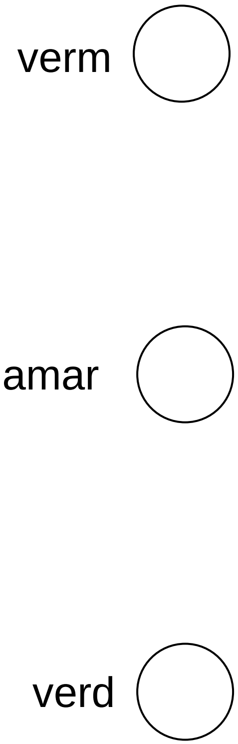
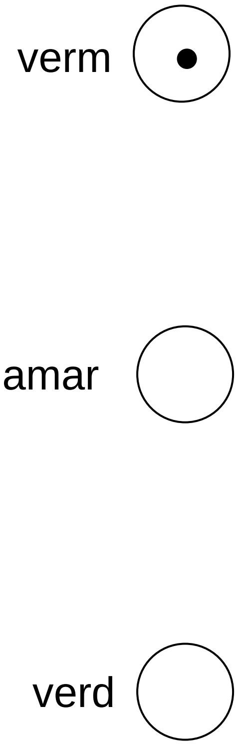
Exercício

- Construa uma Rede de Petri para um semáforo e depois elabore as matrizes de entrada, de saída e de incidência para as transições, além de indicar a marcação inicial, considerando que o semáforo está no vermelho.


verm
amar
verd


verm
amar
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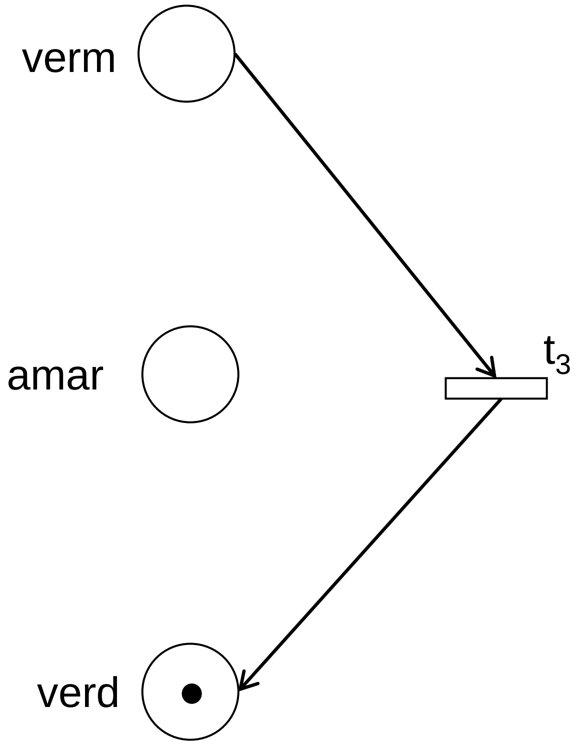
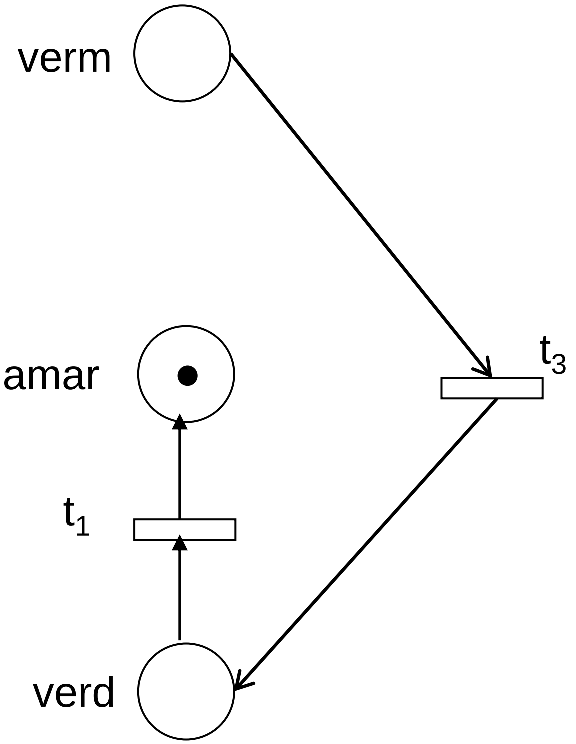
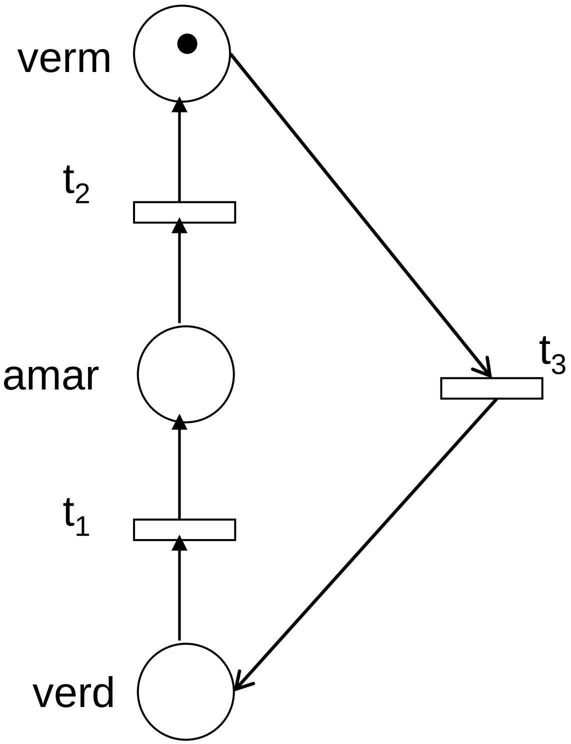
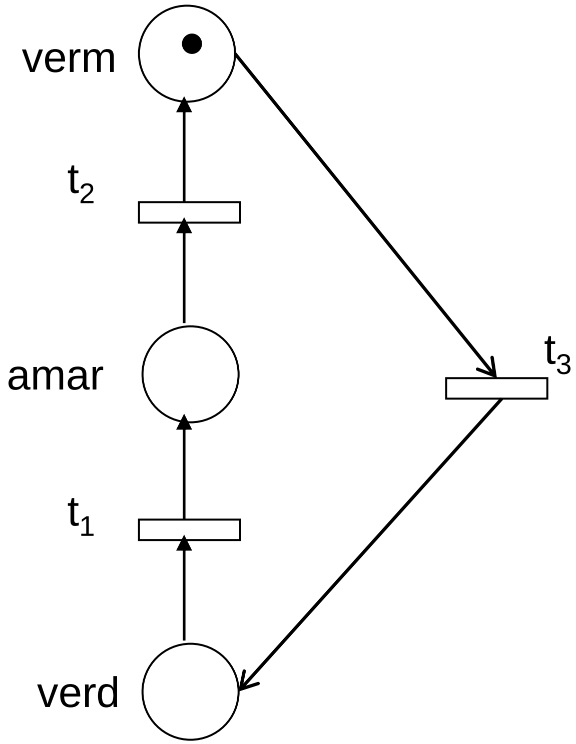
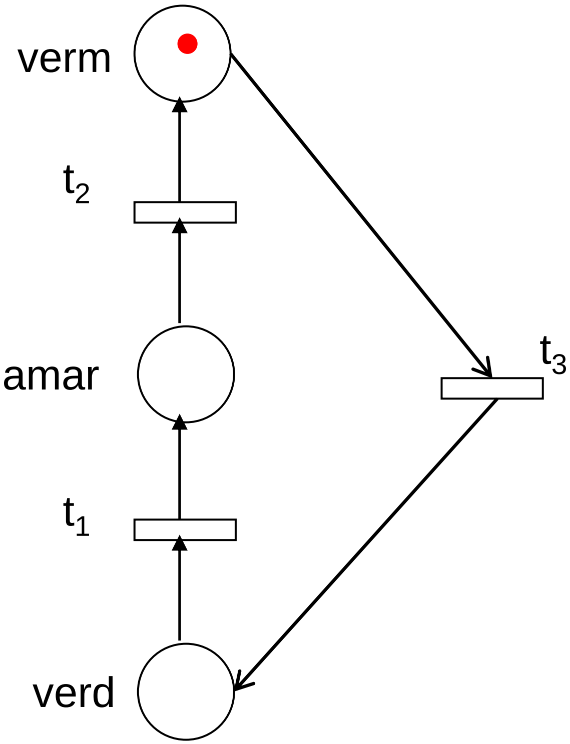

verm
amar
verd
t_3


verm
amar
t3
t1
verd


verm
t2
t3
amar
t1
verd

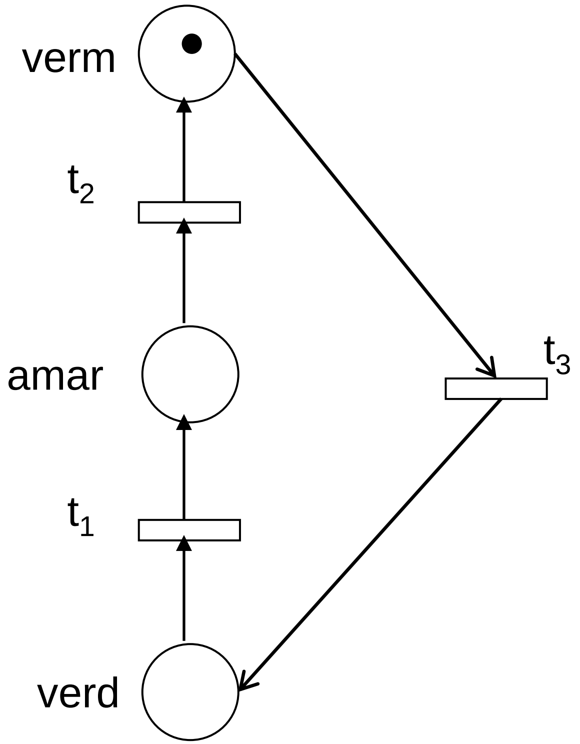


Marcação Inicial



Marcação Inicial

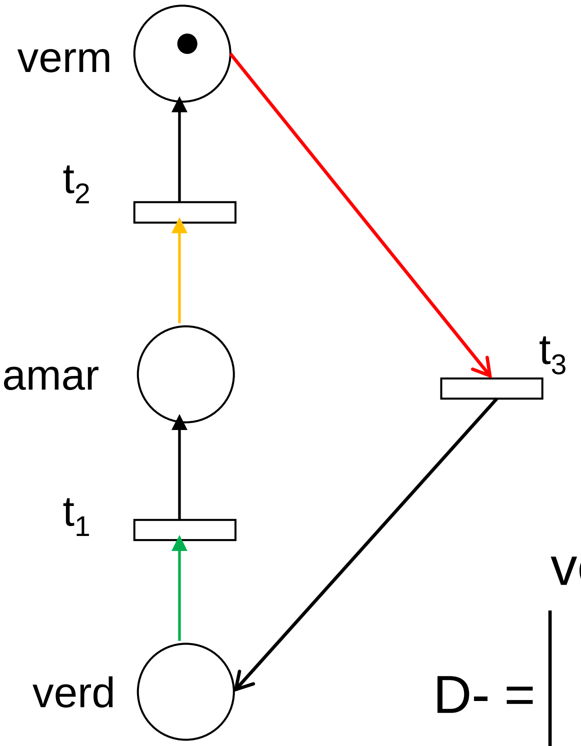
	verm	amar	verd	
$M_0 =$ |	1	0	0	|



Marcação Inicial

$$\begin{array}{cccc} & verm & amar & verd \\ M_0 = | & 1 & 0 & 0 \;| \end{array}$$

