Specification of Information Systems (192330301) Examination

31st January 2013

Explain your answers, but keep them precise: short and to the point.

Problem	a	b	c	d	e	f	
1	3	6	2	3	3	4	21
2	4	4	8	4			20
3	5	4	4	6			19
4	4	4	4				12
5	6	6	6				18
							90

Grade $= (10 + \text{points})/10$

1. a. Discuss the difference between a reactive and a transformational system.

    b. Reactive systems have three kinds of functionality: Information provision, direction, manipulation. Define these kinds of functionality and give an example of each.

    c. Consider the three basic reactive functionalities: Information provision, direction, and manipulation. Describe and explain which notations you would use for which kind of functionality.

    d. The subject domain of a reactive system changes when we add or remove functions from the system. Explain this effect and give an example of changes when adding and removing functions.

    e. What is the structure of the system engineering argument? Give an example.

    f. Explain how the system engineering argument can be used to bound the context of the system, i.e. to find out where the boundary of the context is.

Figure 1: Some ERDs.

2. Figure 1 on page 1 a fragment of the ERD of a keypass entry system such as the one in use at the University of Twente. After signing an

employment contract, an employee can acquire an employee pass, that can then be registered in the building access permissions database, which registers the permissions of the employee to unlock particular doors on the campus. If an employee loses his or her pass, access permissions of the pass are blocked and a new card is issued.

    a. Make two versions of figure 1, (i) one with snapshot cardinalities and (ii) one with historical cardinalities. Briefly explain the diagrams.

    b. Doors give access to building, and sometimes connect two buildings in a corridor. Each building has at least one door. Each door has one or more card readers that can sense a pass and open the door if the pass has permission. Represent this information in an ERD, including snapshot cardinalities.

    c. Students have access to some doors too, using their student pass. It is possible for an employee to become a student, and also for a student to become employee. And a student-employee can finish his or her studies or terminate his or her job at the university. There are two ways to represent these possibilities in an ERD, by dynamic subtypes or by roles. Make two adapted versions of figure 1,

      (i) one with dynamic subtypes and

      (ii) one with roles, each with the proper cardinalities.

    Explain the meaning of each diagram briefly in words.

3. The building access permission database of question 2 has the following functionality:

    – Register employee cards and de-register cards that are no longer valid (because the card was lost or the employee left the organization).

    – Same, for student cards.

    – Add or delete an access permission for an access point to/from a card

    – Upload access points from the building database

    – Verify the status of employees with the HRM system

    – Verify the status of students with the student registration system

Use this information to answer the following questions:

    a. Define the concept of a service by describing the four components of a service description. Use one or more of the above functions as example.

    b. Draw a context diagram for the building access permissions database system.

    c. Some communication channels in the context diagram really represent physical interactions. Explain what a physical interaction is, and represent these in the context diagram by bold lines. Explain why the non-physical interactions are symbolic.

    d. It is debatable whether persons and buildings are part of the context of the system For each of these (persons and buildings) give an argument why it is part of the context and an argument why it is not part of the context.

e. What are the consistency relations between the subject domain ERD and context diagram of a system? Use the subject domain ERD and the context diagram of the building access permission database system as examples.

4. a. What is the difference between an event list entry in transactional form and in scenario form?

b. why can en event list entry in scenario form be transformed into transactional form?

c. Explain how a nondeterministic event list entry can be disambiguated

5. This question is about the teabag boxing system used as an example in the exercises of the book. The following case description is taken from the book.

> The packaging department of a tea company boxes teabags in fully automated packaging cells. Tea bags arrive on a conveyor belt and then drop on a balance, which weighs the bag. A robot arm picks up the bag from the balance, and if the bag's weight is inside a certain interval, it puts the bag in a box. If the weight is outside the interval, it puts it in a separate container. If the box is full, the conveyor belt is stopped and the robot arm replaces the full box with an empty one. When the box is changed, the belt is started again. The device interfaces are as follows: The conveyor belt accepts start belt and stop belt commands. The balance sends a teabag weight message to the controller when a teabag drops in it. The robot arm accepts commands remove teabag and put in box and responds to these with a teabag moved signal, and it accepts a replace box command and responds to this with a box replaced signal. There is an operator that can set the desired weight of the teabags and the required number of bags in a box. Starting and stopping the packaging cell is outside the scope of the controller. You are to design the software that controls the robot arm and interfaces with the operator. The robot arm has a processor and the operator has a workstation.

Figure 2 shows a state transition table for teabag removal. The variable "required" is the required teabag weight, "max" is the maximum number of teabags in a box, and "current" is the current number of bags in a box. For simplicity, we do a straightforward comparison of the weight "w" with the required value.

a. Transform the table in figure 2 into a Mealy diagram with local variables. Start by listing the states of the diagram.

b. Although there is a definite sequence to the events, we nevertheless for clarity decide to split the Mealy diagram into two parts, one for teabag removal and one for box replacement. Transform the Mealy diagram into a statechart with two parallel substates, that deal with teabag removal and box replacement, respectively.

c. Is the statechart equivalent to the Mealy diagram?

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required: Rational
current, max: Natural

Initially		current := 0	Ready to receive tea bag.
Stimulus	**Current controller state**	**Controller response**	**Next controller state**
tea bag arrives(w)	Ready to receive tea bag, w = required	put in box, current := current +1	Waiting for tea bag to be put in box
	Ready to receive tea bag, w ≠ required	remove teabag	Waiting for tea bag to be put in container
teabag removed	Waiting for tea bag to be put in box, current ≥ max	stop belt, replace box	Waiting for box to be replaced
	Waiting for tea bag to be put in box, current < max		Ready to receive tea bag
	Waiting for tea bag to be put in container		Ready to receive tea bag
box replaced	Waiting for box to be replaced	start belt, current := 0	Ready to receive tea bag

Figure 2: A state transition table.