Experiences in the Logical Formalization of the HIPAA and GLBA Privacy Laws

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Privacy in Organizational Processes

Patient medical bills

Patient information

Hospital

Insurance Company

Drug Company

Aggregate anonymized patient information

PUBLIC

Complex Process within a Hospital

Advertising

Patient

Achieve organizational purpose while respecting privacy expectations in the *transfer* and *use* of personal information within and across organizational boundaries.

Making sense of real privacy laws

Observation: Real privacy laws are complex.

- Examples:
  - Health Insurance Portability and Accountability Act (HIPAA)
  - Gramm-Leach-Bliley Act (GLBA)
- Long, dense — HIPAA Privacy Rule has 84 operational clauses for transmissions on $\sim$30 pages
- Too complex to be a practical day-to-day guide.

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Desiderata: Interactive tools for enforcement and analysis

- "Does GLBA permit Bank X to disclose Bob's info to Charlie?"
- "Are Hospital Y's policies consistent with HIPAA?"

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Prior work:

- Logics and languages for specification of privacy policies
  - P3P [Cranor et al.], XACML [OASIS], EPAL [Backes et al.], requirements engineering [Breaux and Antón], LPU [Barth et al.], Privacy APIs [Gunter et al.], deontic logic [I. Lee et al.], SecPAL [Becker et al.], ...

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- Formal specification of privacy laws
  - LPU [Barth et al.]: Examples from HIPAA and GLBA
  - Datalog HIPAA [Lam et al.]: HIPAA §§164.502, 506, and 510
  - Privacy APIs [Gunter et al.]: HIPAA §164.506
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Problem:

- Formalization efforts have not covered full privacy laws.
- Do these techniques scale to specification *and* computer-assisted enforcement of full privacy laws?

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Builds on:
Logic of Privacy and Utility (LPU) [Barth,Datta,Mitchell,Nissenbaum]

A logical formalization of contextual integrity [Nissenbaum]

Outline

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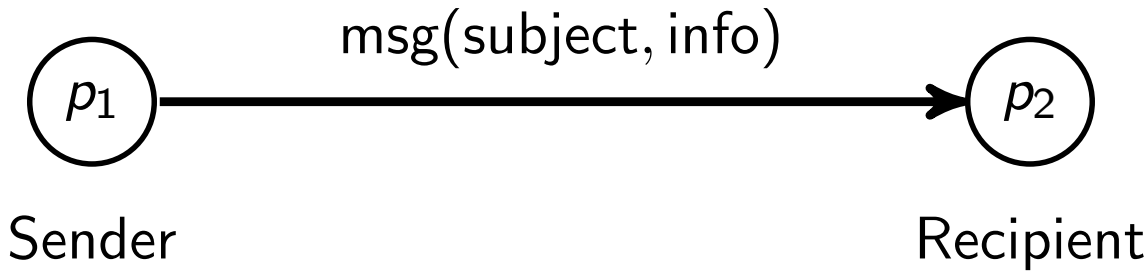
Transmission of protected information



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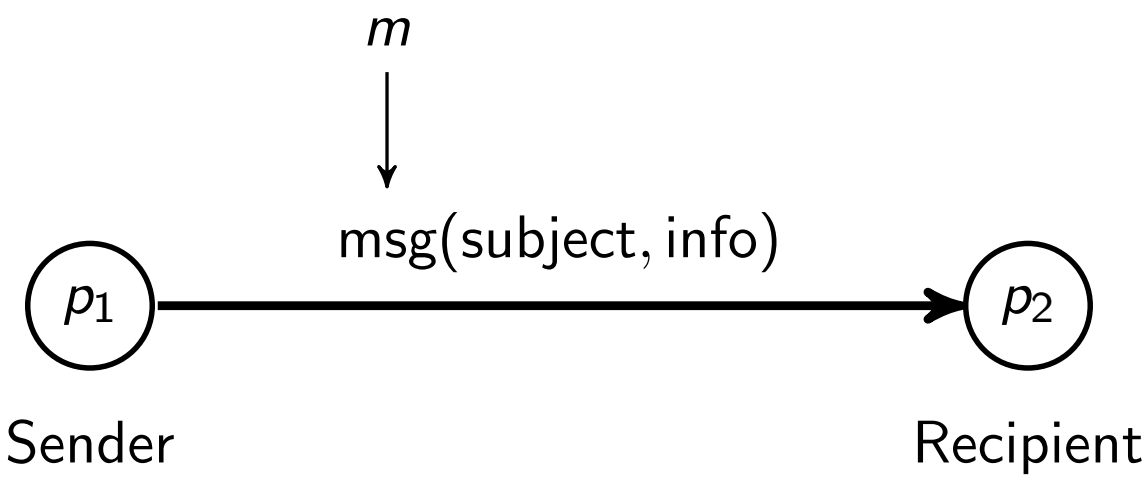

