I-Campus Lecture Sub-System

Software Design Specification

2021.05.16.

Introduction to Software Engineering 41

TEAM 4

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1. Preface

This document describes the procedures and specifications that are involved with designing and implementing a bookmarking and notetaking feature to the i-Campus online learning platform. The following chapter discusses the intended audience for this document and gives brief descriptions on each topic discussed in this document.

1.1. Readership

This document is targeted to the developers and any stakeholders that are involved in the addition of this feature to i-Campus. Developers should use this document in order to view the software structure and procedures that are necessary for implementation. Stakeholders can use this document in order to make sure that their requirements are being met by the developers.

1.2. Scope

This Design Specification is to be used by Software Engineers and Software Quality Engineers as a guide to implement the i-Campus sub-system for video bookmark system.

1.3. Objective

The primary purpose of this Software Design Document is to provide a description of the technical design aspects for i-Campus sub system. This document describes the software architecture and software design decisions for the implementation of our project. It also provides an architectural overview of the system to depict different aspects of the system. Furthermore, it specifies the structure and design of some of the modules discussed in the SRS document and displays some of the use cases that have been transformed into sequential and activity diagrams. Class diagrams show how the programming team would implement the specific module. The intended audience of this document is, but is not limited to, the stakeholders, developers, designers, and software testers.

1.4. Document Structure

- **1. Preface**: this chapter describes readership, scope of this document, object of this system, and structure of this document.
- **2. Introduction**: this chapter describes several tools used for this document, several diagrams used in this document and the references, and object of this project.
- **3. Overall System Architecture**: this chapter describes overall architecture of the system using context diagram, sequence diagram, and use case diagram.
- **4. System Architecture - Frontend**: this chapter describes architecture of the frontend system using class diagram and sequence diagram.
- **5. System Architecture - Backend**: this chapter describes architecture of the backend system using class diagram and sequence diagram.
- **6. Protocol Design**: this chapter describes design of several protocols which used for communication of client and server.
- **7. Database Design**: this chapter describes database design using several ER diagrams and SQL DDL.
- **8. Development Plan**: this chapter describes which tools to use to develop the system, constraints, assumption, and dependencies for developing this system.
- **9. Supporting Information**: this chapter describes baseline of this document and history of this document.

2. Introduction

This goal project is to develop and design an application that can be used to learn lectures uploaded to i-Campus. This system will allow users to create bookmarks at any point in a lecture video and be able to move to the bookmarks as needed. This design document presents the designs that will be used in implementing the feature. The designs described fulfill the requirements specified in the Software Requirements Specifications document presented earlier.

2.1. Objectives

In this chapter, we describe the various tools and diagrams which we have applied to this project in the design phase.

2.2. Applied Diagrams

2.2.1. UML

UML is an acronym for Unified Modeling Language. UML is a widely used tool which helps to model and document software. UML is a language commonly used by business analysts, software architects, and developers to describe, specify, design, and document existing or new business processes, structure, and behavior of software system components. UML can be applied to diverse application domains (e.g., banking, finance, internet, aerospace, healthcare, etc.) It can be used with all major object and component software development methods and for various implementation platforms (e.g., J2EE, .NET). It is based on diagrammatic representations of software components. Visual representations of software systems make finding and correcting errors easier.

2.2.2. Use case Diagram

A central part of the system is the functional requirements that the system fulfills. Use Case diagrams are used to analyze the system's high-level requirements. These requirements are expressed through different use cases. We notice three main components of this UML diagram: Functional requirements – represented as use cases; a verb describing an action. Actors – they interact with the system; an actor can be a human being, an organization or an internal or external application. Relationships between actors and use cases – represented using straight arrows.

2.2.3. Sequence Diagram

Sequence diagrams are one of the most important UML diagrams used by the computer science community and business application developers. Lately, these diagrams have become popular in depicting business processes due to their visually self-explanatory nature. As the name

suggests, sequence diagrams describe the sequence of interactions that happen between actors and objects. Actors or objects are only active when needed or when another object wants to communicate with them. All communication is represented in a chronological manner.

