Lecture 8: Petri-Nets

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Foundations of Software Engineering

CSCI 5828 - Spring Semester, 2000

Today's Lecture

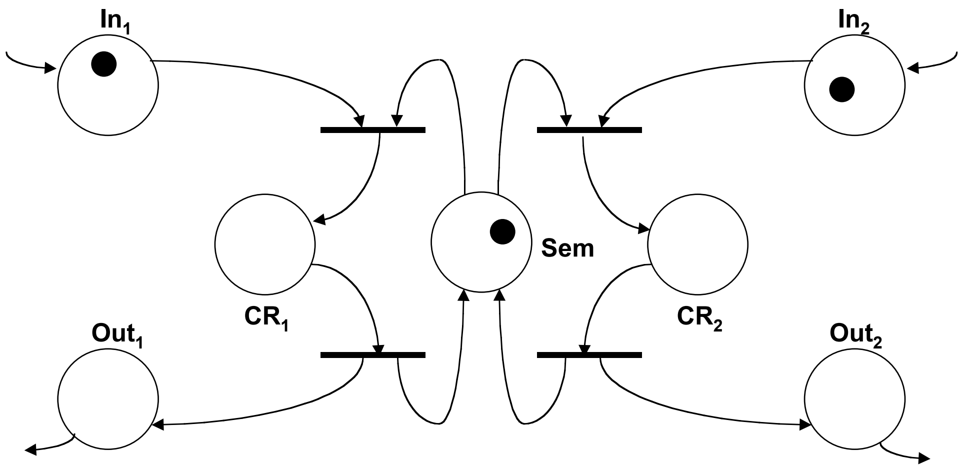
- Introduce the Petri Net Formalism
  - Present several examples

Petri Nets

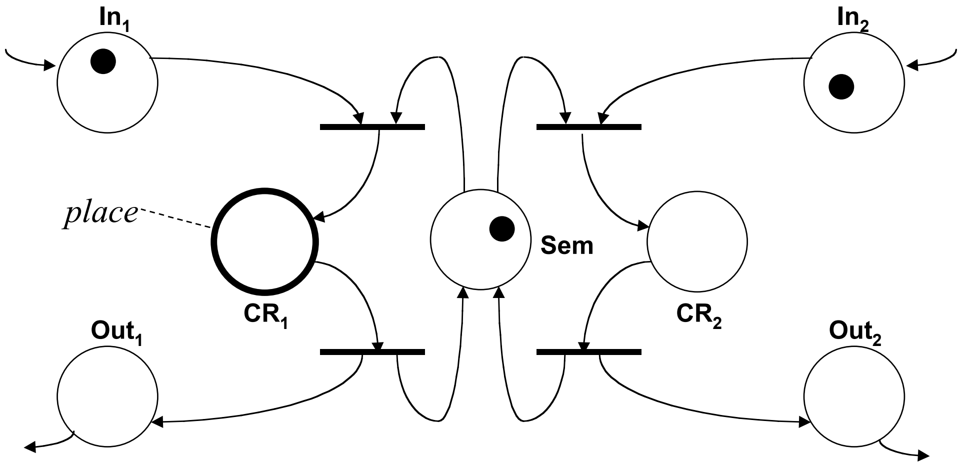
- Formal Definition

***N = {P,T,A,M_0}*, where**
P* is a finite set of *places
T* is a finite set of *transitions
A* is a finite set of *arcs (arrows)
M_0* is the *initial marking* of *N

