A theory of contracts for Web services

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Presentation outline

Web service discovery

- Registries (UDDI...)
- Contain descriptions (WSDL...)
- Several possible search keys:
  - Name
  - Keywords
  - ...
  - Behaviour (available interaction patterns)

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actions/coactions $\alpha ::= a \mid \overline{a}$

contrats $\sigma ::=$

0	*(termination)*
$\alpha.\sigma$	*(actionprefix)*
$\sigma + \sigma$	*(external choice)*
$\sigma \oplus \sigma$	*(internal choice)*

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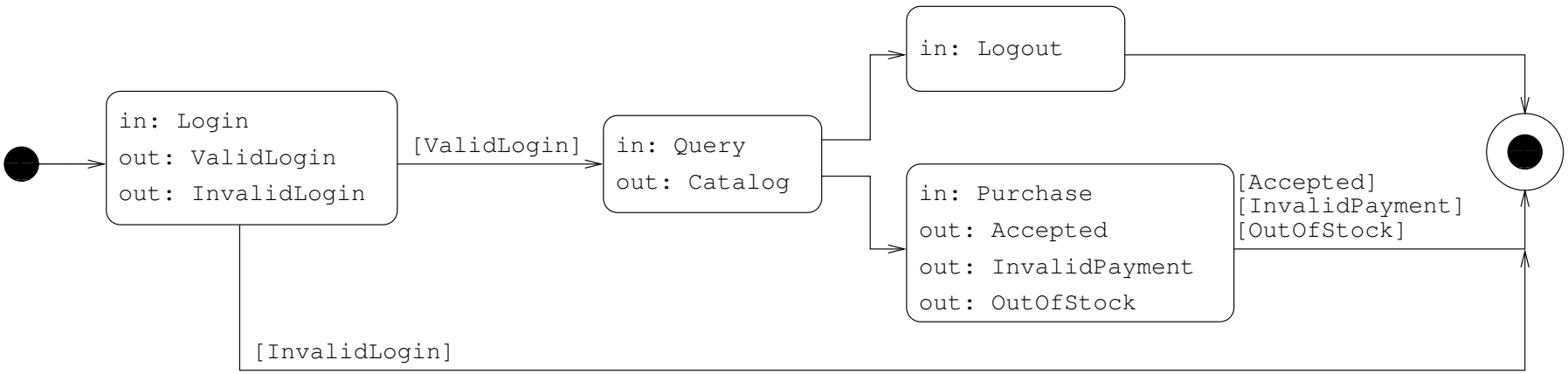
Example



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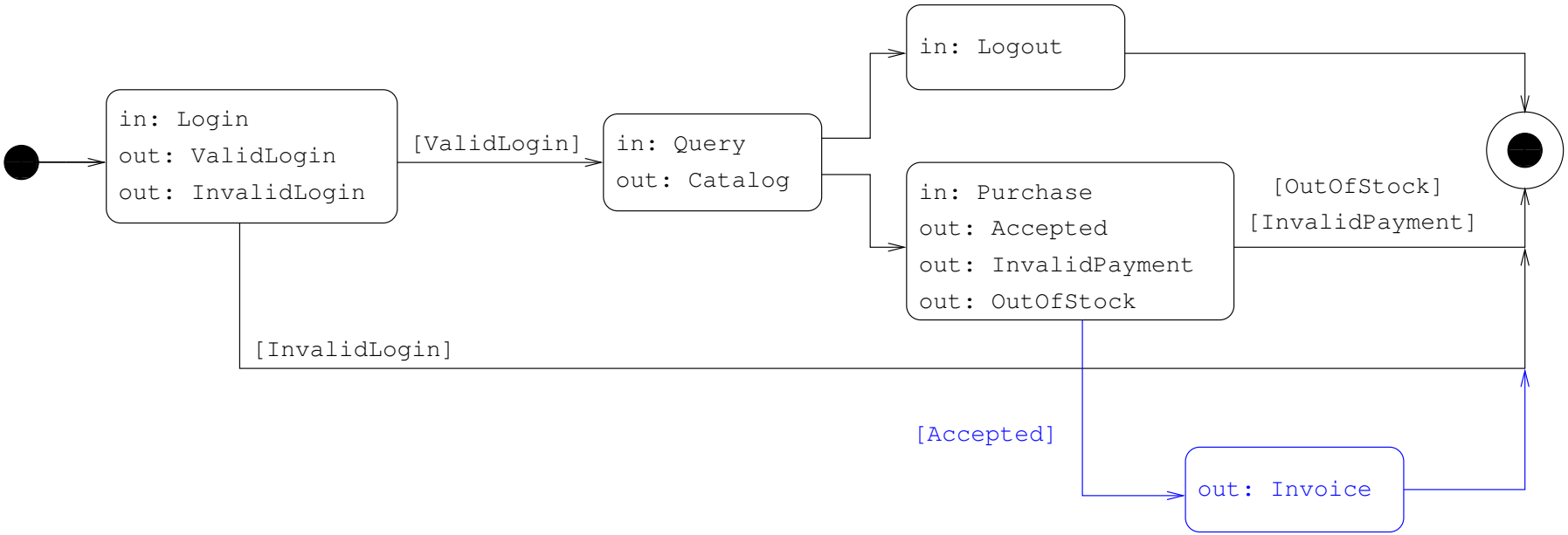