2.2.4. Class Diagram

A class diagram in the Unified Modeling Language (UML) is a type of static structure diagram that describes the structure of a system by showing the system's classes, their attributes, operations (or methods), and the relationships among objects. Just as classes are the building blocks of objects, class diagrams are the building blocks of UML. The various components in a class diagram represent the classes that will be programmed, the main objects, or the interactions between classes and objects. The class shape itself consists of a rectangle with three rows. The top row contains the name of the class, the middle row contains the attributes of the class, and the bottom section expresses the methods or operations that the class may use. Classes and subclasses are grouped together to show the static relationship between each object.

2.2.5. Context Diagram

The system context diagram (also known as a level 0 DFD) is the highest level in a data flow diagram and contains only one process, representing the entire system, which establishes the context and boundaries of the system to be modeled. It identifies the flows of information between the system and external entities (i.e. actors). A context diagram is typically included in a requirements document as is read by the project stakeholders and thus should be written in natural language. The objective of the system context diagram is to focus attention on external factors and events that should be considered when developing a complete set of systems requirements and constraints. A system context diagram is often used early in development to determine the scope and it shows all external entities that may interact with a system. This diagram pictures the system at the center, with no details of its interior structure, surrounded by all its external entities, interacting systems, and environments.

2.2.6. Entity Relationship Diagram

An entity relationship diagram (ERD) shows the relationships of entity sets stored in a database where each entity represents a software component. An entity set is a collection of such entities. These entities can have attributes that define its properties. By defining the entities, their

attributes, and showing the relationships between them, an ER diagram illustrates the logical structure of databases. Entity Relationship diagrams are used to sketch out the design of a database.

2.3. Applied Tools

2.3.1. Microsoft PowerPoint

This is a tool that supports drawing text and figures. It is convenient to draw diagrams using various shapes. In addition, it is easy to edit because it works as full word-processor formatting (which is a tool for working with documents), graphic shapes with attached text for drawing diagrams and tables.

2.3.2. Draw.IO

This is a web-based database modeling tool that lets you quickly and easily create Entity Relationship Diagrams (ERDs), Relational Schemas (Relational Diagrams)

2.4. Project Scope

The i-Campus lecture sub-system was built as a quality-of-life feature for when users wish to find important or necessary parts of a video. It can be used for the purpose of reviewing for an exam, assignment, etc. This system is based on a relational database and information that can be helpful for the lecture will be built on the server for the various lectures that exist in i-Campus.

2.5. References

The user of this SDD may need the following documents for reference:

- Team 1, 2020 Spring. Software Design Document, SKKU.
- Appleton, Brad. A Software Design Specification Template. N.d.
- P. Burke, K. Martin, D. Longtin. Software Design Specification for a One Runway

Airport/Air Traffic Controller Simulation <https://www.academia.edu/29811493/SOFTWARE_DESIGN_SPECIFICATION_FOR_A_ONE_RUNWAY_AIRPORT_AIR_TRAFFIC_CONTROLLER_SIMULATION>.

