STAR Exam

15-04-2025

- Write your answers for risk assessment exercises on **separate sheets** than for software testing!
- This exam consists of **8** exercises, each consisting of several questions. Clearly indicate which question you answer.
- The maximum score is 80 points.
- You are allowed to use a **simple calculator** (i.e. one that is not capable of storing extra notes).
- You are allowed to use a **hand-written** cheat sheet of **1 page A4** (double-sided).

Risk Assessment

Note: write your answers for risk assessment exercises on separate sheets than for software testing!

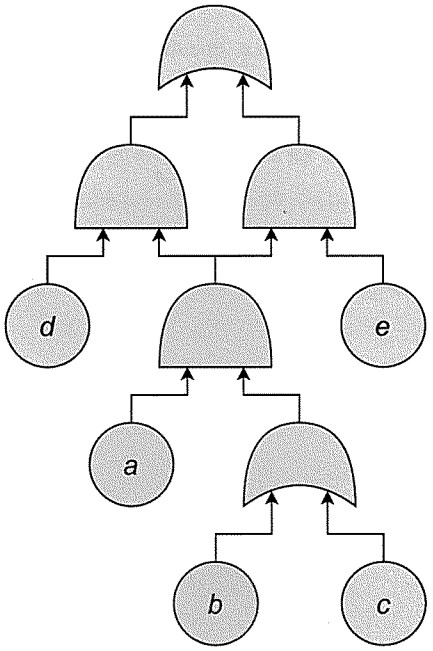
Exercise 1 (Risk management)

(a) (2pts) Give an advantage of using FMEA for risk management over fault trees.

(b) (2pts) Give an advantage of using fault trees for risk management over FMEA.

(c) (6pts) Suppose that your objective is to organize a home-made dinner for your housemates. Give three risks associated with this objective, and for reach risk a strategy to handle that risk. State unde which of the main risk handling strategies your strategy falls, and sketch the risks and their strategies on the risk matrix.

Exercise 2 (Static fault trees) Consider the fault tree below.



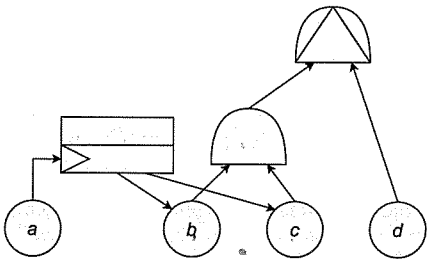
(a) (2pts) List all of its minimal cut sets.

(b) (2pts) Suppose $p_a = p_b = \frac{1}{2}$ and $p_c = p_d = p_e = \frac{1}{4}$. Approximate the failure probability using the cut set method; explain your answer.

(c) (4pts) Give the binary decision diagram of this fault tree, with variable ordering $a < b < c < d < e$.

(d) (3pts) Use the binary decision diagram to calculate the failure probability of the fault tree; explain your answer.

Exercise 3 (Dynamic fault trees) Consider the dynamic fault tree below. Its basic events a, b, c, d have failure rates $\lambda_a, \lambda_b, \lambda_c, \lambda_d$, respectively.



(a) (6pts) Represent this DFT as a Markov chain with at most 6 states, and give its transition matrix.

(b) (3pts) Now suppose $\lambda_a = \lambda_b = \lambda_c = \lambda_d = 10$. Suppose the system has been running without any basic event failure for 40 days. What is the probability that b will not fail for the next 20 days?

Software Testing

Note: write your answers for software testing exercises on separate sheets than for risk assessment!

Exercise 4 (Testing in SE)

(a) (2pts) Name one difference and one similarity for automated testing and model-based testing, with respect to the spent effort by the tester.

(b) (2pts) In Test-Driven-Development, a test is run before the feature is implemented. Why is this done?

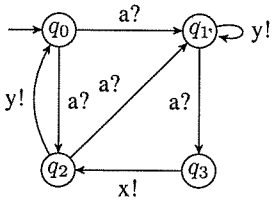
(c) (4pts) The following Java method computes a grade for an imaginary course. Provide a test suite with a minimal number of tests, such that:

- the test suite has 100% branch coverage,
- each test calls `courseGrade` only once, and
- you apply boundary value analysis on all your tests.

```
1 public double courseGrade(double exam, double project, boolean homeworkDone) {
2   if(exam >= 5.0 && exam < 5.5 && homeworkDone) {
3       return 0.5 * exam + 0.5 * project + 0.5;
4   } else if(exam >= 5.5) {
5       return 0.5 * exam + 0.5 * project;
6   } else {
7       return exam;
8   }
9 }
```

(d) (4pts) Draw a flow diagram of the code of above method, and explain why your tests provide 100% branch coverage.

Exercise 5 (LTS) Consider the following LTS:



(a) (1pt) Which states are quiescent? Shortly motivate your answer.

