

# IS 352 SOFTWARE ENGINEERING 2

## COURSE PROJECT INSTRUCTIONS FALL 2022

### Instructions to students:

This is a group project; each group consists of 5 or 6 students. You are to choose your team members. A Student, who is not assigned to any team, will be assigned to a team randomly by the TA.

It is expected that students will participate equally in the work of the group. Group meetings minutes specifying the attendees should be included, and the contribution of each student must be documented in each report.

**Deliverable(s):** A report that should document and present the analysis and design practices and artifacts of a chosen real-time system. The report may also conclude with a section that highlights the problems encountered and lessons learned during the real-time software analysis and design process.

**Submission:** Submission of the reports required will be a softcopy submitted (as per the instructions provided by the TAs) on the deadline specified, in addition to a hardcopy during the on-campus discussions.

**Assessment:** Assessment evaluates individual performance through oral discussions, teamwork performance, and project technical achievements.

### Suggested Approach to carry out the project:

*To complete the required work, follow the guiding steps below:*

- Research the assigned idea (*e.g., by reading articles on existing/planned systems that are relevant to your idea*).
- Decide - *in an abstract & simple approach* - how your proposed system should work, how many real-time (robotic) systems are involved, what are the functions/tasks assigned to each of them.
- Decide what types of motors, cameras, or any sensors, in general, are required.
- Draw a block diagram of the proposed system, consider any architectural concepts/patterns.
- Draw Activity Diagram(s) for the main functions of the proposed system.
- Draw a Use Case Diagram (*using the COMET UML profile and constraints*).
- Draw an initial Class Diagram (*consider object/class structuring*).
- Draw Interaction Diagrams, for the functions presented in the Use-Case diagram, using the Classes determined in the initial Class diagram.
- Draw State-Machine diagrams (*for all state-dependent objects*).
- Update & finalize the Class diagram using the details/insights from both the Interaction & the State-Machine diagrams (*and consider any design patterns*).

## Indicative [Tentative] Deliverables:

**In addition to the implementation, a technical report is expected to include the following sections:**

- Problem definition: You need to provide at least 2 pages describing the requirements and timing constraints of your assigned software system.
- Then you need to apply the design process activities. By combining the studied design methodology: the COMET and Concurrent (Real-Time) UML methods, you may include the following Sections:
  - a. Requirements modeling – This includes:
    - A block diagram of the required system.
    - Activity Diagram(s) for the main functions of the proposed system.
    - An extended use case diagram (using the COMET UML profile and constraints).
    - Stimuli/response identification: this involves identifying the stimuli that the system must process and the associated response(s) for each stimulus.
  - b. Static Analysis modeling – This includes:
    - Detailed class diagram.
  - c. Dynamic Analysis modeling – This include:
    - State Machine diagrams.
    - Interaction diagrams (Collaboration and/or Sequence) by using the COMET UML profile. You need to ensure consistency between the state machine diagram and the set of interaction diagrams.

# COURSE PROJECT DESCRIPTIONS

## [ 10 IDEAS ]

- The descriptions are indicative and not final, thus you need to do your refinements to these requirements, by adding your assumptions and constraints.
- Some of the ideas are well defined and detailed while others are NOT. For those ideas that are not fully detailed, you need to elaborate more and explain in detail how things are working.
- Finally, feel free to discuss your refinements with your TA during the labs.

## Projects' Descriptions

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## 1] A Real-time Cinema Booking System

A real-time system for E-booking where cinema vendor can offer their available movies and allow customers to book cinema seats online for a certain movie. System has two modules: vendor module and customer module.

- System allow vendors to add/delete their movies. Each movie has: Title, Description, Movie Time, Number of seats of this movie.
- Number of seats for each movie will be constant (47 seats) as shown in the figure 1.
- Vendor can view the places of the booked seats for a movie in real-time. Also when vendor navigates to specific movie, he can get notification when any customer books seats (which display total number of booked seats for a movie).
- Vendor Module does not require authentication.
- In the customer module, system allows customer to book number of seats for a movie. Also customer can navigate and view the last added movies and their details pages (movies' details)
- Customer can book seats (available seats which is not booked) for a movie as shown in Figure 2 below. Removing seats is preferable process.
- Customer module requires authentication (register and login)
- Booking seats is a real-time process. (You can see other customers booking in real-time). As a customer you can distinguish your booked seats from other booked seats by colors as shown in figure 2.

