Specification of Information Systems (233030)
Examination

23rd January, 2006

Explain your answers, yet keep your explanations precise. Long-winded answers are not appreciated.

1. a. Define the following concepts: Subject domain and connection domain.

   `Page 12`

   b. Identify the subject domain and connection domain of the following systems. Identify at least three entities and events in the subject domain.

   b1. The course database of the faculty (VIST).

   `Subject domain is the set of courses, their teachers, and the curricula in which these courses are taught. Events are the creation, termination, and change of a course. Connection domain is the set of people and devices that lead from the decisions about which courses there are (made in the chairs, and by the director of education) to the data anterd in the system.`

   b2. The software controlling the entry and exit barriers of a parking garage.

   `The subject domain is the set of cars in the garage, and the set of parking plots. If we assume that sensors at the entry and exit barriers are only triggered by cars, then the system can know how many cars entered and left the garage. That is OK. But a person can walk up the the entry post, push the button for a parking ticket, and then walk through the raised barrier. So a careful student might say: the subject domain is the number of entry requests (cards given) and exit requests (cards returned). And this number has a maximum, namely the number of parking plots in the garage.`

   `The connection domain reaches from the system to the subject domain: wires connecting the system to the relevant sensors, and the sensors themselves.`

   c. Do all subject domain entities appear also in the context diagram of the system? Explain your answer.

   No the subject domain represents *what* the system talks about, the context diagram shows *to whom* the system talks.

   d. The behavior of a reactive system can be described in terms of a non-atomic dialog. Explain how a (stimulus, response dialog) can be transformed into a transactional stimulus-response list.

`Page 178, second guideline.`

2. The ERD in figure 1 shows that students can participate in an exam that is held on a particular date, and that belongs to a subject. Such a participation leads to a grade.

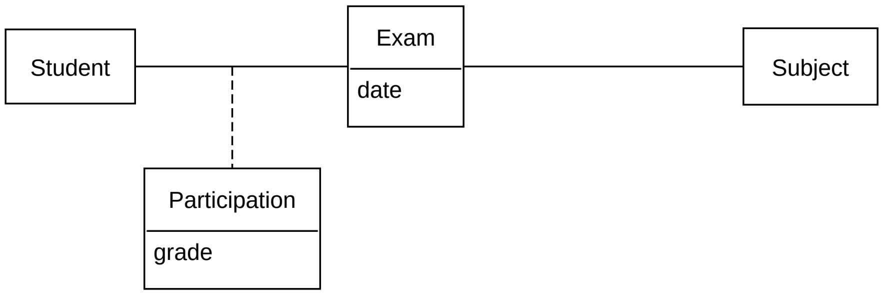

Figure 1: An ERD.

a. Add cardinality properties to the figure, and explain each of them.

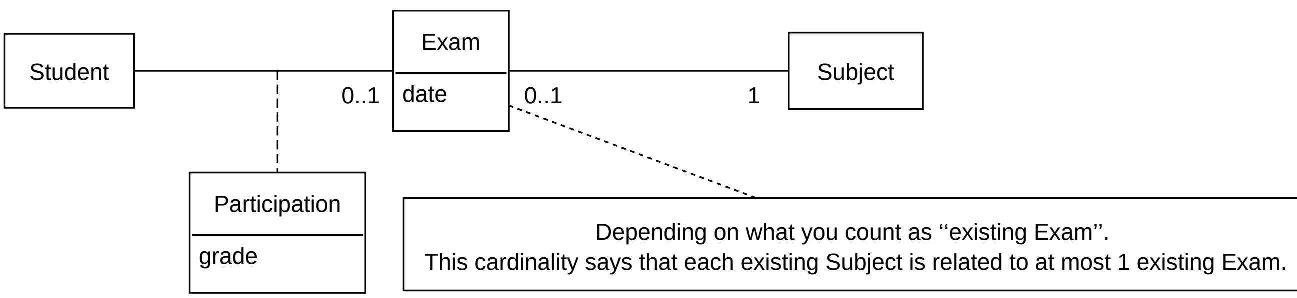

Figure 2: a solution to 2a.