Representação matricial

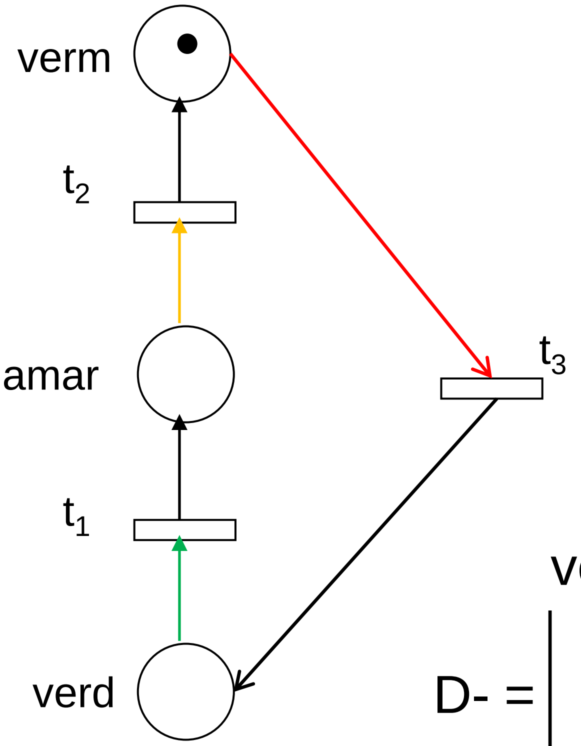


Marcação Inicial

$$\begin{array}{lccc} & \text{verm} & \text{amar} & \text{verd} \\ M_0 = | & 1 & 0 & 0 \ | \end{array}$$

Representação matricial

$$\begin{array}{cc} & \begin{array}{ccc} \text{verm} & \text{amar} & \text{verd} \end{array} \\ D- = & \left| \begin{array}{ccc} & & \\ & & \\ & & \end{array} \right| \begin{array}{l} t_1 \\ t_2 \\ t_3 \end{array} \end{array}$$

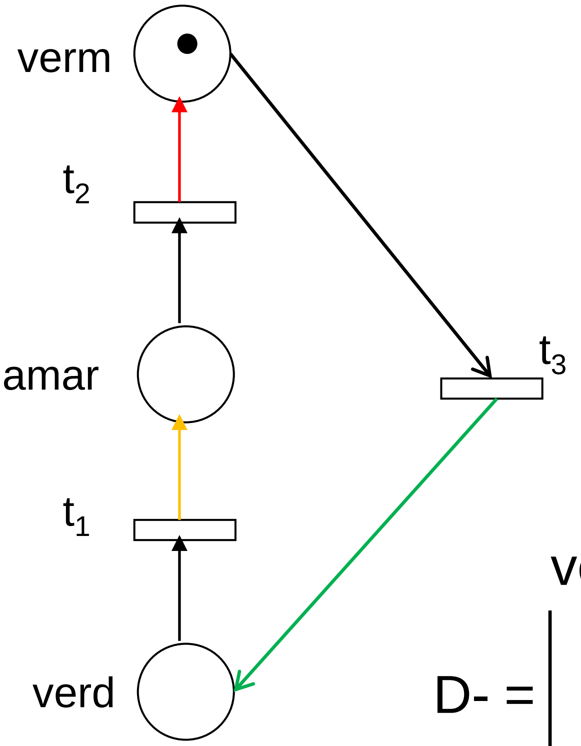


Marcação Inicial

$$\begin{array}{cccc} & \text{verm} & \text{amar} & \text{verd} \\ M_0 = & | \; 1 & 0 & 0 \; | \end{array}$$

Representação matricial

$$\begin{array}{cc} & \begin{array}{ccc} \text{verm} & \text{amar} & \text{verd} \end{array} \\ D- = & \left| \begin{array}{ccc} 0 & 0 & 1 \\ 0 & 1 & 0 \\ 1 & 0 & 0 \end{array} \right| \end{array} \begin{array}{c} \\ t_1 \\ t_2 \\ t_3 \end{array}$$



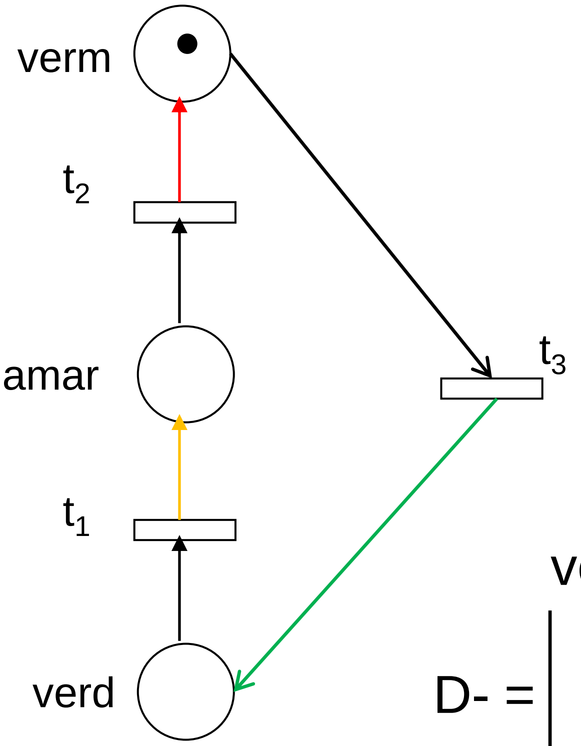
Marcação Inicial

$$
\begin{array}{cccc}
 & \text{verm} & \text{amar} & \text{verd} \\
M_0 = & \left| \begin{matrix} 1 & 0 & 0 \end{matrix} \right. & & \left. \right|
\end{array}
$$

$$M_0 = \begin{vmatrix} 1 & 0 & 0 \end{vmatrix} \quad (\text{verm}, \text{amar}, \text{verd})$$

Representação matricial

$$
D- = \begin{array}{c}
\begin{array}{ccc} \text{verm} & \text{amar} & \text{verd} \end{array} \\
\begin{vmatrix} 0 & 0 & 1 \\ 0 & 1 & 0 \\ 1 & 0 & 0 \end{vmatrix}
\end{array}
\begin{array}{c} \\ t_1 \\ t_2 \\ t_3 \end{array}
\qquad
D+ = \begin{array}{c}
\begin{array}{ccc} \text{verm} & \text{amar} & \text{verd} \end{array} \\
\begin{vmatrix} & & \\ & & \\ & & \end{vmatrix}
\end{array}
\begin{array}{c} \\ t_1 \\ t_2 \\ t_3 \end{array}
$$



Marcação Inicial

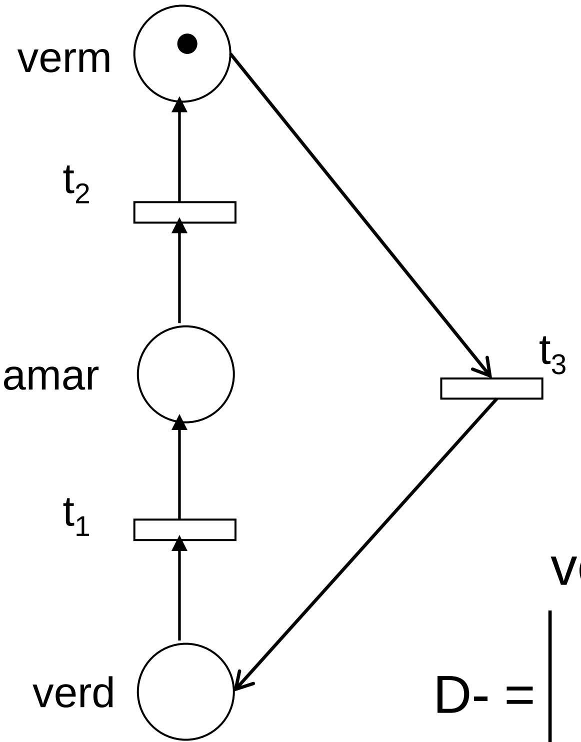
$$M_0 = \begin{array}{ccc} verm & amar & verd \\ \hline \end{array}$$

$$\begin{array}{c|ccc|} & verm & amar & verd \\ M_0 = & 1 & 0 & 0 \end{array}$$

Representação matricial

$$D- = \begin{array}{|ccc|c} verm & amar & verd & \\ 0 & 0 & 1 & t_1 \\ 0 & 1 & 0 & t_2 \\ 1 & 0 & 0 & t_3 \end{array}$$

$$D+ = \begin{array}{|ccc|c} verm & amar & verd & \\ 0 & 1 & 0 & t_1 \\ 1 & 0 & 0 & t_2 \\ 0 & 0 & 1 & t_3 \end{array}$$



Marcação Inicial

$$\begin{array}{cccc} & \text{verm} & \text{amar} & \text{verd} \\ M_0 = & | \; 1 & 0 & 0 \; | \end{array}$$

Representação matricial

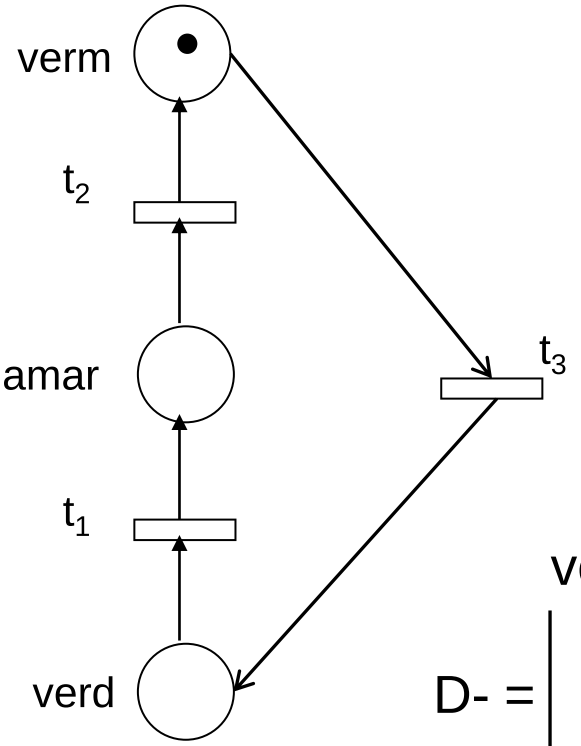
$$D- = \begin{array}{c} \\ \left|\begin{array}{ccc} \text{verm} & \text{amar} & \text{verd} \\ \hline 0 & 0 & 1 \\ 0 & 1 & 0 \\ 1 & 0 & 0 \end{array}\right| \end{array} \begin{array}{c} \\ t_1 \\ t_2 \\ t_3 \end{array}$$

$$D+ = \begin{array}{c} \\ \left|\begin{array}{ccc} \text{verm} & \text{amar} & \text{verd} \\ \hline 0 & 1 & 0 \\ 1 & 0 & 0 \\ 0 & 0 & 1 \end{array}\right| \end{array} \begin{array}{c} \\ t_1 \\ t_2 \\ t_3 \end{array}$$

