A.Y. 2021-2022 Software Engineering 2
Requirement Engineering and Design Project: goal, schedule, and rules

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NO EXCUSE FOR IGNORING WHAT WE WRITE HERE

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1 Goal and approach

The objective of this project is to apply in practice what you learn during lectures with the purpose of becoming familiar with software engineering practices and able to address new software engineering issues in a rigorous way. The project includes two assignments:

1. The preparation of a Requirement Analysis and Specification Document (RASD) for a problem we provide you.
2. The definition of the Design Document (DD) for the system considered in point 1 above.

The two assignments will be reviewed during the final discussions that will take place during the winter exam sessions according to a schedule that will be proposed in the forthcoming months. The evaluation will assess the quality of the artifacts you prepare (accurateness, completeness, soundness) and the quality of your presentation (if you are able to explain your point in an appropriate way and if your presentation fits in the allowed time). Please check the introduction to the course for more information on the evaluation criteria for the R&DD project. The two assignments are described in the rest of this document.

2 Project schedule

- Group registration deadline: 20/10/2021
- RASD submission deadline: 23/12/2021
- DD submission deadline: 09/01/2022
- Final presentation: to be scheduled

Note: **You can submit before the deadlines, if you want/need!**
All deadlines are assumed to expire at **23:59** of the days listed above.

3 Rules

- This assignment is optional and replaces part of the written exam of the Software Engineering 2 course.
- The project is developed in groups of two or three persons. Groups composed of a single student are allowed even if strongly discouraged. The assignments and the corresponding expectations of the professor will be calibrated based on the size of the group.
- Each group interested in taking the project must register itself following the steps indicated in Section 4. “Mixed” groups involving students of the three sections are allowed. When registering, each such group will need to indicate a single “reference” professor. This will be the one holding the discussion at the end of the course and deciding the grade. The choice is up to the students, but if we will realize that there is an unbalance among the groups under the responsibility of each of us, we may change your reference professor. In this case, we will inform you a few days after the group registration deadline.
- Each group MUST provide the requested artifacts within the stated deadlines. A delay of a few days, if notified in advance to the reference professor, will be tolerated, but it will also result in a penalty in the final score. These artifacts will be presented to the reference professor in a final meeting that will be scheduled later.
- Each group MUST release artifacts by committing them into a specific folder of the github repository created for the project (see the following section).
- Each group MUST use the repository not only to upload the final versions of deliverables, but also to commit intermediate versions. We want to see commits performed by all group members. In the case a group wants to use collaborative writing tools (e.g., Google Docs) that keep track of individual contributions, the group will include in the readme file associated with the github repository the link to the online document, making sure that through that link the reference professor will be able to inspect the contributions to the document.
- The material included in your artifacts is not fixed in stone. You can (and are encouraged to) provide updates at any point before the end of the course, if you think these are needed.
- During the development of the project each group will keep track of the number of hours each group member works toward the fulfillment of each deadline.
- For any question related to the project that could be interesting also for the other groups, please use the forum available on the Webeep website. We will answer as promptly as possible.
- This year, some groups of two or three students (not necessarily all) will be assigned a tutor from industry. Tutors will provide advice concerning the quality of the produced documents and how these can be improved. The selection of the groups which will be assigned a tutor, and the assignment itself, will be done randomly, and the groups will be picked among those that will have indicated in their registration form an interest for this tutoring activity. Please notice that we expect that there will not be enough tutors for all groups. The assignment of groups to tutors will be communicated by the end of November. Students who will be assigned a tutor will invite him/her to the project repository and will schedule with him/her two meetings, one right after the RASD submission and the other right after the DD submission. They will then update their documents based on the received feedback. In the assessment of groups with tutors, the assessment criteria will be the same as for non-tutored groups, but we will take into account the status of the initial version of each document submitted to tutors, the received suggestions, and the improvements achieved after applying the changes.

4 Group registration and organization of your repository

You should form your group and register it by going through the following steps:

1. Create a private repository for your project on Github (https://github.com). Please note that, as students, you have the possibility to create a private Github repository for free. Your repository should be named by combining the names of all group members. For instance, BianchiRossiVerdi will be the name of the repository of the group composed of the students Tommaso Bianchi, Maria Rossi e Veronica Verdi. Make sure that all group members have a Github account and have access to the repository. Moreover, invite your reference professor (Github accounts dinitto for Prof. Di Nitto, matteo-g-rossi for Prof. Rossi and maelstromdat for Prof. Tamburri) to access your repository (reading access is sufficient). Attention: last year we noticed that Github has set some restrictions concerning the creation of repositories from accounts of people from specific countries. If you are experiencing this problem, you can use Bitbucket instead (https://bitbucket.org/product/). We do not suggest this one for all groups because it has other limitations concerning the maximum number of private repositories you can have.
2. Register your group by filling in the following form https://forms.office.com/r/1jStUdrwNm. Do not forget to include in the form all relevant data!
3. Create a directory for each of the documents you will be working on.
4. Moreover, create a directory called *DeliveryFolder* where, by the due deadlines, you will commit the pdf version of your documents (name it RASD1.pdf or DD1.pdf, depending on the document you are releasing) plus any additional file you may want to include (e.g., the Alloy model and/or any UML model).
5. After the deadline for submission, should you need to update your document, you can commit in the same folder another pdf file with an increased version number, e.g., RASD2.pdf. The new file should include a section that describes the performed changes.

