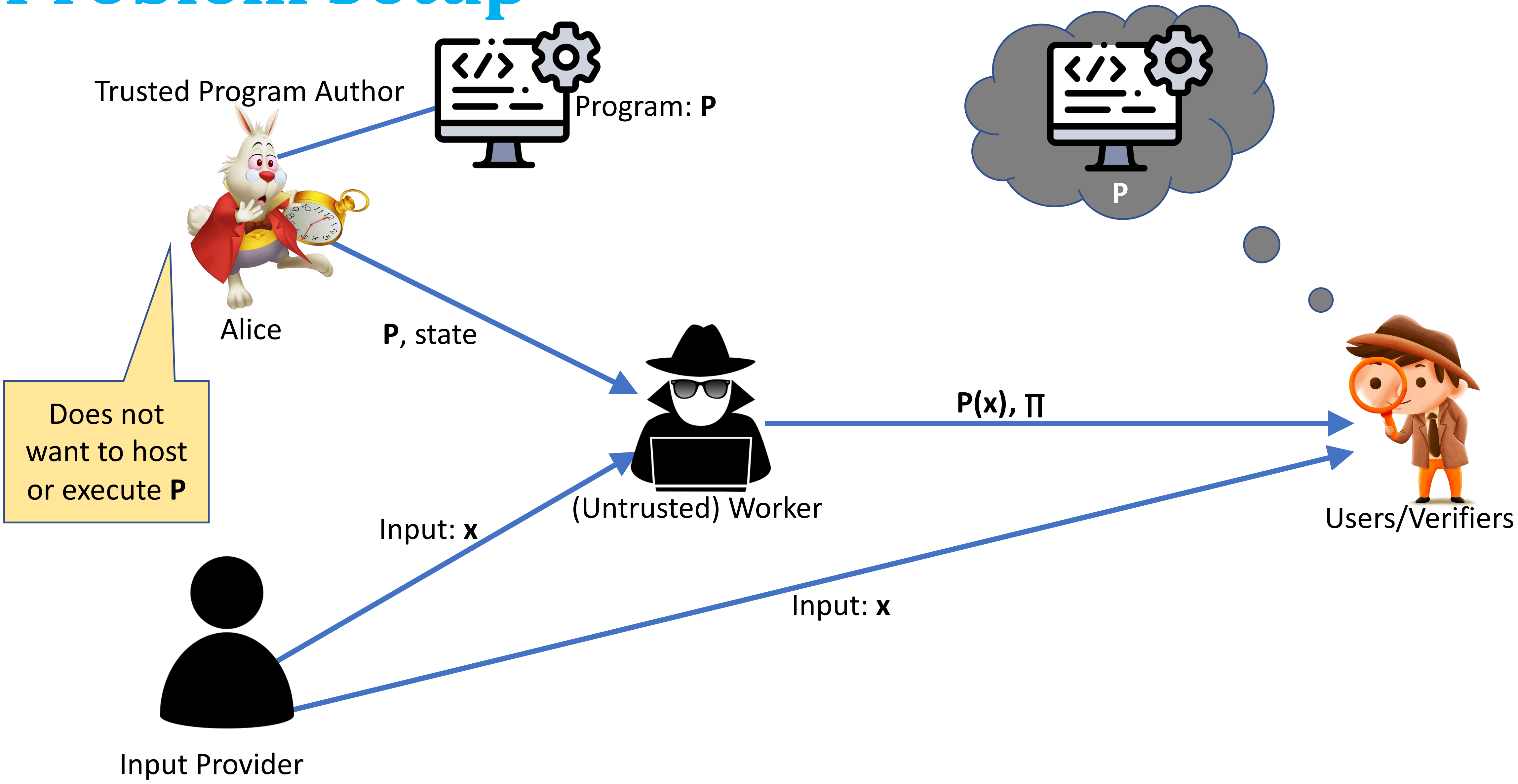

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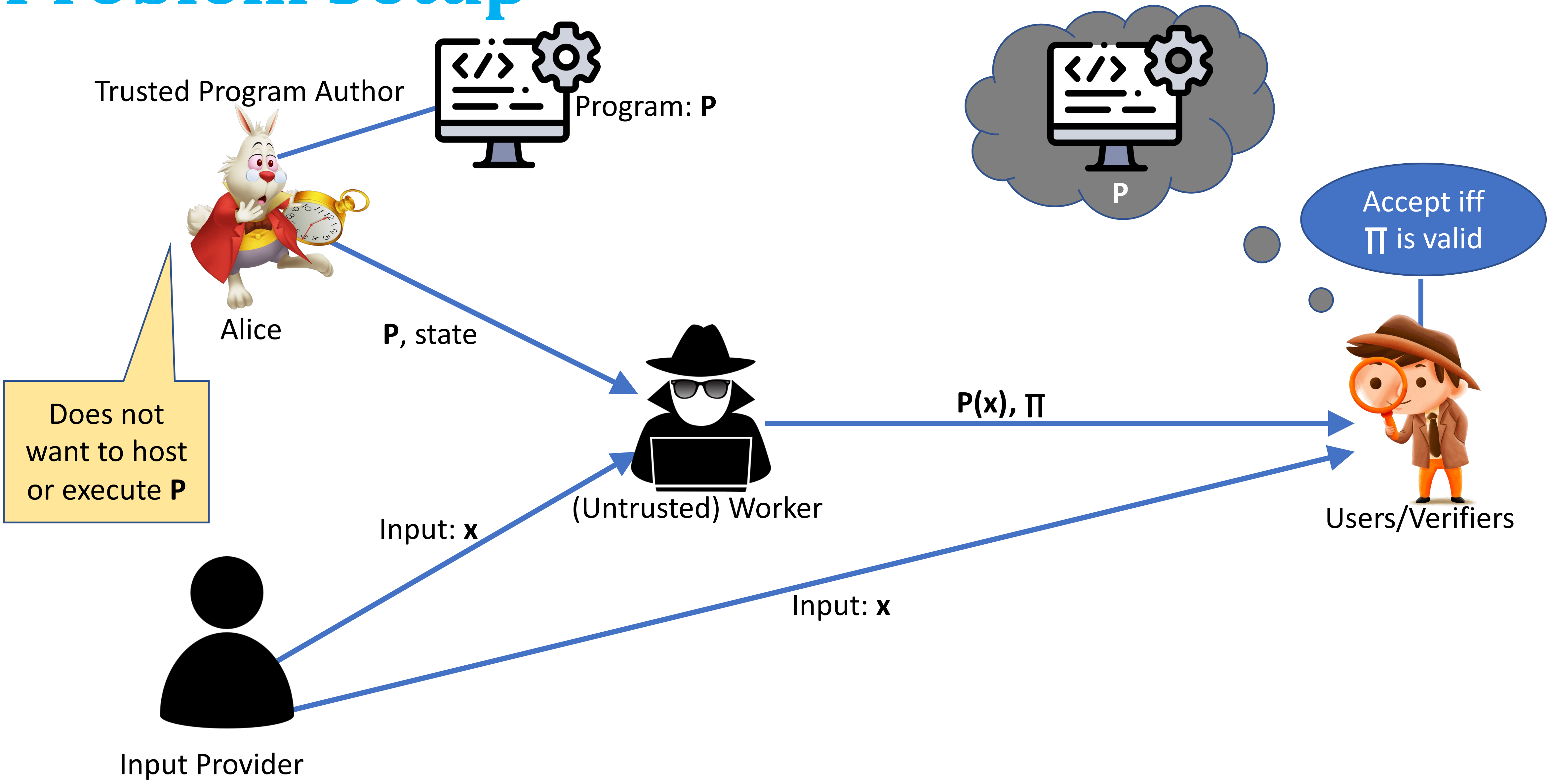

