MICROSOFT Research Cambridge
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Architectural Design Rewriting as an Architecture Description Language

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joint work with
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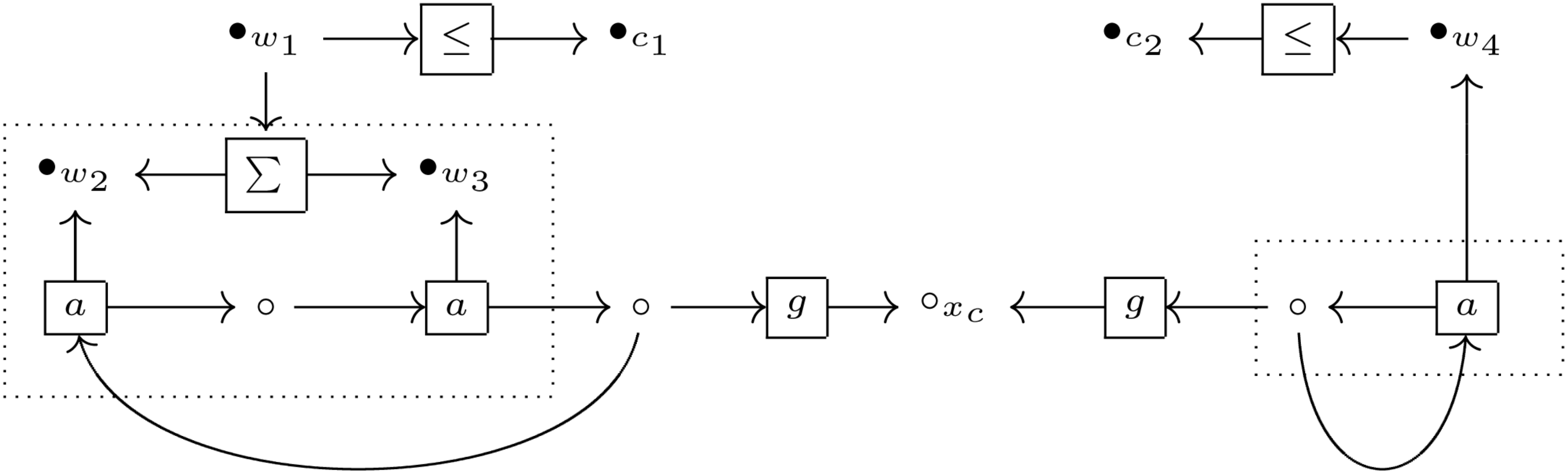
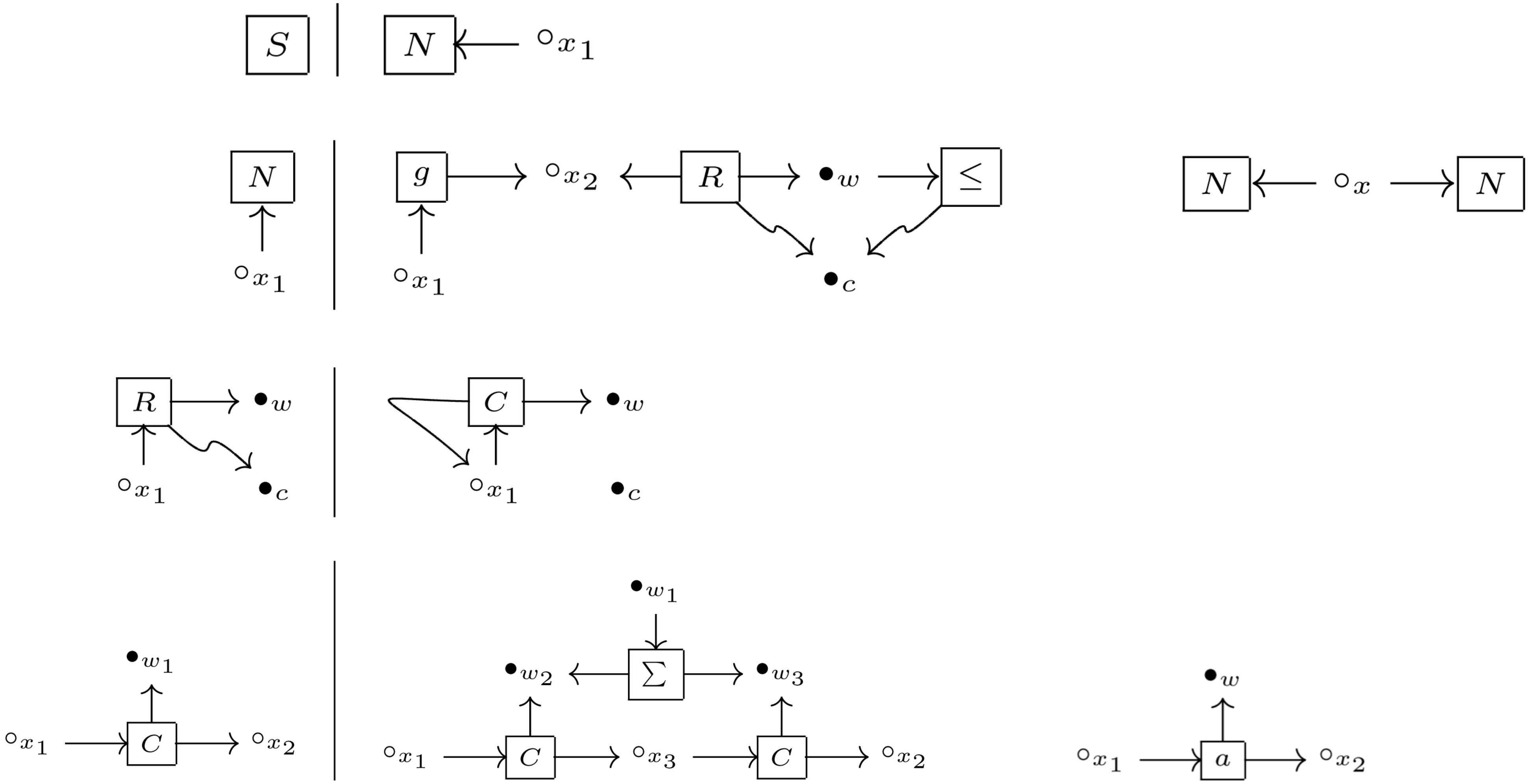
ADR, Architectural Design Rewriting: An Example

