Business Process Compliance

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JIST 2017, 12 November 2017

A Privacy Act

Section 1: (Prohibition to collect personal medical information)

Offence: It is an offence to collect personal medical information.

Defence: It is a defence to the prohibition of collecting personal medical information, if an entity immediately destroys the illegally collected personal medical information before making any use of the personal medical information

Section 2: An entity is permitted to collect personal medical information if the entity acts under a Court Order authorising the collection of personal medical information.

Section 3: (Prohibition to collect personal information) It is forbidden to collect personal information unless an entity is permitted to collect personal medical information.

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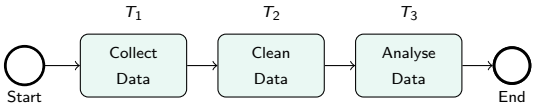
Is the act complied with?

A Business Process



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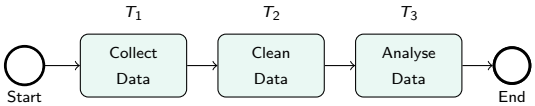

is the process compliant?

Definition of Compliance

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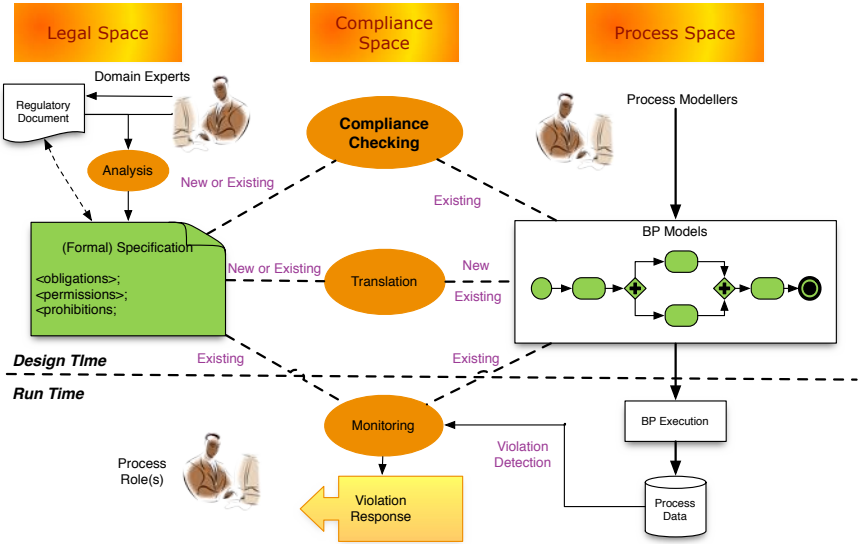
- Conceptually sound representation of processes
- Conceptually sound representation of and reasoning with norms

Compliance Ecosystem



Compliance Recipe

1. Formal Model of Business Processes

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2. Formal Model of Relevant Norms/Normative Frameworks

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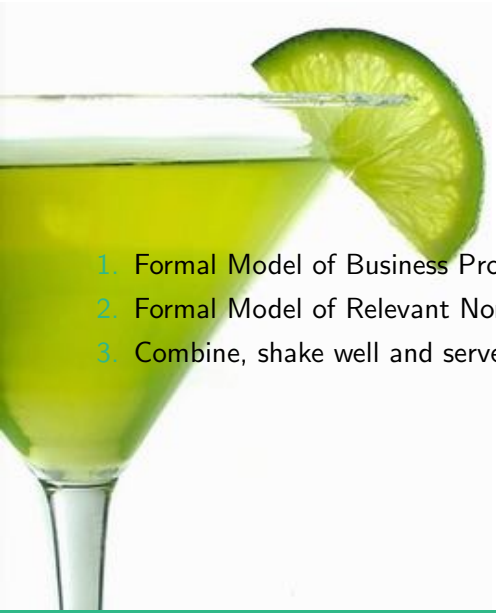

1. Formal Model of Business Processes
2. Formal Model of Relevant Norms/Normative Frameworks
3. Combine, shake well and serve!

Modelling Business Processes

What is a business process model?