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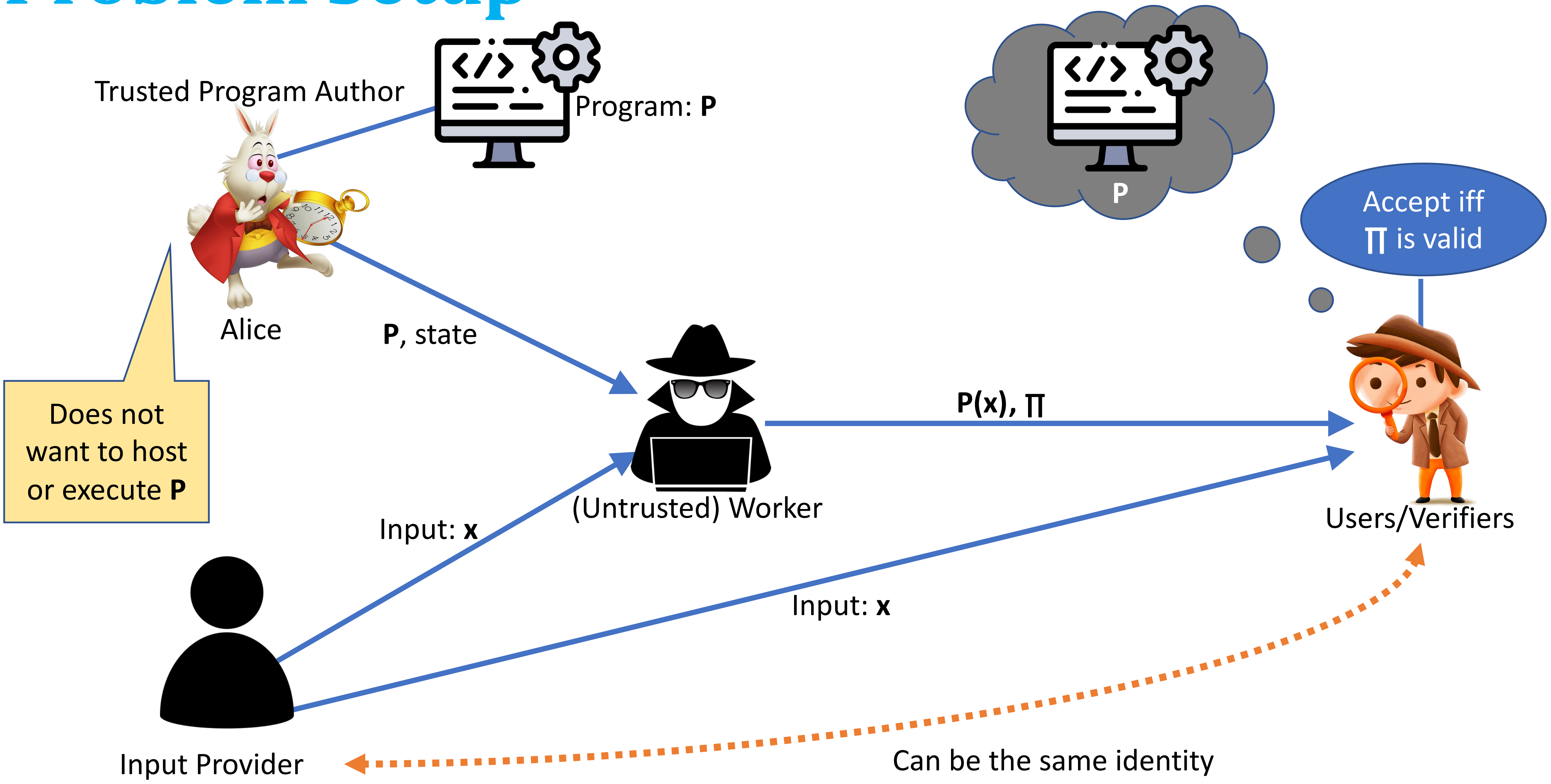