Matriz de trabalho

$$\begin{array}{ccc} \text{verm} & \text{amar} & \text{verd} \end{array}$$

$$D = \left| \begin{array}{ccc} \; & \; & \; \\ \; & \; & \; \\ \; & \; & \; \end{array} \right| \begin{array}{c} t_1 \\ t_2 \\ t_3 \end{array}$$



Marcação Inicial

$$\begin{array}{cccc} & \text{verm} & \text{amar} & \text{verd} \\ M_0 = & | \; 1 & 0 & 0 \; | \end{array}$$

Representação matricial

$$D- = \begin{array}{c|ccc|c} & \text{verm} & \text{amar} & \text{verd} & \\ & 0 & 0 & 1 & t_1 \\ & 0 & 1 & 0 & t_2 \\ & 1 & 0 & 0 & t_3 \end{array}$$

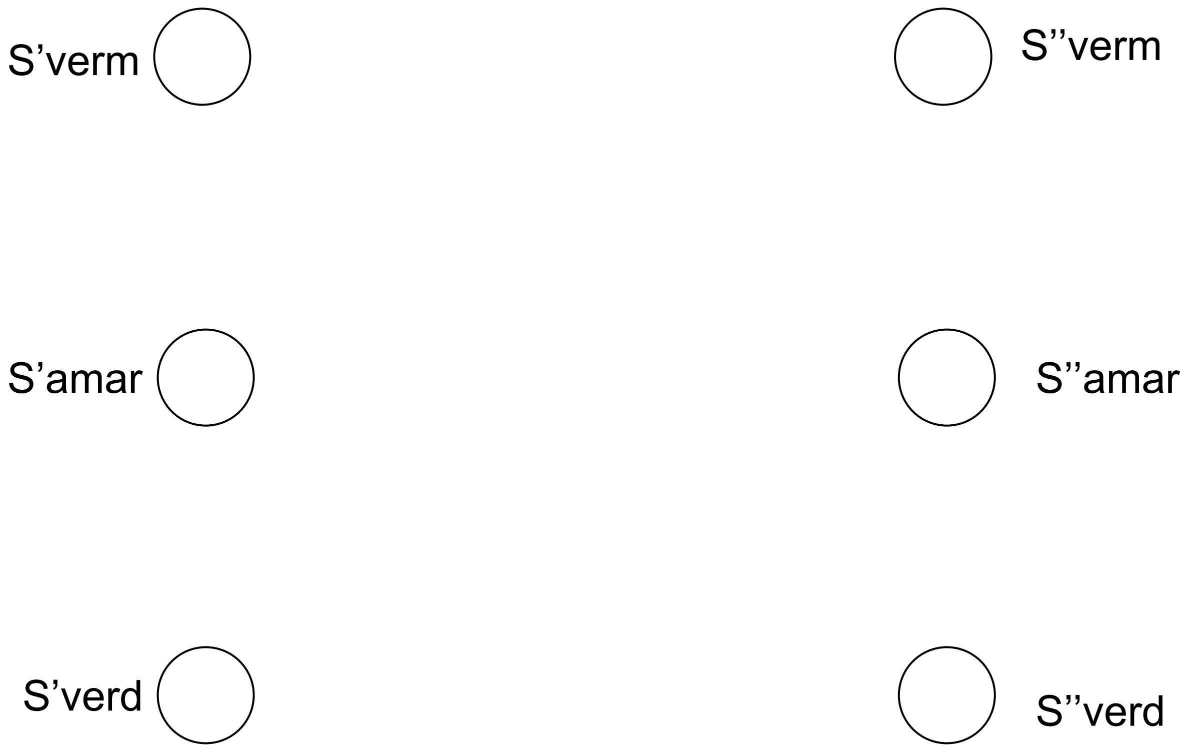
$$D+ = \begin{array}{c|ccc|c} & \text{verm} & \text{amar} & \text{verd} & \\ & 0 & 1 & 0 & t_1 \\ & 1 & 0 & 0 & t_2 \\ & 0 & 0 & 1 & t_3 \end{array}$$

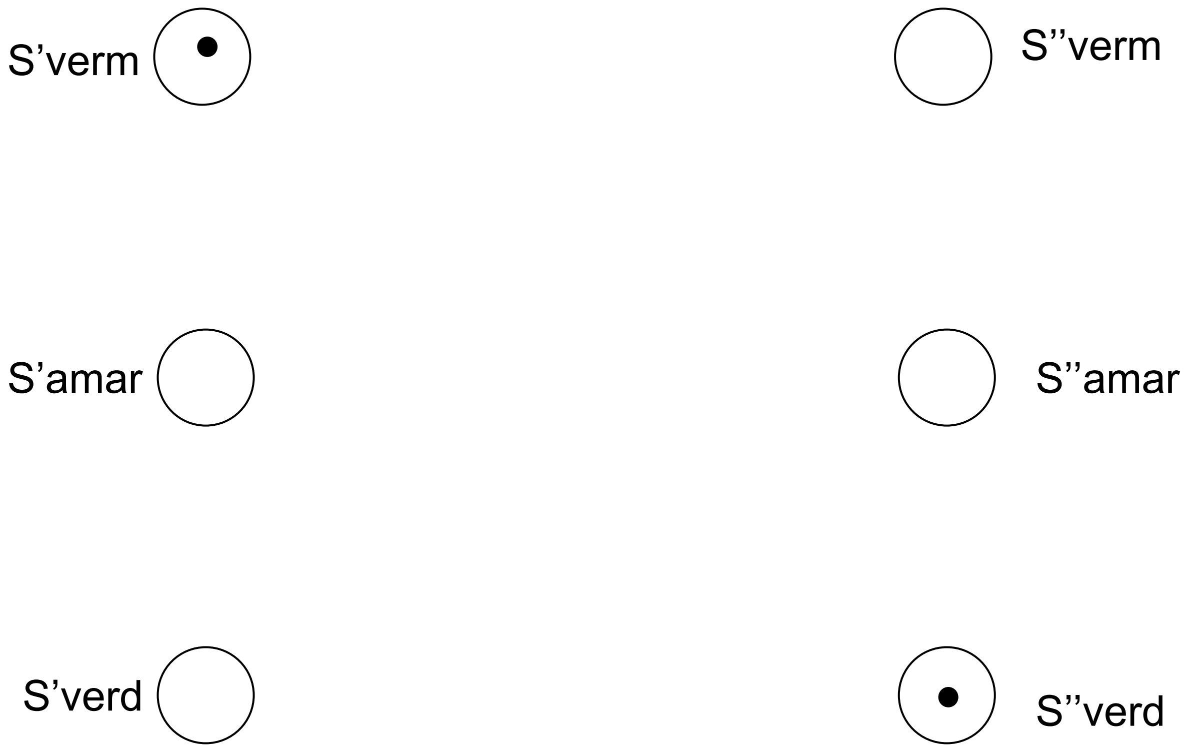
Matriz de trabalho

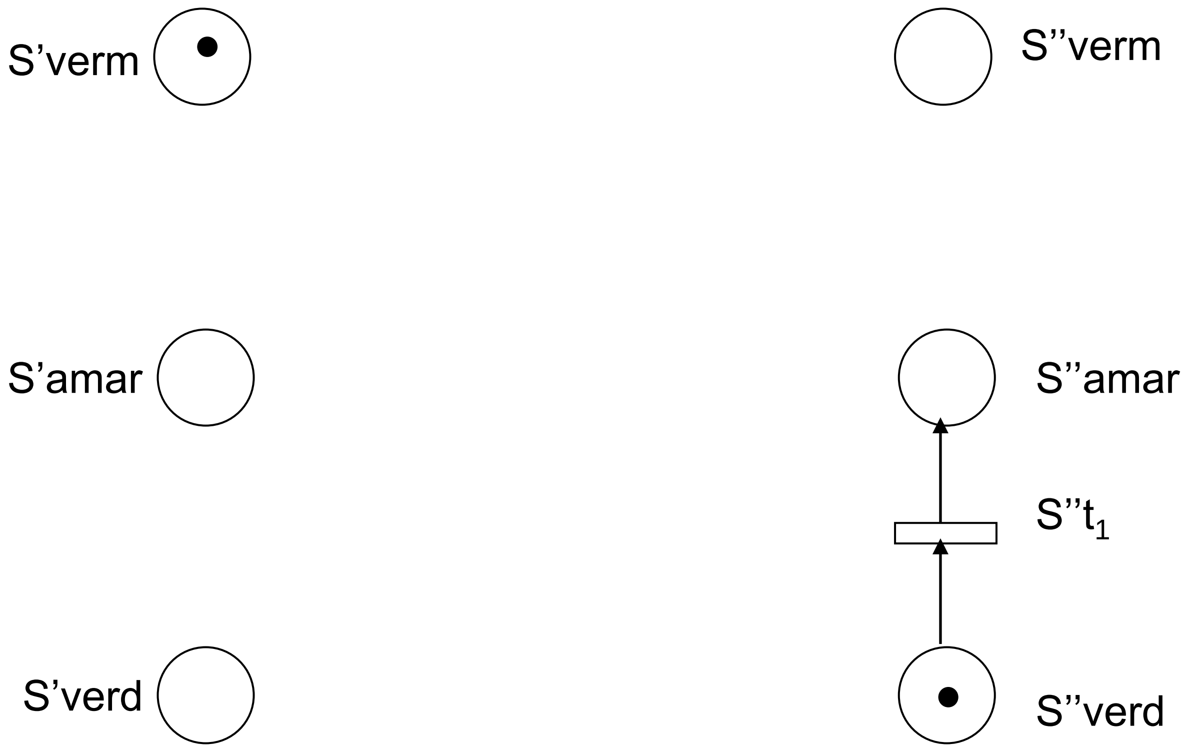
$$D = \begin{array}{c|ccc|c} & \text{verm} & \text{amar} & \text{verd} & \\ & 0 & 1 & -1 & t_1 \\ & 1 & -1 & 0 & t_2 \\ & -1 & 0 & 1 & t_3 \end{array}$$

