VIETNAM NATIONAL UNIVERSITY, HO CHI MINH CITY
UNIVERSITY OF TECHNOLOGY
FACULTY OF COMPUTER SCIENCE AND ENGINEERING

MATHEMATICAL MODELING (CO2011)

Assignment

MATHEMATICAL MODELING and RISK ANALYSIS

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1 Member list & Workload

No.	Fullname	Student ID	Problems	Percentage of work
1	Le Thong Minh Triet	2053521	- Text Text. - Text.	40%
2	Luc Gia Hung	2053071	- Relation & Counting: 4, 5, 6 Bonus: 4, 5, 6. - Graph: 1, 2, 3, Bonus: 1, 2, 3.	20%

2 Background

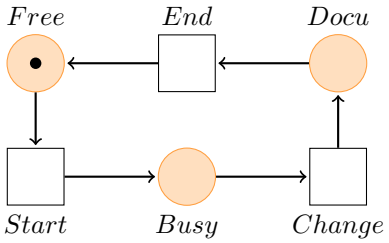
Petri nets have been in the best position to shape some foreseeable developing lines of computer science and to contribute to novel concepts like “model-based,” “ubiquitous,” “pervasive” or “disappearing” software engineering. Petri nets and their extensions are promising methods for modeling and simulating huge systems such as Clinic or Hospital systems. In this assignment, we will study the Petri nets and their applications in the context of computer science.

3 Introduction To Assignment

SCENARIO: Under a SARS pandemic where a huge lack of ICU beds occurs in city H, patients should consult specialists in the outpatient clinic of a hospital, we describe the course of business around a specialist in this outpatient clinic of hospital X as a process model, formally, we use Petri Net.

4 Solving Assignment Problem

4.1 Problem 1



(a) State: Free, Busy, Docu

Transition: Start, End, Change

(b) (i) Figure of transition system that each place cannot contain more than one token in any marking are represented below.

