

# Computing Repairs from Active Integrity Constraints

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## Question

How can we repair a database that no longer satisfies its integrity constraints?

# Outline

## 1 Integrity constraints

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# A database of family relations

Consider a database with information on family relations.

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siblingOf(John, Mary)

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This database should also contain

Missing fact

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Integrity constraint (simple)

$$\forall x \forall y. ((\text{siblingOf}(x, y) \wedge \neg \text{siblingOf}(y, x)) \supset \perp)$$

# Can fix the problem automatically?

## Inconsistency

siblingOf(John, Mary)

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## Another solution

Remove siblingOf(John, Mary)

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# Active integrity constraints

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Specify a constraint **and** propose possible solutions.

Works both ways:

- may express preferences
- may eliminate options

# Family relations, revisited

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# Active integrity constraints

## Definition (Flesca2004)

An *Active integrity constraint* is a formula of the form

$$L_1, \dots, L_m \supset \alpha_1 \mid \dots \mid \alpha_k$$

where  $\{\alpha_1^D, \dots, \alpha_k^D\} \subseteq \{L_1, \dots, L_m\}$ .

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$$\text{siblingOf}(x, y) \wedge \neg \text{siblingOf}(y, x) \supset -\text{siblingOf}(x, y) \mid +\text{Parent}(x)$$

# Intuitive semantics of AICs

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- disjunction on the right (“head”)
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- holds iff one of the  $L_i$ s fails (but...)
- $\{\alpha_1^D, \dots, \alpha_k^D\}$  are *updatable* literals

# Repairs

## Definition (Caroprese et al., 2006)

Let  $I$  be a database and  $\eta$  be a set of (A)ICs. A *weak repair* for  $I$  and  $\eta$  is a consistent set  $\mathcal{U}$  of update actions such that:

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A *repair* is a weak repair that is minimal w.r.t. inclusion.

# Family relations, yet again

## Inconsistency

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## Another repair

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## A weak repair

$+\text{siblingOf}(\text{Mary}, \text{John}), +\text{Parent}(\text{John})$

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## Not a weak repair

$+\text{siblingOf}(\text{Mary}, \text{John}), -\text{siblingOf}(\text{John}, \text{Mary})$

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## Algorithm

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## Lemma

- *This tree is finite.*

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## Lemma

- *This tree is finite.*
- *Every consistent leaf is a weak repair for  $I$  and  $\eta$ .*
- *Every repair for  $I$  and  $\eta$  corresponds to a leaf in the tree.*

# Optimizations

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Inconsistent nodes may also be left out.

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- *founded* repairs take into account the actions in the head
- *justified* repairs avoid justification circles

Intuitively, if  $\mathcal{U}$  is founded, then removing an action from  $\mathcal{U}$  causes some AIC with that action in the head to be violated.

# Computing founded repairs

## Example

Take  $\mathcal{I} = \{a, b\}$  and

$$r_1 : a, \text{ not } b \supset -a$$

$$r_2 : \text{ not } a, b \supset -b$$

$$r_3 : a, \text{ not } c \supset +c$$

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Following the heads of the violated rules, we obtain:

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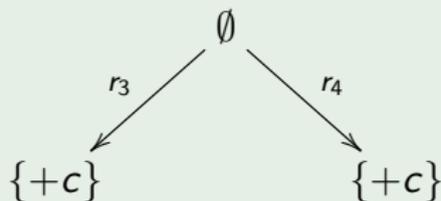
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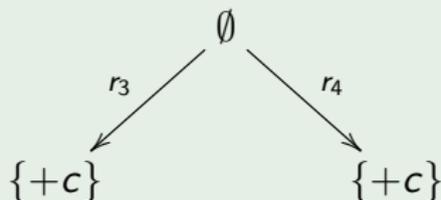
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$\{+c\}$  is a founded repair

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It is a founded repair that is not justified.

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Too restrictive?

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## Motivation

Keep track of the non-updatable atoms in the rules that were used.

# Justified repair trees II

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Corresponding justified repair tree:

$$\begin{array}{c} \emptyset, \emptyset \\ \downarrow r_1 \\ \{-a\}, \{+b\} \\ \downarrow r_3 \\ \{-a, \underline{-b}\}, \{\underline{+b}\} \\ \times \end{array}$$

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*Let  $\mathcal{U}$  be a justified repair for  $\mathcal{I}$  and  $\eta$ . Then there is a leaf  $n$  in the justified repair tree for  $\mathcal{I}$  and  $\eta$  such that  $\mathcal{U}_n = \mathcal{U}$ .*

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Checking that a repair is justified is again NP-complete, so our algorithm is (asymptotically) optimal.

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We also believe that our algorithm is nicer than the one given by Caroprese et al. It was developed following the intuitive semantics of AICs.

# Outline

- 1 Integrity constraints
- 2 Active integrity constraints and repair trees
- 3 More complex repair trees
- 4 Conclusions**

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Thank you.