FAKULTÄT FÜR !NFORMATIK
Faculty of Informatics

Towards Approximating Output-Projected Equilibria in Partially Known Multi-Context Systems

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KBS Knowledge-Based Systems Group

WWTF Wiener Wissenschafts-, Forschungs- und Technologiefonds

Technische Universität Wien
Institut für Informationssysteme
Wissensbasierte Systeme

Multi-Context Systems: Subject of Investigation

- What is a multi-context system?

  A collection of contexts:
  $M = (C_1, \ldots, C_n)$
- What is a context C_i?

  $C_i = (L_i,$ a logic
  $kb_i,$ the context's knowledge base
  $br_i)$ a set of bridge rules (1)
- What is a logic L_i?

  $L = (\mathbf{KB}_L,$ set of well-formed knowledge bases
  $\mathbf{BS}_L,$ set of possible belief sets
  $\mathbf{ACC}_L)$ acceptability function $\mathbf{KB}_L \longrightarrow 2^{\mathbf{BS}_L}$

  Given a knowledge base, $\mathbf{ACC}_L$ answers:

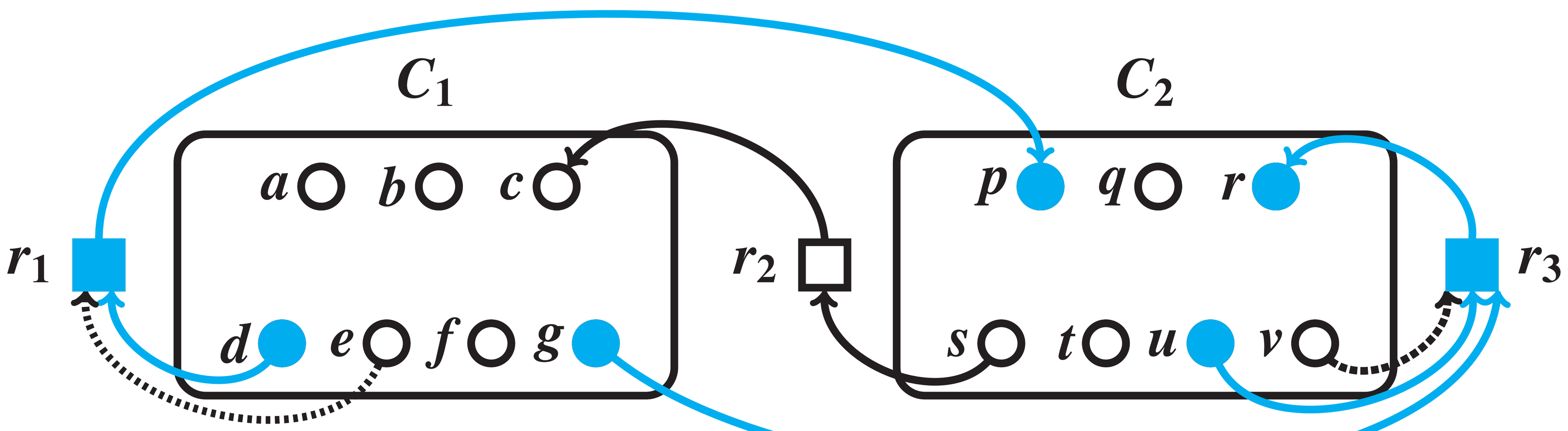
  Which belief sets are accepted?
- What is a bridge rule?

$$(k : s) \leftarrow (c_1 : p_1), \ldots, (c_j : p_j), \mathbf{not}\ (c_{j+1} : p_{j+1}), \ldots, \mathbf{not}\ (c_m : p_m). \quad (1)$$

What is it useful for?

Domain:	Contexts:	Bridge Rules:
WWW	Server or Client	Network Connections
Hospital	Patient DB, Diagnosis System, Ontology (SNOMED, NCI,...)	Knowledge Exchange
In General	Knowledge Processing Units	Information Flow

Example



$r_1 \quad (2:p) \leftarrow (1:d), not(1:e).$
$r_2 \quad (1:c) \leftarrow (2:s).$
$r_3 \quad (2:r) \leftarrow (1:g), (2:u), not(2:v).$

Equilibrium Semantics

- Does C_1 accept $\{d, g\}$ without inputs?

  ⇒ check if $\{d, g\} \in \mathbf{ACC}_1(kb_1)|_{\{d,e,g\}}$
- Does C_2 accept $\{u\}$ with inputs $\{p, r\}$?

  ⇒ check if $\{u\} \in \mathbf{ACC}_2(kb_2 \cup \{p, r\})|_{\{s,u,v\}}$
- If both is true,

  $(\{d, g\}, \{u\})$ is an output-projected equilibrium of M!

