Systems Development

(Dat3, SW3, IxD5, iDA7)

Written Exam

5 January 2018, 10:00-14:00

Student Name	
Student Number	
Study Programme and Semester	

This exam set consists of 16 pages (including this page) with 4 assignments. The weight of each assignment is provided in its title and sub-titles.

You have 4 hours to complete the exam.

Use a readable handwriting in your solution.

Write your solution to each assignment in the space provided in this set. Only solutions written in the exam set can be handed in. You may make a draft of your solution before filling it into the exam set. You can obtain paper for a draft from the exam officials.

You can write your solution in either English or Danish.

The following exam aids are permitted:

- The textbook
- Copies of slides and other course material
- Personal notes from the course

Communication devices such as computers and cell phones are *not permitted*.

You must provide your student id upon request from the officials.

Assignment 1. App Supporting Social Exercising (30%)

A non-profit organization wants to provide an app to support increased exercising by facilitating social contact between users. The aim is to increase the users' exercising by connecting them to other users who want to do the same type of exercises.

Assignment 1.1. System Definition (5%)

The system developers have produced the following system definition:

> An IT-system provided by a non-profit organization to support a community of users in establishing contacts to other users in the community who want to do exercises. A couple of volunteers in the non-profit organization will take care of system administration, but apart from that the users in the community will be the only ones applying the system. A user can set up an event that involves a specific type of exercise, e.g. running, playing football or bicycling. Other users can view the events that are available and sign up for the ones that are interesting for them. Events will have at least a single occurrence, but may also have multiple occurrences that are happening several times with defined time intervals, e.g. weekly. The aim of the system is to increase the amount of exercising for the users. The system allows users to select events, but it will also encourage users to participate in events based on their stated preferences. The system will be based on a server at the non-profit organization and clients on the users' smartphones. It will be developed by a software company in collaboration with volunteers in the non-profit organization and prospective users.

Divide the system definition into the elements of the FACTOR criterion:

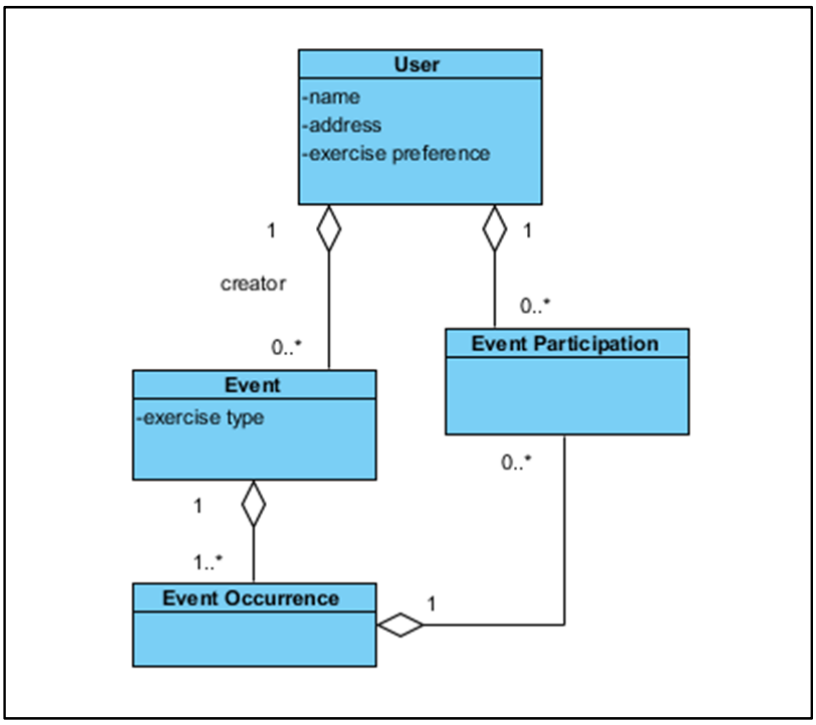
F	A user can set up an event that involves a specific type of exercise, e.g. running, playing football or bicycling. Other users can view the events that are available and sign up for the ones that are interesting for them.
A	An IT-system provided by a non-profit organization to support a community of users in establishing contacts to other users in the community who want to do exercises. A couple of volunteers in the non-profit organization will take care of system administration, but apart from that the users in the community will be the only ones applying the system.

