

MoSIG- 1

Software Engineering

Part 1

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1. Development process

Exercise 1.1

Answer the following questions on Moodle or a sheet. (no copy-past from Internet, please)

- Q1. Give your **own** definition of software Engineering
- Q2. For **you**, what are the activities during a software project?
- Q3. What development process do you know?

Exercise 1.2

In the following situations, choose development process and detail your reasons.

1. System for student management in a university (this system replaces an existing system without any functional evolutions)
2. A new interactive system for travellers to have schedules on their smartphones
3. A system to control subway without drivers
4. A very large system for Air traffic management
5. A very new 3D-system for software maintenance
6. Infrastructure and services for city that wants to become a “smart-city”

2. Requirement engineering

Exercise 2.1 about requirement elicitation method

- Make small groups (3-6 persons)
- Study the elicitation method given by your teacher
- Imagine a scenario of illustrate how this elicitation method is used
- Make a small movie or a set of pictures to « implement » the scenario

Exercise 2.2 - Serious Game: CyberVideo

- Make a Team of 4-5 students
- Among the member, choose 1 client, the other will be play the role of providers
- Starting document
 - Providers: Call for tender (few lines)
 - Client: informal description (3 pages)
- Objectives Providers:
 - Ask client questions in order to find all the requirements described in the informal description
 - Propose a specification document

Exercise 2.3

- Read and learn about requirement elicitation methods.
- At the end of the work, you should be able to
 - cite several elicitation methods
 - explain the principle of a given elicitation method
 - give advantages/limits of a given elicitation method

3. Modelling with UML – use cases

Exercise 3.1¹

BeSafe is an insurance company for car drivers. CarMatch is the name of the system of the company. Using it, staff can search for suitable policies for a member based on the member's age, occupation and where she lives. They can recommend one or more policies to a member. If the member wants to buy a policy, they can sell it to her.



Q1. What use cases are involved here?

Q2. How should they be called?

BeSafe company has several franchise offices. In each of them, there is an insurance supervisor and an insurance assistant, to deal with the operations with the members. Supervisors and assistants have exactly the same use of CarMatch.

Q3. How many actors should be involved in the use case diagram?

Q4. What should their name(s) be?

Here is a transcript of an interview of the user.

User: When we are selling insurance, the first thing is to get the details of the member: their age and occupation, where they live and their insurance history, that is, whether they've had any recent accidents.

Analyst: Where does that come from?

User: Some comes from their membership details in the system, other we'll get it from the phone

Analyst: What happens next?

User: We'll try to find the suitable policy. We'll be searching for the best one, best on the information we have. The system could come up with more than one policy. We recommend the ones the best meet member needs.

Analyst: Do you always get a sale?

User: No. Sometimes the person will decide to buy a policy. Sometimes they won't.

Analyst: So, you always search for a suitable policy, and sometimes you sell one.

User: Yes, exactly.

Q5. From this interview, use <<extends>> and <<includes>> to represent the relationships among the previous use cases.

Exercise 3.2

ADE2 is a new system to manage the reservation of elements such as classrooms and teaching materials (notebook and / or video projector). Only teachers can book elements. The schedule for the rooms can be seen by everyone (teachers and students), but the summary schedule per teacher can only be accessed by teachers. With the system, it is also possible to edit the summary schedule for an entire formation. This can only be done by the teachers responsible of the related formation.

Q1: Propose a use-case diagram for this example.

Exercise 3.3

Q1. Propose a use-case diagram for Cyber-video.

Q2. You can notice that you choose to detail this diagram more or less. When is it relevant to propose an abstract version of the diagram? And a detailed one?

¹ Adapted from « UML, second edition », Schaum's Outline. S. Bennett, J. Skelton, K. Lunn

4. Modelling UML – state diagrams and sequences diagrams

Exercise 4.1²

Q. Draw a state diagram for the control of a telephone answering machine.

The machine detects an incoming call on the first ring and answers the call with a prerecorded announcement. When the announcement is complete, the machine records the caller's message. When the caller hangs up, the machine hangs up and shuts off. Place the following elements in the diagram:

call detected, answer call, play announcement, record message, caller hangs up, announcement complete.

Exercise 4.2²

A simple digital watch has a display and two buttons to set it, the A button and the B button. The watch has two modes of operation, display time and set time. In the display time mode, the watch displays hours and minutes, separated by a flashing colon. The set time mode has two sub modes, set hours and set minutes. The A button selects modes. Each time it is pressed, the mode advances in the sequence: display, set_hour, set_minutes, display, etc. Within the sub modes, the B button advances the hours or minutes once each time it is pressed. Buttons must be released before they can generate an event.