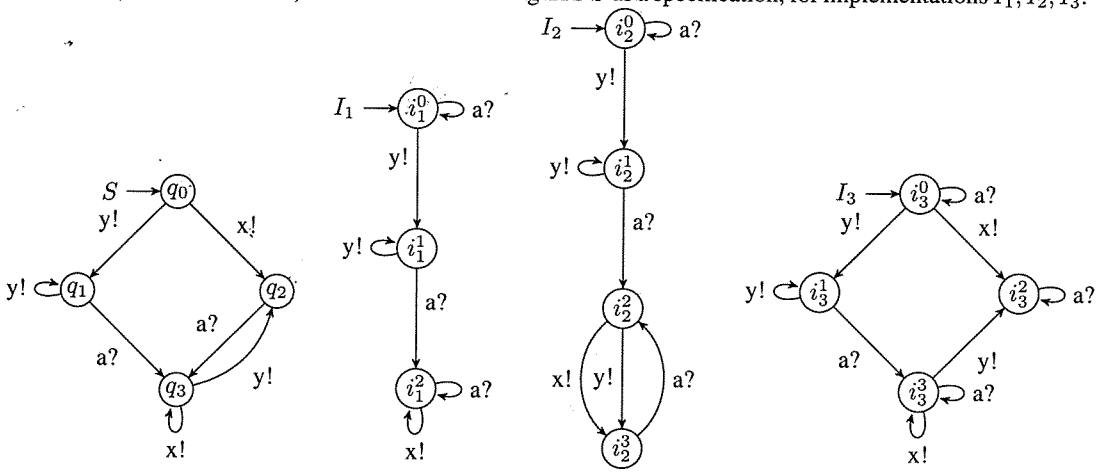
(b) (4pts) Compute the following:

- q_0 after a?
- q_0 after a? a? y!
- q_0 after a? x!
- q_3 after x! a? a?

(c) (4pts) Create a test case, using batch test generation. As a first choice the batch test generation algorithm chooses to take input a?. The test case should detect which nondeterministic a? transition from q_0 was taken: at each of the Pass states that is generated at the last step of the batch generation algorithm, denote which a? transition of the LTS has been taken as the first input.

Exercise 6 (Modeling)
(6pts) Create an STS (i.e. its graphical representation) that models a room with a thermostat, heating and airconditioning. The thermostat initially is set to the temperature of 18 degrees, and the room has the same temperature. The set temperature can be increased or lowered by the user, within bounds: between 10 and 30 degrees. If the room temperature is lower than the set temperature, heating is turned on to increase the room temperature. If the room temperature is higher than the set temperature, airconditioning is turned on to lower the room temperature. Note that you do *not* need to take into account any timing behaviour, changes may happen instantly. Also, you do *not* need to take into account that the room temperature changes by itself over time (e.g. because it is cold outside).

Exercise 7 (ioco & test cases) Consider the following LTS S as a specification, for implementations I_1, I_2, I_3.



(a) (9pts) For each of the implementations I_1, I_2, I_3:

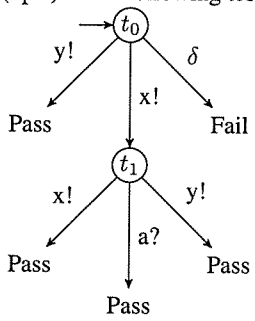
(i) State whether it is ioco to S.

(ii) If ioco does not hold, give a test case that could detect the non-conformance. Clearly indicate at what state of your test case the bug has been found.

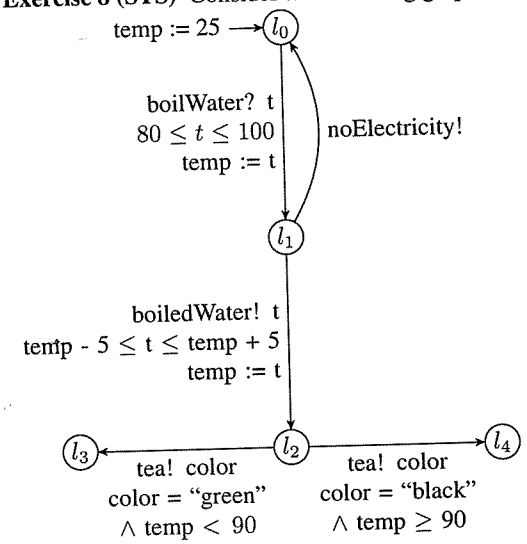
You may assume that the implementation will be fully cooperative, i.e. if there is a choice between several transitions, it will take the one that leads to the bug. Do ensure that your test case is of the format as explained in the lecture.

(iii) If ioco does hold, give an explanation why this is the case.

(b) (3pts) Is the following test case sound for LTS S? Motivate your answer.



Exercise 8 (STS) Consider the following graphical representation of an STS in this exercise:



(a) (4pts) Write down the formal definition of the switches of the STS.

(b) (5pts) Write down the symbolic execution graph of the STS, up to level 3, i.e. take all valid sequences of three switches from the initial state of the graph.

(c) (2pts) Write down a test trace so that the switch from l_2 to l_3 is covered.