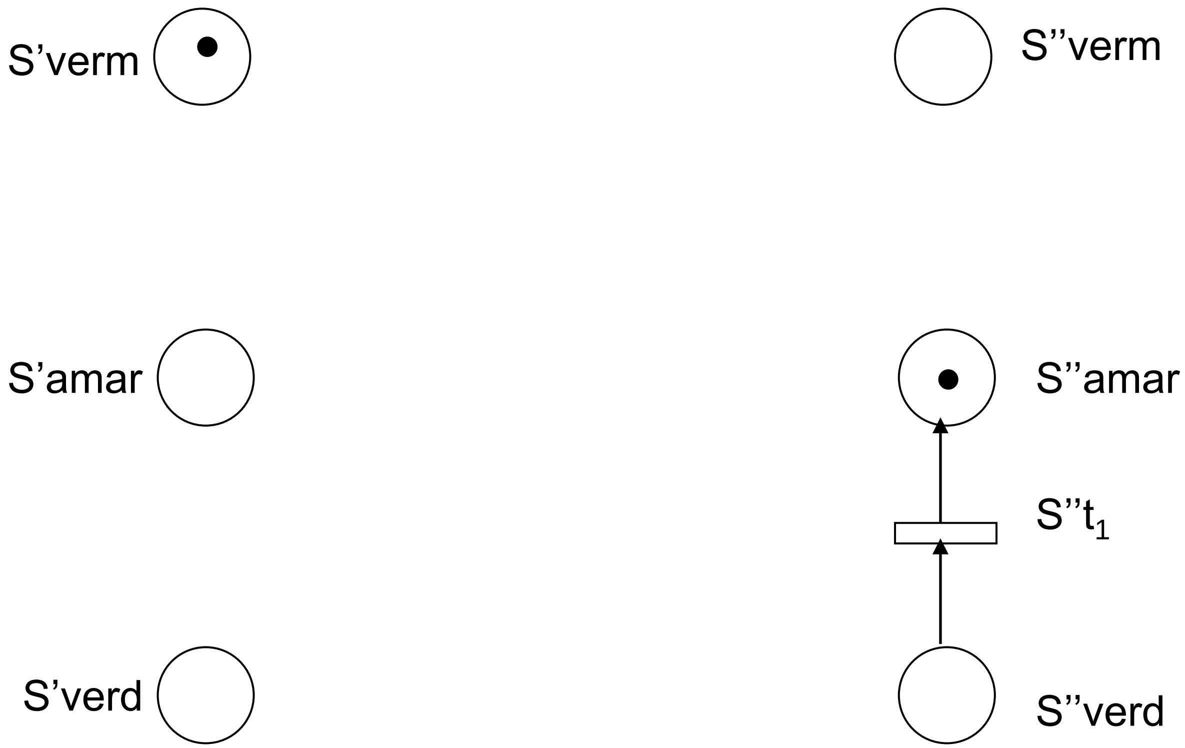
Desafio

- Construir uma Rede de Petri para um semáforo localizado em um cruzamento


S’verm
S’’verm
S’amar
S’’amar
S’verd
S’’verd


S’verm
S’’verm
S’amar
S’’amar
S’verd
S’’verd


S'verm
S''verm
S'amar
S''amar
S''t1
S'verd