Q. Propose a State diagram of the watch.

Exercise 4.3

Q. Propose a state chart diagram to describe the different states of a DVD in the context of the Cyber-video problem.

Exercise 4.4

[Extract from wikipedia] Chess is a two-player strategy board game played on a chessboard. Players are referred to as “White” and “Black” respectively. The objective is to checkmate the opponent's king by placing it under an inescapable threat of capture. To this end, a player's pieces are used to attack and capture the opponent's pieces, while supporting their own. In addition to checkmate, the game can be won by voluntary resignation by the opponent, which typically occurs when too much material is lost, or if checkmate appears unavoidable. A game may also result in a draw in several ways (by agreement, threefold repetition...). The player with the white pieces always moves first. After the first move, players alternately move one piece per turn (during castling, two pieces are moved, but it can be considered in the model as only one “move”). A player may not make any move that would put or leave his or her king under attack. A player cannot “pass”; at each turn they have to make a legal move. If the player to move has no legal move, the game is over; it is either a checkmate (a loss for the player with no legal moves) if the king is under attack, or a stalemate (a draw) if the king is not.

Q1. Propose a state diagram to model a chess party.

Q2. Propose a sequence diagram to model a chess party.

5. Modelling with UML – Class diagram and object diagrams

Exercise 5.1

For the following questions, propose

- 1) a class diagram
- 2) an object diagram that satisfies the class diagram
- 3) an object diagram that does not satisfy the class diagram (and explain why).

Q1. A country has a name and a capital. It shares boundaries with at least one other country.

Q2. An elector votes for at most one candidate.

² from http://www.darshan.ac.in/Upload/DIET/CE/SEM%204/Darshan_Sem4_140703_OOAD_2014%20%28Diagrams%29.pdf

Exercise 5.2

For the following questions, propose a class diagram

Q1. A supermarket proposes different types of products: foodstuffs, objects and flowers. Each product has a bar code and a price. Foodstuffs have an expiry date and flowers have a fresh date.

Q2. A building has several floors. Some of them are composed of offices and flats. Others are dedicated to parking. They are composed of several parking slots.

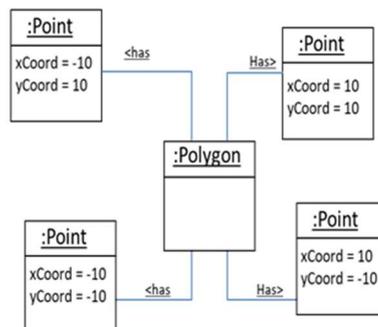
Q3. A media library has different types of media that can be borrowed by the library subscribers.

Exercise 5.3

Q1. Propose a class diagram from the following object diagram.

Q2. Explain your choices of cardinalities.

- What is the smallest number of points to build a polygon?
- Can a point be shared by several polygons? What are the consequences on the object diagram?
- How indicate that points are ordered?



Exercise 5.4

Several classes are presented hereafter. Some of the attributes are references to other classes.

Q. Propose a new class diagram.

Person
BirthDate
IDEmployer1
IDEmployer2
IDEmployer3
IDPerson
Address

Car
IDOwner
IDCar
OwnerType
Model
Year

Loan
IDCar
ClientType
IDClient
IDBank
InterestRate
CurrentBalance

Company
Name
ID

Bank
Name
ID

6. Documenting architecture with UML

Exercise 6.1

Automated speed enforcement is used in some jurisdictions to reduce speeding. Speed cameras (also called photo radar or automated speed enforcement) records a vehicle's speed using radar or other instrumentation and takes a photograph of the vehicle when it exceeds the local threshold limit. This equipment is in a "box", installed on the roads. Such a box has a speed camera, a high-speed camera, a flashbulb, and a software part that coordinates the three.

The boxes send their pictures and the related information to a management center. In this center, an automatic treatment is carried out to identify the number plate and the owner of the car. To identify the owner, the center has a local copy of the national car registration data-base (updated every night). After the automatic treatment is carried out, an operator checks if the number plate is correctly identified. If it is the case, he validates the penalty document. If the automatic recognition failed, he can use a picture editor software of the system to improve the picture. Then he fills the penalty document and validates it.

The center has a database to record all the pictures and all the penalty documents.

Questions:

Q1. Propose a use-case diagram to describe the main system functionalities.

Q2. The system is composed of the "boxes" and of the software in the management center. We want to represent this situation with an UML view. Give a proposition. Your result will be a representation of the architecture of the system at the highest abstraction level.

