

Specifying Privacy Laws

Anupam Datta

Carnegie Mellon University

18734: Foundations of Privacy

Fall 2016

Problem Statement

Question: Is an organization's processes and practices compliant with privacy regulations and internal policies?

- ▶ Examples of organizations
 - ▶ Hospitals, financial institutions, universities, and other organizations that collect and use personal information
- ▶ Examples of privacy regulations
 - ▶ Health Insurance Portability and Accountability Act (HIPAA), Gramm-Leach-Bliley Act (GLBA), SB 1386

Problem Statement

Question: Is an organization's processes and practices compliant with privacy regulations and internal policies?

- ▶ Examples of organizations
 - ▶ Hospitals, financial institutions, universities, and other organizations that collect and use personal information
- ▶ Examples of privacy regulations
 - ▶ Health Insurance Portability and Accountability Act (HIPAA), Gramm-Leach-Bliley Act (GLBA), SB 1386

Goal: Develop methods and tools to aid organizations in compliance activities

Making sense of real privacy laws

Observation: Real privacy laws are complex.

- ▶ Long, dense — HIPAA Privacy Rule has 84 operational clauses for transmissions on ~30 pages
- ▶ Too complex to be a practical day-to-day guide for Chief Privacy Officers.

Making sense of real privacy laws

Observation: Real privacy laws are complex.

- ▶ Long, dense — HIPAA Privacy Rule has 84 operational clauses for transmissions on ~30 pages
- ▶ Too complex to be a practical day-to-day guide for Chief Privacy Officers.

Desiderata: Interactive tools for enforcement and analysis

- ▶ “Are actions by Hospital *Y*’s employees compliant with HIPAA?”
- ▶ “Does GLBA permit Bank *X* to disclose Bob’s info to Charlie?”

Our Results

1. Logics for specifying privacy policies informed by the philosophical theory of contextual integrity
(with A. Barth, J. C. Mitchell, H. Nissenbaum)
(with H. DeYoung, D. Garg, L. Jia, D. Kaynar)

Our Results

1. Logics for specifying privacy policies informed by the philosophical theory of contextual integrity
(with A. Barth, J. C. Mitchell, H. Nissenbaum)
(with H. DeYoung, D. Garg, L. Jia, D. Kaynar)
2. Complete formalizations of HIPAA and GLBA's operational requirements for transmissions
(with H. DeYoung, D. Garg, L. Jia, D. Kaynar)

Our Results

1. Logics for specifying privacy policies informed by the philosophical theory of contextual integrity
(with A. Barth, J. C. Mitchell, H. Nissenbaum)
(with H. DeYoung, D. Garg, L. Jia, D. Kaynar)
2. Complete formalizations of HIPAA and GLBA's operational requirements for transmissions
(with H. DeYoung, D. Garg, L. Jia, D. Kaynar)
3. Automated policy monitoring with minimal human input for enforcement of HIPAA, GLBA.
(with D. Garg, L. Jia)

