

System Modelling – 2nd Mid-Term (example)

9th May 2017

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Exercise 1	/13
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Sum:	/35

Name:

Neptun code:

Entry test (10 points)

Question	1				2				3				4				5			
	A	b	c	d	a	b	c	d	a	b	c	d	a	b	c	d	a	b	c	d
Answer																				

Question	6				7				8				9				10			
	A	b	c	d	a	b	c	d	a	b	c	d	a	b	c	d	a	b	c	d
Answer																				

You have to pass the entry test with at least 5 points out of the 10, otherwise you fail the whole mid-term exam independently of the results of the two main exercises.

Answer the questions by indicating **in the table above** for each answer whether they are **true (T)** or **false (F)**. Correction is accepted as long as it is denoted unambiguously. The number of true answer varies from block to block; it is possible that all answers in a block are true, that or all are false. Each answer (e.g. 2.c) is worth ¼ point if it is correct, 0 point if it is left blank, and -¼ if it is incorrect. The final score given for the whole quiz, however, is at least 0. Note that due to the scoring system, random guessing is not profitable.

1. An infinite loop (livelock) ...
 - a) ... may also occur in a well-structured process model.
 - b) ... cannot occur, if the process model is fully specified.
 - c) ... means that the system cannot leave a given state without diverging from the model, and cannot show any input/output behaviour.
 - d) ... means that the system cannot leave a given partition of the state space (e.g. a loop) without diverging from the model, but it can make state changes within that partition.
2. Modelling environments ...
 - a) ... may display different parts of a model with different concrete syntaxes.
 - b) ... always work with graphical concrete syntaxes, because only code generators and programming languages have a textual syntax.
 - c) ... differ from code generators in that they do not work with concrete syntaxes, while code generators work with graphical concrete syntaxes.
 - d) ... may check the structural correctness by executing static analysis on the abstract syntax, even during editing.
3. A runtime monitor ...
 - a) ... only checks the outputs of the system.
 - b) ... checks the input and output invariants during the execution.

- c) ... substitutes testing, because it is able to prevent the application from faulty operation during execution.
 - d) ... is part of the system that was made based on its specification.
4. Test coverage ...
- a) ... is the measure of the conformity between the expected and experienced output.
 - b) ... is a value between 0 and 1.
 - c) ... can be increased by adding new test cases.
 - d) ... may reach the value of 1, which means that the model/code guaranteed not to contain any errors.
5. Model checking ...
- a) ... checks the model for a random sample of inputs.
 - b) ... mathematically proves the correctness of the model.
 - c) ... requires less computational power than running a test suite, because it does not requires the actual execution of the model.
 - d) ... can show a counterexample if a given requirement is not satisfied by a model.
6. The visitation number of an elementary activity in a process ...
- a) ... is the proportion between throughput and the maximum throughput of the activity.
 - b) ... is the proportion between the throughput of the activity and that of the whole process.
 - c) ... is *less or equal* than its throughput.
 - d) ... is equal to the arrival rate in the stable state.
7. The maximum throughput of a process that is a composition – with any arbitrary control elements – of the elementary activities P and Q (with maximum throughputs X_P és X_Q , respectively) ...
- a) ... is $\min(X_P, X_Q)$, if P and Q are the two branches of a fork-join block.
 - b) ... is $(X_P + X_Q)$, if the choice between P and Q is free.
 - c) ... is always equal to the maximum throughput of the bottleneck from P and Q.
 - d) ... is always $\min(X_P, X_Q)$.
8. Assume that we are analysing the shoe size, the eye colour and the study level (BSc, MSc, PhD) of the individual students.
- a) The shoe size is an ordered categorical variable.
 - b) The eye colour is an ordered categorical variable.
 - c) The study level is an ordered categorical variable.
 - d) The study level is a numerical variable.
9. Assume that we are analysing the shoe size and the results of the two mid-term exams (sum of the total points) of the individual students.
- a) If, when visualizing the two variables on a parallel coordinates diagram, we experience that the broken lines are all parallel to each other, then each student has got exactly that many points on the two exams together, as his shoe size.

- b) If, when visualizing the two variables on a parallel coordinates diagram, we experience that the broken lines are all parallel to each other, then there is a linear dependency between the total exam result and the shoe size of the students.
- c) If, when visualizing the two variables on two histograms, we experience that the two diagrams look identical, then the total exam result of each student are equal to his/her shoe size.

