Exam *Software Testing And Risk assessment*

April 18, 2023, 13:45–16:45

Remarks

- Please provide all answers in English.
- Please write your name on all sheets of paper you want marked.
- You are allowed a 1 A4 cheat sheet, double printed/written.
- The maximum score is 41 points; your grade is calculated by $\texttt{grade} = 1 + \frac{9}{41}\texttt{\#points}$.

Good luck!

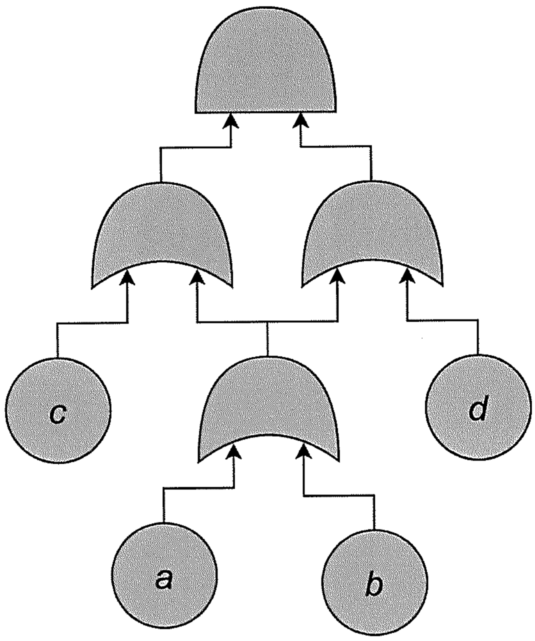
1 Risk management (5 points)

1. (1 point) What are the four main strategies for handling risk? One of these has two sub-strategies, what are these?
2. (2 points) Name one disadvantage for defining risk as *probability times impact*.
3. (2 points) Of each of the scenarios below, categorize under which risk handling strategy it falls, of the 5 you have identified in 1.1. Explain your answer, and also tell what risk is being handled.
   (a) Cycling through a red light to be on time for your STAR exam.
   (b) Setting an extra alarm clock to wake up in time for your STAR exam.
   (c) Not going to your STAR exam because of a tornado warning.
   (d) Hire someone to do your STAR group project for you.

2 Static fault trees (7 points)

Consider the fault tree below.

1. (1 point) List all of its minimal cut sets.
2. (1 point) Suppose $p_a = p_b = 0.25$ and $p_c = p_d = 0.5$. Approximate the failure probability using the cut set method; explain your answer.
3. (3 points) Give the BDD of this fault tree, with variable ordering $a < b < c < d$.
4. (2 points) Use the BDD to calculate the failure probability of the fault tree; explain your answer.

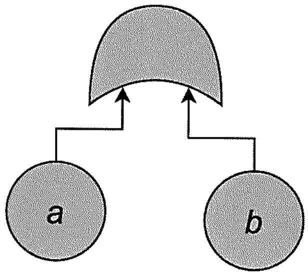


3 Exponential distributions (5 points)

1. (1 points) Consider a device whose failure time is exponentially distributed with $\lambda = \frac{1}{60 \text{ days}}$. Suppose the device has been working for 120 days already and has not failed yet. What is the probability of it continuing to function for another 60 days? Explain your answer.

2. (3 points) Consider the fault tree below. Suppose the failure times of a and b are both exponentially distributed, with rates λ and μ respectively. Given a time $t \geq 0$, find an expression for the probability $\mathbb{P}(\text{top event has failed at time } t)$ in terms of λ, μ, and t. Explain your answer.

3. (1 point) Show that the failure time of the top event is exponentially distributed. What is its failure rate? explain your answer.



4 Black box testing (5 points)

Consider the function `int accumulated_growth(int x, double y,int z)` that given positive integers x and z and positive real y, determines the least nonnegative n such that $x \cdot y^n \geq z$. Inputs where such an n does not exist are not allowed.

1. (2 points) Using equivalence partitioning, divide the input into suitable equivalence classes. Explain your answer. You may assume this function has already been type checked, so you do not have to check for non-integer values or the wrong number of arguments.
2. (1 point) Give a test suite that covers all equivalence classes described above.
3. (2 points) Extend your test suite using boundary value analysis. Explain your answer.

5 White box testing (6 points)

Consider the following program, that computes $\sum_{i=1}^{|N|}(ai + b)$ for an integer N and nonnegative integers a, b:

```
    int LinearSum(int a, b, N)
    if(a < 0 || b < 0){
1     return("error!");
    }
    else{
      if(N < 0){
2       N = -N;
      }
3     i = 0;
4     sum = 0;
      while(i < N){
5       i = i+1;
6       sum = sum + a*i+b;
      };
7     return(sum);
    }
```

For each of the following, either give a test suite that that specifies the given description (and show that it does so), or explain why this is not possible:

1. (2 points) A test suite that provides statement coverage but not decision coverage;
2. (2 points) A test suite that provides decision coverage but not statement coverage;
3. (2 points) A test suite that provides condition coverage but not decision coverage.

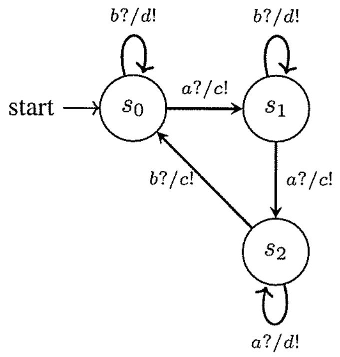
By coverage we mean 100% coverage. We consider the numbered lines to be the statements of this piece of code.

6 Mealy machines (6 points)

Consider the Mealy machine below.

1. (2 points) For each state, give a UIO sequence that is as short as possible. Explain your answer.
2. (1 point) Give a distinguishing sequence for this Mealy machine. Explain your answer.
3. (1 point) Give a transition test for the transition $s_2 \xrightarrow{b?/c!} s_0$.
4. (2 points) Under what assumptions on the implementation is a full transition testing suite:
   (a) sound?
   (b) complete?

   Explain your answer.



7 QLTS (7 points)

Consider the QLTS $\mathcal{I}$ and $\mathcal{Q}$ below; they have input set $L_I = \{a?, b?\}$ and output set $L_O = \{c!\}$.

1. (1 point) Give a test T with at least 2 **fail** states and 2 **pass** states such that $\mathcal{Q}$ passes T.
2. (1 points) Is $\mathcal{I} \sqsubseteq_{\text{ioco}} \mathcal{Q}$ defined? Explain your answer.
3. (2 points) Does $\mathcal{I} \sqsubseteq_{\text{ioco}} \mathcal{Q}$ hold? Explain your answer.
4. (3 points) Let $\mathcal{A}$ and $\mathcal{B}$ be two QLTS such that $\mathcal{A}$ is input-enabled, and obtained from $\mathcal{B}$ by removing some of its transitions (their set of states, initial states, and input and output sets are also the same). Is it true that $\mathcal{A} \sqsubseteq_{\text{ioco}} \mathcal{B}$? Give a proof or a counterexample.