

# Concurrency in Multi-Agent Robotic Systems

---

Calden Wloka

York University, Toronto

31 January, 2011

# Outline

---

- Concurrency in robotics
  - Overview of Petri Nets
  - Introduction of example problem
  - Plan and discussion
-

# Concurrency in robotics

---

- ❑ Physical limitations create the need for procedures to handle concurrency
  - ❑ Cooperation between multiple agents is often desirable, but this increases the need for concurrent control
    - A group of agents in which all robots have identical capabilities is called *homogeneous*
    - A group of agents in which robot capabilities vary between individuals is called *heterogeneous*
-

# Petri Nets

---

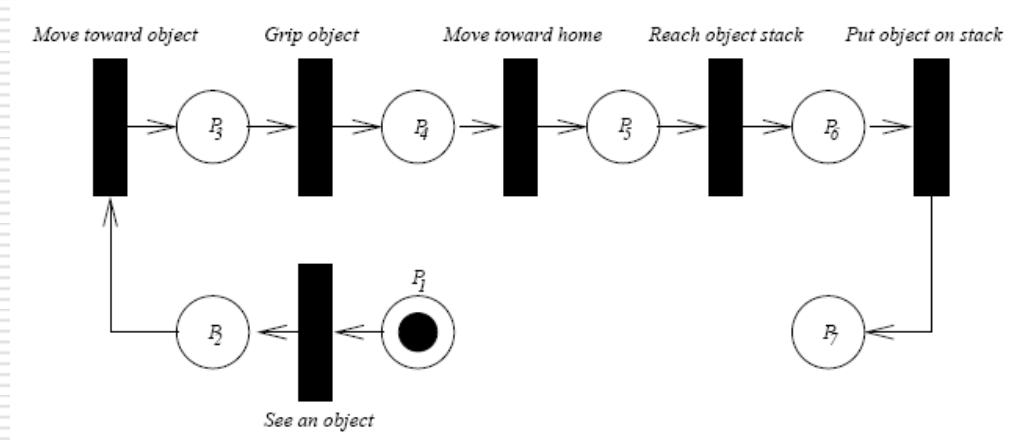
Invented in 1939 by Carl Adam Petri



Carl Adam Petri  
1926 - 2010

- Provide a graphical and well-defined mathematical notation for stepwise procedures that include choice, iteration, and concurrency
  - Consist of a directed graph in which nodes are either transitions (represented with rectangles) or places/conditions (represented with circles)
-

# Petri Nets: A simple example from my paper



Y.T. Kotb, S.S. Beauchemin, and J.L. Barron. Petri Net-Based Cooperation in Multi-Agent Systems. Computer and Robot Vision 2007, pp. 123-130

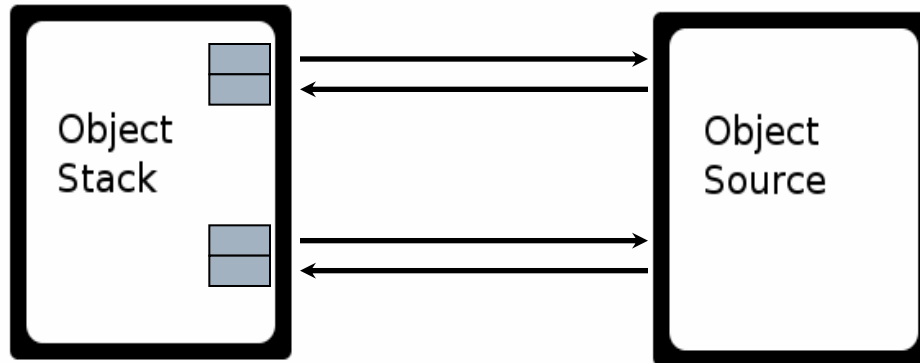


# Sample Two Agent Problem

---

Two agents with two primary tasks:

- ❑ Pick up objects from the source
- ❑ Carry objects and place and place them on the stack



