Business Intelligence and Process Modelling
"Werkcollege" on Petri nets

http://liacs.leidenuniv.nl/~takesfw/BIPM

1 Modelling railway tracks

Consider a circular railroad system with four one-way tracks (1, 2, 3 and 4) and two trains (A and B). No two trains should be at the same track at the same time (and we do not care about the identities of the two trains). Model this situation using a Petri net.

2 Notation

A labeled Petri net N can be formally described using (P, T, F), where P is a finite set of places, T is a finite set of transitions and $F \subseteq (P \times T) \cup (T \times P)$ is a finite set of directed arcs. A marking M is a multi-set over P indicating the marking of N.

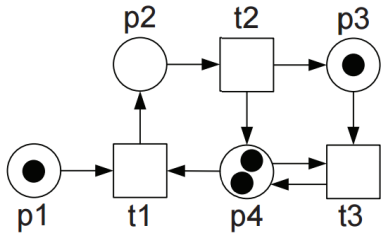

Figure 1: A Petri net.

(a) Map the labeled Petri net in Figure 1 onto $N = (P, T, F)$.

(b) Give the current marking M of the Petri net in Figure 1.

(c) Draw the reachability graph of this Petri net.

3 Modelling light switches

Consider a room with one switch and one light. The light is on or off. The switch is either "up" or "down" and changes the state of the light. Model this situation using a Petri net.

4 Manufacturing a bike

A factory produces one type of bicycles. The parts (frame, pedal, wheel, and brake) are purchased from various suppliers. The factory needs three assemblies steps to make a bicycle. First, a machine of type B assembles a frame and two pedals into semi-product 1. In the second assembly step, a machine of type A assembles semi-product 1 and two wheels into semi-product 2. In assembly step three, a machine of type B mounts two brakes (front and back) to semi-product 2. After this third assembly step, the bicycle is ready. Currently, the factory has three type-A machines and seven type-B machines available. Every machine has a capacity of one.

(a) Model this business process as a Petri net system. Distinguish between the two types of machines and whether the machines are available or not. Assume that the company has initially four copies of each part.

(b) Give a run from the initial marking to a marking where a bicycle has been produced.

5 Reachability graph

Construct a Petri net system that has the reachability graph in Figure 2. Note that states are "abstract" in the sense that they represent some division of tokens over the places.

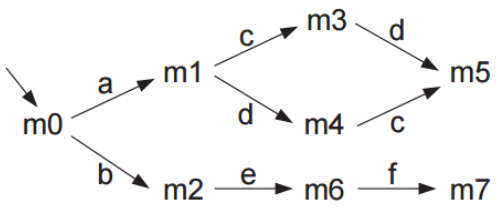

Figure 2: A reachability graph of a Petri net.

6 Manufacturing a chair

In a Petri net, we can also have multiple arcs connecting two nodes (places and transitions). The number of arcs between an input place and a transition then determines the number of tokens required to be enabled. The number of arcs determines the number of tokens to be consumed/produced.

Draw a Petri net for manufacturing a chair as shown in Figure 3. Use multiple arcs as needed. You build a chair from its components: two front legs, two back legs, five cross bars, one square seat frame and one seat cushion. Select some sensible assembly order. Think in terms of of reverse logistics.

Figure 3: A chair.

7 From finite automaton to Petri net

Any finite automaton can also be modelled using a Petri net.

(a) What regular language is modelled by the finite automaton given in Figure 4?

(b) Draw a Petri net modelling the same language.

(c) Describe how you would in general model any finite automaton using a Petri net. What properties restrictions does the resulting Petri net have in terms of the number of places, transitions and tokens and markings?

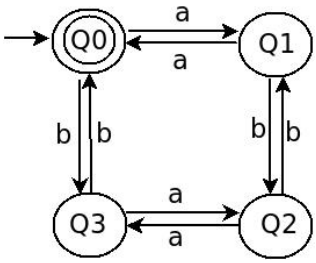

Figure 4: A finite automaton.

Exercises based on slides belonging to the course book
W. van der Aalst, *Process Mining: Discovery, Conformance and Enhancement of Business Processes*, 2nd edition, Springer, 2016. and W. van der Aalst, *Business Information Systems* course, TU/e, 2015.