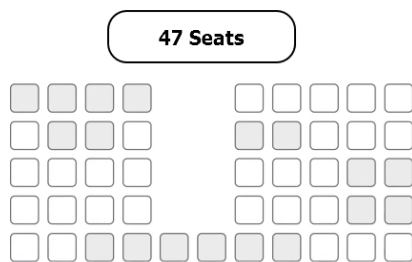


Figure 1

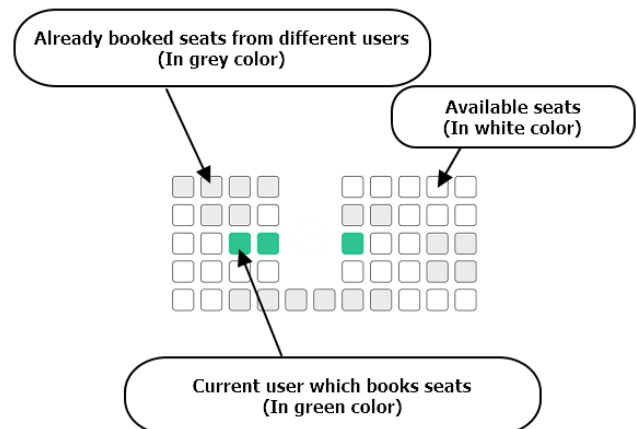


Figure 2

## 2] An Autonomous Intensive Caring Unit (I.C.U) System.

Design an Autonomous system (I.C.U Module / Patient Module) that will search and find the nearest Intensive Caring Unit for a patient:

- In the I.C.U module, the system should add hospitals which contains Intensive Caring Units to its database. When registering new hospital, we should specify some information about the hospital such as hospital Name, hospital area (street, city country), and hospital coordinates (latitude and longitude).
- The hospital can have 1 or more Intensive Caring Units. When adding new I.C.U in system, we should specify: I.C.U specialization (patient's cases that I.C.U can take care of them), room number, whether it is occupied or not (initially, I.C.U is not occupied).
- The system can show all registered hospitals. Also system can access a specific hospital and monitor I.C.U rooms in real-time. (Whether occupied or not, patient info (if room is occupied)).
- In the patient module, the patient should register then login to access the system.
- The system should be capable of contacting the hospitals in the patient area and show the query results (available hospital in patient's area) to the patient. Showing query results on map is preferred.
- The real time system should access the I.C.U information in the hospital to check if it is suitable for the patient's case.
- If the hospital has a suitable I.C.U and not occupied with any patient at that time, the system should make a reservation for the patient and should sent a message to the patient including I.C.U room number to which patient will go.
- If the I.C.U is occupied right now, the real time system should remove it from any other query results appeared to another patients searching at that time (To prevent choosing it as it is already occupied).

### 3] Aerial-Imagery (Crop-Health Surveillance) Drones

Aerial imagery can save farmers a lot of time by giving them a bird's eye view of crops; that way, they can quickly get a sense of vegetation's health, insect issues, irrigation layouts, and weed growth. It even allows them to precisely determine how much pesticide the crops require. The system has two modules: administration module and drone module.

- In administration module, System allows administrators to add/remove agricultural land plots. Admin can add agricultural plot one by one. By default, each agricultural plot contains vegetables.
- Each agricultural land plot has: vegetable type, status, color indicate its status, insect indicator, weed growth level. Status of vegetables in agricultural land plot can be: "healthy", "has insect", "has irrigation problem", "has weed growth problem".
- If agricultural plot has healthy crops/vegetables, then its color will be green and its status "healthy". When vegetables in specific agricultural plot has insects, its status will be "has insect" and its color will be gray. After 5 seconds from using drones to kill these insects, agricultural plot status automatically changes to be "healthy" and its color will be green again. (Which mean this agricultural plot healthy crops/vegetables). The same happens to irrigation problem and weed growth problem. (You can choose their colors). Figure 1 can illustrate the idea.
- Administrator can keep track agricultural plots in real-time. Ex: Admin can monitor the following in real-time: (agricultural plots which are healthy, agricultural plots which have irrigation or weed growth problem, on which agricultural plots drones exist)
- Each 20 second, agricultural plots which contain crops/vegetables can have insects, irrigation or weed growth problem. (this can be done randomly every 20 seconds)
- In drone module, System does require drone authentication (sign in and sign up). Each drone has role.
- In drone module, by default, Crops-insects-checking drones are on ground (not on any agricultural plot). Crops-insects-checking drone take to the skies with Pesticide in order to treat agricultural plot which contains insects. (Crops-insects-checking drone take position on required agricultural plot in order to fire pesticide into it to treat it). After 5 seconds from treating, status of agricultural plot will change from "has insect" to "healthy".
- More than 1 drone can be used. 1 drone for treating insect problems (Crops-insects-checking drone), 1 drone for irrigation problem, and 1 drone for weed growth problem. No 2 drone can be on the same agricultural plot.