Self-contained, temporal and logical order in which a set of activities are executed to achieve a business goal. It describes:

- What needs be done and when (control flows)
- What we need to work on (data)
- Who is doing the work (human and system resources)

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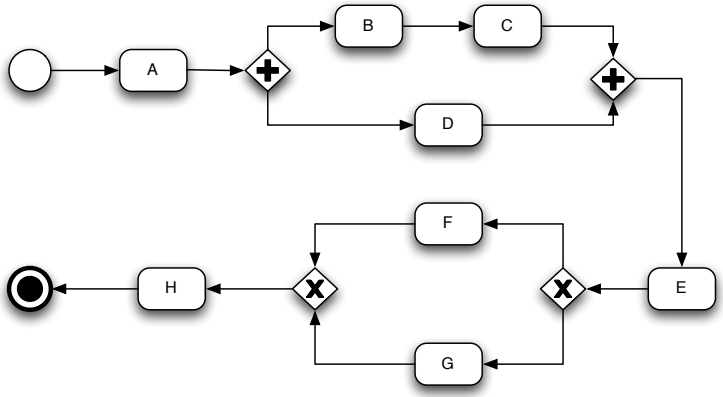
A language for BPM usually has two elements:

- Tasks are activities to be performed
- Connectors consist of
  - sequence (a task is performed after another task),
  - parallel—and-split and and-join—(tasks are to be executed in parallel),
  - choice—(x)or-split and (x)or-join—(at least (most) one task in a set of task must be executed).

Business Process Model



$t_1 : A, B, C, D, E, F, H$
$t_2 : A, B, D, C, E, F, H$
$t_3 : A, D, B, C, E, F, H$

$t_4 : A, B, C, D, E, G, H$
$t_5 : A, B, D, C, E, G, H$
$t_6 : A, D, B, C, E, G, H$

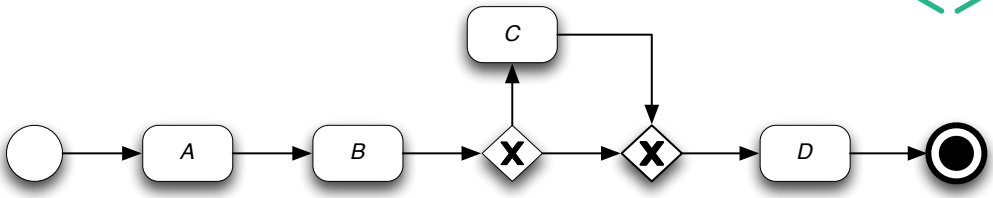
Annotated Traces

Let Lit be a set of literals, T be the set of traces of a process and $\mathbb{N}$ be the set of natural numbers

$$State\colon T \times \mathbb{N} \mapsto 2^{Lit}$$

The function $State$ returns the set of literals describing "what's going on in a trace t after the execution of the n-th task in the process".

Example



Tasks

- A: "turn the light on"
- B: "check if glass is empty"
- C: "fill glass with water"
- D: "turn glass upside-down"

Propositions

- p: "the light is on"
- q: "the glass is full"

Trace 1: $\langle A, B, D \rangle$
Trace 2: $\langle A, B, C, D \rangle$

- $State(i, 1) = \{ p \},\ i \in \{ 1, 2 \}$
- $State(1, 2) = \{ p, q \}$
- $State(2, 2) = \{ p, \neg q \}$
- $State(2, 3) = \{ p, q \}$
- $State(1, 3) = \{ p, \neg q \}$
- $State(2, 4) = \{ p, \neg q \}$

Modelling Norms

Key components of Normative Systems

A normative system is a set of clauses (norms).

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Norms are modelled as **if** ... **then** rules

$$A_1, \ldots, A_n \Rightarrow C$$

- Definitional clauses (constitutive rules: defining terms used in a legal context)
- Prescriptive clauses (norms defining "normative effects")
  - obligations
  - permissions
  - prohibitions
  - violations

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Norms are defeasible (handling exceptions)

Example

Contract fragment

3.1 A “Premium Customer” is a customer who has spent more that $10000 in goods.

3.2 Services marked as “special order” are subject to a 5% surcharge. Premium customers are exempt from special order surcharge.

5.2 The (Supplier) shall on receipt of a purchase order for (Services) make them available within one day.

5.3 If for any reason the conditions stated in 4.1 or 4.2 are not met the (Purchaser) is entitled to charge the (Supplier) the rate of $100 for each hour the (Service) is not delivered.

