

EXERCISES

Requirements in engineering projects

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2. Software Engineering

Exerc. 2.1: Indicate the 15 KAs that constitute the software engineering body of knowledge, according to the SWEBOK guide.

Exerc. 2.2: Identify which elements are included in a software product.

Exerc. 2.3: A *mobile application* is a software application, developed to run on a smartphone or other handheld device. Identify the most important characteristics of a mobile application, according to Salmre (2005, chap. 2).

Exerc. 2.4 (Naveda and Seidman, 2006, pp. 23–24): While developing a software application, two similar defects were detected: one during the requirements phase and another one during the implementation phase. Which of the following sentences is more likely to be true?

1. The most expensive defect to repair is the one detected in the requirements phase.
2. The most expensive defect to repair is the one detected in the implementation phase.
3. The repair cost of the two defects tends to be similar.
4. There is no relation between the phase in which a defect is detected and the repair cost.

Exerc. 2.5: Point out some advantages that result from using an incremental and iterative process in comparison with a sequential process that follows the waterfall model.

Exercises

3. Requirements

Exerc. 3.1 (Naveda and Seidman, 2006, pp. 39–40): Which is the type of elements less appropriate to be included in a requirements document?

1. design restrictions
2. product delivery constraints
3. functionalities to make available
4. performance characteristics

Exerc. 3.2 (Naveda and Seidman, 2006, pp. 33–34): Which is the type of requirements that should not be included in a requirements document?

1. functional requirements
2. maintenance requirements
3. project requirements
4. performance requirements

Exerc. 3.3 (Naveda and Seidman, 2006, pp. 41–42): Which is the element that must be included in a requirements document?

1. acceptance/validation procedures
2. delivery plans
3. quality attributes
4. activities to guarantee the quality

Exerc. 3.4 (Naveda and Seidman, 2006, pp. 57–58): Which of the following arguments is the most solid/strong to justify the specification of the non-functional requirements of a system?

1. The non-functional requirements should only be considered in development contexts subject to tight restrictions (resources, budget, or deadlines).
2. The non-functional requirements are only external characteristics of the system and can be obtained later.
3. If a functionality is present in the system, the non-functional requirements determine how usable and useful it is.
4. The non-functional requirements take less time to specify than the functional requirements.

Exerc. 3.5: Consider the following requirement:

The system should be easy to use for trained persons.

1. Classify this requirement with respect to its type.
2. Is this requirement verifiable? Justify.
3. Rewrite the requirement so that it becomes measurable.

Exerc. 3.6: Ghezzi et al. (1991, pp. 18–36) indicate the following qualities as being the most important for software products and processes: (1) correction, (2) reliability, (3) robustness, (4) performance, (5) facility of utilisation, (6) verifiability, (7) maintainability, (8) reparability, (9) evolvability, (10) reusability, (11) portability, (12) comprehensibility, (13) interoperability, (14) productivity, (15) actuality, (16) visibility.

1. Define each one of those 15 qualities in a succinct but rigorous way.
2. Classify each quality according to the three categories of non-functional requirements suggested by Sommerville (2010).
3. Classify each quality according to the eight types of non-functional requirements proposed by Robertson and Robertson (2006).
4. Bass et al. (1998, p. 76) divide the quality attributes of a software systems in two groups: (1) those that are observable in execution time and (2) those that are not observable in execution time. Based on that division, classify the 15 qualities among those two groups.

Exerc. 3.7: Classify the following non-functional requirements according to the classification scheme proposed by Robertson and Robertson (2006):

R1: The product shall be easy to use for persons that do not dominate the English language.
R2: The product shall follow the new orthographic agreement for the Portuguese language.
R3: The product shall be available 24/7/365.
R4: The product shall be able to register 50.000 items per hour.
R5: The product shall present the money values in the currency chosen by the users.
R6: The product shall fit in a trouser pocket.

