Systems Development

(Dat3, SW3, iDA7, IxD5)

Written Exam

3 January 2020, 10:00-14:00

Student Name	
Student Number	
Study Programme and Semester	

This exam set consists of 21 pages (including this page) with 4 assignments. Before you start, you are advised to check that your exam set contains all pages.

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 can make drafts of your solutions before filling them into the exam set. You may obtain paper for drafts from the exam officials.

You can write your solution in either English or Danish (or a mix). If you are writing in Danish, you are welcome to use the English concepts from the book.

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* in the exam room.

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

Assignment 1. Administration of a Sailing Club (20%)

This assignment is about a system for administration of members and boat slips in a sailing club and its marina.

Assignment 1.1. System Definition (5%)

The sailing club already has an existing system for administration. This system was developed five years ago. This is the system definition that was created when the existing system was developed:

F	The administrative personnel can use the system to register a member and his/her category, and assign a specific boat to a boat slip that fits this particular boat. Members can use the system to update their personal profile information, pay membership fee, register a boat they own, request a specific boat slip and pay for a boat slip that their boat has been assigned to. Administrative personnel and members can see the boat that is assigned to each boat slip, and the boat slips that are vacant.
A	An IT system for administration in a sailing club of members and their boat slips. The system will be used by administrative personnel employed by the sailing club as well as members of the club.
C	The system will be developed by an external software company in collaboration with the administrative personnel and a couple of selected members. It must be possible at a later point in time to extend the system to handle more than one sailing club.
T	The system will run on a PC platform that is already used in the administration, and on smartphones of administrative personnel and members.
O	The sailing club has a number of boat slips available that it rents to its members. There are two categories of members: active and passive. Only active members can rent a boat slip. Active members do not necessarily have a boat, but most of them have one or more boats for which they rent a boat slip for each of them. Active members pay a full membership fee, while passive members pay only half a membership fee.
R	The aim of the system is to facilitate overview over the rented and vacant boat slips, and to provide this information to support administrative personnel and members in effective use of the boat slips available.

The sailing club has now decided that it wants the system extended, so it can handle guests that visit the club's marina with their boat and use vacant boat slips.

The system developers have written the sentences that need to be added to the existing system definition. These additional sentences are shown in the left column of the table below. Each row in the table is an additional sentence to the system definition.

Divide the additional sentences into the six elements of the FACTOR criterion. You do that by making a cross (X) in one of the six cells on the right-hand side of the table. Each such cross means that you believe the sentence in question belongs to the marked element of the FACTOR criterion.

Sentence in the system definition	**F**	**A**	**C**	**T**	**O**	**R**
The additional aim of the extended system is to provide guests with a high level of service by giving them an overview of vacant boat slips that they can reserve for their visit						
A sensor on each boat slip is used to determine if the slip is occupied or vacant						
There will be a server in the sailing club that the members' and guests' smartphones acquire information from						
Guests can use the system to register their name and the name, length and width of their boat						
Guests is a new category of members that pay a small membership fee						
Guests can register the dates on which they will visit the marina, get a list of vacant boat slips in that period, reserve one of them and pay in advance for the visit						
The system will be used by guests who are visiting the marina with their boats						
Members who are away from the marina can use the system to register when they return and need their boat slip						
The extended system will run on the members' and guests' smartphones						
The extended system is developed by an external software company in collaboration with the administrative personnel and a couple of selected members						

Assignment 1.2. Problem Domain and Application Domain Objects (7%)

Below is a list of objects. For each object, mark with a cross (X) whether you think this object belongs to either the problem domain (PD), application domain (AD), both domains (PD and AD), or none of the domains (neither PD nor AD) of the extended system:

	Only in problem domain (PD)	Only in application domain (AD)	Both in problem domain and application domain (PD and AD)	Neither in problem domain nor in application domain
Administrative personnel				
Club member				
Club house				
Guest				
Boat slip				
Boat				
Crane for boats				
Payment for visit				
Sensor on boat slip				