Defeasibility:
Reasonable results with minimum effort

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Factual omniscience and (non-)monotonic reasoning

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VIC= Very Important Conference

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$$Phd \wedge (\neg Weekend \vee (Weekend \wedge VICdeadline \wedge \neg PartnerBirthday)) \wedge \neg Sick \ldots \rightarrow Uni$$

Defeasibility: Example

NATIONAL CONSUMER CREDIT PROTECTION ACT 2009 (Act No. 134 of 2009)
Section 29

(1) A person must not engage in a credit activity if the person does not hold a licence authorising the person to engage in the credit activity.

(3) For the purposes of subsections (1) and (2), it is a defence if:

- (a) the person engages in the credit activity on behalf of another person (the principal); and
- (b) the person is:
  - (i) an employee or director of the principal or of a related body corporate of the principal; or
  - (ii) a credit representative of the principal; and ...

Modelling Obligations: Deontic Logic

Extension of logic with the operators OBL and PERM.

- $SpecialOrderPrice(x) = Price(x) + 5\%$
- $\text{OBL}^{Supplier}\, MakeGoodsAvailble1Day$
- $\text{PERM}_{Purchaser}\, ChargeSupplier$

Modelling Norms

Norms are modelled as rules in FCL.

Language

- literals $p, q, \ldots$ (atomic proposition and their negation)
- deontic literals $\mathrm{OBL}p$ (Obligatory p), $\mathrm{PERM}p$ (Permitted p), $\mathrm{FORB}p$ (Forbidden p, i.e., $\mathrm{OBL}\neg p$.)

Rules

- Normal rules

$$A_1, \ldots, A_n \Rightarrow OB$$

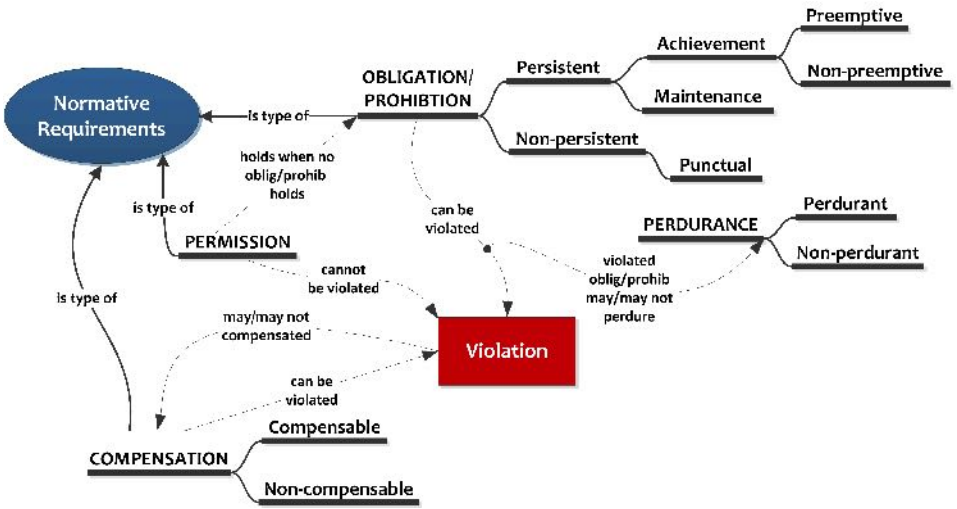
  $A_1 \ldots, A_n$ trigger the obligation of B.

- Rules for violations

$$A_1, \ldots, A_n \Rightarrow \mathrm{OBL}B_1 \otimes \mathrm{OBL}B_2 \otimes \mathrm{OBL}B_3 \otimes \cdots \otimes \mathrm{OBL}B_n$$

  $A_1 \ldots, A_n$ trigger the obligation of B_1 but if B_1 is violated then B_2 is obligatory and so on.

A Legal Zoo


Normative Requirements
is type of
OBLIGATION/ PROHIBTION
Persistent
Achievement
Preemptive
Non-preemptive
Maintenance
Non-persistent
Punctual
holds when no oblig/prohib holds
is type of
PERMISSION
can be violated
PERDURANCE
Perdurant
Non-perdurant
violated oblig/prohib may/may not perdure
cannot be violated
is type of
may/may not compensated
Violation
can be violated
Compensable
COMPENSATION
Non-compensable

Modelling Obligations

Let Lit be a set of literals, T be the set of traces of a process and $\mathbb{N}$ be the set of natural numbers

$$Force\colon\ T \times \mathbb{N} \mapsto 2^{Lit}$$

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$$\mathit{Force}\colon\ T \times \mathbb{N} \mapsto 2^{\mathit{Lit}}$$

The function *Force* returns the set of literals describing what is obligatory for a particular task.

