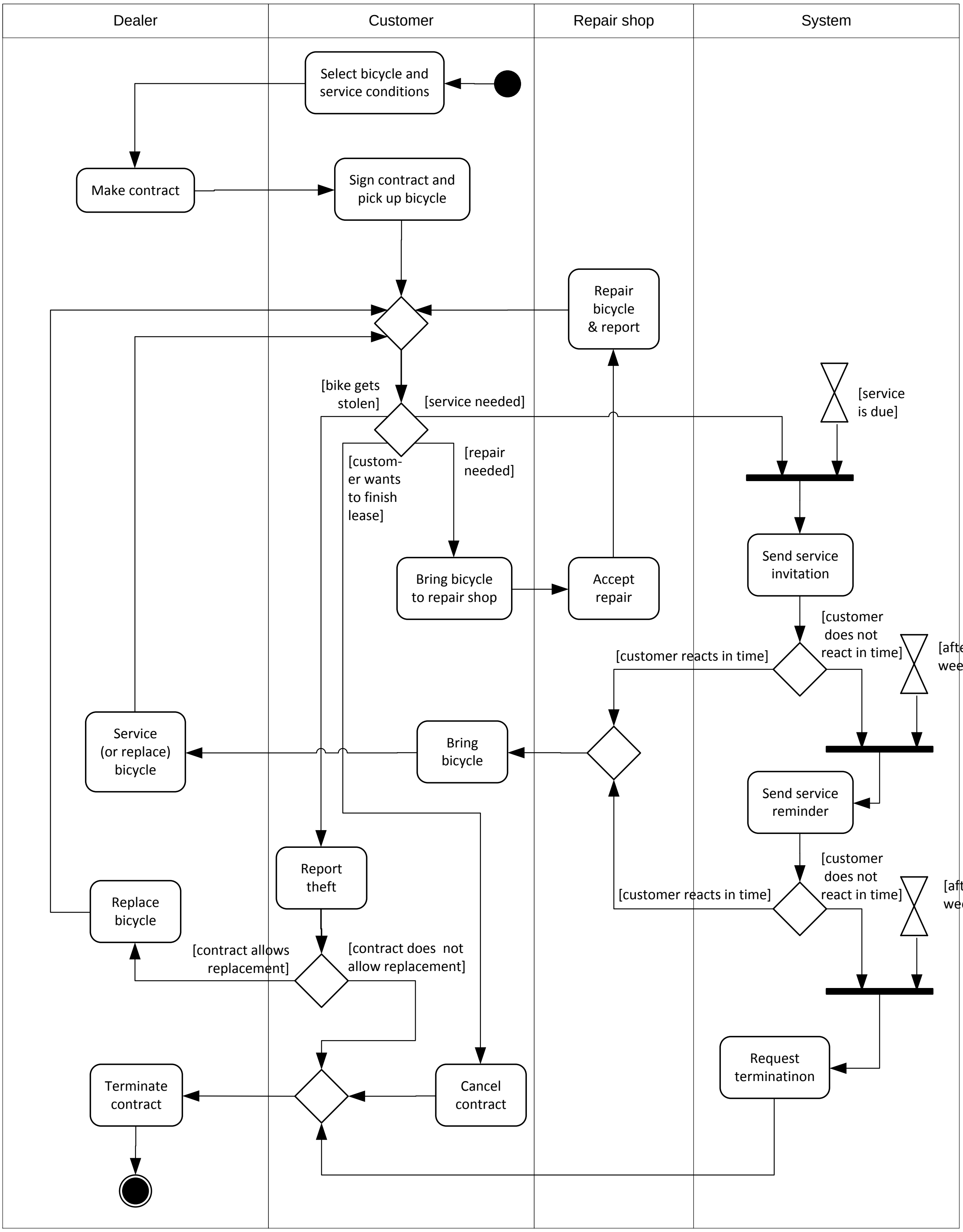
# Solutions to the Software Systems Design Test
# 14 December 2017