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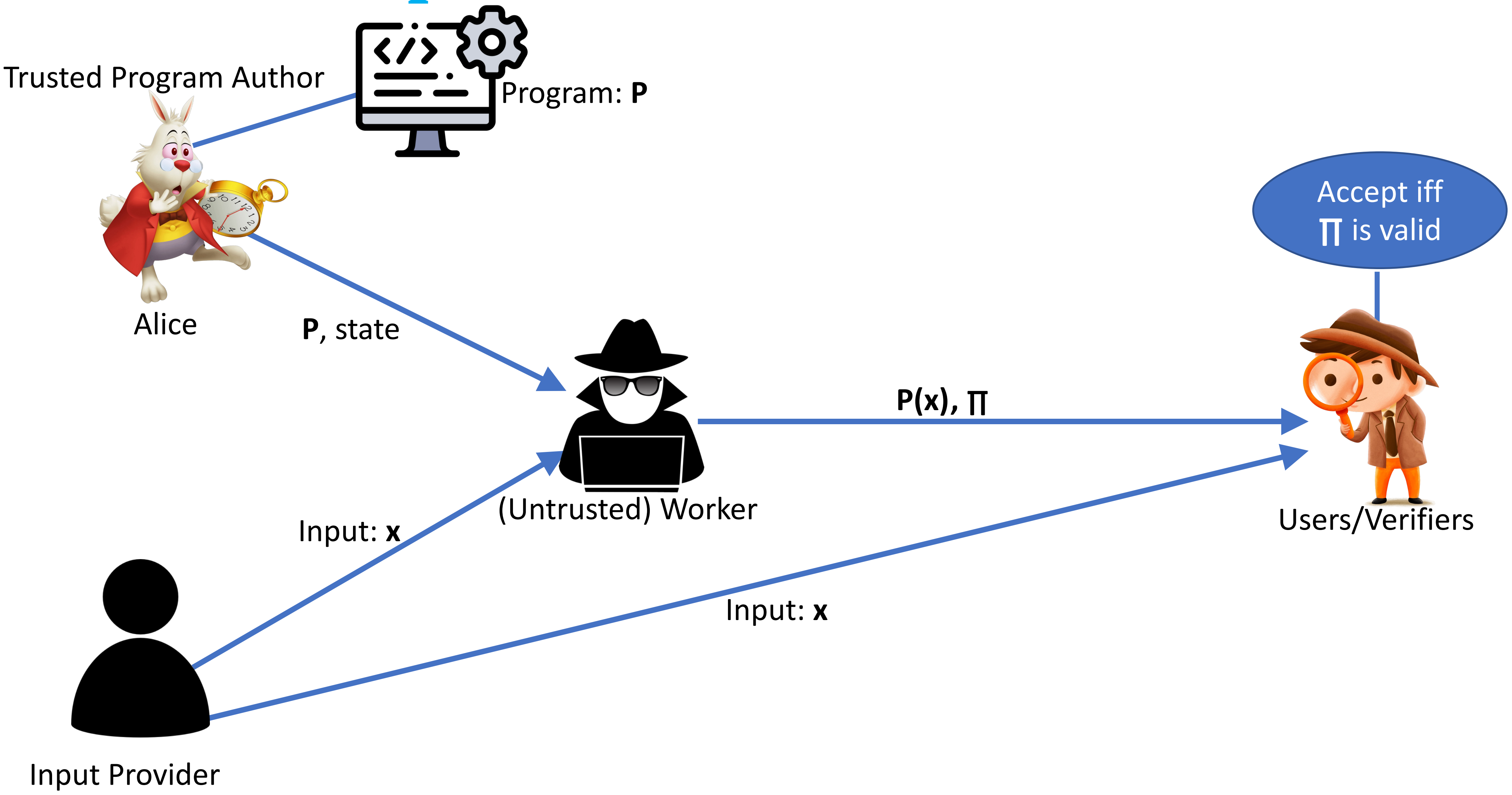

