Choreography Automata

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Good ideas are recyclable

If you have a bunch of dancers...

Good ideas are recyclable

If you have a bunch of dancers...

....would you like to end up with this....

or with THIS?

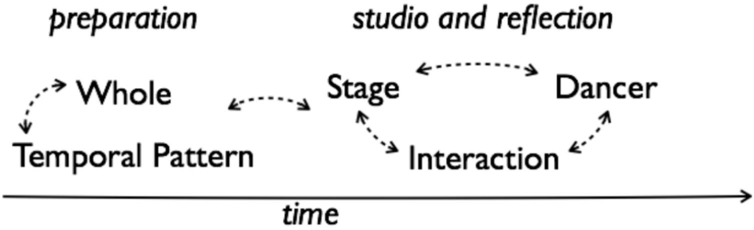
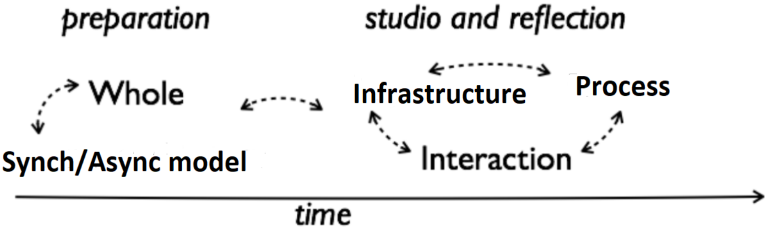
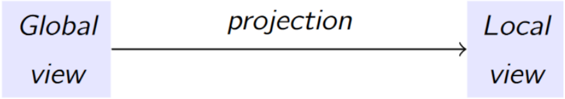


Figure 10. Focal points along the creative phases.

The recycling



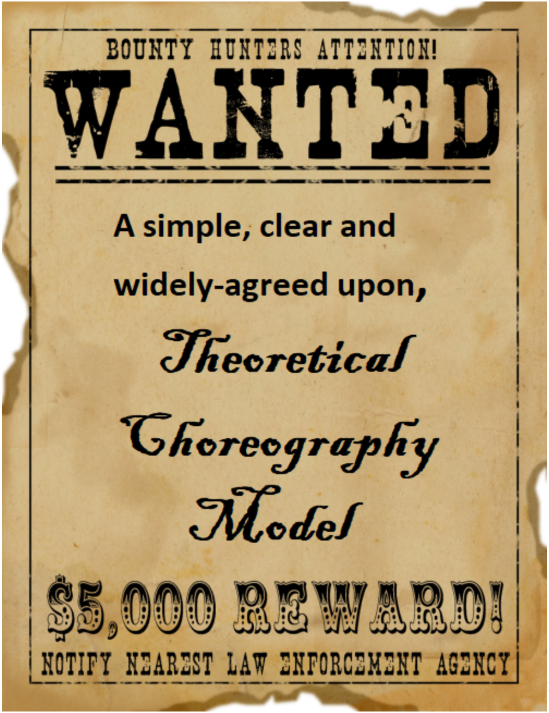
More abstractly:
coexistence of two distinct but related views of a system: the *global* and the *local* views.



projection is an operation producing the local view from the global one

The choreographic approach: A lighthouse on the Formal Verification road

- specification languages: WS-CDL, BPMN, ...
- choreographies for microservices;
- experimental choreographic langauges: Chor
- etc.


BOUNTY HUNTERS ATTENTION!
WANTED
A simple, clear and
widely-agreed upon,
Theoretical
Choreography
Model
$5,000 REWARD!
NOTIFY NEAREST LAW ENFORCEMENT AGENCY

Which abstraction for processes?

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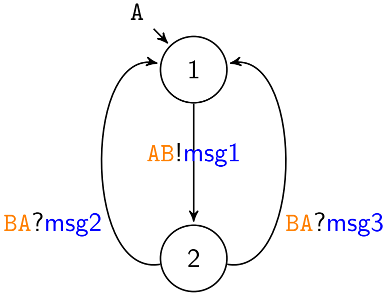

Communicating Finite State Machines (CFSMs)

A formalism for the description and the analysis of distributed systems.

