Systems Development

(Dat3, SW3, IxD5, iDA7)

Written Exam – With Solution

4 January 2019, 10:00-14:00

Student Name	
Student Number	
Study Programme and Semester	

This exam set consists of 18 pages (including this page) with 4 assignments. Before you start, check that your exam set contains all these 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 may make a draft of your solution before filling it into the exam set. You can obtain paper for making a draft from the exam officials.

You can write your solution in either English or Danish (or a mix).

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. Street Food App (20%)

S-Food is 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. S-Food wants an object-oriented analysis of a system to support this business.

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 provided for free by S-Food. In the app, there is a page with a menu with all food shops and bars. You can choose one of these, and for each food shop, there is a list of food items they sell with pictures and prices of each, and for each bar, there is a list of drink items with prices. On these pages, 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.

With the app, 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. Once customers have selected the food and drink items they want in their meal, they go to a checkout page in the app. Here they first authorise payment of the meal through their credit card, which has to be registered in their app. Then they take a picture of the QR code on their table. As soon as a food shop has produced the food in their order, or a bar has the drinks in their order, they deliver it to the table. This means that the customers do all the ordering from their table.

The system is communicating with the smartphone apps over a wireless internet that connects the apps to S-Food's server that runs the system. The app on the customers' smartphones is the frondend of the system.

Each food shop and bar uses a backend system that for each order produces a list of the food or drink items they need to produce and deliver to the customer who made the order. However, in this assignment, you just ignore that backend of the system and only focus on the frontend that the customers will see.

Assignment 1.1. System Definition (5%)

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 food or drink items in each order of a meal, make payment of 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.

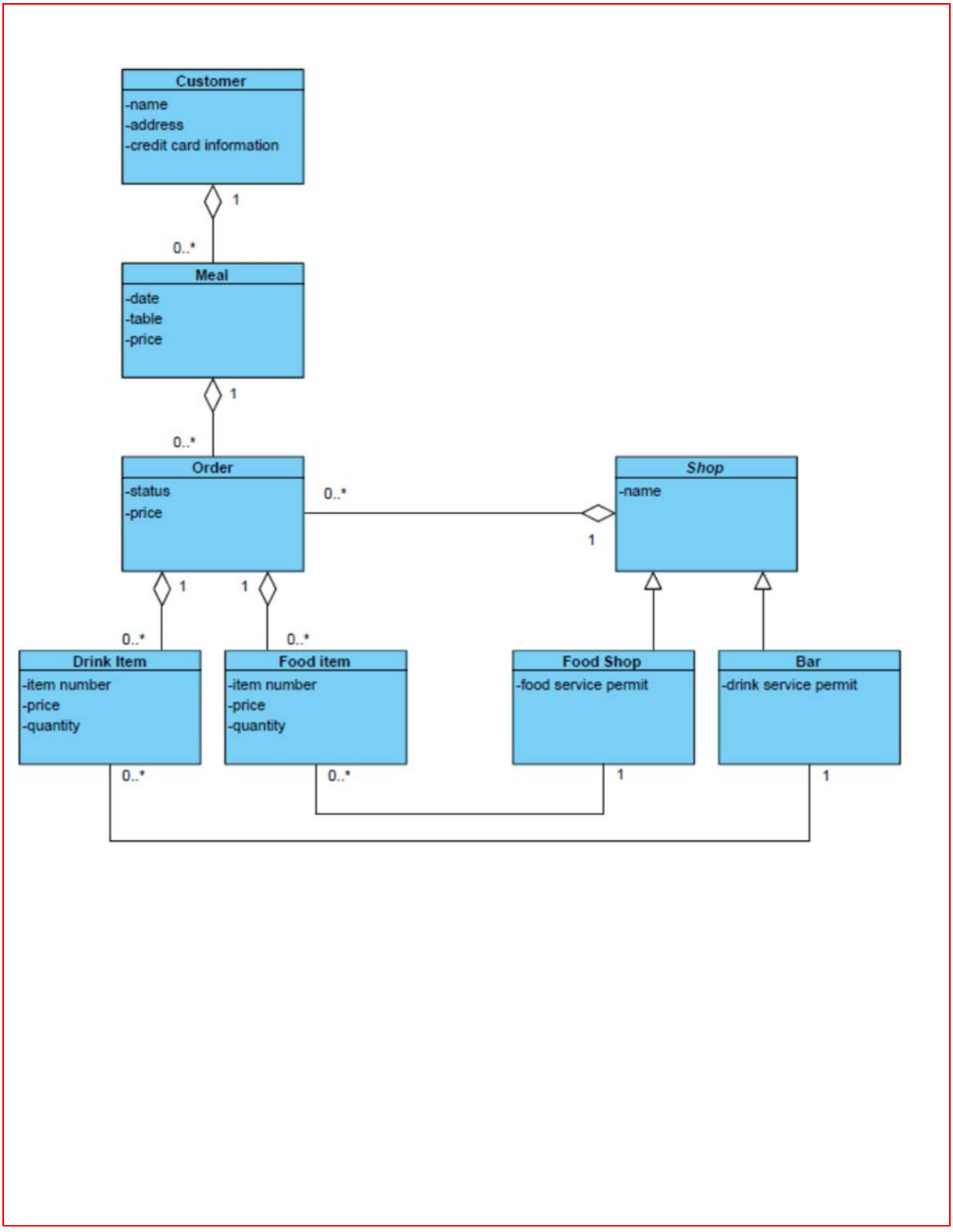
Divide this system definition into the elements of the FACTOR criterion (write your answer in the boxes below).