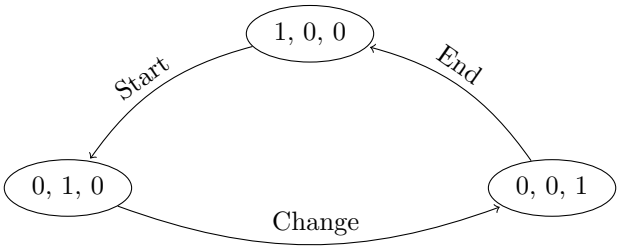


Figure 1: State of the system

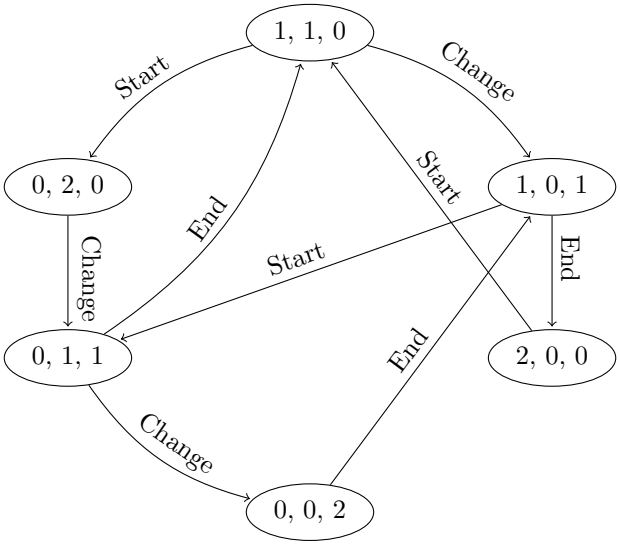


Figure 2: State of the system

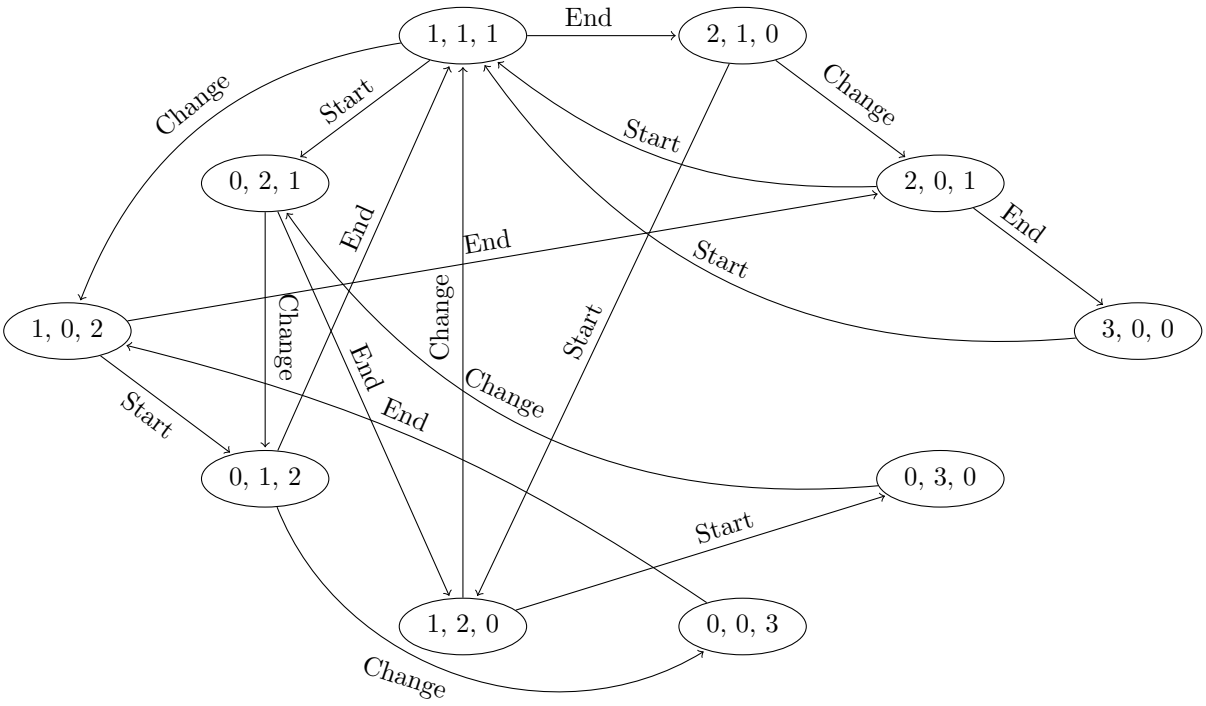


Figure 3: State of the system

(ii) According to Fig. 1, Fig. 2 and Fig. 3, every triplet (x, y, z) creates a transition system that every vertex is a triplet of nonnegative integers (x_0, y_0, z_0) such that:

$$x_0 + y_0 + z_0 = x + y + z$$

So, we can represent the transition system with the given triplet (x, y, z) by finding number of ways to write $S = x + y + z$ as a sum of three integers.

This can be solve by thinking recursively and using induction.

Let $F_k(n)$ be the number of ways to sum k natural numbers so the sum is n.

Assume we have three numbers we want to sum to 4. The number of ways to do this is the same as setting the first digit to **k= 4, 3, 2, 1, 0** in turn and then using remaining digits to sum up **k - 1**

Number of ways to write 4 with three digits =

4 + number of ways to write 0 with two digits +

3 + number of ways to write 1 with two digits +

2 + number of ways to write 2 with two digits +

1 + number of ways to write 3 with two digits +

0 + number of ways to write 4 with two digits

Which is the same as writing (in our notation):

$$F_3(4) = F_2(0) + F_2(1) + F_2(2) + F_2(3) + F_2(4)$$

For the general case we have:

$$F_k(n) = \sum_{l=0}^{n} F_{k-1}(l)$$

It is also easily seen that $F_1(n) = 1$ and $F_k(0) = 1$. This now allows us to expand the first few relations as

$$\begin{aligned} F_1(n) &= 1 \\ F_2(n) &= \sum_{l=0}^{n} F_1(l) = \frac{n+1}{1!} \\ F_3(n) &= \sum_{l=0}^{n} F_2(l) = \frac{(n+1)^2 + (n+1)}{2!} \end{aligned}$$

4.2 Problem 2

(a) Number of tokens in state N_{Pa} shows quantity of patients are treating by the specialist.