- Instructure, inc. 2021 <https://canvas.instructure.com/doc/api/users.html>

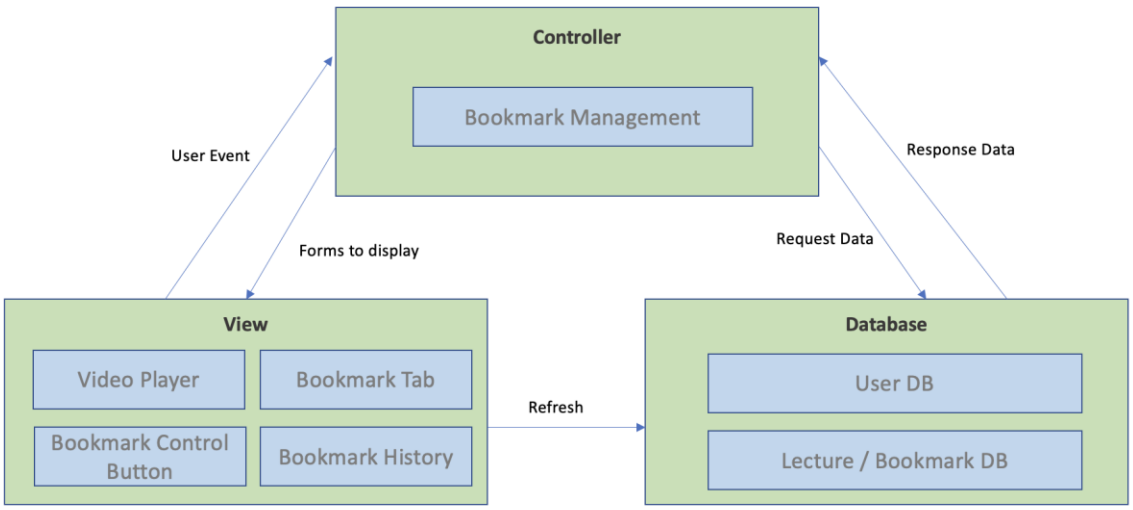
3. System Architecture – Overall

3.1. Objectives

In this chapter, we describe and show the organization of the system. Descriptions of the system range from the frontend design to the backend design.

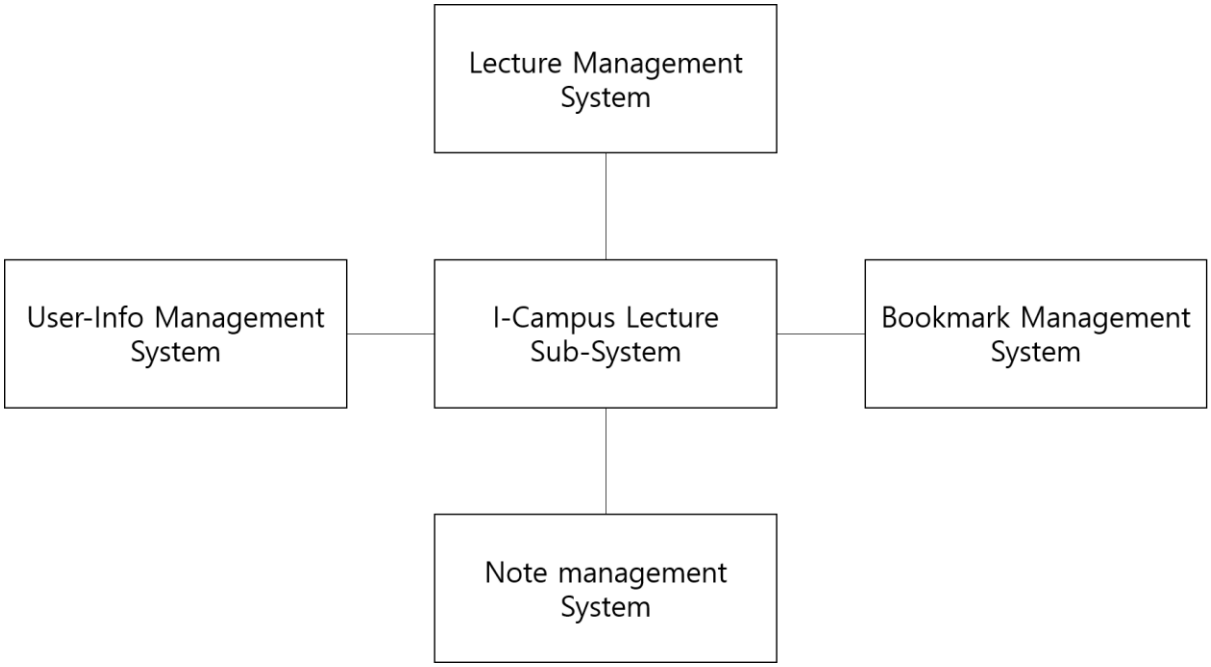
3.2. System Organization

This service is designed by applying the client - server model, frontend Application is responsible for all interactions with users, and the front-end application and back-end application send and receive data through HTTP communication based on JSON. The back-end application distributes design specification requests from the front-end to the controller, obtains the required object information from the database, processes it from the database, and delivers it to the JSON format.