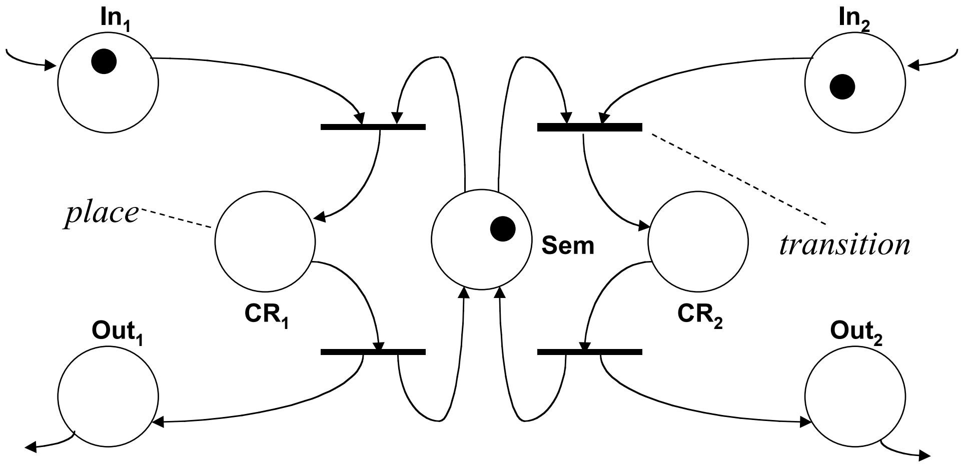
Graphical Representation



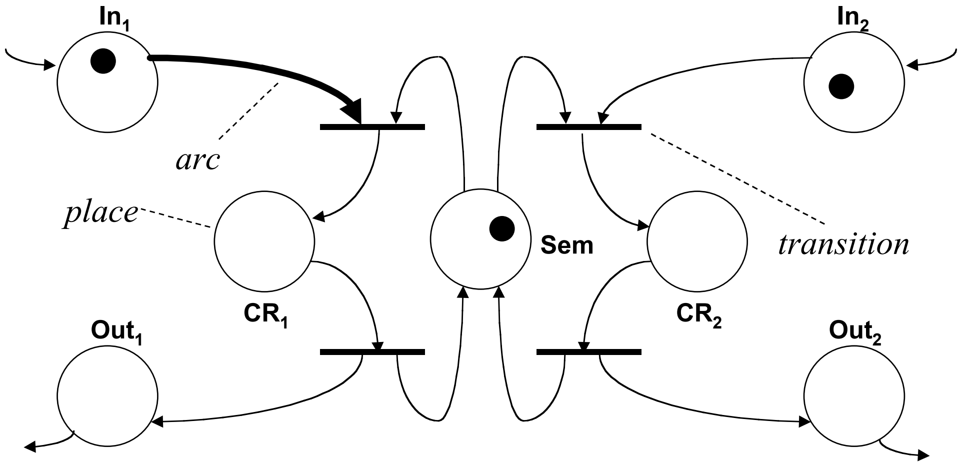
Graphical Representation



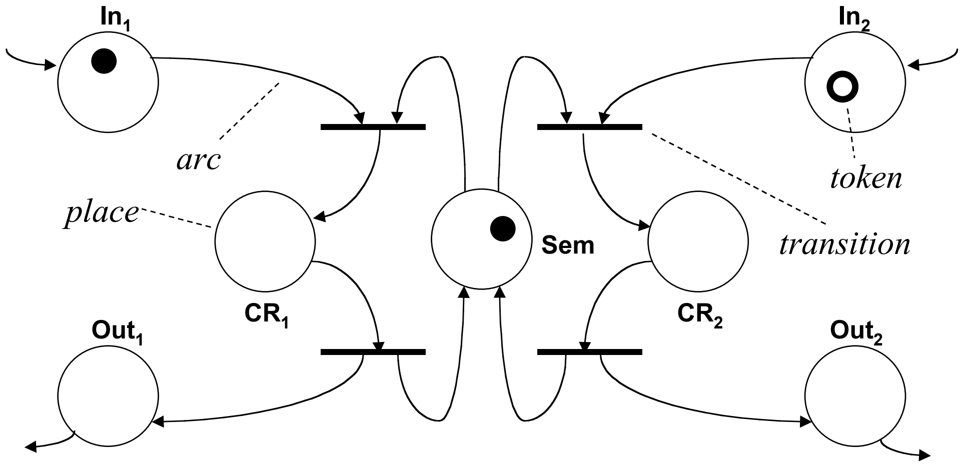
Graphical Representation



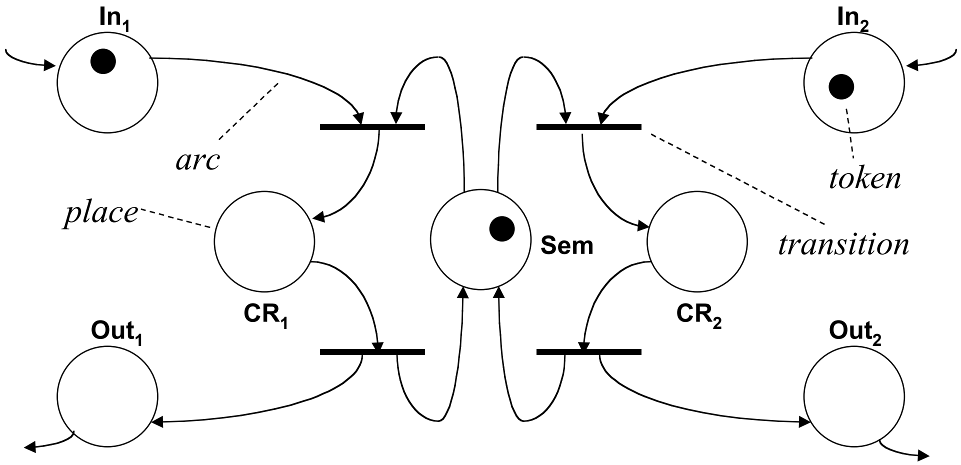
Graphical Representation



Graphical Representation



Graphical Representation