Exerc. 3.8: The following text was obtained from a client that considers it as a good description of what is needed:

(a) The project consists in a database to store historical information about the performance of the athletes of a given club. (b) Users will be able to know which were the original training sessions and (c) to compare them with the sessions actually performed. (d) The system will be easy to use to all coaches and (e) it will be accessible from all the workstations in the club. (f) The system will be developed in Java and (g) must have an acceptable reliability. (h) The system will produce at the end of each month updated information about all the athletes for the main coach. (i) The screen will show tables with the planned sessions Vs. the sessions that were not initiated or completed, and (j) will estimate the date for concluding the project. (k) The system must be operating satisfactorily by December 2019 and (l) will be produced by the IT department, (m) under coordination of the engineering department. (n) The software must run in PCs and smartphones.

Classify the sentences (a) to (n) according to the following types: (i) User requirements, (ii) System requirements, (iii) Design elements, (iv) Plans, (v) Context information, (vi) Irrelevant details.

4. Requirements Engineering

Exerc. 4.1: Identify the three fundamental activities of the requirements engineering process and describe succinctly the objective of each one.

Exerc. 4.2: Based on your experience, explain why there are communication problems, within the scope of the requirements engineering process, when people use technical terminology.

Exerc. 4.3: For each of the seven activities (inception, elicitation, elaboration, negotiation, documentation, validation, and management) of the requirements engineering process:

1. Describe some reasons that make that activity important.
2. Indicate the challenges that must be faced to complete that activity.
3. Identify a potential consequence if the activity is not thoroughly completed.

Exerc. 4.4 (Naveda and Seidman, 2006, pp. 53–54): Which of the following competencies is not part of the principal role of a requirements engineer?

1. Propose a new pattern of work that improves the users performance.
2. Observe how the users work, while he interacts with them, and ask them questions about what they are doing and why.
3. Interpret the information collected from the users to better understand the essence of the work.

4. Establish, as domain specialist, the connection between the users and the development team.

Exerc. 4.5: Identify some causes that make difficult obtaining a complete and coherent requirements document.

Exerc. 4.6 (Naveda and Seidman, 2006, pp. 19–20): An requirements team adopted the following activities to elicit the requirements of a software application: (a) creation of a questionnaire, available via web, to request information related to the proposed functionalities and to obtain suggestions of new functionalities; (b) writing of a document with all the characteristics identified by the questionnaire; (c) creation of a prototype of the graphical interface; and (d) presentation of the prototype to the top managers. Which of the following activities were completely omitted from the requirements engineering process?

(1) elicitation, (2) elaboration, (3) negotiation, (4) documentation, (5) validation.

Exerc. 4.7 (Wickelgren, 2012); coordinated by the instructor: Distribute the participants in a circle. Write in a paper a sentence with at least 12 words, for example, “the history of the albanian town is strongly marked by the difficult survival of its people”. Whisper the sentence to one of the participants, in such a way that she is the only one that hears what you say. Ask now for the sentence to circulate from participant to participant, with the restriction that each one can only say the sentence once. When the sentence arrives at the last participant, ask him to say aloud the sentence that he has received. Write that sentence on the board and share with the participants the original sentence. The group must compare the two sentences and analyse if the meaning is different. The participants should indicate if they felt they have clearly understood the sentence that was whispered to them.

This activity can be repeated, according to three variants. At the end of each one, the group should (1) compare the initial and final sentences, (2) analyse if they are similar or not, (3) try to identify the cause for (no) resemblance, and (4) suggest some ideas on how to communicate more effectively.

Variant 1: use a simpler and shorter sentence, for example, “the baron likes to ingest fried tomatoes”;

Variant 2: use a sentence with at least 15 words, but now allow the participants to whisper the sentence into the ear of her neighbour more than once;

Variant 3: use another sentence with at least 15 words and, for instance, turn on a TV set in the room, to create an element that can distract the participants.

5. Requirements Elicitation

Exerc. 5.1 (Naveda and Seidman, 2006, pp. 63–64): Imagine that a software engineer, who concluded recently his degree at a given university, is leading a requirements engineering team for a project to improve the software application that permits students to enroll and

register in degrees offered by that university. Which of the following requirements elicitation techniques are adequate for capturing the typical and atypical activities involved in the use of the application?

(a) Observation, (b) Prototypes, (c) Interviews, (d) Surveys.