F	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 food or drink items in each order of a meal, make payment of a meal, and register the table where a customer wants his/her orders delivered.
A	A system provided as an app, which is used by customers who want to order food and drinks at S-Food's street food market. The customers come to S-Food at their own initiative, and their only relation to S-Food is that they download and use their app to order and pay for food and drinks.
C	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 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.

T	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.
O	Customer, Food Shop, Bar, Order, Meal, Food item, Drink item.
R	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.

Assignment 1.2. Class Diagram (15%)

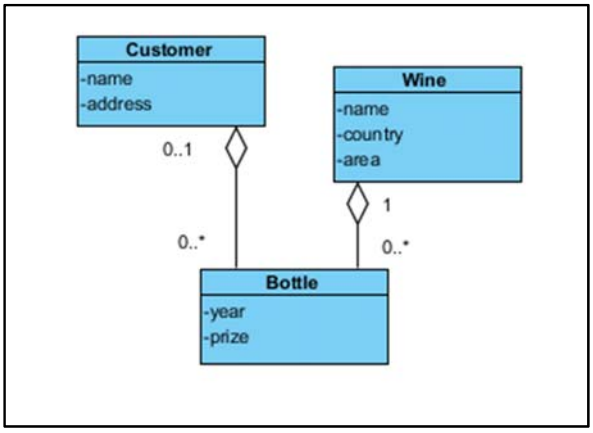
Make a class diagram of the problem domain of this system. The classes must have the relevant attributes (write your answer in the box below):



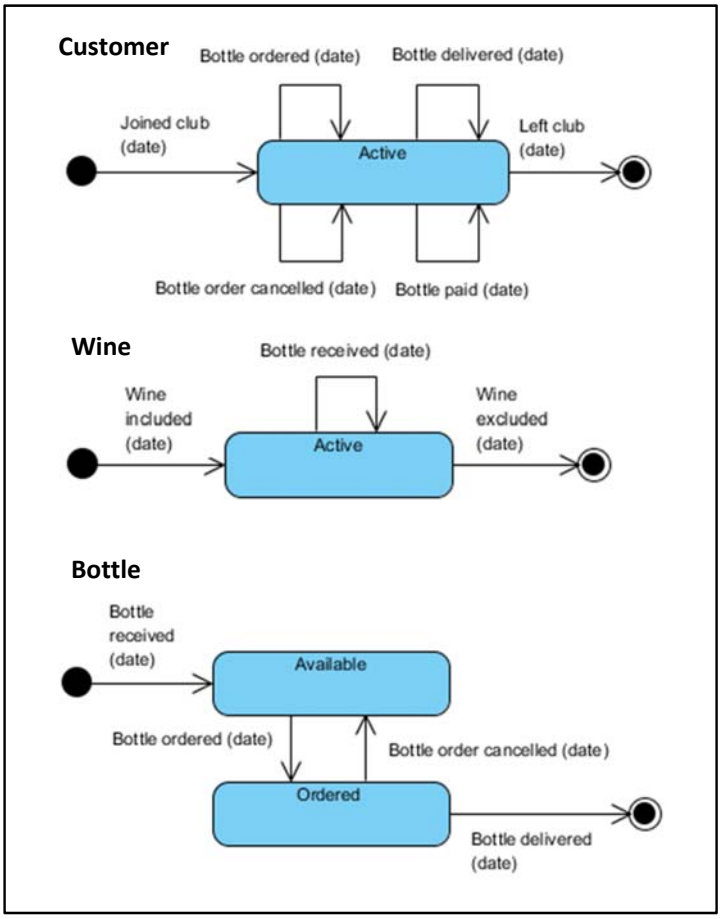
Assignment 2. Wine Club (35%)