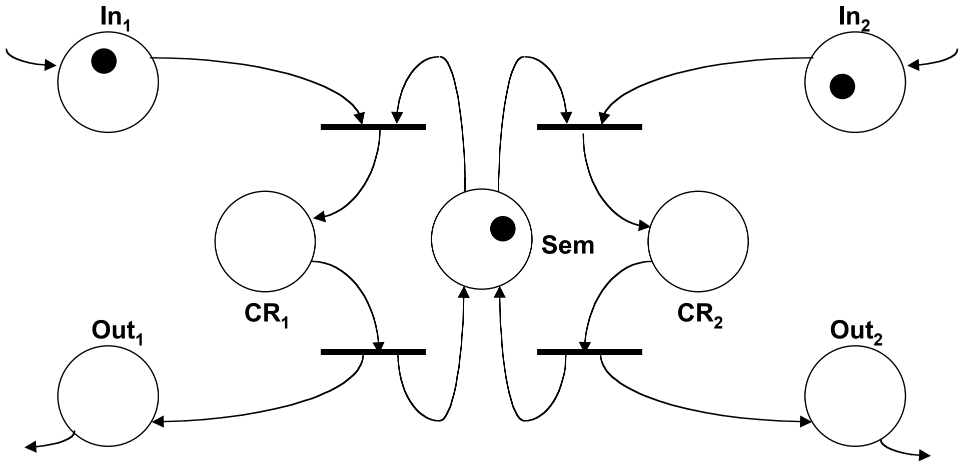
Petri Nets

- Intuitive Meaning
  - – A place holds *tokens*
  - – A transition represents *activity*
  - – An arc connects a place and a transition
  - – A marking is an arrangement of tokens in places, representing *state*
  - – An initial marking represents an initial state

