# Petri Net Controlled Grammar Systems

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$\Rightarrow$ joint work with Jetty Kleijn

## Motivation

| Blackboard Systems | CD grammar systems |
|---|---|
| e.g. [Nii89] | e.g. [CD90] |
| knowledge sources | $n$ grammars |
| blackboard | 1 sentential form |
| control | sequential cooperation protocols |

AI papers like, e.g., [Cor91] and [CL94] claim:

**need for separate control module**

(CD: hypothesis language, graph control)

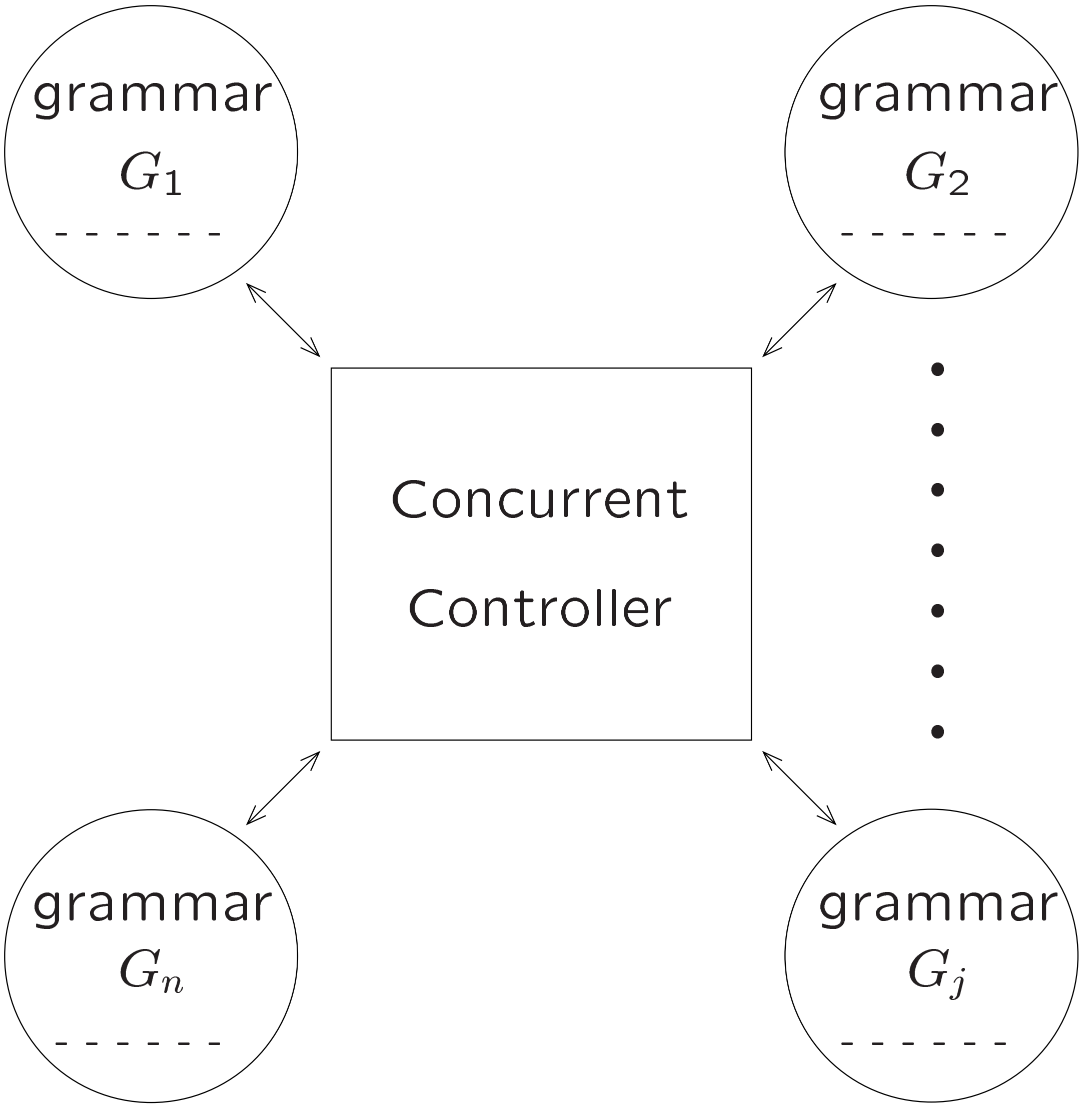
problem solving in which multiple (competing, cooperating, independent) lines of reasoning are **concurrently** pursued

