

# Mise en application Réseaux de Petri

Formation Systèmes à Événements Discrets

1ère édition  
Janvier 2024

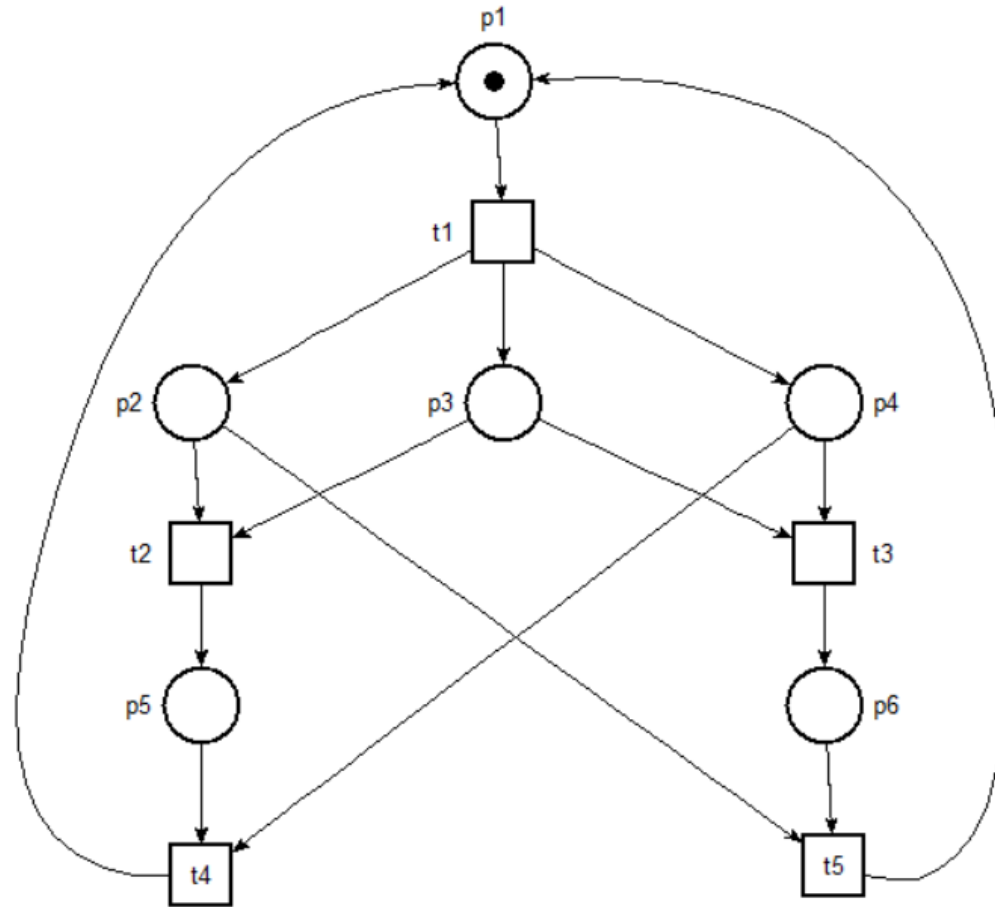


# Plan

- Exercice 1
- Exercice 2 - Réseau ferroviaire

# Exercice 1

# Exercice 1 – Q1



# Exercice 1 – Q1 : Graphe de marquages

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**digest** | places 6 | transitions 5 | **net** | bounded Y | live Y | reversible Y

help

| abstraction | count | props | psets | dead | live |
|-------------|-------|-------|-------|------|------|
| states      | 4     | 6     | 4     | 0    | 4    |
| transitions | 5     | 5     | 5     | 0    | 5    |

