Software Requirements Specification for Software Engineering: subtitle describing software

Team #2, Campus Connections
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Contents

Revision History

Date	Developer(s)	Change
Oct 2	Zihao Du	Add Section 6, 7, 8 Revision 0
Oct 2	Matthew Miller	Add Section 1, 5, 13, 16 Revision 0
Oct 2	Michael Kim	Add Section 15 Revision 0
Oct 2	Waseef Nayeem	Add Section 3, 19 Revision 0
Oct 4	All	Add Functional Requirements
Oct 6	All	Finish Revision 0

1 Purpose of the Project

1.1 User Business

The project being outlined in this document is an social media application with location-specific features for McMaster University to allow the university's students to connect with each other. The project will allow for interaction between users, in addition to allowing users to find information on different parts of the main campus of McMaster University, including on-campus events and room availability in buildings.

1.2 Goals of the Project

1.2.1 **Accurate Data Collection** The product must collect location and directional data to accurately ascertain the position of the user in the building and campus. This will allow the user to interact with the system and other users of the product to enhance social interactions. The error of data must be less than 5%.

1.2.2 **Ease of Use** The product must be user friendly and convenient to use, as many university applications are not used or underused due to the complexity and difficult operation. The end user must be able to easily download and learn the application without external guidance. At least 90% of users should feel comfortable about the product when conducting the user survey.

1.2.3 **Availability** The product must be able to support its users unless there is a planned maintenance or external failures. This is important as the product is using real-time data and significant delays or downtimes will impact the accuracy and usability of the product.

1.2.4 **Reliable Data Communication** The product must have good and secure data communication to support the real-time nature of the product. This is important as the product is using real-time data and significant delays will impact the accuracy and usability of the product. The product must be able to provide the desired output within 5 seconds with good university WiFi connection.

1.2.5 **Protection of Personal Information** The product must keep all personal data provided by users secure in the database. Personal data

will be collected securely and only used for product functions. The application must support the removal of user data upon request. This is important because users will complete a consent form that acknowledges their privacy.

1.2.6 **User Communication** The product must be able to support user-to-user communication. It should provide a friend system for users to add new friends, send messages and emojis to friends and share current location and status (in lecture/event or free) with their friends. This is important because the main purpose of the project is to allow users to connect with peers effectively.

1.2.7 **Interactable Campus Buildings** The product must be able to provide interactions between users and campus buildings. It must show the availability of the lecture halls and information about ongoing events in a building since one of the purposes of the project is to help users utilize campus resources effectively.

1.2.8 **Immersive User Experience** The product should provide an immersive user experience to the users with some XR technologies. At least 90% of the users should find the product much more attractive and immersive than other university applications when conducting the user survey. An immersive user experience is one of the unique selling points of our product.

2 Stakeholders

2.1 Client

The client for this project is the university administration and the related departments who will be approving our project as well as the users.

2.2 Customer

The primary customers are the students and department staff members who will be directly using the mobile application to connect with others and discover events.

2.3 Other Stakeholders

- Legal experts – Could be consulted for legal advice regarding privacy laws
- Subject Matter Experts – Experts in the field of AR development we might consult for guidance
- Usability testers – UI/UX designers / testers we might get recommendations from the design

2.4 Hands-On Users of the Project

- **User Category: Students**
  - User Role: Regular users of the app, including students from various faculties.
  - Subject Matter Experience: Varied levels of experience with the app's features
  - Technological Experience: Varied levels of experience with mobile technology depending on technical background
  - Other User Characteristics: Diverse age groups, ethnicities, interests, and majors
- **User Category: Administrators**
  - User Role: Department members or Club representatives using the app for announcements, events, and communication.
  - Subject Matter Experience: Familiarity with campus events and announcements.
  - Technological Experience: Varied levels of experience with mobile technology depending on technical background
  - Other User Characteristics: Different departments, clubs, roles, responsibilities, older age demographic

2.5 Personas

N/A

2.6 Priorities Assigned to Users

- Key Users (Maximum priority): Students, club representatives and department members who are the most directly involved with the app and are critical to the continued success of the product.
- Secondary Users: Campus visitors and occasional users such as high school students on a university tour learning about the campus.
- Unimportant Users: Users with no association with McMaster university and no authorization looking to misuse the product

2.7 User Participation

Students, club representatives and contributing department members are expected to actively participate in providing feedback, usability testing, and suggesting new features during the development phase. Specifically:

Students can be expected to focus more on the immersion, navigation and the interaction improvements within the app by spending about 2-4 hours a week on the application and providing feedback.

Club/department representatives can be expected to focus more on feedback regarding event related features by spending about 1-3 hours a week on the application and providing feedback.

This method will ensure maximum efficiency in collecting useful feedback from the relevant user groups.

2.8 Maintenance Users and Service Technicians

The finalized version of the product will be regularly serviced and maintained by trained IT support staff and administrators on campus to ensure performance requirements such as reliability, robustness etc. are consistently met. This role will be assumed by the developers in the release build.

3 Mandated Constraints

3.1 Solution Constraints

There are no mandated constraints regarding how the problem must be solved.

3.2 Implementation Environment of the Current System

There are no mandated constraints regarding the implementation environment.

3.3 Partner or Collaborative Applications

There are no mandated constraints regarding interoperation with other applications.

3.4 Off-the-Shelf Software

There are no mandated constraints regarding external software that must be used.

3.5 Anticipated Workplace Environment

There are no mandated constraints regarding anticipated workplace environment.

3.6 Schedule Constraints

- The proof-of-concept shall be ready to demonstrate by Nov. 13-24, 2023.
- Revision 0 shall be complete and demonstrated by Feb. 5-16, 2024.
- The final product shall be complete and demonstrated by Mar 18-29, 2024.

3.7 Budget Constraints

- The project budget must not exceed $750 CAD. The sole source of any funding shall be the team itself.

3.8 Enterprise Constraints

There are no mandated enterprise constraints.

4 Naming Conventions and Terminology

4.1 Glossary of All Terms, Including Acronyms, Used by Stakeholders involved in the Project

Term	Definition
Campus Connections	Campus Connections is the name of the company the capstone project team runs and the name of the application
Extended reality (XR)	AR technology combines the physical world with a "digital twin world" able to interact with it
Augmented reality (AR)	Technology that adds computer-generated components and images to a user's view of the real-world, allowing for an experience that combines virtual and physical components.
User interface (UI)	The section of the overall system where interactions between the user and the system take place.
User experience (UX)	The way a user interacts with the system, and the quality of those interactions.
OSCARplus	OSCARplus is is an appointment, registration and job posting system for McMaster students and alumni
Unified Model Language (UML) diagram	UML diagram is a graphical notation used to construct and visualize object oriented system
Personal Identification Information (PII)	Personal data that could potentially identify a specific individual
Unity	Unity is a cross-platform game engine developed by Unity Technologies
Amazon Web Services (AWS)	Amazon Web Services is a cloud computing provider

Table 1: Naming Conventions and Terminology

5 Relevant Facts And Assumptions

5.1 Relevant Facts

- Due to McMaster University regulations, we cannot collect information on course schedules.[1]

5.2 Business Rules

- Software should follow industry standard security protocols

5.3 Assumptions

- The app is not expected to function outside the campus of McMaster University.
- The backend server host has high availability.
- The backend server host has stable performance.

