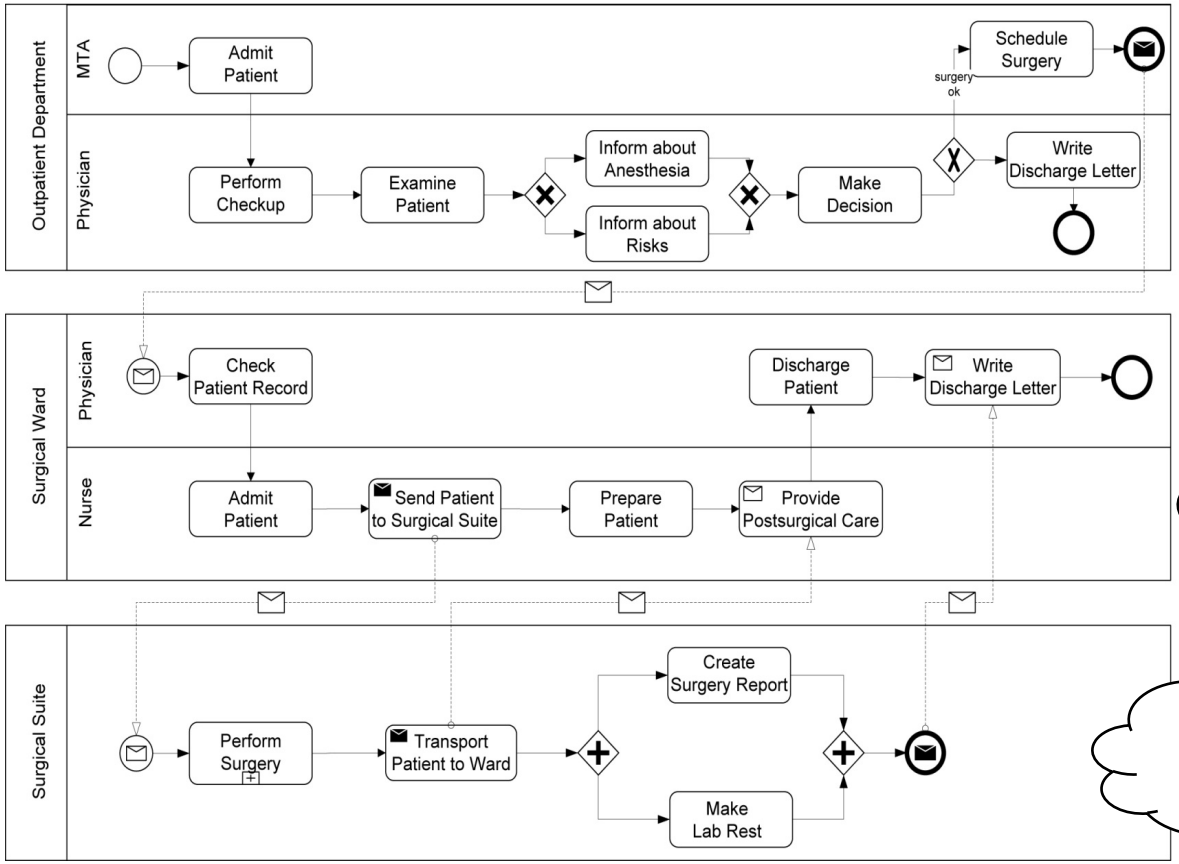
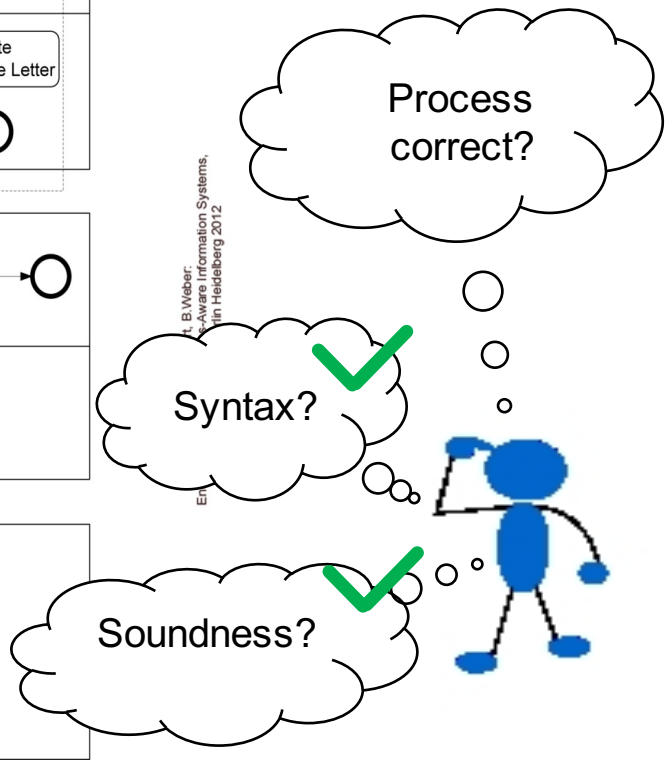
Business Process Compliance