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

Below is the class diagram for the problem domain.



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



Assignment 2.1. Application Domain and Problem Domain (5%)

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

Application Domain (definition)	(Def.: The organization that administrates, monitors, or controls a problem domain.) For this system, it is the wine club's administrative and operational personnel and its customers/members.
Objects (examples)	(Administrative person) Administrator Warehouse clerk Customer/member

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

Problem Domain (definition)	(Def.: The part of a context that is administrated, monitored or controlled by a system.) For this system, it is the part of the context of the wine club system that is administrated by that system. The buying and selling of wine through the club's system (website) by the customer/members and the delivery of their orders.
Objects (examples)	Customer/member Wine Bottle

Assignment 2.2. Actors and Use Cases (10%)

The system supports the following use cases:

- Join as a new member
- Leave as a member
- Include wine in the assortment
- Exclude wine from the assortment
- Register bottle(s) received
- Order bottle(s) of wine
- Cancel bottle order(s)
- Register delivery of bottle(s)

You can assume that payment for orders is handled outside this system.

Define relevant actors for the system and make an actor table (write your answer in the box below – it continues on the next page).

Administrator
Goal: A person who administrates the assortment of the wine club.
Characteristics: The Administrator is using the system regularly to update the assortment of wine that the wine club offers to its customers.
Examples: Administrator A has extensive knowledge about wine and has significant experience with the system and uses it regularly, several times a day.

Warehouse Clerk (Administrative person)
Goal: A person who administers the physical bottles of wine that the wine club has in its warehouse. The Clerk records in the system when bottles are received and when bottles are sent to customers.
Characteristics: There is a group of persons who carry out this job. Their use of the system is characterized by different levels of experience and sophistication with it.
Examples: Clerk A uses only the basic functions of the system, i.e. the ones needed to record receipt and delivery of wine.
Clerk B is technologically curious and uses the system often, optimally, and to the limit of its abilities. B has never had major problems in understanding the system's possibilities, and also examines possibilities that are not necessary to carry out the job as clerk. B often helps other clerks or even customers with advice on the use of the system.

Customer (Member)
Goal: A person who is a member of the club and uses the system to buy wine from the wine club's assortment.
Characteristics: The group of customers is very diverse, ranging from a very low level of computer skills to very advanced users.
Examples: Customer A only uses the system occasionally and only the basic functions for buying wine.
Customer B is using the system regularly to buy wine to B's private wine cellar. B is experienced with the use of the system and all functions that are available to customers.

Assignment 2.2 continued

	Administrator	Clerk	Customer
Join as a new member			X
Leave as a member			X
Include wine in the assortment	X		
Exclude wine from the assortment	X		
Register bottle(s) received		X	
Order bottle(s) of wine			X
Cancel bottle order(s)			X
Register delivery of bottle(s)		X	
Register payment for bottle(s) (not listed above, not required in solution)	X		

