Assignment #1. Due October 16 (Thursday), 2014, in class. Start early as this is much more time consuming exercise than you might initially think. If you cannot attend the class, please arrange submission with TA. Do not hesitate to discuss with TA all the problems as soon as you discover them.

Almost all questions will refer to an Elevator System described below. The Elevator System is considered a benchmark for evaluating the applicability of requirements and specification techniques and tools to real life problems. It illustrates the kind of informal specifications that a systems analyst or software engineer must translate to a computable form.

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ELEVATOR SYSTEM
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An elevator system is to be installed in a building with m floors. The elevator and the control mechanisms are supplied by the manufacturer. The internal mechanism of these are assumed (given). The problem concerns the logic to move elevators between floors according to the following constrains:

a. Each has a set of buttons, one for each floor. These illuminate when pressed and cause the elevator to visit the corresponding floor. The illumination is cancelled when the corresponding floor is visited by the elevator.

b. Each floor has two buttons (except the ground and the top floors), one to request an up-elevator and one to request a down-elevator. These buttons illuminate when pressed. The illumination is cancelled when the elevator visits the floor and is either moving in the desired direction, or has no outstanding requests. In the latter case, if both floor requests buttons are pressed, only one should be cancelled. The algorithm to decide which to service first should minimize the waiting time for both requests.

c. When an elevator has no requests to service, it should remain at its final destination with its doors closed and await further requests (or model a “holding” floor).

d. All requests for elevators from floors must be serviced eventually, with all floors given equal priority (can this be proved or demonstrated?).

e. All requests for floors within elevators must be serviced eventually, with floors being serviced sequentially in the direction of travel (can this be proved or demonstrated?).

f. Each elevator has an emergency button which, when pressed causes a warning
signal to be sent to the site manager. The elevator is then deemed “out of service”. Each elevator has a mechanism to cancel its “out of service” status.

There is a lot of imprecision and ambiguity in the above description. Let us comment on some of them. Let us focus our attention on point 2. First, we read that every floor except the first and the last, has two buttons. There is no implication here - or elsewhere in the specification - that rules out as incorrect an implementation where the first floor has 9 buttons and the last one 4. However in this case we may say that there is one “obviously correct” interpretation, so let us go further into the analysis of point 2. The rule states:

“The illumination is cancelled when the elevator visits the floor and is either moving in the desired direction, or ...”

This sentence can be interpreted in at least two different ways. Consider an elevator going up (the case when the elevator is going down is symmetric.) Then the rule could mean either of the following:

a. Switch off the up button as soon as the elevator reaches the floor coming from below (this interpretation has as exception if the floor is the first or the last one).

b. Switch off the up button after an elevator reaches the floor and starts moving to the up direction.

By examining different elevators, we can see that both interpretations have been used in practice. In general, one does not realize the ambiguity in the sentence like above until one builds a formal model of it. Notice also the imprecision in the following requirement:

“The algorithm to decide which to service first should minimize the waiting time for both requests.”

There are two possible interpretations:

- In no other way should it be possible to serve either request in a shorter time. This interpretation could be infeasible: minimizing the waiting time of one request could require a longer waiting time for the other request;

- The sum of the two waiting times should be minimized. But why just the sum?

Even worse, the waiting time that is forecast at the moment of making the decision could be changed by the coming of other requests during the service. For imagine that, at floor 2, we decide to go up with and elevator to serve a request issued at floor 60, but when going up, the elevator stops for a new call issued at floor 40. This new call was not anticipated when it was decided to choose the elevator that was chosen to serve the original request.
QUESTIONS

1. On page 22 of the textbook and page 7 of Lecture Notes 2 you have a formal description of the door opening problem for train. It was proved in class on the blackboard that SYSREQ can be derived from SOFREQ, DOM and ASM.

   a. In this example SESREQ is defined as

   \[ \text{TrainMoving} \Rightarrow \text{DoorClosed} \]

   What this requirement says when \( \neg \text{TrainMoving} \)? Is this specification complete, correct? Elaborate this problem.

   b. Provide a similar formal description of the car door opening problem in lifts. Prove that

   \[ \text{SOFREQ, DOM, ASM} \Rightarrow \text{SYSREQ} \]

   i.e. SYSREQ is derived from SOFREQ, DOM and ASM. Discuss validity and completeness of your solution.

2. Assume the system-to-be is an elevator system in 15 floors five stars hotel with an outdoor swimming pool on the last floor, two restaurants on 14 floor, spa, gym and indoor pool on floor -1, shops and reception on ground floor, conference rooms on floor 2 and parkings on floors -2 and -3. The chain does not have a similar hotel, the closes one that can be used as a system-as-is has only 6 floors, indoor swimming pool on 6th floor, restaurant on ground floor, gym and spa in the basement and parking is outdoor. Prepare a set of interviews for acquiring knowledge about the elevator system-as-is and for eliciting requirements on the elevator system-to-be. To achieve this,

   (a) identify the set of stakeholders to be interviewed and explain why each of them is relevant to the elicitation process;
   (b) for each interviewee, determine the purpose of the interview and the type of information to be acquired;
   (c) design a structured set of questions for that purpose and that interviewee;
   (d) identify open tracks that might be worth exploring at the end of the interview.

3. Identify the functional and non-functional requirements. For classification of non-functional requirements use the pattern from Lecture Notes 3.

4. Provide one positive (normal), one negative scenario and one abnormal (positive) scenario.
5. Find two weakly conflicting requirements and a boundary condition that makes these requirements strongly conflicting. Usually one requirement represents the customer/guest point of view, another represents stuff or owner point of view (one lift reserved for stuff, not all lifts cover everything, etc.). Explore alternative resolutions for the problem.

6. Identify two risks, provide their severity of consequences using tables like Table 3.2 in the textbook. Also provide a fault tree (like Figure 3.3) for the risk you consider bigger.

7. Use your imagination and provide a sample of DDP risk management for the elevator system. Do all calculations and provide appropriate comments.

8. This is the only question that does not refer to the elevator problem. Consider the criteria from Table 3.7, page 110 of the textbooks (names assigned to columns and rows). Rank them but instead of using AHP method, use *Pairwise Comparisons as described in Lecture Notes 10.*