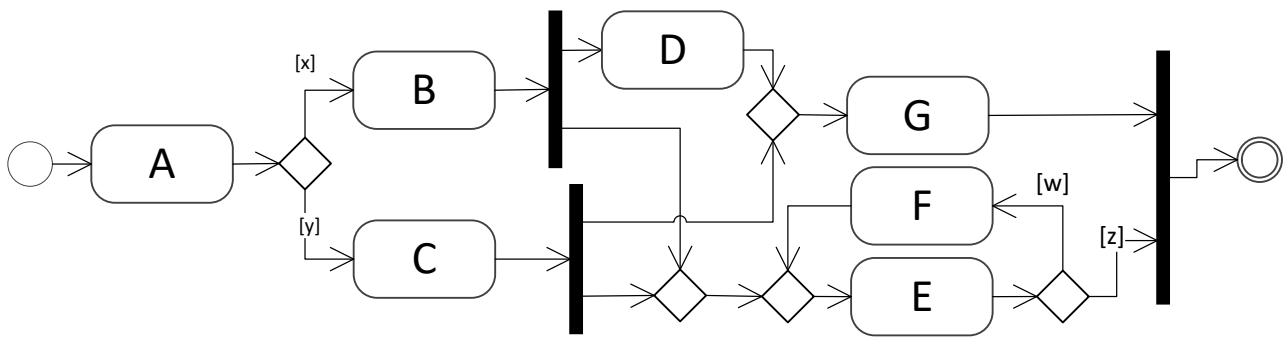
10. The median...

- a) ... is identical to the 2nd quartile, and to the 50th percentile.
- b) ... is always greater than the mode, and less than the average.
- c) ... is explicitly shown on the boxplots.
- d) ... is only defined if the number of the data is odd.

The first exercise can be found on the next page.

Exercise 1 – Analysis of Behavioural Models (13 points)

Consider the process model shown on the below diagram.



We analyse the process.

- What constraints shall be specified for the guards of the model to make it fully (and free of contradictions) specified and deterministic? (2 points)
- What further constraints shall be specified to ensure that the process will always terminate, that is, that no deadlock or livelock can occur in it? (3 points)
- In the following, we assume the above constraints being specified. We check whether the system's operation satisfies the requirements by executing tests. While executing test case t_1 , y and z are true all the time. What will be the activity coverage of this test case? (2 points)
- When executing our whole test suite, we experience that the guards x and w are true in two cases out of three, while the guards y and z are true in one case out of three, in average. Determine the visitation number of each elementary activity in the model (3 points)
- Abstract the model by substituting the loop (as a well-structured block) in the model by an elementary activity H. How many different options do we have during making the abstraction? What test coverage can be reached by t_1 in the abstract model? (3 points)

The second exercise can be found on the next page.

Exercise 2 – Simulation, Data Analysis, and Performance Modelling (12 points)

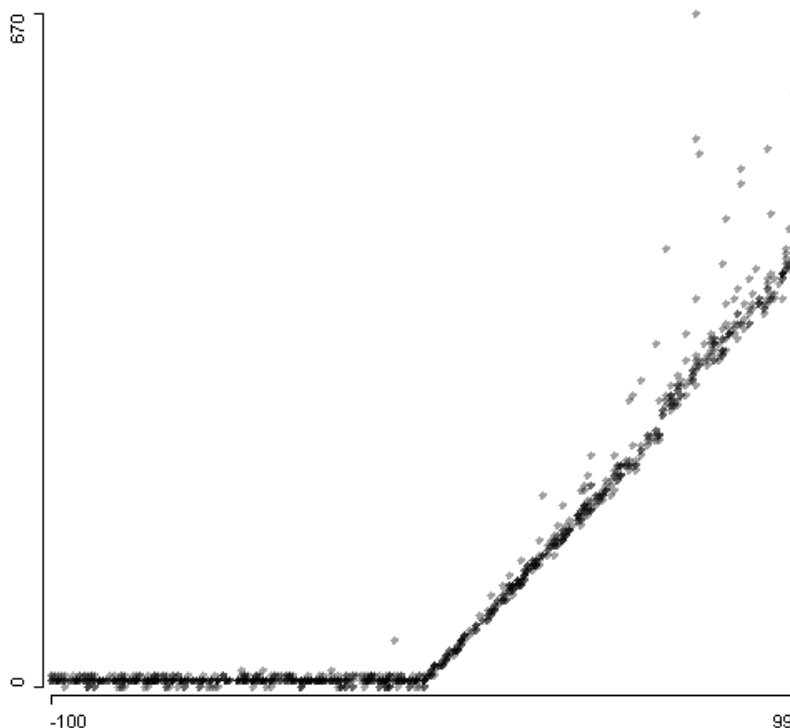
Analyse the following simple function.

```
void f(int a) {
    while (a > 0)
        a--;
}
```

- Draw the control flow graph of the function. (2 points)
- Assuming that the evaluation of the condition of the decisions takes 1 ms, and the execution of the instruction „a--“ takes 3 ms processor time, simulate the execution for the values $a = (-4, -2, 0, 2, 4)$. Draw the execution for $a=2$ by completing the below time diagram, and also compute the total execution times for the other values. (3 points)



- The below scatter plot diagram shows the data collected during the real execution of the function. On the horizontal axis the values of „a“, on the vertical axis the execution times in ms are shown. Considering the content of the function, explain the grouping and position of the dots, the shape of the scattering. (3 points)



- According to our measurements, the average (over the different possible values of parameter „a“) execution time of the function is 100 ms. Assuming a single core processor, determine the maximum throughput of the system that executes this function only. (2 points)
- During a 20 seconds measurement we have seen that the processor was busy for 12 seconds in total. What was the throughput of the system during the measurement? (2 points)