Persistent Obligations: Achievement vs Maintenance

- For an *achievement obligation*, a certain condition must occur at least once before the deadline
  'Customers must pay before the delivery of the good, after receiving the invoice'
- For *maintenance obligations*, a certain condition must obtain during all instants before the deadline:
  'After opening a bank account, customers must keep a positive balance until bank charges are taken out'

Modelling Maintenance Obligations

Definition (Maintenance Obligation)

An obligation o is a *maintenance obligation* in t if and only if

$$\begin{aligned} \exists n, m \in \mathbb{N}\colon\ & n < m, \\ & o \notin \mathit{Force}, \\ & o \notin \mathit{Force}, \\ & \forall k : n \leq k \leq m, o \in \mathit{Force} \end{aligned}$$

A maintenance obligation o is *violated* in t if and only if

$$\exists k : n \leq k \leq m, o \notin \mathit{State}(t, k).$$

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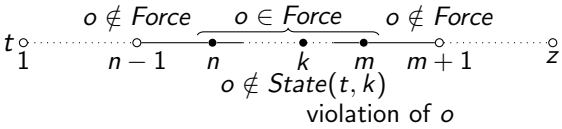
Maintenance obligations can be used to model prohibitions.

Graphical Illustration of a Maintenance Obligation



Modelling Achievement Obligations

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An obligation o is an *achievement obligation* in t if and only if

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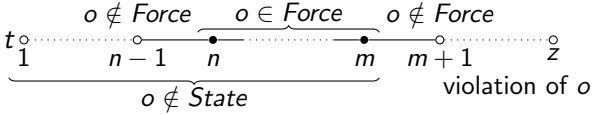
An achievement obligation o is *violated* in t if and only if

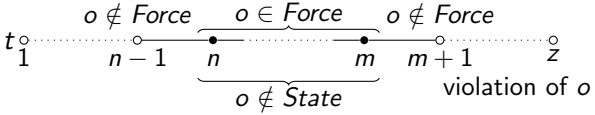
- o is preemptive and $\forall k : k \leq m,\ o \notin \mathit{State}(t, k)$;
- o is non-preemptive and $\forall k : n \leq k \leq m,\ o \notin \mathit{State}(t, k)$.

Graphical Illustration of Achievement Obligations

Achievement preemptive



Achievement non-preemptive



FCL at Work: Exceptions

r_1: $person(x) \Rightarrow \mathrm{OBL}^m \neg creditActivity(x)$

r_2: $ownCreditLicense(x) \Rightarrow \mathrm{PERM} creditActivity(x)$

r_3: $person(x), onBehalfOf(x, y), employee(x, y) \Rightarrow \mathrm{PERM} creditActivity(x)$

