

Title	法令文の中の不整合の検出
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法令文の中の不整合の検出

東条 敏

1. 否定 ($\neg$) の不整合
2. or ($\vee$) の不整合
3. 含意 ($\rightarrow$) の不整合

Conceptual conflict

cf. Hagiwara (JURIX '06)

$guilty \wedge \neg guilty \vdash \perp$

$guilty \wedge innocent \vdash \perp$

$possible \wedge impossible \vdash \perp$

$human \wedge car \vdash \perp$

Assumptive facts

$$\begin{aligned} P_1 &\leftarrow Q_1, Q_2, Q_3. \\ \neg P_1 &\leftarrow Q_2, Q_3, Q_4. \end{aligned}$$

$$\begin{aligned} P_2 &\leftarrow Q_1, Q_2, Q_3. \\ \neg P_2 &\leftarrow Q_1, Q_2. \end{aligned}$$

$$\begin{aligned} P_3 &\leftarrow Q_1, Q_2, \neg Q_3. \\ \neg P_3 &\leftarrow Q_1, Q_2, Q_3. \end{aligned}$$

$$\begin{aligned} \forall x P_4 &\leftarrow Q_1, Q_2, Q_3(x). \\ \neg P_4 &\leftarrow Q_1, Q_2, Q_3(a). \end{aligned}$$

Conditio Sine Qua Non

“A caused B” if “if A had not happened, B would not have happened.” (J. Glaser, 1858)

1. Lethal dose is 100mg.
2. *A* put 60mg.
3. *B* put 60mg.
4. If *A* had not put 60mg, *C* would not have died.
5. *A* is culpable for the death of *C*.

Conditio Sine Qua Non – cont'd

1. Lethal dose is 100mg.
2. *A* put 120mg.
3. *B* put 120mg.
4. Even though *A* had not put 120mg, *C* would have died.
5. *A* is not culpable for the death of *C*??

Occam's razor

The more reasons are employed, the less plausible the result becomes.



We need to find the minimal explanation. (Economy of reasoning)

Which is the minimal explation?

- A_{120mg}
- B_{120mg}
- $A_{120mg} \vee B_{120mg}$
- A_{120mg} **or** B_{120mg}

Minimal explanation

- A_{120mg} implies $A_{120mg} \vee B_{120mg}$.

Minimal explanation

- A_{120mg} implies $A_{120mg} \vee B_{120mg}$.
- If A_{120mg} caused C_{died} , then $A_{120mg} \vee B_{120mg}$ caused C_{died} ?

Minimal explanation

- A_{120mg} implies $A_{120mg} \vee B_{120mg}$.
- If A_{120mg} caused C_{died} , then $A_{120mg} \vee B_{120mg}$ caused C_{died} ?
- If yes, then $A_{120mg} \vee B_{120mg} \vee D_{120mg} \vee E_{120mg}$ caused C_{died} . The cause is obviously too weakened.

Formalization in Abduction

B Background theory

C Set of facts

O Observation

$$B \cup C \models O$$

In our case,

B Known rules

C Possible causes

O Result

$$\{A_{120mg} \supset C_{died}\} \cup \{A_{120mg}\} \models \{C_{died}\}$$

(i) C.S.Q.N. by Belief Revision

$T * P$: revision of T by P , is the set of maximal consistent subsets of $T \cup P$ including P .

Ex.

$\{\alpha \supset \beta, \alpha\} * \{\neg\beta\}$ is either $\{\alpha \supset \beta, \neg\beta\}$ or $\{\alpha, \neg\beta\}$

First approximation: for any S in $B \cup \{C * \{\neg A\}\}$, $S \not\models O$ (unless A , not O), then A is a cause of O .

$\Downarrow$

In order to entrench B , we revise the above as: for any S in $C * \{B \cup \{\neg A\}\}$, $S \not\models O$, then A is a cause of O . A is a critical cause if there is no A' such that $A' \models A$.

Example 1

$$\begin{cases} B = \{A_{120} \supset C_{died}, B_{120} \supset C_{died}\} \\ C_1 = \{A_{120}, B_{120}\} \\ O = C_{died} \end{cases}$$

A_{120} is not a cause.

$$\begin{cases} B \cup C_1 \models C_{died} \text{ and} \\ C_1 * (B \cup \{\neg A_{120}\}) \ni B \cup \{\neg A_{120}, B_{120}\} \\ \text{entails } C_{died}. \end{cases}$$

$A_{120} \vee B_{120}$ is a cause.

$$\begin{cases} B \cup C_1 \models C_{died} \text{ and} \\ C_1 * (B \cup \{\neg(A_{120} \vee B_{120})\}) \ni \\ B \cup \{\neg A_{120} \wedge \neg B_{120}\} \\ \text{does not entail } C_{died}. \end{cases}$$

Furthermore, $A_{120} \vee B_{120}$ is a critical cause.