Q3. Identify the main components required to build the management center system, and represent how they are connected with an UML view. Your result will be a representation of the architecture of the management center system.

Q4. About the software in the boxes, what are the key non-functional constraints?

Exercise 6.2

You find the following description on Wikipedia.

"Three-tier architecture is a client–server software architecture pattern in which the user interface (presentation), functional process logic ("business rules"), computer data storage and data access are developed and maintained as independent modules, most often on separate platforms Typically, the user interface runs on a desktop PC or workstation and uses a standard graphical user interface, functional process logic that may consist of one or more separate modules running on a workstation or application server, and an RDBMS on a database server or mainframe that contains the computer data storage logic. Data transfer between tiers is part of the architecture.

Q. To explain the three-tier architecture, draw an architectural description using the principles of (1) separation of concerns and (2) abstraction.

7. Testing

```

1. public class IntegerDivision {
2.     public static int IntDiv(int x, int y) {
3.         int z = 0;
4.         int signe = 1;
5.         if (x < 0) {
6.             signe = -1;
7.             x = -x;
8.         }
9.         if (y < 0) {
10.            signe = -signe;
11.            y = -y;
12.        }
13.        if (y == 0) {
14.            throw new IllegalArgumentException("Argument nul:"+y);
15.        }
16.        while (x >= y) {
17.            x = x - y;
18.            z = z + 1;
19.        }
20.        z = signe * z;
21.        return z;
22.    }
23. }

```

Exercise 7.1 *First step in testing*

Here above is the Java program of the Integer Division (Euclid Algorithm)

Q1. Write (and execute JUnit) tests for this program

Q2. Feed-back

- How many test data did you chose? Why?
- What data did you chose? Why?

Exercise 7.2 *Coverage-based selection (white-box testing)*

Q1. Draw the control flow-graph of the Integer Division program

Q2. Propose a test data set to achieve line coverage.

How many tests (at least) are necessary to achieve line coverage?

Q3. Does the previous set achieve branch coverage? If necessary complete the test set to achieve branch coverage.

How many tests (at least) are necessary to achieve branch coverage?

Q4. What can you say about your tests now? Is the program free of bugs? Why?

Exercise 7.3 *black-box testing*

Q1. Apply the input partition technique and all-combination strategy to select tests for the IntegerDivision program

Q2. Complete your previous tests

Q3. What can you say about your tests now? Is the program free of bugs? Why?

Exercise 7.4 *Checking the quality of your tests*

Line 17: while (x >= y) {

- Replace “>=” by “>”
- Execute your tests

Q1. Why is this modification erroneous?

Q2. Do your tests find the error?

Q3. If it doesn't, what does it means?

Exercise 7.5

Hereafter is a program that compares two strings and prints if they are equals or not.

Q1. Propose a test set based on an equivalence partition strategy.

```

1. equal : boolean
2. string1, string2: string
3. Read(string1, string2)
4. equal = (string1.length == string2.length)
5. if equal then
6.     for (i=1 ; i<= string1.length; i++) {
7.         equal = (string1.character[i] == string2.character[i])
8.     }
9. if equal then
10.     print(« same strings »)
11.     else
12.     print(« different strings »)

```

Q2. Draw the control-flow graph of the program.

Q3. Check if the test set produced in question Q1 covers all statements and all branches of the control-flow graph.

Q4. What is the fault in the program?

Exercise 7.6

Let “example(x,y,z)” be a program with 3 inputs.

Let {x1,x2,x3}, {y1,y2,y3} and {z1,z2} be the selected data for testing.

Q1. How many tests do we obtain with an all-combination approach?

Q2. Propose a test set satisfying a pairwise coverage

Exercise 7.7

Hereafter is a program that computes the current day number. It is a number between 1 and 366. January 1st is day 1. For a leap year (also known as an intercalary year or a bissextile year), the 31st of December is day 366. It is day 365 for common year.

```

1 public int CurrentDayNumber (int day, int month, int year){
2   if (InvalideDate(day, month, year)){
3     throw new IllegalArgumentException();
4   }
5   int diff = (month-1)* 31+day;
6   final int[]monthOf30Days = {4,6,9,11};
7   int i = 0;
8   while(i< monthOf30Days.length){
9     if (month > monthOf30Days[i]){
10      diff = diff -1;
11    }
12    i++;
13  }
14  if (month > 2){
15    if (! leap(year)){
16      diff = diff -3;
17    }
18    else {
19      diff = diff -2;
20    }
21  }
22  return diff;
23 }

```

Q1. Draw the control-flow graph of the program.

Q2. Give a test data set that covers all branches of the programs.

