

Trial and Error

Take-home SPIN problem, March 15, 2011

Deadline for solutions: April 4, 2011

1. Introduction

Your task is to model a simple system where a group of workers, by trial and error, learn to operate a few more or less advanced tools. You will also verify a few properties of the model.

2. The model

A factory employs R workers who can use N tools numbered from 1 to N . Tools with smaller numbers are more advanced and difficult to operate, i.e., if a worker can operate tool 3 then (s)he can operate all tools of higher numbers as well. Initially no worker knows how to operate any tool.

A worker comes to a tool store and takes the most advanced tool available, even if (s)he cannot operate it. The worker takes the tool from the store and begins to use it, but whenever a more advanced tool (i.e. one of a smaller number) becomes available, (s)he comes back and exchanges the current tool for a more advanced one.

A worker who does not know how to operate a tool, can break it. A broken tool must be returned to the store, where it is immediately repaired and made available to workers. The worker who broke a tool is left without a tool and must obtain one from the store.

Workers learn from their own mistakes: every broken tool extends their ability to operate one additional tool. For example, if a worker who can operate tool 7 (but not tool 6) breaks tool 3, (s)he learns to operate tool 6 (but not tool 5).

You should model this system so that the constants R and N be as easy to modify as possible. Further, use SPIN to verify the properties listed below. For verification you can use any technique provided: LTL formulas, assertions, acceptance or non-progress cycles etc.

3. Properties to verify

- 1) Does the system necessarily stops (i.e. enters a state where all workers forever keep their current tools) after finitely many steps?
- 2) Is it possible that the system stops before all workers learn to operate all tools?
- 3) Will every worker necessarily learn to operate some tool? Consider cases $N \geq R$ and $N < R$.
- 4) For $R > N$, is it possible that every worker will learn to operate tool 1?

5) Is it possible that a worker will use a tool less advanced (i.e. of a higher number) than the one (s)he used before?

6) If tool 1 becomes available, will it eventually be grabbed by some worker?

For what maximal values of N and R did you manage to perform a full verification of property 1)?