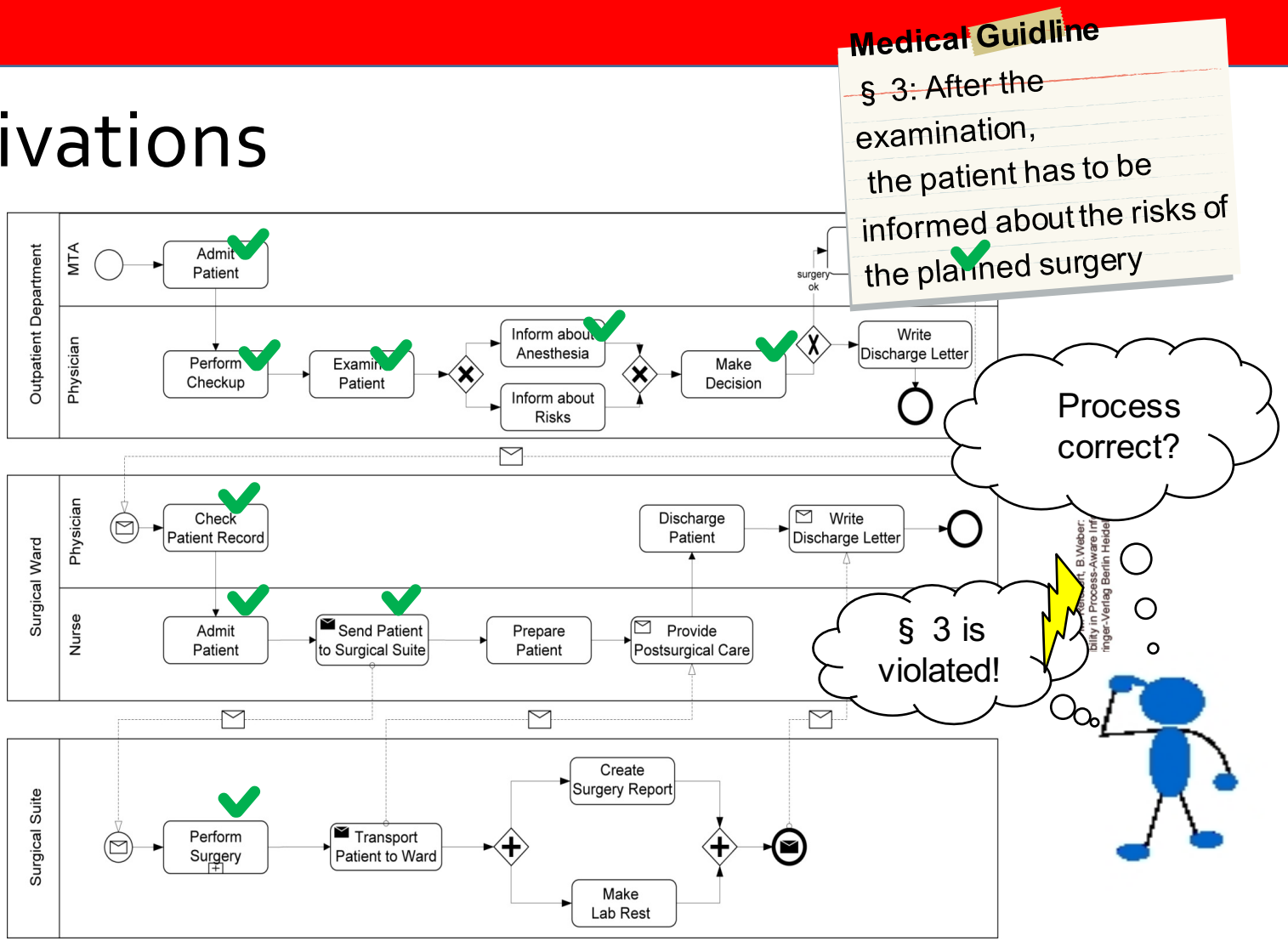
Barbara Re

Motivation

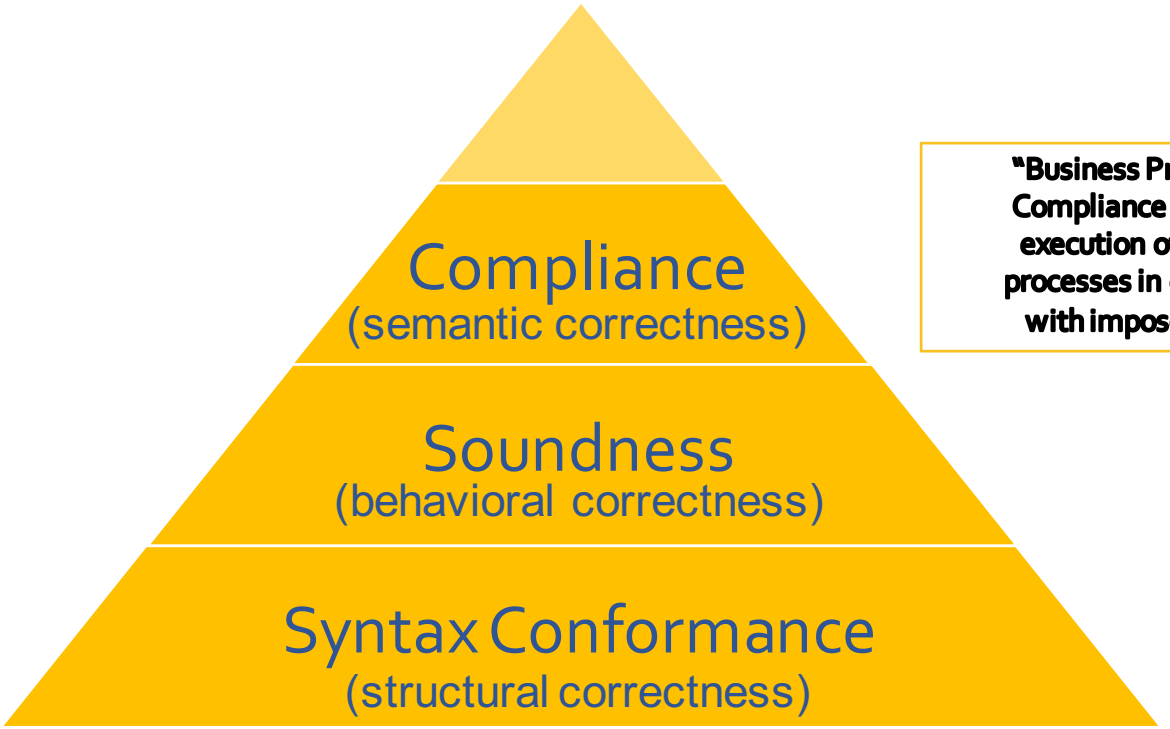

Outpatient Department
MTA
Admit Patient
Schedule Surgery
surgery ok
Physician
Perform Checkup
Examine Patient
Inform about Anesthesia
Inform about Risks
Make Decision
Write Discharge Letter
Surgical Ward
Physician
Check Patient Record
Discharge Patient
Write Discharge Letter
Nurse
Admit Patient
Send Patient to Surgical Suite
Prepare Patient
Provide Postsurgical Care
Surgical Suite
Perform Surgery
Transport Patient to Ward
Create Surgery Report
Make Lab Rest


Process correct?
Syntax?
Soundness?