S''verd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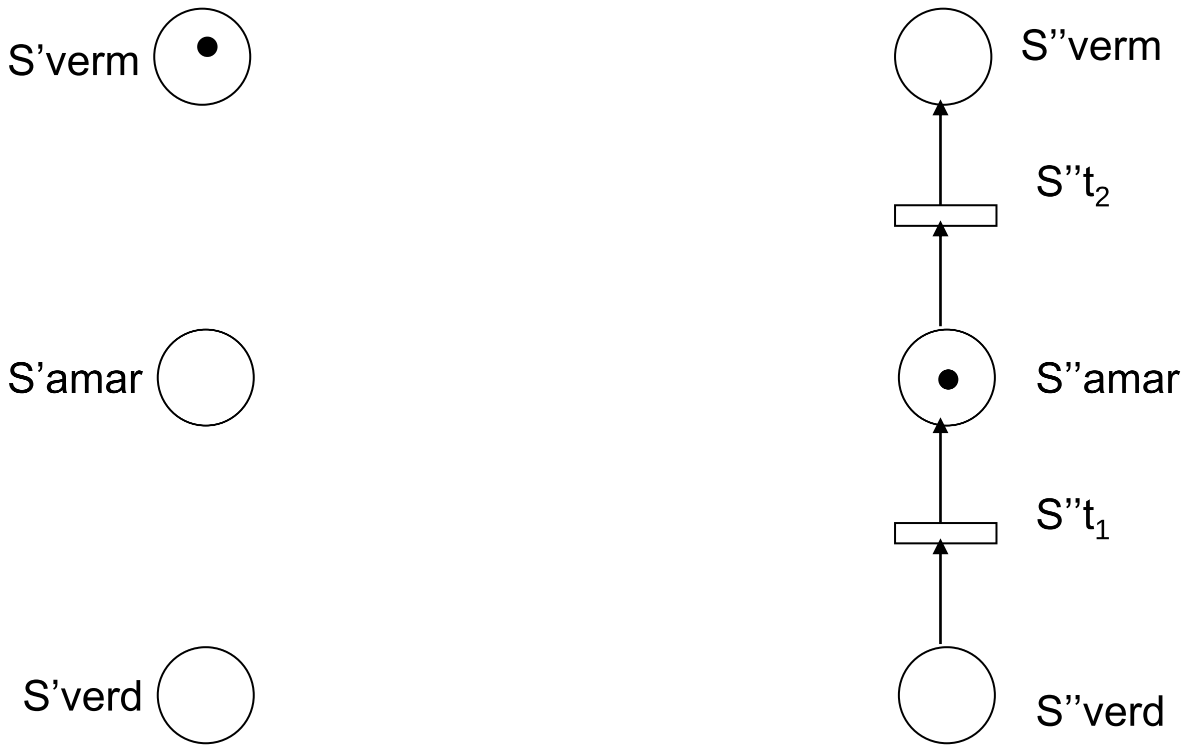
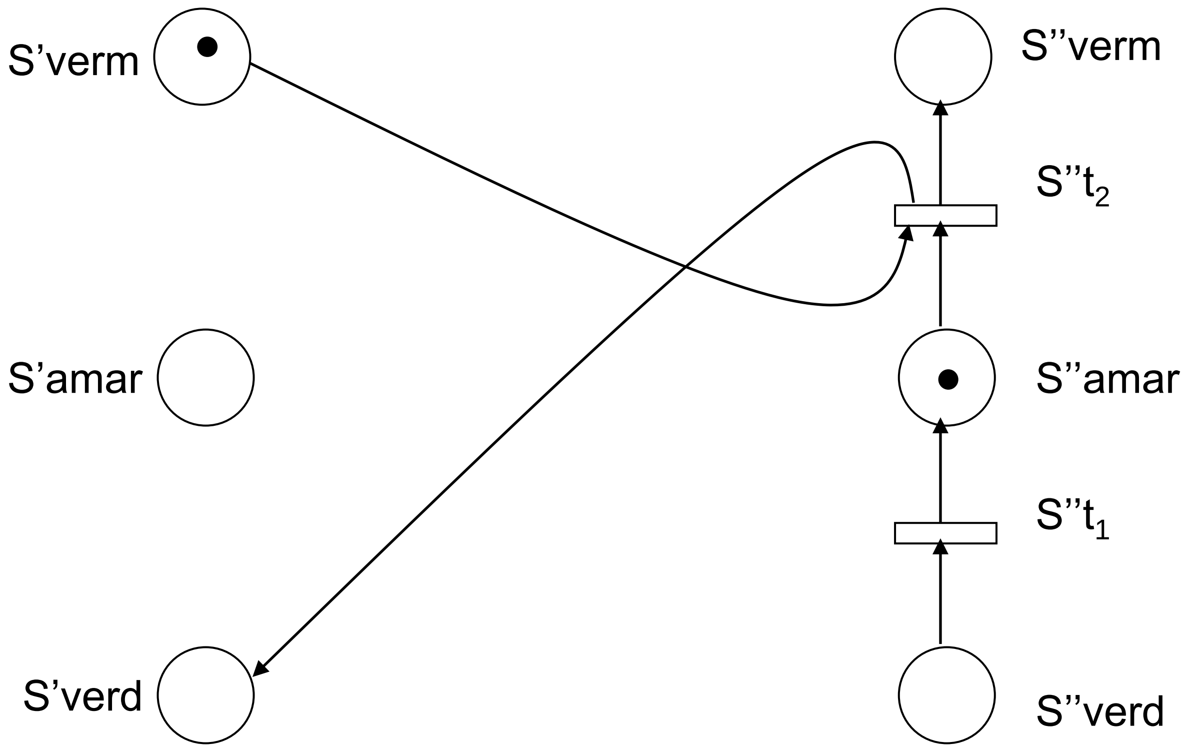
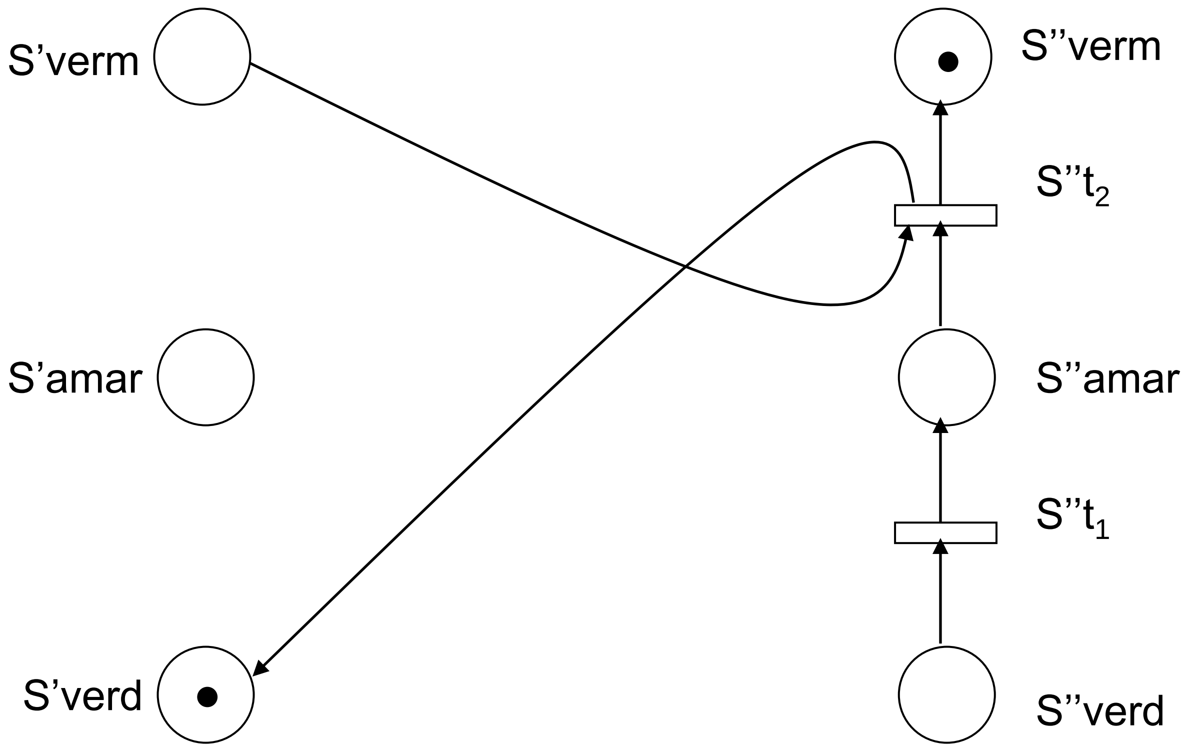
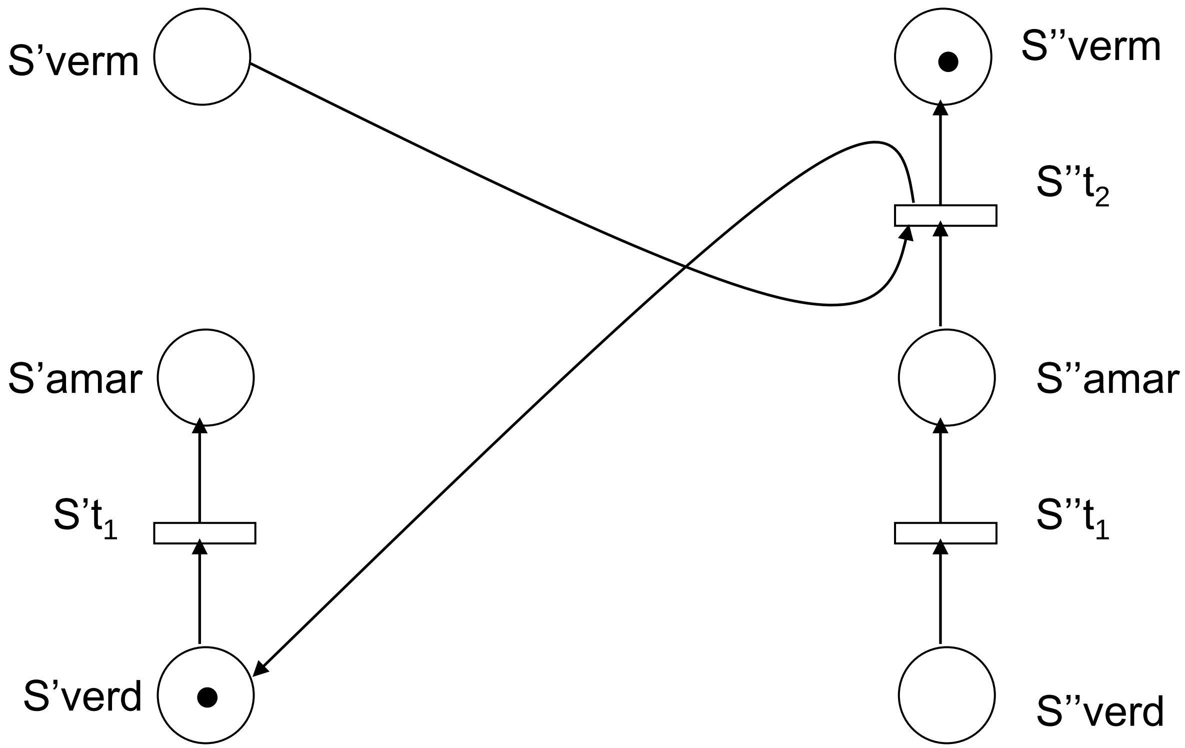
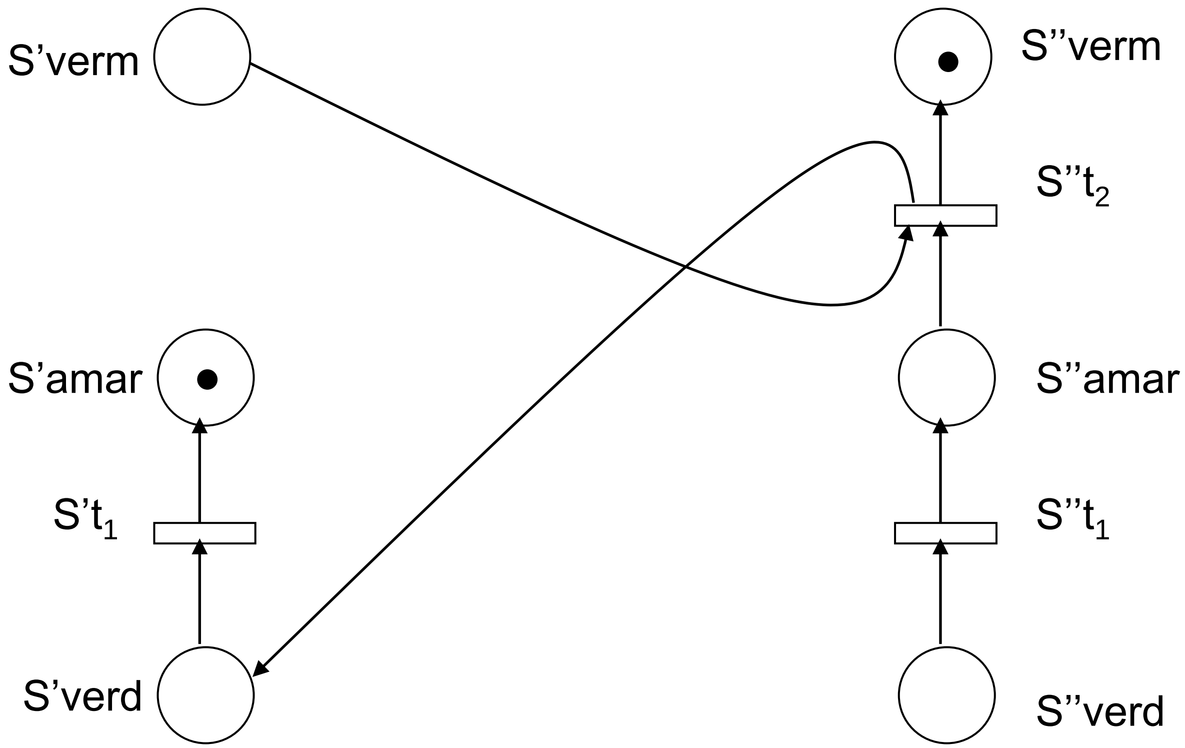
S''verm
S'amar
S''amar
S''t_1
S'verd
S''verd