# Sample Two Agent Problem

---



## Task 1:

See an object  
Move toward object  
Grip object  
Move toward home

## Task 2:

Reach object stack  
Put object on stack

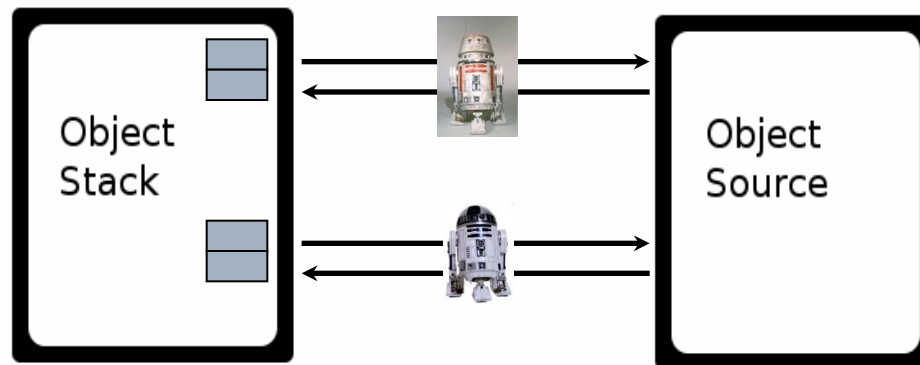


## Task 1:

See an object  
Move toward object  
Grip object  
Move toward home

## Task 2:

Reach object stack  
Put object on stack



# Sample Two Agent Problem

---



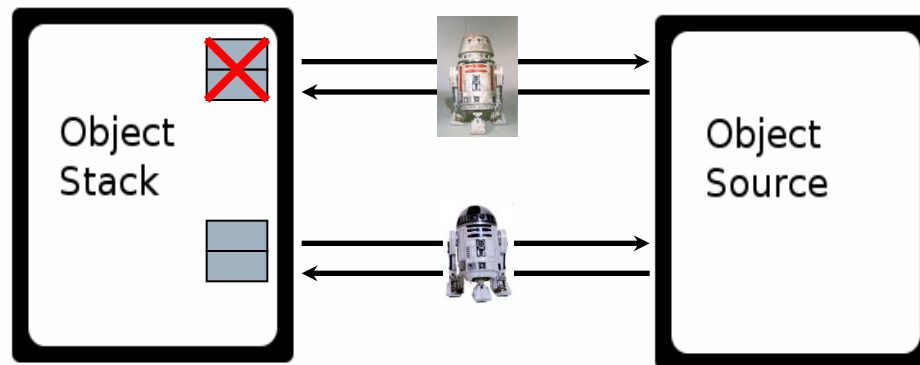
**Task 1:**  
See an object  
Move toward object  
Grip object  
Move toward home

~~**Task 2:**  
Reach object stack  
Put object on stack~~



**Task 1:**  
See an object  
Move toward object  
Grip object  
Move toward home

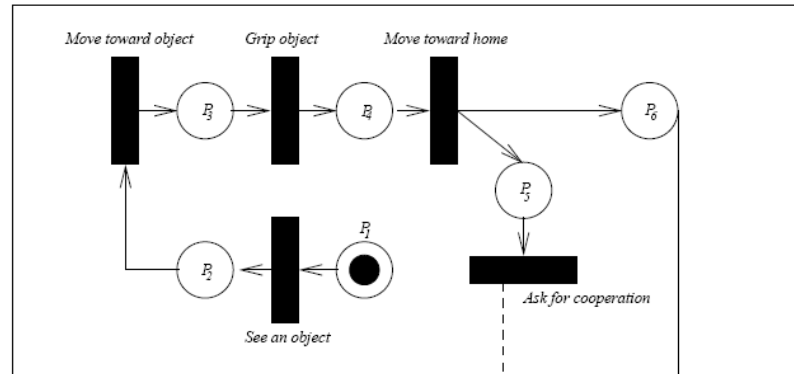
**Task 2:**  
Reach object stack  
Put object on stack



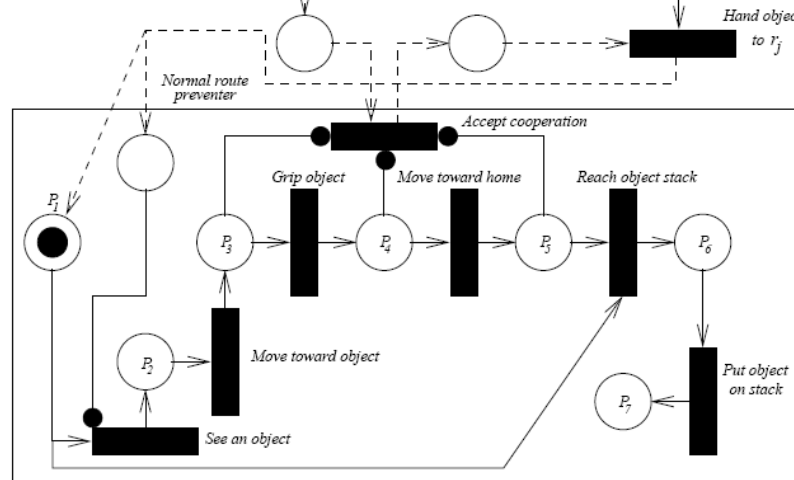


# Petri Net for Sample Two Agent Problem

R2D1



R2D2



# Plan and Discussion

---

- ❑ Simulate the sample problem using Petri Nets and with direct planning methods for comparison
  - ❑ Test implementation over a range of parameters (action speeds, number of agents)
  - ❑ Questions?
-