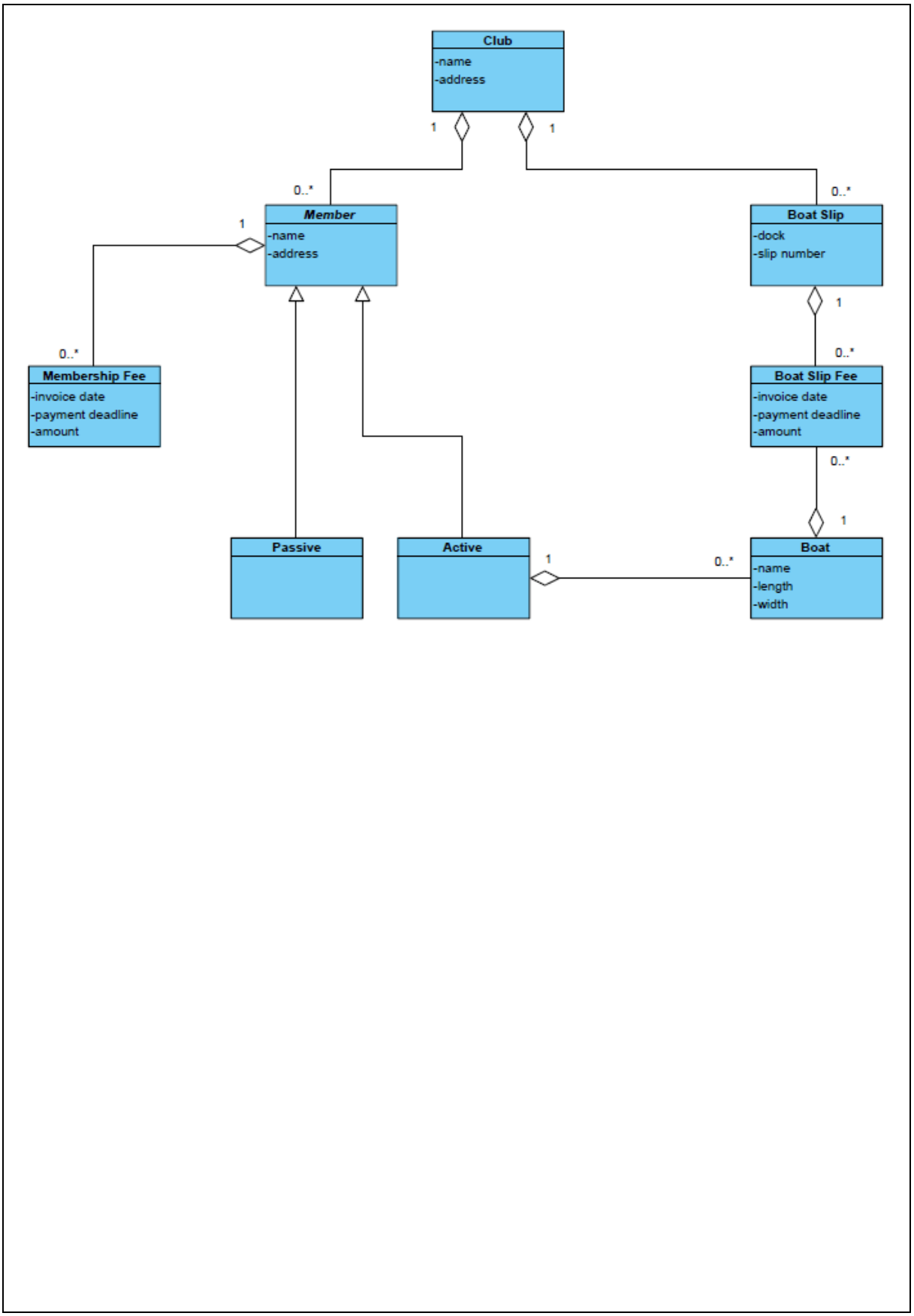
List of vacant boat slips				
Payment of membership fee				
Software company				
Smartphone				
Crew on boat				

Assignment 1.3. Class Diagram (8%)

The sailing club, members and boat slips are administered this way:

- The sailing club has a name and address.
- A member has a name and an address.
- The club's boat slips are located at a number of docks. Each boat slip is located at a specific dock, e.g. Dock 4, Boat slip 7, and all boat slips at a dock are numbered sequentially.
- Each boat, for which an active member is assigned a boat slip, is registered with boat name as well as length and width, which is used to calculate the slip fee for renting the boat slip.
- All active and passive members of the club receive an annual invoice for their membership fee. The membership invoice has an invoice date, a payment deadline and the amount to be paid.
- For each boat slip that is assigned to a member's boat, the member receives an annual invoice for the slip fee. The slip fee invoice has an invoice date, a payment deadline and the amount to be paid.
- Guest who visits the marina for the first time in a year have to pay a small membership fee that will be valid for the rest of the year.
- Guests have to reserve a vacant boat slip and pay for their visit before they arrive to the marina.