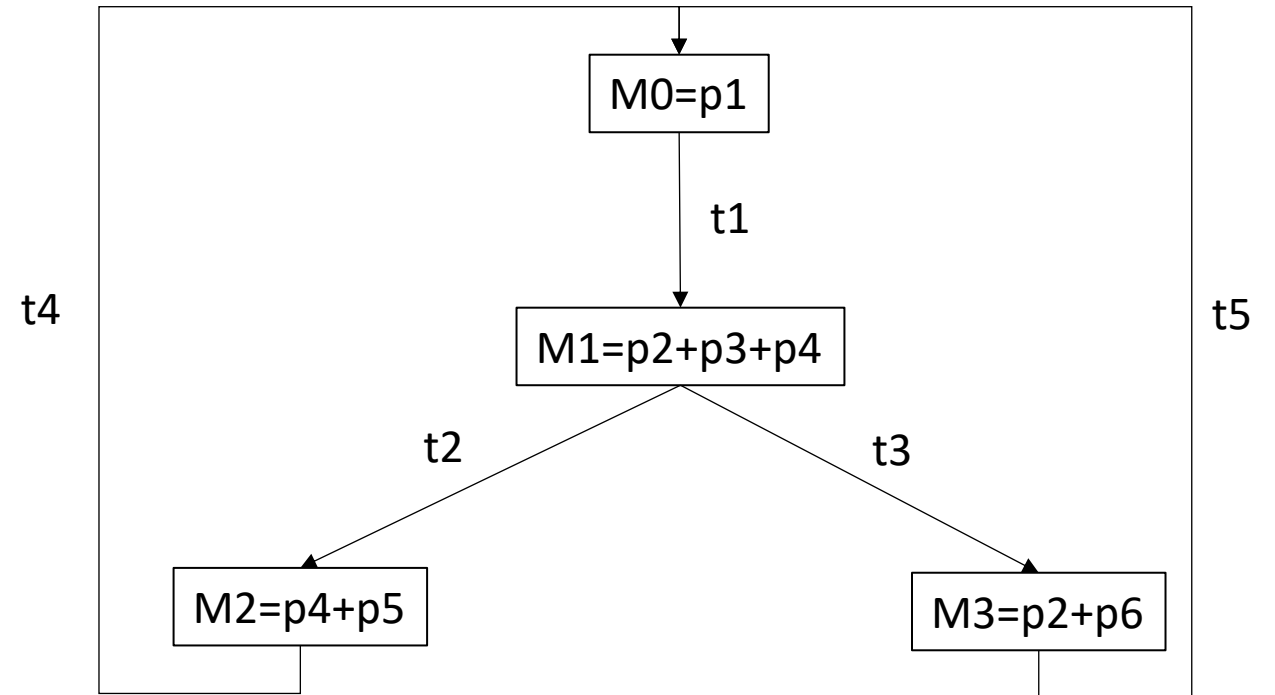
state 0  
props p1  
trans t1/1

state 1  
props p2 p3 p4  
trans t2/2 t3/3

state 2  
props p4 p5  
trans t4/0

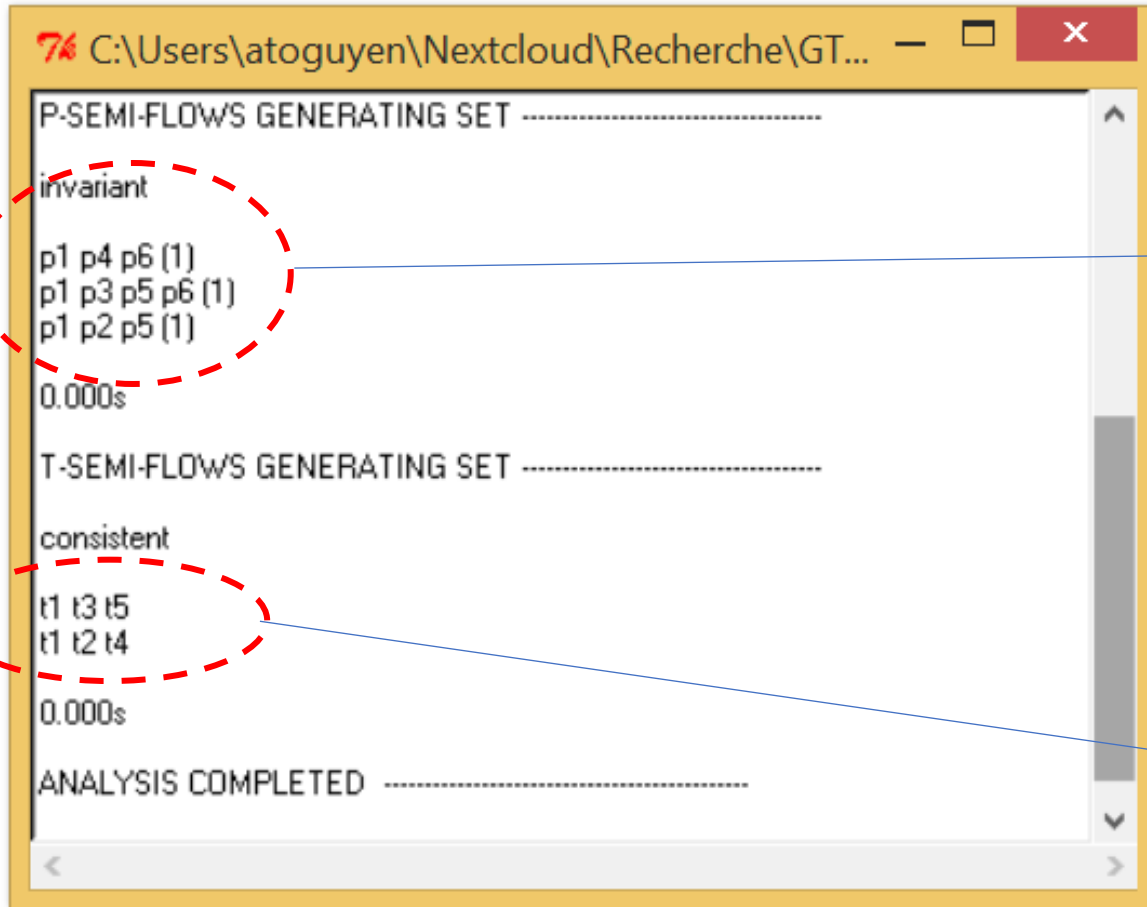
state 3  
props p2 p6  
trans t5/0

Le modèle est borné.



Le RdP est vivant et réversible !!!

# Exercice 1 – Q1 : Analyse structurelle



Invariants de marquage minimaux :