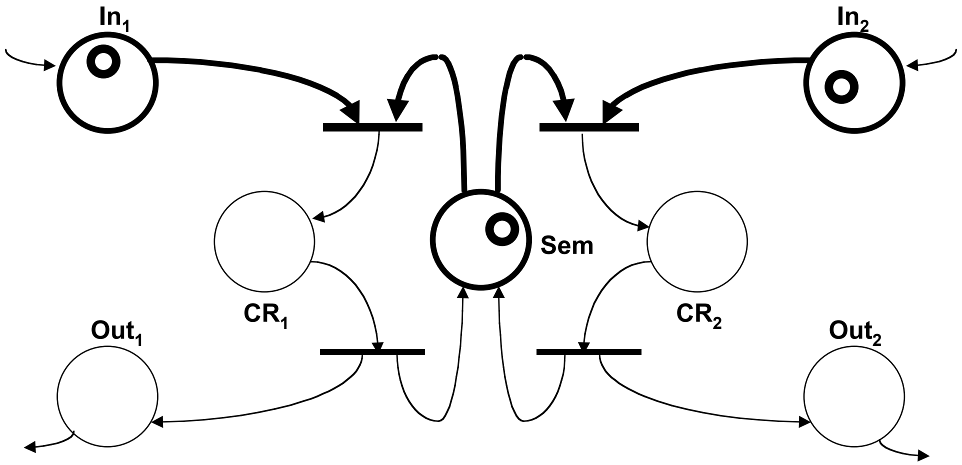
Execution Model

- Input and Output Places
  - – Place *P* is an *input place* for transition *T* if there is an arc from *P* to *T*
  - – Place *P* is an *output place* for transition *T* if there is an arc from *T* to *P*
- Enabled Transition
  - – A transition is *enabled* if there is at least one token at each of its input places

Petri Net Semaphore



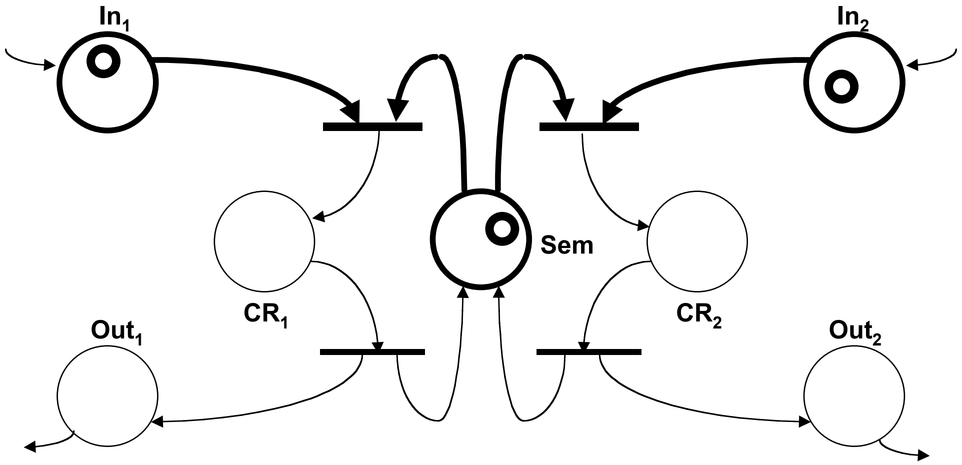
Enabled Transitions



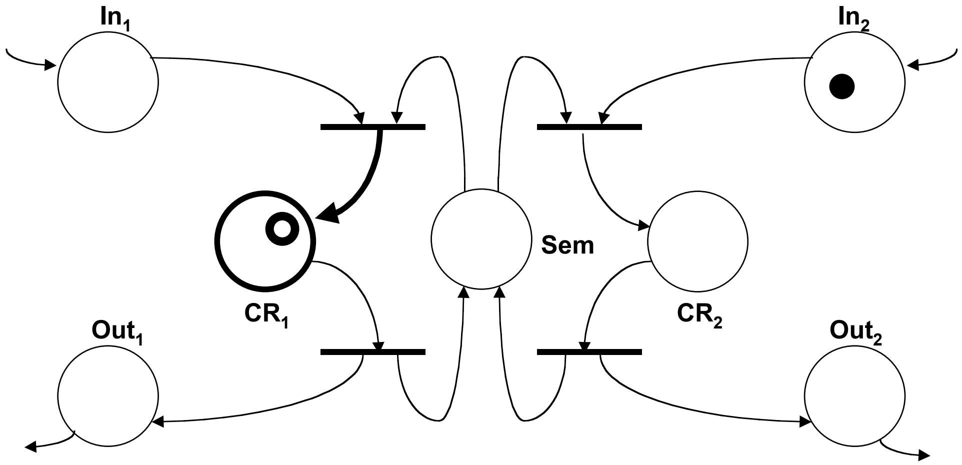
Execution Model

- Firing a Transition
  - An enabled transition is nondeterministically selected and *fired* by removing one token from each of its input places and depositing one token at each of its output places
- Firing Sequence
  - A *firing sequence* is a sequence $<t_0,t_1,\ldots,t_n>$ such that t_0 is enabled and fired in M_0, t_1 is enabled and fired in M_1, etc.

