Behavioural, Functional, and Non-Functional Contracts for Dynamic Selection of Services

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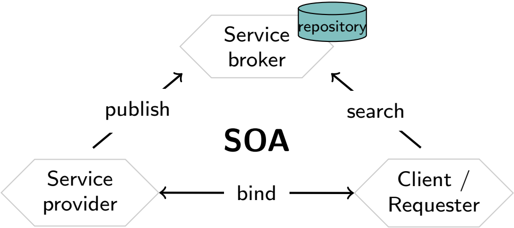

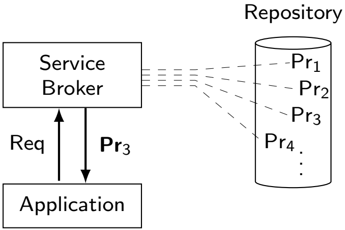

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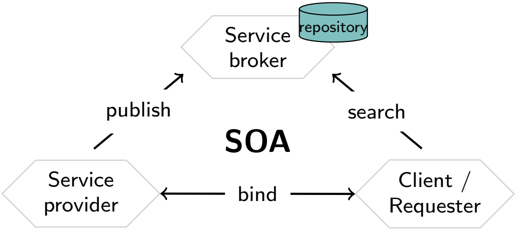

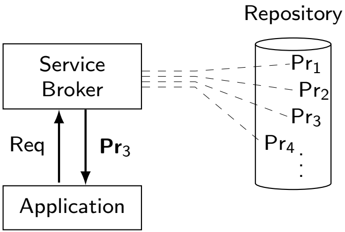

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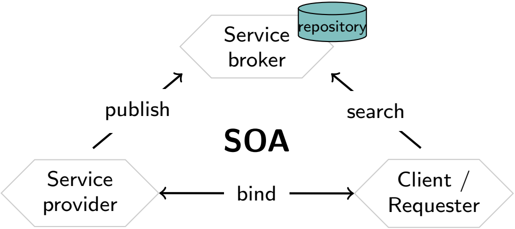

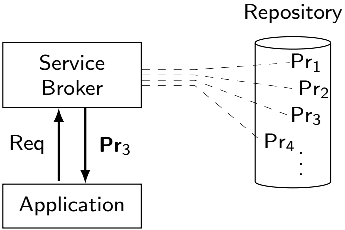

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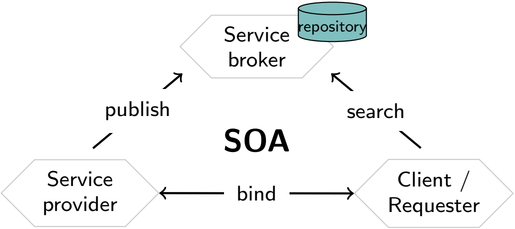
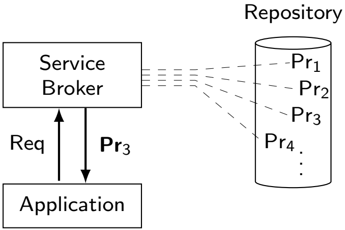


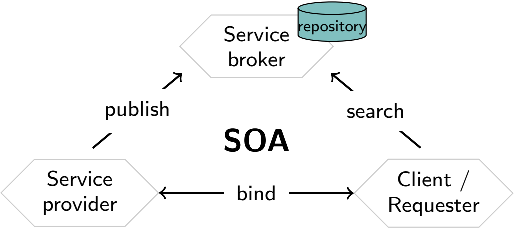


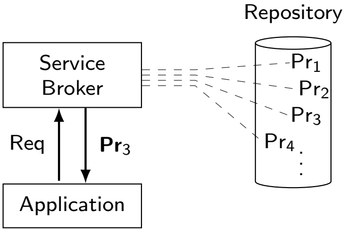
Prologue . . . . A bird-eye view

A proposal . . . . Some details & peculiarities

Conclusions . . . . Remarks & future work

In the next few minutes...