Motivations



Motivation – Layers of Correctness



"Business Process Compliance means the execution of business processes in compliance with imposed rules."

Compliance Rule

- (Business Process) Compliance Rule: "A Compliance Rule is a semantic condition on the execution of business processes."

Let $\Sigma = \{a_1, a_2, a_3, \ldots\}$ be the set of activities/tasks and Σ^* the set of all execution traces (i.e. sequences) of activities of A, then a compliance rule c can be considered as a function:

$$c: \Sigma* \longmapsto \mathbb{B}$$

Examples for Medical Compliance Rules

§ 1	Before a surgery may be performed, first the patient has to be prepared for it and then be sent to the surgical suite.
§ 2	After examining the patient a decision has to be made. However, this must not be done before the examination.
§ 3	After the examination, the patient has to be informed about the risks of the planned surgery.
§ 4	Before scheduling the surgery the patient has to be informed about anesthesia.
§ 5	If a surgery has not been scheduled it must not be perfomed.
§ 6	After a patient is discharged a discharge letter has to be written.
§ 7	After performing the surgery and before writing the discharge letter, a surgery report must be created and a lab test made.

Modeling Compliance Rules

§ 1	Before a surgery may be performed, first the patient has to be prepared for it and then be sent to the surgical suite.
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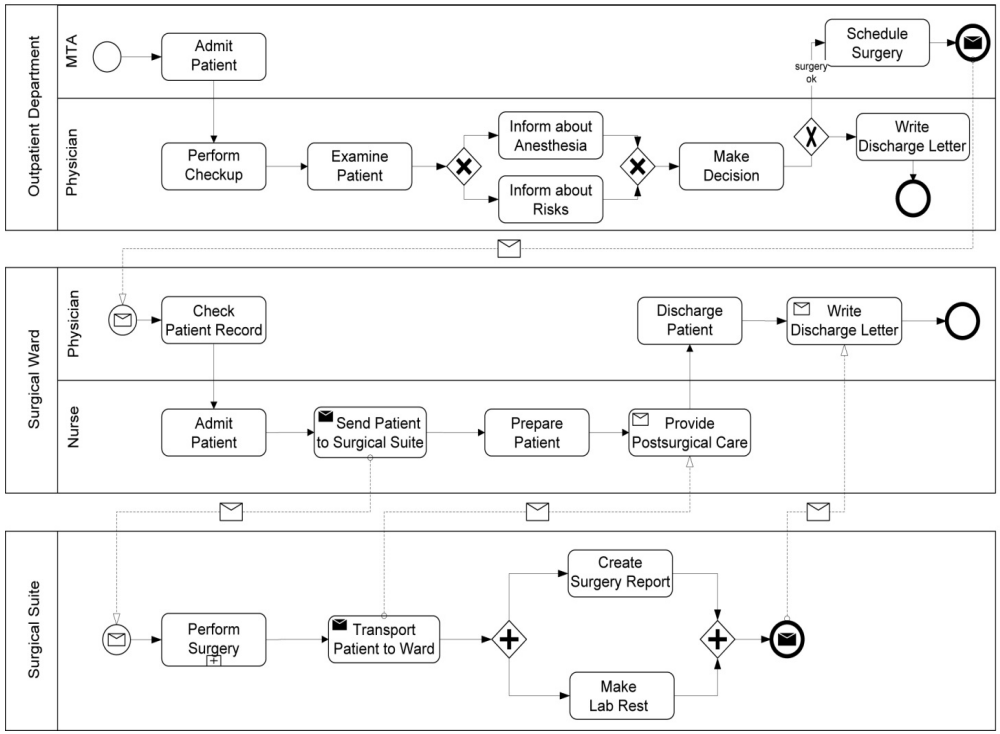
§ 5	If a surgery has not been scheduled it must not be perfomed.
§ 6	After a patient is discharged a discharge letter has to be written.
§ 7	After performing the surgery and before writing the discharge letter, a surgery report must be created and a lab test made.

Usefulness?

How to ensure compliance?



§ 1	Before a surgery may be perforemd the patient has to be prepared for it and be sent to the surgical suite
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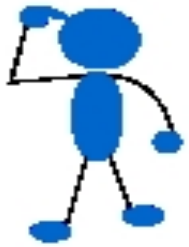
§ 3	After the examination, the patient has to be informed about the risks of the planned surgery
§ 4	Before scheduling the surgery the patient has to be informed about anesthesia
§ 5	If a surgery h… …ed.
§ 6	After a p… …tten.
§ 7	After perfor… …discharge letter, a surgery report mu… …test made

Any execution compliant?

M. F. … iabling Flexibility in … @ Springer-Ve…



⇒ costly
⇒ slow
⇒ error-prone

Modeling Compliance Rules

Plain Text → Logical Formalisms → Graphical Models

Linear Temporal Logic – LTL

LTL enriches propositional logic with the temporal operators:

X (next) **F** (finally) **G** (global)

U (until) **W** (weak until)

Le $\Sigma = \{a_1, a_2, a_3, \ldots\}$ be a of propositions/activities; the syntax of LTL is:

<LTL> ::= a_1 | a_2 | a_3 | … | true | false |

¬ <LTL> | (<LTL>) | <LTL> ⇒ <LTL> |

<LTL> **Λ** <LTL> | <LTL> **V** <LTL> |

<LTL> **U** <LTL> | <LTL> **W** <LTL>

X <LTL> | **F** <LTL> | **G** <LTL> |

Modeling Compliance Rules

Plain Text → Logical Formalisms → Graphical Models

Semantic of LTL

$\Sigma = \{a_1, a_2, a_3, \ldots\}$ – a set of activities

$\sigma = < \sigma_1, \sigma_2, \sigma_3, \ldots > \in \Sigma^*$ – a trace of activities