5 The problem: DREAM - Data-dRiven PrEdictive FArMing in Telengana[1]

Context: Agriculture plays a pivotal role in India's economy as over 58% of rural households depend on it as the principal means of livelihood, 80% of whom are smallholder farmers with less than 2 hectares of farmland. More than a fifth of the smallholder farm households are below poverty. Globally there will be 9.7 billion people in the world by 2050 (as per a recent UN estimate). Food demand is expected to increase anywhere between 59% to 98% by 2050 (source Harvard Business Review). Climate change continues to be a real and potent threat to the agriculture sector, which will impact everything from productivity to livelihoods across food and farm systems and is predicted to result in a 4%-26% loss in net farm income towards the end of the century. This calls for a revamp of the entire mechanism that brings food from farms to our plates. The COVID-19 pandemic has greatly highlighted the massive disruption caused in food supply chains exposing the vulnerabilities of marginalized communities, small holder farmers and the importance of building resilient food systems. It has become even more important now that we develop and adopt innovative methodologies and technologies that can help bolster countries against food supply shocks and challenges.

[1] This project is an elaboration of an initiative presented to us by colleagues working at UNDP India, a United Nations division (https://www.in.undp.org/) and within the Healthsites initiative https://www.healthsites.io/. This is an ongoing initiative promoted by Telengana's government.

Telengana's long-term goal: Telengana is the 11th largest state in India with a geographical area of 112,077 km^2 and 35,193,978 residents (data from 2011) (see https://en.wikipedia.org/wiki/Telangana for more details). The goal of Telengana's government is to design, develop and demonstrate anticipatory governance models for food systems using digital public goods and community-centric approaches to strengthen data-driven policy making in the state.

This will require the involvement of multiple stakeholders, from normal citizens to policy makers, farmers, market analysts, agronomists, etc.

First possible step toward the achievement of the goal

In the first place, Telengana wants to partner with IT providers with the aim of acquiring and combining:

- Data concerning meteorological short-term and long-term forecasts. Telengana already collects and makes available such data (see https://www.tsdps.telangana.gov.in/aws.jsp).
- Information provided by the farmers about their production (types of products, produced amount per product).
- Information obtained by the water irrigation system concerning the amount of water used by each farmer.
- Information obtained by sensors deployed on the territory and measuring the humidity of soil.
- Information obtained by the governmental agronomists who periodically visit the farms in their areas.

Acquiring and combining such data, DREAMS will support the work of three types of actors: policy makers, farmers, and agronomists. In the following we describe the needs of each category of actor.

Telengana's policy makers. They want to:

- Identify those farmers who are performing well, especially when they demonstrate to be resilient to meteorological adverse events, as these farmers will receive special incentives and will be asked to provide useful best practices to the others.
- Identify those farmers who need to be helped as they are performing particularly badly.
- Understand whether the steering initiatives carried out by agronomists with the help of good farmers produce significant results.

Farmers. They want to:

- Visualize data relevant to them – for instance, weather forecasts, personalized suggestions concerning specific crops to plant or specific fertilizers to use – based on their location and type of production.
- Insert in the system data about their production and any problem they face.
- Request for help and suggestions by agronomists and other farmers.
- Create discussion forums with the other farmers.

Agronomists. They want to:

- Insert the area they are responsible of.
- Receive information about requests for help and answer to these requests.
- Visualize data concerning weather forecasts in the area and the best performing farmers in the area.
- Visualize and update a daily plan to visit farms in the area, assuming that all farms must be visited at least twice a year, but those that are under-performing should be visited more often, depending on the type of problem they are facing.
- Confirm the execution of the daily plan at the end of each day or specify the deviations from the plan.

6 Project Scope

You are required to explore the above problem and define the corresponding RASD and DD. In particular:

- **Groups composed of a single student** will focus only on the features offered to government policy makers.
- **Groups composed of two students** will focus on the features offered to policy makers and farmers, but not to those offered to agronomists.
- Finally, **groups of three students** will address all points in the description above.