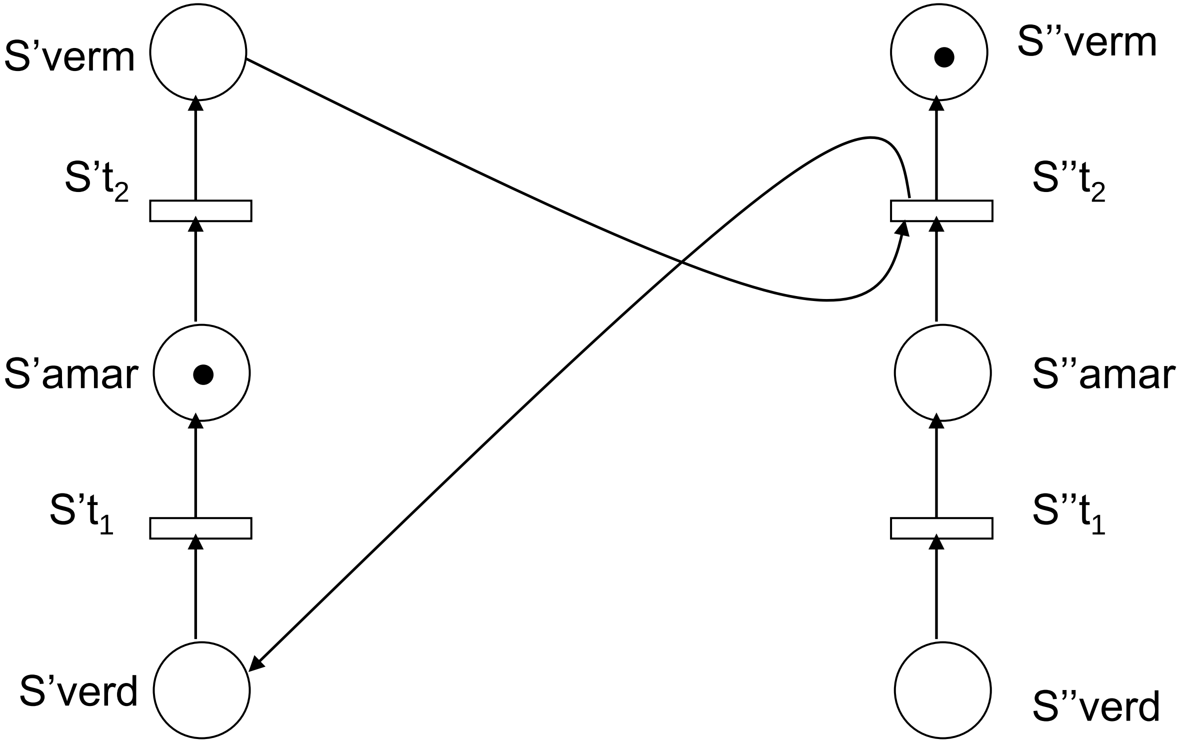

S'verm
S'amar
S'verd
S''verm
S''t2
S''amar
S''t1
S''verd


S’verm
S’’verm
S’’t2
S’amar
S’’amar
S’’t1
S’verd
S’’verd

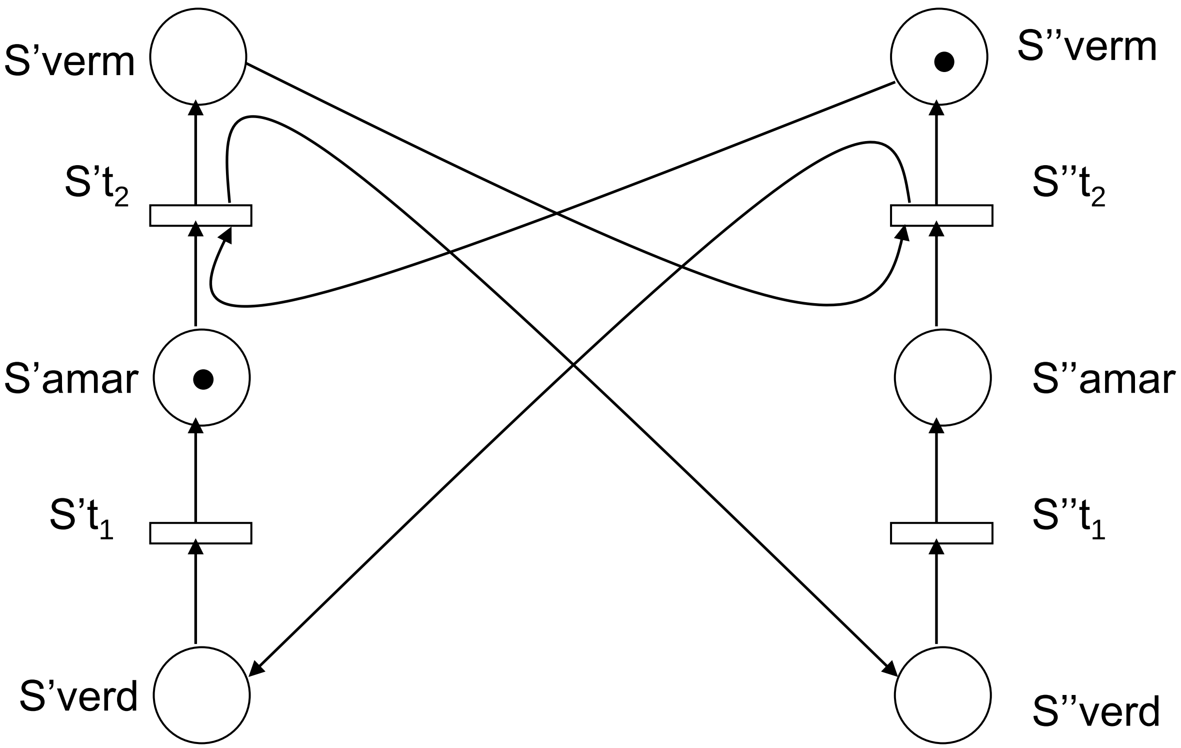

S'verm
S''verm
S''t_2
S'amar
S''amar
S''t_1
S'verd
S''verd

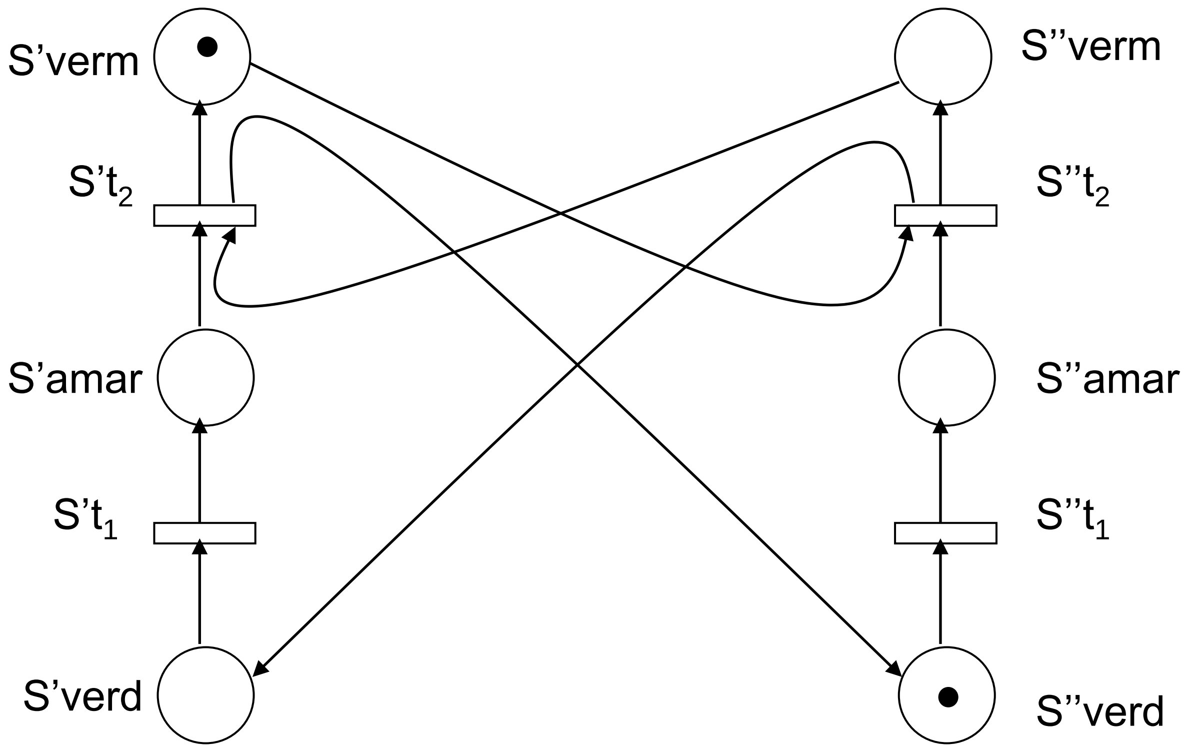

S’verm
S’’verm
S’’t2
S’amar
S’’amar
S’t1
S’’t1
S’verd
S’’verd


S'verm
S''verm
S''t2
S'amar
S''amar
S't1
S''t1
S'verd
S''verd



S'verm
S''verm
S't2
S''t2
S'amar
S''amar
S't1
S''t1
S'verd
S''verd


S'verm
S''verm
S't2
S''t2
S'amar
S''amar
S't1
S''t1
S'verd
S''verd


S'verm
S''verm
S't2
S''t2
S'amar
S''amar
S't1
S''t1
S'verd
S''verd

Análise do Modelo

1) Verificar se uma transição específica pode ser disparada, uma ou mais vezes, a partir de uma marcação qualquer

Marcação ≥ $e[t_i]$.D-

$e[t_i]$ é o número de vezes que quero executar a transição

Identificar na matriz D- a quantidade de tokens necessários para disparar a transição

Sendo todos os elementos da marcação desejada maiores ou iguais aos elementos correspondentes em $e[t_i]$.D-, a transição pode disparar o número de vezes desejado

EXEMPLO

$$M_0 = \begin{array}{ccc} \text{verm} & \text{amar} & \text{verd} \\ \hline \end{array}$$

$$\begin{array}{c} \\ M_0 = \end{array} \begin{array}{ccc} \text{verm} & \text{amar} & \text{verd} \\ \left| 1 \right. & 0 & \left. 0 \right| \end{array}$$

$$\begin{array}{c} \\ e[t_2] = \end{array} \begin{array}{ccc} t_1 & t_2 & t_3 \\ \left| 0 \right. & 1 & \left. 0 \right| \end{array}$$

$$D- = \begin{array}{ccc} \text{verm} & \text{amar} & \text{verd} \end{array}$$

$$D- = \left| \begin{array}{ccc} 0 & 0 & 1 \\ 0 & 1 & 0 \\ 1 & 0 & 0 \end{array} \right| \begin{array}{c} t_1 \\ t_2 \\ t_3 \end{array}$$

$$\mathbf{M_0 \geq e[t_2]. \quad D-}$$

EXEMPLO

$$M_0 = \begin{array}{ccc} \text{verm} & \text{amar} & \text{verd} \\ \left| \begin{matrix} 1 & 0 & 0 \end{matrix} \right. & & \left. \right| \end{array}$$

$$e[t_2] = \begin{array}{ccc} t_1 & t_2 & t_3 \\ \left| \begin{matrix} 0 & 1 & 0 \end{matrix} \right| \end{array}$$

$$D- = \begin{array}{cccc} \text{verm} & \text{amar} & \text{verd} & \\ \left| \begin{matrix} 0 & 0 & 1 \\ 0 & 1 & 0 \\ 1 & 0 & 0 \end{matrix} \right| & & & \begin{matrix} t_1 \\ t_2 \\ t_3 \end{matrix} \end{array}$$

$$\mathbf{M_0 \geq e[t_2]. \quad D-}$$

$$1 \quad 0 \quad 0 \quad \geq \quad 1. \quad 0 \quad 1 \quad 0$$

EXEMPLO

$$M_0 = \begin{array}{c} \begin{array}{ccc} \text{verm} & \text{amar} & \text{verd} \end{array} \\ \left| \begin{array}{ccc} 1 & 0 & 0 \end{array} \right| \end{array}$$

$$e[t_2] = \begin{array}{c} \begin{array}{ccc} t_1 & t_2 & t_3 \end{array} \\ \left| \begin{array}{ccc} 0 & 1 & 0 \end{array} \right| \end{array}$$

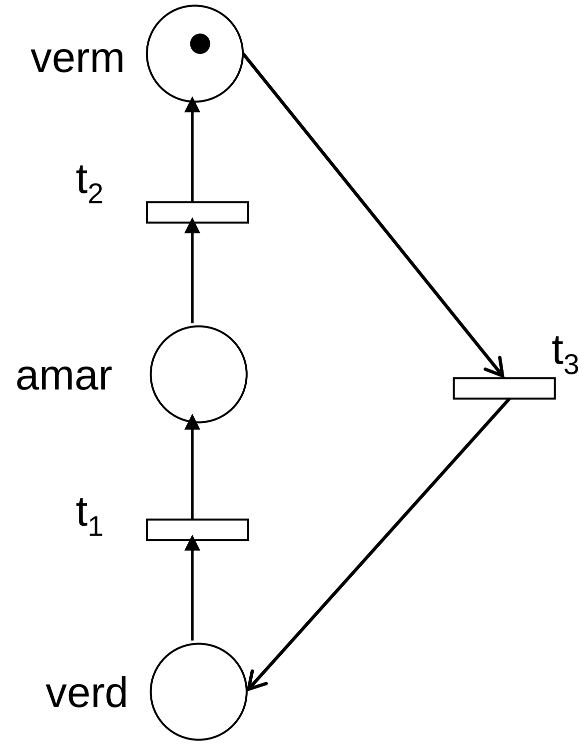
$$D- = \begin{array}{cc} \begin{array}{ccc} \text{verm} & \text{amar} & \text{verd} \end{array} & \\ \left| \begin{array}{ccc} 0 & 0 & 1 \\ 0 & 1 & 0 \\ 1 & 0 & 0 \end{array} \right| & \begin{array}{c} t_1 \\ t_2 \\ t_3 \end{array} \end{array}$$

$$\mathbf{M_0 \geq e[t_2]. \quad D-}$$

$$1 \quad 0 \quad 0 \quad \geq \quad 1. \quad 0 \quad 1 \quad 0$$

$$1 \quad 0 \quad 0 \quad \geq \quad 0 \quad 1 \quad 0$$

EXEMPLO



$$\begin{array}{cccc} & verm & amar & verd \\ M_0 = & \vert\; 1 & 0 & 0 \;\vert \end{array}$$

$$\begin{array}{cccc} & t_1 & t_2 & t_3 \\ e[t_2] = & \vert\; 0 & 1 & 0 \;\vert \end{array}$$

$$\begin{array}{cc} & \begin{array}{ccc} verm & amar & verd \end{array} \\ D- = & \left|\begin{array}{ccc} 0 & 0 & 1 \\ 0 & 1 & 0 \\ 1 & 0 & 0 \end{array}\right| \begin{array}{c} t_1 \\ t_2 \\ t_3 \end{array} \end{array}$$

$$\mathbf{M_0 \geq e[t_2].\; D-}$$

$1 \quad 0 \quad 0 \quad \geq \quad 1. \quad 0 \quad 1 \quad 0$

$1 \quad 0 \quad 0 \quad \geq \quad 0 \quad 1 \quad 0$ **FALSO, portanto não pode disparar**