6 The Scope of the Work

6.1 The Current Situation

Currently, students do not have effective ways to connect with peers of same interest and resources available on campus. One of the most accessible tools for students to utilize campus resources is OSCARplus. However it is for McMaster students and Alumni only, and does not support interactions between users – users cannot see if their friends and classmates are joining the events nor send/read comments from others.
As for room availability information, there is no official management system for visitors and students. Students always occupy empty rooms their found to meet with friends and classmates. Due to poor management and messy process, it is usually very difficult to find an appropriate place for team discussion and club events.

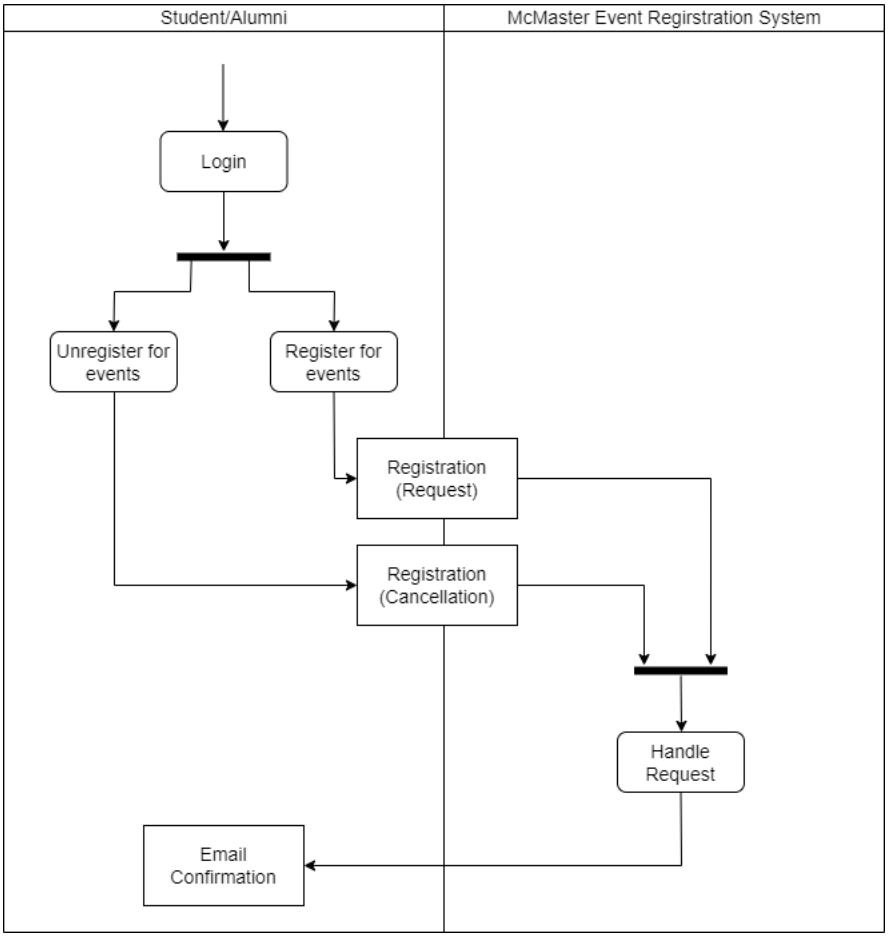

Figure 1: Context Diagram

6.2 The Context of the Work

The context diagram depicted below illustrates the interactions of the system with adjacent external systems and services.

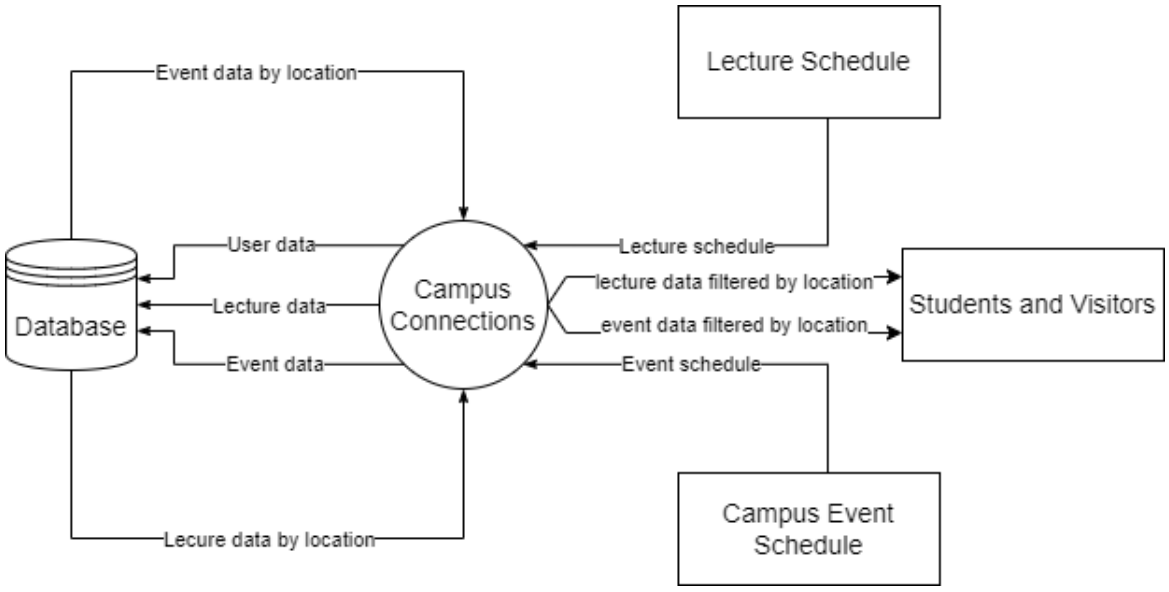

Figure 2: Current Event Registration Situation

6.3 Work Partitioning

Event Name	Input/Output	Summary
Provide lecture schedule	IN: Lecture schedule	Give schedule of lectures when there is an update and after every semester
Provide event schedule	IN: Event schedule	Give schedule of campus events periodically and when there is an update
Record user data	OUT: User data	Record user related data, including user settings, user friends and registered events
Record lecture data	OUT: Event data	Record lecture data, including lecture name, time, duration and location
Record event data	OUT: Event data	Record event data, including event name, time, duration and location
Display event schedule	IN: event data, OUT: event data filtered by location	Display events that are going to be held in in a given building
Display lecture schedule	IN: lecture data, OUT: lecture data filtered by location	Display lectures that are going to be held in in a given building

Table 2: Business Event List

6.4 Specifying a Business Use Case (BUC)

The following is an activity diagram for the Display event schedule process. The trigger of this business user case will be user interaction, and input will

be campus event data from database. What will be displayed is a schedule of events held inside a specific building with detailed event information.