Make a class diagram of the problem domain of the extended system. You do this by adding to the class diagram for the existing system which is provided below. New classes must have the relevant attributes. If you want to delete an existing class, structure or attribute, just cross it out or strike it over (write your answer in the box below by adding to the class diagram that is provided):


Club
-name
-address
1
1
0..*
0..*
Member
-name
-address
1
Boat Slip
-dock
-slip number
1
0..*
0..*
Membership Fee
-invoice date
-payment deadline
-amount
Boat Slip Fee
-invoice date
-payment deadline
-amount
0..*
1
Passive
Active
1
0..*
Boat
-name
-length
-width

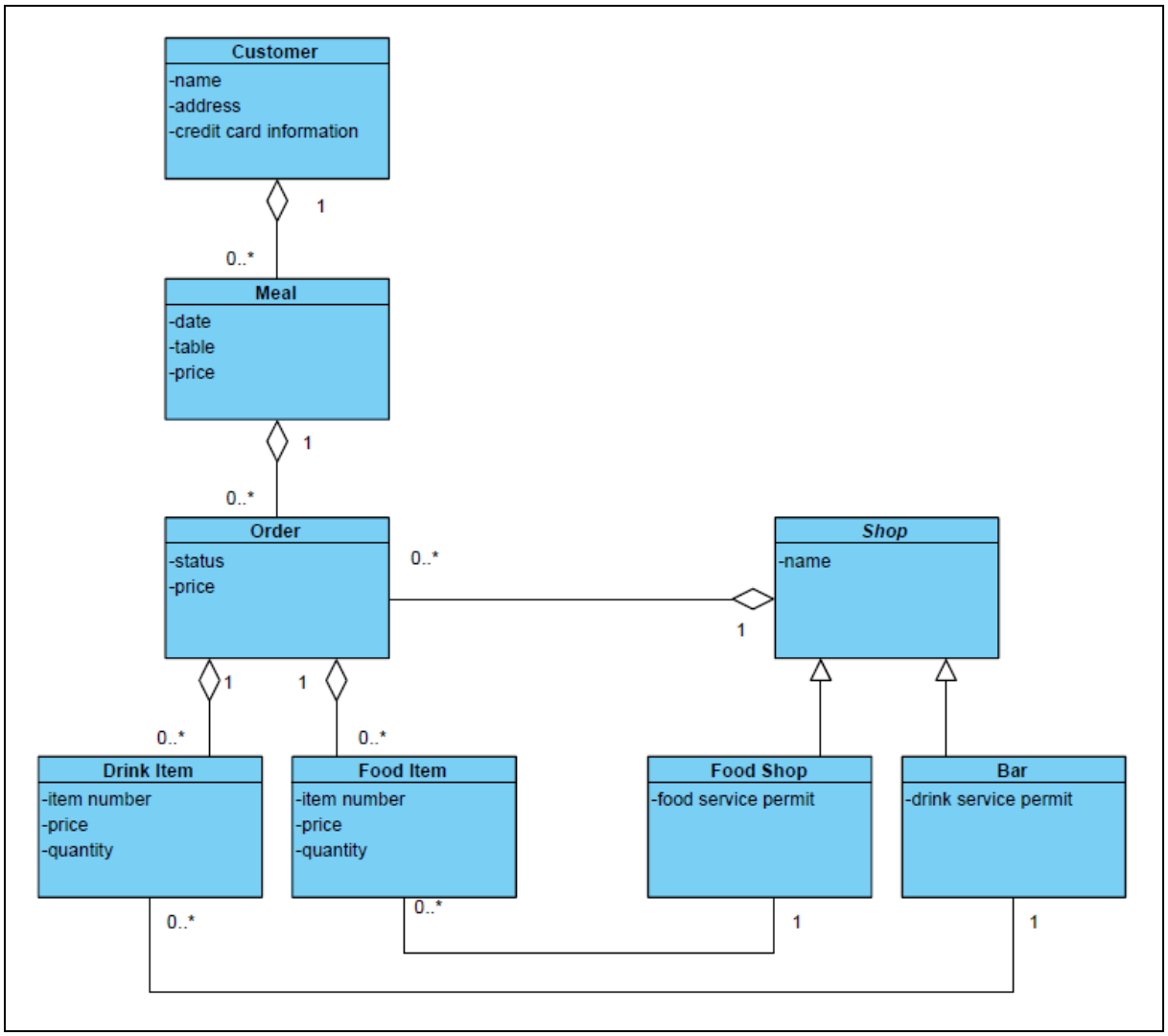
Assignment 2. Street Food (30%)