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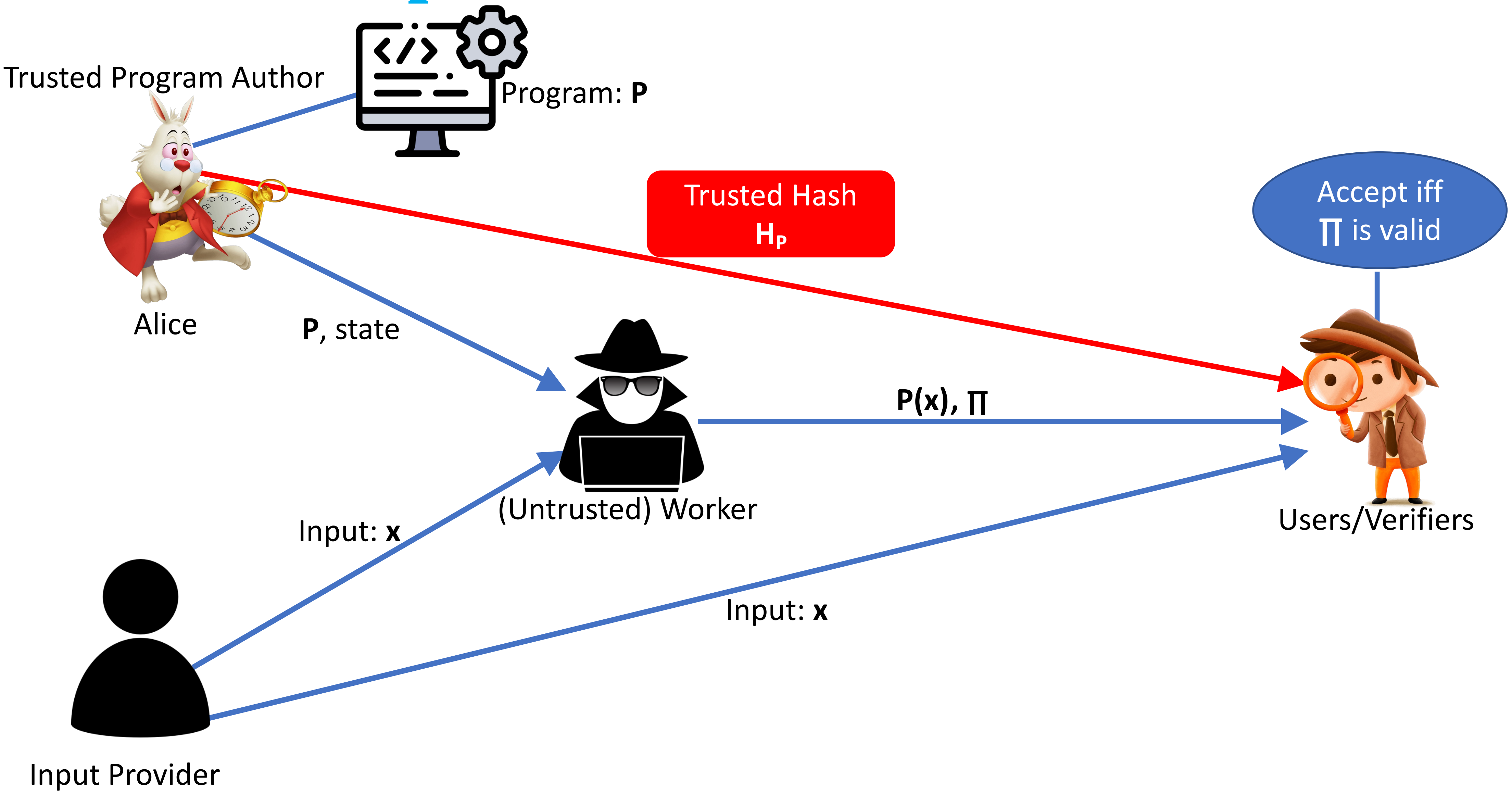

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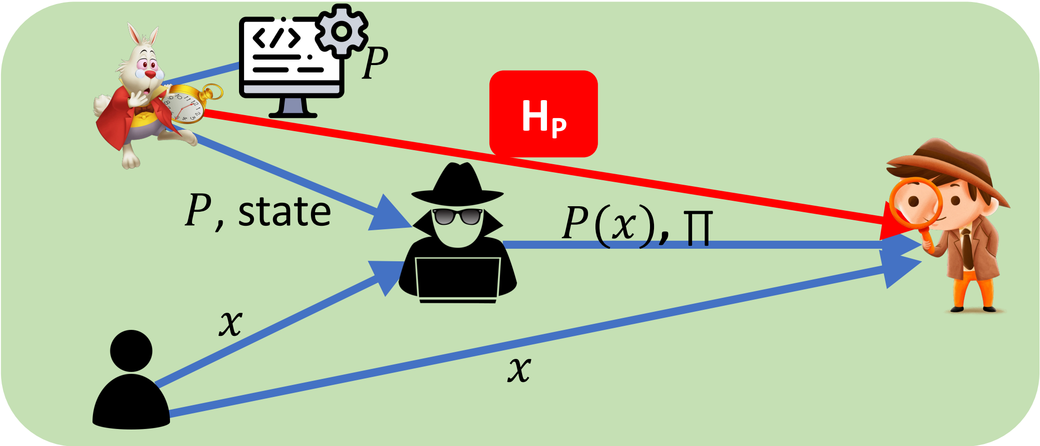

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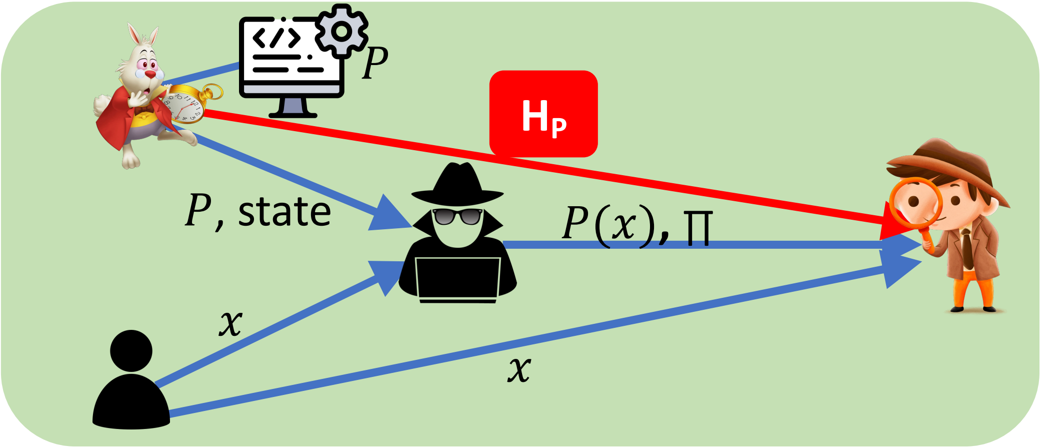

Non-Interactive Delegation

- Uni-directional Arrows
- No Back and Forth Communication

Public Verification

- Same proof ∏ for all verifiers

Public Delegation

- No pre-processing specific to P before delegating to Worker
- No dependence of H_P on input x

Succinctness

- $|\prod|$: poly $(\lambda, \log|P|, |x|)$
- Verifier run-time: poly $(\lambda, \log|P|, |x|)$
- Prover run-time: poly $(\lambda, |P|, |x|)$

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	• [KP16]: LWE (Private Verification) • [KRR13]: Subexp secure FHE (Private Verification) • [GGP10]: FHE (Private Delegation)	• [Mic00,BCC+17,Gro10,PR17]: Random Oracle/Non Standard Knowledge Assumptions • [KPY19]: Standard Assumptions but verifier knows **P**

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Very recent work [CJJ21] comes the closest by achieving "SNARG for P from LWE"

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Our Work: Fully Non-Interactive Public Delegation + Public Verification from Standard Assumptions and Verifier does not know **P**

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Main Theorem

Assuming the hardness of the LWE problem, there exists a construction for publicly verifiable non-interactive succinct delegation for committed programs with CRS size, proof size and verifier time poly(λ, log |P|, |x|) and prover run time being poly(λ, |P|, |x|).