φ, ψ – LTL -Formulas over P

$$< a, \ldots > \models a$$

$$< \sigma_1, \sigma_2, \sigma_3, \ldots > \models \mathbf{X}\,\phi \leftrightarrow < \sigma_2, \sigma_3, \ldots > \models \phi$$

$$\sigma \models \mathbf{F}\,\phi \leftrightarrow \sigma \models \phi \vee \mathbf{X}\,\mathbf{F}\,\phi$$

$$\sigma \models \mathbf{G}\,\phi \leftrightarrow \sigma \models \phi \wedge \mathbf{X}\,\mathbf{G}\,\phi$$

$$\sigma \models \psi\,\mathbf{U}\,\phi \leftrightarrow \sigma \models \varphi \vee (\psi \wedge \mathbf{X}\,(\psi\,\mathbf{U}\,\phi) \wedge \mathbf{F}\,\phi)$$

$$\sigma \models \psi\,\mathbf{W}\,\phi \leftrightarrow \sigma \models \varphi \vee (\psi \wedge \mathbf{X}\,(\psi\,\mathbf{W}\,\phi))$$

Modeling Compliance Rules

Plain Text → Logical Formalisms → Graphical Models

§ 1	(¬Perform_surgery W Prepare_patient) Λ (¬Perform_surgery W Send_patient_to_surgical_suite)
§ 2	(G (Examine_patient ⇒ F Make_decision)) Λ (¬Make_decision U Examine_patient)
§ 3	G (Examine_patient ⇒ F Inform_about_risks)
§ 4	¬Schedule_Surgery W Inform_about_anesthesia
§ 5	(G ¬Schedule_surgery) ⇒ (G ¬Perform_surgery)
§ 6	G (Discharge_Patient ⇒ F Write_discharge_letter)
§ 7	G (¬Perform_surgery ⇒ (F Write_discharge_letter ⇒((¬ Write_discharge_letter U Create_surgery_report) Λ (¬ Write_discharge_letter U Make_lab_test))))

Pros and cons?

$$(G\ (Examine\_patient \Rightarrow F\ Make\_decision)) \wedge (\neg Make\_decision\ U\ Examine\_patient)$$

+	-
unique semantic	hard to comprehend
automatic verification with Model Checking	requires experts

Modeling Compliance Rules

Alternative Logical Formalisms

- Predicate Logic
- Deontic Logic, Abduktive Logic
- μ-Calculus, π-Calculus, Event-Calculus
- CTL, PLTL, CTL*
- Grammars, FCL
- …