$$M(p1)+M(p4)+M(P6)=1$$

$$M(p1)+M(p3)+M(p5)+M(P6)=1$$

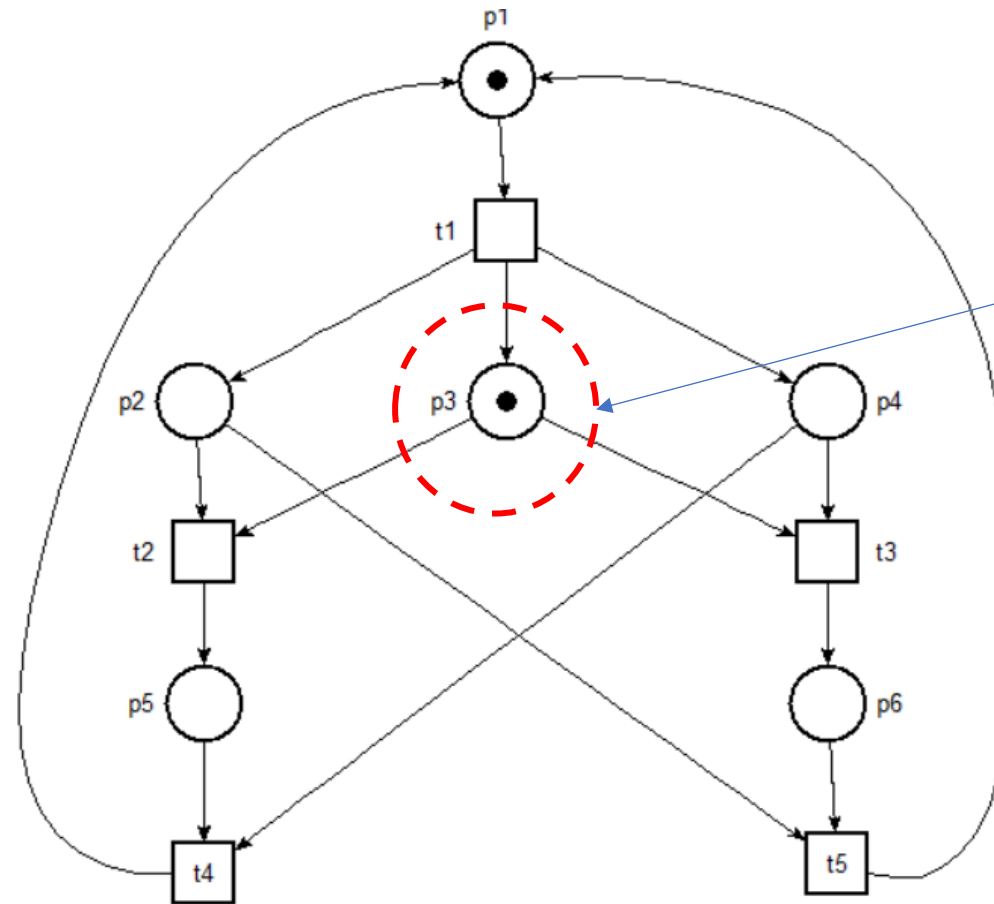
$$M(p1)+M(p2)+M(P5)=1$$

Séquences répétitives minimales :

$$t1*t3*t5$$

$$t1*t2*t4$$

# Exercice 1 – Q2



Jeton supplémentaire pour le marquage initial !!!

# Exercice 1 – Q2 : Graphe de marquages

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**digest**

places 6 transitions 5 net bounded Y live N reversible N

**abstraction**

|             | count | props | psets | dead | live |
|-------------|-------|-------|-------|------|------|
| states      | 5     | 6     | 5     | 1    | 1    |
| transitions | 7     | 5     | 5     | 0    | 0    |

help

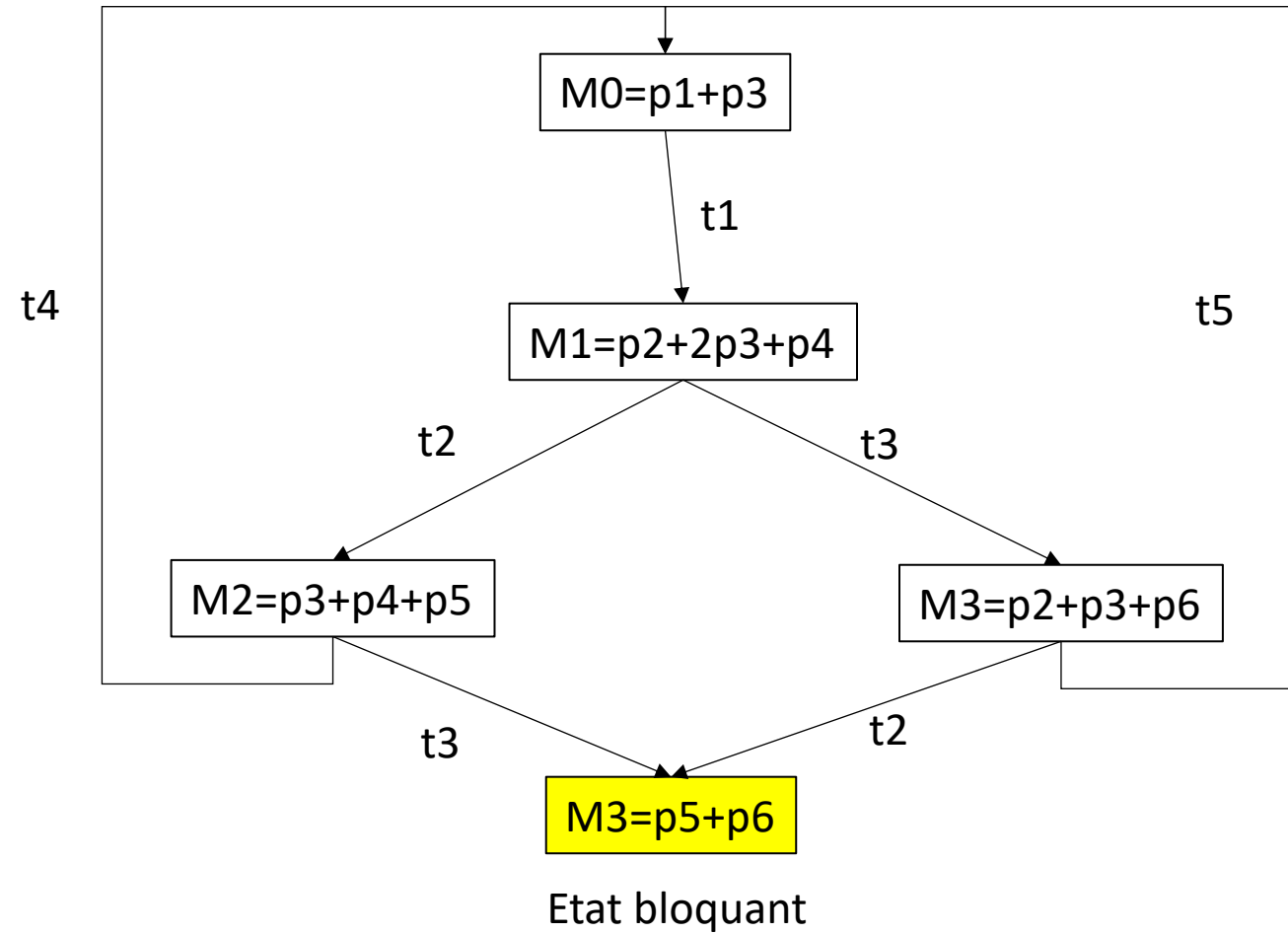
state 0  
props L.scc p1 p3  
trans t1/1