A machine $M_{\mathtt{A}}$

- $M_{\mathtt{A}}$ can send msg1 to machine $M_{\mathtt{B}}$;
  asynchronously; *through the directed buffered FIFO channel* AB
- Then, either msg2 or msg3 can be received from $M_{\mathtt{B}}$;
  through channel BA;
- and so on....

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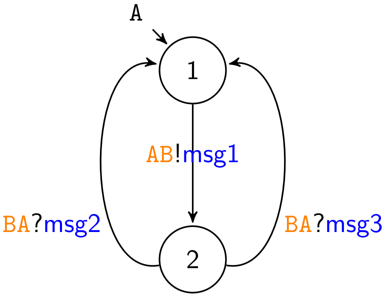

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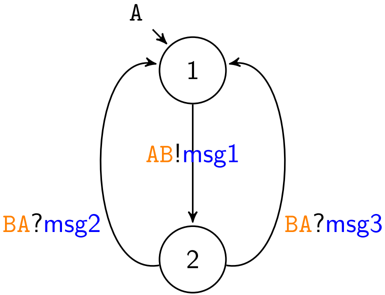

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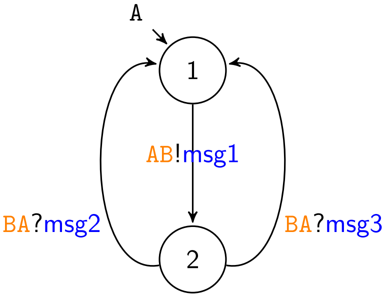

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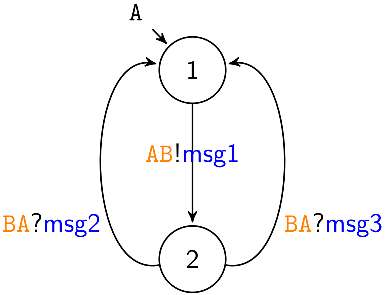

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Systems of CFSMs

A *system* of CFSMs:

$$S = (M_{\mathrm{p}})_{\mathrm{p} \in \mathbf{P}}$$

- $\mathbf{P}$ is the set of *roles* (participants) of S, and
- for each $\mathrm{p} \in \mathbf{P}$, $M_{\mathrm{p}} = (Q_{\mathrm{p}}, q_{0\mathrm{p}}, \mathbb{A}, \delta_{\mathrm{p}})$ is a CFSM.

A *configuration* of S:

$$s = (\vec{q}, \vec{w})$$

- $\vec{q} = (q_{\mathrm{p}})_{\mathrm{p} \in \mathbf{P}}$ *the overall state of the system*
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System transitions:

$$(q, w) \xrightarrow{\texttt{AB}!msg} (q', w')$$

- $(q_{\texttt{A}},\ \texttt{AB}!msg,\ q'_{\texttt{A}}) \in \delta_{\texttt{A}}$
- $\forall \texttt{p} \neq \texttt{A}.\ q'_{\texttt{p}} = q_{\texttt{p}}$
- $w'_{\texttt{AB}} = w_{\texttt{AB}} \cdot msg$ and $\forall \texttt{pr} \neq \texttt{AB}.\ w'_{\texttt{pr}} = w_{\texttt{pr}}$

Similarly for

$$(q, w) \xrightarrow{\texttt{AB}?msg} (q', w')$$

Synchronous communications

It is easy to equip CFSMs also with a synchronous communications.

Choreographies for CFSMs systems: Which description formalism?

It takes a thief to catch a thief... so

Choreography Automata

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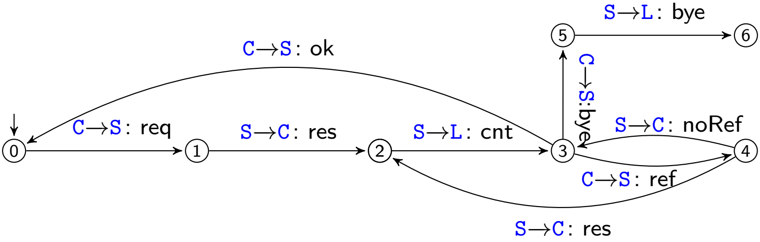
Choreography Automata through an Example



An apparent resemblance

Choreography Automata **vs.** Conversation Protocols
(by Bultan et al.)

They look alike, but actually their semantics and underlying communication models do differ.