C	It will be developed by a software company in collaboration with volunteers in the non-profit organization and prospective users.
T	The system will be based on a server at the non-profit organization and clients on the users' smartphones.
O	User, Event. Events will have at least a single occurrence, but may also have multiple occurrences that are happening several times with defined time intervals, e.g. weekly.
R	The aim of the system is to increase the amount of exercising for the users. The system allows users to select events, but it will also encourage users to participate in events based on their stated preferences.

The system developers describe the problem domain as follows:

- The community is made up of the users who have registered in the system
- A user can create an event
- An event happens at least once, in which case there is exactly one event occurrence for the event
- An event may also be repeated, in which case there are several event occurrences for the event
- A user can sign up to participate in an event occurrence

The system developers have modelled this with the following class diagram:



The system developers have also described the behavior in the problem domain as follows:

- A user can join the community by registering in the system
- A user can leave the community whenever he wants to by registering that in the system
- A user can create events, where each has a specific exercise type
- After an event is created, the user creates one or more event occurrences, where each has a date, time and place
- A user can sign up for event occurrences that are created by other users; and cancel the signup if he decides that
- The users who have signed up for an event occurrence can participate when the event occurrence happens
- Users can rate an event occurrence they have participated in (after it has happened)
- After an event occurrence is created, it can be opened for signup; at this time, other users may sign up and cancel their signups
- At a point in time, signup will be closed and other users can no longer sign up or cancel
- When the first event occurrence of an event has happened, it is not possible to create further event occurrences
- When all event occurrences have happened, the event and all its event occurrences as well as all the open user participations will be marked as completed
- A user participation starts with the user signing up for an event occurrence; then the user can either participate or cancel
- If a user leaves the community, all his open user participations will be marked as completed

Assignment 1.2. Event Table (5%)

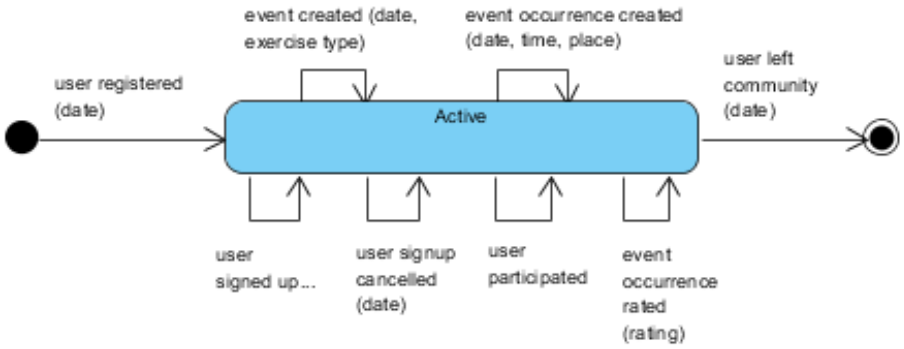
The table below lists all events in the problem domain. For each event in the table, mark which problem domain classes it is related, using a '+' (for sequence and selection) or an '*' (for iteration):

