Software Systems Design Test
14 December 2017, 8:45–11:45

Program: Technical Computer Science / Business & IT, University of Twente
Module: 201700117 Software Systems
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- Different questions will be graded by different persons. Therefore we ask you **to use a separate sheet for each question** (not the back side of another question).
- You are allowed to consult the manual and a printed version of the slides. It is not allowed to consult other materials – including your own notes.
- Diagrams can be drawn with pen or pencil as you like.
- When you are ready, please hand in only the answers to the questions. You can take the test with you.

Questions 1–4 relate to the following case description.

Bicycle Lease Administration

More and more we live in a service-oriented society, where customers pay for services, rather than acquire goods. Lease cars have been around for a while, but these days you can also lease washing machines and all kinds of other things. The Federation of Bicycle Dealers in the Netherlands has recognized the trend and developed a master plan for bicycle lease to support its members' bicycle shops. Market research has shown that there is large potential for bicycle leasing, ranging from the very high-end (businessmen in big cities who want a brand new looking bicycle with perfect service) to the very low-end (people whose bicycle was stolen and cannot afford a new one right now).

You are requested to design parts of an information system that is needed to realize this plan. In this description we concentrate on the leasing and service process. To keep the model limited in size (for this test) we will ignore all financial transactions as well as some low-level details.

There is a range of different standard contracts for bicycle lease. All contracts will include periodic service, every 6 or 12 months (depending on the age of the bicycle), where the dealer inspects and services the bicycle as appropriate. There are contracts which include all repairs, whenever something gets broken, and contracts without repair. Apart from the price difference, some people find it more convenient to repair a punctured tyre themselves, rather than to bring the bicycle to a repair shop.

In the most expensive lease contracts, the customer will be provided with a brand new bicycle every few years. Then the bicycle will be called for service as usual but rather than servicing the bicycle, the dealer replaces it with a new one. (The not-so-brand-new bicycle will then be leased (cheaper) to another customer or sold off.)

Customers can access the system through the website of the Federation or by means of a dedicated app. If you want to lease a bicycle, you can select one of the bicycles which the dealers (bicycle shops) have on offer. You select a bicycle from a particular dealer and one of the standard lease contracts.

The dealer will then make an individual contract. You are requested to sign the contract when you pick up the bicycle from the dealer. Contracts have a specific start date but possibly no end date. A customer who wants to terminate the lease can notify the dealer (though the website or app), who will formally terminate the contract.

When service is due, i.e., the specified period has nearly elapsed, the system will automatically notify the customer. The customer should bring the bicycle to the dealer within 4 weeks. The dealer then services the bicycle (or replaces it) and updates the administration accordingly.

If customers fail to bring forward their bicycle for inspection within 4 weeks, they will automatically receive a reminder. This reminder states that service is overdue, that the customer has a contractual obligation to have the bicycle serviced, and that the lease contract will be terminated if they do not comply within another 4 weeks.

If indeed the customer does not come for the overdue service in this period, the system will notify the dealer and the dealer will terminate the contract. (*What happens next is out of our scope. If the customer fails to bring back the bicycle the dealer could turn it over to a collection agency, but this does not need to be modelled.*)

Bicycles can suffer from major or minor breakdowns. If a lease bicycle needs repair, the customer can contact any bicycle shop to do the repair. This could be the dealer, but it could be another bicycle shop if that is more convenient, e.g. nearer to the location of the broken bicycle. When a leased bicycle is offered for repair, the repair shop will look up in the system what the specific conditions in the lease contract are and accepts the repair. (*We ignore the case that the repair would be refused*). When the repair is done, the repair shop enters into the system the nature and date of the repair as well as the costs. (*If the contract includes repair the costs will eventually be refunded by the dealer*).

Unfortunately, a lot of bicycles get stolen. If this happens, the customer should report this (through app or website) as soon as possible.

The insurance – included in every lease contract – will pay out to the dealer if certain conditions have been fulfilled (e.g. the customer can hand in both original keys of the prescribed lock that mounted on the bicycle). If the insurance conditions were not kept, the customer must refund the market value of the bicycle.

It may happen that a stolen bicycle is recovered by the police, but chances are so small that for the lease procedure it is assumed that a stolen bicycle will never return. Depending on the specifics of the lease contract, two things can happen when a bicycle gets stolen: the dealer will either terminate the contract or provide a comparable bicycle as a replacement.

Question 1 (Activity Diagram) [2 points]

Draw an activity diagram for the leasing and servicing of a bicycle, from the selection of a bicycle by the customer to the termination of the contract.

Question 2 (Use Cases) [1.5 points]

Please note: if someone accesses the system though an app, in a narrow interpretation of 'system' the app would be the actor. At this level of abstraction it is more convenient to make no distinction between accessing the system directly or by means of an app (i.e., we consider the app to be part of the system's interface just like the website).

2a (Actor list) [0.3 points]

Make an actor list for the proposed system.

2b (Use case diagram) [1.2 points]

Draw a use case diagram for the lease and service process.