8. Software Engineering Mid-term Exam (annals)

No document, no smartphone - Use the answer sheet

Exercise 1 (6)

Q1.1) Which development process is the most appropriated to deal with risks?

- | | |
|-----------------|--------------------------|
| a. Incremental. | d. V-cycle |
| b. Prototyping | e. Waterfall |
| c. Spiral | f. None of the previous. |

Q1.2) When prototyping is appropriate?

- | | |
|--|------------------------------------|
| a. When requirements are well defined. | d. When there is a technical risk. |
| b. For projects with large development teams. | e. None of the previous. |
| c. When a customer cannot define requirements clearly. | |

Q1.3) Requirements are easily understandable and defined. The project is between small and medium size. Which process is best suited among the following?

- | | |
|----------------|----------------|
| a. Spiral | d. Incremental |
| b. Waterfall | e. Iterative |
| c. Prototyping | f. Agile |

Q1.4) Selection of a software development process is based on:

- | | |
|-------------------------------------|--------------------------|
| a. Requirements | d. Tools of the company |
| b. Development team & Users | e. None of the previous. |
| c. Project type and associated risk | |

Q1.5) Which of the following requirements are non-functional? [1]

- | |
|--|
| a. Users must change the initially assigned login password immediately after the first successful login. The initial should never be reused. |
| b. The software automatically validates customers against the ABC Contact Management System. |
| c. The Sales system should allow users to record customers' sales. |
| d. The software system should be integrated with banking API. |
| e. A website should be capable enough to handle 20 million users without affecting its performance. |
| f. The software should work on any OS. |

Q1.6) Which statements are true?

- | |
|--|
| a. Questionnaires and Interviews are the same elicitation method. |
| b. Questionnaires cannot be used without Interviews. |
| c. Conducting some interviews is cheaper than a questionnaire to collect a huge set of data. |
| d. None of the previous. |

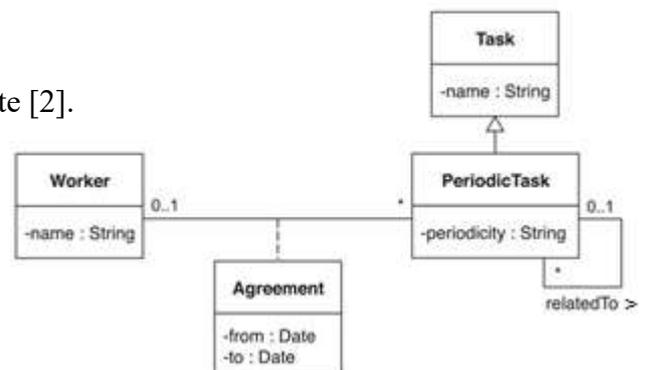
1.7) What is the meaning of requirement elicitation in software engineering? Give a few sentences to explain when, what for, how, who.

Exercise 2 (3)

The diagram given on the right was found on the website [2].

Q2) Rephrase it in English or French.

Advice: take care to express all parts of the model; keep the sentences simple



Exercise 3 (3)

E-business is a software system used in the C-Company. This company is specialized in consulting: its employees are consultants. They help other business companies (their customers) to find solutions to specific issues. When a contract is signed with a customer, the consultant responsible for the project, called senior consultant, initiate a project in E-business software. The consultants that work on the project have to record their consultancy visits in E-business. Optionally, it is possible to record the visit expenses associated with a visit. At the end of the project, the responsible closes the project. This action generates the invoice for the customer.

Q3.1) Propose a use case diagram to model E-Business system.

Exercise 4 (4)

TARS is a Traffic Accident Reporting System dedicated to city police [3]. This system is developed to deal with accident reports inside a city. An accident involves persons, vehicles, or both. Thus, an accident report indicates the date, the vehicles and the persons involved. The plate of a vehicle is recorded. Persons are known by their name, address and phone number. For each vehicle, the owner, and the driver are known. Sometimes, there is no driver because the vehicle is parked. For privacy reason, a vehicle instance or a person instance can only be involved in one accident report³.

An accident report also indicates the localization of the accident: it corresponds to one street or several in case of a crossroads. All the streets of the city are known. An accident report is issued by one traffic policeman. Like any policeman, a traffic policeman has an id, a name, and a rank. All the policemen of the city are known in the system. To use the TARS system, a traffic policeman needs to pass a qualification. The date of the qualification is recorded in the system. For privacy reasons, policeman data and person data are separated.

Q4) Propose a class diagram to model this text.

Exercise 5 (4)

A-company is an e-commerce company. The customers can do their commands on the web site of the A-company.