This assignment is about S-Food, a company that is running a modern street food business. S-Food owns a large building where they rent small shops to food producers and bars that are selling their products in the building. In the building, there are about 10 food shops, a couple of bars and a large seating area with tables and chairs, where the customers consume food and drinks. When the customers arrive to the building, they go to the seating area and find a table. All tables are numbered, and the number is displayed with a QR code on the table.

To order and pay food and drinks, customers have to download an app to their smartphones. The app is the frontend to the system, and it is provided for free by S-Food. S-Food has made this system definition for the frontend system:

> A system provided as an app, which is used by customers who want to order food and drinks at the street food market operated by S-Food. The customers come to S-Food on their own initiative, and their only relation to S-Food is that they download and use the app to order and pay for food and drinks. The system is primarily an administrative tool that is responsible for registering all customers and their orders, and facilitating secure payment of these with the customers' credit cards. Secondarily, it is a communication medium that customers use to request delivery of orders from the food shops and bars. The system can register a new customer with credit card information, compose a meal with a number of orders for food shops and bars, select the food or drink items for each order of a meal, make payment for a meal, and register the table where a customer wants his/her orders delivered. The app is running on each customer's smartphone. It communicates through a wireless network with a server that registers what the individual customer has ordered and paid. On the smartphone, there is always a copy of all meals from the current day, so they are available if the wireless network should fail. The app includes a QR code reader. The app will be developed by S-Food's own IT department in cooperation with S-Food's sales department, the food shops and bars, and a few customers that will be selected to represent the whole customer segment. It may be necessary to resolve conflicting requirements between these different groups. The app will be used by users with very different levels of IT skills.

Below is a class diagram of the problem domain:



The S-Food app is used for ordering food and drinks in the following way:

- When customers have downloaded the app, they first register their information.
- A customer composes a meal consisting of a number of orders.
- An order is either a number of food items from a single food shop or a number of drink items from a single bar. Making an order starts with identifying the food shop/bar from which the customer wants to order.
- For each food shop/bar, the app can display a list of food items/drink items they are selling, with pictures and prices of each. The customers select the items they want to order. For some items, it is also necessary to order a number of items or a quantity (for example, by weight). If customers want more information about the food, they can walk around and visit the shops.
- Once customers have finalised the orders they want in their meal, they check out. First, they authorise payment of the meal through their credit card. Then they register the QR code on their table.
- As soon as a food shop/bar has produced an order, they deliver it to the table.

Assignment 2.1. Statechart Diagrams (15%)

Make statechart diagrams for the three classes Customer, Meal and Order (write your answer in the box below – there is more space on the following page, if you need it).

(assignment 2.1 continued)

Assignment 2.2. Event Table (7%)

Make an event table for the three classes Customer, Meal and Order (write your answer in the box below).

Assignment 2.3. Patterns (8%)

Identify object-oriented patterns in the class diagram above (on page 7), and for each pattern describe which classes it connects and if relevant, the role of each class in the pattern (write your answer in the table below – there are more rows than needed).

