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

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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 ~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?”
Making sense of real privacy laws

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?
Our work

Contributions:

1. PrivacyLFP, a logic and signature for expressing privacy laws
2. Complete formalizations of HIPAA and GLBA's operational requirements for transmissions
3. Ambiguities in HIPAA and GLBA revealed by our formalization
4. Preliminary ideas for enforcement of HIPAA, GLBA, etc.

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Structure of privacy laws
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Features of the logic PrivacyLFP
  Features with syntactic support only
  Features with semantics

Ambiguity in GLBA's limits on redisclosure

Preliminary ideas for enforcement

Conclusion
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Conclusion
Transmission of protected information

Sender

$p_1$

msg(subject, info)

$p_2$

Recipient
Transmission of protected information

Sender $p_1$ sends a message $m$ to Recipient $p_2$: $msg(subject, info)$
Transmission of protected information

\[ p_1 \xrightarrow{msg(\text{subject, info})} p_2 \]

\[ m \quad q \]

Sender \xrightarrow{msg(\text{subject, info})} Recipient
Transmission of protected information

Sender

$p_1$

msg(subject, info)

$m \quad q \quad t$

Recipient

$p_2$
Transmission of protected information

msg(\textit{Bob}, \textit{phi})

Alice \rightarrow Charlie
Norms of transmission in privacy laws

**Positive norms, \( \varphi_i^+ \):** Transmission *may occur* if condition is satisfied.

- “A covered entity may disclose protected health information for treatment activities [...].” [HIPAA §164.506(c)(2)]
Norms of transmission in privacy laws

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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.

$$maysend(p_1, p_2, m) \triangleq \left( \bigvee_i \varphi_i^+ \right) \land \left( \bigwedge_j \varphi_j^- \right)$$
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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.

$$\varphi'_{164.508a2} \triangleq \varphi'_{164.508a2} \lor (\varphi_{e164.508a2iA} \lor \cdots)$$
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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

**Gramm-Leach-Bliley Act:**
- No positive norms
- 5 negative norms and 10 exceptions
- Negative norms require notices and opt-out opportunities ($§§$6802 and 6803)
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Purposes of disclosures

HIPAA §164.506(c)(2)

“A covered entity may disclose protected health information for [the purpose of] treatment activities of a health care provider.”
Purposes of disclosures

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**Conclusion:** Purpose constants and $\in_U$ predicate for subpurpose hierarchy

- $(\text{blood-tests} \in_U \text{treatment})$ because blood tests are a type of treatment.
Purposes of disclosures

HIPAA § 164.506(c)(2)

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Conclusion: Purpose constants and $\in_{\mathcal{U}}$ predicate for subpurpose hierarchy

\begin{itemize}
  \item (blood-tests $\in_{\mathcal{U}}$ treatment) because blood tests are a type of treatment.
\end{itemize}

$$\varphi_{164\_506\_c2}^+ \triangleq \text{activerole}(p_1, \text{covered-entity}) \land (t \in_{\mathcal{T}} \text{phi}) \land (u \in_{\mathcal{U}} \text{treatment}(p_2)) \land \text{activerole}(p_2, \text{provider})$$
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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Conclusion: Include uninterpreted \textit{believes}-\ldots predicates
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**Conclusion:** Include uninterpreted \(\mathit{believes-}\ldots\) predicates

\[
\varphi_{164.512f4}^+ \triangleq \text{active role}(p_1, \text{covered-entity}) \land \\
(t \in_T \mathit{phi}) \land \\
\text{belong to role}(q, \text{deceased}) \land \\
\text{active role}(p_2, \text{law-enforcement-official}) \land \\
(u \in_U \text{death-notification}(q)) \land \\
\mathit{believes-death-may-be-result-of-crime}(p_1, q)
\]
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Principals’ dynamic roles

**Observation:** Principals’ roles are dynamic.
- Principals enter and exit customer relationships with banks.
- Principals are active in other roles (e.g., doctor) during customer relationship.
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- Principals enter and exit customer relationships with banks.
- Principals are active in other roles (e.g., doctor) during customer relationship.