(Controlled CD: still sequential)

**subdivide** blackboard into **regions** of particular kind of info (product of sentential forms)

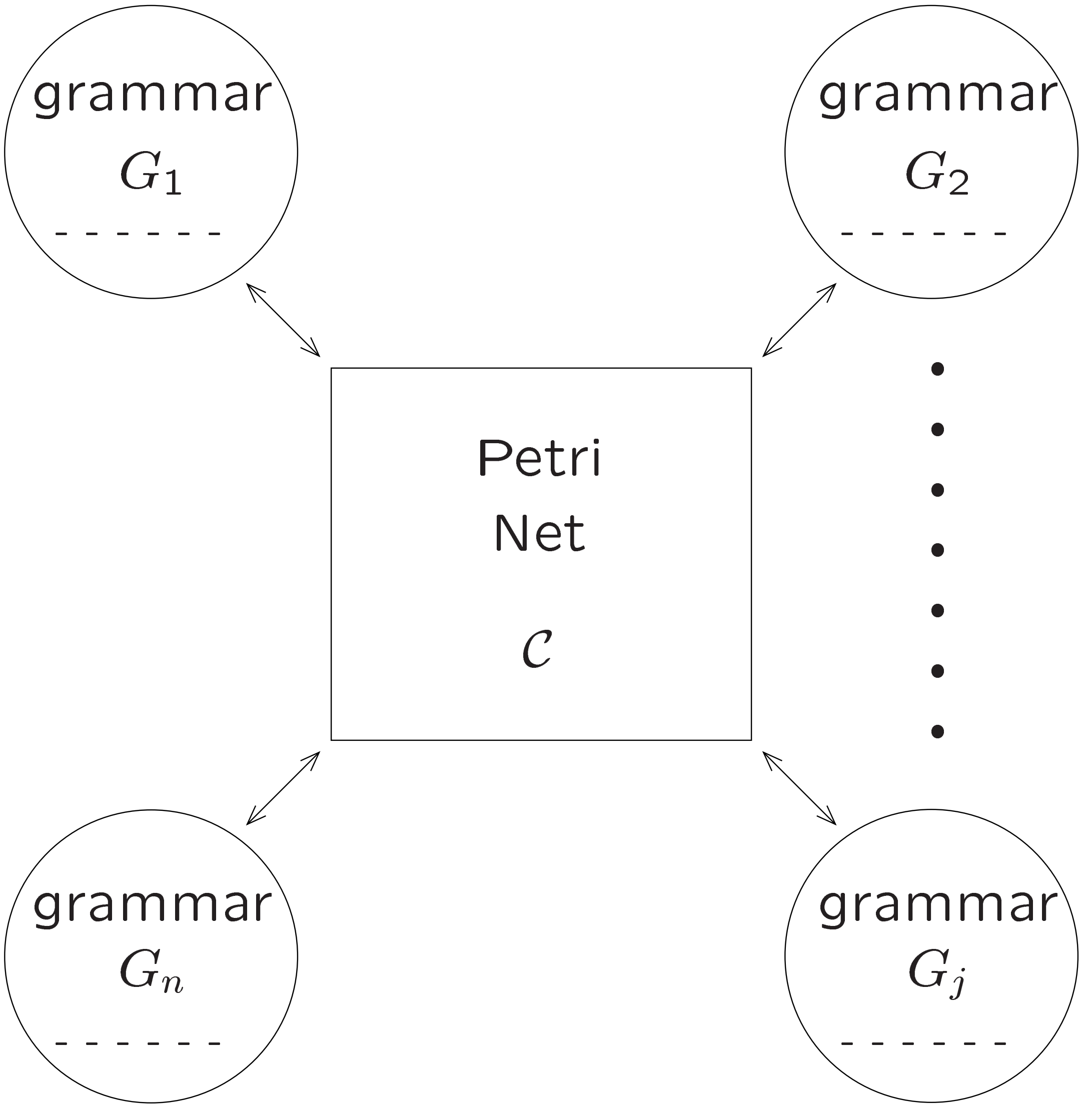
(PC: communication, component language)