(b) Petri net N_{Pa} which contains five patients in state wait, no patient in state inside, and one patient is in state done are represented by the following graph:

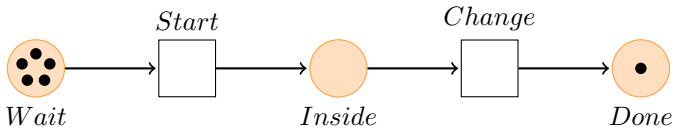


Figure 4: Petri Net for patients

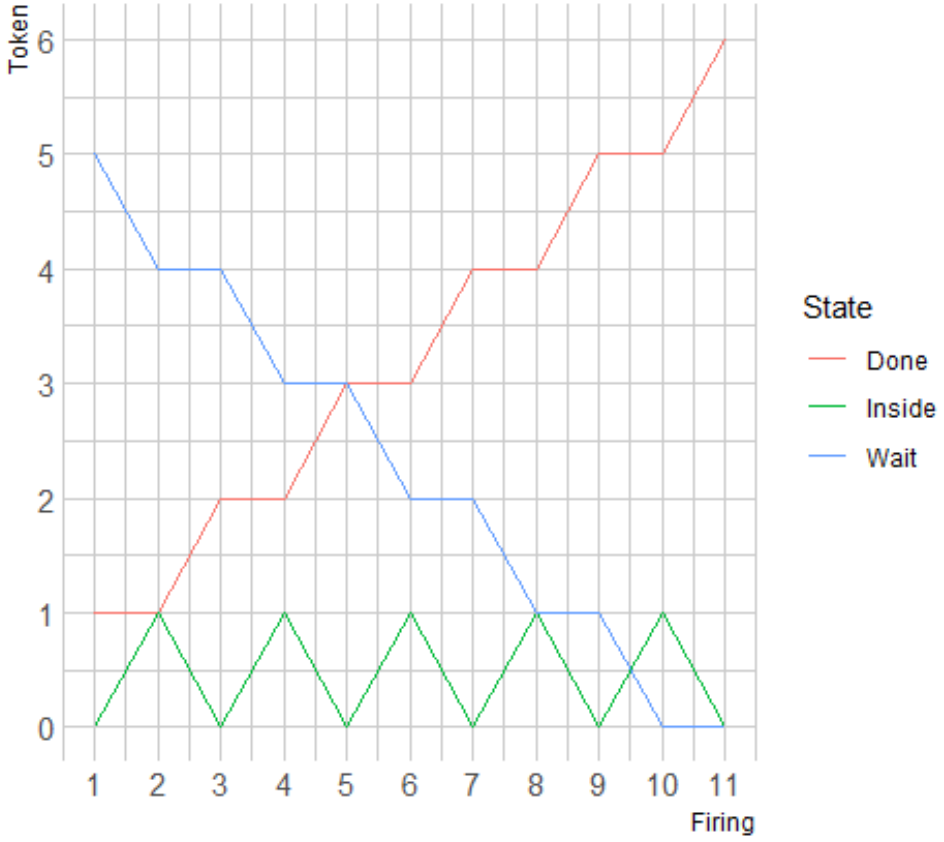


Figure 5: Marking of the Petri Net when firing