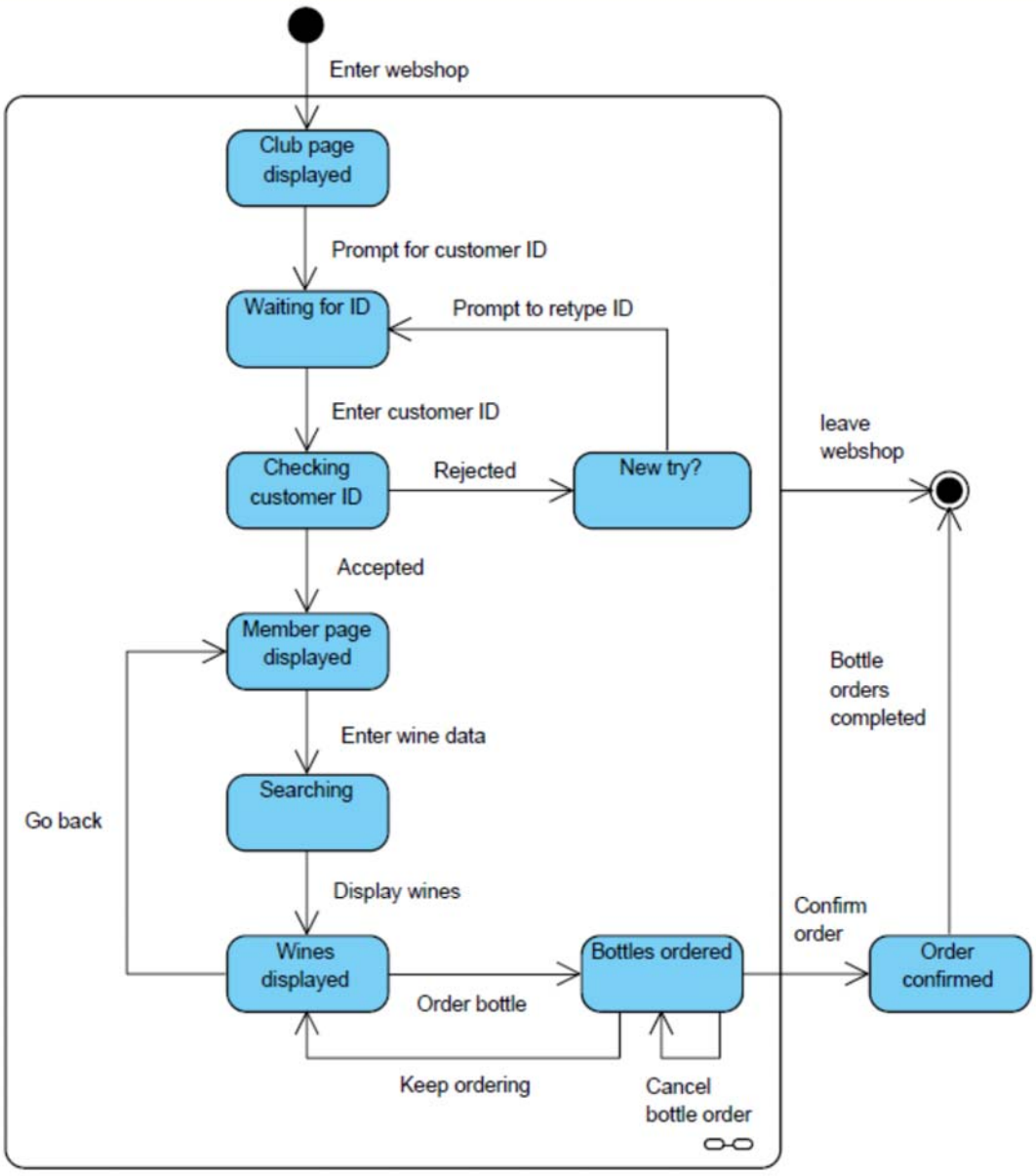
Assignment 2.3. Functions (10%)

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

Function name	Complexity	Function type
Register member joined	Medium	Update
Register member left	Simple	Update
Register wine included	Medium	Update
Register wine excluded	Simple	Update
Register bottle received	Medium	Update
Register bottle ordered	Medium	Update
Register bottle order cancelled	Simple	Update
Find customer data	Simple	Read
Register bottle delivered	Simple	Update
Calculate price of order	Medium	Read+Compute+Update
Register bottle paid	Simple	Update
(List bottles to be delivered to customer)	Medium	Read
(List bottles not paid by customer)	Complex	Read
Inform when bottles in stock is too low	Medium	Signal
Display wine available to customer	Medium	Read
Calculate what a customer owes	Medium	Read+Compute
(Inform when a customer owes too much)	Complex	Signal
Functions in parenthesis are optional		

Assignment 2.4. Use Case (10%)

Describe the use case 'Order bottles of wine' (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 that, just make a note about it at the bottom of the box below.