`See figure 2.`

b. Each exam can accomodate at most 30 participants, and each student can do exams for a subject maximally three times. Add cardinalities to represent this. If a property cannot be represented by a snapshot cardinality, write it as a comment in the diagram.

`See See figure 3. Snapshot reading:`

- ∗ `In any state of the world, each existing student participates in at most one existing exam.`
- ∗ `In any state of the world, each exam has at most 30 participants.`

c. The grade that a student has for a participation in an exam, is known some time after the actual participation. Adapt figure 1 to represent this.

`See See figure 4.`

d. The exam participation database is nationalized and we must now represent the fact that a student participates in an exam for a subject

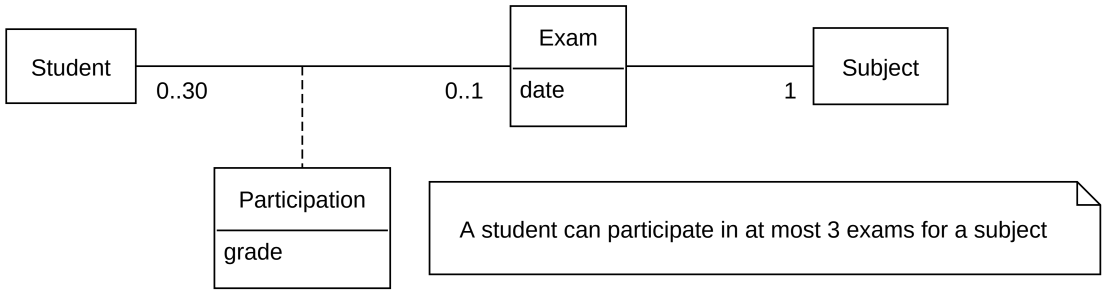

Figure 3: An answer to 2b

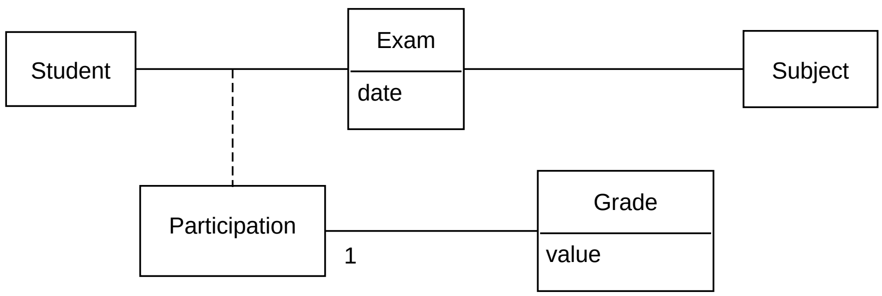

Figure 4: An answer to 2c

given at a particular university. One subject can be given at several universities. Adapt figure 1 to represent this.

`See See figure 5. This is the connection trap (page 88 exercise 7).`

3. Figure 6 shows a statechart for a book-lending process. A book is either in or out, and when it is out, the library can remind the borrower to return or extend the loan. If a borrower does not respond to the second reminder, the book is written off. (No doubt you can think of numerous improvements to this simplistic process. But we will use this simple process for the exercise.)

   (a) The diagram contains several after(t) events. Explain the meaning of these events.

   (b) Use state hierarchy to reduce the number of return and extend arrows in the diagram.

   `See figure 7. The extend loop brings the book back to the initial state of Checked out, regardless with state of Checked out it is currently in.`

   (c) Use a local variable to count the number of reminders. Take care that this variable has a correct value at all times.