Example 2

$$\begin{cases} B = \{A_{120} \supset C_{died}, B_{120} \supset C_{died}\} \\ C_2 = \{A_{120} \vee B_{120}\} \\ O = C_{died} \end{cases}$$

A_{120} is not a cause.

$$\begin{cases} B \cup C_2 \models C_{died} \text{ and} \\ C_2 * (B \cup \{\neg A_{120}\}) \ni B \cup \{\neg A_{120}, A_{120} \vee B_{120}\} \\ \text{entails } C_{died}. \end{cases}$$

$A_{120} \vee B_{120}$ is a cause.

$$\begin{cases} B \cup C_2 \models C_{died} \text{ and} \\ C_2 * (B \cup \{\neg(A_{120} \vee B_{120})\}) \ni \\ \quad B \cup \{\neg A_{120} \wedge \neg B_{120}\} \\ \text{does not entail } C_{died}. \end{cases}$$

Furthermore, $A_{120} \vee B_{120}$ is a critical cause.

Problems of C.S.Q.N.

Example 1 shows:

- A_{120} is not a cause though A should be blamed.
- $A_{120} \vee B_{120}$ is a cause.
- $A_{120} \vee B_{120}$ is a critical cause.

Exmample 2 shows:

- A_{120} is not a cause.
- $A_{120} \vee B_{120}$ is a cause.
- $A_{120} \vee B_{120}$ is a critical cause.
- But if A_{120} is a cause, $A_{120} \vee B_{120}$ is also a cause.

C.S.Q.N. does not satisfy Occam's razor.

(ii) Solution by Minimal Abduction

$\left\{ \begin{array}{l} B \text{ Background theory} \\ H \text{ Abducibles (a set of propositional formulae)} \\ O \text{ A propositional formula} \end{array} \right.$

$E (\subseteq H)$ is an explanation iff

- $B \cup E \models O$ and $B \cup E \not\models \perp$.
- E is minimal if for any $E' \subset E$, $B \cup E' \not\models O$.

Example 1 – revisited –

When $H = \{A_{120}, B_{120}\}$, the minimal explanations of O becomes $\{\{A_{120}\}, \{B_{120}\}\}$. That is,

either A_{120} or B_{120} is the minimal cause.

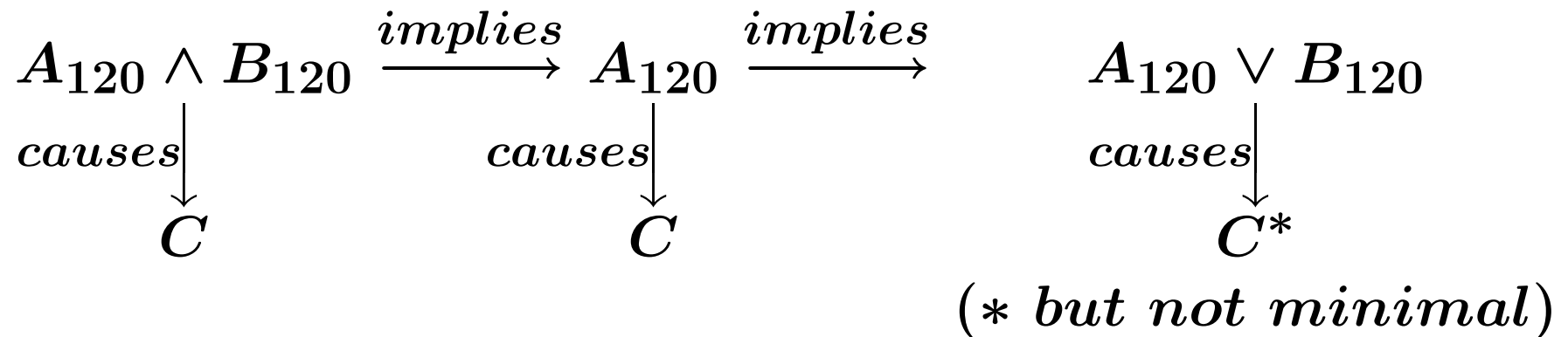
In other words, there are two minimal explanations.

Example 2 – revisited –

When $H = \{A_{120} \vee B_{120}\}$, the minimal explanations of O becomes $\{\{A_{120} \vee B_{120}\}\}$. That is,

$A_{120} \vee B_{120}$ is the minimal cause.

Issue 1: Logical Implication and Causation



In our case,

$$A_{120} \supset \text{implies} (A_{120} \vee B_{120}) \supset \text{causes } C_{died},$$

But

$$A_{120} \not\supset C_{died}.$$

cf. Deduction theorem: $\alpha \vdash \beta \iff \vdash (\alpha \supset \beta).$

Issue 2: Scope of a predicate

$(A \text{ or } B) \text{ put } 120\text{mg}$
vs.
 $(A \text{ put } 120\text{mg}) \text{ or } (B \text{ put } 120\text{mg})$

Issue 2: Scope of a predicate

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$$K_A(\alpha \vee \beta) \not\supset K_A\alpha \vee K_B\beta$$

Issue 2: Scope of a predicate

$(A \text{ or } B) \text{ put } 120\text{mg}$
vs.
 $(A \text{ put } 120\text{mg}) \text{ or } (B \text{ put } 120\text{mg})$

$A \not\supset A \vee B$ (substructural logic)

Summary

- **Formalization of C.S.Q.N. to clarify its paradox.**
- **Minimal explanation, to distinguish between disjunction of causes and a disjunctive cause.**

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