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Find a service suitable for a given client

Two possible ways:

- Directly, by defining a contract for the client
- Starting from a known suitable service

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  $\rightarrow$compliance relation

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Relating client and service: **compliance**

- Clients too are described by contracts
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Definition of compliance

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Relating two services: **subcontract**

Informal definition

$\sigma \preceq \tau$: "a client designed for a σ service will work with a τ one."

τ may:

1. be more deterministic:

$$\overline{a} \oplus \overline{b}.c \preceq \overline{a}$$

$$\overline{\texttt{InvalidLogin}} \oplus \overline{\texttt{ValidLogin}} \preceq \overline{\texttt{ValidLogin}}$$

2. offer more choices:

$$\overline{a} \preceq \overline{a} + \overline{b}.d$$

$$\texttt{Logout+Purchase} \preceq \texttt{Logout+Purchase+SaveForLater}$$

3. offer longer interaction patterns:

$$\overline{a} \preceq \overline{a}.\overline{b}.d$$

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Transitivity problem!

- So we want:

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- but with the client contract $a.\omega + b.\overline{c}.\omega$ we have:

$$a.\omega + b.\overline{c}.\omega \dashv \overline{a} \oplus \overline{b}.c \qquad a.\omega + b.\overline{c}.\omega \not\dashv \overline{a} + \overline{b}.d$$

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Gluing compliance and subcontracting: **Filters**

Filters are operators that, at each step, let only pass a subset of the available actions.

Property

if $\sigma \preceq \tau$ then for some filter f: $\quad \rho \dashv \sigma \iff \rho \dashv f(\tau)$

Filters are "proofs" of subcontracting

$$f : \sigma \preceq \tau$$

$$f : \sigma \preceq \tau \quad \wedge \quad \rho \dashv \sigma \quad \iff \quad \rho \dashv f(\tau)$$

- deduction system for subcontracting: $f : \sigma \preceq \tau$,
- algebraic theory for filters
- existence and effectiveness of a most general filter (via cut-elimination, yields subcontracting coherence)
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Application to languages

Our contracts work for any language as long as they come equipped with:

1. A labelled transition system

$$P \xrightarrow{\mu} P'$$

μ is either a visible action or an invisible τ action

2. A type system

$$\vdash P : \sigma$$

σ is a contract

3. The latter abstracts the former.

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Process compliance and filtering

Compliance *for processes*

- Client P is compliant with server Q if: $P \parallel Q \longrightarrow\!\!\!\!\!\!\not\quad$ implies $P \xrightarrow{\omega}$

Add filters to the language: $f[P]$

- Transition relation
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Theorem (Process filtering)

If $\vdash P : \rho$ *and* $\vdash Q : \sigma$ *and* $f : \rho \dashv f(\sigma)$, *then* $P \dashv f[Q]$

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- Asymmetric choices
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Axiomatisation of the weak subcontract relation

(Must)
$$l_\sigma \vee l_\tau : \sigma \oplus \tau \preceq \sigma$$

(DepthExt)
$$\mathbf{0} : \mathbf{0} \preceq \sigma$$

(Prefix)
$$\frac{f : \sigma \preceq \tau}{\alpha.f : \alpha.\sigma \preceq \alpha.\tau}$$

(Weakening)
$$\frac{f : \sigma \preceq \tau \quad g \wedge l_\tau \leqslant f}{f \vee g : \sigma \preceq \tau}$$

(Transitivity)
$$\frac{f : \sigma \preceq \sigma' \quad g : \sigma' \preceq \sigma''}{f \wedge g : \sigma \preceq \sigma''}$$

(IntChoice)
$$\frac{f : \sigma \preceq \sigma' \quad f : \tau \preceq \tau'}{f : \sigma \oplus \tau \preceq \sigma' \oplus \tau'}$$

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