state 1  
props L.scc p2 p3\*2 p4  
trans t2/2 t3/3

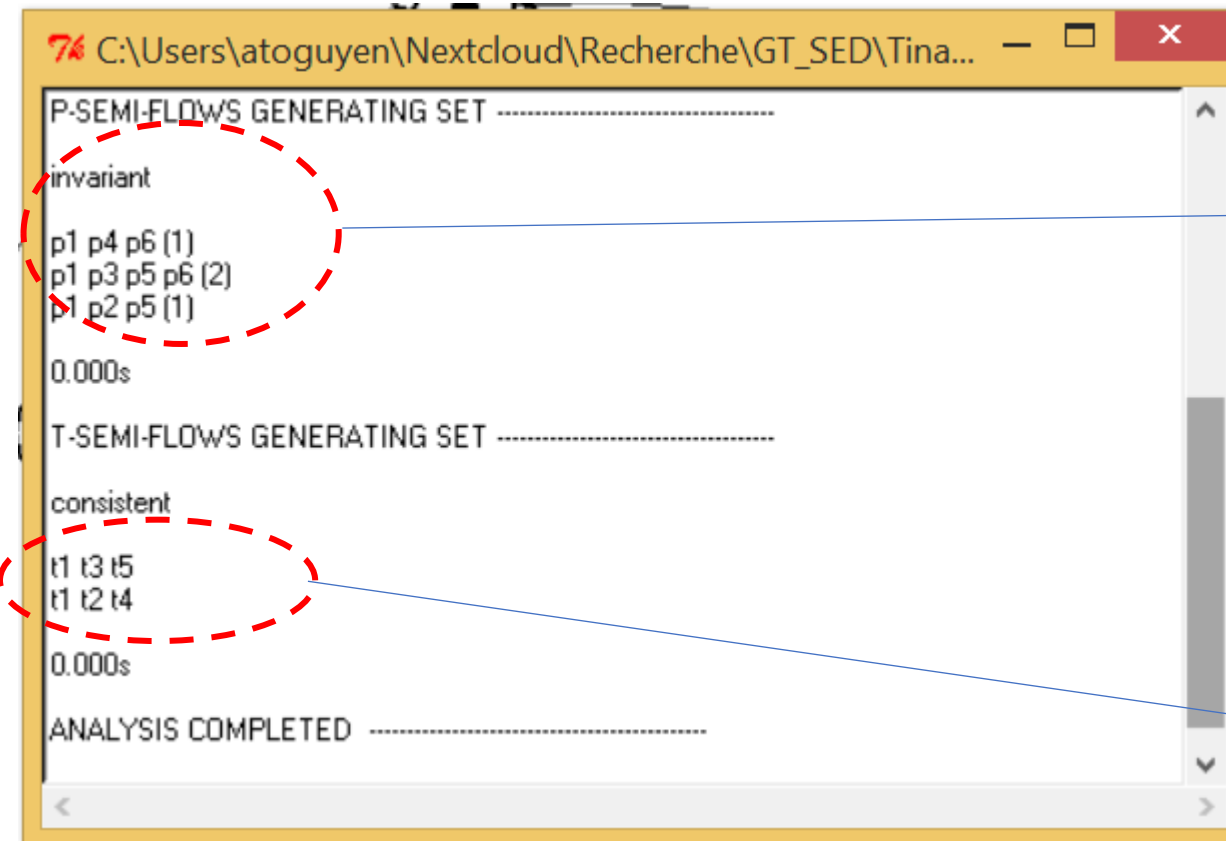
state 2  
props L.scc p3 p4 p5  
trans t4/0 t3/4

state 3  
props L.scc p2 p3 p6  
trans t5/0 t2/4

state 4  
props p5 p6  
trans



# Exercice 1 – Q2 : Analyse structurelle



Invariants de marquage minimaux :

$$M(p1)+M(p4)+M(P6)=1$$

$$M(p1)+M(p3)+M(p5)+M(P6)=2$$

$$M(p1)+M(p2)+M(P5)=1$$

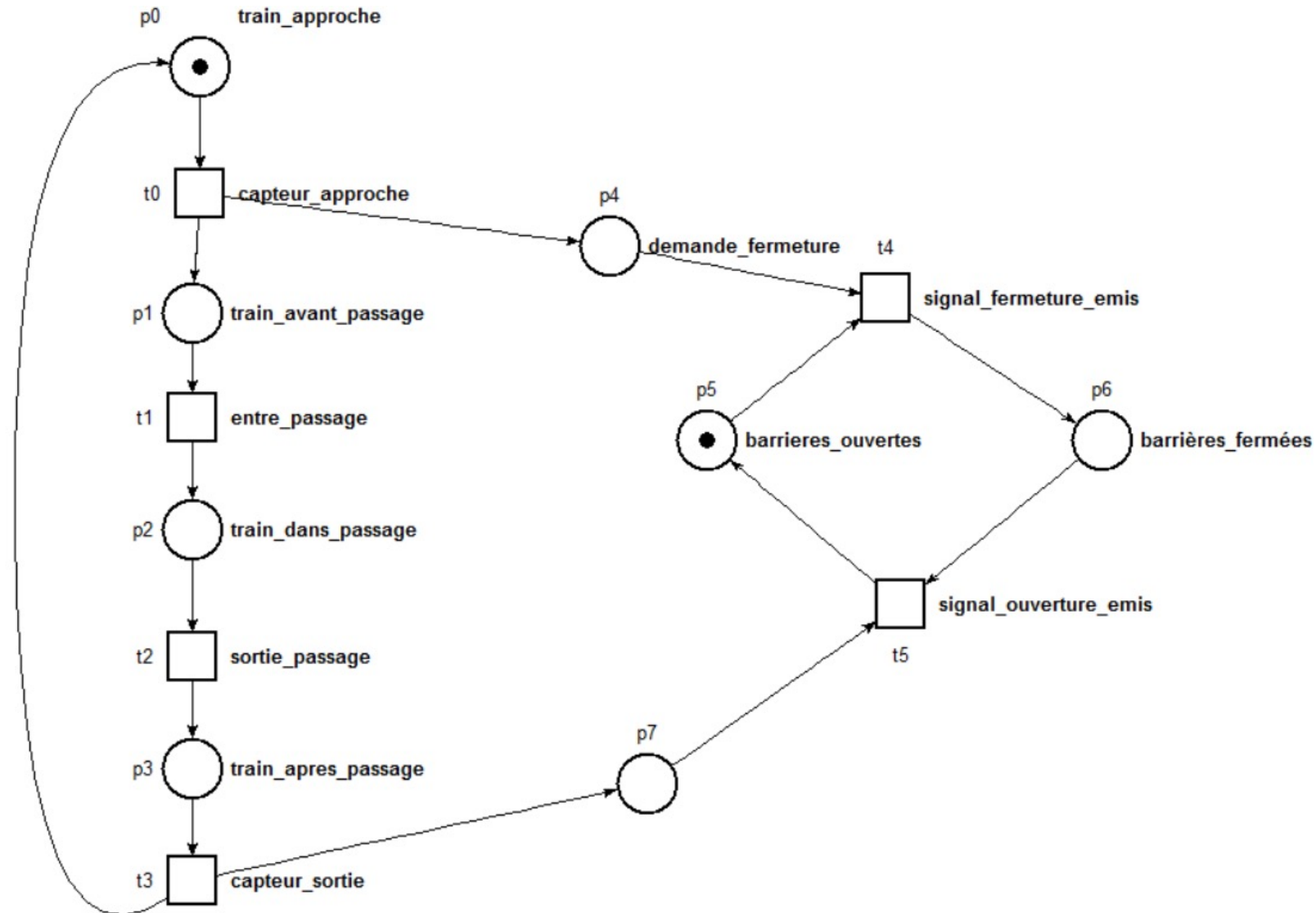
Séquences répétitives minimales :