➔ **But the problems remain the same**

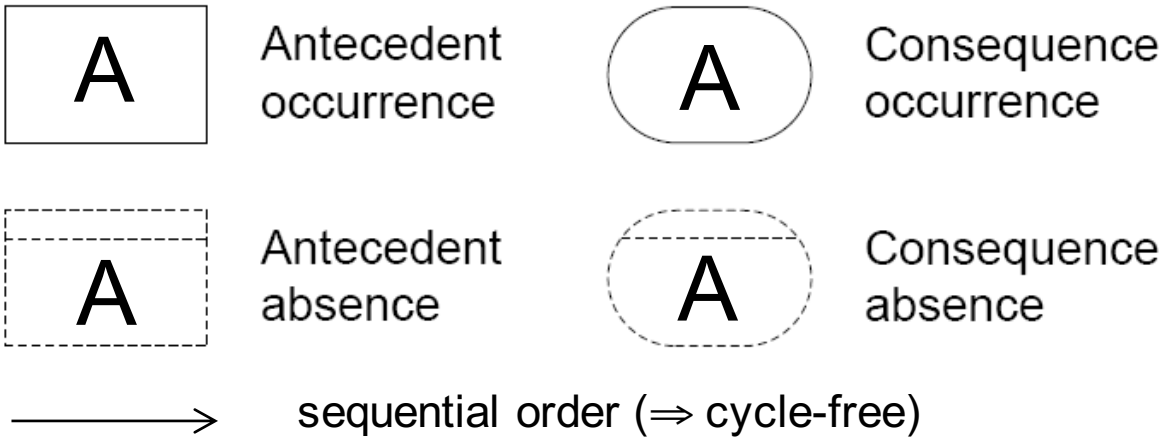
Modeling Compliance Rules

Plain Text → Logical Formalisms → Graphical Models

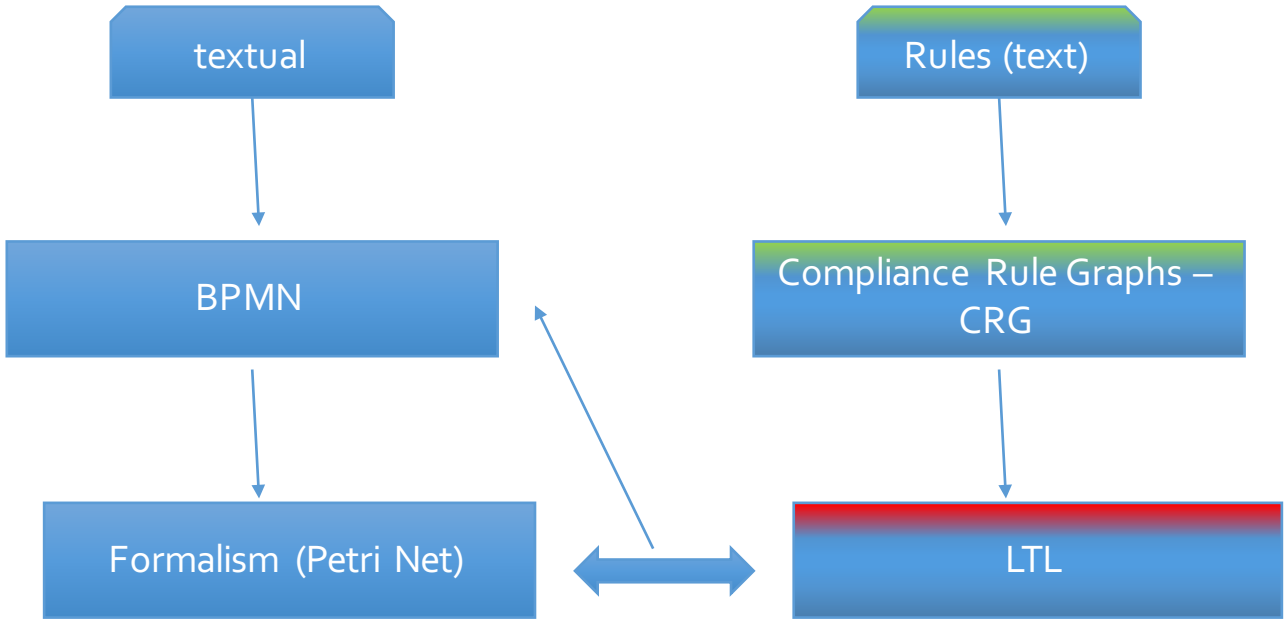
Compliance Rule Graphs – CRG

CRGs consist of an antecedent and a consequence pattern.

The basic building bricks are the following elements:



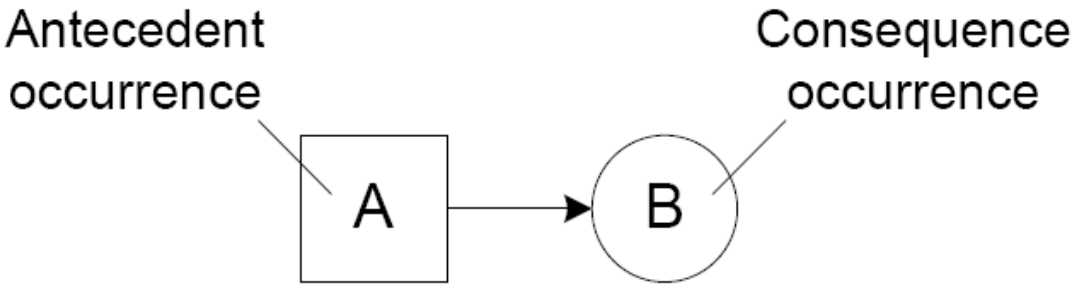
Compliance Rules in the Model Analysis



Modeling Compliance Rules

Plain Text → Logical Formalisms → Graphical Models

Example 1/4



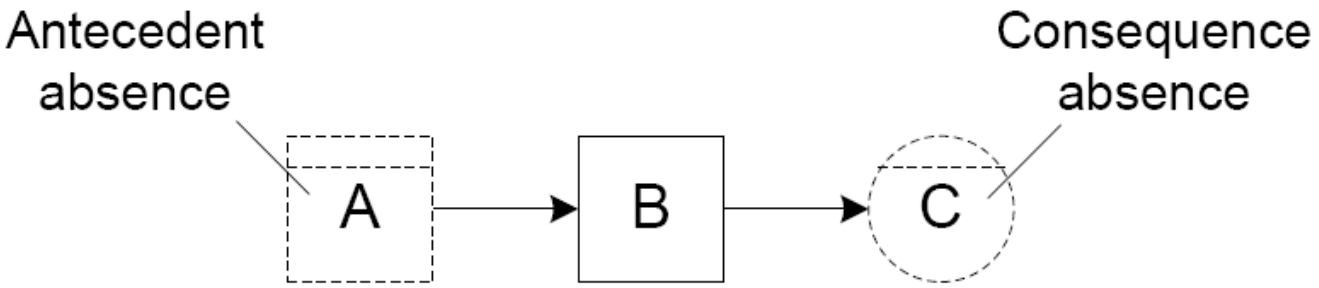
< E, D, F, G, B > (✓)
< C, A, B, D, B > ✓
< A, F, A, D, B > ✓

< G, C, F, D, G > (✓)
< G, C, B, A, D > ⚡
< A, D, B, G, A > ⚡

Modeling Compliance Rules

Plain Text → Logical Formalisms → Graphical Models

Example 2/4



If there is no "A" before any occurrence of "B", than "C" is not allowed after that "B".

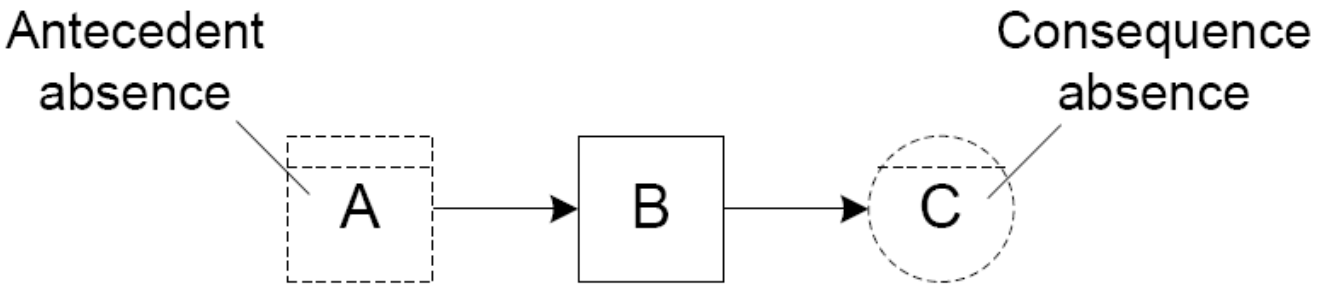
< A, B, F, C, D > ✓
< B, F, D, B, A > ✓
< G, F, E, D, E > ✓

< G, D, B, F, D > ✓
< B, G, E, C, D > ✗
< B, A, B, F, C > ✗

Modeling Compliance Rules

Plain Text → Logical Formalisms → Graphical Models

Example 2/4



If there is no "A" before any occurrence of "B", than "C" is not allowed after that "B".