$r_1 \prec r_2, \; r_1 \prec r_3$

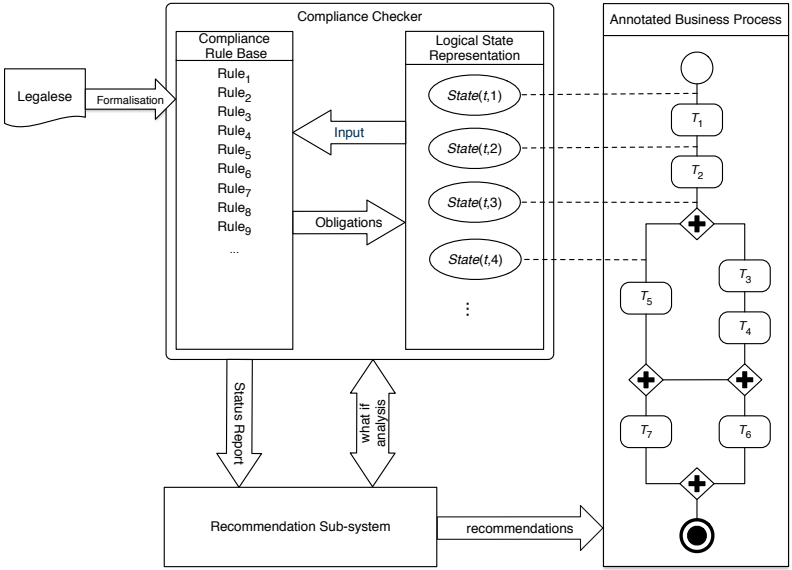
BPM Compliance

Business Process Compliance Problem

Given a business process model

- identify what holds in the process
- identify what norms are valid for the process
  - determine what are the obligations, prohibitions, and permissions in force
  - determine when the obligations, prohibitions and permissions are in force in the process (for each trace)

Compliance Architecture



Finally Compliant!

Definition

- An execution trace is *compliant* iff all violated obligations in force have been compensated for.
- An execution trace is *fully compliant* iff there are no violations.
- A process is (*fully*) *compliant* iff all its execution traces are (fully) compliant.

Example and Evaluation

A Privacy Act

Section 1: (Prohibition to collect personal medical information)

Offence: It is an offence to collect personal medical information.

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Section 2: An entity is permitted to collect personal medical information if the entity acts under a Court Order authorising the collection of personal medical information.

Section 3: (Prohibition to collect personal information) It is forbidden to collect personal information unless an entity is permitted to collect personal medical information.

Offence: an entity collected personal information

Defence: an entity being permitted to collect personal medical information.

Making Sense of the Act

- Collection of medical information is forbidden.
- Destruction of the illegally collected medical information excuses the illegal collection.
- Collection of medical information is permitted if there is an authorising court order.
- Collection of personal information is forbidden.
- Collection of personal information is permitted if the collection of medical information is permitted

Formalisation of the Privacy Act

- collection of medical information is forbidden
  - c destruction of medical information compensates the illegal collection

$$r_1 : \Rightarrow \mathrm{OBL}^m \neg \mathit{medicalInfo} \otimes \mathrm{OBL}^{\mathit{anpp}} \mathit{destroy}$$

- collection of medical information is permitted if acting under a court order

$$r_2 : \mathit{courtOrder} \Rightarrow \mathrm{PERM}\, \mathit{medicalInfo}$$

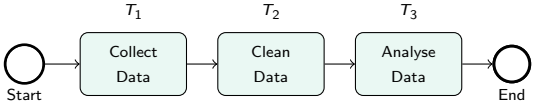
- collection of personal information is forbidden

$$r_3 : \Rightarrow \mathrm{OBL}^m \neg \mathit{personalInfo}$$

- collection personal information is permitted if collection of medical information is permitted

$$r_4 : \mathrm{PERM}\, \mathit{medicalInfo} \Rightarrow \mathrm{PERM}\, \mathit{personalInfo}$$

Are We Compliant?



$r_1 : \Rightarrow \mathrm{OBL}^{m} \neg \mathit{medicalInfo} \otimes \mathrm{OBL}^{\mathit{anpp}} \mathit{destroy}$

$r_2 : \mathit{courtOrder} \Rightarrow \mathrm{PERM} \mathit{medicalInfo}$

$r_3 : \Rightarrow \mathrm{OBL}^{m} \neg \mathit{personalInfo}$

$r_4 : \mathrm{PERM} \mathit{medicalInfo} \Rightarrow \mathrm{PERM} \mathit{personalInfo}$

$r_1 \prec r_2, \; r_3 \prec r_4$

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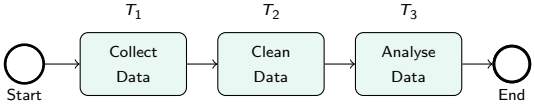

$State(start) : \neg courtOrder$

$r_1 : \Rightarrow \mathrm{OBL}^{m} \neg medicalInfo \otimes \mathrm{OBL}^{anpp} destroy$

$r_2 : courtOrder \Rightarrow \mathrm{PERM} medicalInfo$

$r_3 : \Rightarrow \mathrm{OBL}^{m} \neg personalInfo$

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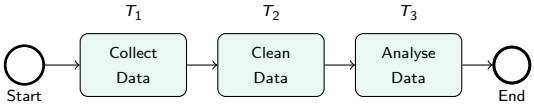