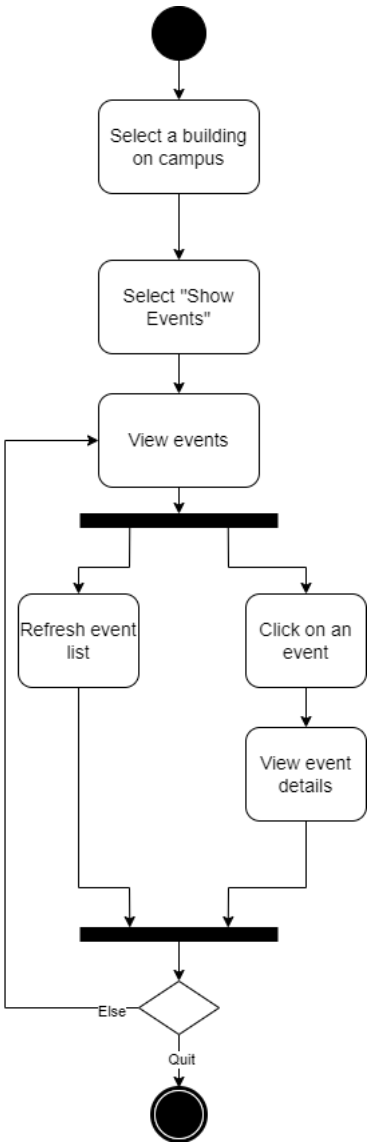

Figure 3: Activity diagram for Display Event Schedule Process

7 Business Data Model and Data Dictionary

7.1 Business Data Model

The following UML class diagram shows all types of business data that will be used in this project.
All the classes represent corresponding business data, all these entries and their attributes will be defined and explained in the data dictionary. class are defined in the data dictionary.

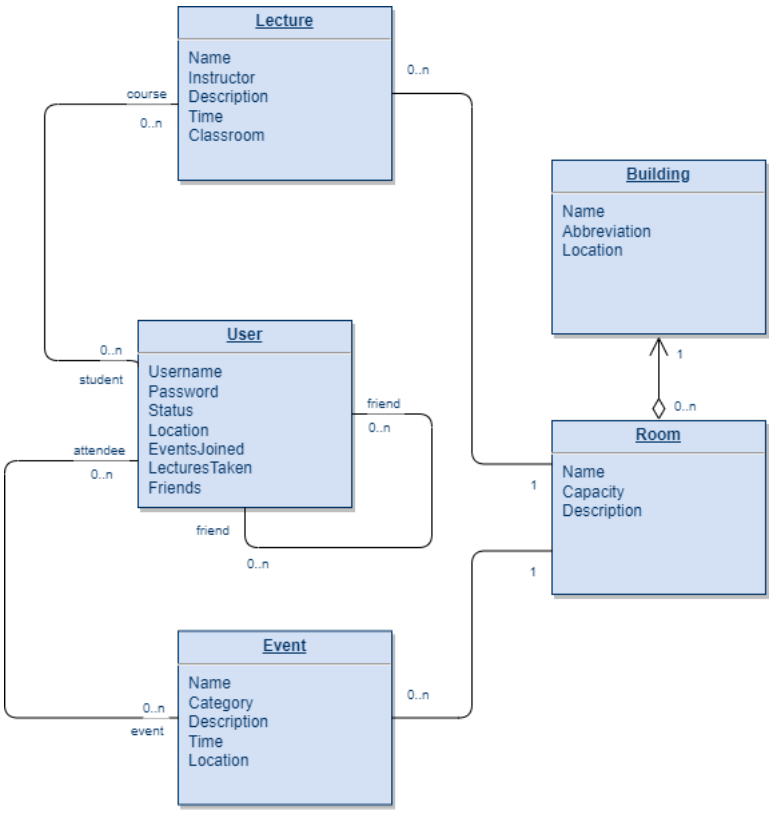

Figure 4: UML class model

7.2 Data Dictionary

This section will include definition of all classes in UML class model and their attributes. Some self-explanatory attributes like name will be ignored.

Name	Content	Type
Lecture	McMaster course data	Class
Lecture.Instructor	Course instructor	Attribute
Lecture.Time	Course schedule	*HH/MM/SS 24 hour clock*
Lecture.Classroom	Course location	Room
Event	McMaster on-campus event data	Class
Event.Category	Held by which department	Attribute
Event.Time	Event time	*HH/MM/SS 24 hour clock*
Lecture.Location	Event location	Room
User	User account data, friends data, location, event & lecture attendance	Class
User.Location	Geographic location	Attribute
User.Status	Online or not	Boolean, Attribute
User.EventsJoined	List of event	Event, Attribute
User.LecturesTaken	List of lecture	Lecture, Attribute
User.Friends	List of friends	User , Attribute
Building	McMaster main campus building	Class
Building.Abbreviation	Abbreviation of building name	Attribute
Building.Location	Geographic location	Attribute
Room	Room inside a building	Class
Room.Capacity	Room capacity	Number, Attribute

Table 3: Data Dictionary

8 The Scope of the Product

8.1 Product Boundary

The use case diagram depicted below identifies the boundaries between the users and the product.

