Concurrency:
State Models & Design Patterns

Practical Session

Week 12

Deadline for submission: 10-Dec-2017, 1159 pm

Exercises 11

Discussion

Exercise 11 - Task 1

Answer the following questions about Petri nets:

a) List and briefly explain all the elements a petri net consists of.

A Petri net C is defined as

$$C = \langle P, T, I, O \rangle \text{ with marking function } m$$

in which:

i. *P is a finite set of places*
ii. *T is a finite set of transitions*
iii. *I is an input function*

$$I : T \to Nat^P$$

iv. *O is an output function*

$$O : T \to Nat^P$$

v. *m is a marking function of C that mapps tokens to individual places*

$$m : P \to Nat$$

Exercise 11 - Task 1

Answer the following questions about Petri nets:

b) How can nets model concurrency and synchronization?
Transitions can represent competing processes, and places can represent resources, with tokens indicating the availability of a resource.

c) What is the reachability set of a net? How can you compute this set?
The reachability set R(C, u) of a net C is the set of all markings u' reachable from the initial marking m. There exist various solutions to compute that set, e.g., using a tree structure.

Exercise 11 - Task 1

Answer the following questions about Petri nets:

d) What kinds of Petri nets can be modeled by finite state processes?
Petri nets that are bounded can be modeled using FSP.

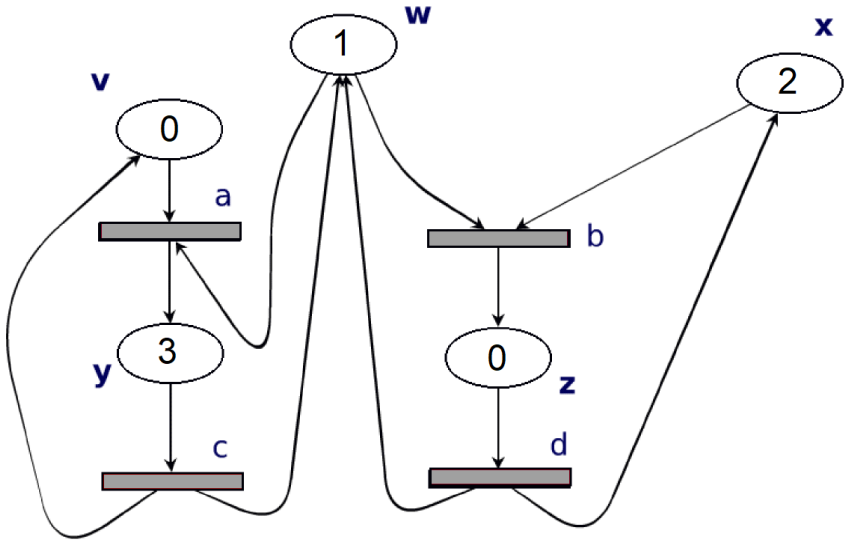
e) What are some simple conditions for guaranteeing that a net is bounded?
All transitions in the Petri net have the same number of incoming and outgoing edges

f) What could you add to Petri nets to make them Turing-complete?
Adding zero tests to the definition would be the easiest way to make the Petri nets Turing-complete.

Exercise 11 - Task 2

Perform some analysis on the provided Petri nets:

a) Provide the definition of the Petri net in figure 1.