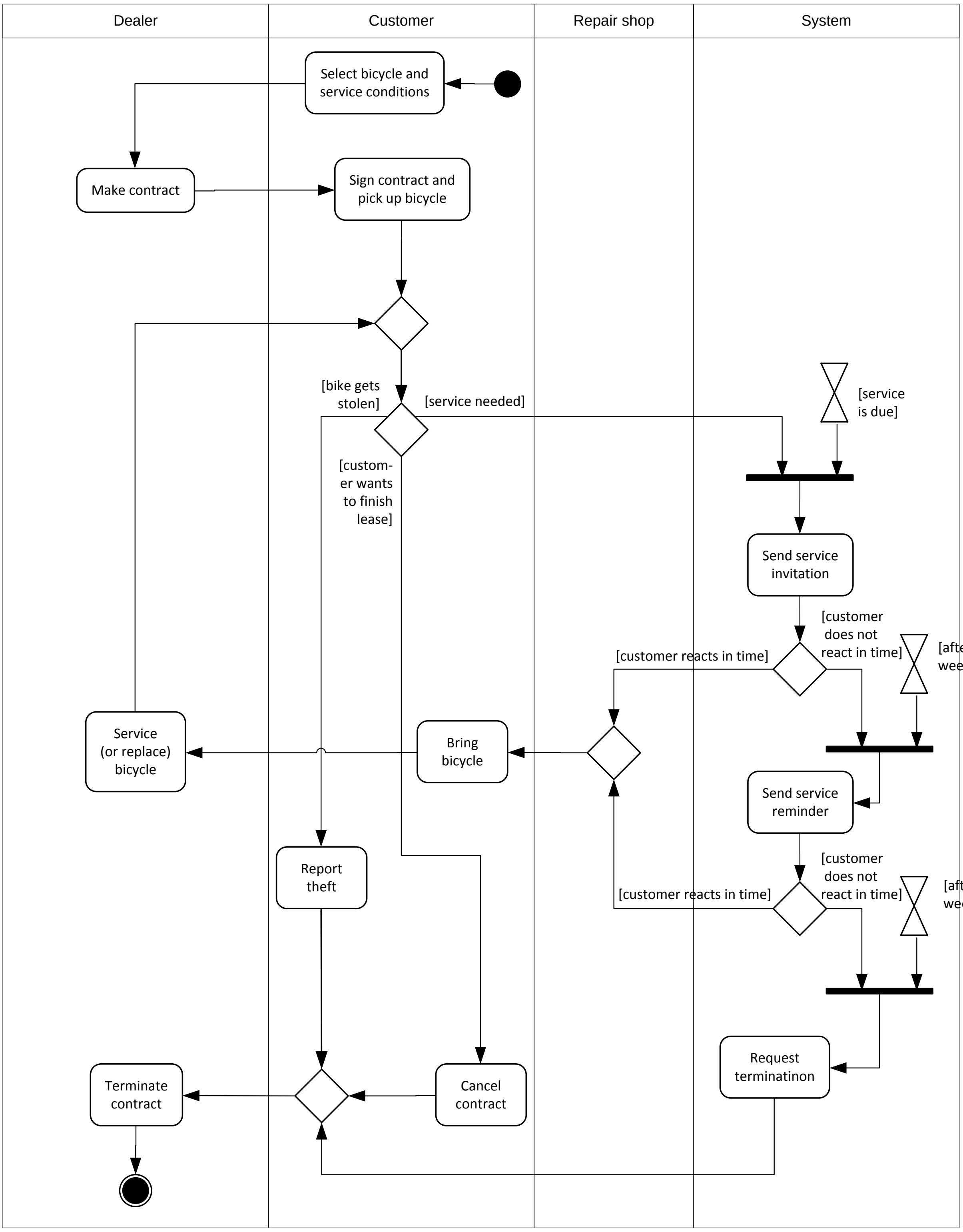
## Question 1 (Activity Diagram) [2 points]

The standard solution is given below. See page 2 for an alternative solution for a possible different interpretation of the question.


Dealer
Customer
Repair shop
System
Select bicycle and service conditions
Make contract
Sign contract and pick up bicycle
Repair bicycle & report
[bike gets stolen]
[service needed]
[service is due]
[custom- er wants to finish lease]
[repair needed]
Bring bicycle to repair shop
Accept repair
Send service invitation
[customer does not react in time]
[customer reacts in time]
[after 4 weeks]
Service (or replace) bicycle
Bring bicycle
Send service reminder
Report theft
[customer reacts in time]
[customer does not react in time]
[after 4 weeks]
Replace bicycle
[contract allows replacement]
[contract does not allow replacement]
Request terminatinon
Terminate contract
Cancel contract

However, the question turned out to be ambiguous. The intention was to model *everything* from the selection of a bicycle to the termination of a contract. It could also be interpreted as *only activities related to leasing and servicing* (i.e., not included repairs and replacing the bicycle when it gets stolen). This interpretation yields the activity diagram below. (Stealing is still included as it may lead to termination of the contract).