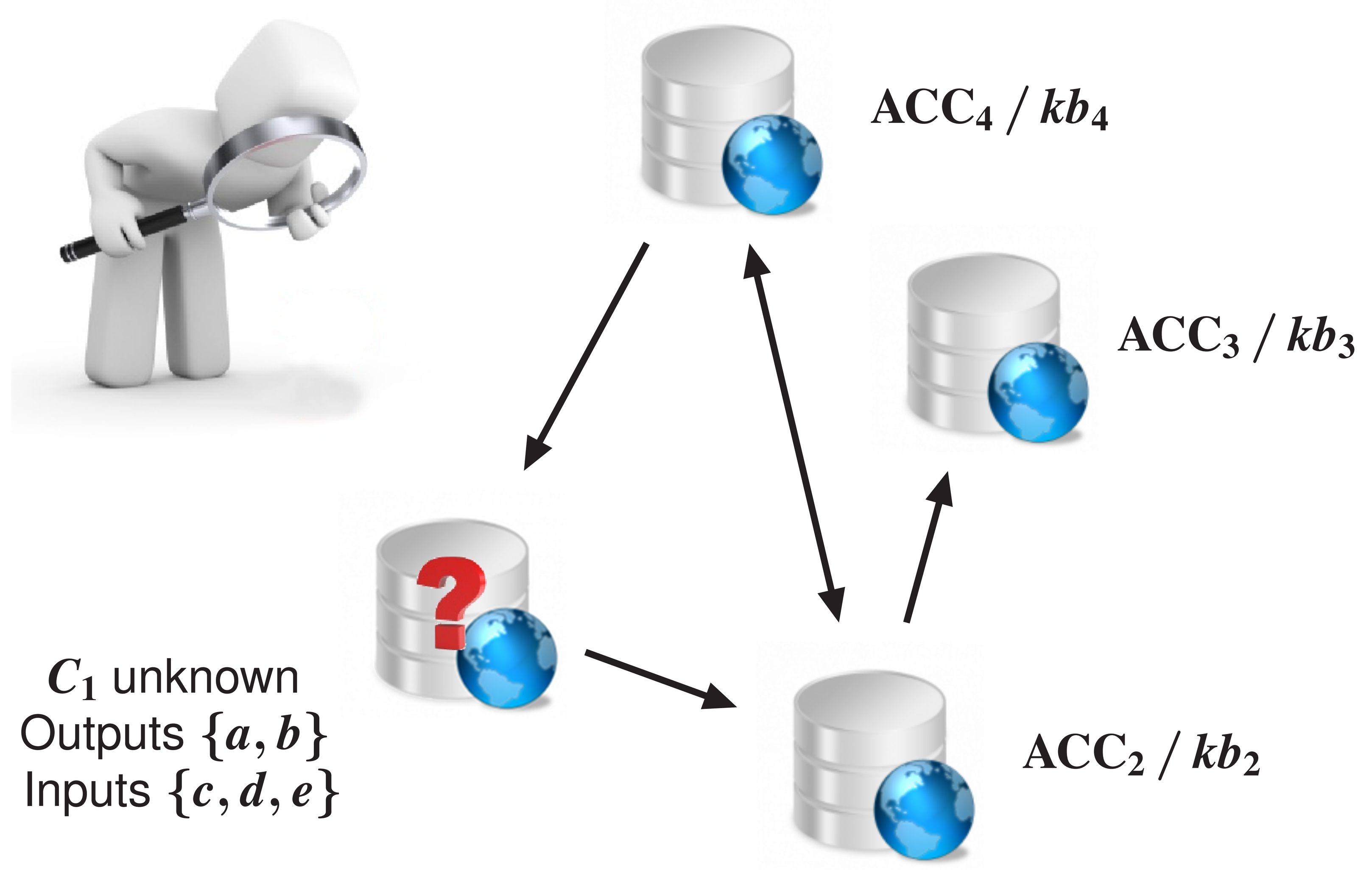
References

- Gerhard Brewka and Thomas Eiter. Equilibria in heterogeneous nonmonotonic multi-context systems. In *AAAI*, pg 385–390, 2007.
- Thomas Eiter, Michael Fink, Peter Schüller, and Antonius Weinzierl. Finding explanations of inconsistency in nonmonotonic multi-context systems. In *KR*, 2010. to appear.
- Marco Schaerf and Marco Cadoli. Tractable reasoning via approximation. *Artificial Intelligence*, 74(2):249–310, 1995.

Incomplete Information

- Contexts may be partially specified

  ⇒ because of proprietary content
  ⇒ because of complicated functionality
- What can we do?



Boolean Function Representation

for C_1:

⇒ we do not check $\{a, \bar{b}\} \in \mathbf{ACC}_1(kb_1 \cup \{c, \bar{d}, e\})|_{\{a,b\}}$

$\updownarrow \updownarrow \quad \updownarrow \updownarrow \updownarrow$

⇒ we check instead $f_1(1, 0, \ldots\ldots\ldots\ldots 1, 0, 1) \stackrel{?}{=} 1$

where f_1 is a Boolean Function

Partial Knowledge Representation

We use a partially defined Boolean function for f_1:

$$pf_1 : \{0, 1\}^{|IN_1|+|OUT_1|} \longrightarrow \{0, 1, \star\}$$

Approximations for Output-Projected Equilibria

We assume

what we know to be true is true, nothing else is true.

⇒ $\underline{pf}_1 = pf$ with all $\star$ set to $\mathbf{0}$
⇒ we get an underapproximation of output-projected equilibria (fewer than really exist)

We assume

what we know to be false is false, nothing else is false.

⇒ $\overline{pf}_1 = pf$ with all $\star$ set to $\mathbf{1}$
⇒ we get an overapproximation of output-projected equilibria (more than really exist)

Results

We obtain lower and upper bounds on reality!

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