$P = \{v,w,x,y,z\}$

$T = \{a,b,c,d\}$

$I(a) = \{v,w\}$ $O(a) = \{y\}$

$I(b) = \{w,x\}$ $O(b) = \{z\}$

$I(c) = \{y\}$ $O(c) = \{v,w\}$

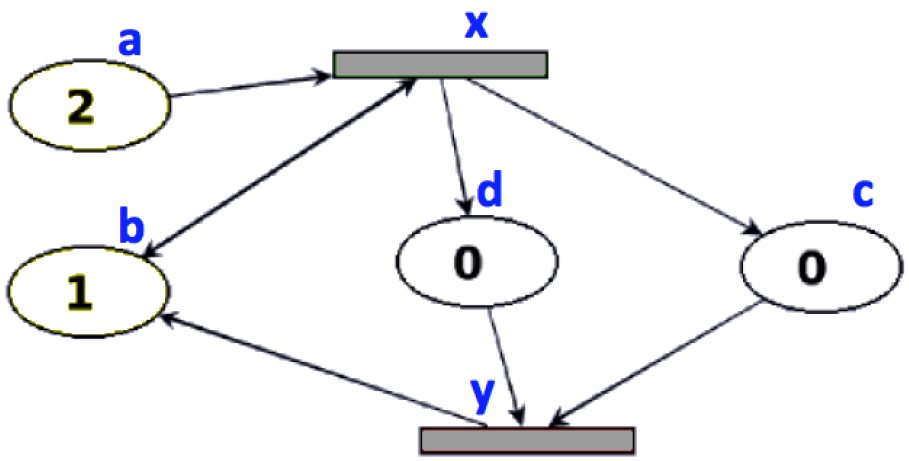
$I(d) = \{z\}$ $O(d) = \{w,x\}$

$m = \{w,x,x,y,y,y\}$

Exercise 11 - Task 2

Perform some analysis on the provided Petri nets:

b) Provide the definition of the Petri net in figure 2.



$P = \{a,b,c,d\}$

$T = \{x,y\}$

$I(x) = \{a,b\}$ $O(x) = \{b,c,d\}$

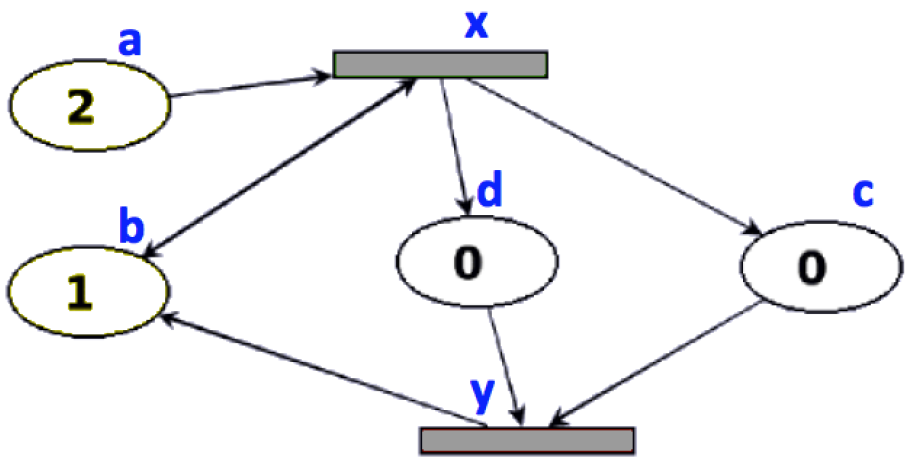
$I(y) = \{c,d\}$ $O(y) = \{b\}$

$m = \{a,a,b\}$

Exercise 11 - Task 2

Perform some analysis on the provided Petri nets:

c) Is the Petri net in Figure 2 bounded? Safe? Conservative? Are all the transitions live?