Exerc. 5.2 (Naveda and Seidman, 2006, pp. 69–70): For the system indicated in the previous question, during the requirements elicitation process, some students were interviewed. They have indicated the functionalities that they would like to see incorporated in the final solution. Afterwards, the client has requested to remove some of the requirements proposed by the students. Which of the following arguments is the less strong for justify the removal of those requirements?

1. The requirements from the students are not representative of those from the student population.
2. The requirements from the students are ambiguous and cannot be tested.
3. The requirements from the students are contrary to the interests of the client.
4. The client does not consider the students as system stakeholders.

Exerc. 5.3 (Naveda and Seidman, 2006, pp. 51–52): Which of the following arguments is the strongest to justify the use of the observation technique in a company?

1. Direct interaction with users permits a continuous discussion about the various forms of work.
2. Observation permits one to see not just the normal workflow, but also less typical situations.
3. Observation is a traditional technique for capturing requirements and the company has experience in using it.
4. Observation aids in the observer/observed interaction, when they exchange ideas in real-time.

Exerc. 5.4: Suppose that the analysts of a software product project have a reduced knowledge about the respective domain. Which requirements elicitation techniques are the most appropriate in that case?

Exerc. 5.5: Explain the main reasons why the combined use of ethnographical techniques with prototyping is useful for eliciting requirements.

Exerc. 5.6: Identify the problems that are present in the following questions that are part of a questionnaire for collecting information about a software application:

1. Why do you prefer the menus on the left rather than the right side?

2. Do you normally use the same password on different systems?
3. Where do you download email messages?
☐ at home ☐ at the office ☐ at school
4. When you go to the canteen, do you drink orange juice and eat soup?
☐ yes ☐ no
5. How many hours did you sleep last night?
☐ 9-12 ☐ 6-8 ☐ <6 ☐ >12
6. How many email messages do you receive on average each day?
☐ <30 ☐ 30-50 ☐ 50-70 ☐ >70

Exerc. 5.7: Identify all the stakeholders for the following systems:

1. lifts in a hotel (see Illustration ??);
2. commercial plane;
3. train station;
4. web application to reserve rooms in hotels and B&Bs;
5. web application for buying tickets for musical concerts and cultural events.

Exerc. 5.8: Select an engineering system in which you are currently working. If it is not possible to select a system, imagine that you are involved in a project for developing a system for a logistics company (in which trucks are used). The objective of that system is to permit truck drivers to receive radio messages with delivery instructions.

1. List the types of stakeholders in the system.
2. List the job titles and roles of the persons that you consider relevant to interview for each type of stakeholder identified in question 1.
3. If you have considered a real project, speak to the persons listed in question 2; ask them whom they interact with (for instance, clients and suppliers) to achieve their business objectives. Exclude persons that not do not seem relevant.
4. Repeat the previous steps, until the list of stakeholders stabilises.

Exerc. 5.9: Consider the following situations in which you were supposed to apply the observation technique. Answer and justify the questions.

1. You are developing a product to help a pastry business. Do you think that it is ethical to go to a competitor, sit down at a table, ask for a coffee, and observe the customers and the employees?

2. You are developing a game for teenagers. Do you think that it is ethical to go to a school to observe how they behave? And what is your opinion about approaching some of them and asking some questions?
3. You are developing a product for a hospital. Do you think that it is ethical to observe the behaviour of the persons in the waiting room? do you think that it is ethical to attend the appointments that patients have with their doctors? And what is your opinion about approaching some of them (patients or doctors) and asking some questions?

Exerc. 5.10 (Gregory et al., 2013): The objective of this exercise is to gain some experiment in interviewing someone and taking notes.

before Make an appointment about ‘mobility’ (or another topic that matches your academic or professional interests) with a person that you know (friend, family member, or co-worker). Prepare a set of questions to ask the interviewee.

during During one hour, conduct an interview. The topic is mobility, which the interviewed person may interpret in a variety of forms and for which you can decide how to ask the questions. Develop the interview as a conversation, using the answers to conduct it in a natural way. Listening and understanding the perspective of the person are fundamental for the success of the interview. Don’t record the interview, but take notes of the most important terms and sentences.

after Describe (3–4 pages) the interview, including: your name; a pseudonym of the interviewee, sex, age and occupation; a short description of the scenario in which the interview took place. Include your pre-prepared questions and describe the conversation. Conclude with your thoughts about the interview: the interactions and the dynamic that was established with the interviewed person, her analysis of the addressed topics, and any other observations that may seem pertinent.