4.3 Problem 3

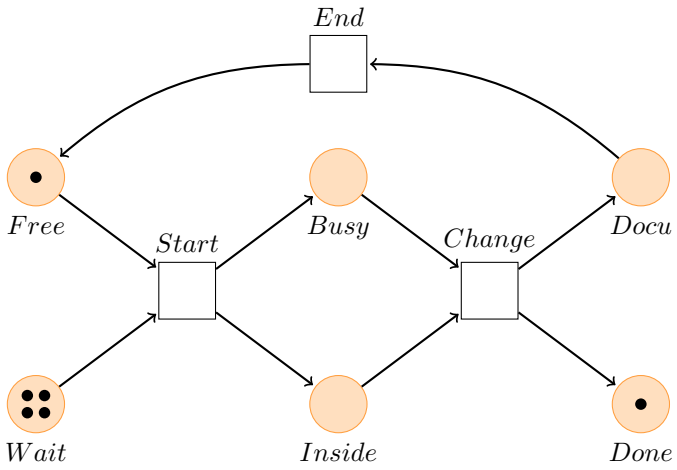


Figure 6: Petri Net for the problem 3

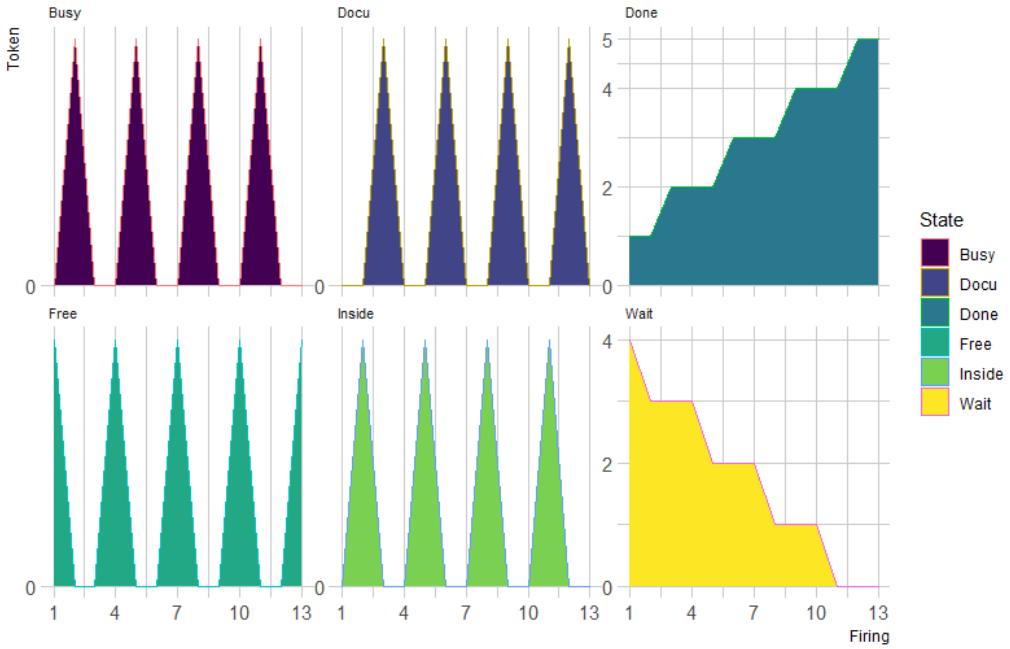


Figure 7: Marking of the Petri Net when firing

4.4 Problem 4

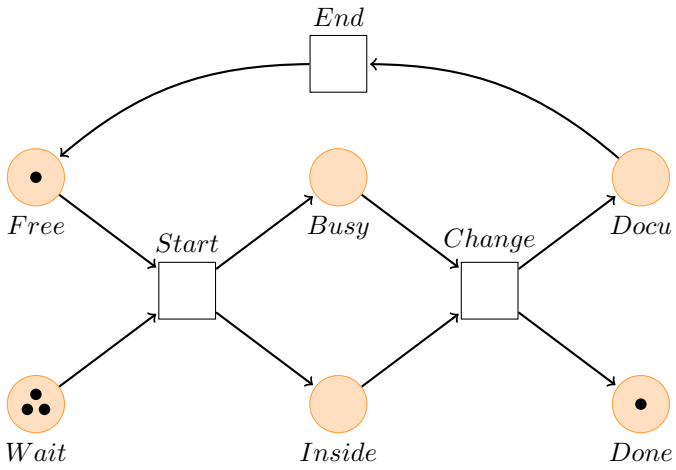


Figure 8: The Petri net for the problem 4.