Rings of Agents with Gateways

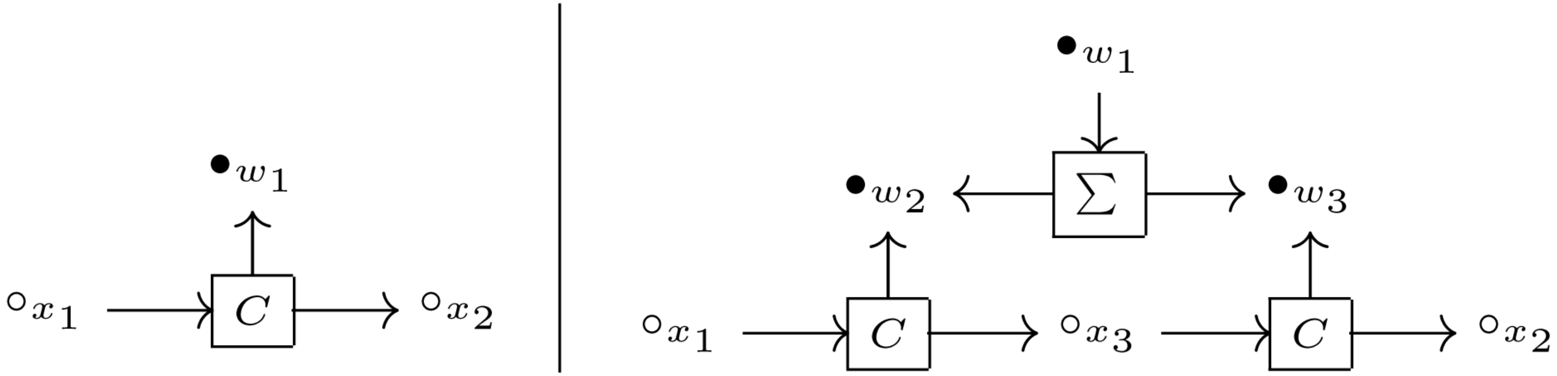


The combined load of all the agents of a ring
should not exceed a given threshold

Productions



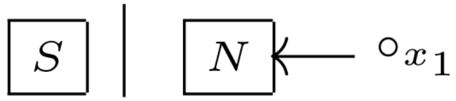
Productions Are Operations



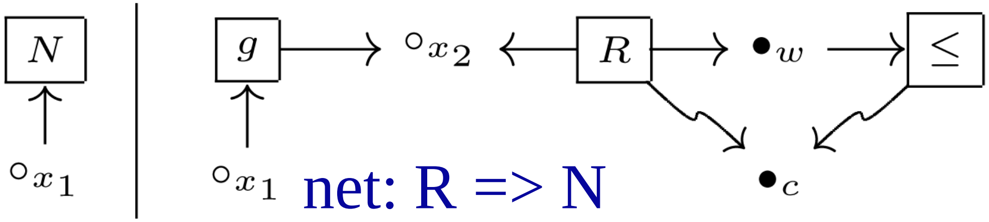
chains: C x C => C

- Design = graph with interface
- Operation chains maps two C-designs to a C-design
  chains(X:C,Y:C):C
- Values of the algebra are software architectures, sorts are nonterminals, carriers are architectural styles
- Ordinary process algebra-like operations on graphs (parallel composition, restriction) are easily represented