Prologue

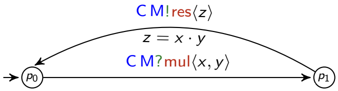
This talk in 1 slide

The problem

This talk in 1 slide

The problem

$z = x \cdot y$



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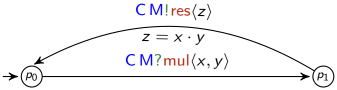
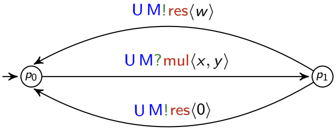
The problem

$z = x \cdot y$
$w = x \cdot y \neq 0$





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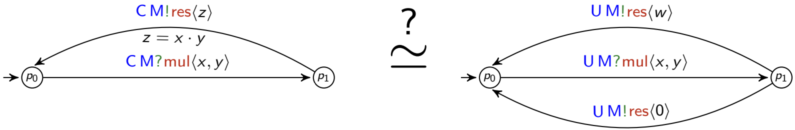

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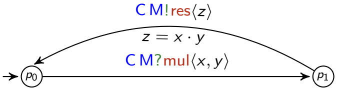
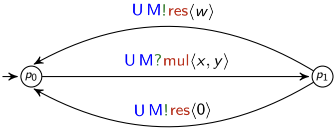
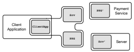


$\overset{?}{\simeq}$



Our proposal: [1, 7] + [3] + [4, 6]



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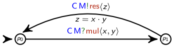
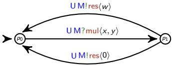




+ QoS-CFSMs

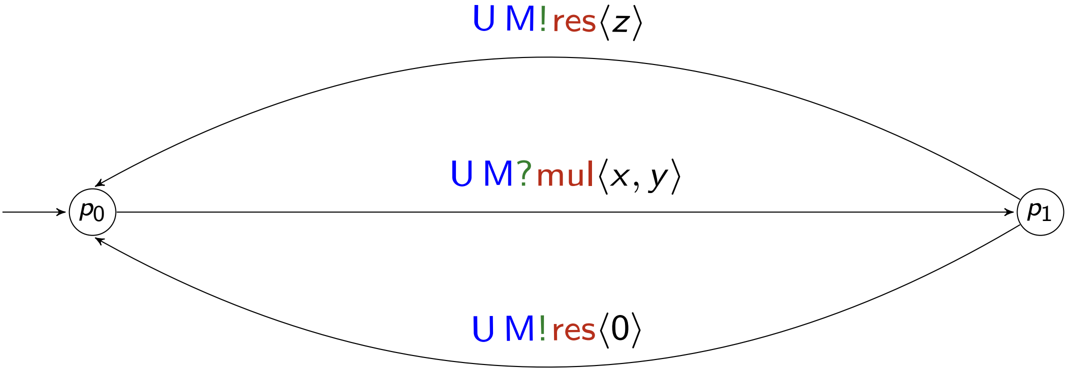
which yields

- ✓ A semantic-based discovery relying on behavioural and (non-)functional contracts
- ✓ Bisimulation-based compliance
- ✓ A bisimulation algorithm of service compliance modulo name matching

Preliminaries

Our behavioural

We borrow (with some adaptation) ________ CFSM from [2]