Publicly Verifiable Non-Interactive Succinct Delegation

Such a delegation scheme in the CRS model involves the following PPT algorithms:

- Setup(1^λ): Randomized setup algorithm that outputs crs
- ProgAuth($1^\lambda, crs$): Randomized algorithm that outputs $P, state, H_P$
- Prover(crs, $P, state, H_P, x$): Deterministic algorithm that outputs a value y and proof $\prod$
- Verifier(crs, $H_P, x, y,\prod$): Deterministic verifier which either accepts or rejects

Publicly Verifiable Non-Interactive Succinct Delegation

Completeness

For all PPT ProgAuth, if crs is appropriately generated and Prover runs honestly then,

$$\Pr[V(crs, H_P, x, y, \prod) = 1 \wedge P(x) = y] = 1$$

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Proof Size: $poly(\lambda, log\ |P|, |x|)$

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Soundness

For all PPT adversaries (A_1, A_2) and all ProgAuth, if crs is appropriately generated and $(\mathrm{x}, \mathrm{aux}) \leftarrow A_1(crs)$, $(\mathrm{y}, \prod) \leftarrow A_2(crs, P, H_P, x, aux)$, then

$$\Pr[V(crs, H_P, x, y, \prod) = 1 \wedge P(x) \neq y] \leq negl(\lambda)$$

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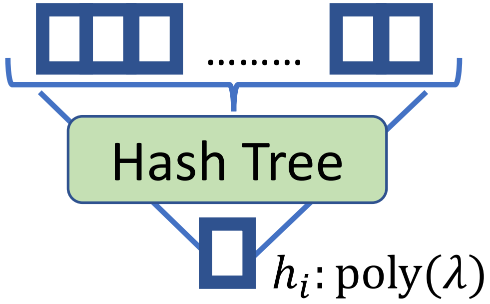

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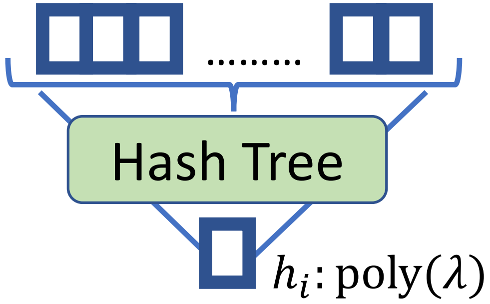

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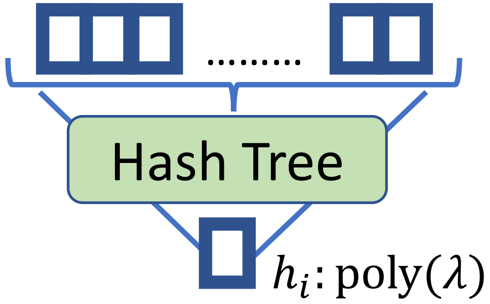

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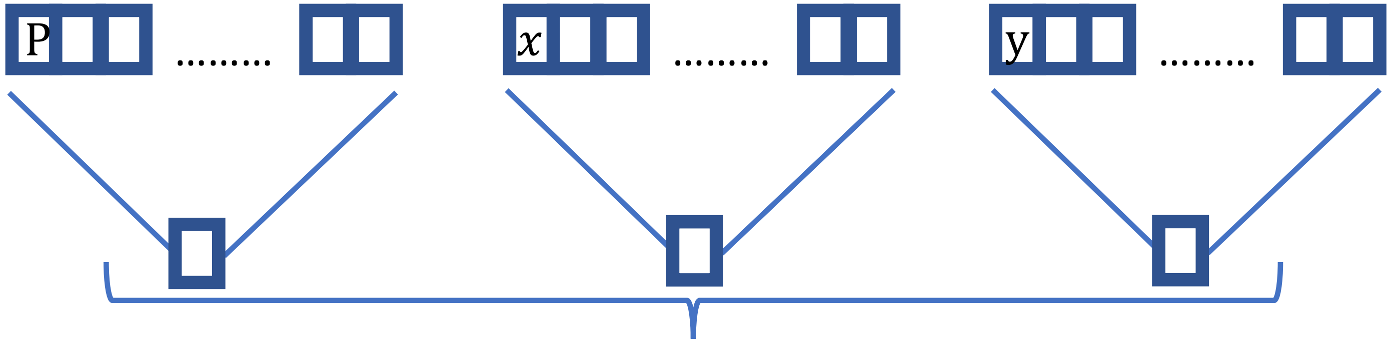

h_0: poly(λ)