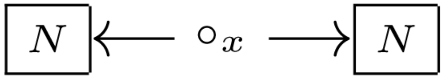
An Algebra of Design Operations



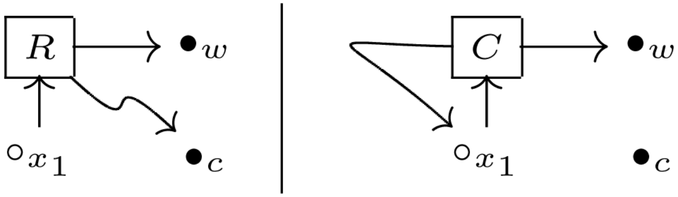
system: N => S



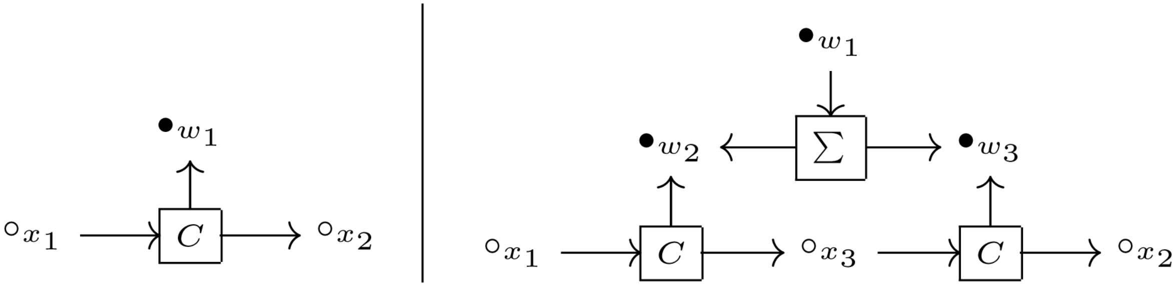
net: R => N



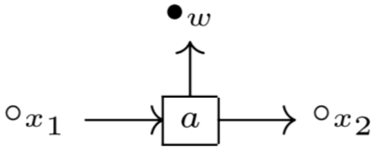
nets: N x N => N



ring: C => R

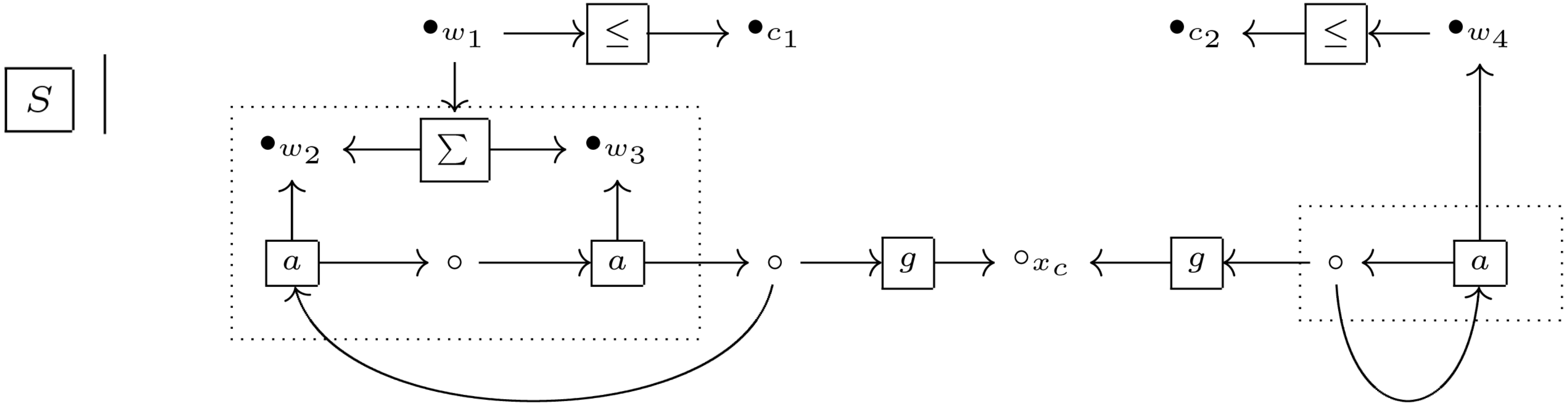


chains: C x C => C



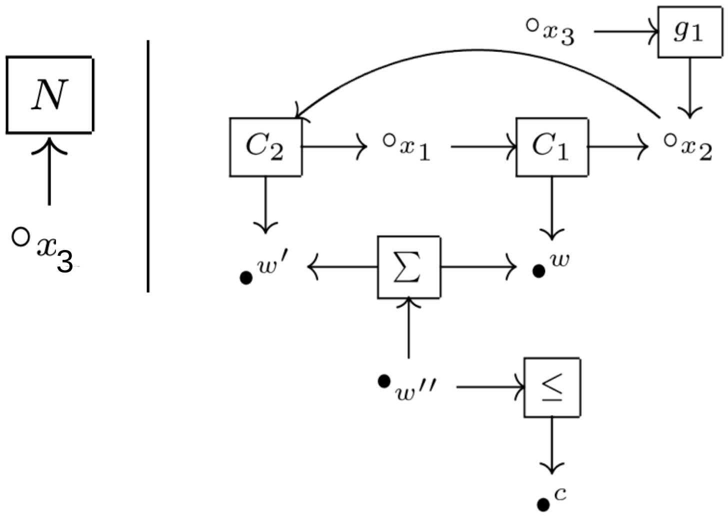
chain: => C

Rings of Agents with Gateways



system(nets(net(ring(chains(chain,chain)),net(ring(chain)))): S

Partial Designs



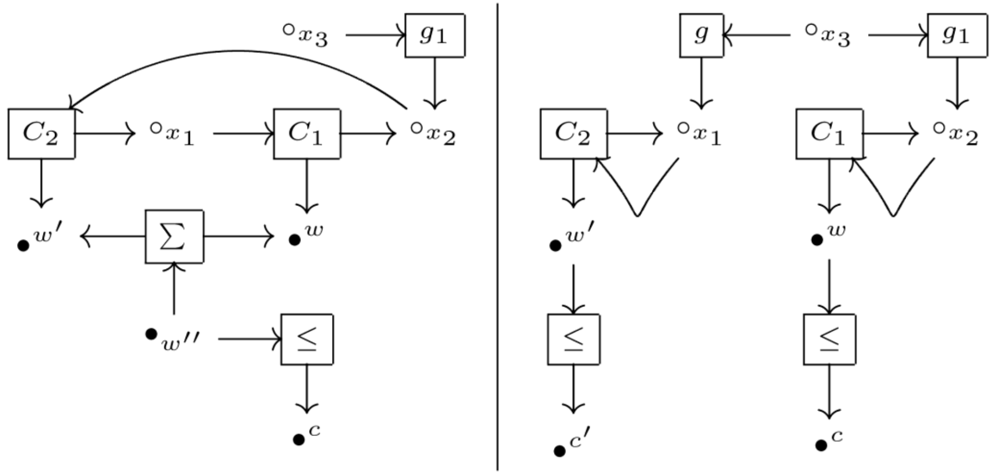
net(ring(chains(X:C,Y:C))): N

=

net(ring(Z:C))[chains(X:C,Y:C):C/Z]

- Terms with variables represent partial designs
- Substitution means refinement; the inverse abstraction
- Terms have more information than their evaluations: they are proofs of type

Term Rewriting