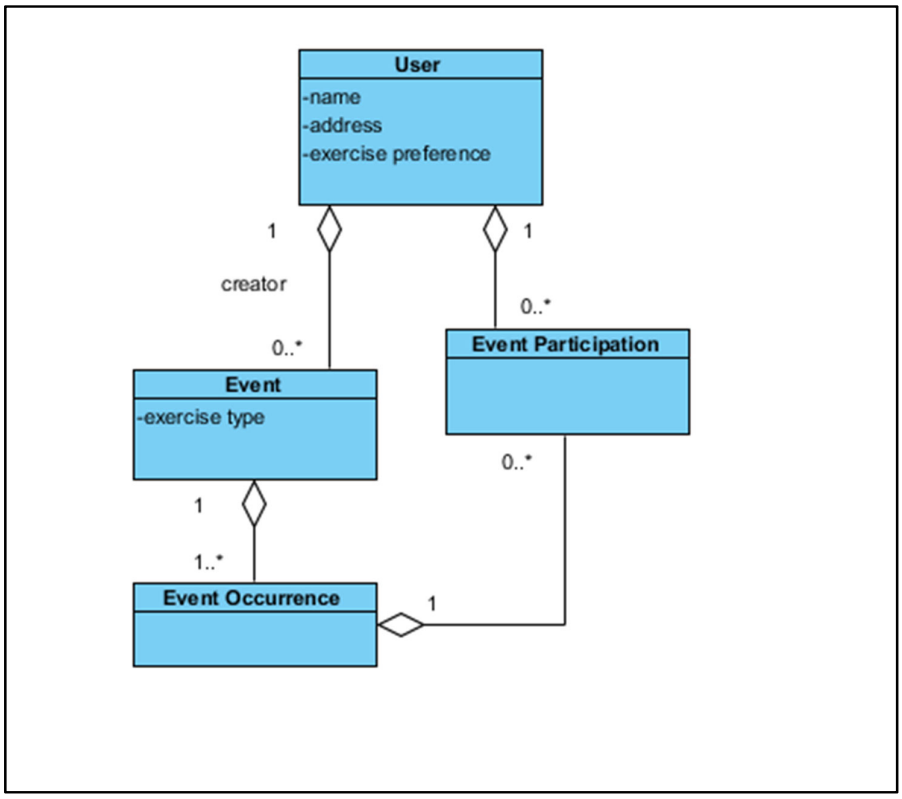
Pattern	Classes connected

Assignment 3. App Supporting Social Exercising (35%)

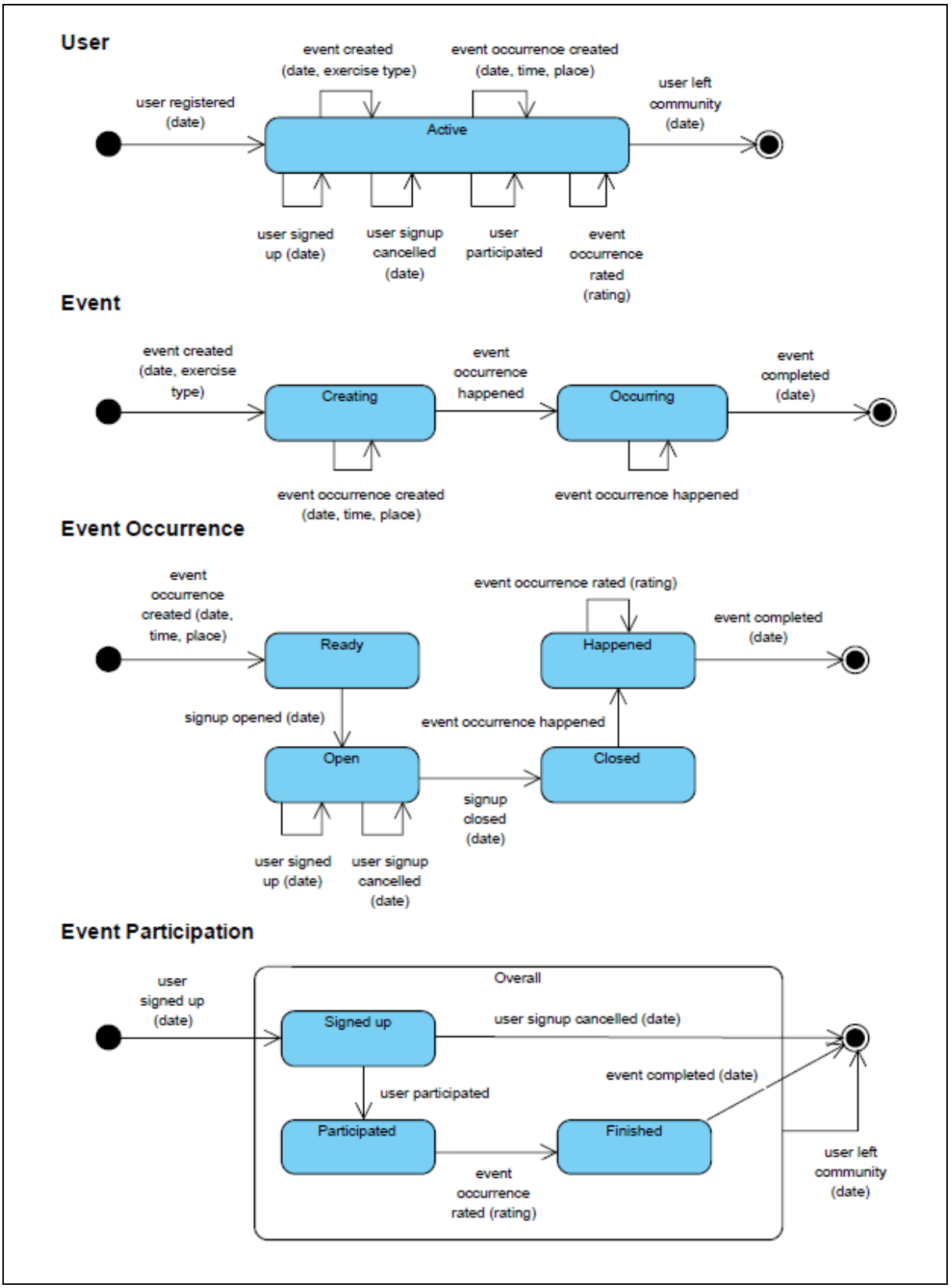
This assignment is about an app that a non-profit organization wants to provide to support increased exercising by facilitating social contact between users. The system developers have produced the following system definition:

> 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 interest them. Events will have at least a single occurrence, but may also have multiple occurrences within defined time intervals, e.g. weekly. The aim of the system is to increase the amount of exercising for 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 selected prospective users.

The system developers have modelled the problem domain with the following class diagram:



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


User
event created
(date, exercise type)
event occurrence created
(date, time, place)
user registered
(date)
Active
user left
community
(date)
user signed
up (date)
user signup
cancelled
(date)
user
participated
event
occurrence
rated
(rating)
Event
event created
(date, exercise
type)
Creating
event
occurrence
happened
Occurring
event
completed
(date)
event occurrence created
(date, time, place)
event occurrence happened
Event Occurrence
event
occurrence
created (date,
time, place)
event occurrence rated (rating)
Ready
Happened
event completed
(date)
signup opened (date)
event occurrence happened
Open
Closed
signup
closed
(date)
user signed
up (date)
user signup
cancelled
(date)
Event Participation
user
signed up
(date)
Overall
Signed up
user signup cancelled (date)
event completed (date)
user participated
Participated
Finished
user left
community
(date)
event
occurrence
rated (rating)

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

Give a textual description of the application domain for this system and give relevant examples of objects in this application domain (write your answer in the boxes below).

Application Domain (description)	
Objects (examples)	

Give a textual description of the problem domain for this system and give relevant examples of objects in this problem domain (write your answer in the box below).

Problem Domain (description)	
Objects (examples)	

Assignment 3.2. Actors and Use Cases (10%)

The system supports a number of use cases, including the following (not a complete list):

- Join as a new member
- Leave as a member
- Create event and event occurrence(s)
- Sign up for an event occurrence
- Register participation in and rating of an event occurrence
- For an event, produce a list of event occurrences with participants and ratings for each participant
- Clean up (by deleting users and events that have been inactive for at least 6 months)

Make the relevant actor specifications and an actor table for these use cases (write your answer in the box below – it continues on the next page).

(assignment 3.2 continued)

Assignment 3.3. Functions (10%)

Make a complete function list for the use cases above (with complexity and function type for each function) (write your answer in the box below – there are more rows than needed).

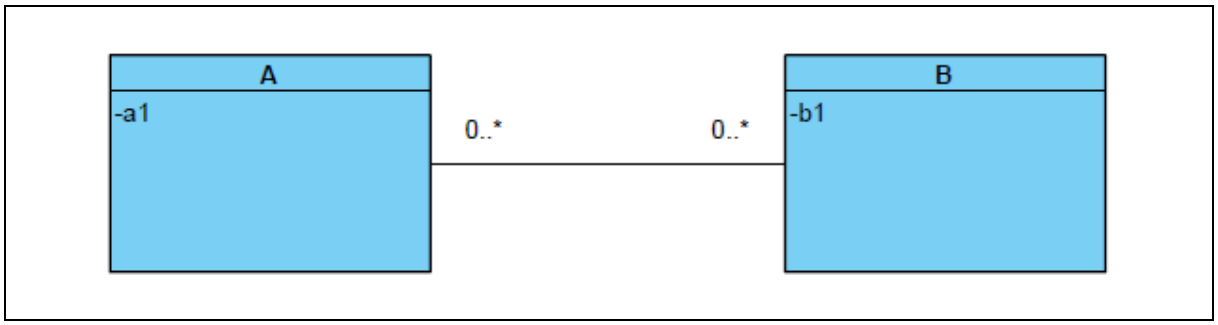
Function name	Complexity	Function type

Assignment 3.4. Use Case (10%)