   `See figure 8.`

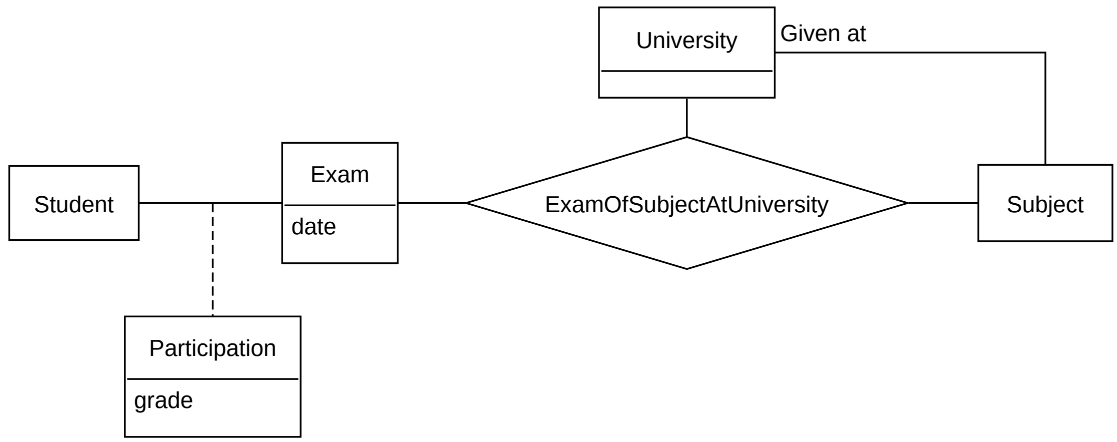

Figure 5: An answer to 2d

(d) When a book is not checked in, it can be reserved. When it is reserved, its loan period cannot be extended. Add a parallel Reservation process to the diagram in which this is expressed.

`See figure 9. The two processes coordinate by means of the in(state) predicate. See the transitions triggered by reserve and extend.`

4. Figure 10 shows a DFD of the control of a robot that boxes teabags. The bags arrive on a conveyor belt, passing a Scale that weighs them. If the weight of a bag is too high or too low, the robot must remove them. If the weight is within an acceptable interval, they are allowed to pass and then will drop from the conveyor belt into a box. If the box is full, the robot replaces it with an empty one.

(a) Explain the following decomposition guidelines, and show how each of them is applied in figure 10.

a1 Functional decomposition

a2 Event-oriented decomposition

a3 Device-oriented decomposition

a4 Subject-oriented decomposition

`Section 19.4.`

```
a1 functional: all bubbles are functions
 * event: Weight teabag and Check for full box respond to events.
 * device: Weigh teabag and Check for full box deal with devices.
   Could also be said of Change box, Remove teabag and Change teabag
   weight (interface to operator).
 * Subject: The data stores represent two desired properties of
   the subject domain.
```

(b) Make an STD (Mealy diagram) for Control teabag boxing. Assume that the robot arm can replace a box fast enough before the next teabag arrives. List any other assumptions that you make.

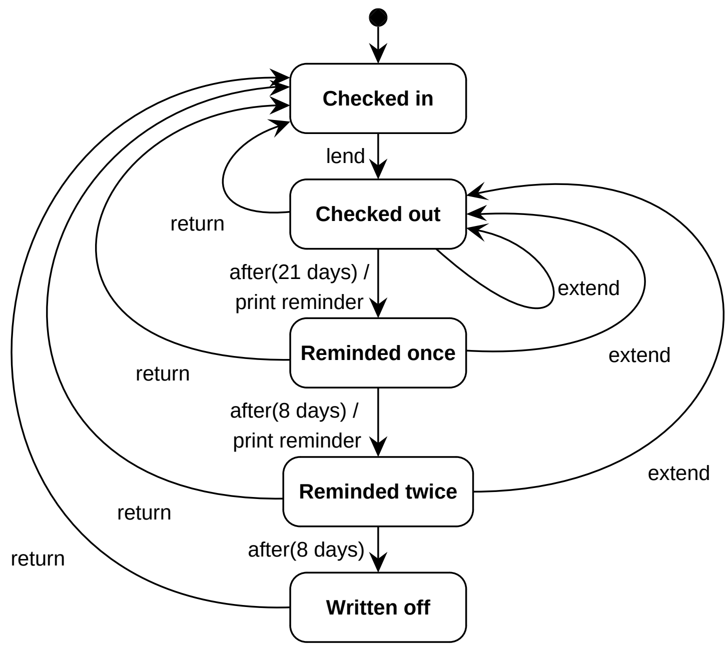

Figure 6: A Mealy diagram.