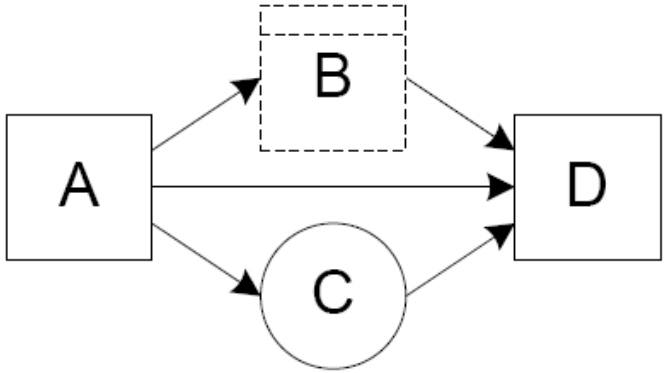
< A, B, F, C, D > ✓
< B, F, D, B, A > ✓
< G, F, E, D, E > ✓

< G, D, B, F, D > ✓
< B, G, E, C, D > ✗
< B, A, B, F, C > ✗

Modeling Compliance Rules

Plain Text → Logical Formalisms → Graphical Models

Example 3/4

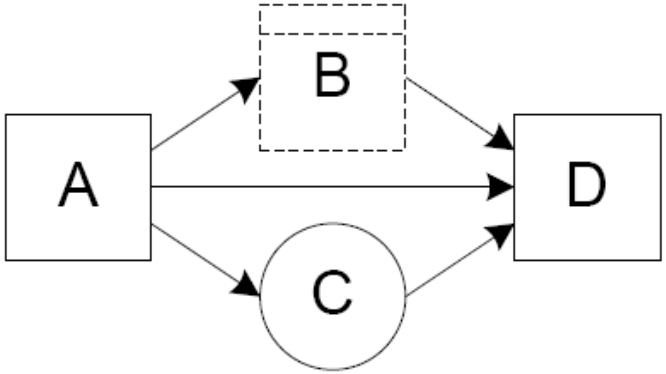


If an occurrence of "A" is followed by a "D" without a "B" lying inbetween, then an "C" is required to occur after that "A" and before that "D".

< A, F, B, G, C > ✓
< E, A, E, C, D > ✓
< E, A, E, B, D > ✓

< G, B, E, G, D> ✓
< A, F, D, G, B > ✗
< A, F, D, C, D > ✗

Exercise



A B C D (✓)

A D E C ↯

C A B D (✓)

D C A A (✓)

A C C A D ✓

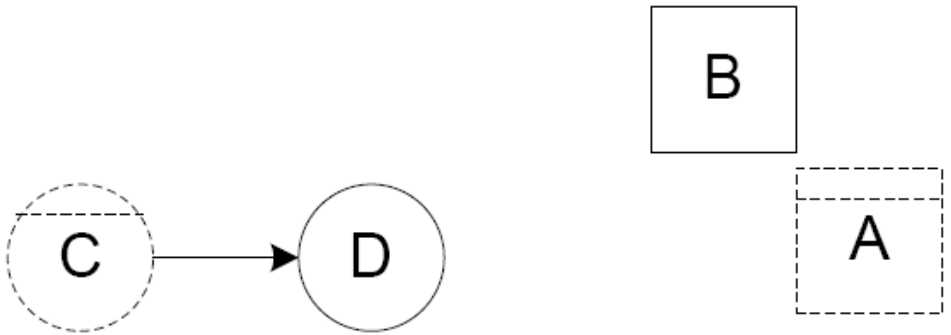
D D A C D D ✓

C A C D ✓

Modeling Compliance Rules

Plain Text → Logical Formalisms → Graphical Models

Example 4/4



If a "B" occurs but no "A", then a "D" has to occur, without an occurrence of "C" in front of that "D".

< E, D, F, G, B > ✓

< D, F, C, E, B > ✓

< A, B, C, E, D > (✓)

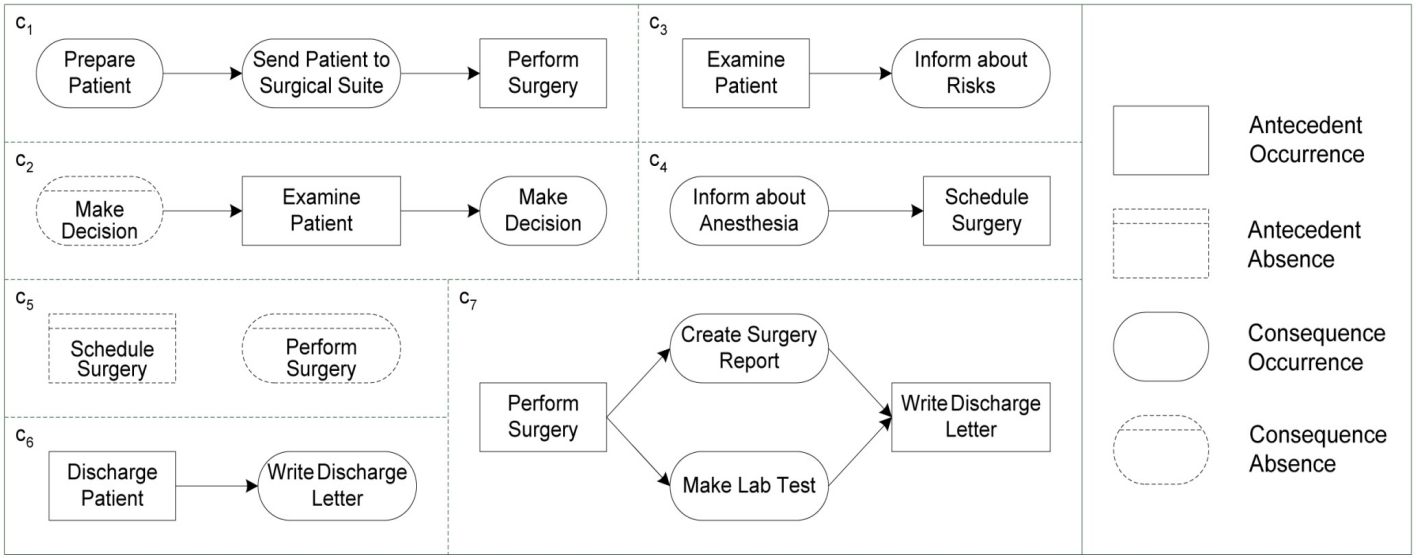
< G, C, B, A, D > (✓)