## Proposed Model




Use concurrent controllers introduced in [Kee96] for controlling sequential components

## Proposed Model (continued)

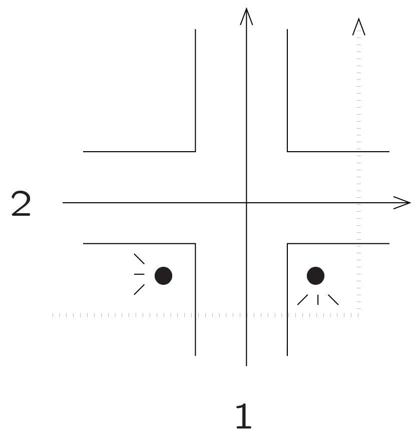



Petri Net $\leadsto$ $n$-dimensional Generalized Individual Token Net Controller

Apply controller to grammar systems

# Example $n$-GITNC

Oversimplified situation
of diagonally
crossing at crossing




Three components:

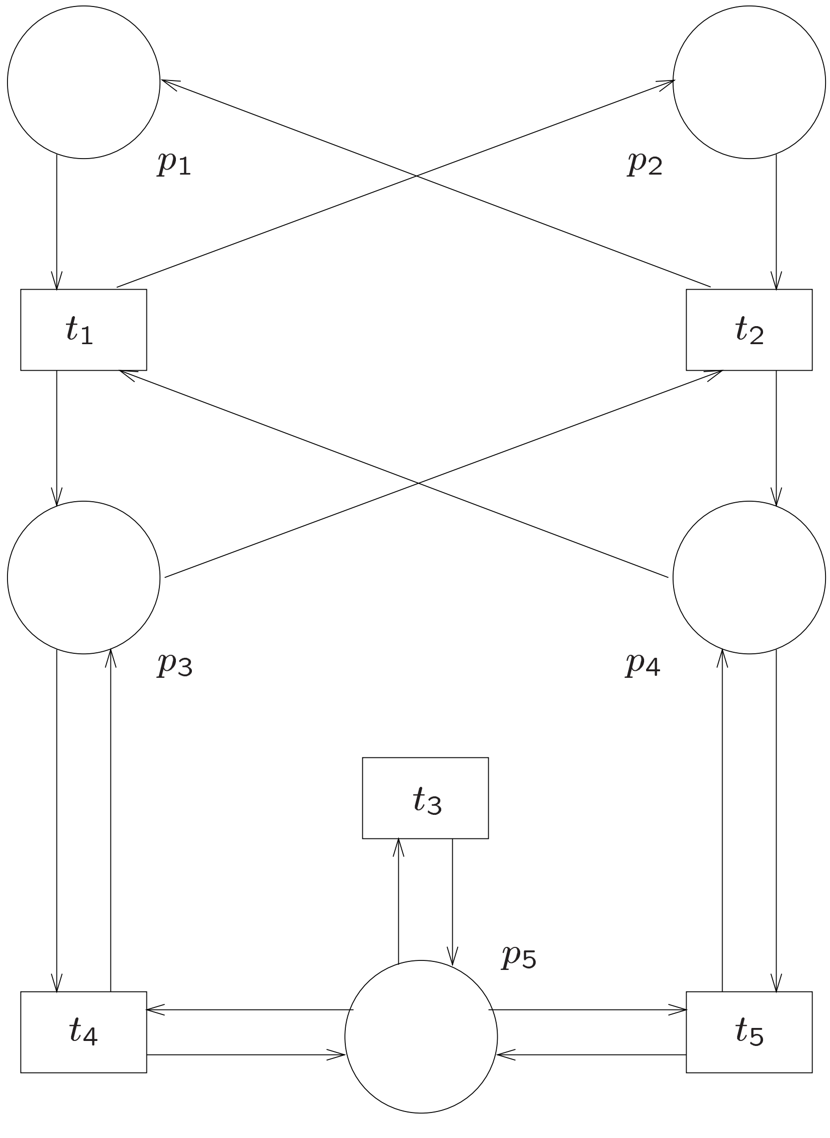
- two traffic lights with actions **r**ed and **g**reen and behaviour $\{r, g\}^*$