Análise do Modelo

2) Verificar se uma sequência de transições pode ser executada concorrentemente

Marcação ≥ (e[t_i].D-) + (e[t_j].D-)

Calcula e[ti].D- para cada elemento considerado na sequência de transições a serem disparadas e soma os valores dos vetores obtidos

Compara o vetor resultante da soma, de forma que todos os elementos do vetor marcação devem ser maiores ou iguais aos elementos correspondentes ao vetor soma, para que a sequência de transição possa disparar de forma simultânea

EXEMPLO

$$
\begin{array}{cccc}
 & \text{verm} & \text{amar} & \text{verd} \\
M_0 = & \Big| \; 1 & 0 & 0 \; \Big|
\end{array}
$$

$$
\begin{array}{cccc}
 & t_1 & t_2 & t_3 \\
e[t_1] = & \Big| \; 1 & 0 & 0 \; \Big|
\end{array}
\qquad\qquad
\begin{array}{cccc}
 & t_1 & t_2 & t_3 \\
e[t_3] = & \Big| \; 0 & 0 & 1 \; \Big|
\end{array}
$$

$$
\begin{array}{cc}
 & \begin{array}{ccc} \text{verm} & \text{amar} & \text{verd} \end{array} \\
D^- = & \left| \begin{array}{ccc} 0 & 0 & 1 \\ 0 & 1 & 0 \\ 1 & 0 & 0 \end{array} \right| \begin{array}{c} t_1 \\ t_2 \\ t_3 \end{array}
\end{array}
$$

$$\mathbf{M_0 \quad \geq (e[t_1] \,.\quad D^- \quad) + (e[t_3] \,.\, D^- \quad)}$$

EXEMPLO

$$M_0 = \begin{array}{c} \begin{array}{ccc} \text{verm} & \text{amar} & \text{verd} \end{array} \\ \left| \begin{array}{ccc} 1 & 0 & 0 \end{array} \right| \end{array}$$

$$e[t_1] = \begin{array}{c} \begin{array}{ccc} t_1 & t_2 & t_3 \end{array} \\ \left| \begin{array}{ccc} 1 & 0 & 0 \end{array} \right| \end{array} \qquad e[t_3] = \begin{array}{c} \begin{array}{ccc} t_1 & t_2 & t_3 \end{array} \\ \left| \begin{array}{ccc} 0 & 0 & 1 \end{array} \right| \end{array}$$

$$D- = \begin{array}{cc} \begin{array}{ccc} \text{verm} & \text{amar} & \text{verd} \end{array} & \\ \left| \begin{array}{ccc} 0 & 0 & 1 \\ 0 & 1 & 0 \\ 1 & 0 & 0 \end{array} \right| & \begin{array}{c} t_1 \\ t_2 \\ t_3 \end{array} \end{array}$$

$$\mathbf{M_0 \geq (e[t_1] \,.\, D-) + (e[t_3] \,.\, D-)}$$

$$1 \quad 0 \quad 0 \quad \geq (1 \,.\, \quad 0 \quad 0 \quad 1 \,) + (1 \,.\, \quad 1 \quad 0 \quad 0 \,)$$

EXEMPLO

$$M_0 = \begin{array}{c} \\ \end{array}\begin{array}{ccc} verm & amar & verd \\ \left|\; 1 \right. & 0 & \left. 0 \;\right| \end{array}$$

$$e[t_1] = \begin{array}{ccc} t_1 & t_2 & t_3 \\ \left| 1 \right. & 0 & \left. 0 \right| \end{array} \qquad e[t_3] = \begin{array}{ccc} t_1 & t_2 & t_3 \\ \left| 0 \right. & 0 & \left. 1 \right| \end{array}$$

$$D- = \begin{array}{cccc} verm & amar & verd & \\ \end{array}$$

$$D- = \left| \begin{array}{ccc} 0 & 0 & 1 \\ 0 & 1 & 0 \\ 1 & 0 & 0 \end{array} \right| \begin{array}{c} t_1 \\ t_2 \\ t_3 \end{array}$$

$$\mathbf{M_0 \geq (e[t_1] \,.\, D-) + (e[t_3] \,.\, D-)}$$

$$1 \quad 0 \quad 0 \quad \geq (\, 1 \,.\, 0 \quad 0 \quad 1\,) + (1 \,.\, 1 \quad 0 \quad 0\,)$$

$$1 \quad 0 \quad 0 \quad \geq \; (\, 0 \quad 0 \quad 1) + (1 \quad 0 \quad 0)$$

EXEMPLO

$$M_0 = \begin{array}{c} \begin{matrix} \text{verm} & \text{amar} & \text{verd} \end{matrix} \\ \left| \begin{matrix} 1 & 0 & 0 \end{matrix} \right| \end{array}$$

$$e[t_1] = \begin{array}{c} \begin{matrix} t_1 & t_2 & t_3 \end{matrix} \\ \left| \begin{matrix} 1 & 0 & 0 \end{matrix} \right| \end{array} \qquad e[t_3] = \begin{array}{c} \begin{matrix} t_1 & t_2 & t_3 \end{matrix} \\ \left| \begin{matrix} 0 & 0 & 1 \end{matrix} \right| \end{array}$$

$$D- = \begin{array}{cc} \begin{matrix} \text{verm} & \text{amar} & \text{verd} \end{matrix} & \\ \left| \begin{matrix} 0 & 0 & 1 \\ 0 & 1 & 0 \\ 1 & 0 & 0 \end{matrix} \right| & \begin{matrix} t_1 \\ t_2 \\ t_3 \end{matrix} \end{array}$$

$$\mathbf{M_0 \geq (e[t_1] \,.\, D-) + (e[t_3] \,.\, D-)}$$

$$1 \quad 0 \quad 0 \geq (1 \,.\, 0 \quad 0 \quad 1) + (1 \,.\, 1 \quad 0 \quad 0)$$

$$1 \quad 0 \quad 0 \geq (0 \quad 0 \quad 1) + (1 \quad 0 \quad 0)$$

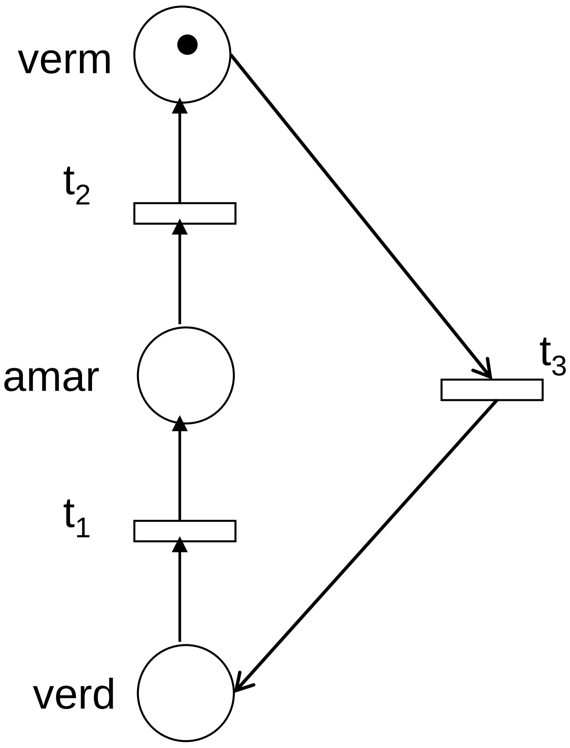
$$1 \quad 0 \quad 0 \geq (1 \quad 0 \quad 1)$$

EXEMPLO

$$\begin{array}{cccc} & \text{verm} & \text{amar} & \text{verd} \\ M_0 = & \multicolumn{3}{c}{\left| \begin{array}{ccc} 1 & 0 & 0 \end{array} \right|} \end{array}$$

$$\begin{array}{cccc} & t_1 & t_2 & t_3 \\ e[t_1] = & \multicolumn{3}{c}{\left| \begin{array}{ccc} 1 & 0 & 0 \end{array} \right|} \end{array} \qquad \begin{array}{cccc} & t_1 & t_2 & t_3 \\ e[t_3] = & \multicolumn{3}{c}{\left| \begin{array}{ccc} 0 & 0 & 1 \end{array} \right|} \end{array}$$

$$\begin{array}{cc} & \begin{array}{ccc} \text{verm} & \text{amar} & \text{verd} \end{array} \\ D- = & \left| \begin{array}{ccc} 0 & 0 & 1 \\ 0 & 1 & 0 \\ 1 & 0 & 0 \end{array} \right| \begin{array}{c} t_1 \\ t_2 \\ t_3 \end{array} \end{array}$$



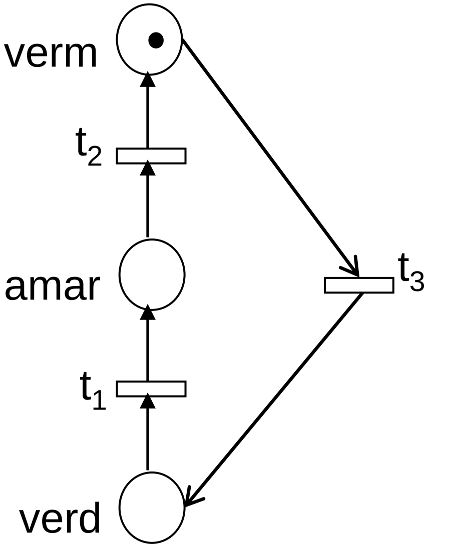
M_0 $\geq$ (e[t_1] . D-) + (e[t_3] . D-)

1 0 0 $\geq$ (1 . 0 0 1) + (1 . 1 0 0)

1 0 0 $\geq$ (0 0 1) + (1 0 0)

1 0 0 $\geq$ (1 0 1) **FALSO, portanto não pode disparar simultaneamente**

Análise do Modelo



3) Identificar um novo estado para o sistema

M’’ = M’ + e[t_i].D

EXEMPLO

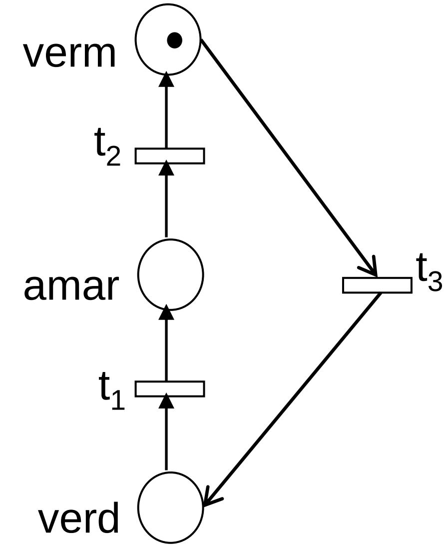
Dado que t_3 está habilitada em M_0

$$M_0 = \begin{array}{ccc} verm & amar & verd \\ \hline 1 & 0 & 0 \end{array}$$

$$e[t_3] = \begin{array}{ccc} t_1 & t_2 & t_3 \\ \hline 0 & 0 & 1 \end{array}$$

$$D = \begin{array}{ccc|c} verm & amar & verd & \\ 0 & 1 & -1 & t_1 \\ 1 & -1 & 0 & t_2 \\ -1 & 0 & 1 & t_3 \end{array}$$