(a thorough comparison in the Related Works section of the paper)

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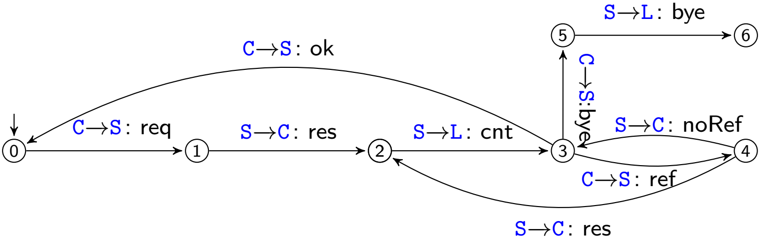
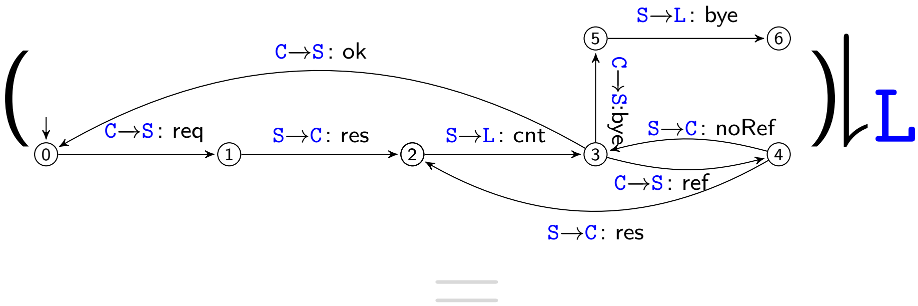


Projection


C→S: ok
S→L: bye
C→S:bye
S→C: noRef
C→S: req
S→C: res
S→L: cnt
C→S: ref
S→C: res
0
1
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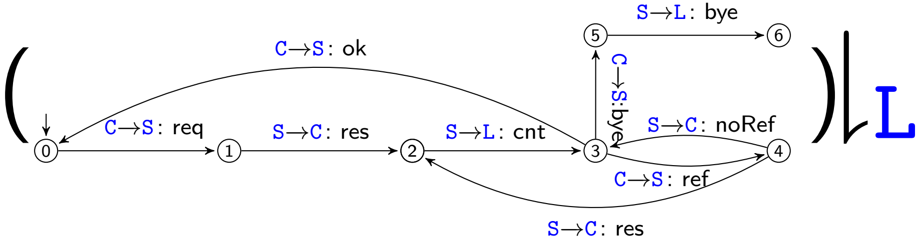
Projection



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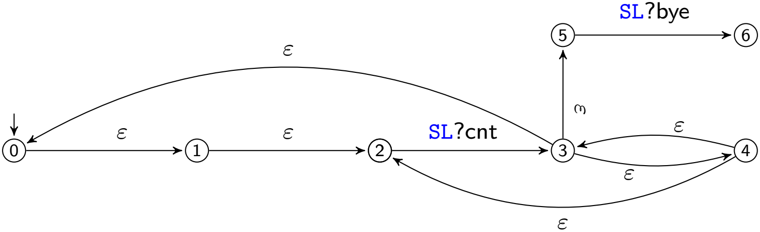

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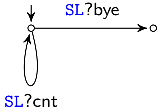

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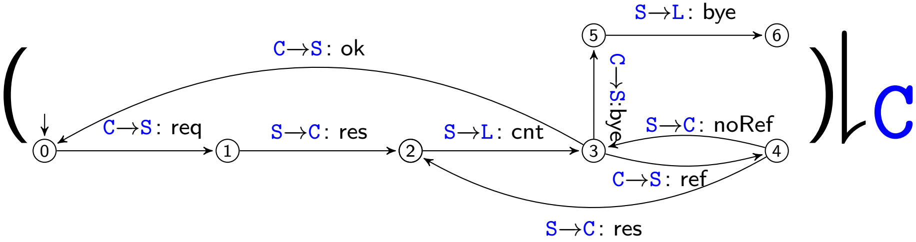
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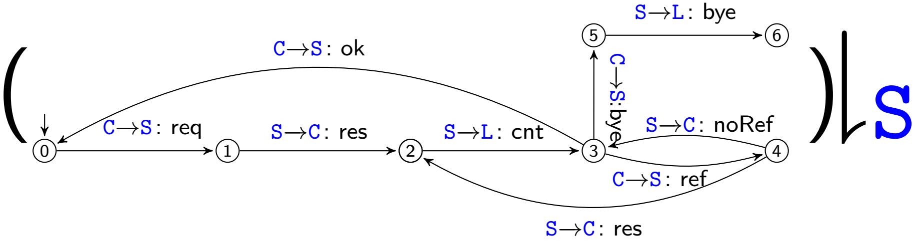