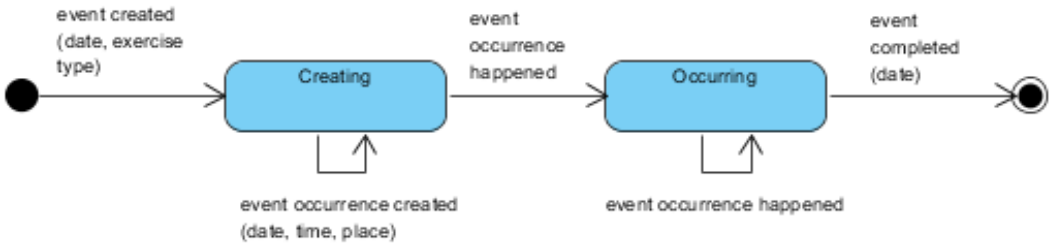
	User	Event	Event Occurrence	Event Participation
user registered (date)	+			
user left community (date)	+			+
event created (date, exercise type)	*	+		
event occurrence created (date, time, place)	*	*	+	
event occurrence happened		*	+	
event completed (date)		+	+	+
signup opened (date)			+	
signup closed (date)			+	
user signed up (date)	*		*	+
user signup cancelled (date)	*		*	+
user participated	*			+
event occurrence rated (rating)	*		*	+

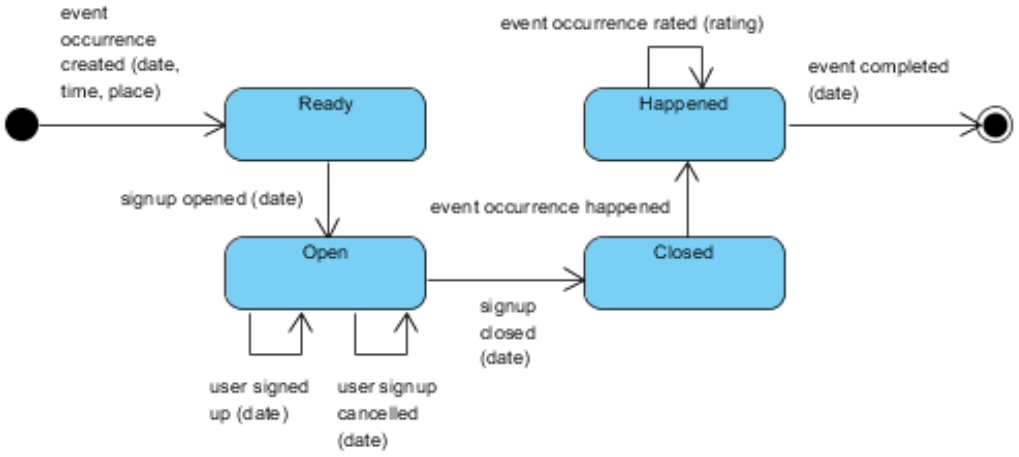
Assignment 1.3. Statechart Diagrams (20%)

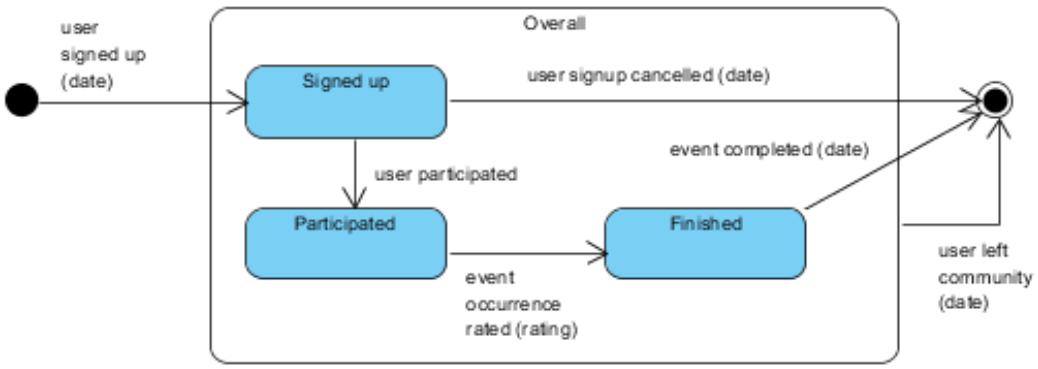
Make a statechart diagram for each of the four classes in the class diagram above (write your answer in the box below and on the next page):

(assignment 1.3 continued)









Assignment 2. Object-Oriented Concepts (5%)