$$t1*t3*t5$$

$$t1*t2*t4$$

## Exercice 2 : réseau ferroviaire

# Exercice 2 – Q1 – Modèle du système



# Exercice 2 – Q1 – Graphe des marquages

The screenshot shows the PetriNetTools application window with the file 'errlog.txt' open. The window has a menu bar with 'digest' and 'help'. Below the menu bar is a toolbar with buttons for 'places', 'transitions', 'net', 'bounded', 'live', and 'reversible'. The 'net' button is selected. Below the toolbar is a table with the following columns: 'abstraction', 'count', 'props', 'psets', 'dead', and 'live'. The table has two rows: 'states' and 'transitions'. The 'count' column contains question marks for all entries. The 'props', 'psets', 'dead', and 'live' columns also contain question marks for all entries.

| abstraction | count | props | psets | dead | live |
|-------------|-------|-------|-------|------|------|
| states      | ?     | ?     | ?     | ?    | ?    |
| transitions | ?     | ?     | ?     | ?    | ?    |

Below the table, the application displays a list of states and a reachability graph.

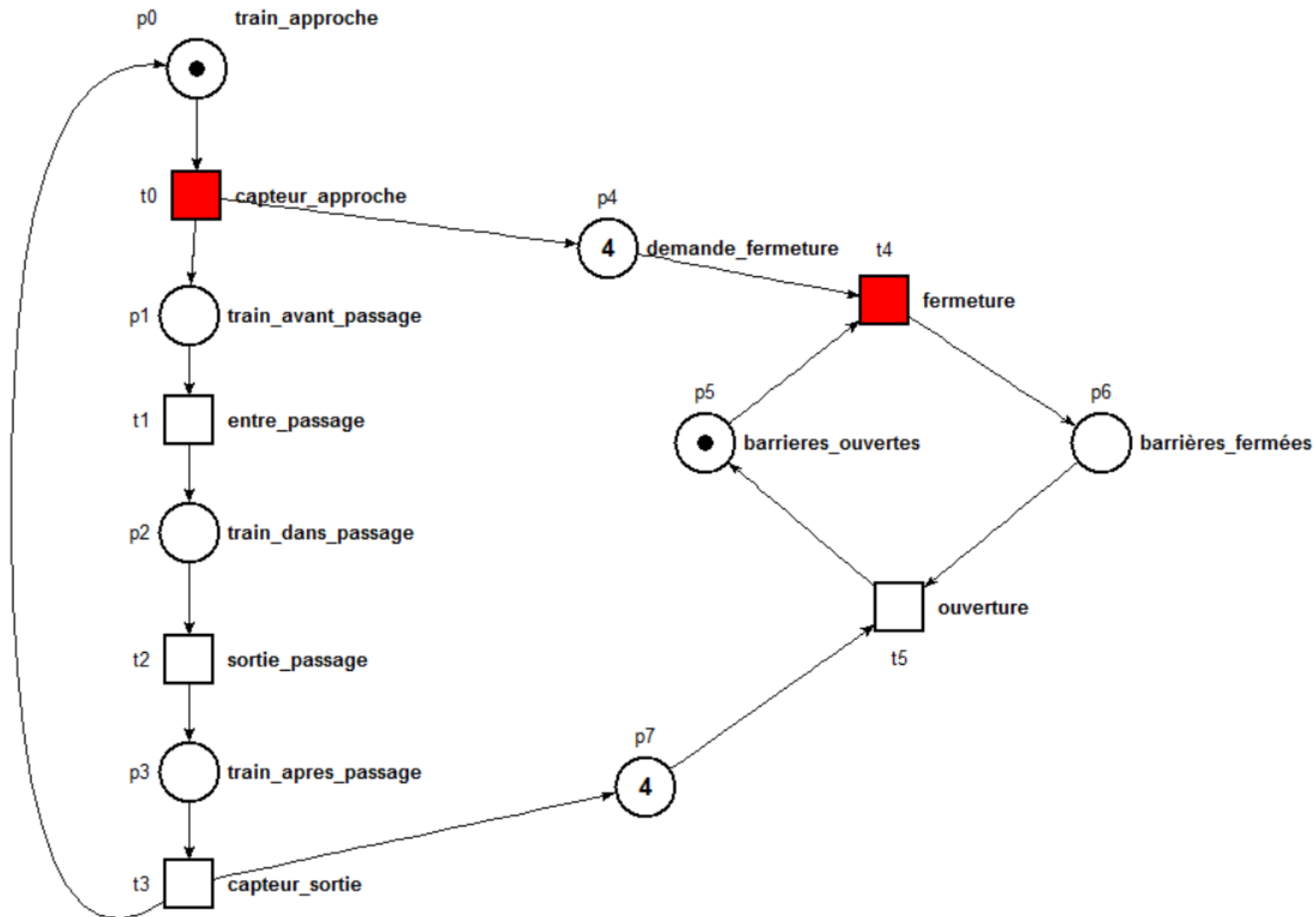
0: p0 p5  
1: p1 p4 p5  
2: p2 p4 p5  
3: p1 p6  
4: p3 p4 p5  
5: p2 p6  
6: p0 p4 p5 p7