- one pedestrian with actions **s**tand, **w**alk in direction 1 and **w**alk in direction 2 and behaviour $s^*w_2s^*w_1s^*$

Synchronizations:

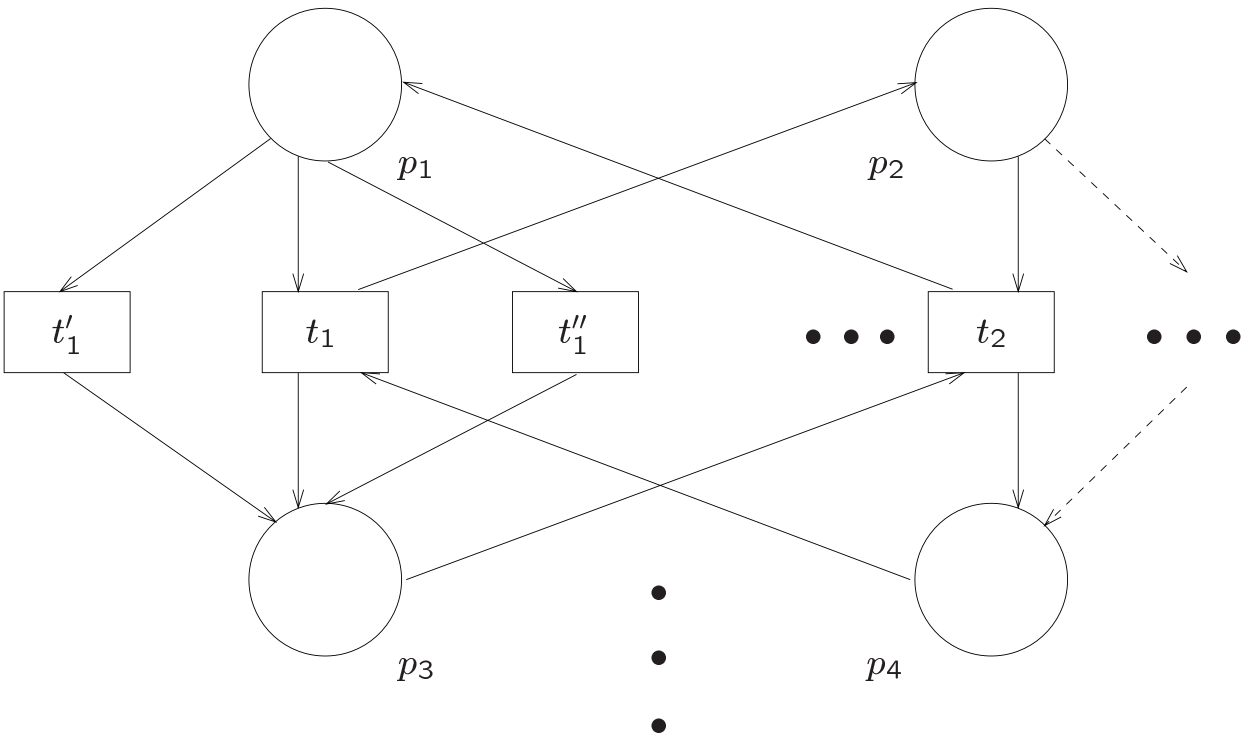
$$\begin{pmatrix} g \\ \lambda \\ w_1 \end{pmatrix}, \begin{pmatrix} \lambda \\ g \\ w_2 \end{pmatrix}, \begin{pmatrix} g \\ r \\ \lambda \end{pmatrix}, \begin{pmatrix} r \\ g \\ \lambda \end{pmatrix} \text{ and } \begin{pmatrix} \lambda \\ \lambda \\ s \end{pmatrix}$$