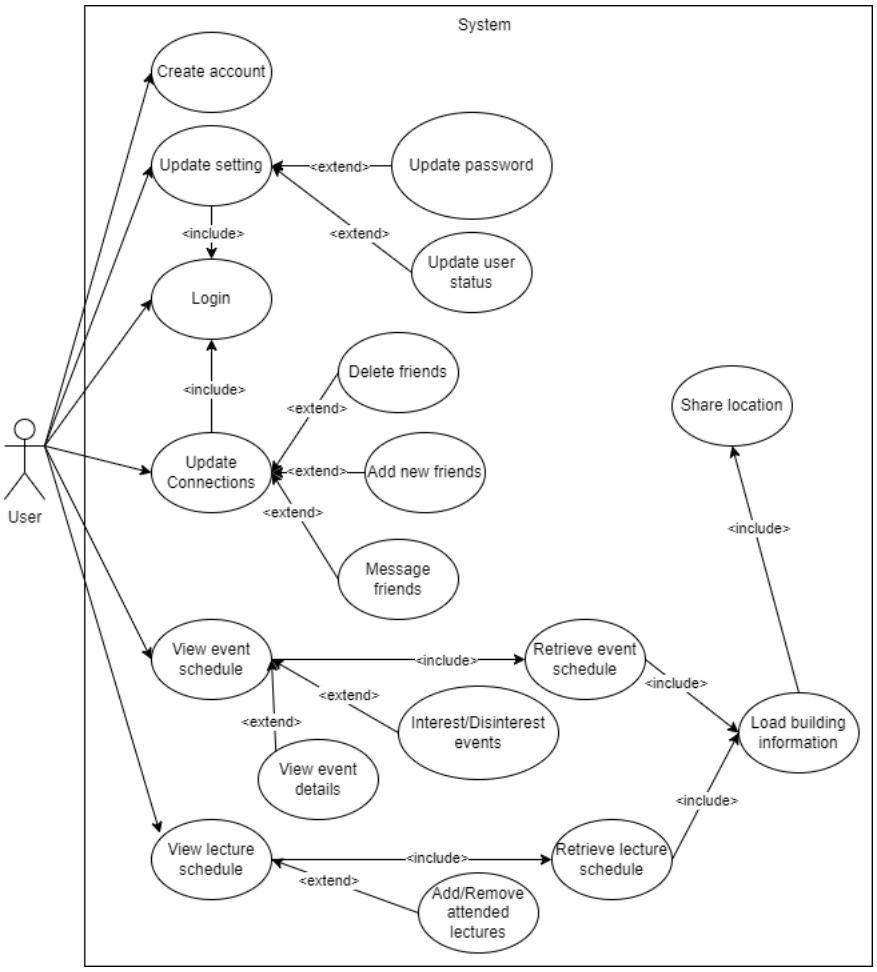

Figure 5: Use Case Diagram

8.2 Product Use Case Table

PUC No	PUC Name	Actor/s	Input & Output
1	Create Account	User	Username & Password (in)
2	Update Password	User	Username & New Password (in)
3	Update User Status	User	New Status (in)
4	Login	User	Username & Password (in), Response message (out)
5	Add New Friend	User	Friend Username (in), Friend Request (out)
6	Delete Friend	User	Friend Username (in), Confirmation Message (out)
7	Message Friend	User	Message Content (in), Message Sent Notification (out)
8	View Event Details	User	User Interaction (in), Event details (out)
9	Interest/Disinterest Event	User	User Interaction & Event Name (in)
10	Add/Remove attended lecture	User	User Interaction & Lecture Name (in)
11	Retrieve Event Schedule	System	New Schedule (out)
12	Retrieve Lecture Schedule	System	New Schedule (out)
13	Load Building Information	System	Location & Sensor data (in), Building Name (out)

Table 4: Product Use Case

8.3 Individual Product Use Cases (PUC's)

Use case #1: Create Account
Precondition: None
Trigger: The user clicks on create account button
Outcome

1. User provides the required information
2. System verifies all required information has been provided
3. System securely registers user information
4. User is redirected back to the Home page

Postcondition: The user has successfully created an account and account information is stored and secured in a database.

Use case #2: Update Password
Precondition: The user has already created an account
Trigger: The user clicks on change password button
Outcome

1. User navigates to change password page
2. User provides old password
3. User provides new password
4. System verifies old password is correct and new password is valid
5. System updates password of current user in the database
6. User is redirected back to the Home page

Postcondition: The user has successfully changed the password.

Use case #3: Update User Status
Precondition: The user has already created an account
Trigger: The user clicks on change status button
Outcome

1. User navigates to change status page

2. User updates status to a new status

3. System updates user status and redirects back to the Home page

Postcondition: The user status has been changed successfully.

Use case #4: Login
Precondition: The user has already created an account
Trigger: The user clicks on login button on the home page
Outcome

1. User navigates to login page

2. System verifies all required information has been provided and matches the database record

3. User is redirected to the home page as alogged-in user

Postcondition: The user has successfully logged in to the created account with all settings and connections loaded from the database.

Use case #5: Add New Friend
Precondition: The user has already logged in
Trigger: The user searches for another user and sends a friend request
Outcome

1. User searches for another user

2. User sends a friend request

3. System sends the request and user information to the destined user

4. Destined user accepts/rejects the request

5. User receives a notification

Postcondition: The user gets a new connection in their friends list.
Postcondition 2: The user is rejected and gets a notification about that.

Use case #6: Delete Friend
Precondition: The user has already logged in and has at lease one friend
Trigger: The user clicks delete button on friend page
Outcome

1. User searches for a friend
2. User deletes the friend
3. System sends a confirmation prompt
4. User continues to delete
5. User receives a notification

Postcondition: The friend is deleted from user's friends list.

Use case #7: Message Friend
Precondition: The user has already logged in and has at lease one friend
Trigger: The user texts a friend on friend page
Outcome

1. User searches for a friend
2. User start to text the friend
3. System sends message to the destined friend

Postcondition: The friend receives a message from the user.

Use case #8: View Event Details
Precondition: The user has already logged in and necessary sensors are working properly
Trigger: The user clicks on an event
Outcome

1. User moves the device to target a building on campus
2. User finds a list of events
3. User clicks on one of the event
4. System displays more information about the event

Postcondition: The content, time and location of the event are displayed.

Use case #9: Interest/Disinterest Event
Precondition: The user has already logged in and had a target building
Trigger: The user clicks on interest/disinterest button
Outcome

1. User browses the event list of the target
2. User navigates to an event detail page with a specific name
3. User clicks on the corresponding button
4. System sends the request to the database
5. System displays the new state of the event

Postcondition: The user event list in the database is updated and the UI changes correspondingly.

Use case #10: Add/Remove Attended lecture
Precondition: The user has already logged in and had a target building
Trigger: The user clicks on add/remove button
Outcome

1. User browses the lecture list of the target
2. User navigates to a lecture detail page with a specific course code
3. User clicks on the corresponding button
4. System sends the request to the database
5. System displays the new state of the lecture

Postcondition: The user lecture list in the database is updated and the UI changes correspondingly.

Use case #11: Retrieve Event Schedule

Precondition: None
Trigger: A request to update schedule is sent or trigger by the system timer
Outcome

1. System sends a request to the on-campus schedule interface
2. System gets the up-to-date schedule
3. System stores the new schedule to the database

Postcondition: The new schedule is stored in the database and will be utilized later.

Use case #12: Retrieve Lecture Schedule
Precondition: None
Trigger: A request to update schedule is sent or trigger by the system timer
Outcome

1. System sends a request to lecture schedule interface
2. System gets the up-to-date schedule
3. System stores the new schedule to the database

Postcondition: The new schedule is stored in the database and will be utilized later.

Use case #13: Load Building Information
Precondition: Location share is allowed and sensors are set properly
Trigger: A request for event/lecture schedule is sent by the user
Outcome

1. System gets geographic location and sensor data from the device
2. System finds the most likely building on campus
3. System displays building information

Postcondition: The system provides information of the building the user locates now.

9 Functional Requirements

9.1 Functional Requirements

FR-1: The system shall allow users to create accounts.
Rationale: Users must be associated with accounts to identify themselves and expand their social networking.
Fit Criterion: Users must be able to create an account with a unique username and a password.

FR-2: The system shall allow users to change their password.
Rationale: This will allow users to improve the security of their account and recover the account if they forget their password.
Fit Criterion: Users may change password in the settings menu after proving their identity. The user must be notified afterwards.

FR-3: The system shall allow users to add friends.
Rationale: One of the main purposes of this application is to make students connect with peers easily. For this to happen, they should be able to make friends on this social media platform.
Fit Criterion: Users can search for other users through username and send a friend request, added friends can be removed from the friend list.