REACHABILITY GRAPH:

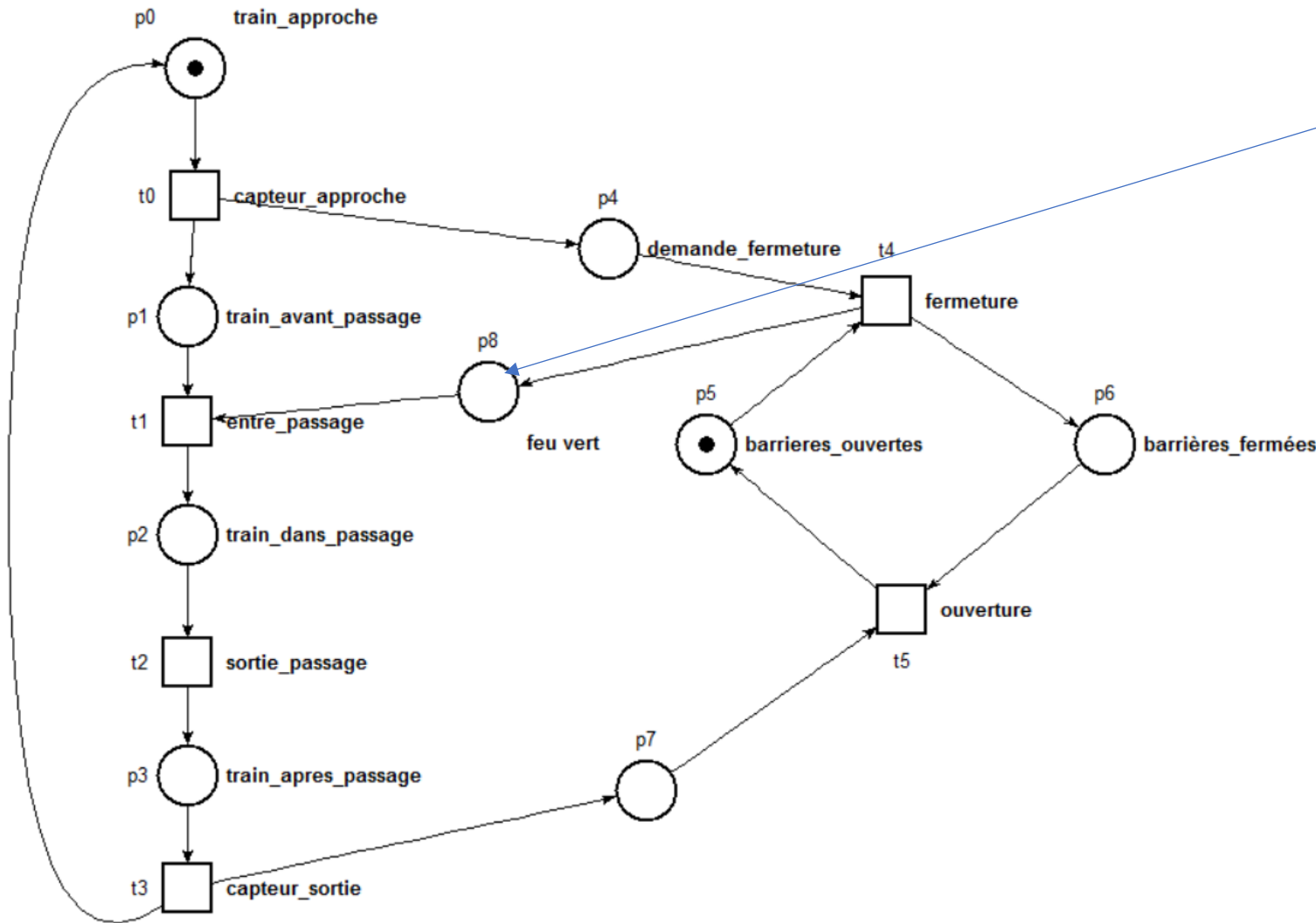
0 -> t0/1  
1 -> t1/2, t4/3  
2 -> t2/4, t4/5  
3 -> t1/5  
4 -> t3/6, t4/?  
5 ->  
6 ->

Le RdP est non borné. En effet, on peut itérer les passages de trains (séquence  $t1*t2*t3*t4$ ) sans commander la fermeture et l'ouverture de la barrière. Il va y avoir une accumulation de jetons dans les places p4 et p7 dont le marquage peut tendre à l'infini.

# Exercice 2 – Q1 – Vérification de la non-finitude par simulation



# Exercice 2 – Q2 – Modèle du système



Ajout d'une place pour contrôler le comportement du train.