Our behavioural and functional contracts

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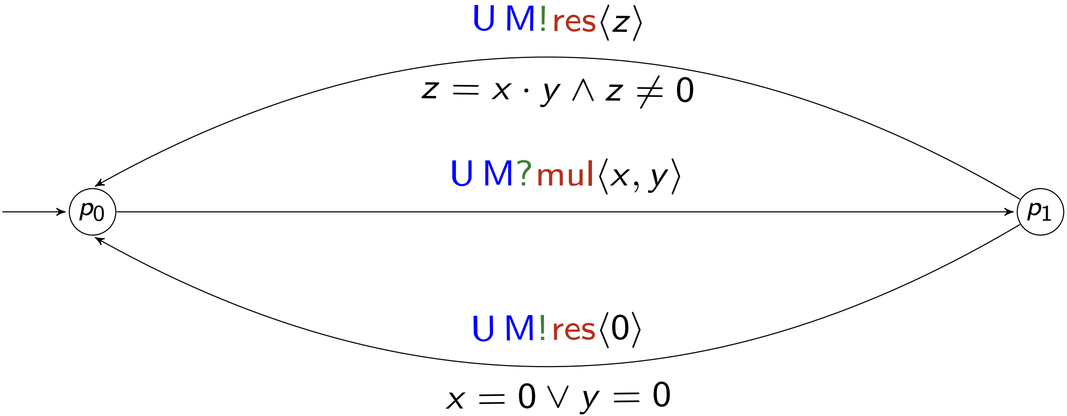

Our non-functional contracts

A variant of CFSMs yields our behavioural contracts; our non-functional contracts are

$$\underline{\text{QoS constraints}} = \text{FOL}_{=} + \text{Real Close Fields}$$

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- positive elements have square roots
- polynomial of odd degrees have zeros

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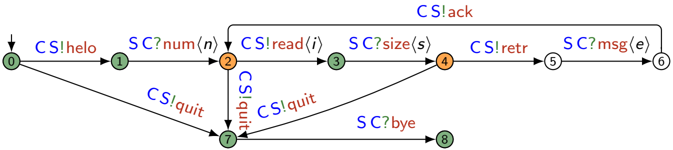

$$\Gamma_{\text{Low}} = \{\mathsf{t} \leq 0.01,\ \mathsf{c} \leq 0.01,\ \mathsf{m} \leq 0.01\}$$

$$\Gamma_{\text{DB}} = \{\mathsf{t} \leq 3 \implies (\exists x)(0.5 \leq x \leq 1 \land \mathsf{c} = \mathsf{t} \cdot x),\ \mathsf{t} > 3 \implies \mathsf{c} = 10,\ \mathsf{m} \leq 5\}$$

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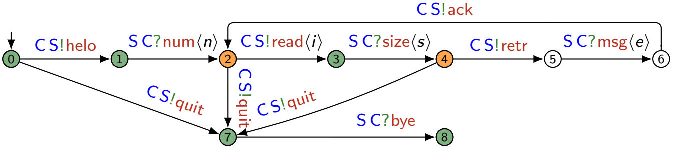

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$\dots$

RCFs allow us to formalise QoS aggregation operators [4, 6]

[A proposal]

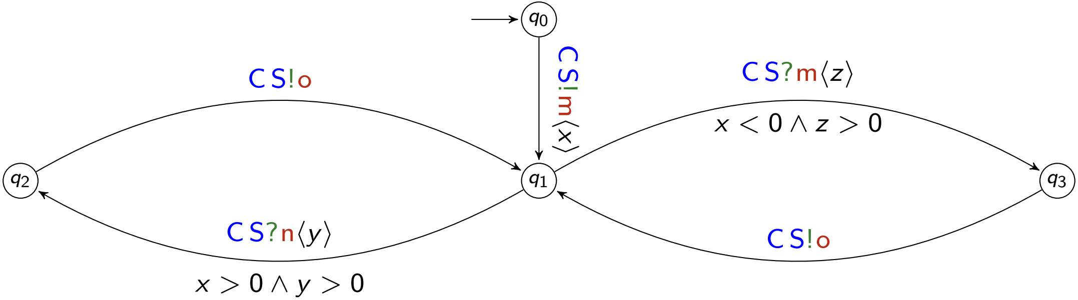
Extended CFSMs

An extended CFSM (e-CFSM for short) is a tuple $\langle M, F, \mathsf{qos}, \mathsf{asrt} \rangle$ where:

- $M = \langle Q, q_0, \rightarrow \rangle$ is a CFSM with $F \subseteq Q$ the set of final states ,
- asrt maps transitions of M to $\mathsf{FOL}_{=}$
- $\mathsf{qos} : Q \rightarrow \mathcal{C}$ maps states of M to set of QoS constraints

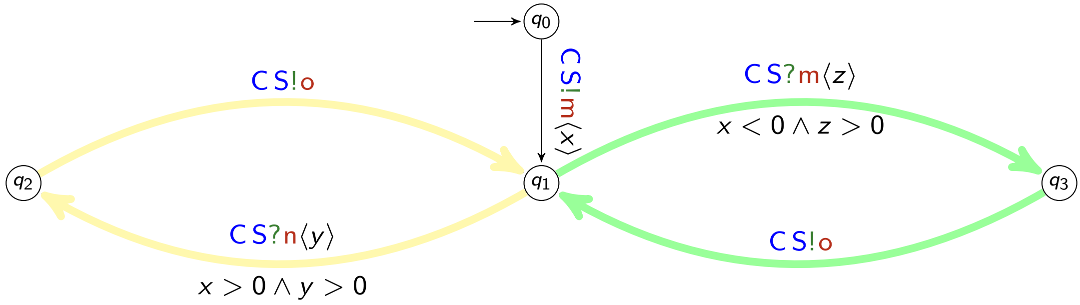
An extended communicating system is a map $(M_{\mathsf{A}})_{\mathsf{A} \in \mathcal{P}}$ assigning an A-local e-CFSM M_{A} to each $\mathsf{A} \in \mathcal{P}$.

Oddities

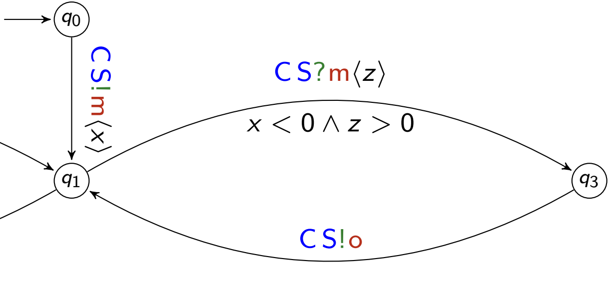


q_0
q_1
q_2
q_3
C S!o
C S!m$\langle x\rangle$
C S?m$\langle z\rangle$
$x < 0 \wedge z > 0$
C S?n$\langle y\rangle$
$x > 0 \wedge y > 0$
C S!o

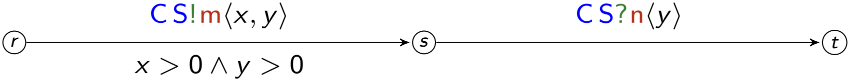
Oddities



Oddities



q_0
q_1
q_2
q_3
C S!m⟨x⟩
C S!o
C S?m⟨z⟩
$x < 0 \wedge z > 0$
C S?n⟨y⟩
$x > 0 \wedge y > 0$
C S!o



r
s
t
C S!m⟨x, y⟩
$x > 0 \wedge y > 0$
C S?n⟨y⟩

Knowledge

The residual $\phi \,\overline{\wedge}\, l$ of an assertion ϕ after l is $\perp$ unless