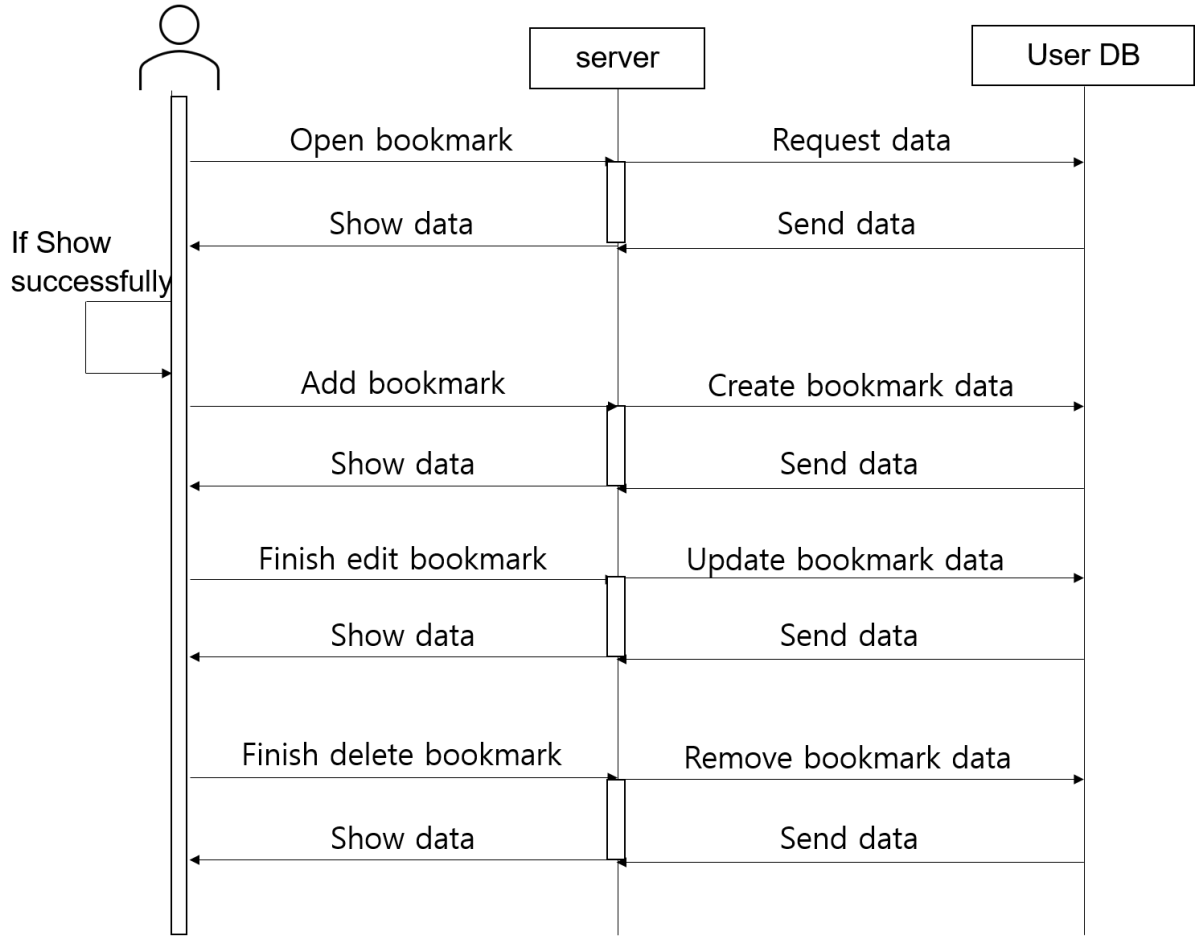
[Figure 1] Overall system architecture

3.2.1. Context Diagram



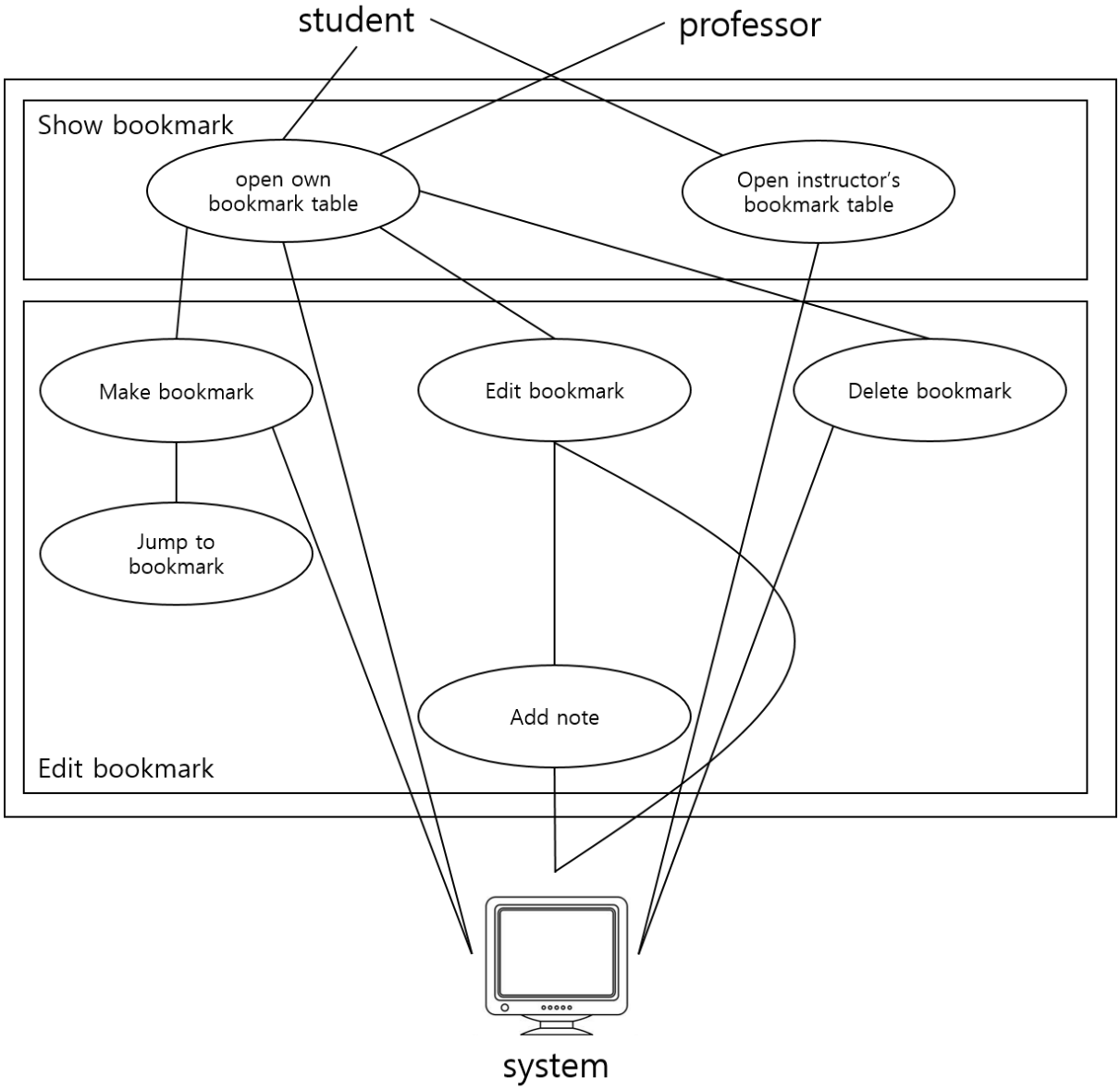
[Figure 2] Overall context diagram

3.2.2. Sequence Diagram



[Figure 3] Overall sequence diagram

3.2.3. Use Case Diagram



[Figure 4] Use case diagram

4. System Architecture – Frontend