# Exercice 2 – Q2 – Graphe des marquages

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**digest**

places 9 transitions 6 net bounded Y live Y reversible Y

| abstraction | count | props | psets | dead | live |
|-------------|-------|-------|-------|------|------|
| states      | 7     | 9     | 7     | 0    | 7    |
| transitions | 8     | 6     | 6     | 0    | 6    |

help

state 0  
props p0 p5  
trans t0/1

state 1  
props p1 p4 p5  
trans t4/2

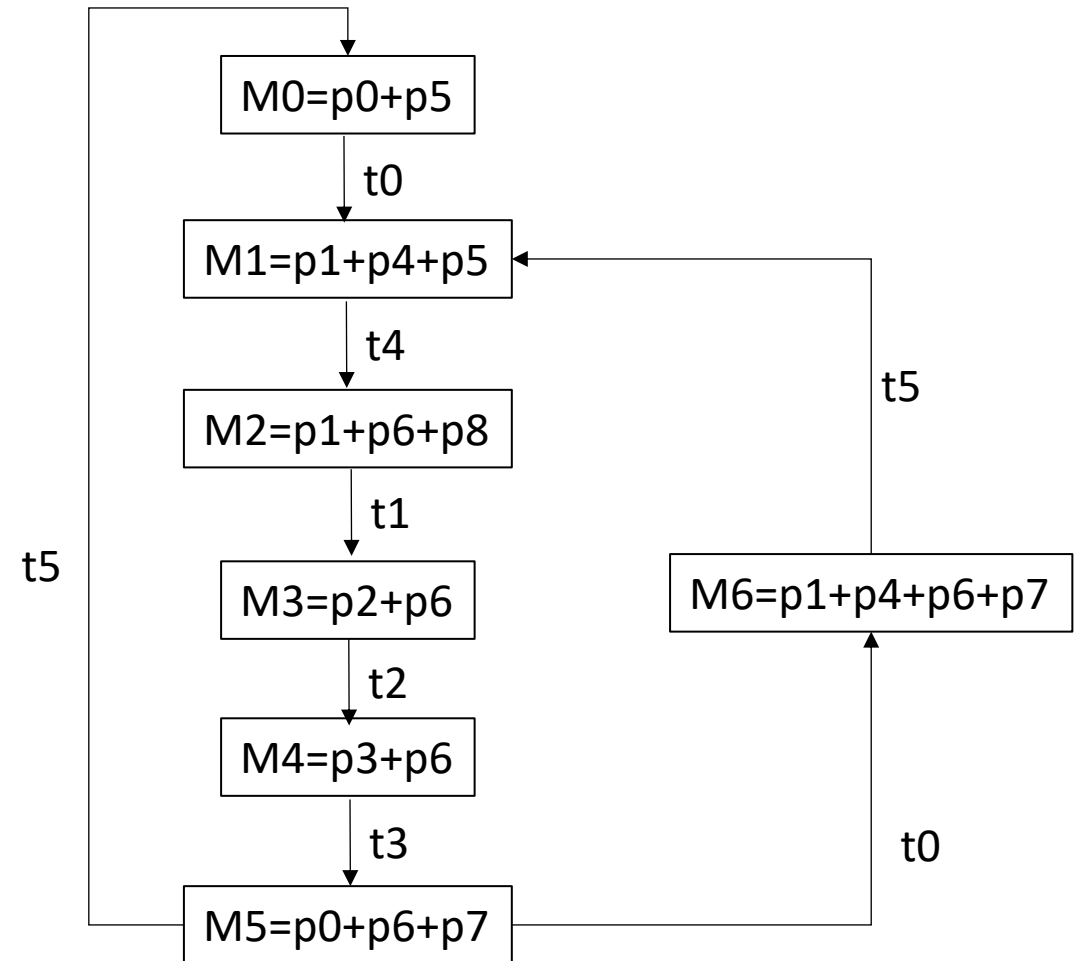
state 2  
props p1 p6 p8  
trans t1/3

state 3  
props p2 p6  
trans t2/4

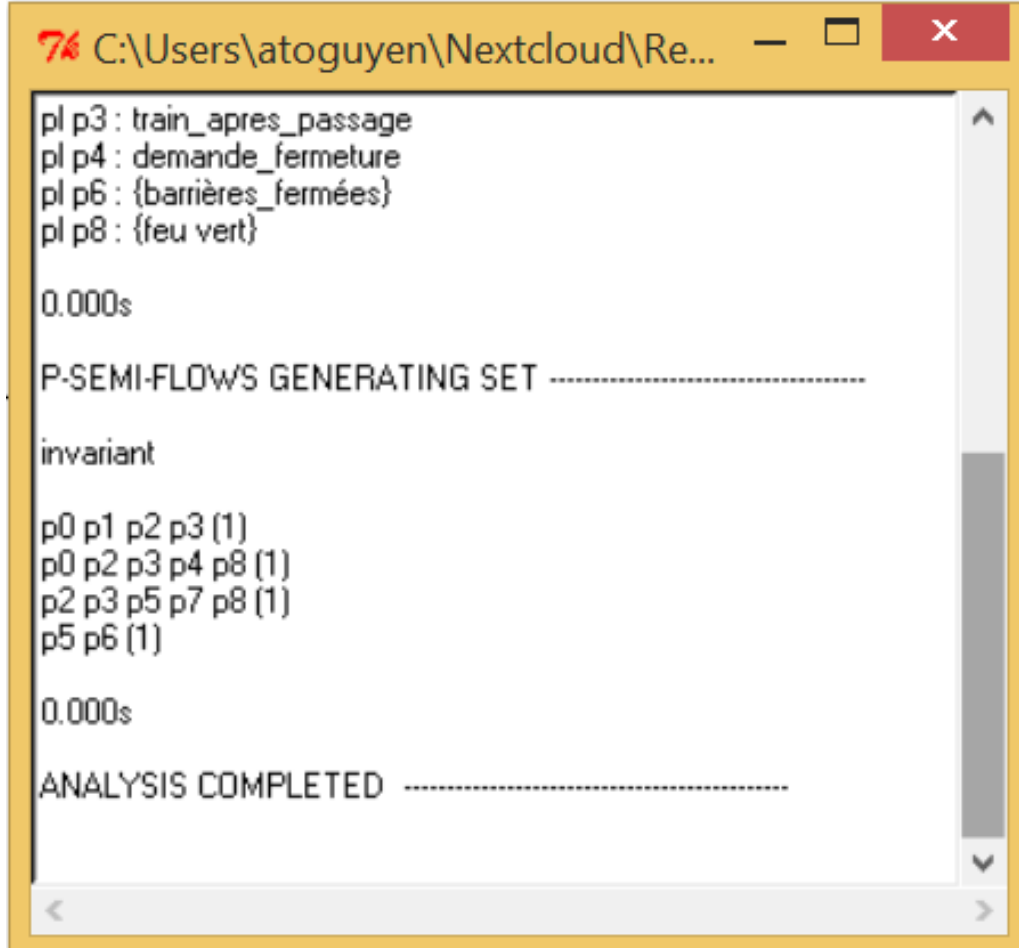
state 4  
props p3 p6  
trans t3/5

state 5  
props p0 p6 p7  
trans t5/0 t0/6

state 6  
props p1 p4 p6 p7  
trans t5/1



# Exercice 2 – Q2 – Analyse structurelle



A screenshot of a software window titled "C:\Users\atoguyen\Nextcloud\Re..." with standard Windows window controls. The window contains a text area with the following content:

```
pl p3 : train_apres_passage
pl p4 : demande_fermeture
pl p6 : {barrières_fermées}
pl p8 : {feu vert}

0.000s

P-SEMI-FLOWS GENERATING SET -----

invariant

p0 p1 p2 p3 (1)
p0 p2 p3 p4 p8 (1)
p2 p3 p5 p7 p8 (1)
p5 p6 (1)

0.000s

ANALYSIS COMPLETED -----
```