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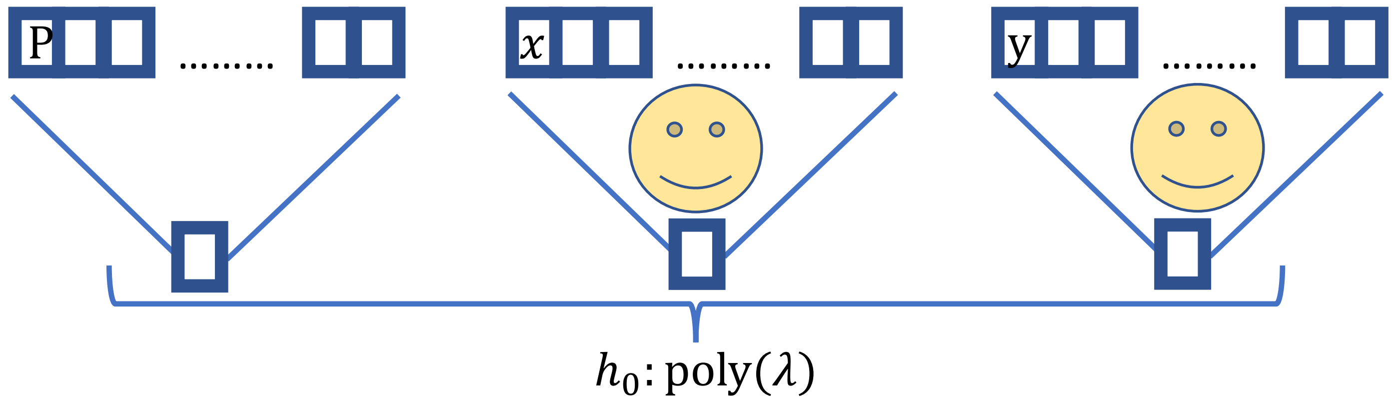

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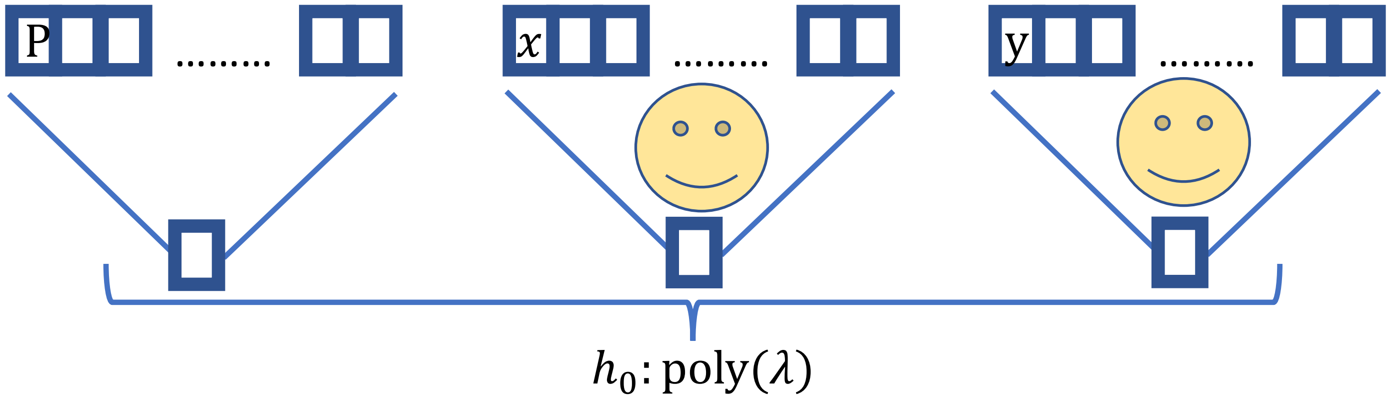

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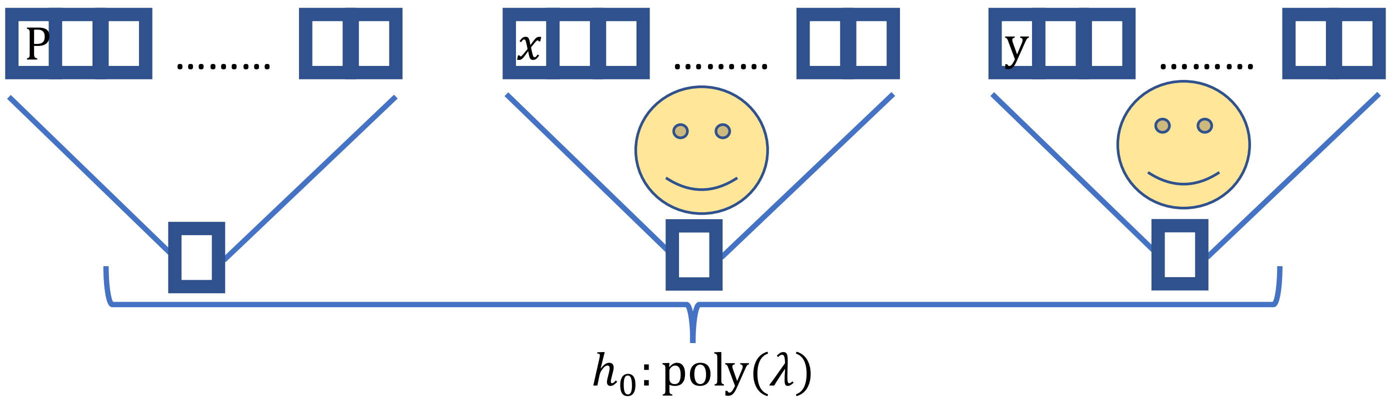