$$
\begin{aligned}
p(x_1, \ldots, x_n) \,\overline{\wedge}\, l &= p(x_1, \ldots, x_n) && \text{if } \mathit{var}(l) \cap \{x_1, \ldots, x_n\} = \emptyset \\
(\neg\phi) \,\overline{\wedge}\, l &= \neg(\phi \,\overline{\wedge}\, l) && \text{if } \phi \,\overline{\wedge}\, l \neq \perp \\
(\phi_1 \vee \phi_2) \,\overline{\wedge}\, l &= (\phi_1 \,\overline{\wedge}\, l) \vee (\phi_2 \,\overline{\wedge}\, l) && \text{if } \phi_1 \,\overline{\wedge}\, l \neq \perp \text{ and } \phi_2 \,\overline{\wedge}\, l \neq \perp \\
((\exists x)\phi) \,\overline{\wedge}\, l &= (\exists x)(\phi \,\overline{\wedge}\, l) && \text{if } x \notin \mathit{var}(l) \text{ and } \phi \,\overline{\wedge}\, l \neq \perp \\
((\exists x)\phi) \,\overline{\wedge}\, l &= ((\exists x)\phi) \,\overline{\wedge}\, l((\exists y)(\phi[y/x])) \,\overline{\wedge}\, l && \text{if } x \in \mathit{var}(l),\ y \text{ fresh, and } \phi \,\overline{\wedge}\, l \neq \perp
\end{aligned}
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Knowledge

The residual $\phi \,\overline{\wedge}\, l$ of an assertion ϕ after l is $\bot$ unless

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\end{aligned}
$$

The knowledge $\mathcal{K}(\pi)$ on π is $K(\pi, \{True\})$ where

$$
K(\pi, X) = \begin{cases} \bigwedge_{\psi \in X} \psi, & \pi \text{ is the empty path} \\ K(\pi', \{\psi \mid \psi \in X \text{ and } \psi \,\overline{\wedge}\, l \neq \bot\} \cup \{\phi\}), & \pi = q \xrightarrow[\phi]{l} \pi' \end{cases}
$$

Bisimulating e-CFSMs

Let M_1 and M_2 be two e-CFSMs respectively with states Q_1 and Q_2 and initial states $p_0 \in Q_1$ and $q_0 \in Q_2$.

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A relation $\mathcal{R} \subseteq (Q_1 \times \mathrm{FOL}_=) \times (Q_2 \times \mathrm{FOL}_=)$ is a simulation if $\big(p, K\big)\mathcal{R}\big(q, K'\big)$ and $p \xrightarrow[\phi]{l} p'$ in M_1 imply that there is $T = \{q \xrightarrow[\psi_1]{l} q_1, \ldots, q \xrightarrow[\psi_k]{l} q_k\} \neq \emptyset$ in M_2 and

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1. $\neg\big(((K \,\overline{\wedge}\, l) \wedge \phi) \implies \bigvee_{q \xrightarrow[\psi]{l} q' \in T}((K' \,\overline{\wedge}\, l) \wedge \psi)\big)$ unsat

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2. for all $q \xrightarrow[\psi]{l} q' \in T$, $\big(p', \overline{(K \,\overline{\wedge}\, l) \wedge \phi \wedge \psi}\big)\mathcal{R}\big(q', \overline{(K' \,\overline{\wedge}\, l) \wedge \psi}\big)$

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3. if $p \in F_1$, then $q \in F_2$ and $\mathrm{qos}(p) = \langle \Sigma, \Gamma_1 \rangle$ and $\mathrm{qos}(q) = \langle \Sigma, \Gamma_2 \rangle$ then $\neg(\bigwedge_{\phi \in \Gamma_1} \phi \implies \bigwedge_{\phi \in \Gamma_2} \phi)$ unsat

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M_2 simulates M_1 if there is a simulation $\mathcal{R}$ such that $\big(p_0, \mathit{True}\big)\mathcal{R}\big(q_0, \mathit{True}\big)$.

Conclusions

In the paper

- an example on the POP protocol
- bisimulation checking algorithm module name matching

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Some doubts...

- is the approach feasible? (From one reviewer)
- isn't bisimulation to strong a notion for compliance?

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We are planning to

- to consider simulation akin to behavioural subtyping
- extend **SEArch** to support [5]
- generalise to name embeddings

Thank you

&

Thank reviewers

References I

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[2] D. Brand and P. Zafiropulo. On Communicating Finite-State Machines.
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[6] C. L. Pombo, A. E. M. Suñé, and E. Tuosto. A dynamic temporal logic for quality of service in choreographic models.
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