FR-4: The system shall allow users to delete friends.
Rationale: When users add users as friends by accident or they no longer connect with each other, they should be able to remove them from the friend list.
Fit Criterion: Users can remove any friends from their friend list.

FR-5: The system shall allow users to send text messages to other users.
Rationale: This will make the app more interactive and encourage and enhance socialization between users.
Fit Criterion: Users must be able send messages and to view received messages.

FR-6: The system shall allow users to send audio messages to other users.
Rationale: This also improves interactivity and encourages socialization and can be more efficient at times than texting.

Fit Criterion: Users must be able record and send audio messages and and listen to received messages.

FR-7: The system shall allow users to share their location with others.
Rationale: For the purpose of expanding social networking, users shall be able to share their current location with friends to meet in person.
Fit Criterion: Users should be able to share their real-time location with friends as long as they agree on the corresponding terms.

FR-8: The system shall allow users to view events on the McMaster University campus.
Rationale: Currently there is no way for students of McMaster University to keep up with all the different types of events that are hosted by different clubs and departments. This is one of the main purposes of this application to allow users to discover the time and place for as many events as possible in an intuitive manner
Fit Criterion: Users will be able to see current / upcoming events at campus buildings that they are looking at / positioned near as well as a cumulative list of nearing events.

FR-9: The system shall allow users to pin events they are interested in.
Rationale: It will be much easier for users to find events they are interested in and willing to join again. So that they do not have to browse the event list again and again. While their friends can see what events they are likely to join.
Fit Criterion: Users should be able to pin an event from the event list, this event will be displayed on the user page and accessible to all their friends.

FR-10: The system shall allow users to unpin events.
Rationale: In case users are no longer interested in the event or they pinned the event by mistake.
Fit Criterion: Users shall be able to unpin an event they pinned before.

FR-11: The system shall allow users to view lecture schedule information.
Rationale: This will allow users to verify their availability for events without needing to leave the app.
Fit Criterion: Users must be able view lecture times and locations.

FR-12: The system shall allow users to pin lectures they are attending.
Rationale: Sharing schedules with friends can increase friendship. If two friends are taking the same course, they can join lectures, discuss assignments and prepare for midterms together. So it is important for the system to have the functionality to display lectures a user is taking.
Fit Criterion: Users should be able to pin a lecture from the list as attended lecture, this lecture will be displayed on the user page and accessible to all their friends.

FR-13: The system shall allow users to unpin lectures.
Rationale: In case users are no longer taking the lecture or they added the lecture by mistake.
Fit Criterion: Users shall be able to unpin a lecture they pinned before.

FR-14: The system shall have administrator accounts that have special modification access.
Rationale: Administrator accounts should be utilized for the purpose of providing accurate and up-to-date event and lecture information.
Fit Criterion: The system shall be able to mark specific users as administrators and give them access to edit, add and remove all in-app assets.

FR-15: The system shall allow users with an administrator account to add, edit, and remove events.
Rationale: The event information must be up to date and accurate. The administrator account will maintain all events so that there is a singular source of information. Additionally, this reduces the chances of errors being introduced to the system.
Fit Criterion: A new event can be created only by a user who is logged in as an administrator. The information for those events can be changed only by administrators. Events can be deleted only by administrators.

FR-16: The system shall allow users with an administrator account to add, edit, and remove lectures from the schedule.
Rationale: The lecture information must be up to date and accurate as well. Administrators are needed to manage the schedule.
Fit Criterion: A lecture on the schedule can be created, deleted, or updated by a user who logged in as an administrator.

FR-17: Each event shall be associated with a club/department, location and time.
Rationale: In order for the application to schedule events for the users to see and interact with, all specific details about the event should be provided to the system
Fit Criterion: When a department/club requests for an event to be posted on the application, they have to provide details about the building and room number it will be held in, along with the date and time the event will take place at.

FR-18: Each lecture shall be associated with an instructor, location and time.
Rationale: In order to find empty rooms and help users who want to attend specific lectures, all details about the lectures should be provided to the system.
Fit Criterion: When a lecture is added or modified, all the details mentioned above must be set as mandatory fields.

FR-19: The system shall allow users to create a virtual avatar.
Rationale: A customizable avatar makes user accounts more personal and improves the immersiveness of the app.
Fit Criterion: When the user creates an account, they will be prompted to design an avatar with some basic level of customization provided in the application. This avatar will be used to virtually identify the user.

FR-20: The system shall allow users to modify a virtual avatar.
Rationale: The user might feel the need to update the appearance of their avatar to better represent themself.
Fit Criterion: The avatar created in the user's registration process can be modified at any time through the settings menu.

FR-21: The system shall recognize buildings on campus.
Rationale: When navigating the campus, users should be able to see their avatar on the map and recognize the buildings through their camera with some XR technologies.
Fit Criterion: User must see their avatars moving correspondingly on the map when they travel on campus, and when they observe a specific building through their camera, the application should recognize it and display details

about this building.

10 Look and Feel Requirements

10.1 Appearance Requirements

LF-A1: The product shall have a user-friendly layout, with icons being intuitive and screen components not being congested.
Fit criterion: Users are able to run different features through icons without needing assistance or a tutorial during user testing. No components overlap on any screen.

LF-A2: The product shall provide visual feedback to the users when they're using different features and switching pages.
Fit criterion: The chosen method of visual feedback for each component must appear 100% of the time when the triggering options are selected.

LF-A3: The product shall adapt to different mobile screen sizes.
Fit criterion: Visual elements do not exceed the borders of the screen of any device.

10.2 Style Requirements

LF-S1: The colors and themes shall be consistent across different pages.
Fit criterion: Consistency checks show the same color scheme being used on all pages.

LF-S2: The color scheme used shall be appealing and not cause eye strain.
Fit criterion: At least 90% of users agree with the statement that the screen doesn't cause strain during a survey.

11 Usability and Humanity Requirements

11.1 Ease of Use Requirements

UH-EOU1: The product shall have a UI that is clear and easy to navigate.
Fit criterion: Users in the testing stage are able to find their way to specific pages and access different features without needing to try again more than 3 times.

11.2 Personalization and Internationalization Requirements

UH-PI1: The product shall provide information about ongoing lectures and events personalized to each user.
Fit criterion: The name, time, location, and course are displayed on a page for those lectures.

UH-PI2: The product shall allow users to customize their profiles and avatars.
Fit criterion: Customized profile information for a user are stored under their account.

11.3 Learning Requirements

UH-L1: The product shall include a short tutorial on its features on the first launch, and be available upon request from the user.
Fit criterion: The tutorial appears and runs to completion when the product is launched on a new device and/or under a new account. It appears and runs to completion again when its requested.

UH-L2: The product shall be designed so that it is easy for users to remember how to use its features after learning them once.
Fit criterion: During testing, users are able to perform processes and access features without any help after an initial tutorial.

11.4 Understandability and Politeness Requirements

UH-UP1: The product shall have a simple and intuitive design that is easy for users to understand.
Fit criterion: Users in the testing stage are able to find their way to specific pages and access different features without needing to try again more than 3 times.