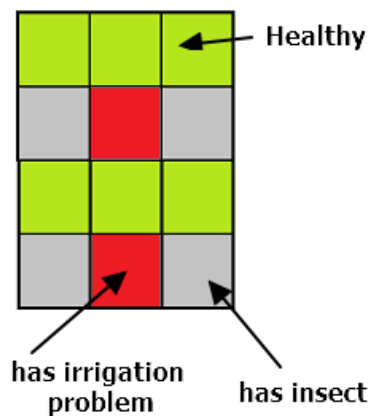


Figure 1

## 4] Seed-Planting & Crop-Spraying Drones

As a part of the agricultural industry, drones are being employed for various operations in aerial surveillance, land inspection, monitoring, spraying fertilizers, checking for diseased or rotting crops, and much more. The system has two modules: administration module and drone module.

- In administration module, System allows administrators to add/remove agricultural land plots. Initially admins should add 10 agricultural land plots in one step. Later, admin can add agricultural plot one by one.
- Each agricultural land plot has: status, color indicate its status, water level, fertilizer level. Status of agricultural land plot can be: "contains no crops", "start planting crops", "contains crops", "contains diseased crops", or "contains rotted crops".
- By default any agricultural plot has no crops. If agricultural plot has no crops, then its color will be brown and its status "contains no crops". When seeding drone start planting any agricultural plot, its status will be "start planting crops" and its color will be yellow. After 5 seconds, agricultural plot status automatically changes to be "contains crops" and its color will be green (which mean this agricultural plot has plants(crops) )
- Administrator can keep track agricultural plots in real-time. Ex: Admin can monitor the following in real-time: (agricultural plots which are planted, agricultural plots which needs water and fertilizers, which agricultural plots have diseased or rotting crops, on which agricultural plots drones exist)
- Each 20 second, agricultural plots which contain crops can be infected with disease. (this can be done randomly every 20 seconds)
- In drone module, System does require drone authentication (sign in and sign up). Each drone has role.
- In drone module, Seed-Planting Drones take to the skies loaded with seedpods containing germinated seeds and nutrients. By default, seed-planting drones are on ground (not on any agricultural plot). Seed-planting drone take to the skies with seedpods in order to plant agricultural plot which contains no crops (seed-planting drone take position on required agricultural plot in order to fire seeds into it to plant it). Start planting will change status of agricultural plot from "contains no crops" to "start planting crops". After 5 seconds, status of agricultural plot changes to "contains crops"
- More than 1 drone can be used. 1 drone for seeding (seed-planting drone), 1 drone for irrigation agricultural plots with water, 1 drone for fertilizing agricultural plots and 1 drone for spraying diseased agricultural plots. No 2 drone can be on the same agricultural plot.

## 5] Autonomous Robotic Waste Sorting (Real-Time Waste Identification).

Robotic Waste Sorting identifies recyclables in real-time and is cost-effective. It makes multiple sorting decisions autonomously. For example, separating thermoform trays, aluminum, 3D fiber, and residue from a waste stream. The sorting process is 100% autonomous and the need for human contact with waste is eliminated (*reduces any health risks that come along with human labor*). Robotic Waste Sorting exceeds human performance in every metric: speed, accuracy, consistency, safety, & cost. System has three modules: administration module and waste-sorting machine module and user module.