Exerc. 5.11 (Gregory et al., 2013): The objective of this exercise is to experiment observing the behaviour of the persons in a given public place and to take notes.

before Choose a public place that seems interesting to observe. Examples of possible places are: airport, train station, car park, hospital waiting room, post office, bank, supermarket, canteen, bar, gymnasium, museum, library. The local should allow you to observe and take notes without being disturbed.

during For a time span of 60 minutes, observe and register the movements, interactions, sounds, space and everything that captures your attention. Take short notes while you observe. If someone asks you what you are doing, tell her that you are doing a school project.

after Elaborate on the material that you have collected. You are expected to write at least three pages. Justify the place you selected and present the respective blueprint. Describe what you have observed (indicating who, where, when, how) and provide your own interpretation. Conclude the text with your interpretation of a rule that is applicable to the local. What patterns were you able to identify? what exceptions were detected? are there persons that behave distinctly from the others?

6. Requirements Prioritization and Negotiation

Exerc. 6.1 (Naveda and Seidman, 2006, pp. 71–72): While eliciting requirements, the analyst has registered, for each requirement, the name of the person that firstly proposed that requirement and the date in which that proposal was made. Which of the following missing pieces of information will have a bigger impact (negative, due to its absence) on the activities associated with change management?

(a) Traceability, (b) Requirements type, (c) Priority, (d) Source.

Exerc. 6.2 (Naveda and Seidman, 2006, pp. 37–38): Which of the following sentences better portrays the requirements management process?

1. Measuring the requirements quality permits saying that they remain unchanged over time.
2. A requirement, once rejected, should remain rejected.
3. Change is inescapable, so the requirements management process should take into consideration that fact.
4. One should use a computer-based tool to trace a set of (functional and non-functional) requirements.

Exerc. 6.3: Consider that you have six requirements (R_1 to R_6). Rank them, according to the importance (weight 70%) and user satisfaction (weight 30%) criteria, with the AHP method.

importance							user satisfaction						
	R_1	R_2	R_3	R_4	R_5	R_6		R_1	R_2	R_3	R_4	R_5	R_6
R_1	1	2	2	1/5	1/2	1	R_1	1	1	3	4	1/2	1/4
R_2	1/2	1	2	1/5	1/2	1/4	R_2	1	1	2	5	1/3	1/4
R_3	1/2	1/2	1	1/5	1	1/4	R_3	1/3	1/2	1	1/2	1/7	1/7
R_4	5	5	5	1	5	2	R_4	1/4	1/5	2	1	1/7	1/9
R_5	2	2	1	1/5	1	2	R_5	2	3	7	7	1	1/2
R_6	1	4	4	1/2	1/2	1	R_6	4	4	7	9	2	1

Exerc. 6.4: Which of the following criteria/dimensions should exist in a mechanism for the classification of requirements negotiation processes?

(a) Support to renegotiation, (b) Strategy to resolve conflicts, (c) Level of automatisisation, (d) Support to documentation.

Exerc. 6.5: Describe each possible posture that a stakeholder can have with respect to the negotiation process.

Exerc. 6.6; coordinated by the instructor: Divide the participants in the session in pairs for playing arm wrestling (also known as *bras de fer*). If you are reading this book outside the context of an academic course, find a friend or family member to play with you. There are 30 seconds to play and the objective for each player is to maximise the number of points. At the end, each participant indicates the number of points obtained, the winner being obviously the one that was able to accumulate more points.