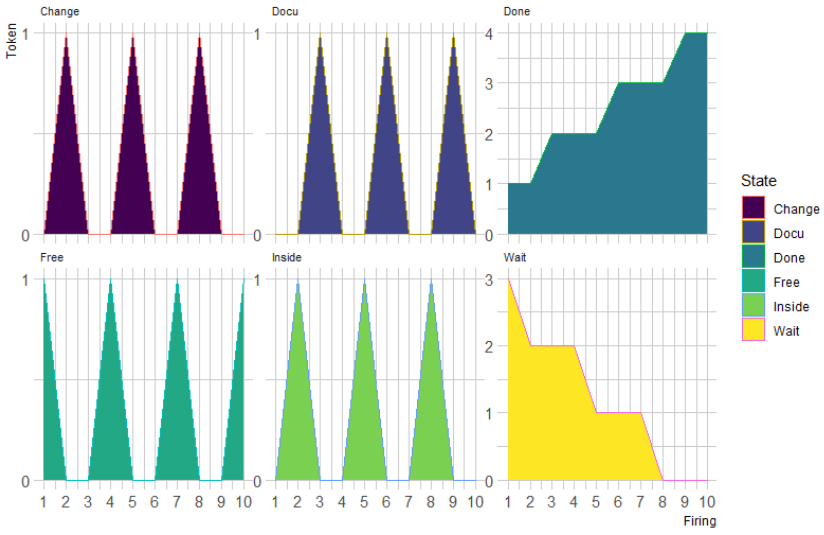


Figure 9: Marking of the Petri net when firing once

From the Fig. 9, we can see all places are reachable because there is always a sequence of steps to each place.

4.5 Problem 5

The superimposed Petri net N is not deadlock free because state Done is not the state of at least one node. Therefore, there is not a node is enabled in state Done

4.6 Problem 6

COL: INT = int

COL: SPEC = union S_1: INT + S_2: INT

var i: INT

var s: SPEC

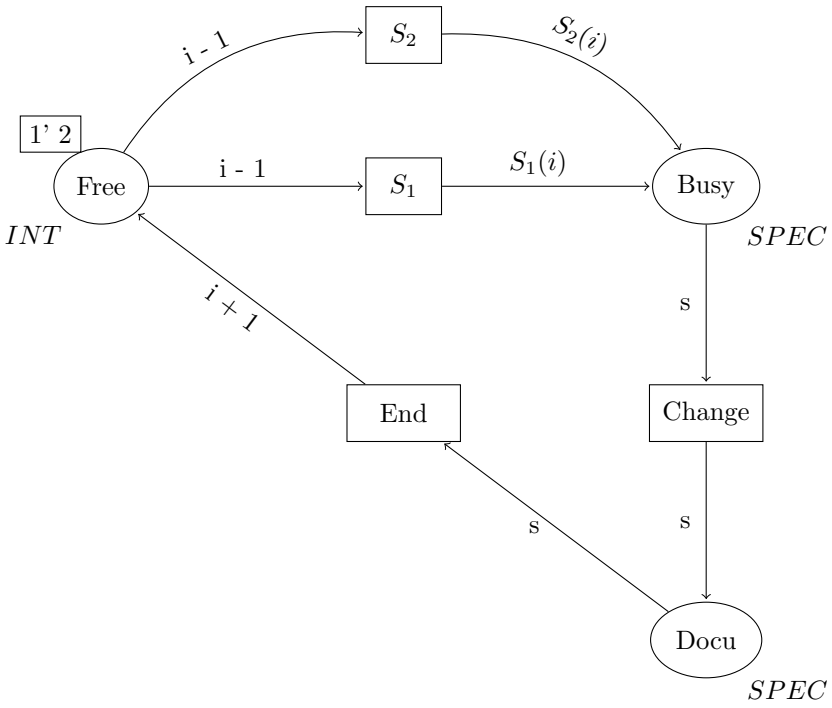


Figure 10: CPN for two specialists

ASSUMPTION:

Two specialists are distinguished and working in the same process.

There are three places in Fig. 10: Free, Busy and Docu. A transition represents an action of this business process. Graphically, a rectangle represents a transition. The CPN in Fig.. 10 has four transitions: S1, S2, Change and End.

In Fig. 10, place FREE is of type INT and two remaining places are of type SPEC

(union of two type S1 and S2). Type S1 and S2 indicate that the Specialist is $Specialist_1(S_1)$ or the $Specialist_2(S_2)$

References

[1] ...

[2] ...