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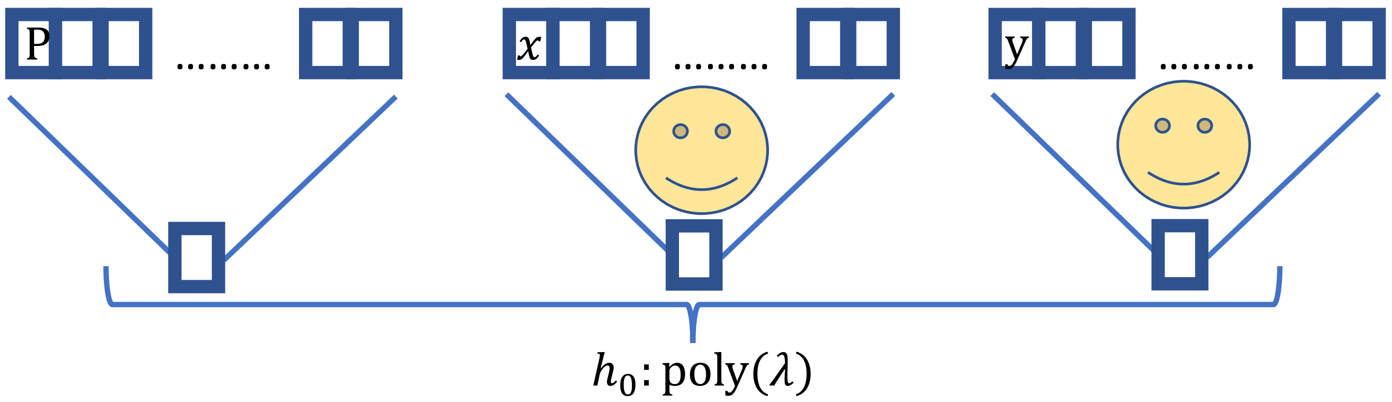

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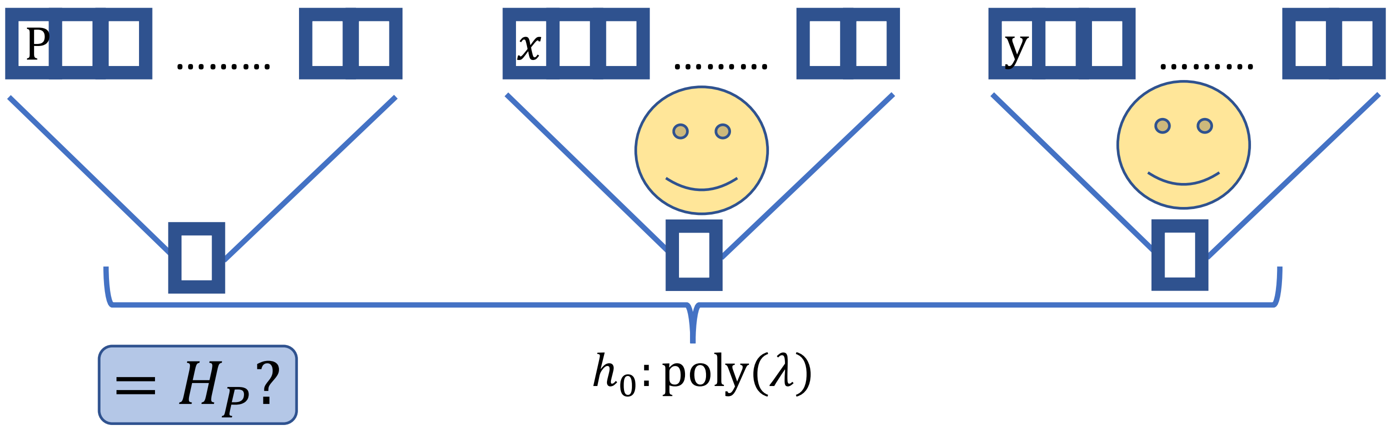

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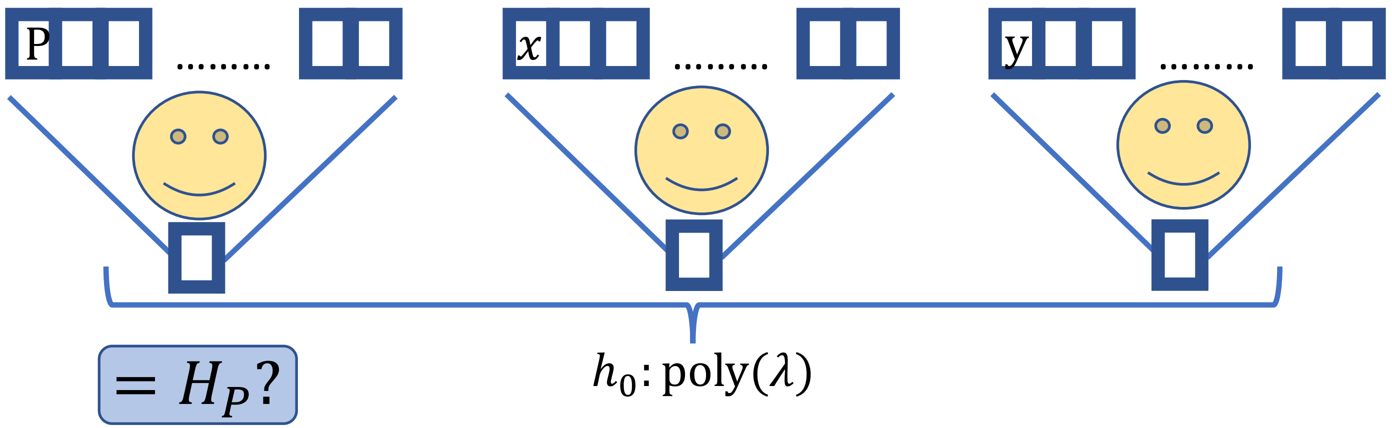