`See figure 11. Assumption: A teabag can be removed fast enough before the next one arrives.`

(c) The control process is really engaged in two parallel processes. Change the architecture of figure 10 in the following way: Draw a communication diagram (not a DFD) that contains two processes, Control teabag removal and Control box change. Explain which data store(s) of figure 10 are encapsulated in which component of this new architecture, and why you did that.

`See figure 12. Teabag count is part of the local state of teabag boxing control, representing part of the subject domain. Because it is maintained by that process itself, it should be encapsulated in that process.`

`Required teabag weight represents the desired state of the subject domain. Because it is maintained by the operator, it is better to keep it separate.`

(d) Starting from the same observation as (c), we decide to represent the Control teabag boxing process by a statechart with two parallel subprocesses, namely , Control teabag removal and Control box change. We also decide to use local variables if that clarifies the model. Draw this statechart, and draw the communication diagram (not DFD) that represents this architecture.

`See figures 13 and 14.`

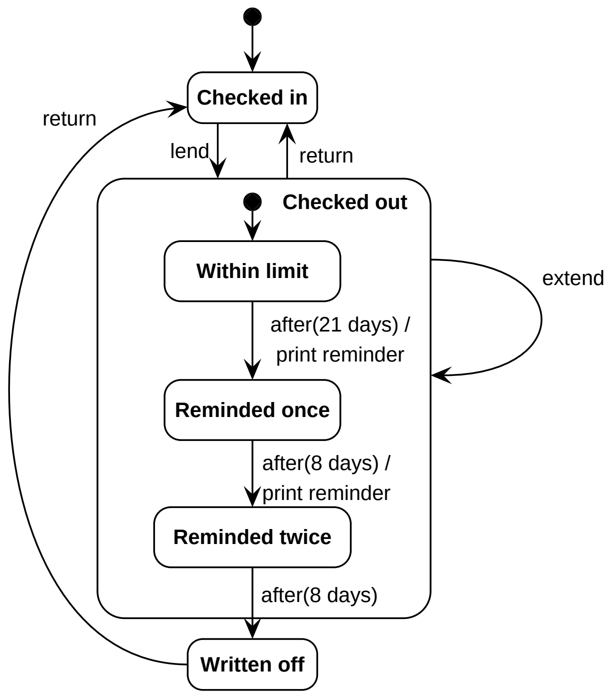

Figure 7: 3b: Introducing hierarchy.