Exerc. 6.7 (Raiffa, 1982, pp. 262–267); coordinated by the instructor: Divide the students in groups of three persons, designated by A, B and C. If you are reading this book outside the context of an academic course, find two friends or family members to play. The objective of the game for each participant is, during at most 30 minutes, to negotiate within her group an agreement that maximises her individual gain, taking into account the point limits defined in the following table:

agreement	persons	total gain
1	just A or just B or just C	0
2	A and B	118
3	A and C	84
4	B and C	50
5	A and B and C	121

Before the negotiation starts, each participant should carefully analyse this table, establish a strategy, and write it for further analysis. In this phase, the participants do not communicate among them. During the negotiation, if two persons wish to have a private conversation, they can do it just once, during 2 minutes. At the end of the negotiation, the group must indicate which persons are in the agreement and how (i.e., with numbers) the gain is divided among them. Those that do not participate in the agreement have zero points. When all negotiations are concluded, the results for the three different roles (A, B and C) in each group are announced. Based on that information, each group analyses the performance of each element and discusses what happened in the negotiation.

Exerc. 6.8; coordinated by the instructor: Imagine that a given city is threatened by a bombing attack. There are 12 persons interested in seeking protection in an air-raid shelter, that however can only accommodate six persons:

men

- A 40 year old violinist, addicted in cocaine;
- A 25 year old lawyer;

- A priest with 75 year old;
- A 20 year old atheist, responsible for several murders;
- A 28 year old physicist, that only enters the shelter if carrying a gun;
- A 21 year old poet, that adores to declaim his poems;
- A 47 year old homosexual;

women

- The wife of the lawyer, that is coming out of the madhouse; the lawyer and the wife prefer to stay together, even if outside the shelter, than to be separated;
- A 34 year old prostitute;
- A university student that did a vow of chastity;
- A 12-year-old girl with a low IQ;
- A 32 year old woman with mental disabilities, that has epilepsy.

1. Make your list, deciding which six persons shall enter the shelter.
2. Form a group with three other persons and decide upon a unique list with the six persons to enter the shelter, base on the individual lists.
3. All the students should now produce a list of six persons, based on the lists of each group.

7. Writing in a Natural Language

Exerc. 7.1 (Naveda and Seidman, 2006, pp. 29–30): The use of a natural language (for instance, English or Spanish) and intuitive diagrams is used for documenting user requirements. What is the main reason?

1. To eliminate the communication difficulties among the stakeholders.
2. To facilitate understanding.
3. To have no ambiguities.
4. To be precise.

Exerc. 7.2 (Naveda and Seidman, 2006, pp. 27–28): Which of the following sentences does not constitute a valid system requirement?

1. The product shall be developed using an agile method.
2. The product shall respond to all requests in less than 5 s.

3. The product shall be composed of 12 modules.
4. The product shall use always menu screens to communicate with the users.

Exerc. 7.3: Consider the following requirement:

The system shall be easy to use for trained persons.

1. What is the type of this requirement?
2. Is it verifiable? If not, rewrite it so that it is verifiable.

Exerc. 7.4: The marketing director has sent you an email message with material for various requirements. Select the relevant parts of the text and rewrite them so that that turn into requirements with an appropriate formulation.

From: Joanne Francis (marketing director)
To: Fred Wallace (production manager)
Subject: idea for a game console for cars

Fred,

As a result of my meeting with Mr. Shigeru Miyamoto, I think I have identified a new opportunity to extend the products portfolio of our company. We should develop a video game console to be used inside a family car. The console should turn off when there is no interaction from the passengers for more than 10 min. When the driver is making a phone call, with the help of an hands-free kit, the console should be put in standby mode. The console should weight less than 2 kg, so that it can be easily transported from one car to another one, either by the parents or the children. The price should be relatively low as a way to be competitive in the market. What is your opinion?

Best regards
JF

Exerc. 7.5: The following are requirements of a controller of a swimming pool:

R1: The input valves should be open when the swimming pool is filling.
R2: The input valves stop when the level of the water reaches 2 m.
R3: The level of the water should increase gradually.
R4: The output valves must be open when the water is higher than 2.1 m.

Which defects this set of requirements present?

(a) ambiguous, (b) solution-dependent, (c) incomplete, (d) not verifiable.

Exerc. 7.6: Analyse the following list of user requirements and indicate if they are clear and verifiable. If not, reformulate them so that they possess those properties.