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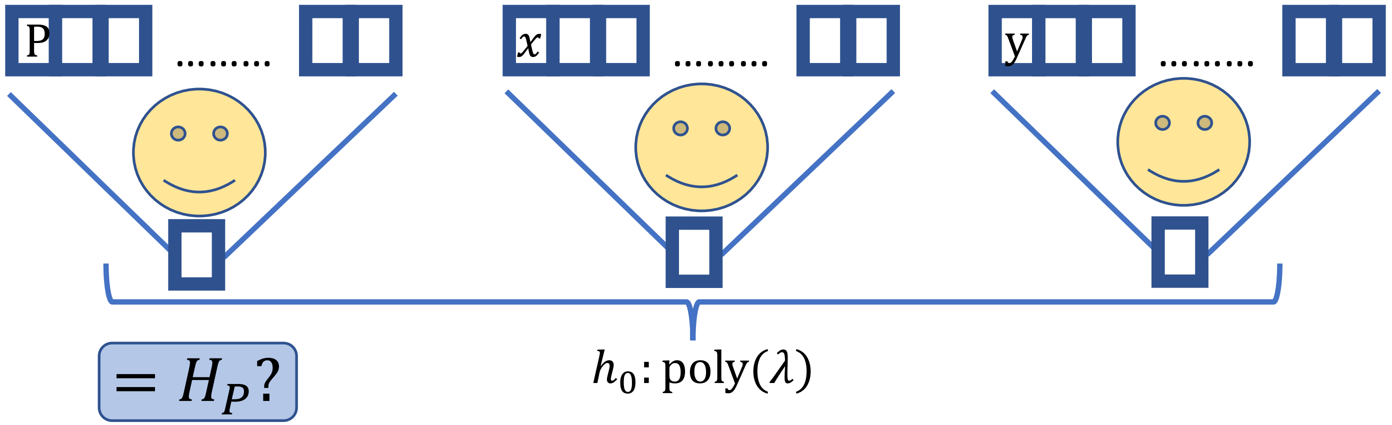

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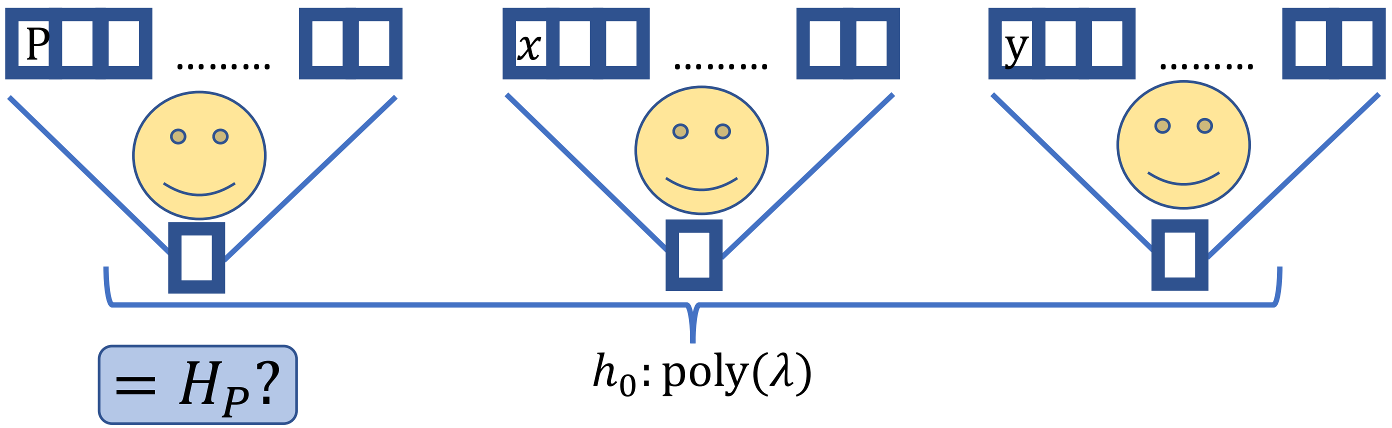

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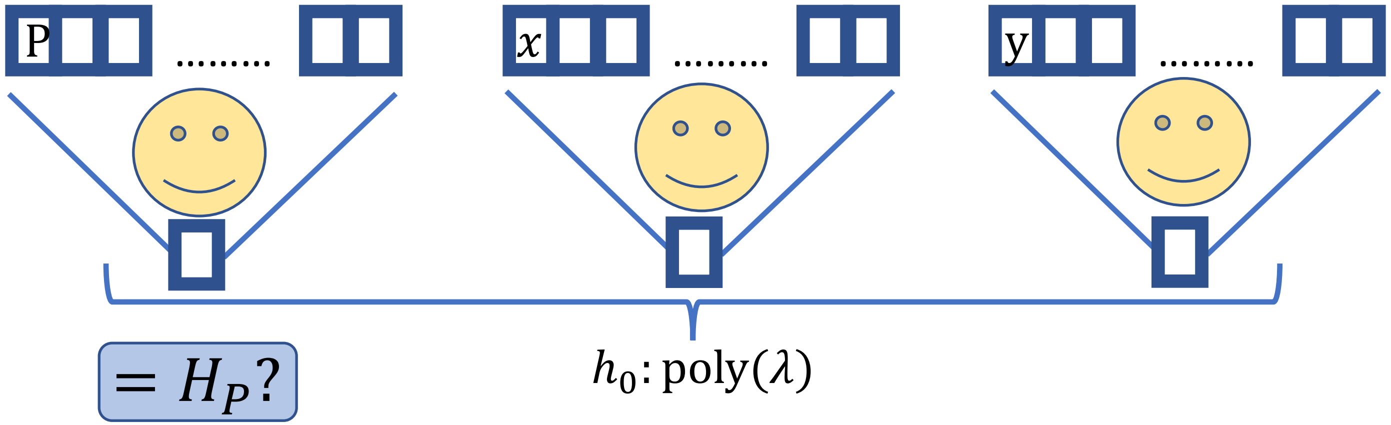

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- Now, we can use the techniques from CJJ21 to construct a **SEMI-TRUSTED** SNARG **For NP.**

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- Nothing changes in the real world. In the simulated world, we can switch the CRS to have a commitment of 1 and the NIZK/NIWI proof will not use $\prod$ at all.

THANK YOU!