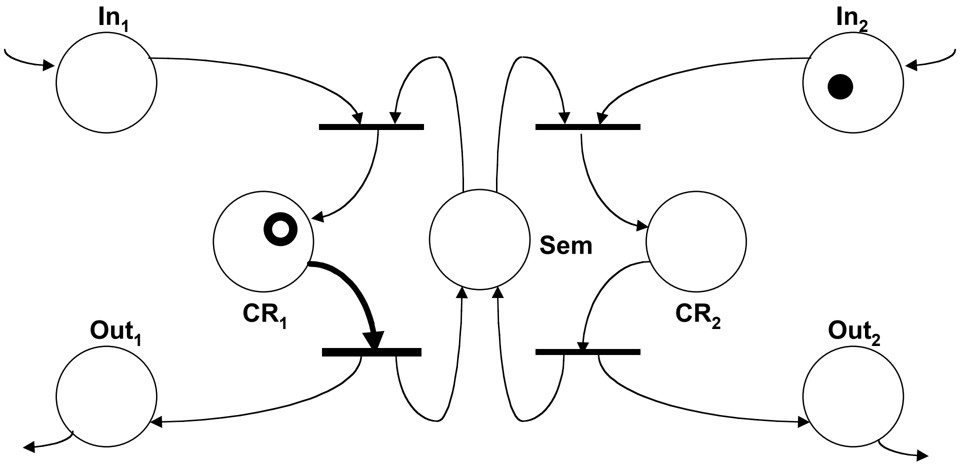
Enabled Transitions



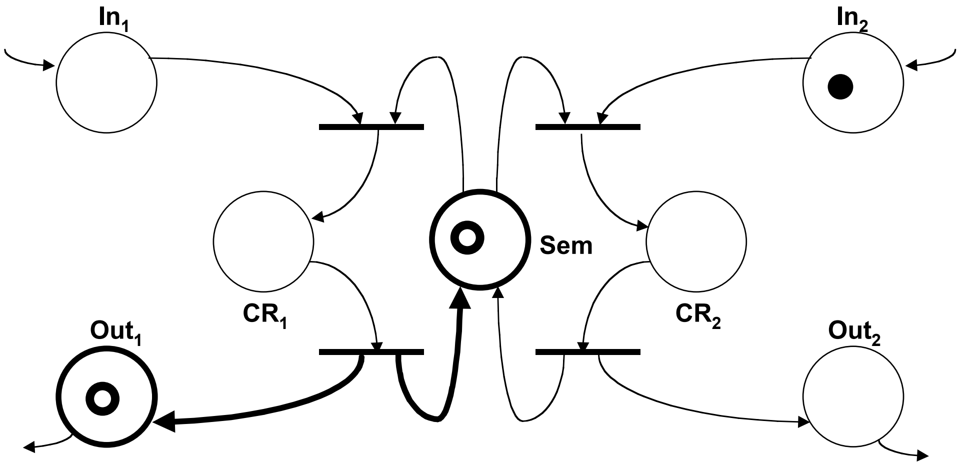
After Firing



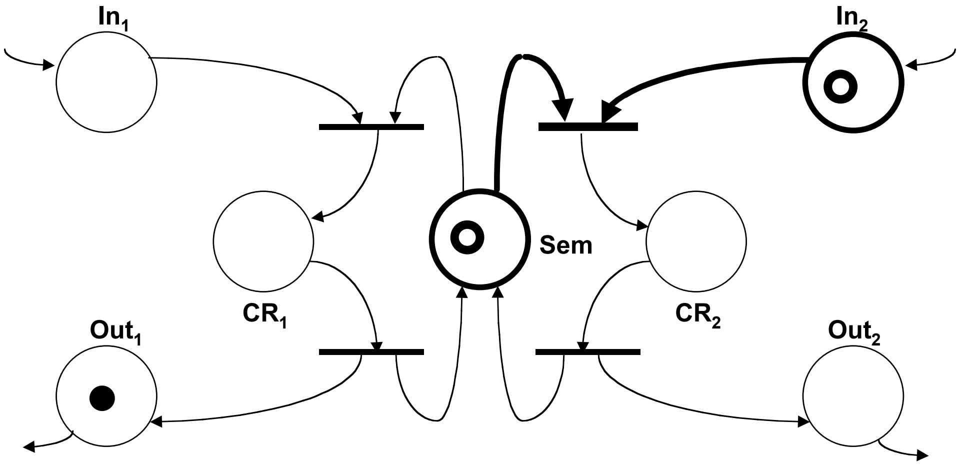
Enabled Transition



After Firing



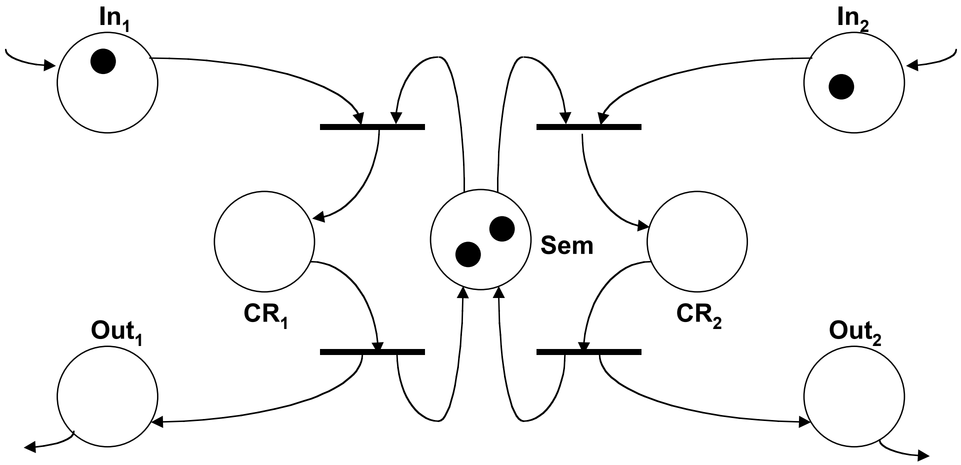
Enabled Transition