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$Force(T_1) : \quad \text{OBL}^m \neg medicalInfo$
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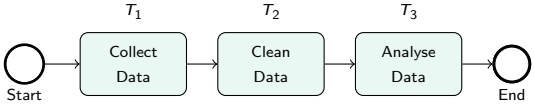

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$\mathit{State}(T_1) : \mathit{medicalInfo}$

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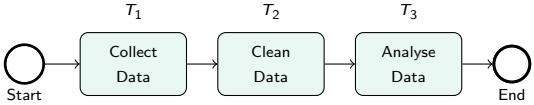

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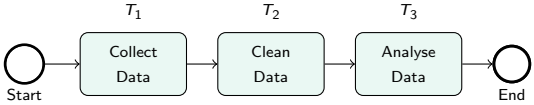

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$\mathit{Violated}(T_1) : \mathrm{OBL}^{m} \neg \mathit{medicalInfo}$

$\mathit{Force}(T_2) : \mathrm{OBL}^{\mathit{anpp}} \mathit{destroy}$

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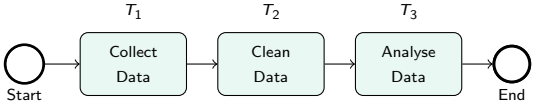

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$r_1 \prec r_2, \; r_3 \prec r_4$

$\mathit{State}(\mathit{start}) : \neg \mathit{courtOrder}$

$\mathit{Force}(T_1) : \; \mathrm{OBL}^{m} \neg \mathit{medicalInfo}$

$\mathrm{OBL}^{m} \neg \mathit{personalInfo}$

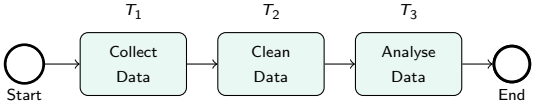
$\mathit{State}(T_1) : \mathit{medicalInfo}$

$\mathit{Violated}(T_1) : \mathrm{OBL}^{m} \neg \mathit{medicalInfo}$

$\mathit{Force}(T_2) : \mathrm{OBL}^{\mathit{anpp}} \mathit{destroy}$

$\mathit{State}(T_2) : \mathit{personalInfo}$

Are We Compliant?



$r_1 : \Rightarrow \mathrm{OBL}^m \neg medicalInfo \otimes \mathrm{OBL}^{anpp}\, destroy$

$r_2 : courtOrder \Rightarrow \mathrm{PERM}\, medicalInfo$

$r_3 : \Rightarrow \mathrm{OBL}^m \neg personalInfo$

$r_4 : \mathrm{PERM}\, medicalInfo \Rightarrow \mathrm{PERM}\, personalInfo$

$r_1 \prec r_2, \; r_3 \prec r_4$

$State(start) : \neg courtOrder$

$Force(T_1) : \; \mathrm{OBL}^m \neg medicalInfo$
$\mathrm{OBL}^m \neg personalInfo$

$State(T_1) : medicalInfo$

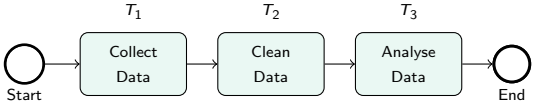
$Violated(T_1) : \mathrm{OBL}^m \neg medicalInfo$

$Force(T_2) : \mathrm{OBL}^{anpp}\, destroy$

$State(T_2) : personalInfo$

$Violated(T_2) : \mathrm{OBL}^m \neg personalInfo$

Are We Compliant?



$r_1 : \Rightarrow \mathrm{OBL}^m \neg \mathit{medicalInfo} \otimes \mathrm{OBL}^{\mathit{anpp}}\, \mathit{destroy}$

$r_2 : \mathit{courtOrder} \Rightarrow \mathrm{PERM}\, \mathit{medicalInfo}$

$r_3 : \Rightarrow \mathrm{OBL}^m \neg \mathit{personalInfo}$

$r_4 : \mathrm{PERM}\, \mathit{medicalInfo} \Rightarrow \mathrm{PERM}\, \mathit{personalInfo}$

$r_1 \prec r_2, \; r_3 \prec r_4$

$\mathit{State}(\mathit{start}) : \neg \mathit{courtOrder}$

$\mathit{Force}(T_1) : \; \mathrm{OBL}^m \neg \mathit{medicalInfo}$
$\mathrm{OBL}^m \neg \mathit{personalInfo}$

