Global Escape in Multiparty Sessions

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joint work with **Elena Giachino** & **Nobuko Yoshida**

Workshop on Behavioural Types
21 April 2011

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Interactional exceptions (Structured Interactional Exceptions for Session Types. Carbone, Honda, Yoshida. CONCUR'08)

not only local but also coordinated actions among communicating peers: exception affects a collection of parallel processes and an escape needs to move into another dialogue in a concerted manner

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  - asyncronous notification to multiple partners
  - nested exceptions

Coordinated Actions Model

From *Coordinated Exception handling- Romanovsky et al.*

Fault tolerance needs error isolation to define exactly which part of the system to recover, and to prevent errors from unlimited propagation. One way to control complexity is to *restrict interaction and communication*: exception contexts are defined as regions in which the same exceptions are treated in the same way

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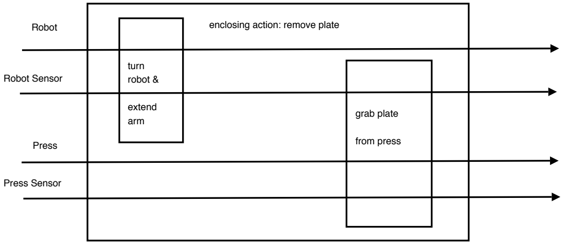
Atomic actions

The activity of a group of components constituites an atomic action if there are no interactions between that group and the rest of the systems for the duration of the activity

Coordinated Actions



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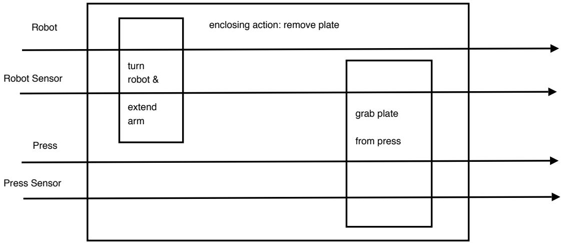

$$\left[(s_1, s_2), \left[s_1, \gamma_{TR}, \gamma_{HTR}\right]; \left[s_1, \gamma_{GP}, \gamma_{HGP}\right], \gamma_{HRP}\right]$$

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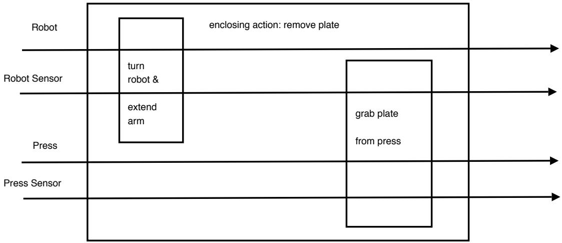

$$[(s_1, s_2), [s_1, \gamma_{TR}, \gamma_{HTR}]; [s_1, \gamma_{GP}, \gamma_{HGP}], \gamma_{HRP}]$$

$\texttt{Robot} = \mathrm{try}(s_1, s_2)\{\mathrm{try}(s_1)\{P^R\}\ \mathrm{catch}\ \{Q^R\}\}\ \mathrm{catch}\ \{Q'^R\}$
$\texttt{RobotSensor} = \mathrm{try}(s_1, s_2)\{\mathrm{try}(s_1)\{P^{RS}\}\ \mathrm{catch}\ \{Q^{RS}\}; \mathrm{try}(s_1)\{P'_{RS}\}\ \mathrm{catch}\ \{Q'^{RS}\}\}\ \mathrm{catch}\ \{Q''^{RS}\}$
$\texttt{Press} = \mathrm{try}(s_1, s_2)\{\mathrm{try}(s_1)\{P^P\}\ \mathrm{catch}\ \{Q^P\}\}\ \mathrm{catch}\ \{Q'^P\}$
$\texttt{PressSensor} = \mathrm{try}(s_1, s_2)\{\mathrm{try}(s_1)\{P^S\}\ \mathrm{catch}\ \{Q^{PS}\}\}\ \mathrm{catch}\ \{Q'^{PS}\}$