2.1. Define what a class is (write your answer in the box below)

Class: A description of a collection of objects sharing: structure, behavioral pattern, and attributes

2.2. Define what an object is (write your answer in the box below)

Object: An entity with identity, state, and behavior

2.3. Explain the relation between class and object (write your answer in the box below)

An object is created from the description of a class
An object belongs to a class (from which it was created)
Each class contains a set of objects; we refer to them as the objects of the class

Assignment 3. Truck Fleet Monitoring (35%)

A company operates a fleet of large trucks. The trucks are transporting containers for the company's customers. The company wants a system to monitor its fleet of trucks. The purpose of the system is to monitor the position of each truck as well as where the driver of the truck is in solving a specific task. A task is to move one or more containers from an origin X to a destination Y. A task is defined by a customer in collaboration with the company's sales department. When a task is to be carried out, a dispatcher in the company makes one or more assignments to the task. A single assignment is to transport one container from X to Y, and it has one truck as well as one or two drivers allocated to carry out the assignment. The system must provide information about the trucks and drivers assigned to a task and who the drivers of each truck are; it must also provide information about the time when an assignment started, when it is expected to be completed and when it is actually completed; it must also provide information about the specific container that an assignment involves. The system will be developed by an external software company, and the sales department, the dispatcher and the drivers will be involved in the development. The sales department and dispatcher will use PCs connected to a centralized server in the company's headquarter. Each driver will have a mobile computer that helps him get an overview of the task and report back to the headquarter on task progress.

Assignment 3.1. Problem Domain and Application Domain Objects (5%)

Which of the following objects belong either to the Problem Domain (PD), Application Domain (AD), both domains (PD and AD), or none of the domains (neither PD nor AD):

	Only Problem Domain (PD)	Only Application Domain (AD)	Both Problem and Application Domain (PD & AD)	Neither Problem Domain nor Application Domain
Company		X		
Truck	X			
Customer	X			
Container	X			
Sales department		X		
Dispatcher		X		
Driver			X	
Task	X			
Server				X
Mobile computer		X		