Análise do Modelo



3) Identificar um novo estado para o sistema

$M'' = M' + e[t_i].D$

EXEMPLO

Dado que t_3 está habilitada em M_0

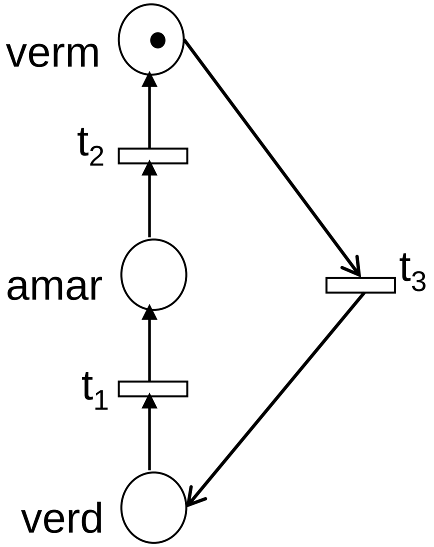
$M_1 = M_0 + e[t_3] . D$

$$\begin{array}{cccc} & verm & amar & verd \\ M_0 = & \multicolumn{3}{c}{\left| \begin{array}{ccc} 1 & 0 & 0 \end{array} \right|} \end{array}$$

$$\begin{array}{cc} & \begin{array}{ccc} t_1 & t_2 & t_3 \end{array} \\ e[t_3] = & \left| \begin{array}{ccc} 0 & 0 & 1 \end{array} \right| \end{array}$$

$$\begin{array}{ccc} & \begin{array}{ccc} verm & amar & verd \end{array} & \\ D = & \left| \begin{array}{ccc} 0 & 1 & -1 \\ 1 & -1 & 0 \\ -1 & 0 & 1 \end{array} \right| & \begin{array}{c} t_1 \\ t_2 \\ t_3 \end{array} \end{array}$$

Análise do Modelo



3) Identificar um novo estado para o sistema

$$\mathbf{M'' = M' + e[t_i].D}$$

EXEMPLO

Dado que t_3 está habilitada em M_0

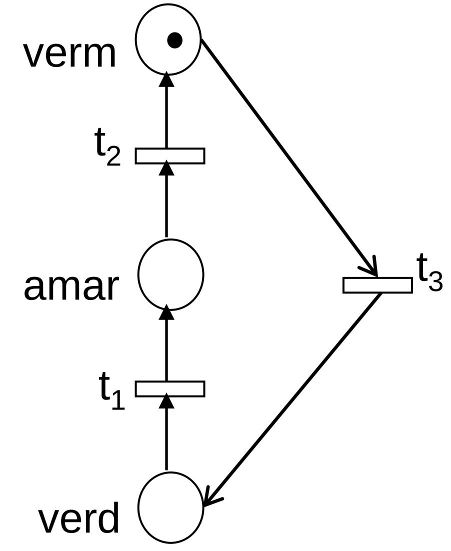
$$\begin{array}{cccc} & \text{verm} & \text{amar} & \text{verd} \\ M_0 = & \left| \begin{array}{c} 1 \end{array} \right. & 0 & \left. \begin{array}{c} 0 \end{array} \right| \end{array}$$

$$\begin{array}{cccc} & t_1 & t_2 & t_3 \\ e[t_3] = & \left| \begin{array}{c} 0 \end{array} \right. & 0 & \left. \begin{array}{c} 1 \end{array} \right| \end{array}$$

$$\begin{array}{cc} & \begin{array}{ccc} \text{verm} & \text{amar} & \text{verd} \end{array} \\ D = & \left| \begin{array}{ccc} 0 & 1 & -1 \\ 1 & -1 & 0 \\ -1 & 0 & 1 \end{array} \right| \begin{array}{c} t_1 \\ t_2 \\ t_3 \end{array} \end{array}$$

$$\mathbf{M_1 = \quad M_0 \quad + e[t_3] \, . \quad D}$$

$$M_1 = 1 \;\; 0 \;\; 0 \; + \; 1 \; . \; -1 \;\; 0 \;\; 1$$



Análise do Modelo

3) Identificar um novo estado para o sistema

$M'' = M' + e[t_i].D$

EXEMPLO

Dado que t_3 está habilitada em M_0

$$M_0 = \begin{array}{c} \begin{array}{ccc} verm & amar & verd \end{array} \\ \left| \begin{array}{ccc} 1 & 0 & 0 \end{array} \right| \end{array}$$

$$e[t_3] = \begin{array}{c} \begin{array}{ccc} t_1 & t_2 & t_3 \end{array} \\ \left| \begin{array}{ccc} 0 & 0 & 1 \end{array} \right| \end{array}$$

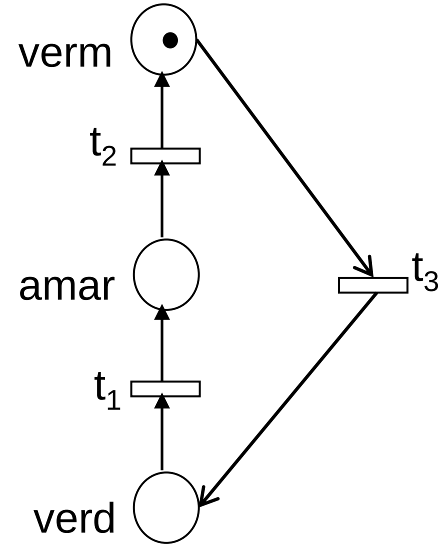
$$D = \begin{array}{cc} \begin{array}{ccc} verm & amar & verd \end{array} & \\ \left| \begin{array}{ccc} 0 & 1 & -1 \\ 1 & -1 & 0 \\ -1 & 0 & 1 \end{array} \right| & \begin{array}{c} t_1 \\ t_2 \\ t_3 \end{array} \end{array}$$

$$\mathbf{M_1 = \quad M_0 \quad + e[t_3] . \quad D}$$

$$M_1 = 1\ \ 0\ \ 0\ \ + \ \ 1\ . \ \ -1\ \ 0\ \ 1$$

$$M_1 = 1\ \ 0\ \ 0\ \ + \ \ -1\ \ 0\ \ 1$$

Análise do Modelo



3) Identificar um novo estado para o sistema

$M'' = M' + e[t_i].D$

EXEMPLO

Dado que t_3 está habilitada em M_0

$$\begin{array}{cccc} & verm & amar & verd \\ M_0 = & |\ 1 & 0 & 0\ | \end{array}$$

$$\begin{array}{cccc} & t_1 & t_2 & t_3 \\ e[t_3] = & |\ 0 & 0 & 1\ | \end{array}$$

$$\begin{array}{ccccc} & verm & amar & verd & \\ D = & \left|\begin{array}{c} 0 \\ 1 \\ -1 \end{array}\right. & \begin{array}{c} 1 \\ -1 \\ 0 \end{array} & \left.\begin{array}{c} -1 \\ 0 \\ 1 \end{array}\right| & \begin{array}{c} t_1 \\ t_2 \\ t_3 \end{array} \end{array}$$

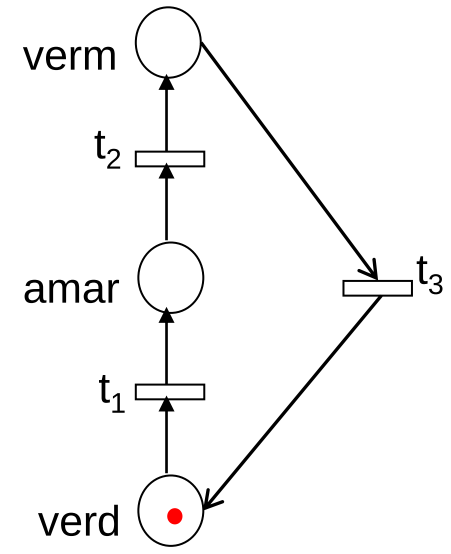
$M_1 = \quad M_0 \quad + e[t_3] . \quad D$

$M_1 = 1\ \ 0\ \ 0\ \ + \ \ 1\ . \ \ -1\ \ 0\ \ 1$

$M_1 = 1\ \ 0\ \ 0\ \ + \ \ -1\ \ 0\ \ 1$

$M_1 = 0\ \ 0\ \ 1$

Análise do Modelo



3) Identificar um novo estado para o sistema

$M'' = M' + e[t_i].D$

EXEMPLO

Dado que t_3 está habilitada em M_0

$$
\begin{array}{cccc}
 & \text{verm} & \text{amar} & \text{verd} \\
M_0 = & | \; 1 & 0 & 0 \; |
\end{array}
$$

$$
\begin{array}{cccc}
 & t_1 & t_2 & t_3 \\
e[t_3] = & | \; 0 & 0 & 1 \; |
\end{array}
$$

$$
D = \begin{array}{c}
\begin{array}{ccc} \text{verm} & \text{amar} & \text{verd} \end{array} \\
\left|\begin{array}{ccc} 0 & 1 & -1 \\ 1 & -1 & 0 \\ -1 & 0 & 1 \end{array}\right|
\end{array}
\begin{array}{c} \\ t_1 \\ t_2 \\ t_3 \end{array}
$$

$M_1 = \quad M_0 \quad + e[t_3] . \quad D$

$M_1 = 1 \; 0 \; 0 \; + \; 1 \; . \; -1 \; 0 \; 1$

$M_1 = 1 \; 0 \; 0 \; + \; -1 \; 0 \; 1$

$M_1 = 0 \; 0 \; 1$

$$
\begin{array}{cccc}
 & \textbf{verm} & \textbf{amar} & \textbf{verd} \\
\mathbf{M_1 =} & \mathbf{| \; 0} & \mathbf{0} & \mathbf{1 \; |}
\end{array}
$$

Considerações finais

- Aplicação de Álgebra Linear na Computação:

1) Uso na modelagem e verificação de sistemas, principalmente aqueles que envolvem problemas de concorrência por recursos

2) Uso em fluxo de redes para aplicação de técnicas de otimização vindas da Álgebra Linear

Referência

Cap.5 e 6 – Fundamentos Matemáticos para a Ciência da Computação (seção 5.1 e 6.3); Gersting, J.L.