7 The documents to be created

Each document you produce will include the following elements:

- **A FRONT PAGE** that includes the project title, the version of the document, your names and the release date.
- **A TABLE OF CONTENTS** that includes the headers of the first three levels of headings in your document, with the corresponding page number. At the beginning of this document you find a table of contents that you can use as an example. Since in this document there are no level three heading (e.g., 3.1.1), they are not part of the table of contents.

The specific characteristics that each document should have are described in the next subsections.

7.1 Assignment 1 - RASD

The *Requirements analysis and specification document (RASD)* contains the description of the scenarios, the use cases that describe them, and the models describing the requirements and specification for the problem under consideration. You are to use a suitable mix of natural language, UML, and Alloy. Any Alloy model should be validated through the tool, by reporting the models obtained by using it and/or by showing the results of assertion checks. Of course, the initial written problem statement we provide suffers from the typical drawbacks of natural language descriptions: it is informal, incomplete, uses different terms for the same concepts, and the like. You may choose to solve the incompleteness and ambiguity as you wish, but be careful to clearly document the choices you make and the corresponding rationale. You will also include in the document information on the number of hours each group member has worked towards the fulfillment of this deadline. As a reference structure for your document, you should refer to the one reported below that is derived from the one suggested by IEEE. Please include in the document information about the effort spent by each group member for completing this document.

1. **INTRODUCTION**
   A. *Purpose*: here we include the goals of the project
   B. *Scope*: here we include an analysis of the world and of the shared phenomena
   C. *Definitions, Acronyms, Abbreviations*
   D. *Revision history*
   E. *Reference Documents*
   F. *Document Structure*
2. **OVERALL DESCRIPTION**

A. *Product perspective*: here we include scenarios and further details on the shared phenomena and a domain model (class diagrams and statecharts)
B. *Product functions*: here we include the most important requirements
C. *User characteristics*: here we include anything that is relevant to clarify their needs
D. *Assumptions, dependencies and constraints*: here we include domain assumptions

3. **SPECIFIC REQUIREMENTS:** Here we include more details on all aspects in Section 2 if they can be useful for the development team.
   A. *External Interface Requirements*
      A.1 *User Interfaces*
      A.2 *Hardware Interfaces*
      A.3 *Software Interfaces*
      A.4 *Communication Interfaces*
   B. *Functional Requirements*: Definition of use case diagrams, use cases and associated sequence/activity diagrams, and mapping on requirements
   C. *Performance Requirements*
   D. *Design Constraints*
      D.1 *Standards compliance*
      D.2 *Hardware limitations*
      D.3 *Any other constraint*
   E. *Software System Attributes*
      E.1 *Reliability*
      E.2 *Availability*
      E.3 *Security*
      E.4 *Maintainability*
      E.5 *Portability*
4. **FORMAL ANALYSIS USING ALLOY:** This section should include a brief presentation of the main objectives driving the formal modeling activity, as well as a description of the model itself, what can be proved with it, and why what is proved is important given the problem at hand. To show the soundness and correctness of the model, this section can show some worlds obtained by running it, and/or the results of the checks performed on meaningful assertions.
5. **EFFORT SPENT:** In this section you will include information about the number of hours each group member has worked for this document.
6. **REFERENCES**

7.2 Assignment 2 - DD

The *Design document (DD)* must contain a functional description of the system, and any other view you find useful to provide. You should use all the UML diagrams you need to provide a full description of the system. Alloy may also be useful, but not mandatory. You will also include information on the number of hours each group member has worked towards the fulfillment of this deadline. As a reference structure for your document please refer to the following one:

1. **INTRODUCTION**
   A. *Purpose*

B. *Scope*
C. *Definitions, Acronyms, Abbreviations*
D. *Revision history*
E. *Reference Documents*
F. *Document Structure*

2. **ARCHITECTURAL DESIGN**
   A. *Overview*: High-level components and their interaction
   B. *Component view*
   C. *Deployment view*
   D. *Runtime view*: You can use sequence diagrams to describe the way components interact to accomplish specific tasks typically related to your use cases
   E. *Component interfaces*
   F. *Selected architectural styles and patterns*: Please explain which styles/patterns you used, why, and how
   G. *Other design deci*sions
3. **USER INTERFACE DESIGN**: Provide an overview on how the user interface(s) of your system will look like; if you have included this part in the RASD, you can simply refer to what you have already done, possibly providing here some extensions if applicable.
4. **REQUIREMENTS TRACEABILITY**: Explain how the requirements you have defined in the RASD map to the design elements that you have defined in this document.
5. **IMPLEMENTATION, INTEGRATION AND TEST PLAN**: Identify here the order in which you plan to implement the subcomponents of your system and the order in which you plan to integrate such subcomponents and test the integration.
6. **EFFORT SPENT:** In this section you will include information about the number of hours each group member has worked for this document.
7. **REFERENCES**