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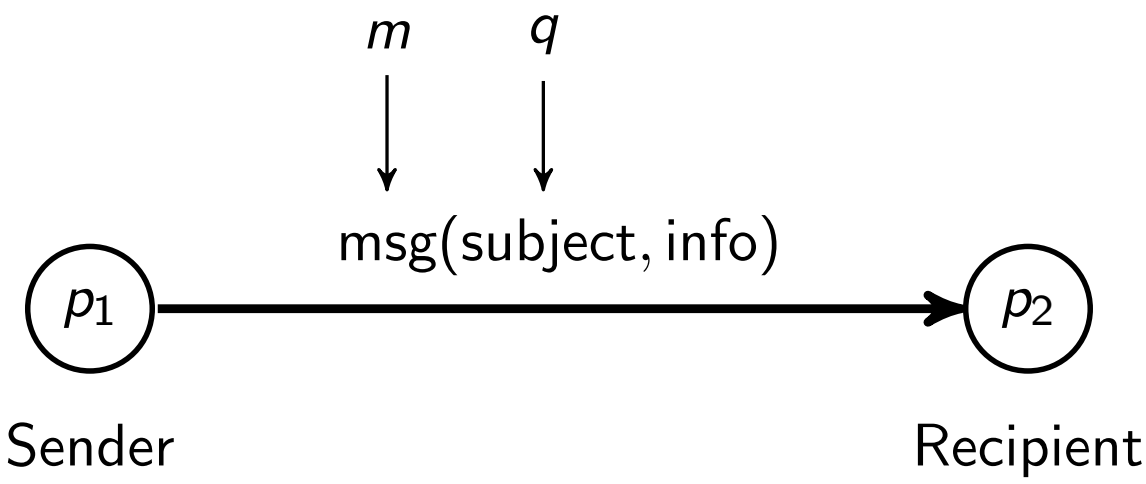

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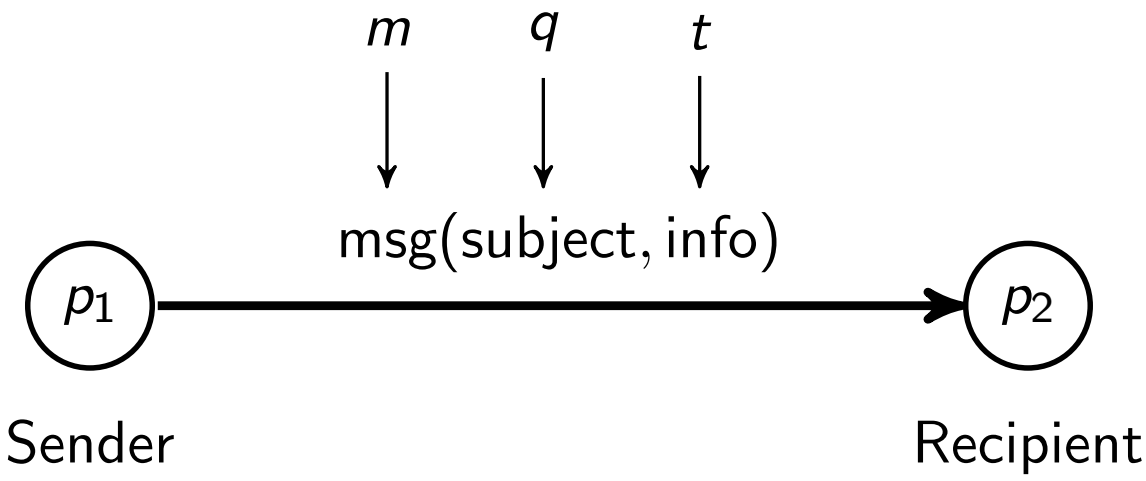