**Conclusion:** Distinguish the roles held from the active role.
- $\text{belongstорole}(\text{Alice}, \text{customer}(\text{X}))$: Alice is a customer of $\text{X}$.
- $\text{belongstорole}(\text{Alice}, \text{doctor}(\text{Bob}))$: Alice is Bob’s doctor.
- $\text{activerole}(\text{Alice}, \text{doctor}(\text{Bob}))$: Alice is currently active as Bob’s doctor.
- $\neg\text{activerole}(\text{Alice}, \text{customer}(\text{X}))$: Alice is not currently active as a customer of $\text{X}$. 
Past and future temporal requirements

**GLBA §6802(b)(1)**

“A financial institution may not disclose nonpublic personal information unless the consumer is given the opportunity to [opt-out], **before** the time that such information is disclosed.”
Past and future temporal requirements

**GLBA §6802(b)(1)**

“A financial institution may not disclose nonpublic personal information unless the consumer is given the opportunity to [opt-out], before the time that such information is disclosed.”

**GLBA §6803(a)**

“At the time of establishing a customer relationship and not less than annually during such relationship, a financial institution shall provide a disclosure to such customer, of such institution’s policies and practices with respect to [disclosing nonpublic personal info].”
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**Conclusion:** Borrow operators from temporal logic and TPTL.
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- $\Diamond \phi$: “$\phi$ is true at some past time.”
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- □φ: “φ is true at some past time.”
- ◊φ: “φ is true at some future time.”
Past and future temporal requirements

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- $\Diamond \phi$: “$\phi$ is true at some past time.”
- $\Diamond \phi$: “$\phi$ is true at some future time.”
- $\downarrow x. \phi$: Use $x$ as a name for the current time in $\phi$. 
Past and future temporal requirements

GLBA §6802(b)(1)

“A financial institution may not disclose nonpublic personal information unless the consumer is given the opportunity to [opt-out], before the time that such information is disclosed.”

$$\varphi_{6802b1} \triangleq \text{activerole}(p_1, \text{institution}) \land$$

$$\left( t \in T \ \text{npi} \right) \land$$

$$\neg \text{activerole}(p_2, \text{affiliate}(p_1)) \land$$

$$\text{belongstorole}(q, \text{consumer}(p_1))$$

$$\rightarrow$$

$$\downarrow x. \ \Box \left( \downarrow y. \ (x - y \geq 14) \land$$

$$\exists m'. \ \text{send}(p_1, q, m') \land$$

$$\text{is-notice-of-potential}$$

$$\text{disclosure}(m', p_1, p_2, q, t, u))$$
Self-referential legal clauses

§6802(c) of GLBA

“A nonaffiliated third party that receives nonpublic personal information from a financial institution shall not disclose such information to any other person, unless such disclosure would be lawful if made directly to such other person by the institution.”

\[
\text{Institution} \quad \text{Nonaffiliate} \quad \text{Nonaffiliate}
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Self-referential because definition of lawful transmissions relies on the lawfulness of a hypothetical disclosure.
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Conclusion: Use recursion (fixed points) to model self-reference.

\[ \nu \text{ maysend}(p_1, p_2, m). (\bigvee_i \phi_i^+) \land (\bigwedge_j \phi_j^-) \]
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Ambiguity in GLBA’s limits on redisclosure

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GLBA §6802(c) has short range of limits on redisclosure

Consider the scenario:

Institution Nonaffiliate Nonaffiliate Nonaffiliate

Solution: Demand that the information's origin could legally send the information directly.

Note: Discussion of other ambiguities can be found in the paper.
GLBA §6802(c) has short range of limits on redisclosure

Consider the scenario:

Institution  Nonaffiliate  Nonaffiliate  Nonaffiliate

This does not seem in the spirit of GLBA §6802(c)!

Solution: Demand that the information's origin could legally send the information directly.

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Consider the scenario:

\[ i \rightarrow p_0 \rightarrow p_1 \rightarrow p_2 \]

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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)
Properties of enforcement

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**Goal:** Devise decision procedures for predicates that seem mechanically undecidable.
Audit effort during enforcement

Two decision procedures:

1. Standardized data formats
   - 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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Even if experts are used for auditing, the logic directs their efforts.

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```
p1 \xrightarrow{\text{msg}(q, t, u)} p2
```
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Outline

Structure of privacy laws

Features of the logic PrivacyLFP
  Features with syntactic support only
  Features with semantics

Ambiguity in GLBA’s limits on redisclosure

Preliminary ideas for enforcement

Conclusion
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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. Ambiguities in HIPAA and GLBA revealed by our formalization
4. 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!