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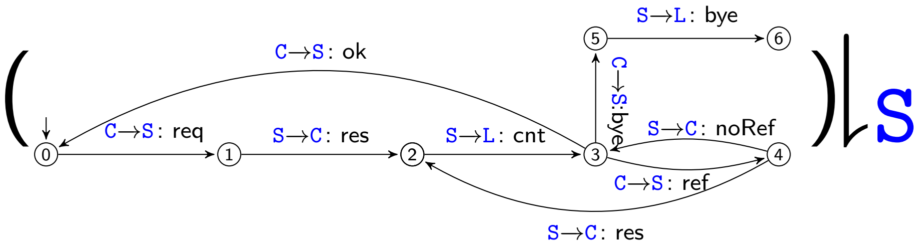

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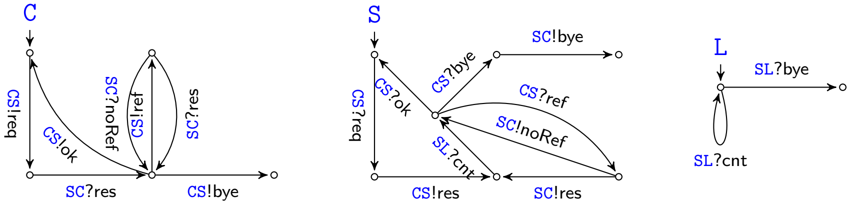

- The behaviour of the system of CFSMs perfectly match the overall behaviour described by the choreography automata:
- The system is **Live**, *i.e. if a machine is willing to perform some actions, the system can evolve so that one eventually is done*
- The system is **Deadlock-Free** *i.e. it will never get stuck (the system does progress)*
- The system is **Lock-Free** *i.e. if a machine can perform some actions, sooner or later it will do one (any single machine does progress)*

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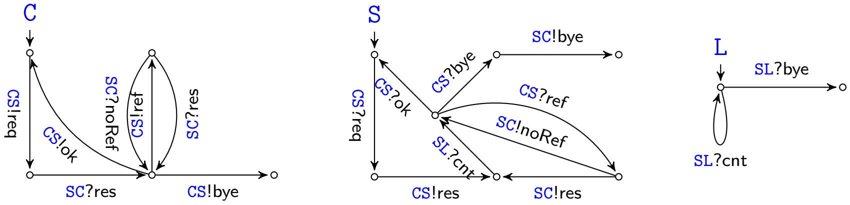

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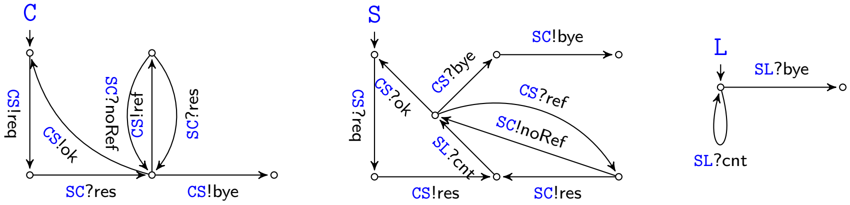

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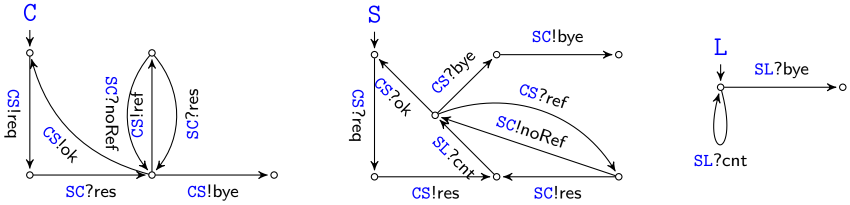