Outline

Structure of privacy laws

Outline

Structure of privacy laws

Privacy Concepts

- Subjective concepts

- Mechanically Enforceable Concepts

Outline

Structure of privacy laws

Privacy Concepts

- Subjective concepts

- Mechanically Enforceable Concepts

Enforcement

Outline

Structure of privacy laws

Privacy Concepts

- Subjective concepts

- Mechanically Enforceable Concepts

Enforcement

Conclusion

Outline

Structure of privacy laws

Privacy Concepts

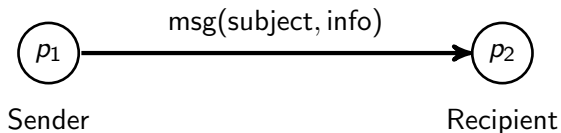
- Subjective concepts

- Mechanically Enforceable Concepts

Enforcement

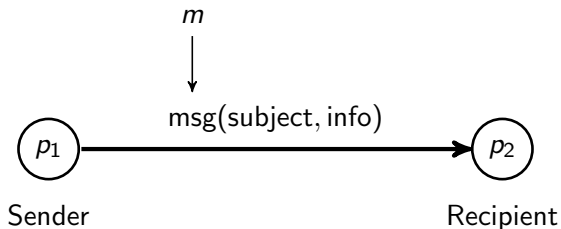
Conclusion

Transmission of protected information



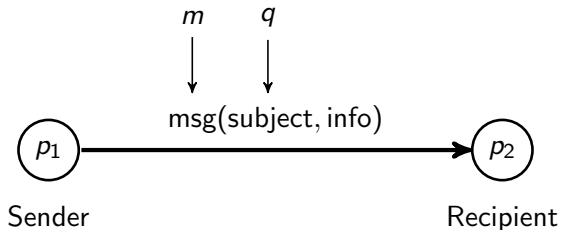
**Transmissions of this form are governed by contextual norms
(Nissenbaum 2004)**

Transmission of protected information



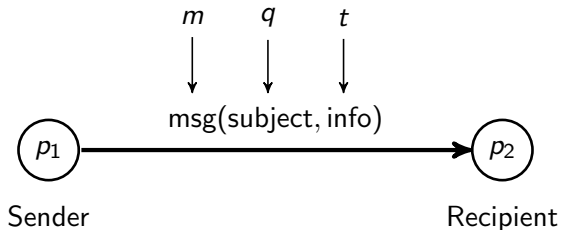
Transmissions of this form are governed by contextual norms (Nissenbaum 2004)

Transmission of protected information



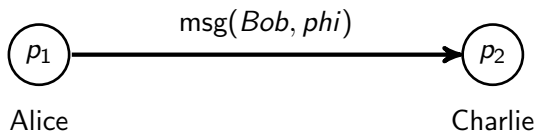
Transmissions of this form are governed by contextual norms (Nissenbaum 2004)

Transmission of protected information



Transmissions of this form are governed by contextual norms (Nissenbaum 2004)

Transmission of protected information



**Transmissions of this form are governed by contextual norms
(Nissenbaum 2004)**

Norms of transmission in privacy laws

Positive norms, φ_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

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

- ▶ “A covered entity may disclose protected health information for treatment activities [...]” [HIPAA §164.506(c)(2)]

Negative norms, φ_j^- : Condition *must be satisfied* if transmission occurs.

- ▶ “A covered entity must obtain an authorization for any use or disclosure of psychotherapy notes.” [HIPAA §164.508(a)(2)]

Norms of transmission in privacy laws

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

- ▶ “A covered entity may disclose protected health information for treatment activities [...]” [HIPAA §164.506(c)(2)]

Negative norms, φ_j^- : Condition *must be satisfied* if transmission occurs.

- ▶ “A covered entity must obtain an authorization for any use or disclosure of psychotherapy notes.” [HIPAA §164.508(a)(2)]

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.

$$\text{maysend}(p_1, p_2, m) \triangleq \left(\bigvee_i \varphi_i^+ \right) \wedge \left(\bigwedge_j \varphi_j^- \right)$$

Norms of transmission in privacy laws

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

- ▶ “A covered entity may disclose protected health information for treatment activities [...]” [HIPAA §164.506(c)(2)]

Negative norms, φ_j^- : Condition *must be satisfied* if transmission occurs.

- ▶ “A covered entity must obtain an authorization for any use or disclosure of psychotherapy notes.” [HIPAA §164.508(a)(2)]

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.

$$\text{maysend}(p_1, p_2, m) \triangleq \left(\bigvee_i \varphi_i^+ \right) \wedge \left(\bigwedge_j \varphi_j^- \right)$$

Norms of transmission in privacy laws

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

- ▶ “A covered entity may disclose protected health information for treatment activities [...]” [HIPAA §164.506(c)(2)]

Negative norms, φ_j^- : Condition *must be satisfied* if transmission occurs.