net(ring(chains(X:C,Y:C))):N

=>

nets(ring(X:C),ring(Y:C)):N

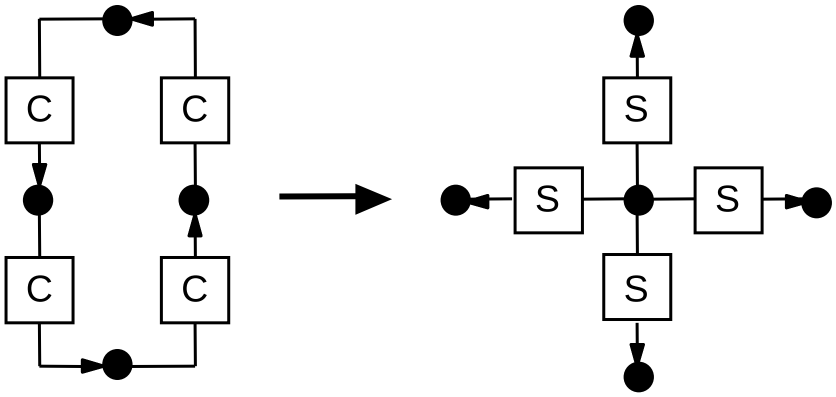
- Rewriting rules L => R con be instantiated and contextualized
- Rewritings are concurrent and guaranteed to preserve typing
- Rewritings can be triggered by the constraint structure:

e.g. here w''≥c/2 and w≥c/6 and w'≥c/6, when implied by the present set of constraints, could trigger a duplication of the ring

Conditional Rewriting SOS style

- Conditional rules can be of the form:
- X: A =a=> Y:B implies L(X):C =b=> R(Y):D
- Complex transitions can be constructed which guarantee synchronous updatings, e.g. nested wrappings for QoS
- Types need not be preserved, but consistent type modifications can be proved
- Process algebra-like semantics with synchronization, extrusion, etc. can be modeled