- In the administration module, System allows administrators to add/remove waste-sorting machine. Each machine has (name, machine power on or off, machine in maintenance or not, list of materials to identify and sort, sorting categories).
- Wastes (materials) are categorized into 2 categories (Recycled materials and Non-recycled materials). The main role of waste-sorting machine is to identify wastes (materials) and sort them into those categories.
- In the administration module, Administrator can keep track machines in real-time. Ex: Admin can navigate to specific machine and monitor the following in real-time: (how many recycled material till now, how many non-recycled materials till now, if the machine is powered on or off, if the machine is in maintenance or not)
- In user module, System does require user authentication (sign in and sign up)
- In user module, user can choose machine and assign materials (as list) to it (to identify and sort them). Number of materials assigned to a machine is not fixed.
- In user module, user can choose machine and turn it into maintenance mode. The machine will not run (will not be able to identify materials)
- In waste-sorting machine module, you can power on or off the machine. If the machine is off then any assigned material can't be identified or sorted.
- Waste-sorting machine identify materials one by one in real-time. It takes 2 seconds per material to identify and sort it in one of the two categories (machine shows the 2 categories with sorted materials).
- Note: The machine/robot can identify almost any material in real-time (plastic, cardboard, paper, cartons, aluminum, steel).



## 6] An Elevator Control System

Elevator Control System is the system responsible for coordinating all aspects of elevator service such as travel, speed, and accelerating, decelerating, door opening speed and delay, leveling and so on. There are some classical case studies requirements for this system. System has two modules: administration module and user module.

- System allows administrators to add elevators to the building. Administrators can add up to 3 elevators only for the building. The building has 15 floor.
- Each elevator has (Door (initially, door is closed), whether elevator is moving or not, floor at which the elevator is (current position of elevator), maximum number of users that elevator can hold (3 users only)).
- Administrator can keep track elevators in real-time. Ex: Admin can navigate to specific elevator and monitor the following in real-time: (how many user are in the elevator, in which floor the elevator is, is the elevator moving or not, is the elevator's door opened or closed). If the elevator is moving, the floor number changes every 3 seconds.
- In user module, System does require user authentication (sign in and sign up)
- In user module (system which is in the elevator itself). By default user is in a specific floor and can go up or down using any elevator.
- Using elevator is a real-time process (which mean there are more than 1 user using these 3 elevators. Any action which is done by user is reflected to other users). Steps:
  - First: user can see if elevator is moving or not and can see in which level the elevator is.
  - Second: user can't use or control moving elevator. Also user can't use or request elevator whose door is opened and users are in it.
  - Third: user can use elevator when it is in his floor, otherwise user request an elevator (if user request elevator, then we consider elevator is moving.). Elevator that 3 seconds to pass from floor to another.
  - Fourth: if the elevator is in user's floor, user can open the door and enter the elevator. More than one user can enter the elevator if they are going the same floor. Maximum number of users per elevator is 3. So if fourth user is in the same floor, he can't enter (user) the elevator because 3 users already is there.
  - When choosing floor to go. We consider elevator is moving and take 3 seconds in each floor.
  - When arriving the target floor, users can go out so other users can use it.

## 7] A Burglar Alarm System

A Burglar alarm system is a system designed to detect intrusion – unauthorized entry – into a building or area. Security alarms are used in residential, commercial, industrial, and military properties for protection against burglary (theft) or property damage, as well as personal protection against intruders. System has two modules: police module and user module.

- User module requires authentication (register and login). Each user has a house.
- In user module, Burglar alarm system allows users to add/remove rooms in their houses. Each room has: Name, sensor, list of furniture. There is 2 types of sensors (movement detectors sensor, door sensor that detect door opening). Each room has different number of furniture (not constant).
- If user logged in successfully, then he can add rooms in his house as described above. If user logging failed 3 times, then we consider him a theft. Other web page is opened to the theft.
- We entering as a theft, you can access any room. If the room has movement detectors sensor, then when clicking on any furniture, sensor is used and send this information to police module in real-time. If the room has door sensor, so from the beginning when theft click on the room to enter, sensor is used and send this information to police module in real-time.
- After sensor is used (whether door or movement sensor) and police module take action, alarm is fired in user module (on theft page) changing background of web page from white to red and preventing the theft from entering any room (rooms web pages).
- In police module, Police man can keep track user houses in real-time. Ex: police man can monitor the following in real-time: (whether it is normal user or a theft, how many rooms in the house, if we considered the user as a theft in which room theft is standing right now).
- If user is considered as theft, the police man in police module take decision. The decision is to fire alarm in the house. When firing the alarm, in user module (theft web page), the background color of the web page will change from white to red in real-time and prevent the theft from entering any room (rooms web pages) in the house.