Syntax and Semantics

P, Q	::=	$\overline{a}[2..n](\tilde{s}).P$	Multicast Request
	|	$a[\mathrm{p}](\tilde{s}).P$	Accept
	|	$r!\langle\tilde{e}\rangle$	Output
	|	$r?(\tilde{x}).P$	Input
	|	$r \triangleleft l.P$	Select
	|	$r \triangleright \{l_i : P_i\}_{i \in I}$	Branch
	|	$\mathrm{try}(\tilde{r})\{P\}\ \mathrm{catch}\ \{P\}$	Try-Catch
	|	$\mathrm{throw}(\tilde{r})$	Throw

|	$\mathrm{if}\ e\ \mathrm{then}\ P\ \mathrm{else}\ \ P$	Conditional
|	$P \mid P$	Parallel
|	$P; P$	Sequencing
|	$\mathbf{0}$	Inaction
|	$(\nu n)P$	Hiding
|	$\mathrm{def}\ D\ \mathrm{in}\ P$	Recursion
|	$X\langle\tilde{e}\tilde{s}\rangle$	Process call
|	$s : L$	Named queue

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[Thr]

$$\Sigma \vdash \mathrm{try}(\tilde{r})\{\mathcal{C}[\mathrm{throw}(\tilde{r})] \mid P\}\ \mathrm{catch}\ \{Q\}$$
$$\longrightarrow \Sigma \uplus \mathrm{throw}(\tilde{r}) \vdash \mathrm{try}(\tilde{r})\{\mathcal{C} \mid P\}\ \mathrm{catch}\ \{Q\}$$

[RThr]

$$\Sigma, \mathrm{throw}(\tilde{r}) \vdash \mathrm{try}(\tilde{r})\{P\}\ \mathrm{catch}\ \{Q\} \longrightarrow \Sigma, \mathrm{throw}(\tilde{r}) \vdash Q\{s^{\varphi+1}/s^{\varphi}\}_{s^{\varphi}\in\tilde{r}}$$

$(\mathrm{throw}(\tilde{r}')\in\Sigma$ *implies* $\mathrm{try}(\tilde{r}')\ldots\notin P,\ \tilde{r}'\subseteq\tilde{r})$

[ZThr]

$$\Sigma \vdash (\nu\tilde{s})(\textstyle\prod_i \mathcal{E}_i[\mathrm{try}(\tilde{r})\{\mathbf{0}\}\ \mathrm{catch}\ \{Q_i\}])_{i\in 1..n} \longrightarrow \Sigma \vdash (\nu\tilde{s})(\textstyle\prod_i \mathcal{E}_i)_{i\in 1..n}$$

$(\mathrm{throw}(\tilde{r})\notin\Sigma)$

Typing

$$
\begin{array}{llcl}
\text{Partial} & \gamma & ::= & \mathrm{p}_1 \to \mathrm{p}_2 : k\langle \tilde{S} \rangle \mid \mathrm{p}_1 \to \mathrm{p}_2 : k\{l_i : \gamma_i\}_{i \in I} \mid \\
 & & & [\tilde{k}, \gamma, \gamma] \mid \gamma; \gamma \mid \gamma \parallel \gamma \mid \mu \mathbf{t}.\gamma \mid \mathbf{t} \\
\text{Global} & G & ::= & \gamma; \text{end} \mid \text{end} \\
\text{Sorts} & S & ::= & \text{bool} \mid \ldots \mid \langle G \rangle
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$$

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Goals:

- to check that the enclosed try-catch block is listening on a smaller set of channels: independence of the components w.r.t. exceptions

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Goals:

- to check that the enclosed try-catch block is listening on a smaller set of channels: independence of the components w.r.t. exceptions
- to check that no session request or accept occurs inside a try-catch block

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- consistent: despite asynchrony and nesting of exceptions, communications in default and exception handling conversations do not mix
- safe: linearity of communications inside sessions and absence of communication mismatch are enforced carrying out fundamental properties of session types

We ensure these properties using:

- an asynchronous linguistic construct for exceptions signalling
- multi-level queues