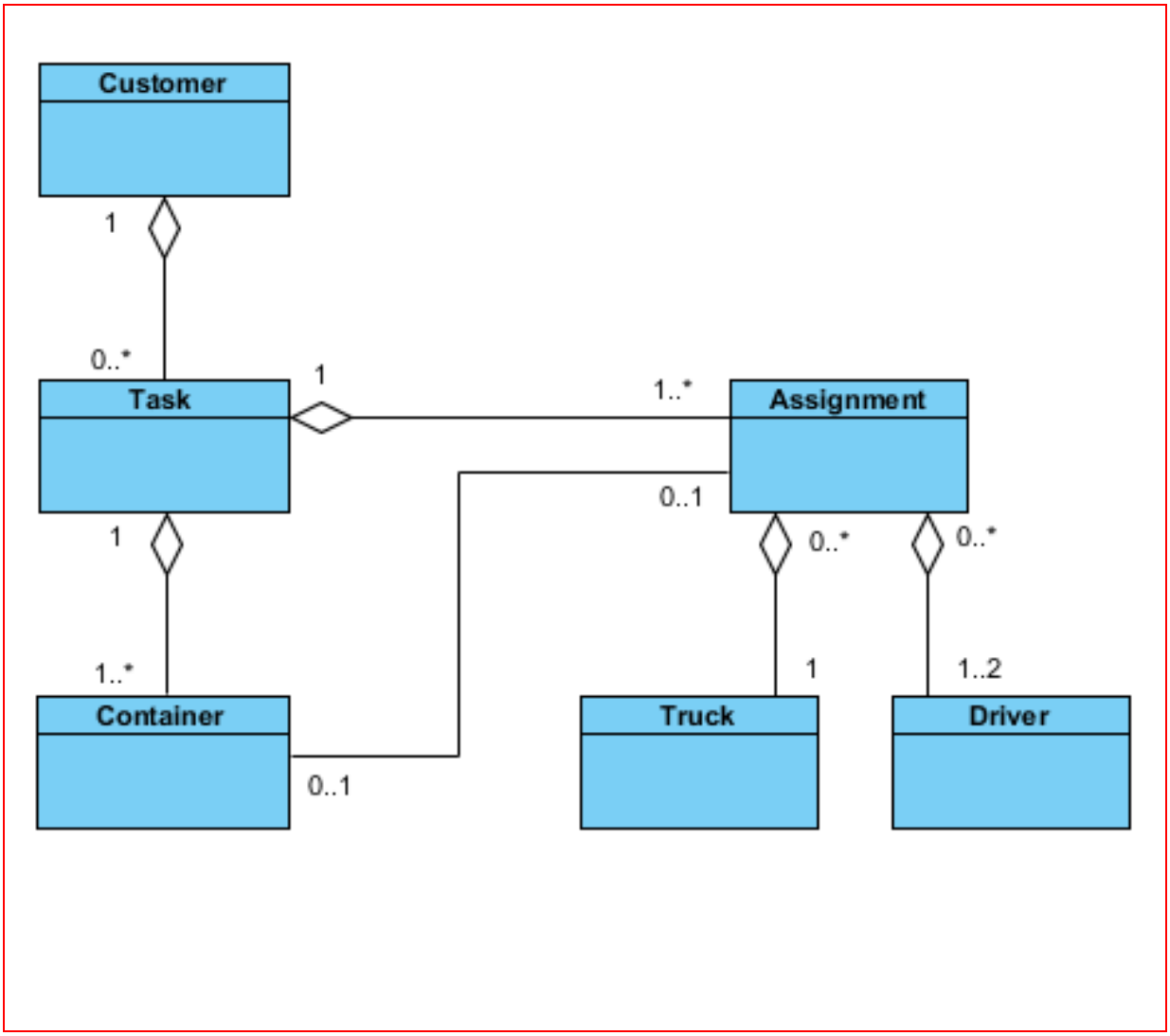
Assignment 3.2. System Definition(10%)

Make a system definition divided into the six elements of the FACTOR criterion (fill in the six elements in the table below).

F	The company wants a system to monitor its fleet of trucks. A task is defined by a customer in collaboration with the company's sales department. When a task is to be carried out, a dispatcher in the company makes one or more assignments to the task. The system must provide information about the trucks and drivers assigned to a task and who the drivers of each truck are; it must also provide information about the time when an assignment started, when it is expected to be completed and when it is actually completed; it must also provide information about the specific container that an assignment involves.
A	A company operates a fleet of large trucks. The trucks are transporting containers for the company's customers. Truck drivers on assignments, dispatchers and the sales department
C	The system will be developed by an external software company, and the sales department, the dispatcher and the drivers will be involved in the development.
T	The sales department and dispatcher will use PCs connected to a centralized server in the company's headquarter. Each driver will have a mobile computer that helps him get an overview of the task and report back to the headquarter on task progress.
O	A task is to move one or more containers from an origin X to a destination Y. A single assignment is to transport one container from X to Y, and it has one truck as well as one or two drivers allocated to carry out the assignment.
R	The purpose of the system is to monitor the position of each truck as well as where the driver of the truck is in solving a specific task.

Assignment 3.3. Class Diagram (15%)

Make a class diagram of the problem domain of this system. The classes must have the relevant attributes (write your answer in the box below):



Assignment 3.4. System Architecture (5%)

Design the system architecture of the system.