UH-UP2: The product shall abstain from using technical and software-specific language.
Fit criterion: No instance of technical and software-specific language are found upon a review of all text displayed by the product.

11.5 Accessibility Requirements

UH-A1: The colors used by the different components of the product shall contrast enough for items on the screen to be more easily visible.
Fit criterion: The color contrast is at least 4.5:1 per the Web Content Accessibility Guidelines' AA standards for accessibility.[2]

12 Performance Requirements

12.1 Speed and Latency Requirements

P-SL1: Popup resoponses following successful image recognitions must appear not long after on the user's screen.
Fit criterion: The time from recognition to the appearance of the response is at most 3 seconds.

P-SL2: A user must receive a message sent to them by another user quickly after being sent.
Fit criterion: The message must be received by the recipient at most 2 seconds after it was sent by the sender.

P-SL3: The application will update the user's shared location with their friends shortly after the location change.

Fit criterion: A user's updated location must appear on their friends' ends within 10 seconds of the location change.

12.2 Safety-Critical Requirements

P-SC1: The application will not collect or share any user's location or personal data without getting permission from the user.
Fit criterion: User's personal information does not appear in the database if the user did not grant permissions.

P-SC2: User data such as messages and location information will be securely encrypted to protect user's privacy.
Fit criterion: Contents of data packets being transmitted are nonsense when inspected with network monitoring tools.

P-SC3: The application will comply with all relevant privacy laws and guidelines.
Fit criterion: The usage of a user's personal information by the product abides by the Privacy Act, The Personal Information Protection and Electronic Documents Act, and Canada and Ontario's data protection laws.[3][4]

12.3 Precision or Accuracy Requirements

P-PA1: The product shall accurately identify buildings scanned by the user.
Fit criterion: The product identifies a building with an accuracy of at least 80%.

P-PA2: The shall accurately determine the user's location on campus and display it based on their permissions.
Fit criterion: The user's location on the product is within a 25m radius of the user's true location.

12.4 Robustness or Fault-Tolerance Requirements

P-RF1: The user will be informed in case of network connectivity issues and the application will not crash.
Fit criterion: A notification in the product appears when the network strength is below -75dBm and/or the server is experiencing issues.

P-RF2: The messaging functionality will still work as planned if there is are issues collecting location information for users.
Fit criterion: All messages sent by users are received by the recipients at the speed specified by P-SL2 when location features are disabled.

12.5 Capacity Requirements

P-C1: The product shall accomodate massive amounts of people using the product simultaneously.
Fit criterion: The product accomodates a minimum of 5,000 simultaneous users during peak hours.

P-C2: The database will store event information for all campus buildings for a long time after the addition of the events.
Fit criterion: Information for an event added to the database is still present at least 3 months after its addition.

12.6 Scalability or Extensibility Requirements

P-SE1: This product will be capable of processing about 20 people concurrently in the release build with a plan of expanding it to support all students on campus or about 40,000 people by the final version.

P-SE2: This product will be capable of storing account and personal information of about 100 users in the release build with a plan of expanding it to support up to 40,000 users by the final version.

P-SE3: The application architecture will allow for the addition of new campus buildings and clubs without considerable drawbacks in performance.

12.7 Longevity Requirements

P-L1: This product will be expected to operate without major malfunctions in release build for a minimum of 1 year while undergoing further development.

p-l2: The finalized product will remain compatible with the promised operating systems and devices for a minimum of 3 years.

13 Operational and Environmental Requirements

13.1 Expected Physical Environment

OE-EPE1: The product will be installed on the user's smartphone (iPhone or Android).

OE-EPE2: The product will be used around the main campus of McMaster University.

13.2 Wider Environment Requirements

N/A

13.3 Requirements for Interfacing with Adjacent Systems

OE-IAS1: The product shall interface with the latest four major releases of iOS.

OE-IAS2: The product shall interface with the latest four major releases of

Android OS.

OE-IAS3: The product shall interface with ARKit for AR capabilities on Apple devices.

OE-IAS4: The product shall interface with ARCore for AR capabilities on Android devices.

13.4 Productization Requirements

OE-P1: The product shall be downloadable through the App Store for Apple devices.
Fit criterion: The product can be downloaded onto an Apple device through the App Store.

OE-P2: The product shall be downloadable through the Google Play Store for Android devices.
Fit criterion: The product can be downloaded onto an Android device through the Google Play Store.

13.5 Release Requirements

N/A

14 Maintainability and Support Requirements

14.1 Maintenance Requirements

MS-M1: Major updates could be rolled out during periods of reduced usage such as Reading Week, after exams, or Spring semester.

14.2 Supportability Requirements

MS-S1: Feature requests or issues can be sent to the product GitHub.

MS-S2: A user manual will be complied and stored in the GitHub, this manual will be updated with Frequently Asked Questions and other entries as additional features are introduced.

14.3 Adaptability Requirements

MS-A1: The product shall be accessible on Android 11 and above for Android devices, iOS 15 and above for iPhone devices, and Windows 10 and above for PCs, as these operating systems are still supported and receive security updates.

15 Security Requirements

15.1 Access Requirements

S-A1: The product shall have three levels of access:

1. The first will be before login and account creation, where anyone can access. They must not have access to anything beyond the login, account creation, and account recovery pages.

2. The second will be after login that verifies their identity, where the user has provided information matching the McMaster student or faculty member with McMaster email account. Only the user can access this page.

3. The third level will the the administrator account, used for adding, deleting, or editing official events. This account can be accessed by login that verifies that they are the maintainer, this will be used by the maintainers to check the functionality of the product and pull logs that are not accessible to users.

Fit criterion: Certain features and sections of the product exclusive to higher access levels are not accessible by ends with a lower access level.

15.2 Integrity Requirements

S-IG1: The product shall prevent introduction of duplicate data, to guarantee that all user identities are unique.
Fit criterion: Product blocks an attempt to create a user account using student/faculty-exclusive information (e.g. MacID) tied to an already existing account.

15.3 Privacy Requirements

S-P1: All data collected must be encrypted on disk in the server by standard encryption algorithm.

S-P2: All data collected must be encrypted on transit by industry standard encryption algorithm.

S-P3: The product will require users to agree on the terms prior to account creation and additional data submission.

S-P4: The product must erase all data if the user requests, or when account is deleted.

S-P5: Accounts that are inactive for a certain period of time shall be deleted after notice to prevent unnecessary data being held.

15.4 Audit Requirements

N/A (This currently does not apply, once the product is ready to be used in multiple universities and regions, audit requirements will be reconsidered.)

15.5 Immunity Requirements

S-IN1: The product must only use open source libraries with many users and continuous security updates.

S-IN2: The product must undergo vulnerability checks before a build is pushed to the users.

S-IN3: Security updates must be done as soon as possible when they are announced for used packages.

16 Cultural Requirements

16.1 Cultural Requirements

CUL-C1: The product shall not be offensive to any marginalized groups.
Fit Criterion: The product shall not use any language or symbols deemed offensive by a marginalized group.