4.1. Objectives

This chapter describes the functionality, structure, and relationships of the components that make up the frontend.

4.2. Subcomponents

4.2.1. User controller

This shows the different permissions and functions depending on the user's type. The user's type in that course is automatically taken from the course api in Canvas.

4.2.1.1. Attributes

These are the attributes that profile object has.

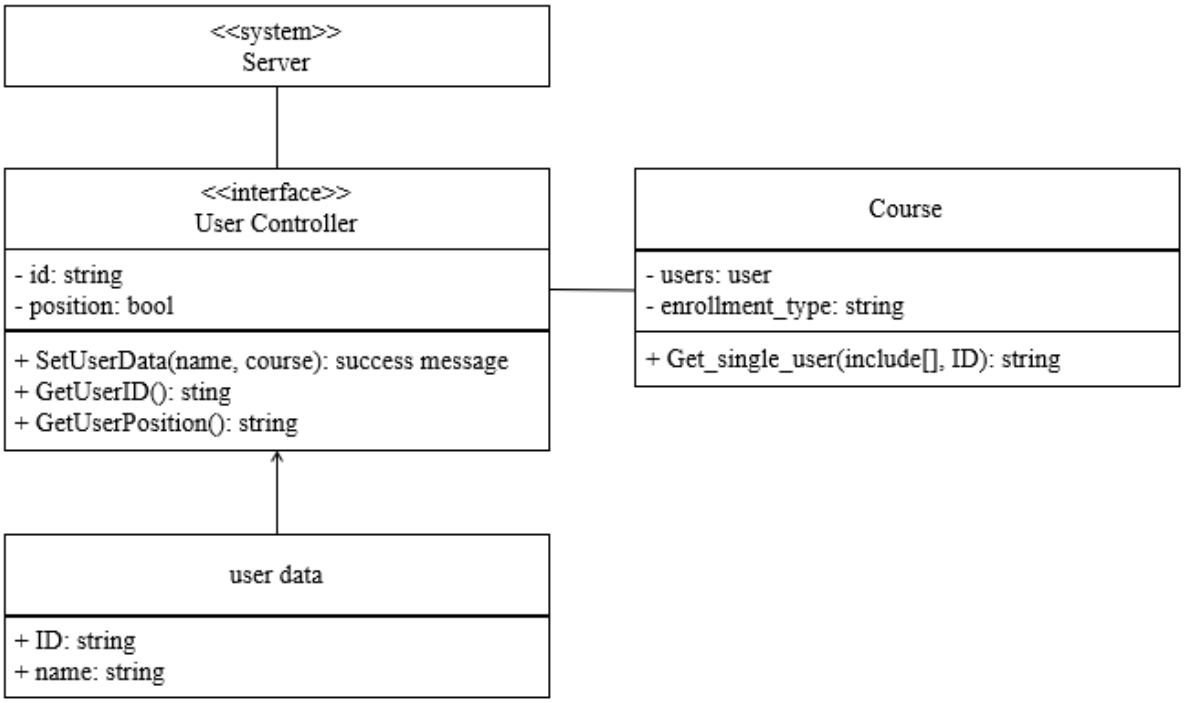
- **User id**: id of the user (email address)
- **Position**: The role of the user in the course (Instructor or learner).

4.2.1.2. Methods

These are the methods that profile class has.