< H, F, B, G, E > ↯

< C, B, D, E, B > ↯

Modeling Compliance Rules

Plain Text → Logical Formalisms → Graphical Models



M. Reichert, B.Weber:
Enabling Flexibility in Process-Aware Information Systems,
@ Springer-Verlag Berlin Heidelberg 2012

Modeling Compliance Rules

Alternative Graphical Models

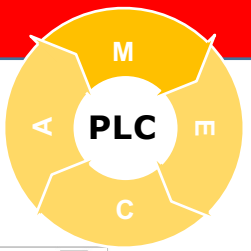
- Automata
- BPMN-Q
- G-CTL

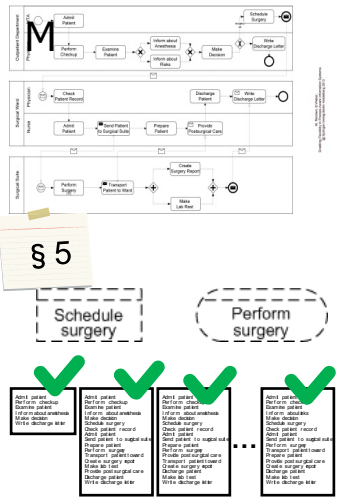
Ensure Business Process Compliance

- **A Prioir Compliance Checking**
- **Run Time Compliance Checking**

- Change Time Compliance Checking
- A Posteriori Compliance Checking

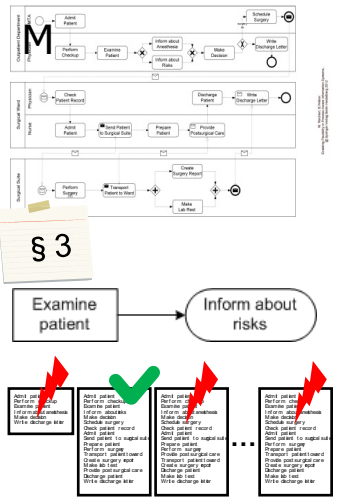
A Priori Compliance





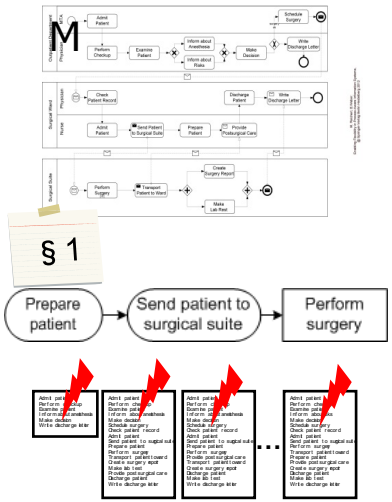
all traces comply

M complies with § 5



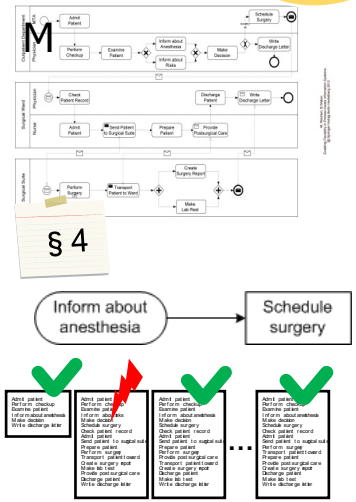
at least one trace complies

M partially complies with § 3



all traces violate

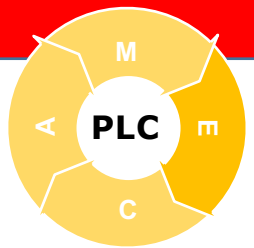
M violates § 1

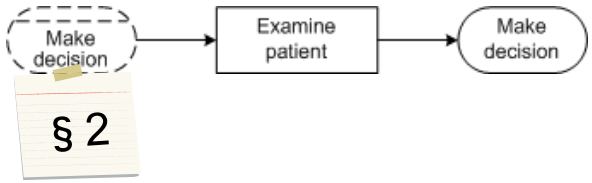
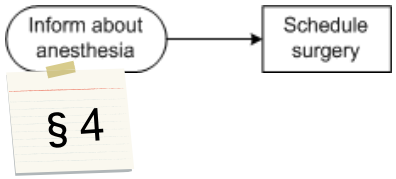