CUL-C2: The product shall not be offensive to any religious or groups.
Fit Criterion: The product shall not use any language or symbols deemed offensive by a religious or ethnic group.

17 Compliance Requirements

17.1 Legal Requirements

COM-L1: The data collected from users will be handled as per the same legal requirements for the university.

17.2 Standards Compliance Requirements

COM-SC1: The encryption on data in storage and in transit must be industry standard.

COM-SC2: The application will abide by the guidelines set by the university and club managers, adding options to accomodate their requests.

18 Open Issues

- To target iOS devices, a device capable of building iOS apps is required.

19 Off-the-Shelf Solutions

19.1 Ready-Made Products

- **Snapchat:** Snapchat is an existing social media platform that makes use of AR technology through its Lenses feature which provides various filters and effects that users can apply to their content.
- **Instagram:** Instagram is another platform that incorporates AR in the form of filters and effects.
- **TikTok:** TikTok similarly uses AR for visual effects and filters.
- **Facebook:** Many clubs at McMaster use Facebook Groups to coordinate events.
- **Meetup:** Meetup is another platform designed for organizing and finding events and other social gatherings.
- **CampusGroups:** CampusGroups is a platform that focuses specifically on university student groups. It allows universities to create private communities for various events and other student engagement activities.

19.2 Reusable Components

- Models and art assets can be obtained from the Unity Asset Store or similar sources.
- Existing database solutions such as MongoDB.

- Vuforia is another AR toolkit. It also provides an API for Unity.

19.3 Products That Can Be Copied

- Groups, events and a friend system similar to other popular social media apps. (Facebook, Instagram, . . .)
- AR camera modes or filters similar to TikTok or Snapchat.
- Text and voice messaging as is common in other social media apps. (Facebook, Instagram, . . .)

20 New Problems

20.1 Effects on the Current Environment

This application will not take place of any existing official tools. It intends to improve certain social networking processes students are following and provide a platform for users to connect with each other better. The following are some changes that will impact users.

Expand Networking
Students will be able to expand networking when attending events lectures on this social media platform. Users may lose connection with peers when there is a failure in the system.
Event Registration
Students and alumni will be able to login with their McMaster email and write comments about on campus events, which means there will be a risk of personal identification information (PII) leakage if the data is not stored securely.
Available Room Management
This application can be utilized to get information about lecture time and location which should not be displayed publicly. Therefore insecure data storage may lead to data breaches.

20.2 Effects on the Installed Systems

The application will be completely stand alone and will not be interfacing with any existing systems. As described in the previous section, this application should not affect or replace any existing systems.

20.3 Potential User Problems

Any potential adverse reactions related to using the device in which application is being launched on (mobile device or tablet) would extend to the use of this application. Any adverse reactions of Virtual Reality and Augment Reality, like nausea, dizziness and disorientation would be introduced to the use of the application as well.

20.4 Limitations in the Anticipated Implementation Environment That May Inhibit the New Product

- The database free plan is not able to cope with our projected user growth pattern.
- Low quality internet connection will lead to latency between user inputs and in-game reactions or even failures of loading in-game assets.
- The accuracy of input data totally depends on device sensor. Low accuracy data may cause bad user experience.

20.5 Follow-Up Problems

Any failures or downtime on Unity game engine and its third-party libraries may affect the availability of this application. In-game schedules may fail to load when the event and lecture schedule interfaces are down or the two external systems are under maintenance. There will also be a risk of violating privacy laws in the future since the application is collection personal information and there may be new laws prohibit this kind of information collection.

21 Tasks

21.1 Project Planning

The project schedule will follow the deadline for the deliverables outlined in the SFWRENG 4G06 course outline.

Phase	**Task**	**Deadline**
Revision 0	Hazard Analysis	Oct 20, 2023
	Verification and Validation Plan	Nov 3, 2023
	Proof of Concept Demo	Nov 13-24, 2023
	Design Document	Jan 17, 2024
	Demonstration	Feb 5-16, 2024
	Verification and Validation Report	Mar 6, 2024
Revision 1	Final Demonstration	Mar 18-29, 2024
	EXPO Demonstration	April 2024
	Final Documentation	Apr 4, 2024

Table 5: Project Plan

21.2 Planning of the Development Phases

The development of the project will be divided into two phases

- Revision 0, initial development
- Revision 1, refinement of the project and documents

Revision 0 starts now and ends with the Verification and Validation Report. In this phase, the team will work on some design-related documents and specify the scope of the project, what skills the team will be using, and how the interaction of different components be. Then the team will start implementation as proof of concept and demonstrate their product to stakeholders. After that, the team will write a V&V report based on the demonstration and stakeholder feedback.
Revision 1 will focus on the refinement of the application and documents. In the previous phase, the team finished a bunch of drafted documents, and in this phase, the team should put all effort into incorporating feedback into these documents and the application itself. There will not be any major new features added in Revision 1.

22 Migration to the New Product

22.1 Requirements for Migration to the New Product

There are no requirements to migrate to this product besides recruiting sufficient number of users. With the the starting users, there may not be enough engagement for this application to be widely used.

22.2 Data That Has to be Modified or Translated for the New System

Currently, all data we need are in OSCARplus and club management part of the university administration. These data will be requested via API or a new web based or internal input system will be made to move all the data over to our product.

As this product handles real time data, there is no need to migrate outdated data to the product.

23 Costs

In the initial release build of our application, we will be keeping costs at an absolute minimum. We will be utilizing free technologies such as Vuforia for image recognition features and MongoDB as our database solution, our development expenses will remain at $0. Additionally, we plan on using GitHub's free hosting service for the deployment of our application, further eliminating any hosting-related expenses. We plan to scale our infrastructure with time where we may explore more premium options, such as AWS S3 bucket and MongoDB Atlas, to ensure the continued seamless operation and performance of our application while serving all McMaster students.

24 User Documentation and Training

24.1 User Documentation Requirements

- Digital User Manual:

  The purpose of the document will be to outline the main functions the product serves such as navigation and event discovery and how the user

can make use of them. This will also highlight some common possible errors / mistakes that can occur and how the user should interact with the system to avoid them in the first place or handle them in a sensible manner if they occur.

- Event Posting Guideline:

  The purpose of this document will be to streamline and outline the process for clubs and departments to post events in the proper manner

- Privacy Policy:

  This document will display the data handling and user privacy rights clearly.

- Terms of Service:

  This document will outline terms of service and all user responsibilities.

Motivation:

User documentation will be created by the developers and will improve the on-app experience of the users.

24.2 Training Requirements

- Admin training:

  Training provided to authorized club and department representatives on additional features associated with admin accounts such event posting / management and handling user issues.

Motivation:

To provide a better experience for administrators and avoid overwhelming them with the additional features presented to them. The training plan and the physical training will be carried out by different developers.

25 Waiting Room

- User generated content such as text or image posts.
- "Gamification" features (i.e. collectibles, achievements, stickers, ...) to increase or incentivize social engagement.