R5: The communication system can only “crash” at most once a month.
R6: The system shall be easy to learn by students with minimal training.
R7: The average delay for the users of a system to pay tolls shall be less than 15 s.
R8: All users shall use the same mobile application.
R9: The maximum delay between the submission of a questionnaire and its confirmation must be half an hour.
R10: The operator shall be able to communicate by mobile phone with the bus driver.

Exerc. 7.7: Some of the following requirements present defects that can lead to difficulties in subsequent development phases. Identify those defects and improve the text of each requirement:

R11: The truck driver shall be able to obtain instantaneous answers, if he provides a recognised voice command.
R12: The operator should be able to turn off the system, by unplugging the electrical cable.
R13: The fire extinguishing subsystem must activate when the temperature is over the level of normal operation.
R14: The escalator must stop with no danger to the pedestrians, in the unlikely case of an unexpected fault in the controller system.

Exerc. 7.8: Consider a system that permits one to manage the process of submission of computer programming school works (in Ruby) realised by groups of students enrolled in a given course. Each program is submitted by one of the students of the group and is reviewed by the assistants of the professor that coordinates the course. Rewrite, when necessary, the following user requirements in the light of the recommendations addressed in this chapter.

R15: A student must submit in the system his group's program, through a web interface that exhibits soft colours.
R16: The course coordinator assigns an assistant to each submitted Ruby program, in order to revise it.
R17: Typically, the system, itself developed in Ruby, must not assign a program of a group to the assistants that declared conflicts of interest with that group (for example, because one of the members is from his family).
R18: The system shall allow the edition of comments about each program. Those comments will be introduced, as soon as possible, by the respective reviewers. The professor introduces in the system the mark of each program based on the comments. The marks use the 0–10 scale.

Exerc. 7.9: Identify for the following sentences the possible interpretations that each one can give rise. Rewrite each one so that it has only one interpretation:

1. Jane has visited Margret's beach house, that left her delighted.

2. The invitation was sent to single aunts and daughters.
3. The banks charge interests to the companies due to delays of their responsibility.
4. The discount applies to children and pensioners.
5. The discount applies to children or pensioners.
6. The parents shall acknowledge the reception of the messages about their child.

8. Modelling

Exerc. 8.1: Construct a domain model for:

- the draughts (or checkers) game;
- chess.

Exerc. 8.2: Construct an activity diagram that models the set of tasks, performed by the (male and female) students of a college, since when they take a shower until they dress. The minimum set of tasks to include in the diagram is: dress up shirt, wear pants/skirt, wear underwear, put shoes on, brush teeth, take shower, and shave. The following set of rules must be respected:

- the hygiene tasks, except for the shower, can be executed simultaneously with the dressing tasks;
- obviously, only boys should shave themselves;
- girls may use either pants or skirts;
- when a student is dressing up, he can change the socks if he feels that they do not match with the shirt.

Exerc. 8.3: Consider that a book in a library can be in one of the following states, throughout its existence: received, ready to be catalogued, available for consulting (at the library), available for requisition, blocked, borrowed, missing.

- Model the states of the entity 'book' with an adequate diagram.
- Add to the diagram the 'reserved' state. Assume that a book can have various persons in a waiting list.
- Add to the diagram the state 'late', when a book is not returned by the specified deadline. This state is not strictly necessary, since whenever a book is not returned on time, the penalties can be associated with the reader and not with the book.

Exerc. 8.4: Consider a system to manage a virtual bookshop, that includes the activities that go from the acquisition of the books up to their sale. The customers and the manager access the system through a web browser. The payments are made with a credit card. The bookshop works with new books acquired from publishers that have automatic acquisition systems. The system calculates the cost of the delivery based on the weight of the books and the delivery destination. The managers can produce reports about the best-sellers and the customers with more visits to the website. The system must also recommend books to the customers based on their previous interests. When a book is ordered, it is immediately sent if it is in stock; otherwise, it is requested from the publisher and the customer is informed about the expected delivery deadline.

- Construct a state diagram for the book entity. Consider the states ‘available at catalogue’, ‘borrowed’, ‘in stock’, ‘sold’, ‘sent’, and ‘returned’.
- Construct a use case diagram, considering the participation of three different entities: book shop, customer, and credit card operator.
- Construct an activity diagram that models and relates the business processes of a book shop.

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