- ▶ “A covered entity must obtain an authorization for any use or disclosure of psychotherapy notes.” [HIPAA §164.508(a)(2)]

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.

$$\text{maysend}(p_1, p_2, m) \triangleq \left(\bigvee_i \varphi_i^+ \right) \wedge \left(\bigwedge_j \varphi_j^- \right)$$

Norms of transmission in privacy laws

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

- ▶ “A covered entity may disclose protected health information for treatment activities [...]” [HIPAA §164.506(c)(2)]

Negative norms, φ_j^- : Condition *must be satisfied* if transmission occurs.

- ▶ “A covered entity must obtain an authorization for any use or disclosure of psychotherapy notes.” [HIPAA §164.508(a)(2)]

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.

$$\text{maysend}(p_1, p_2, m) \triangleq \left(\bigvee_i \varphi_i^+ \right) \wedge \left(\bigwedge_j \varphi_j^- \right)$$

Norms of transmission in privacy laws

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

- ▶ “A covered entity may disclose protected health information for treatment activities [...]” [HIPAA §164.506(c)(2)]

Negative norms, φ_j^- : Condition *must be satisfied* if transmission occurs.

- ▶ “A covered entity must obtain an authorization for any use or disclosure of psychotherapy notes.” [HIPAA §164.508(a)(2)]

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**.

$$\text{maysend}(p_1, p_2, m) \triangleq \left(\bigvee_i \varphi_i^+ \right) \wedge \left(\bigwedge_j \varphi_j^- \right)$$

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.

$$\varphi_{164.508a2'}^- \triangleq \varphi_{164.508a2}^- \vee (\varphi_{164.508a2iA}^e \vee \dots)$$

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.

$$\varphi_{164.508a2'}^- \triangleq \varphi_{164.508a2}^- \vee (\varphi_{164.508a2iA}^e \vee \dots)$$

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.

$$\varphi_{164.508a2'}^- \triangleq \varphi_{164.508a2}^- \vee (\varphi_{164.508a2iA}^e \vee \dots)$$

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**.

$$\varphi_{164.508a2'}^- \triangleq \varphi_{164.508a2}^- \vee (\varphi_{164.508a2iA}^e \vee \dots)$$

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.

$$\varphi_{164.508a2}^- \triangleq \varphi_{164.508a2}^- \vee (\varphi_{164.508a2iA}^e \vee \dots)$$

“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.

$$\varphi_{164.512c1}^+ \triangleq \varphi_{164.512c1}^+ \wedge \varphi_{164.512c2}^e$$

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.

$$\varphi_{164.508a2}^- \triangleq \varphi_{164.508a2}^- \vee (\varphi_{164.508a2iA}^e \vee \dots)$$

“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.

$$\varphi_{164.512c1}^+ \triangleq \varphi_{164.512c1}^+ \wedge \varphi_{164.512c2}^e$$

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.

$$\varphi_{164.508a2}^- \triangleq \varphi_{164.508a2}^- \vee (\varphi_{164.508a2iA}^e \vee \dots)$$

“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.

$$\varphi_{164.512c1}^+ \triangleq \varphi_{164.512c1}^+ \wedge \varphi_{164.512c2}^e$$

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.

$$\varphi_{164.508a2}^- \triangleq \varphi_{164.508a2}^- \vee (\varphi_{164.508a2iA}^e \vee \dots)$$

“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.

$$\varphi_{164.512c1}^+ \triangleq \varphi_{164.512c1}^+ \wedge \varphi_{164.512c2}^e$$

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

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:

- ▶ Primarily negative norms
 - ▶ 5 negative norms and 10 exceptions
 - ▶ Negative norms require notices and opt-out opportunities (§§6802 and 6803)
- ▶ Allow all transmissions not explicitly denied

Important property of formalization:

- ▶ Traceability: Each clause in the law corresponds to one norm in formalization (roughly)

Outline

Structure of privacy laws

Privacy Concepts

Subjective concepts

Mechanically Enforceable Concepts

Enforcement

Conclusion

Outline

Structure of privacy laws

Privacy Concepts

Subjective concepts

Mechanically Enforceable Concepts

Enforcement

Conclusion

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

HIPAA §164.506(c)(2)

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

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

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.”