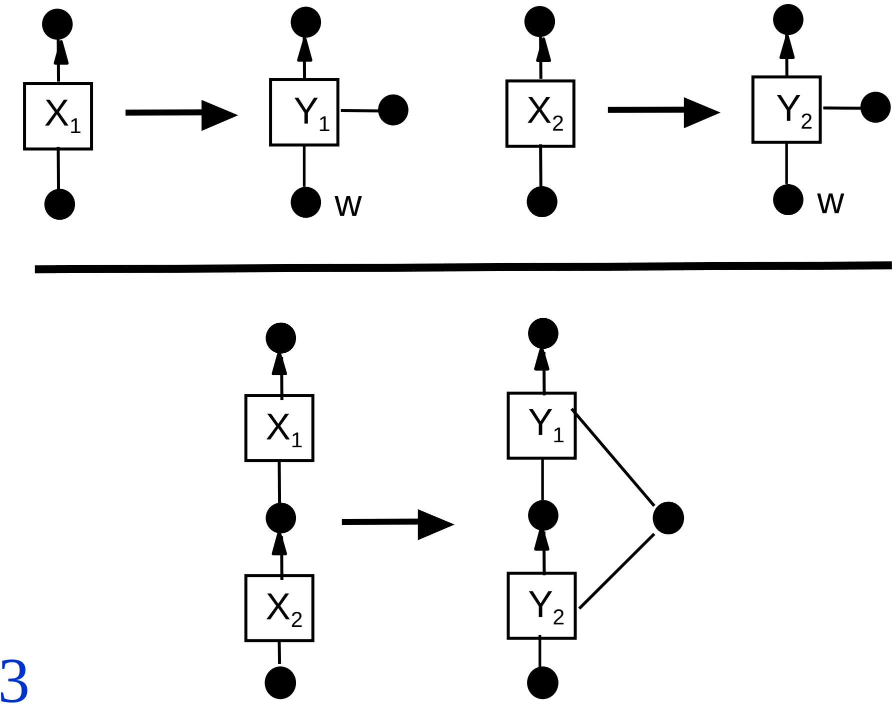
A Rewriting

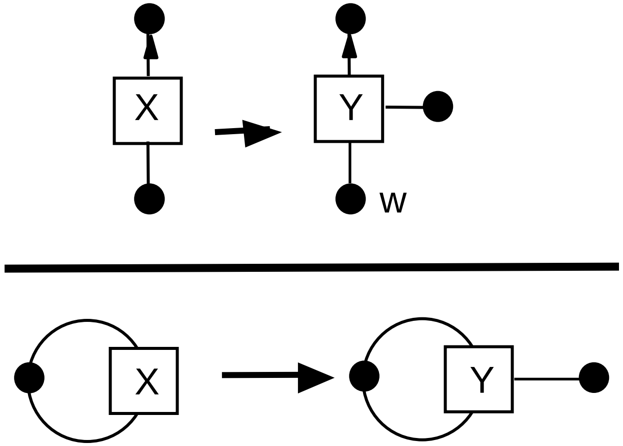


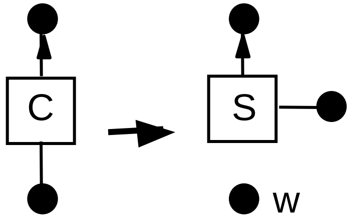
ring(chain(chain(C,C),chain(C,C))):1 =>

star(join(join(ray(S),ray(S)),join(ray(S),ray(S)))):1

Conditional Rewriting Rules







C:2 => ray(S:2):3

$$\frac{X:2 => Y:3 \qquad .}{ring(X):1 => star(Y):1}$$

$$\frac{X_1:2 => Y_1:3 \qquad X_2:2 => Y_2:3\ .}{chain(X_1,X_2):2 => join(Y_1,Y_2):3}$$

Conclusion

- ADR models design, execution and reconfiguration phases
- Process calculi tailored to software architecture
- Presentation in ADR style of:
  - SRML, Sensoria Reference Modeling Language
  - SHR, Synchronized Hyperedge Replacement
  - UML
  - REO, by Farhad Arbab et al., CWI
- SENSORIA case studies about web services
- Implementation in MAUDE
  - Graphical structure
  - Basic operations
  - Reconfiguation as rewriting
- ADR site: http://www.albertolluch.com/index.html?x=adr.html