***All tests have been graded for both alternatives, so that solutions according to the second interpretation still could get 100 % of the points. For those who chose the first interpretation, the higher of both grades counts.***

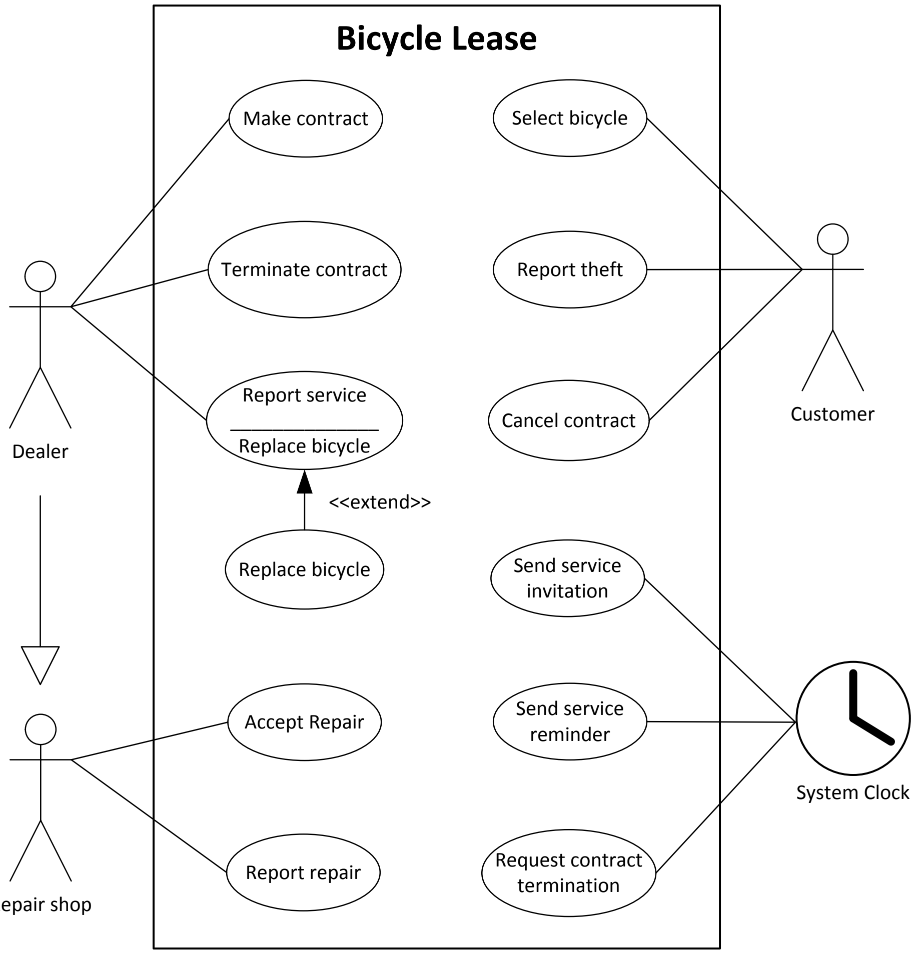

Dealer
Customer
Repair shop
System
Select bicycle and service conditions
Make contract
Sign contract and pick up bicycle
[bike gets stolen]
[service needed]
[service is due]
[custom-er wants to finish lease]
Send service invitation
[customer does not react in time]
[customer reacts in time]
[after 4 weeks]
Service (or replace) bicycle
Bring bicycle
Send service reminder
Report theft
[customer does not react in time]
[customer reacts in time]
[after 4 weeks]
Request terminatinon
Terminate contract
Cancel contract

## Question 2 (Use Cases) [1.5 points]

### 2a (Actor list)

| ***Actor*** | ***Description*** |
|---|---|
| Customer | Person who leases a bicycle |
| Dealer | Bicycle shop which leases the bicycle to the customer |
| Repair shop | Bicycle shop which carries out repair.<br>Could be dealer or other bicycle shop |
| System clock | Sends notifications about service |