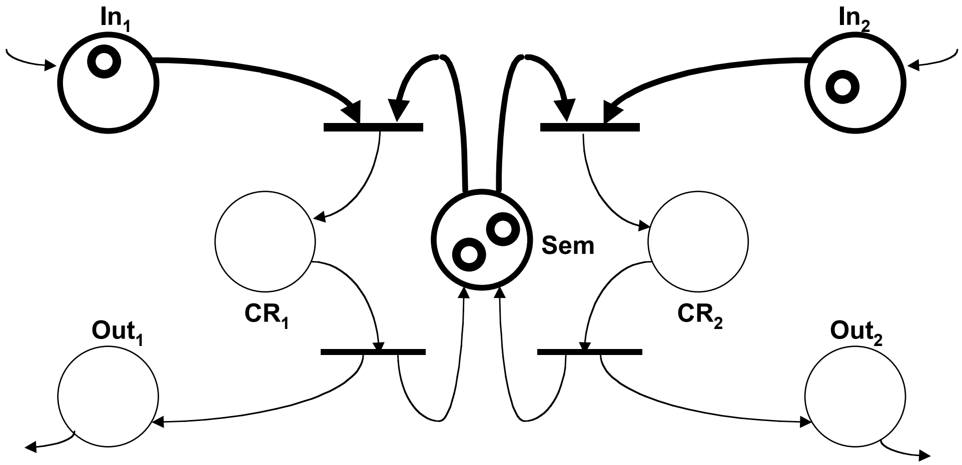
Breaking the Semaphore

- Lets look at the semaphore example again and see how a change to the initial marking will change the semantics of the Petri Net
  - In particular, we will break the semantics of the semaphore by adding *one* token

