on asynchrony and choreographies

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outline

1. *choreographies at a glance*
2. *asynchrony*
3. *conclusions*

overview of choreographies

choreographies

a model for distributed computation based on "common practice"

- used for modeling interactions between web services
- high-level languages, alice-and-bob notation
- good properties: message pairing, deadlock-freedom
- no orchestrator
- projectable to local views

different usages

- choreographies as specifications (types)
- choreographies as programs (executable)

the world of choreographies

common features (present in most languages)

- message passing/method selection
- conditional and (tail) recursion

additional features (only in particular languages)

- channel passing
- process spawning
- asynchrony
- web services
- ...

$\rightsquigarrow$ the target language for projection reflects these design choices

our motivation

goal

- study foundational aspects of choreographies
- identify minimal primitives required for particular constructions
- framework: choreographic programming (but. . .)

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$\leadsto$ "bottom-up" approach, rather than "top-down"

this work

asynchronous semantics

- uniform approach, applicable to different models
- reuse out-of-order execution

$\leadsto$ hopefully cleaner than previous proposals

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$$p \to q$$

- two-step communication
  - "send" action for p
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a simple choreography model

syntax

$$C ::= \mathbf{0} \mid \mathsf{p}.e \to \mathsf{q}; C$$

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$$C ::= \mathbf{0} \mid \mathtt{p}.e \to \mathtt{q}; C$$

semantics

$$\frac{e \downarrow_{\mathtt{p}} v}{\mathtt{p}.e \to \mathtt{q}; C, \sigma \to_s C, \sigma[\mathtt{q} \mapsto v]} \ \textit{Synch}$$

$$\frac{\{\mathtt{p},\mathtt{q}\} \# \{\mathtt{r},\mathtt{s}\}}{\mathtt{p}.e \to \mathtt{q}; \mathtt{r}.e' \to \mathtt{s} \equiv \mathtt{r}.e' \to \mathtt{s}; \mathtt{p}.e \to \mathtt{q}} \ \textit{Swap}$$

$$\frac{C \equiv C_0 \qquad C_0, \sigma \to_s C_0', \sigma' \qquad C_0' \equiv C'}{C, \sigma \to_s C', \sigma'} \ \textit{Struct}$$

$\rightsquigarrow$ plus: $\equiv$ is a congruence

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  - $\mathsf{p} \notin \{\eta_1, \ldots, \eta_n\}$
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  - $\to_s$ is a big-step semantics refined by $\to_a$

a possibility for $\rightarrow_a$

capitalize on swap

$$\frac{}{\mathtt{p}.e \rightarrow \mathtt{q} \equiv \mathtt{p}.e \xrightarrow{x} \bullet_{\mathtt{q}}; \bullet_{\mathtt{p}} \xrightarrow{x} \mathtt{q}} \; \textit{Unfold}$$

$$\frac{e \downarrow_{\mathtt{p}} v}{\mathtt{p}.e \xrightarrow{x} \bullet_{\mathtt{q}}; C, \sigma \rightarrow_a C[v/x], \sigma} \; \textit{Async}|\textit{Send}$$

$$\frac{}{\bullet_{\mathtt{p}} \xrightarrow{v} \mathtt{q}; C, \sigma \rightarrow_a C, \sigma[\mathtt{q} \mapsto v]} \; \textit{Async}|\textit{Recv}$$

$$\frac{\{\mathtt{p}\}\#\{\mathtt{r},\mathtt{s}\}}{\mathtt{p}.e \xrightarrow{x} \bullet_{\mathtt{q}}; \mathtt{r}.e' \rightarrow \mathtt{s} \equiv \mathtt{r}.e' \rightarrow \mathtt{s}; \mathtt{p}.e \xrightarrow{x} \bullet_{\mathtt{q}}} \; \textit{Swap}'$$

an example

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$\rightsquigarrow$ the two "receive" actions at $\mathtt{q}$ cannot be swapped

results

desired properties

this relation satisfies the properties we identified earlier (see paper)

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furthermore

- formal correspondence with synchronous semantics
- projection theorem wrt an asynchronous process calculus

modularity

- adaptable to other communication primitives
  - label selection
  - name mobility

modularity

- adaptable to other communication primitives
  - label selection
  - name mobility
- nice interplay with other choreography primitives
  - minimal choreographies (see paper)
  - procedural choreographies (see our forte'17 paper + tr)
  - multiparty session types
  - ...

outline

conclusions

- asynchronous semantics for choreographic communication
- abstract(-ish) description of asynchrony (paper only)
- precise characterization in terms of synchronous communication
- modular development, easily adaptable/extendable

thank you!