Bounded: *Yes, 3-bounded*

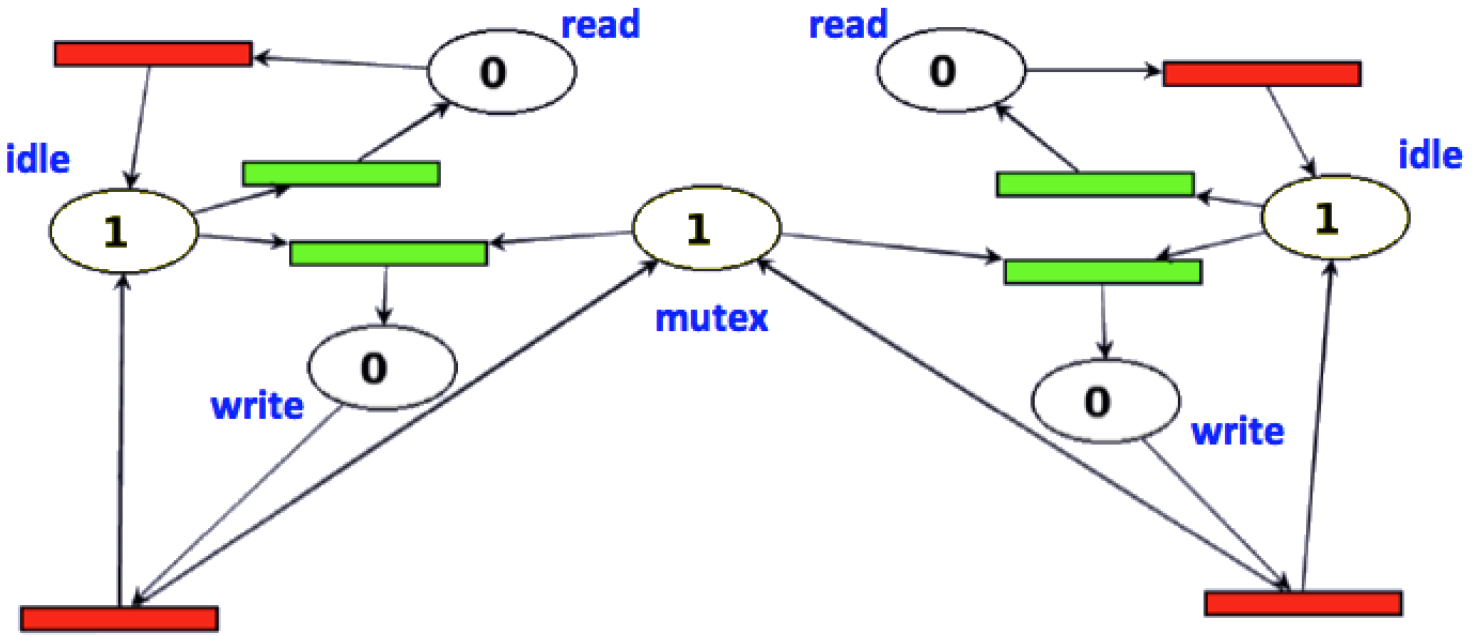
Safe: *No (see place a)*

Conservative: *No (transitions x / y)*

All T Live: *No (deadlocking)*

Exercise 11 - Task 3

Two machines need to interact with a database. The machines can read, write or stay idle. Model the situation using Petri nets ensuring that the machines cannot write at the same time.



Exercise 11 - Task 4

Answer the following questions about lock objects and threads:

a) How do the classes ReentrantLock and Semaphore support fairness?

The constructors ReentrantLock(boolean fair) and Semaphore(int permits, boolean fair) provide parameters to enable FIFO-based fairness.

b) What are daemon threads in Java? What is their purpose? How can you create them?

Daemon are threads that they will transition into the TERMINATED state as soon as all user threads terminated. They should perferrably be used for stateless or non-critical operations and can be created by calling setDaemon(true) on new threads.

Exercises 12

Preview

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Exercise 12 - Task 1

Answer the following *questions*:

a) What is a Software Architecture? What is its benefit?

b) What are the potential disadvantages when using layered architectures?

c) Provide an example in which the pattern Specialist Parallelism could be a legitimate architectural choice. Justify your answer!

d) The concepts Result Parallelism, Specialist Parallelism and Agenda Parallelism represent three ways of thinking about the problem. Can you tell on what they focus? Provide one sentence for each one of them.

Exercise 12 - Task 1

Answer the following *questions*:

e) What is a Flow Architecture? What are Blackboard Architectures?

f) Which blackboard style should be preferred when we have multiple processors? Why?

g) What are Unix pipes and how do you use them?

Exercise 12 - Task 2

Now we change roles: It is your turn to ***send me questions of topics you are still not familiar with*** for the next practical session. The best questions will be presented in front of you. I will try my best to answer all the questions you submit. For each question you ask you will retrieve a point (maximum of 3 points, no bonus this time :).

Next Time: Q&A Session

13-Dec-2017, 1200am until open-end

We will meet for the Q&A session a week before the exam.

Please prepare and submit your questions in advance to me by mail, if you have any.