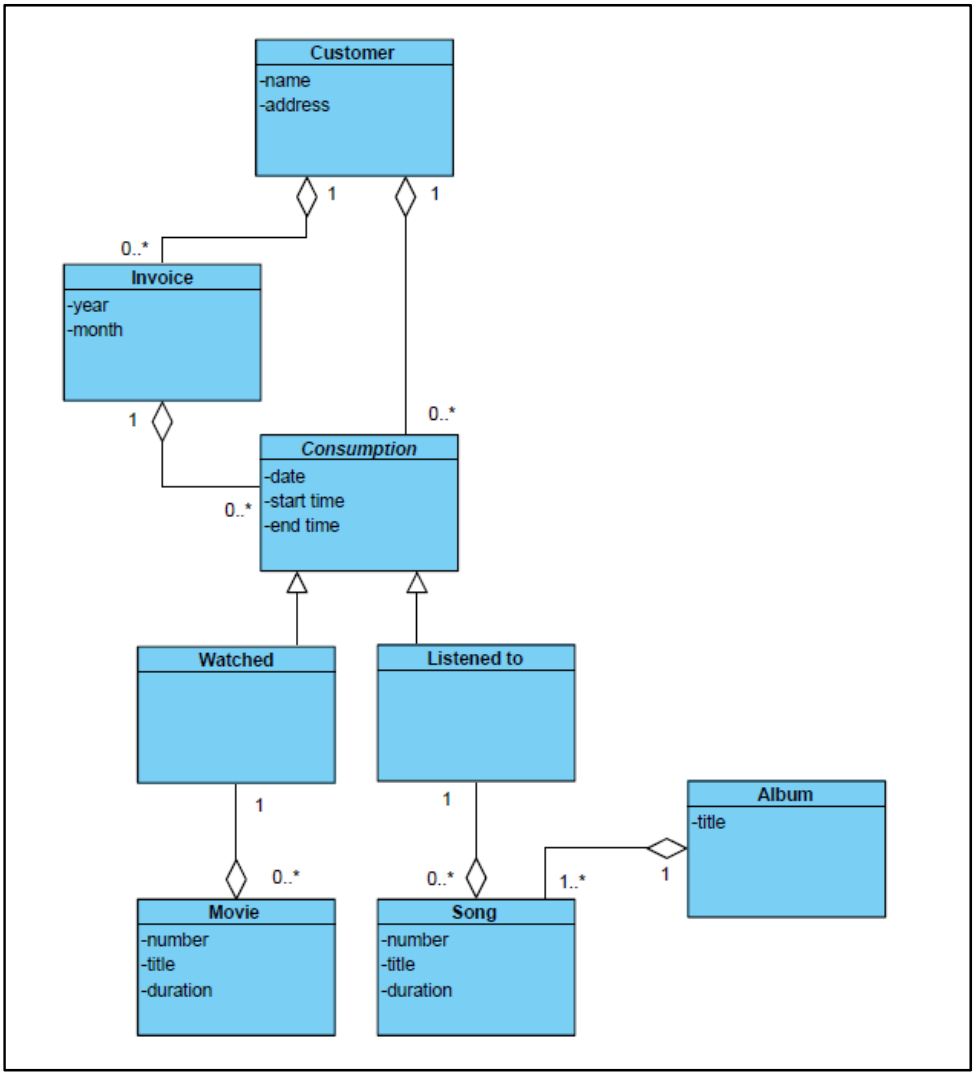
Objects: Customer, Bottle, Wine
Functions: Register bottle ordered, Register bottle order cancelled
New attributes: Customer ID (in Customer class)

Assignment 3. Streaming Service (35%)

This assignment is about a system for administration of consumption on a streaming service for movies and music. The owner of the service has together with a software development company made the following system definition:

F: Register the movies the customers watch and the songs they listen to, and support payment by customers for their consumption of these movies and songs.
A: Will be used only by the administrative personnel that is employed by the organization that provides the streaming service
C: Developed for and in collaboration with the administrative personnel.
T: PC platform with common tools.
O: Customer, Movie, Song.
R: Registration, administration and payment of the customers' consumption through the streaming service.