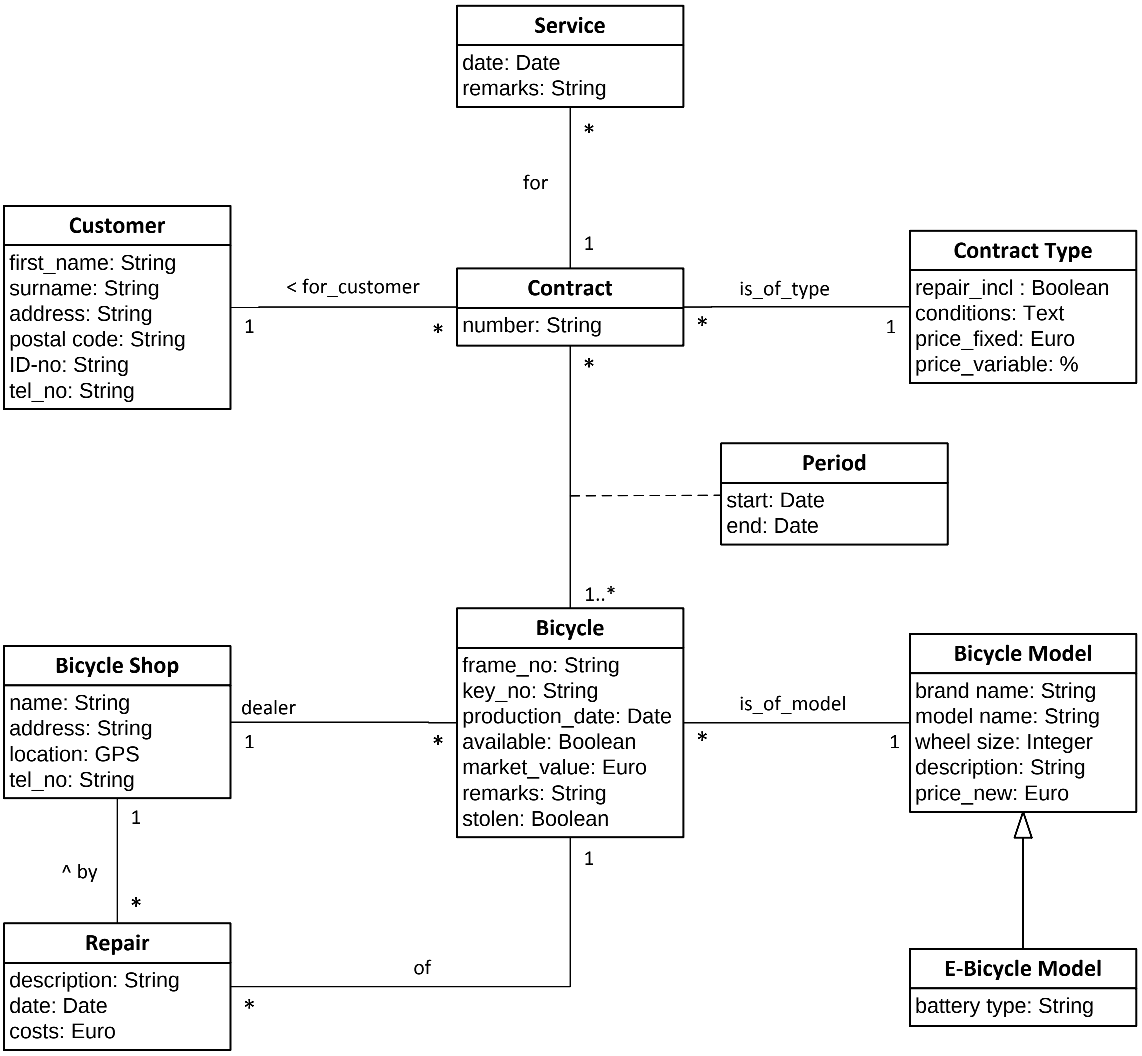
### 2b (Use case diagram)



Remarks:

- Please note the generalization: A Dealer can do all the activites of a Repair shop, but not the other way round. (Dealer and Repair shop are different roles of a bicycle shop. Not every bicycle shop who does repairs is also a dealer of lease bicycles.)
- Replace bicycle is a proper extension. High-end customers get a new bicycle every few years rather than servicing their current bicycle. This comes with some extra administrative work for the dealer.