- Select the architectural pattern(s) that is/are relevant for the system:

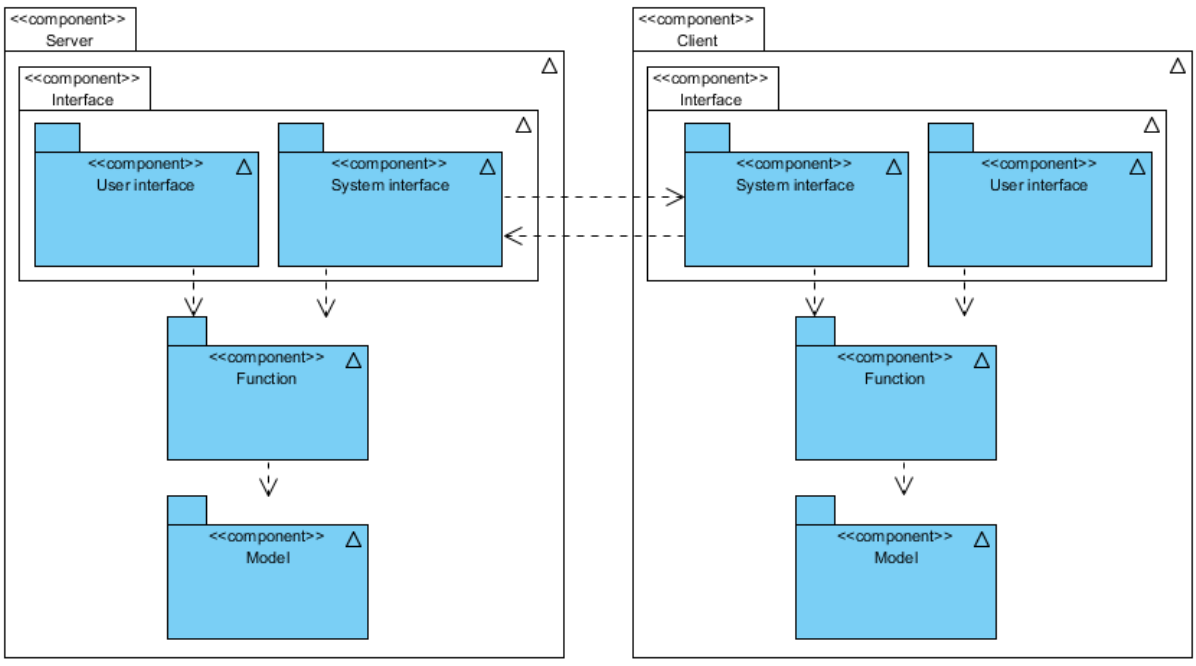
  The Generic Architecture and the Client-Server Architecture with distributed data.

- Explain the reason for this selection:

  The generic architecture is chosen as the basis for the server and the clients. There is no fixed number of clients and they are geographically dispersed, so the client-server architecture is chosen.

  The distributed data form is chosen because it allows the driver to monitor and report about tasks if there is no connection to the server.

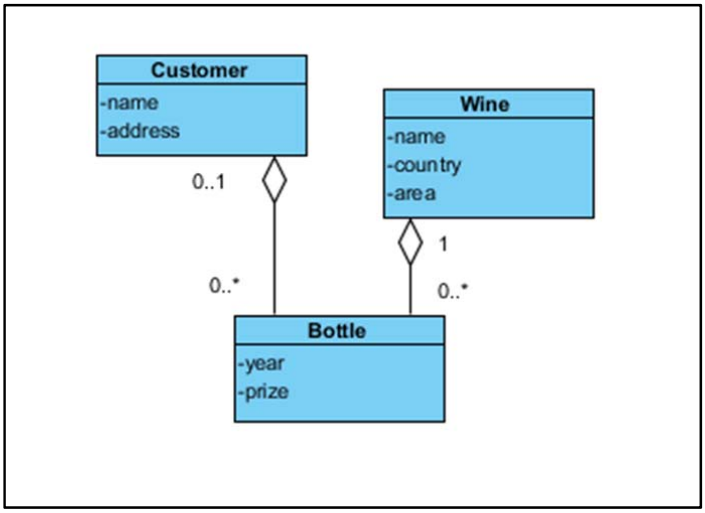
- Make a diagram with the component architecture for the system. You can disregard the technical platform (write your answer in the box below)



Assignment 4. Web Shop for Wine Club (30%)

A wine club is selling wine through its web shop to a group of customers who are members of the club. A Customer can join the club and thereby becomes an active member. Eventually, the Customer may leave the club. In the meantime, while the Customer is active, he can order wine from the club.