# Example $n$-GITNC $\mathcal{C}$ (continued)




(initial and final) marking, firing sequence $t_1t_3t_2t_5t_1t_3t_4$

## Example $n$-GITNC Grammar System $\Gamma$



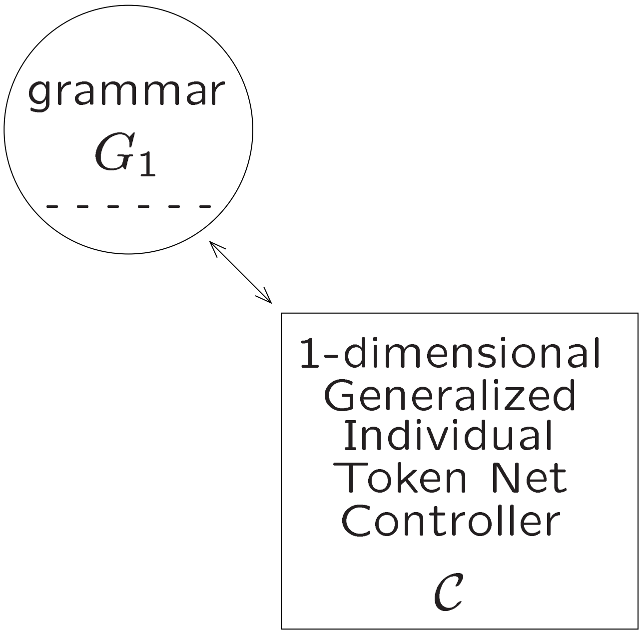

configuration $\left( \begin{pmatrix} --- \\ v_i \\ --- \end{pmatrix},\ M \right) \stackrel{t}{\Longrightarrow}_\Gamma \left( \begin{pmatrix} --- \\ v'_i \\ --- \end{pmatrix},\ M' \right)$,

$v_i \stackrel{\pi}{\Longrightarrow}_{G_i} v'_i$, $\pi$ production

vector language $\mathbb{V}(\Gamma)$
(product of terminal strings, final marking)

## Behaviour

cf $n$-GITNC grammar system:
all components context-free grammars




$$\mathbb{V}(\text{cf 1-GITNCGS}) = \mathbb{L}(\text{rC})$$

Corollary: $CD(f) \subseteq \mathbb{V}(\text{cf 1-GITNCGS})$,

$f \in \{*\} \cup \{\leq k, = k, \geq k \mid k \geq 1\}$

## Incorporation Lemma

reg $n$-GITNC grammar system:
all components regular grammars

regular $n$-GITNC grammar system $\Gamma$

$$\rightsquigarrow$$

$n$-GITNC $\mathcal{C}$

such that

$$\mathcal{V}(\Gamma) = \mathcal{V}(\mathcal{C})$$

Use existing theory of $n$-GITNCs ([Kee96])

Corollary of [KK97]:

$$\mathbb{V}(\text{reg n-GITNCGS}) = n - \mathbb{R}\text{at}$$

## Discussion / Future work

Conflict resolution

Degree of concurrency

Deadlock

Speed-up

Delay

Safeness

**Link back to blackboard systems**

# References

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