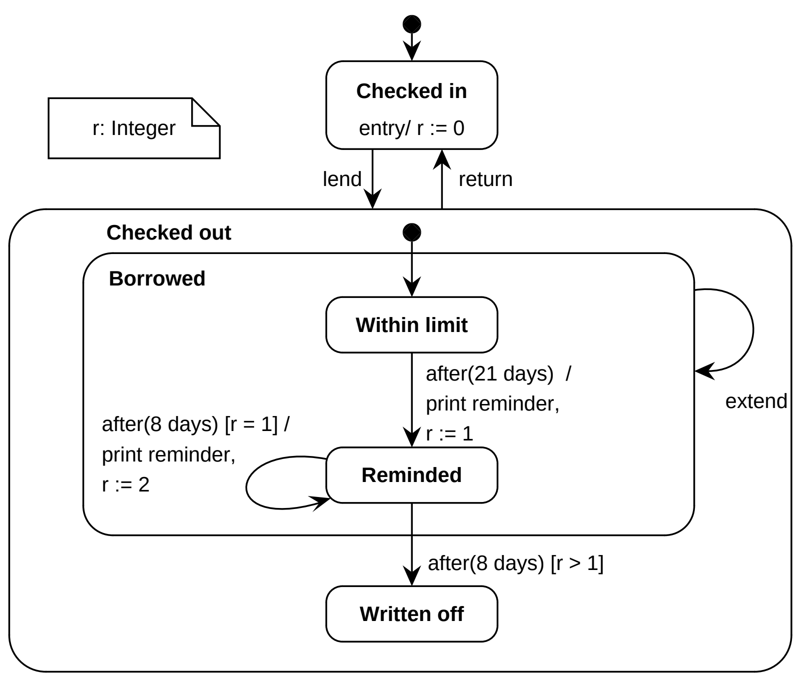

Figure 8: 3c: Using a local variable.

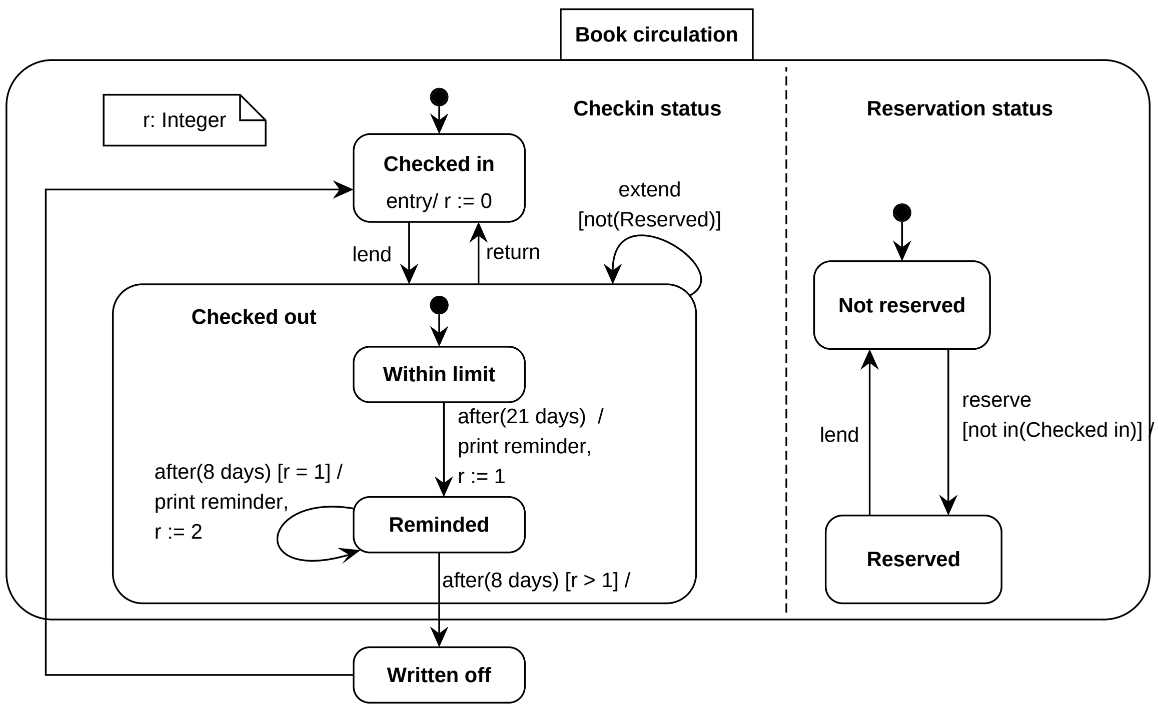

Figure 9: 3d: Adding a parallel process.