$\mathit{State}(T_1) : \mathit{medicalInfo}$

$\mathit{Violated}(T_1) : \mathrm{OBL}^m \neg \mathit{medicalInfo}$

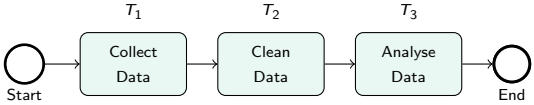
$\mathit{Force}(T_2) : \mathrm{OBL}^{\mathit{anpp}}\, \mathit{destroy}$

$\mathit{State}(T_2) : \mathit{personalInfo}$

$\mathit{Violated}(T_2) : \mathrm{OBL}^m \neg \mathit{personalInfo}$

$\mathit{State}(T_3) : \mathit{destroy}$

Are We Compliant?



$r_1 : \Rightarrow \mathrm{OBL}^m \neg \mathit{medicalInfo} \otimes \mathrm{OBL}^{\mathit{anpp}}\, \mathit{destroy}$

$r_2 : \mathit{courtOrder} \Rightarrow \mathrm{PERM}\, \mathit{medicalInfo}$

$r_3 : \Rightarrow \mathrm{OBL}^m \neg \mathit{personalInfo}$

$r_4 : \mathrm{PERM}\, \mathit{medicalInfo} \Rightarrow \mathrm{PERM}\, \mathit{personalInfo}$

$r_1 \prec r_2, \; r_3 \prec r_4$

$\mathit{State}(\mathit{start}) : \neg \mathit{courtOrder}$

$\mathit{Force}(T_1) : \; \mathrm{OBL}^m \neg \mathit{medicalInfo}$

$\mathrm{OBL}^m \neg \mathit{personalInfo}$

$\mathit{State}(T_1) : \mathit{medicalInfo}$

$\mathit{Violated}(T_1) : \mathrm{OBL}^m \neg \mathit{medicalInfo}$

$\mathit{Force}(T_2) : \mathrm{OBL}^{\mathit{anpp}}\, \mathit{destroy}$

$\mathit{State}(T_2) : \mathit{personalInfo}$

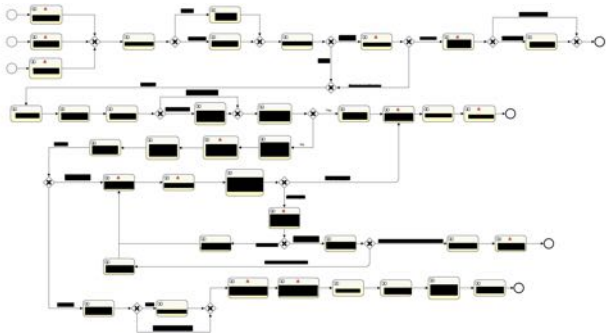
$\mathit{Violated}(T_2) : \mathrm{OBL}^m \neg \mathit{personalInfo}$

$\mathit{State}(T_3) : \mathit{destroy}$

$\mathit{Compensated}(T_3) : \mathrm{OBL}^m \neg \mathit{medicalInfo}$

The Regorous Evaluation

Formalised Chapter 8 (Complaints) of TCPC 2012. Modelled the compliant handling/management processes of an Australian telco.



41 tasks, 12 decision points (xor), 2 loops
shortest trace: 6 traces longest trace (loop): 33 tasks
longest trace (no loop): 22 tasks
over 1000 traces, over 25000 states

The Regorous Evaluation

TCPC 2012 Chapter 8. Contains over 100 commas, plus 120 terms (in Terms and Definitions Section).
Required 223 propositions, 176 rules.

Punctual Obligation	5	(5)
Achievement Obligation	90	(110)
Preemptive	41	(46)
Non preemptive	49	(64)
Non perdurant	5	(7)
Maintenance Obligation	11	(13)
Prohibition	7	(9)
Non perdurant	1	(4)
Permission	9	(16)
Compensation	2	(2)

Conclusions

Conclusions

- Extended business processes with semantic annotations
- Developed conceptually sound logic for modelling norms (just hinted today!)
- Business process compliance methodology
- Business process compliance is at least an NP-complete problem (not shown today!)
- Model checking using temporal logic does not work (not shown today!)
- Implemented practical solution

Questions?

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