Self Assembling Trees

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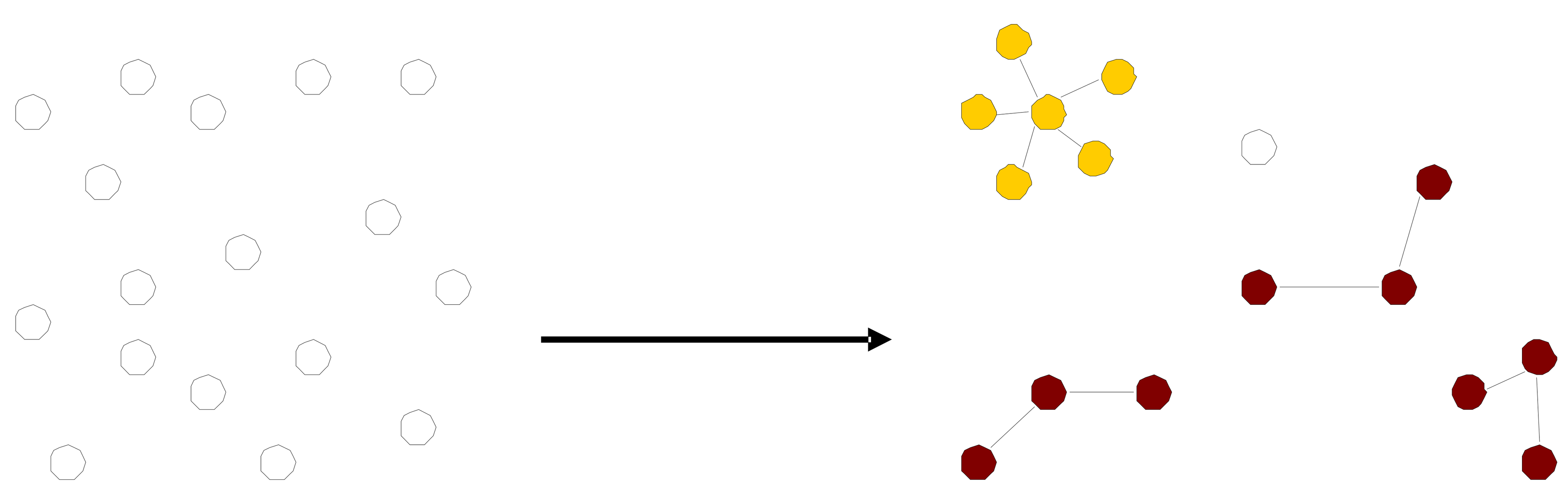
Goal

Obtaining a collective assembling of independent agents into predefined trees.



Constraints

- Local interactions
- No centralised decision
- No global knowledge of the environment

Applications

- Distributed robotics
- Molecular biology
- Genetic engineering
- Nanotechnology

Modelisation

Syntax (CCS)

Action:	α ::=	a | $\bar{a}$ | ...	Action on a channel
		| τ	Silent action
Process:	P ::=	0	End of process
		| $\Sigma\ \alpha_i.P_i$	Sum
		| (P | P)	Product
		| (a) P	Restriction

$a.(\bar{b}.P+c.Q) \mid \bar{a}.R \mid b.S$

↓

$(\bar{b}.P+c.Q) \mid R \mid b.S$

↓

$P \mid R \mid S$

Justification

- Point to point communication
- Smooth treatment of distribution

Bisimulation (≈)

Notion of equivalence between CCS terms

Algorithm

$$\mathrm{NODE}_i := \tau.(\mathrm{BUILD}_i^{\delta(i)} \mid \mathrm{WAIT}_{i*}^{\delta(i)}) + \textstyle\sum_j r_{ij}.(\mathrm{BUILD}_i^{\delta(i)-1} + \mathrm{WAIT}_{ij}^{\delta(i)-1})$$

where $\delta(i)$ stands for the connection capability of node i

$$\mathrm{BUILD}_i^{n+1} := \textstyle\sum_j \bar{r}_{ij}.\mathrm{BUILD}_i^{n}$$

$$\mathrm{BUILD}_i^{0} := 0$$

$$\mathrm{WAIT}_{ia}^{n+1} := \bar{w}_i.\mathrm{WAIT}_{ia}^{n+1}$$

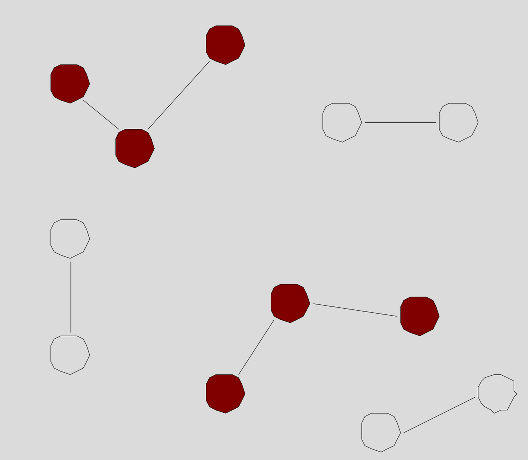
$$\mathrm{WAIT}_{ij}^{0} := w_j.\uparrow_j$$

$$\mathrm{WAIT}_{i*}^{0} := \underline{ok}_i.\uparrow_*$$

Causal encoding

- Causal Simulation
- No Bad State

Deadlocks



From partial correctness to fully correctness

Syntax (Reversible CCS)

Memories	m ::=	< >, <1>.m, <2>.m, <∗,a,P>.m, <m,a,P>.m, <∘>.m
RCCS process	$\mathcal{R}$ ::=	m▷P | ($\mathcal{R}$ | $\mathcal{R}$) | (a) $\mathcal{R}$

Theorem

Let S be a LTS and P a CCS process

If $S = LTS_K^c(P)$ Then $\ell_K(P) \approx S$

$\ell_K(P)$: the exact same process seen as a K-reversible process

Conclusion

	Specification
	↓
Programmer part	CCS term in causal encoding relation with the specification
	↓
Theorem	RCCS term bisimilar to the specification