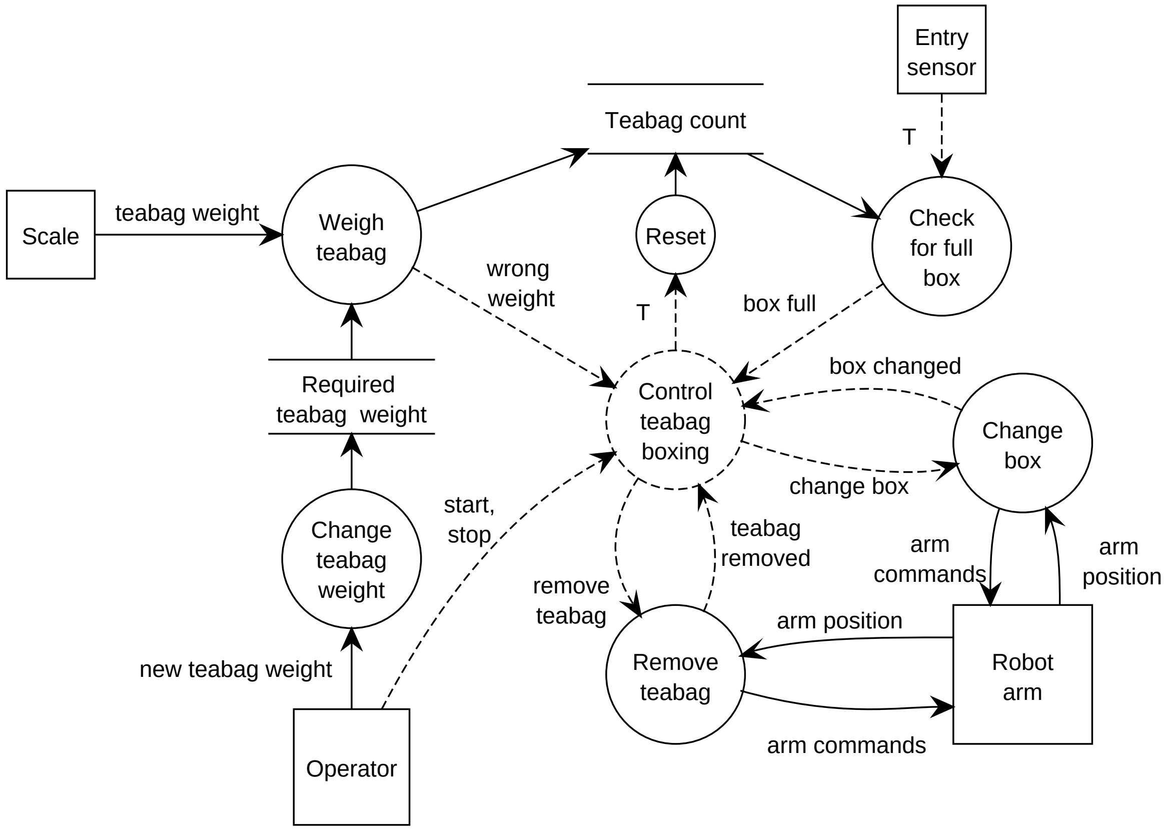

Figure 10: DFD for the control of a teabag boxing process.

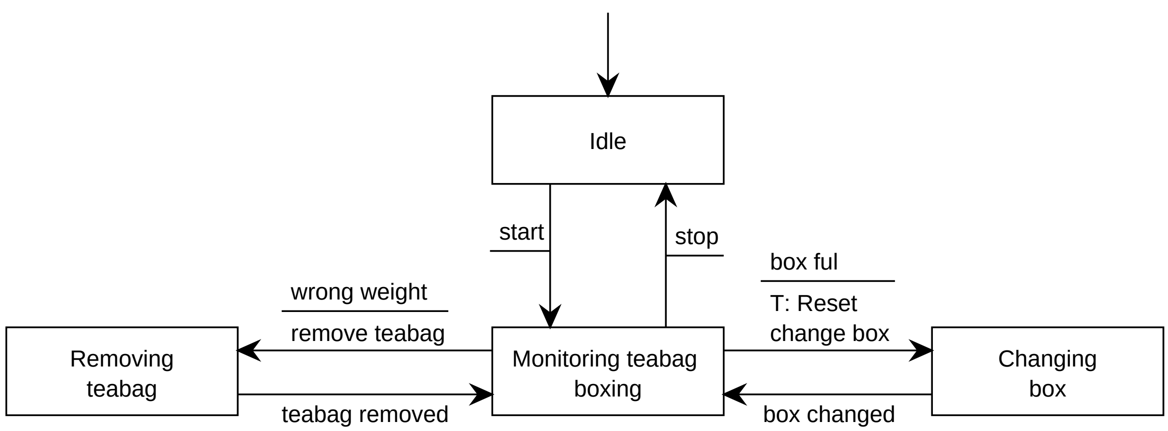

Figure 11: 4b:STD for figure 10.