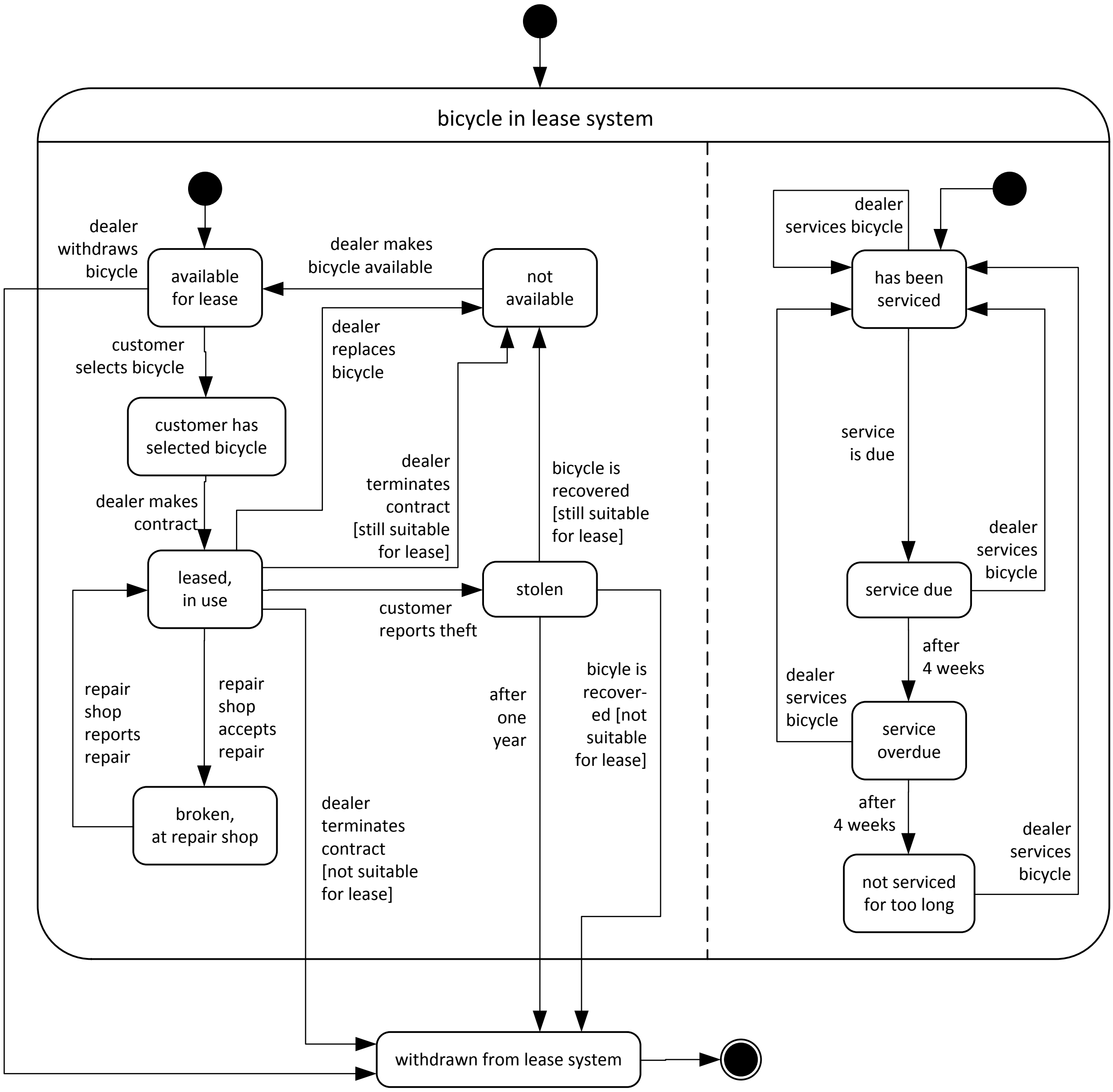
## Question 3 (Class Diagram) [3 points]



Remarks:

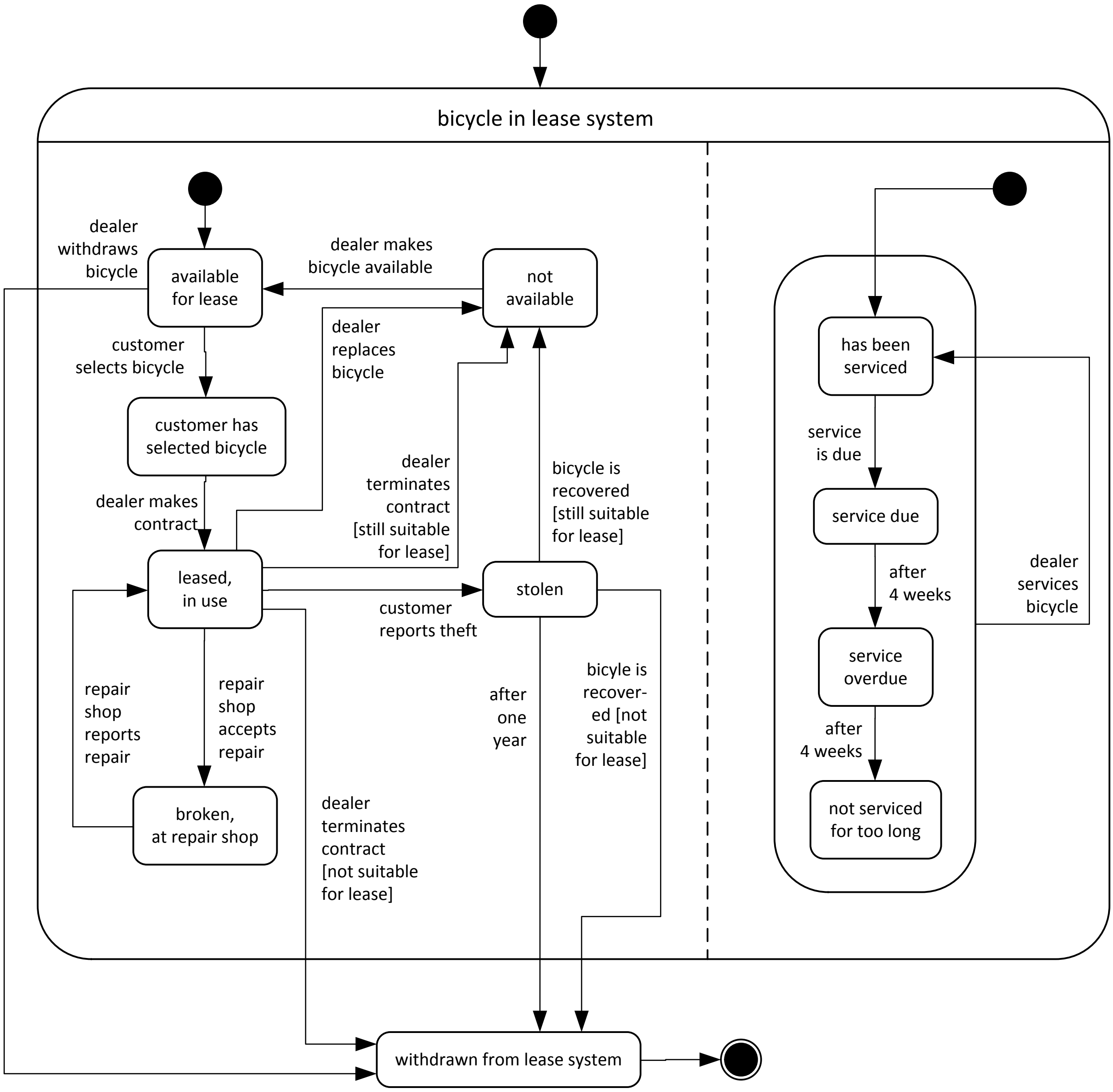
- There are *two* is-of-type relations: *Contract* vs. *Contract Type* and *Bicycle* vs. *Bicycle Model*. In both cases, hints were given in the text (e.g. “standard contracts”, “individual contracts”, various atttibutes of a bicycle model) that should be clear enough if you are aware of this kind of construct (see *Car* vs. *Car Type* in the slides).
- *Period* is an association class, because there is exactly one period for the combination of a contract and a bicycle. There can be different bicycles under one contract (high-end contract with bicycle replacement) and different contracts for one bicycle (re-lease of a previously leased bicycle), hence modelling start and end date as attributes of contract or attributes of bicycle is not specific enough.
- If *Period* is correctly modelled, it does not matter whether *Service* and *Repair* are associated with *Contract* or with *Bicycle Service*. In either case, it is clear which object of the other class is meant; from the repair date it is known in which period the repair took place.
- There is no subclass for *Regular* (i.e., non-E) *Bicycle Model*; it is not needed because it has no attributes and no associations.
- Note that *dealer* is the role name of the *Bicycle Shop* in the association with *Bicycle.*