at least one trace violates

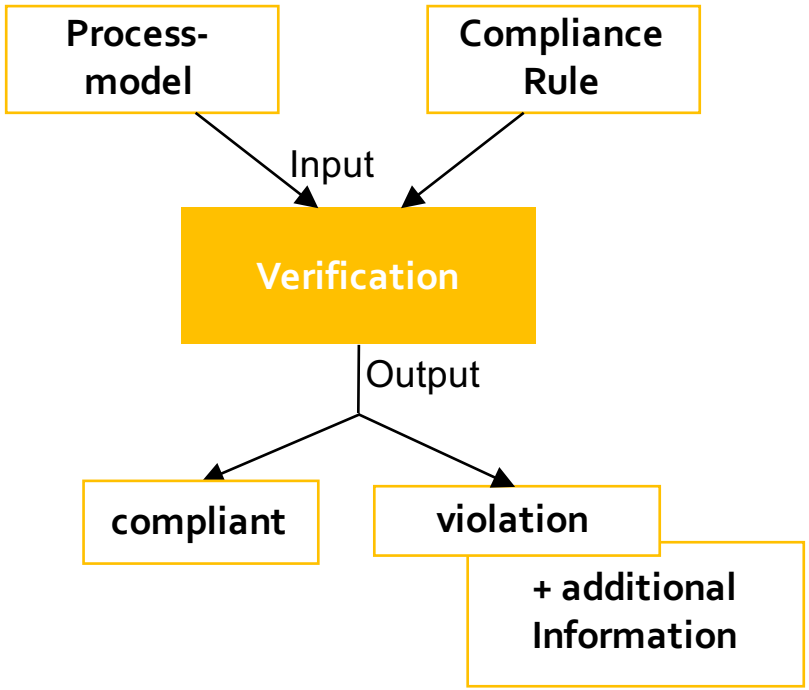
M partially violates § 4

Run Time Compliance

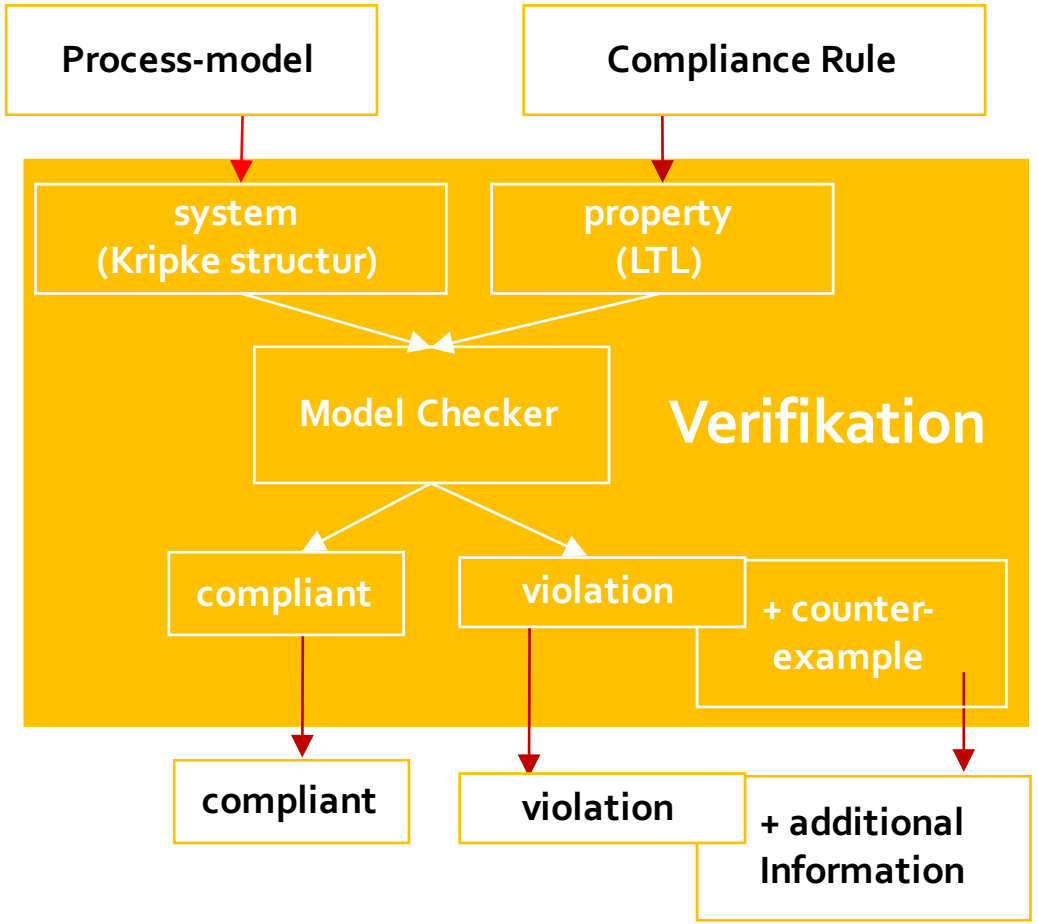


	Admit patient Perform checkup Examine patient Inform about anesthesia **Make decision** I_1	Admit patient Perform checkup Examine patient Inform about risks Make decision Schedule surgery I_2
	 I_1 curably violates § 2 I_1 violates § 2	 I_2 complies with § 2
	 We do not know if I_1 complies with § 4	 I_2 incurably violates § 4 I_2 violates § 4

Compliance Checking

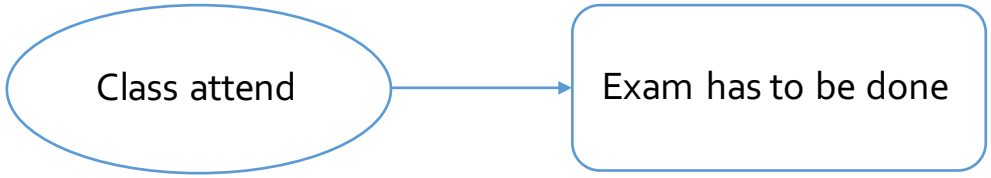


Compliance Checking - Model Checking

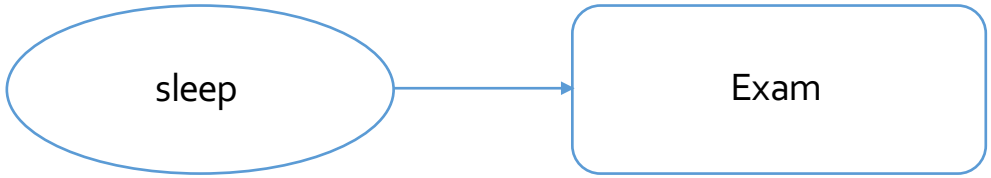


Exercise

Before an exam may be done, first the student has to attend classes.



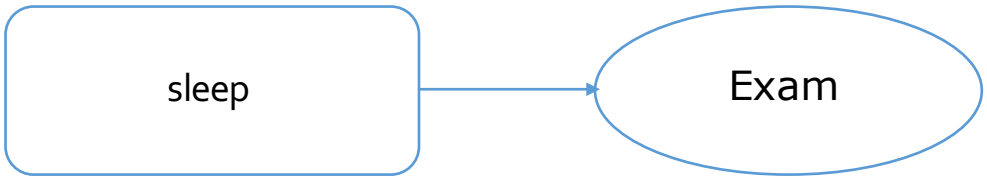
The day before exam the student need to get enough sleep.



Exercise

While waiting for the exam to begin, avoid speaking to any nervous students and absorbing their negative energy.

The day before exam the student need to get enough sleep.



References

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