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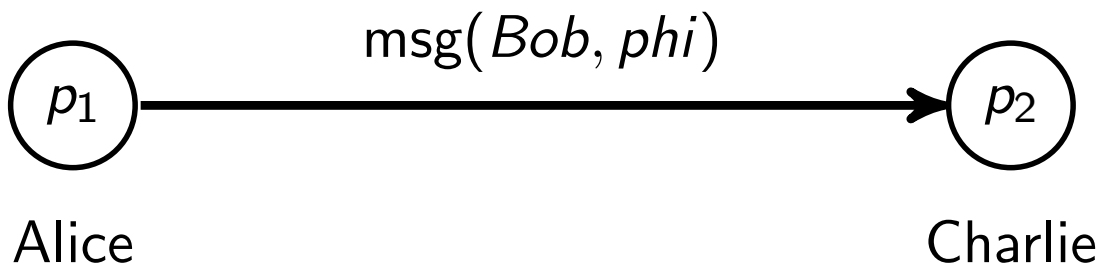

Norms of transmission in privacy laws

Positive norms, φ_i^+: Transmission *may occur* if condition is satisfied.

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A transmission is lawful if and only if it satisfies at least one of the law's positive norms and all of the law's negative norms.

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Exceptions refine norms of transmission

Exceptions to negative norms:

"A covered entity must obtain an authorization for any use or disclosure of psychotherapy notes, except [...]."

Conclusion: Satisfy either the core or one of the exceptions.

$$\varphi^{-}_{\texttt{164.508a2}'} \triangleq \varphi^{-}_{\texttt{164.508a2}} \vee (\varphi^{e}_{\texttt{164.508a2iA}} \vee \cdots)$$

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"Exceptions" to positive norms:

- A covered entity may disclose information to report abuse.
- Disclosures under previous require informing the victim.

Conclusion: Satisfy the core and its refinements.

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Structure of HIPAA and GLBA privacy laws

Health Insurance Portability and Accountability Act:

- Primarily positive norms
  - 56 positive norms, 7 negative norms, and 19 exceptions
  - Negative norms for patient consent or opt-out opportunity (§§164.508 and 164.510)
- Deny all transmissions not explicitly allowed

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Gramm-Leach-Bliley Act:

- No positive norms
  - 5 negative norms and 10 exceptions
  - Negative norms require notices and opt-out opportunities (§§6802 and 6803)
- Allow all transmissions not explicitly denied

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Principals' beliefs and professional judgement

HIPAA §164.512(f)(4)

"A covered entity may disclose protected health information about an individual who has died to a law enforcement official for the purpose of alerting law enforcement if the covered entity has a suspicion that the death may have resulted from criminal conduct."

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Observation: Principals' roles are dynamic.

- Principals enter and exit customer relationships with banks.
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Conclusion: Distinguish the roles held from the active role.

- $\mathit{belongstorole}(\text{Alice}, \mathit{customer}(X))$: Alice is a customer of X.
- $\mathit{belongstorole}(\text{Alice}, \mathit{doctor}(\text{Bob})$: Alice is Bob's doctor.
- $\mathit{activerole}(\text{Alice}, \mathit{doctor}(\text{Bob}))$: Alice is currently active as Bob's doctor.
- $\neg\mathit{activerole}(\text{Alice}, \mathit{customer}(X))$: Alice is *not* currently active as a customer of X.

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- $\Diamond\phi$: "ϕ is true at some future time."
- $\downarrow x.\,\phi$: Use x as a name for the current time in ϕ.

