

Homework 3 - maze

In this homework, we will solve mazes using a model checker. A maze is given as a 2D grid. The shape of the corridors is given by walls, denoted by w . Letter r stands for a robot that is longing for a charging place c . The robot receives commands to move up, down, left, or right. In the subsequent step, the robot either moves in the requested direction or reports one of the following errors. If the command leads to a wall, the robot will stay at its location and report a wall error. There could also be gates $g1, g2, g3$ that are initially locked, and the robot can pass each gate only if the corresponding key $k1, k2$, or $k3$ has been already found (visited). Without the corresponding key, the robot is not allowed to enter the position with the gate and reports a locked-gate error. The maze may also contain traps t . If the robot visits a trap, it generates a trap warning and for any other subsequent move commands, it reports a trap error.

Moreover, there could be puddles p and driers d . When the robot visits a puddle, the robot's chassis soaks up the water from the puddle and starts rusting. The rusting robot reports a rust warning and needs to visit a drier in at most three subsequent steps. Otherwise, the chassis seizes up, and the robot reports a stuck error. Visiting a puddle soaks up all its water; hence, it disappears for any future visit. The robot can use a drier repeatedly.

For simplicity, let us assume the maze is surrounded by walls and that in each position, there is at most one thing.

w	w	w	w	w	w	w	w	w	w
w	k3	g2	k1	r	g1	k2	g3	c	w
w	w	w	w	w	w	w	w	w	w

(a) maze01.csv

w	w	w	w	w	w	w	w	w	w	w
w	r	k1	d			p	g1	c	t	w
w	w	w	w	w	w	w	w	w	w	w

(b) maze02.csv

Figure 1: Examples of mazes.

Build nuXmv modules for the two mazes of Figure 1. Each maze is also specified in an enclosed csv file and there are also two nuXmv files: "maze0*.smv" a template for your module and "maze0*_simple_test.smv" for testing. You can run the test by `nuXmv -pre cpp maze01_simple_test.smv`. The test is designed for checking one trace on maze01.smv. The traces with expected outputs are depicted in Figure 2 and Figure 3. Note that errors are delayed (they report an unsuccessful movement) while the warnings refer to the current robot position. Feel free to edit the nuXmv test file for deeper testing.

Please, explain the basic ideas of your construction briefly in comments or in a separate PDF report. In case of ambiguity or opacity, feel free to ask by email (rehak@fi.muni.cz) or come to consultations.

step_counter	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
dir	u	r	l	r	r	r	l	l	l	l	l	r	r	r	r	r	r	r	?
errors:																			
wall	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
locked_gate	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
trap	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
stucked	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
warnings:																			
trap_warn	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
rusting	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
drier	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
unl_g1	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	1	0	0	0
k1_found	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
unl_g2	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0
k2_found	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1
unl_g3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
k3_found	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1
charging	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
robot position	E2	E2	E2	D2	E2	F2	G2	F2	E2	D2	C2	B2	C2	D2	E2	F2	G2	H2	I2

Figure 2: The trace checked on maze01 by maze01_simple_test.smv.

step_counter	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
dir	u	r	r	r	r	r	l	l	l	r	r	r	r	r	d	r	u	l	?
errors:																			
wall	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0
locked_gate	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
trap	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1
stucked	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
warnings:																			
trap_warn	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1
rusting	0	0	0	0	0	0	1	1	1	0	0	0	0	0	0	0	0	0	0
drier	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
unl_g1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
k1_found	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
unl_g2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
k2_found	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
unl_g3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
k3_found	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
charging	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0
robot position	B2	B2	C2	D2	E2	F2	G2	F2	E2	D2	E2	F2	G2	H2	I2	I2	J2	J2	J2

Figure 3: The trace checked on maze02 by maze02_simple_test.smv.