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

$$\varphi_{164.506c2}^+ \triangleq \text{activerole}(p_1, \text{covered-entity}) \wedge (t \in_{\mathcal{T}} \text{phi}) \wedge (u \in_{\mathcal{U}} \text{treatment}(p_2)) \wedge \text{activerole}(p_2, \text{provider})$$

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.”

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.”

Conclusion: Include uninterpreted *believes*-. . . predicates

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.**”

Conclusion: Include uninterpreted *believes*-... predicates

$$\begin{aligned} \varphi_{164.512f4}^+ \triangleq & \text{activerole}(p_1, \text{covered-entity}) \wedge \\ & (t \in_{\mathcal{T}} \text{phi}) \wedge \\ & \text{belongstorole}(q, \text{deceased}) \wedge \\ & \text{activerole}(p_2, \text{law-enforcement-official}) \wedge \\ & (u \in_{\mathcal{U}} \text{death-notification}(q)) \wedge \\ & \text{believes-death-may-be-result-of-crime}(p_1, q) \end{aligned}$$

Outline

Structure of privacy laws

Privacy Concepts

Subjective concepts

Mechanically Enforceable Concepts

Enforcement

Conclusion

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].”

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].”

Conclusion: Borrow operators from temporal logic.

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.**”

$$\begin{aligned}
 \varphi_{6802b1}^- &\triangleq \text{activerole}(p_1, \text{institution}) \wedge \\
 &\quad (t \in \mathcal{T} \text{ npi}) \wedge \\
 &\quad \neg \text{activerole}(p_2, \text{affiliate}(p_1)) \wedge \\
 &\quad \text{belongstorole}(q, \text{consumer}(p_1)) \\
 &\quad \supset \\
 &\quad \downarrow x. \diamond (\downarrow y. (x - y \geq 14) \wedge \\
 &\quad \quad \exists m'. \text{send}(p_1, q, m') \wedge \\
 &\quad \quad \text{is-notice-of-potential} \\
 &\quad \quad \text{-disclosure}(m', p_1, p_2, (q, t), u))
 \end{aligned}$$

Syntax of the Policy Logic

Objective predicates	p_O	
Subjective predicates	p_S	
Objective atoms	P_O	$::= p_O(t_1, \dots, t_n)$
Subjective atoms	P_S	$::= p_S(t_1, \dots, t_n)$
Formulas	α, β	$::= P_O \mid P_S \mid \top \mid \perp \mid$ $\alpha_1 \wedge \alpha_2 \mid \alpha_1 \vee \alpha_2 \mid \neg \alpha \mid$ $\forall \vec{x}.(c \supset \alpha) \mid \exists \vec{x}.(c \wedge \alpha) \mid$ $\downarrow x.\alpha \mid \alpha \mathcal{S} \beta \mid \alpha \mathcal{U} \beta \mid \Box \alpha \mid \square \alpha$
Restrictions	c	$::= P_O \mid \top \mid \perp \mid c_1 \wedge c_2 \mid c_1 \vee c_2 \mid$ $\exists x.c$

- ▶ Subjective predicates p_S model beliefs and purposes
- ▶ Restricted quantifiers $\forall \vec{x}.(c \supset \alpha)$, $\exists \vec{x}.(c \wedge \alpha)$
- ▶ Temporal operators $\downarrow x.\alpha$, $\alpha \mathcal{S} \beta$, $\alpha \mathcal{U} \beta$, $\Box \alpha$, $\square \alpha$ ($\Diamond \alpha$, $\diamond \alpha$ defined)

Related Work on Privacy Policy Specification

- ▶ 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.], ...

Related Work on Privacy Policy Specification

- ▶ 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.], ...
- ▶ 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
 - ▶ Deontic logic [I. Lee et al.]: Examples from FDA CFR §610.40