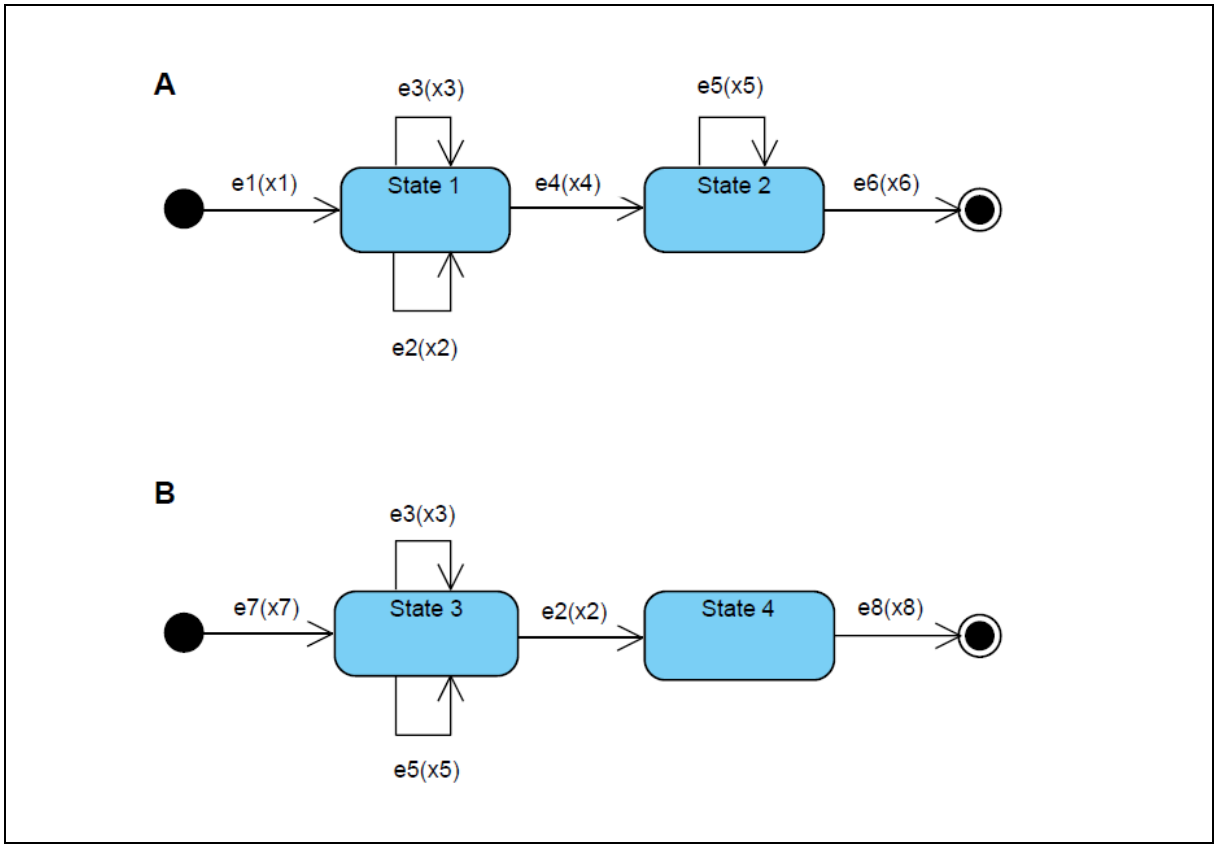
Make a use case specification for ‘Create event and event occurrence(s)’ (with objects and functions) (write your answer in the box below). If necessary, you may introduce new attributes to the classes in the problem domain; if you do, make a note about it at the bottom of the box below.

Assignment 4. Model Component (15%)

This assignment is about design of a model component. Consider the class diagram below:



The statechart diagrams for the two classes in the class diagram are shown below:



Assignment 4.1. Event Table (5%)

Make an event table (with '+' for sequence and selection; and '*' for iteration) for the model of this problem domain (write your answer in the box below).

Assignment 4.2. Model Component Design (10%)

Design the model component of a system for administration of this problem domain (write your answer in the box below).