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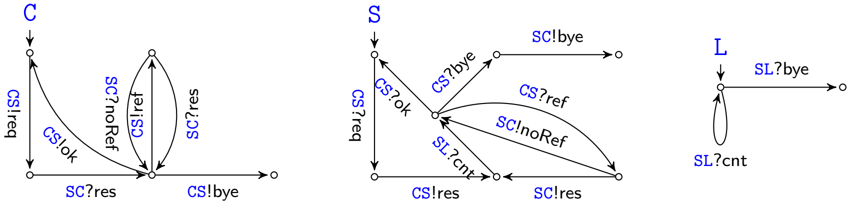

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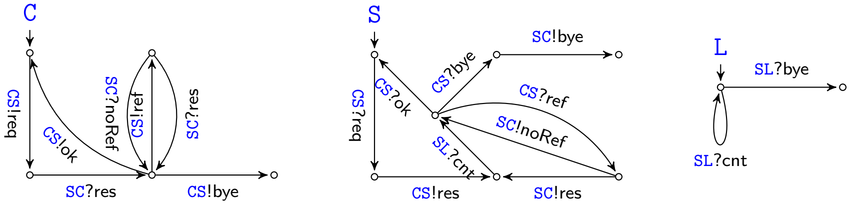

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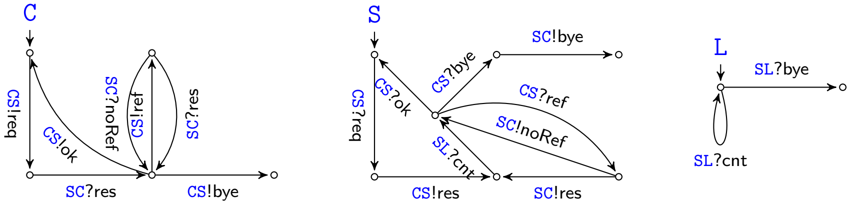

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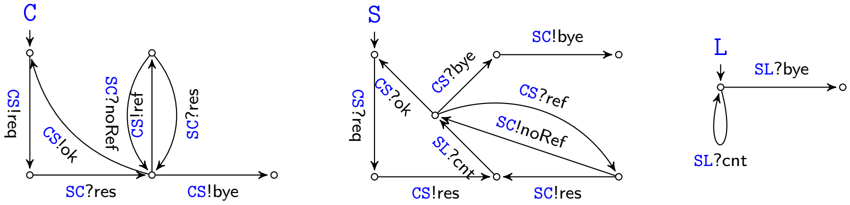

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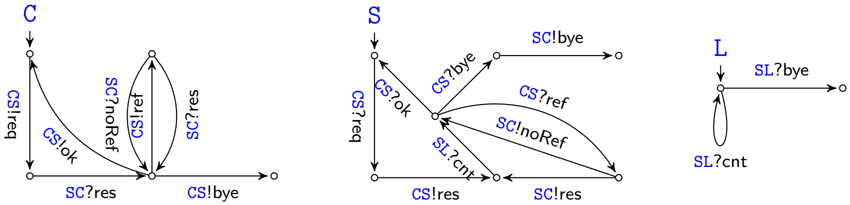

Both for **Synchronous** and **Asynchronous** communications

There ain't no such thing as a free lunch

Only the projections of *well-behaved* Choreography Automata are *well-behaved*.

Theorem

Given a well-formed c-automaton CA, the system obtained by projection, $(CA\lfloor_{\mathtt{A}})_{\mathtt{A}\in\mathcal{P}}$, is live, lock-free, and deadlock-free both for synchronous and asynchronous communications.

Definition (Well-formedness)

A c-automaton CA is well-formed if (roughly)

- when there is a choice, a single participant decides;
- all the partecipants are eventuelly made aware of the choices made;
- parallelism of independent interactions must be made explicit by interleaving them

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Given a well-formed c-automaton CA, the system obtained by projection, $(CA\lfloor_{\mathtt{A}})_{\mathtt{A}\in\mathcal{P}}$, *is live, lock-free, and deadlock-free both for synchronous and asynchronous communications.*

Definition (Well-formedness)

A c-automaton CA is well-formed if (roughly)

- when there is a choice, a single participant decides;
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