**Etats du trains :**  $M(p0)+M(p1)+M(p2)+M(p3)=1$

**Gestion de l'autorisation de passage :**

$M(p0)+M(p2)+M(p3)+M(p4)+M(p8)=1$

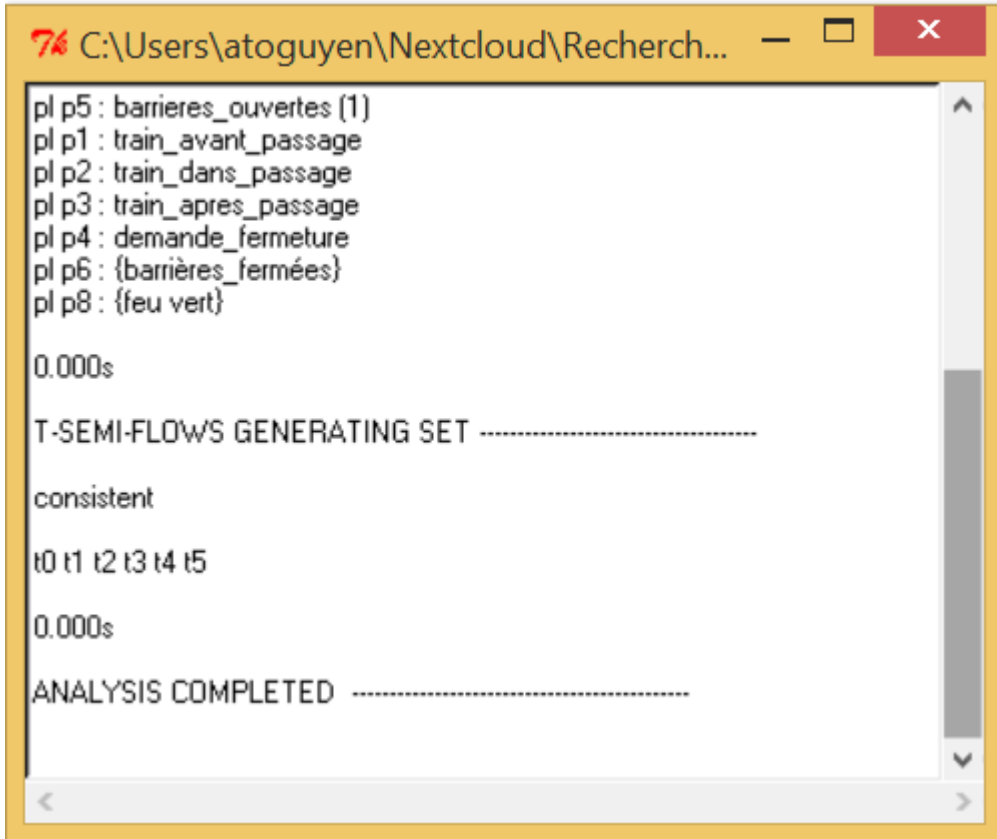
**Gestion ouverture des barrières:**

$M(p2)+ M(p3)+ M(p5)+M(p7)+M(p8)=1$

**Etats des barrières :**

$M(p5)+M(p6)=1$

# Exercice 2 – Q2 – Analyse structurelle

A screenshot of a software window titled "C:\Users\atoguyen\Nextcloud\Recherch...". The window contains a list of places: pl p5 : barrieres\_ouvertes (1), pl p1 : train\_avant\_passage, pl p2 : train\_dans\_passage, pl p3 : train\_apres\_passage, pl p4 : demande\_fermeture, pl p6 : {barrieres\_fermées}, and pl p8 : {feu vert}. Below this list, it shows "0.000s", "T-SEMI-FLOWS GENERATING SET -----", "consistent", "t0 t1 t2 t3 t4 t5", "0.000s", and "ANALYSIS COMPLETED -----".

```
pl p5 : barrieres_ouvertes (1)
pl p1 : train_avant_passage
pl p2 : train_dans_passage
pl p3 : train_apres_passage
pl p4 : demande_fermeture
pl p6 : {barrieres_fermées}
pl p8 : {feu vert}

0.000s

T-SEMI-FLOWS GENERATING SET -----

consistent

t0 t1 t2 t3 t4 t5

0.000s

ANALYSIS COMPLETED -----
```

**Il y a un T-semiflot qui  
correspond à la séquence  
répétitive stationnaire :  
 $t_0 * t_4 * t_1 * t_2 * t_3 * t_5$**

# Equipe pédagogique

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