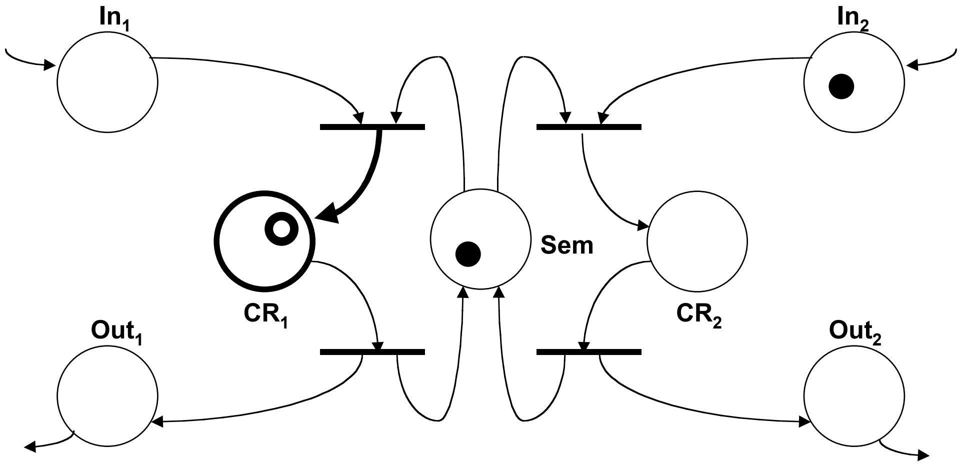
Petri Net Semaphore



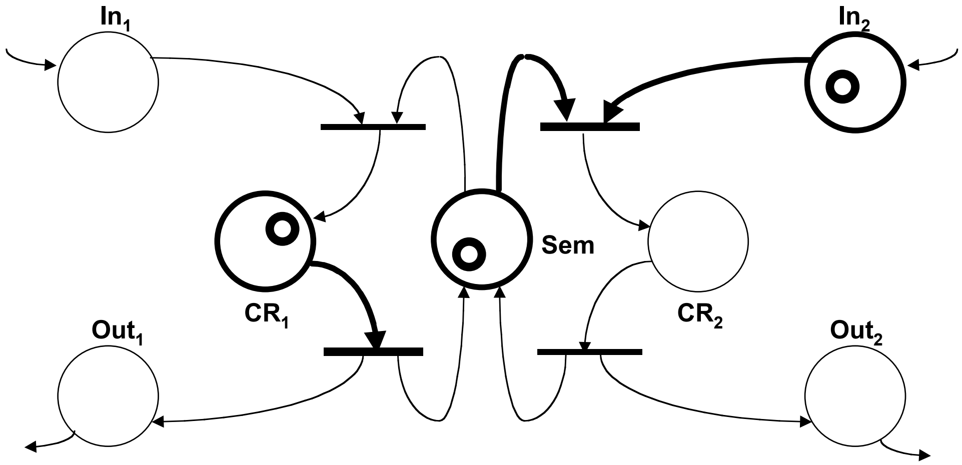
Enabled Transitions



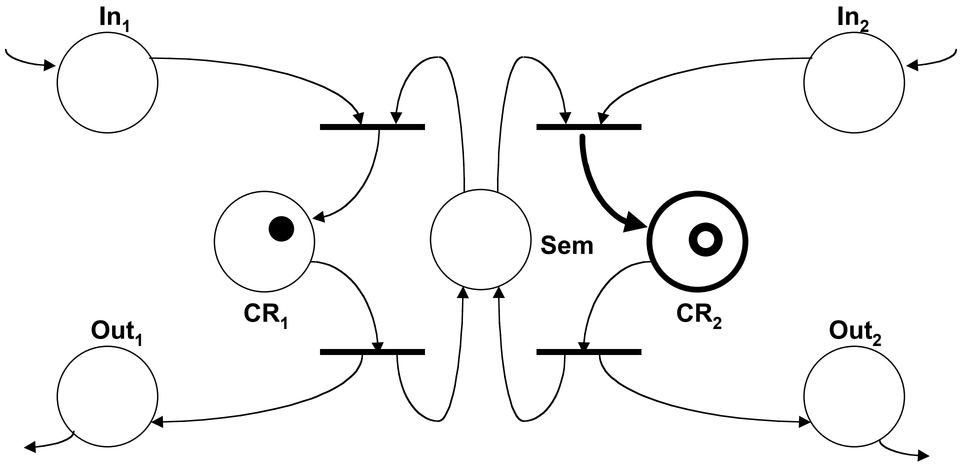
After Firing



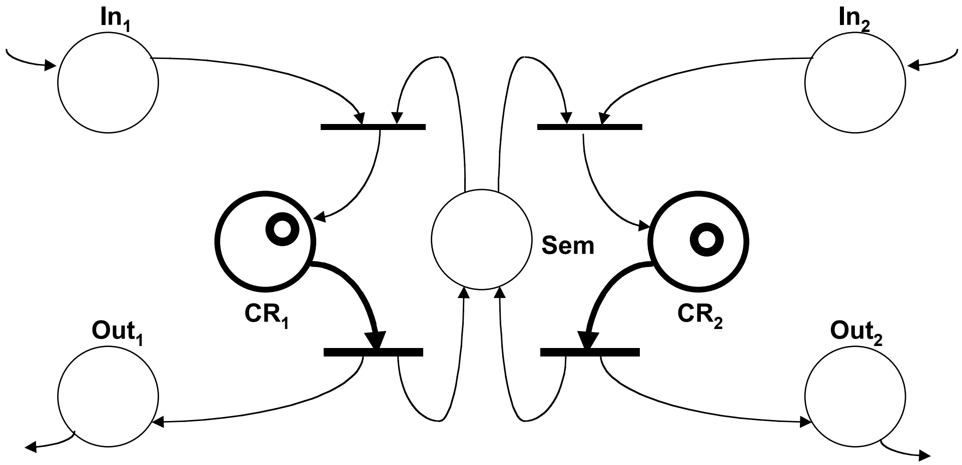
Enabled Transitions



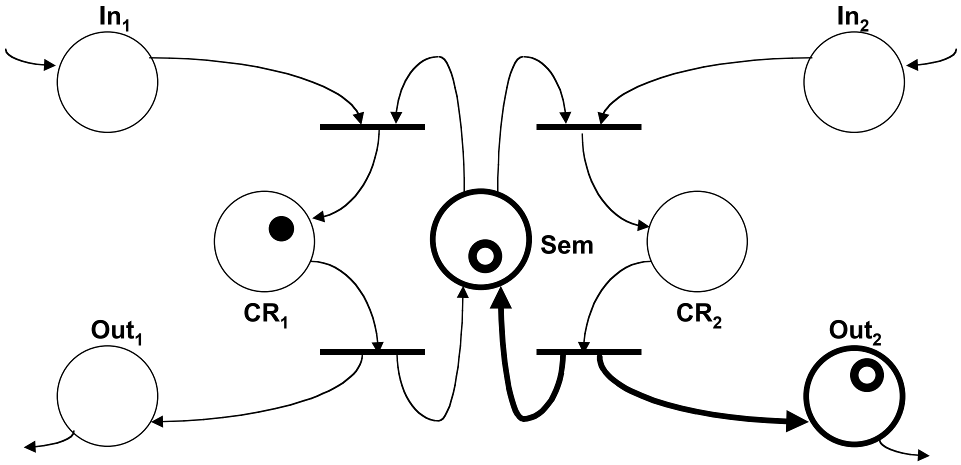
After Firing



Enable Transitions



After Firing



Filling Station Example

- Lets model the following situation
  - Fuel Pumps
  - Spaces next to Pumps
  - A cashier that takes payment
- Questions
  - What is the concurrency that we want modeled?
  - How do we handle the parameterization of the Petri net? (e.g. lets say I want to add a pump)