Below is the class diagram for the problem domain.

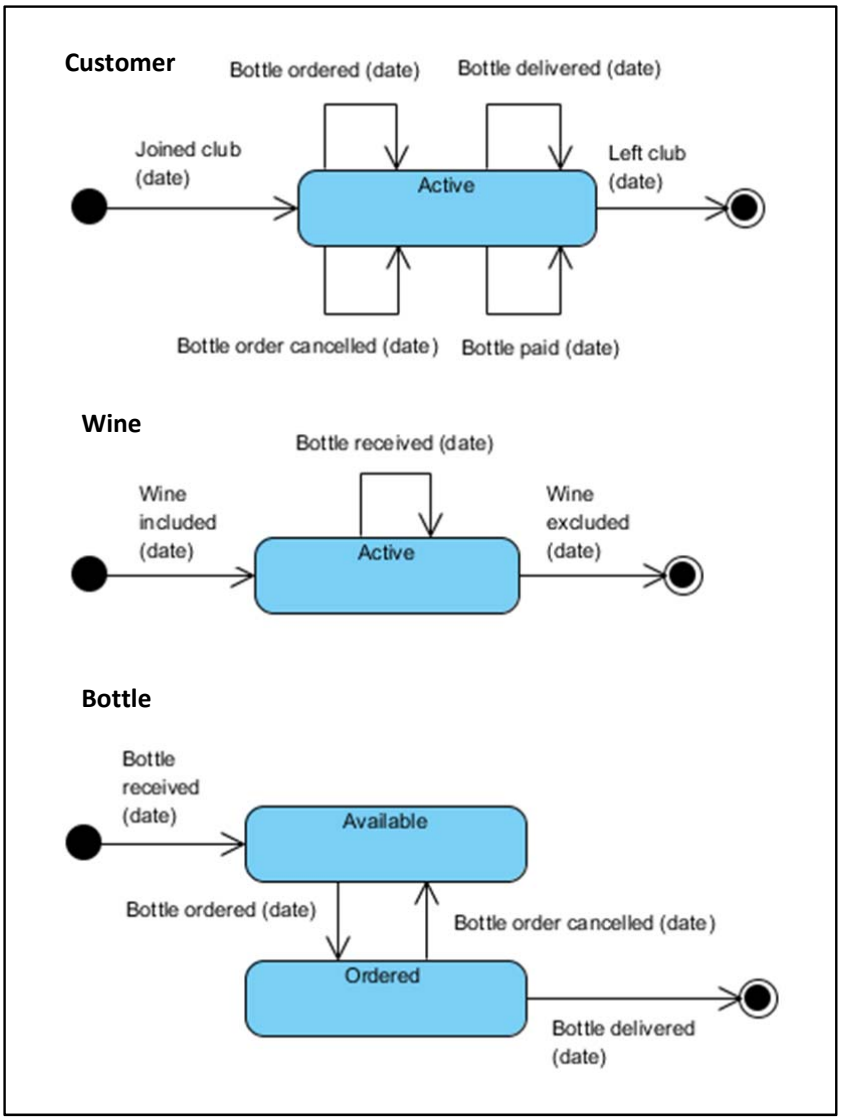


Assignment 4.1. Patterns (5%)

Which of the following patterns are used in the class diagram above (check the boxes for the patterns that you think are used):

- ☐ The role pattern
- (X) The relation pattern (not obvious but acceptable between Customer and Wine)
- (X) The hierarchy pattern (not obvious but acceptable between Customer and Bottle)
- X The item-descriptor pattern (between Wine and Bottle)
- ☐ The stepwise relation pattern
- ☐ The stepwise role pattern
- ☐ The composite pattern

Below are the statechart diagrams for the classes in the problem domain.