26 Ideas for Solution

Implementation ideas for solutions

- AR feature
  - Vuforia supports some AR functionalities and works as a library of Unity
  - gather.town might be a good design approach to follow after from the campus navigation and interaction perspective
- Server
  - AWS might be a purchasable and reliable option for the back-end

27 References

1. Freedom of Information and Protection of Privacy Act (FIPPA), McMaster University; University Secretariat, https://secretariat.mcmaster.ca/privacy/notice-of-collection-use-and-disclosure/

2. Web Content Accessibility Guidelines (WCAG) 2, Web Accessibility Initiative, www.w3.org/WAI/WCAG21/quickref/#contrast-minimum. Accessed 13 Oct. 2023.

3. Legislative Services. "Personal Information Protection and Electronic Documents Act." Personal Information Protection and Electronic Documents Act, 28 Sept. 2023, laws-lois.justice.gc.ca/eng/acts/p-8.6/.

4. "Consolidated Federal Laws of Canada, Privacy Act." Privacy Act, 28 Sept. 2023, laws-lois.justice.gc.ca/eng/ACTS/P-21/page-1.html#h-397177.

Appendix — Reflection

The information in this section will be used to evaluate the team members on the graduate attribute of Lifelong Learning. Please answer the following questions:

1. What knowledge and skills will the team collectively need to acquire to successfully complete this capstone project? Examples of possible knowledge to acquire include domain specific knowledge from the domain of your application, or software engineering knowledge, mechatronics knowledge or computer science knowledge. Skills may be related to technology, or writing, or presentation, or team management, etc. You should look to identify at least one item for each team member.

   The team members will need to collectively acquire some technical and non-technical skills and knowledge in order to succeed in this capstone project. The following is a list of skills that are critical to the project and course deliverables.

   1 Presentation skills for demonstrations and capstone EXPO

   2 Documentation skills

   3 Team management skills including time management and work distribution

   4 Skills of Unity game development

   5 Skills of Unity AR development

   6 Integrating external backend systems into a Unity project

   7 Skills of git

   8 Front-end development skills

   9 Back-end development skills including server deployment and database

   10 Organizational skills to lead meetings and discussions on unclear topics in the project

2. For each of the knowledge areas and skills identified in the previous question, what are at least two approaches to acquiring the knowledge or mastering the skill? Of the identified approaches, which will each team member pursue, and why did they make this choice?

For non-technical skills, team members can develop those skills by practicing and attending courses/workshops. Members can leverage LinkedIn Learning and McMaster workshops to develop management and organizational skills. For documentation and presentation skills, team members can also join related events hosted by the university or refer to past documents and presentations.
There are even more resources available for developing technical skills. Online learning platforms like Udemy will be used for the team to learn new technology-specific domain knowledge and skills. Other online resources like YouTube tutorials and official documentation can help the team master those technical skills as well.
Listed below under each team member's name is a list of skills that the team member will focus on and why they decide to work on them.

- **Zihao Du**
  - Skills: 1, 2, 3, 4, 8

  Soft skills are quite important for a team and an engineer. And that's why I'd like to focus on soft skills like presentation skills and documentation skills. It will be not only critical to succeed in this capstone project but also beneficial to software engineering careers. Communication plays a very important role in software engineer's daily work and I will take this opportunity to further improve my skills.
  I'll also focus on Unity game development and front-end development because that attracts me the most and what I have the most experience in and I'd like to strengthen my skills and learn more about game development during this project.
- **Michael (Minsung) Kim**
  - Skills: 3, 7, 9, 10

  All documentation and work progress will be tracked on git and meetings. Additionally, the work done will always be added to git to keep track of all work records. This will improve my skills in git and allow me to resolve merge conflicts better and manage any issues from the CI/CD pipeline. As the liaison, I need to ensure that the team is on the right track and no misunderstandings are left. We will have meetings regarding work done to keep everyone

updated and let everyone know which tasks may be difficult or require further clarification. There will be discussions before the supervisor meeting so that we know what we need to ask and what subjects we could use their advice in.
I will focus on the back-end of the project so that data communication is secure and efficient. I am very interested in the database architecture and encryption that goes into on disk and in transit communication. I will learn more about different databases such as SQL and MongoDB, their benefits and security. As I have the advanced databases course, this will help me with the database skills. The information security course will help with the data encryption part of the back-end development as well. Further research and looking into open source libraries that support back-end will help significantly as well.

- **Firas Elayan**
  - Skills: 4, 5, 6, 7, 9

  Unity and other general platforms for developing products such as the one in our capstone project are a new field to me that I do not have a lot of experience in. I'd like to acquire a near-advanced level of technical skills in relation to those platforms so that I'm able to build an array of good products of a very useful type that function properly and meet all requirements.
  Git is an extremely beneficial tool if used correctly. I'd like to improve my skills in git to ensure this project and future projects I participate in building have a smooth development life, especially with how expensive errors and issues can become the more complex the project gets.

- **Matthew Miller**
  - Skills: 1, 2, 4, 8, 9

  I want to work on my presentation skills and documentation skills so that I can focus on improving my oral and written communication skills. Since I have autism, communication has always been a challenge, so I would like to take the opportunity to work on those skills. I also chose to focus on Unity game development skills, front-end development skills, and back-end development skills so that I can gain experience with a variety of different coding skills.

- **Waseef Nayeem**
  - Skills: 2, 4, 5, 6, 10

  I have chosen to focus on a combination of skills that I am experienced in as well ones that are more difficult or new to me. Game development is one of my passions and main hobbies and I always want to learn new techniques to improve my skills. This is why I want to focus on the Unity game and AR development tasks. Since most of my experience is with 2D games, 3D will pose some challenges that I am excited to tackle. I am also interested in learning how to integrate external systems and services into game engines such as Unity as I believe the experience will benefit my future projects. My work on prior projects has taught me the importance of proper documentation. I could improve my documentations skills by practicing technical writing or documentation prior projects. I could also learn new documentation tools and techniques such as using GitHub's wiki features or making a ReadTheDocs page. Lastly, I would like to improve my organization and participation in team settings. To accomplish this I could prepare a personal agenda of items ahead of time or log a to-do list of action items.

- **Abhiram Neelamraju**
  - Skills: 3, 4, 5, 6

  The skills I plan on acquiring and focusing on have been chosen based on where I feel like I want to improve the most and where I feel like I can contribute the most. I want to be a good team member and possess good team management skills so that I can do well in the future as well in team oriented- environments. I can do so by taking an active role in group discussions and doing my fair share of work on time. I'm also extremely interested in learning about the Unity engine as a whole (4,5,6). Starting from learning basic skills related to Unity game development and Unity AR development. These skills can be acquired through looking through the detailed and comprehensive documentation available online and well as free video tutorials on websites such as YouTube. The specific skills for Integrating external backend systems into a Unity project is more specific and will be learned

more through reading documentation, but there are still video tutorials that teach these skills which I will be following. I also plan on exploring paid options for digital courses on websites such as coursera and Udemy.