They have also made the following class diagram of the problem domain of the system:



Note: The cardinalities between Watched-Movie and Listened to-Song should be swapped.

Assignment 3.1. Patterns (10%)

Identify object-oriented patterns in the class diagram above, 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 box below – there are more lines than needed).

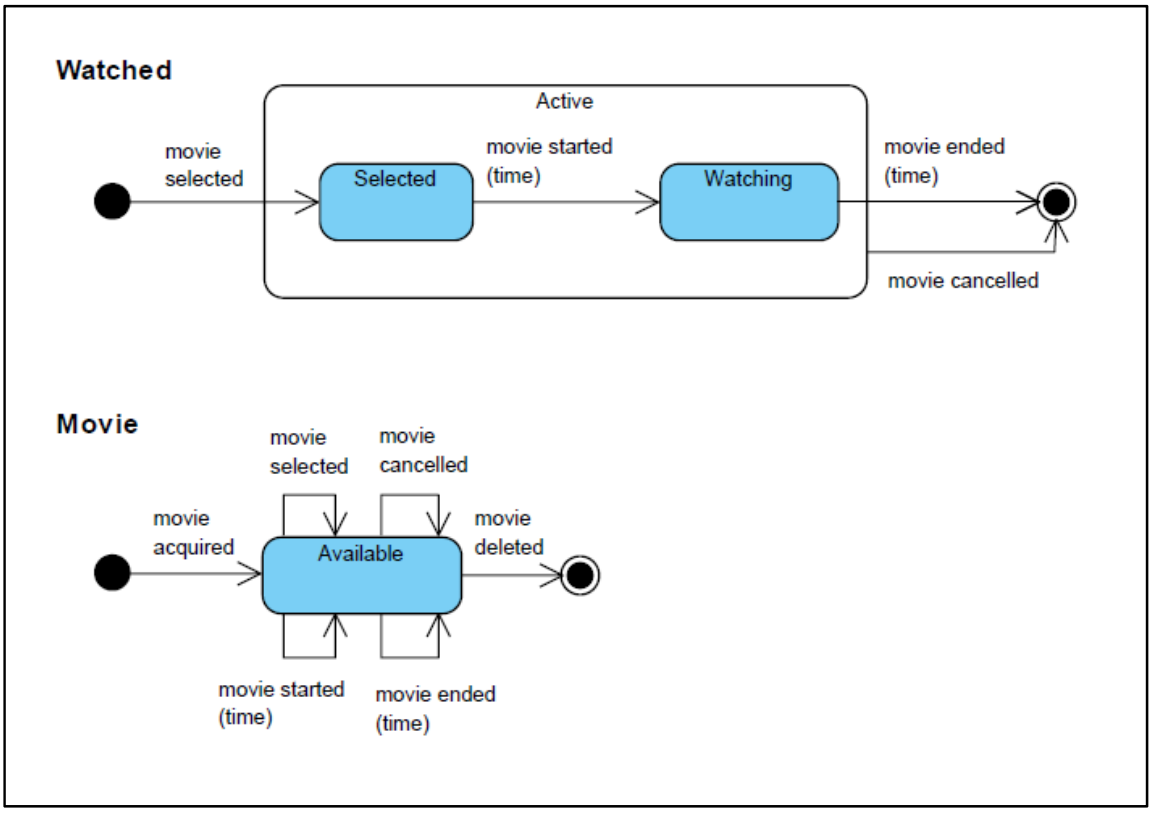
Pattern	Classes connected
Hierarchy	Customer-Invoice-Consumption
Hierarchy	(not so obvious, but OK) Customer-Consumption
Relation	Customer-Watched-Movie
Relation	Customer-Listened to-Song
Hierarchy	Album-Song
Role	(not so obvious, but OK) Customer-Consumption-Watched/Listened to
Item-Descriptor	Song-Listened to
Item-Descriptor	Movie-Watched

Assignment 3.2. Event Table (10%)