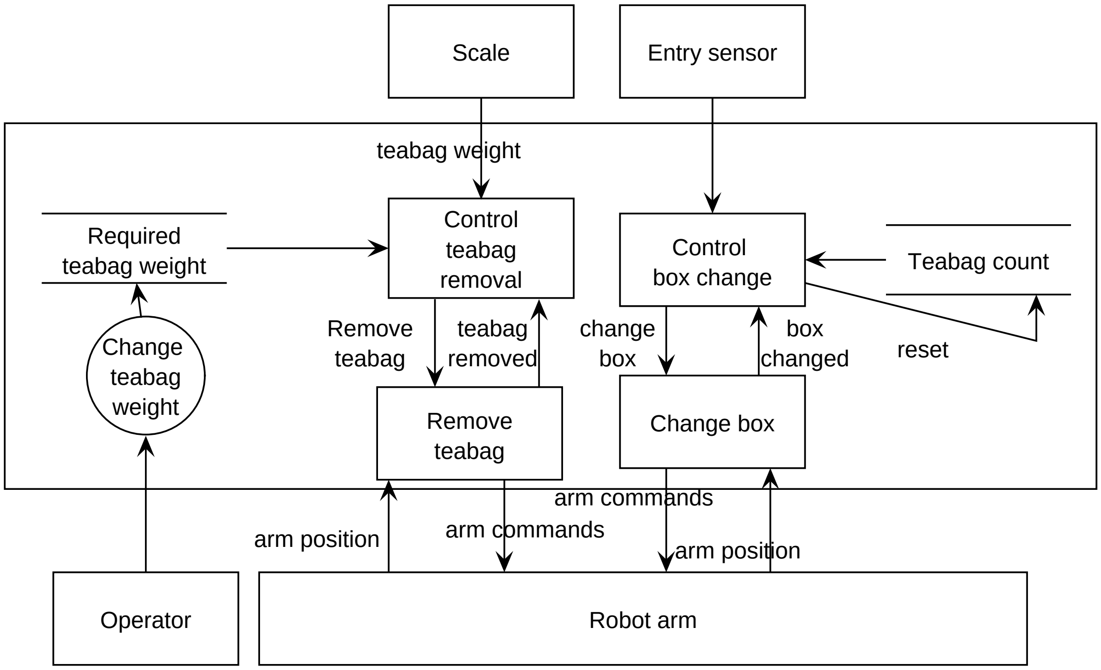

Figure 12: 4c: improved architecture.