- You do <u>not</u> have to include use cases for activities that don't relate to the lease and service process (such as bicycle shops uploading descriptions of bicycles that can be leased).
- Also, you do <u>not</u> have to include auxiliary use cases to look up things in the system, like "Find Contract" (comparable to "Find Booking" in the Theatre Tickets case) as illustrated in Figure 1.

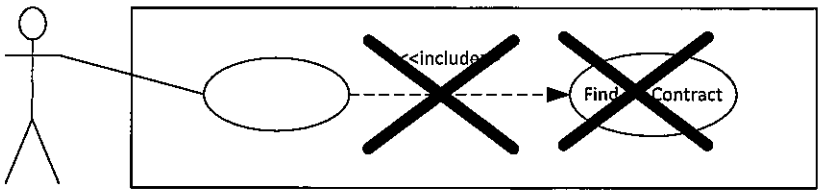

Figure 1: There is no need to include auxiliary use cases to look up things

Question 3 (Class Diagram) [3 points]

Draw a class diagram for the proposed system.

In addition to what was mentioned in the case description above, take the following information into account:

- For a customer is known: surname; first name; address; postal code; telephone number; ID number (passport or driver's license).
- A bicycle is characterized by: brand name; model name; wheel size of the model; a verbal description of the model; price (new) of the model; frame number; lock key number; production date; whether or not it is available for lease; market value; sundry remarks; whether or not the bicycle has been stolen.
  For E-bicycles, additionally, the battery type of the bicycle model is known.
- For a bicycle shop (whether it is the dealer who leases the bicycle or the shop who carries out a repair makes no difference) the following information is stored: name of the shop; address; location; telephone number.
- There are different kinds of lease contracts, identified by the following information: whether or not repairs are included in the lease price; a text with lease conditions. Furthermore, the price per month is determined by two parameters, depending on the type of contract: a fixed price plus a fixed percentage of the market value of the bicycle.
  Individual lease contracts are identified by a unique contract number.
  A contract is for one customer but can relate to more than one bicycle: when the customer gets a new bicycle every few years, the contract does not change, but it is known for which period (start and end date) the contract applied to which bicycle.
  For a single bicycle there can be different contracts as well; if the contract with one customer has been terminated, it can be leased to another customer.
- For each repair is known: the bicycle; a description of the repair; the date; the costs; the bicycle shop which carried out the repair.
  For each periodic service (always carried out by the dealer) is known: the contract; the date; remarks about the service provided.

Question 4 (State Machine) [2.3 points]

The description on page 1–2 focussed on the lease process from the perspective of the lease contract: the activity diagram ends when the lease contract is terminated. For the state machine we shift the perspective somewhat, and look at the state of a bicycle. If a lease contract is terminated, the bicycle could be made available for another lease.

Draw a state machine for the state of bicycle. Please take into account service and repair as described on page 1–2, as well as the following information:

(see next page)

- When a bicycle is replaced according to the contract (for a customer who gets a new bicycle every year), it is not immediately available for another lease. The dealer has to do two things: (1) service the bicycle as usual, so that it is in a state that it could be leased again, (2) making it available for lease by uploading a new description to the web site, possibly with a different lease price. The order of these steps is not determined. A dealer could do the service directly or postpone it until a new customer is interested.
- When a lease is terminated, the dealer determines whether the bicycle is still suitable for further lease. If not, the bicycle is written off, i.e., withdrawn from the system. If the bicycles I still suitable for further lease, it is handled the same as in the above case, i.e. the dealer can first service the bicycle and then make it available for lease or the other way round.
- When a bicycle has been stolen, there is a possibility that it will be recovered by the police. If this happens, the bicycle is not immediately available for lease (the original lease contract no longer applies anyway – either it was terminated or the customer got another bicycle). Depending on its physical state, it is written off or it is made available with the same two steps as in the cases above.
  If a stolen bicycle is not recovered within a year, it will be written off automatically, as chances for its return are practically zero by then.
- At any time the dealer can withdraw a bicycle that is available for lease (when someone wants to buy it, or when no customer wanted it for a long time). You may assume that withdrawn bicycles are not entered into the system again.

Hint: please note that actions related to the periodic servicing of a bicycle are independent from actions related to lease status and intermediate repairs.

Question 5 (Software Metrics) [1.2 points]

5a (Coupling) [0.4 points]

1. What maintenance problems are caused by high afferent coupling (CA)?
2. What maintenance problems are caused by high efferent coupling (CE)?

5b (Cyclomatic complexity) [0.8 points]

Consider the following Java method

```
public int getIndexOf(List<String> list, String element) {
      int i = 0;
      while (i < list.size() && !list.get(i).equals(element)) {
            i = 1 + 1;
      }
      if (i < list.size())
            return i;
      else
            return -1;
}
```

3. Draw the flow graph for getIndexOf, taking into account that the &&-operator in a composite condition implies that the right-hand side operand is evaluated only if the left-hand side operand yields **true**.
   How can the cyclomatic complexity (CC) be computed from this graph? Which value do you get for CC?

4. In fact it is possible to rewrite the method `getIndexOf` in such a way that the cyclomatic complexity would be lower. What would you change to achieve that?