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$$
\begin{aligned}
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& (t \in_{\mathcal{T}} \mathit{npi}) \wedge \\
& \neg \mathit{activerole}(p_2, \mathit{affiliate}(p_1)) \wedge \\
& \mathit{belongstorole}(q, \mathit{consumer}(p_1)) \\
& \rightarrow \\
& \downarrow x.\ \Diamond\!\!\!\!-(\downarrow y.\ (x - y \geq 14) \wedge \\
& \qquad \exists m'.\ \mathit{send}(p_1, q, m') \wedge \\
& \qquad\quad \mathit{is\text{-}notice\text{-}of\text{-}potential} \\
& \qquad\quad\ \mathit{\text{-}disclosure}(m', p_1, p_2, (q, t), u))
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Properties of enforcement

Observations:

Enforcement by execution-time access control alone is insufficient.

- Purposes, beliefs, future obligations, etc. are not, a priori, mechanically decidable.
- Cannot always demand human involvement at execution time (e.g., medical emergency)

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Goal: Devise decision procedures for predicates that seem mechanically undecidable.

Audit effort during enforcement

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   - Have lawyers draft a single annual notice so that the truth of *is-annual-notice* is determined en masse for all customers.

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Audit Effort	Example	GLBA	HIPAA
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Large, expert	Beliefs, compliance with other laws	15 of 15	84 of 84

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- Properties
  - Sound: Any extension of log satisfies residual policy iff it satisfies original policy

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- Applied iteratively as log records more actions:

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$$\texttt{reduce}(L_2, \varphi_1) = \varphi_2$$
$$\ldots$$

- Properties
  - Sound: Any extension of log satisfies residual policy iff it satisfies original policy
  - Minimal: Residual policy contains only those predicates whose truth cannot be determined from the current log (e.g., future obligations, subjective predicates)

Audit effort during enforcement

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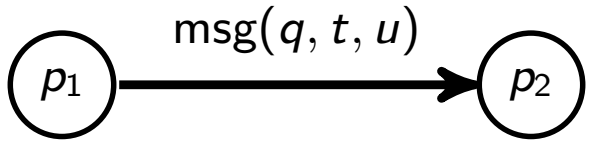

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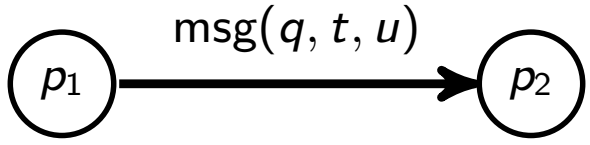

$activerole(p_1, covered\text{-}entity) \wedge$

$activerole(p_2, law\text{-}enforcement) \wedge$

$belongstorole(q, deceased) \wedge$

$(t \in_{\mathcal{T}} phi) \wedge$

$(u \in_{\mathcal{U}} death\text{-}notification(q)) \wedge$

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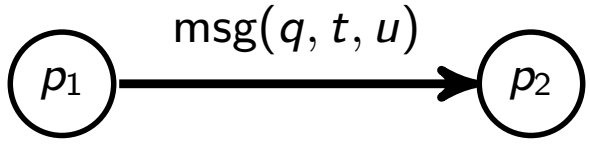

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$activerole(p_1, covered\text{-}entity) \wedge$
$activerole(p_2, provider(q)) \wedge$
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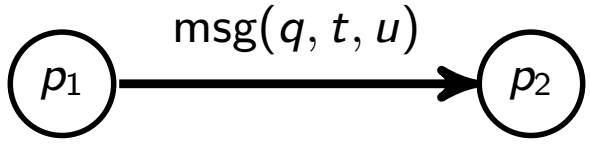

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$(u \in_{\mathcal{U}} death\text{-}notification(q)) \wedge$
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$activerole(p_1, covered\text{-}entity) \wedge$
$activerole(\ldots, prosecutor(q)) \wedge$
$(t \in_{\mathcal{T}} phi) \wedge$
$(\ldots \in_{\mathcal{U}} treatment(p_2))$

Outline

Conclusion

Contributions:

1. PrivacyLFP, a logic and signature for expressing privacy laws
   - Purposes, beliefs, dynamic roles, concrete temporal requirements, and self-referential clauses
2. Complete formalizations of HIPAA and GLBA's operational requirements for transmissions
3. Preliminary ideas for enforcement of HIPAA, GLBA, etc.

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Future work:

- Enforcement!
- Semantics for de-identified data and purposes to reduce audit effort

Thank you!