First, the customers are making their choices of articles: They can add articles in their basket and remove them. At any moment, the customer can validate a non-empty basket: after it is not possible to add or remove an article anymore. The customer has two weeks to pay its basket; **meanwhile**, the company prepare the packet to be sent. Note that the payment can be accepted or rejected. So, from the payment viewpoint, the command can be in “waiting payment” state, “rejected” state, or “paid” state. From the packet viewpoint, the command can be in state “preparing”, “waiting” (if something is missing), or “ready”. When the command is in both states “paid” and “ready”, the command is sent (delivering state).

Command
nb:int {number of articles}
add(article) remove(article) cancel(command) validate(basket)

The client can cancel the command at any moment before the command is sent.

Q5.1) Express this text with an appropriate UML model. It should be based on the given Command class.

Q5.2) Propose one non-trivial question which can be asked to remove ambiguities in your model.

References

- <https://www.guru99.com/functional-vs-non-functional-requirements.html>
- <https://modeling-languages.com/uml-class-diagrams-practice-usability-tools/>
- Al-Shabi, Mohammed & Ansari, Gufran. (2012). Modeling of Traffic Accident Reporting System through UML Using GIS. International Journal of Advanced Computer Science and Applications. 3. 26-30.

³ If a vehicle is involved in several accidents, the system will create several instances of the same vehicle. Same for persons.

Last Name:		First Name:		1.1
1.2	1.3	1.4	1.5	1.6
1.7				
2				
3				

9. Additional exercises to prepare the exam

Exercise 9.1

Q. Explain the limits of the following requirements. Propose reformulation.

- From the application code, interface with the package must be as simple as possible.
- Installation of the software must be easy and straightforward.

Exercise 9.2

Q. What are the risks when using an interview method as elicitation technique?

Exercise 9.3

Q1. What are the weaknesses of a development model based on agile methods?

Q2. What is the main difference between an iterative and an incremental life-cycle?

Exercise 9.4

Consider the following class diagram⁴:

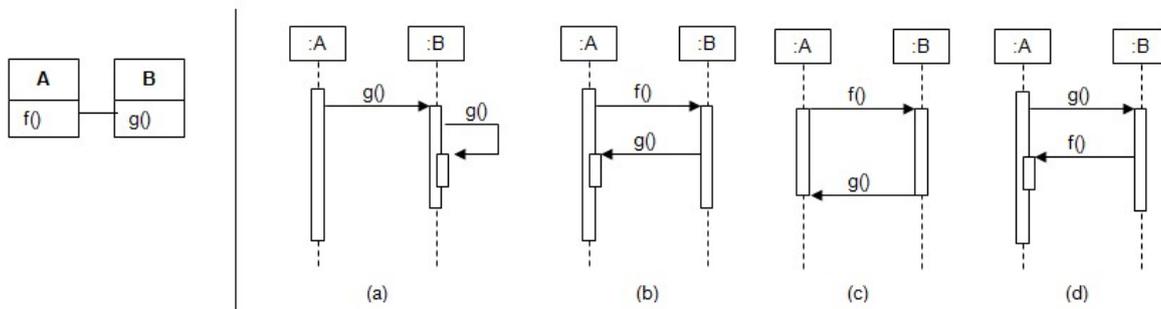


Q.1 Based on the class diagram above, is there any way to express with an object diagram that Jane (a girl) likes Brian (a boy)?

Q.2 Mark each of the statements below true or false, according to the following diagram¹.



- (True / False) A player can play for two NBA or NFL teams simultaneously.
- (True / False) A player can be traded among teams.



Q.3 Which of the following sequence diagrams given above are potentially valid for the class diagram?

Exercise 8.5

Q. Propose an UML class diagram that models the data relationships described in the following paragraph⁵.

We want to model a system for management of flights and pilots. An airline operates flights. Each airline has an ID. Each flight has an ID a departure airport and an arrival airport: an airport as a unique identifier. Each flight has a pilot and a co-pilot, and it uses an aircraft of a certain type; a flight has also a departure time and an arrival time.

An airline owns a set of aircrafts of different types. An aircraft can be in a working state or it can be under repair. In a particular moment an aircraft can be landed or airborne. A company has a set of pilots: each pilot has an experience level: 1 is minimum, 3 is maximum.

A type of airplane may need a particular number of pilots, with a different role (e.g.: captain, co-pilot, navigator): there must be at least one captain and one co-pilot, and a captain must have a level 3.

⁴ <http://sce2.umkc.edu/BIT/burris/pl/modeling/qanda.html>

⁵ <http://softeng.polito.it/tongji/SE/ex/exercises-w2.pdf>