Computer Controlled Systems II.
Tutorial: Petri net simulation and analysis

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Overview

Petri nets

- $PN = (P, T, I, O)$
  - P set of places
  - T set of transitions
  - $P \cap T = \emptyset$
  - $I : T \to P^\infty$ input function of transitions
  - $O : T \to P^\infty$ output function of transitions
- Operation
  - tokens on places
  - enabled and firing transitions
  - concurrency, conflict, confusion
  - state = marking vector

Analysis

- Dynamic properties
  - deadlock
  - liveness
  - boundedness (finiteness)
  - conservation
  - reachability
  - can be analysed using the reachability graph
- Structural
  - place invariants
  - transition invariants

PIPE - Platform Independent Petri Net Editor

- Source
  - https://sourceforge.net/projects/pipe2/files/PIPEv4/PIPEv4.3.0/ (lates stable version)
- Constructing Petri nets
  - simple Petri nets
  - place capacity
  - timed, prioritized transitions
  - arc weights, inhibitor arcs
  - "colored" tokens - NOT CPN!
- Simulation
- Analysis
  - Incidence matrix
  - Invariant analysis
  - Reachability graph
  - State space analysis (boundedness, safeness, deadlocks)
- Documentation:
  http://sarahtattersall.github.io/PIPE/user_guide.html

Simple exercises

Create a simple Petri net that

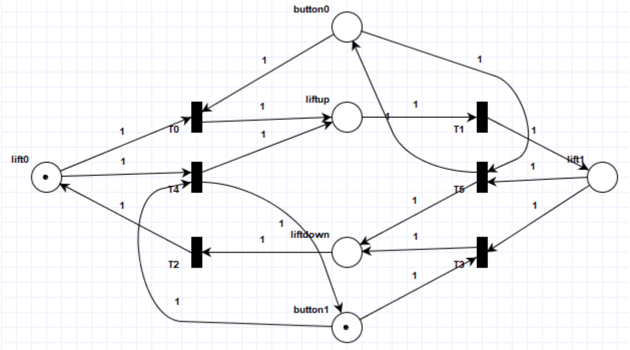
1. is bounded
2. is unbounded (infinite)
3. is safe
4. is conservative
5. has conflicted transitions

Simple example

Elevator in a building with two floors

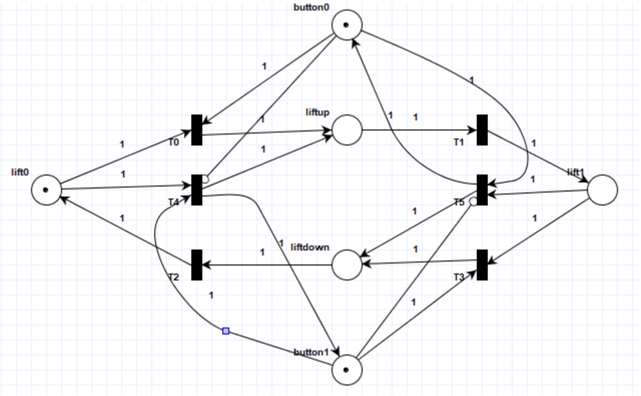
- calling the elevator with a button on each floor
- only two travelling directions
  - going up (from 1st to 2nd floor)
  - going down (from 2nd to 1st floor)
- operation conditions:
  - e.g. IF the button on the first floor is pressed AND the elevator is on the 1st floor THEN the elevator goes up
  - IF the button on the first floor is pressed AND the elevator is on the 2nd floor THEN the elevator goes down
  - etc...

Solution 1



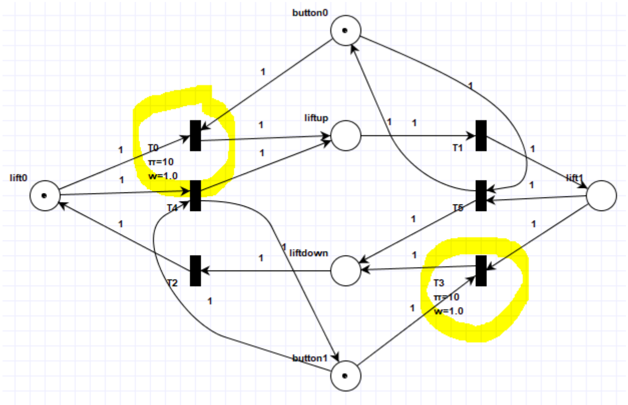
- conflict: the elevator is called on both floors at the same time
- view the reachability graph

Conflict resolution 1



- inhibitor arcs
- view the reachability graph

Conflict resolution 2



- transitions with priority
- view the reachability graph