The behaviour in the problem domain can be described as follows:

- A customer can join the streaming service and leave it. In between these, he/she is a member of the streaming service.
- A member can select a movie and watch it. It can be cancelled during watching.
- A member can select a song and listen to it. It can be cancelled while listening to it.
- A member select movies and songs, and they pay for the movies and songs they select.
- Movies and songs are acquired by the service and deleted when members no longer select them.
- An invoice is generated each month with the consumption of the customer during that month.
- The customer pays the invoice within a certain time limit defined on the invoice.
- If the customer does not pay within the time limit, he/she is excluded from the club. When a customer is excluded from the club, he/she has to pay before being able to leave the club.
- While being excluded, it is not possible to watch movies and listen to songs.

The system developers have also made the following two statechart diagrams.



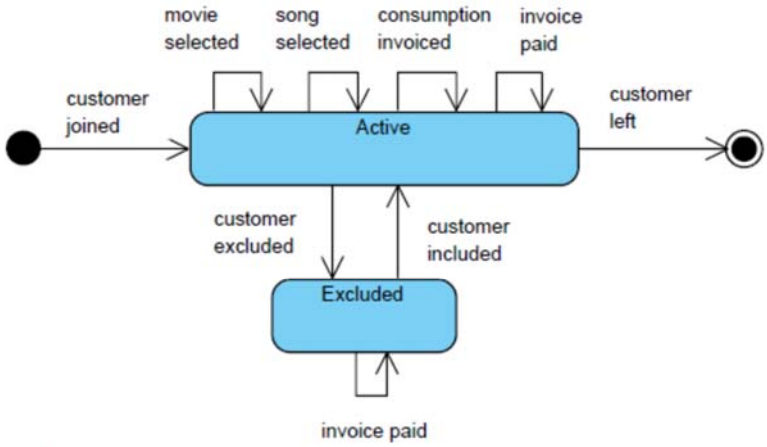
Make a complete event table for this problem domain (write your answer in the box below).

	Customer	Invoice	Consumption	Movie	Watched	Album	Song	Listened to
customer joined	+							
customer left	+							
movie acquired				+				
movie deleted				+				
movie selected	*		+	*	+			
movie started	(*)			*	+			
movie ended	(*)			*	+			
movie cancelled	(*)			*	+			
song acquired						*	+	
song deleted							+	
song selected	*		+				*	+
song started	(*)						*	+
song ended	(*)						*	+
song cancelled	(*)						*	+
Invoice created		+						
consumption invoiced	*	*	+					
invoice paid	*	+						
customer excluded	*							
customer included	*							

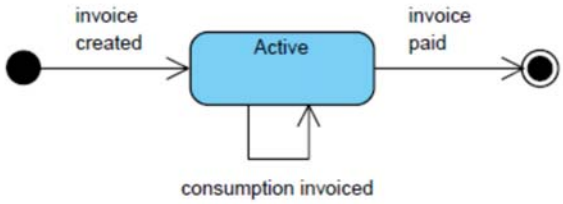
Assignment 3.3. Statechart Diagrams (15%)

Make statechart diagrams for the three classes Customer, Invoice and Consumption (write your answer in the box below).

Customer



Invoice



Consumption

Assignment 4. App Supporting Social Exercising (10%)

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.

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.

Explain which system architecture you would use for this system and give the reasons why (write your answer in the box below).

- Use a client-server architecture, because there is a central server and a varying number of clients on the users' smartphones, and they are geographically dispersed.
- Distributed data: The client only has the part of the model that is relevant to that client and the functions+user interface for the users of the system, because it allows the user to access the relevant part of the model even if the connection to the server is lost; and the smartphone has processing power to run functions locally.
- Alternative to distributed data: Local presentation: All data are centralised, and the clients only have user interface. Downside: nothing works if the connection to the server is lot, and the input to and output from the functions may require considerable network traffic.
- The server has the complete model and functions+user interface for system administration, because one central, complete model is a simple solution to ensure consistency; and the administration functions and user interface is needed by the administrative staff.
- The client and server are based on the Generic architecture, because the requirements may change, so a strict and closed architecture with standard components is the optimal solution.

Make a diagram of your system architecture (write your answer in the box below).