Assignment 4.2. Behavior (10%)

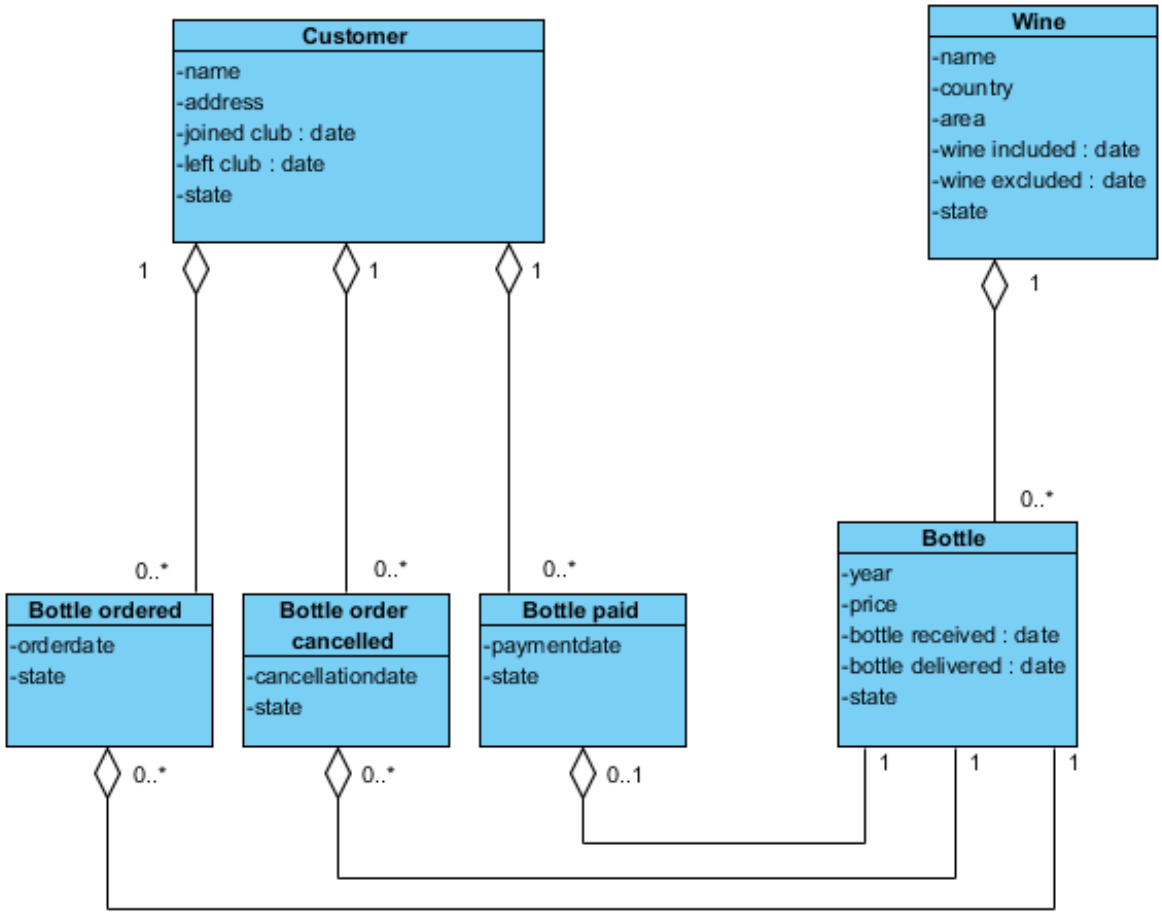
Make an event table for this problem domain (write your answer in the box below)

	Customer	Wine	Bottle
joined club (date)	+		
left club (date)	+		
bottle ordered (date)	*		*
bottle delivered (date)	*		+
bottle order cancelled (date)	*		*
bottle paid (date)	*		
wine included (date)		+	
wine excluded (date)		+	
bottle received (date)		*	+

Assignment 4.3. Model Component (15%)

Design the model component for a system that supports the administration of the members of the wine club and their buying of wine (write your answer in the box below)

Simple Solution



Enhanced Solution