## 8] A Real-time Restaurant Reservation System

A restaurant reservation real-time system will let the users book a table at their favorite restaurant. Information, such as availability or the number of seats for the table, are provided upon booking. System has two modules: vendor module and customer module.

- System allow vendors to add/delete their restaurants.
- Each Restaurant has (name, description, image, food category (The type of food that this restaurant offers), number of tables, number of seats at each table, time slots per day to reserve, Sales point location)
- Number of seats at each table will be at most (6 seats) but number of tables will not be constant and will vary from one restaurant to another.
- Time slots per day will be constant (5 slots) ex: 10:00, 10:30, 11:00, etc. Food category (fish restaurant, desserts restaurant, etc.) can be static data stored in the database directly.
- Vendor can view the places of the booked tables in his restaurant (in real-time). Vendor module does not require authentication.
- In customer module, system allows customer to book table or remove reservation. Customer can navigate around food categories and view the added restaurants in these categories. Customer module does not require authentication.
- After selecting a restaurant and viewing its details, Customer can book a table from the available ones as shown in Figure 1
- When booking, Customer determine number of seats for the table (Max 6 seats), Reservation Date and choose from unreserved time slots as Shown in Figure 2. Reservation happens in real-time (other users can show reserved tables in real-time).



Figure 1

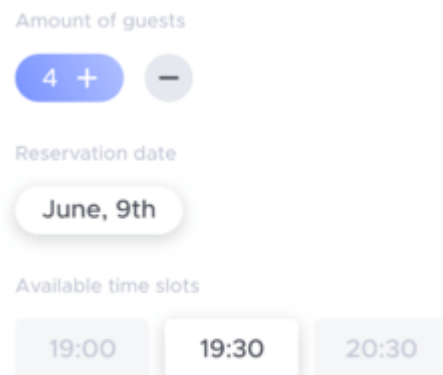
A digital booking interface. At the top, it says 'Amount of guests' with a blue button showing '4' and '+' and '-' icons. Below is 'Reservation date' with a button showing 'June, 9th'. At the bottom, 'Available time slots' are shown as three buttons: '19:00', '19:30' (which is highlighted with a white border and a slight shadow), and '20:30'.

Figure 2

## 9] A Real-time Email Client System

Why not use your skills to develop email system? Real-time email system is designed for sending and receiving electronic mail.

- System does require user authentication (sign in and sign up).
- User can compose new email. Each Email has (subject, from, to, CC, Email body, and date of sending email). User can access all his emails in real-time (get all new emails without reloading or changing the page)
- In the system, you can categories your emails into pages. For example: sent emails are shown in “sent” page (folder), received emails are shown in “Inbox” page.
- Also you can create folders to add Emails to. For example you can access specific email and choose to add it to specific folder (which is created before) to access this emails easy in future.
- User can send the composed email to many users at once (Cc feature). Number of users which we can write in Cc has no limits.
- User can reply to specific email. User also can use “reply all” to reply to all users mentioned in specific email (if Cc is used). Replied emails should appear in the same page where the original email is found.
- It is preferred to allow user to delete email. (Note: if the email is sent to many users, email will not show only for the user who deleted this email.)

## 10] A Real-time Quiz Management System

Real-time quiz management system will consist of a wide range of questions on different topics, fields, and subjects. The system is a resourceful tool for individuals who wish to practice mock quizzes and tests. System has two modules: professor module and student module.

- System allow professors to add/delete their quizzes.
- Each quiz has (course name, quiz name (title), quiz date, list of questions). Questions in the quiz is True or False question.
- Number of questions in each quiz is changeable (Professor can add questions as he wants). Professor should add the answer for each add question.
- Professor can follow student answers in real-time. Ex: professor will navigate to quiz page, so he can see students that are practicing quiz right now and monitor the following: (in which question each student are solving, what is the answers of the solved questions, what is student total score till solved question)
- When student finish quiz, professor can know final score and amount of time taken to finish the quiz.
- In student module, System does require user authentication (sign in and sign up).
- Student can see added quizzes in real-time and it is preferable to filter them by course name. Student can choose the quiz to start. After starting quiz, student can leave or finish the quiz. If he finishes the quiz, final score should appear to him
- Only two students can take quiz at the same time. If a third student entered to the system, he can find the quiz but he can't enter until one of the students leaves or finishes the quiz.