## Question 4 (State Machine) [2.3 points]



Remarks:

- It was stated that servicing is independent from the lease status and intermediate repairs, so it makes sense to model this in parallel.
  If the intermediate repairs were not there, it would have been possible to model the states related to service as a substate of “leased, in use”. The presence of the state “broken, at repair shop” makes this infeasible (or it should be handled in parallel within the composite stated “leased, in use”, service could become due according to the schedule when the bicycle is at a repair shop).
- The right part of the diagram has multiple transitions “dealer services bicycle”. The number of transitions could be reduced by introduction another composite state, as in the diagram below.


bicycle in lease system
dealer withdraws bicycle
available for lease
dealer makes bicycle available
not available
customer selects bicycle
dealer replaces bicycle
customer has selected bicycle
dealer makes contract
dealer terminates contract [still suitable for lease]
bicycle is recovered [still suitable for lease]
leased, in use
stolen
customer reports theft
repair shop reports repair
repair shop accepts repair
after one year
bicycle is recover-ed [not suitable for lease]
broken, at repair shop
dealer terminates contract [not suitable for lease]
withdrawn from lease system
has been serviced
service is due
service due
after 4 weeks
service overdue
after 4 weeks
not serviced for too long
dealer services bicycle

## Question 5 (Software Metrics) [1.2 points]

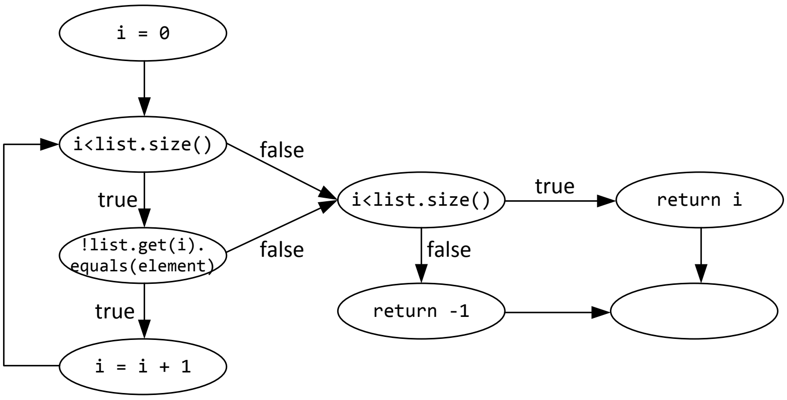
### 5a (Coupling)

1. High CA of a class *C* means that it is hard to know all the effects in other classes of a change in *C*, so you'd better not change it if you can avoid it.

2. High CE of a class *C* means that there is a potential lack of stability, as changes in classes on which *C* depends may cause errors.
   Alternatively: Dependency on a lot of other classes makes *C* harder to test.

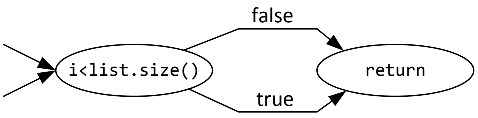
### 5b (Cyclomatic complexity)

3. A flow graph can be drawn as follows:



We find #edges =10, #nodes = 8,   CC = E – N + 2 = 4

Alternatively, the last part of the graph can be simpified as shown below, yielding
#edges = 8, #nodes = 6,   CC = E – N + 2 = 4



4. The test `i<list.size()` is included twice. The test at the end of the method can be eliminated by a `return` from whithin the loop if `list.get(i).equals(element)` evaluates to `true`:

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

The resulting flow graph would have 2 binary decision nodes, rather than 3, yielding CC = 3.