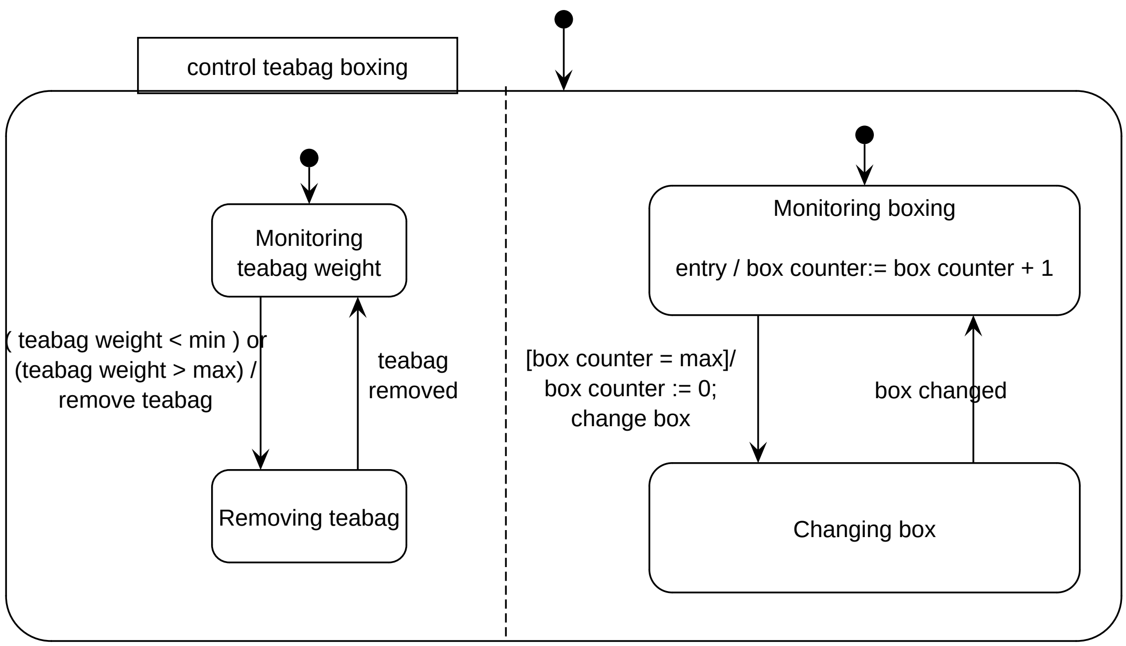

Figure 13: 4d: Statechart alternative.

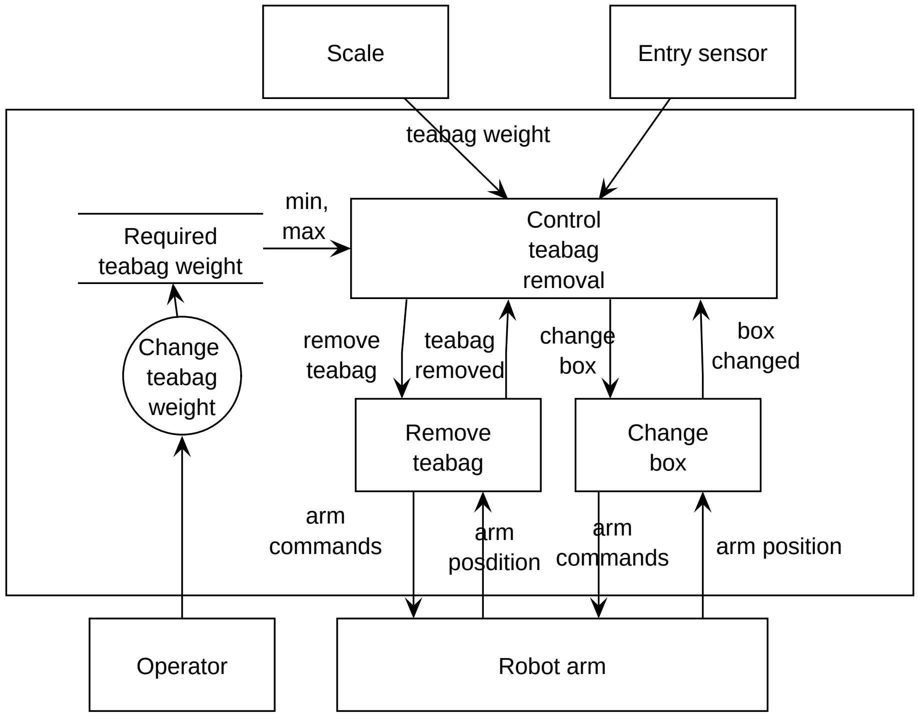

Figure 14: 4d: Architecture for statechart alternative.

Problem	a	b	c	d	
1	4	4, 4	4	4	20
2	5	5	5	5	20
3	2	6	6	6	20
4	3, 3, 3, 3	5	5	8	30
					90

Grade = (10 + points)/10