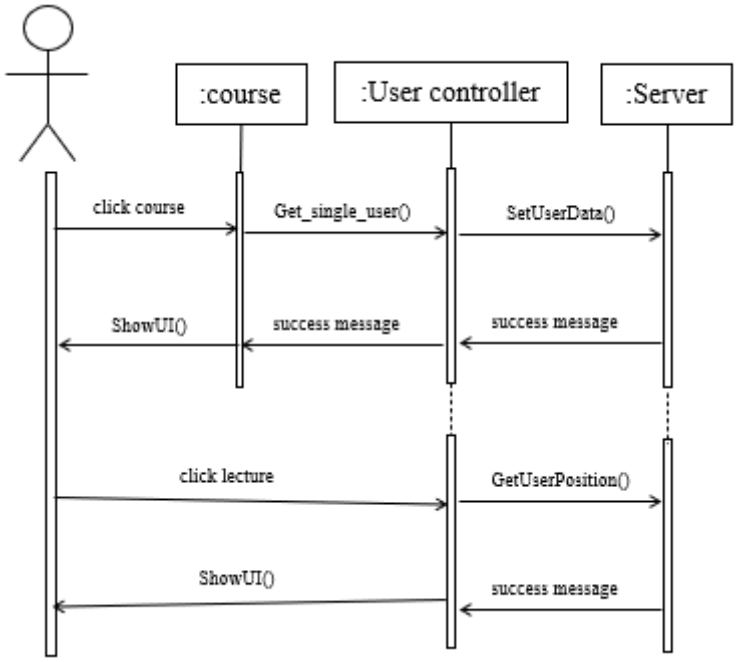
- SetUserData(name, course)
- GetUserID()
- GetUserPosition()
- ShowUI(position)

4.2.1.3. Class Diagram



[Figure 5] Class diagram – User Controller

4.2.1.4. Sequence Diagram



[Figure 6] Sequence diagram – User Controller

4.2.2. Bookmark Controller

manages bookmark tables that manage the creation, modification, deletion, and other features of bookmarks.

4.2.2.1. Attributes

These are the attributes that profile object has.

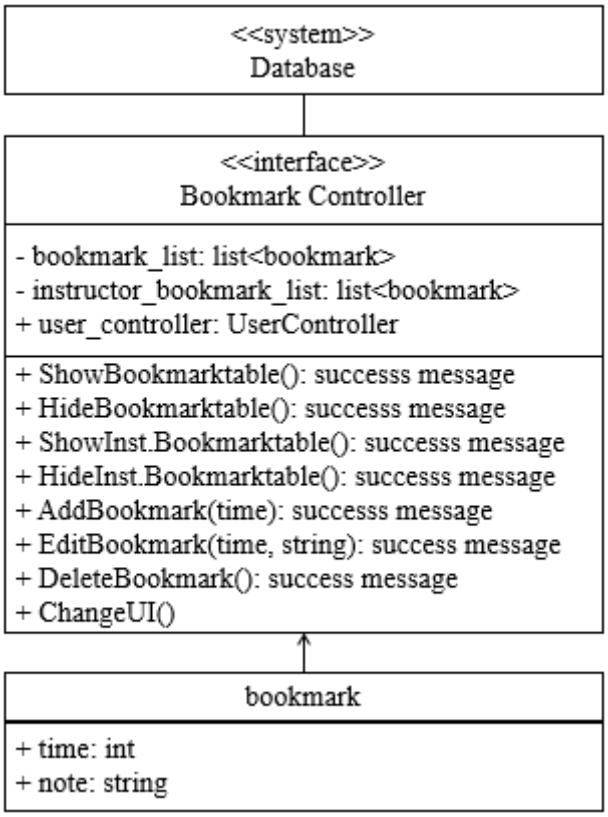
- **bookmark_list**: List of bookmarks made by user.
- **instructor_bookmark_list**: List of bookmarks made by instructor of course. If user is intstructor, this list will be empty.
- **user_controller**: It changes the flow according to user data.

4.2.2.2. Methods

These are the methods that profile class has.

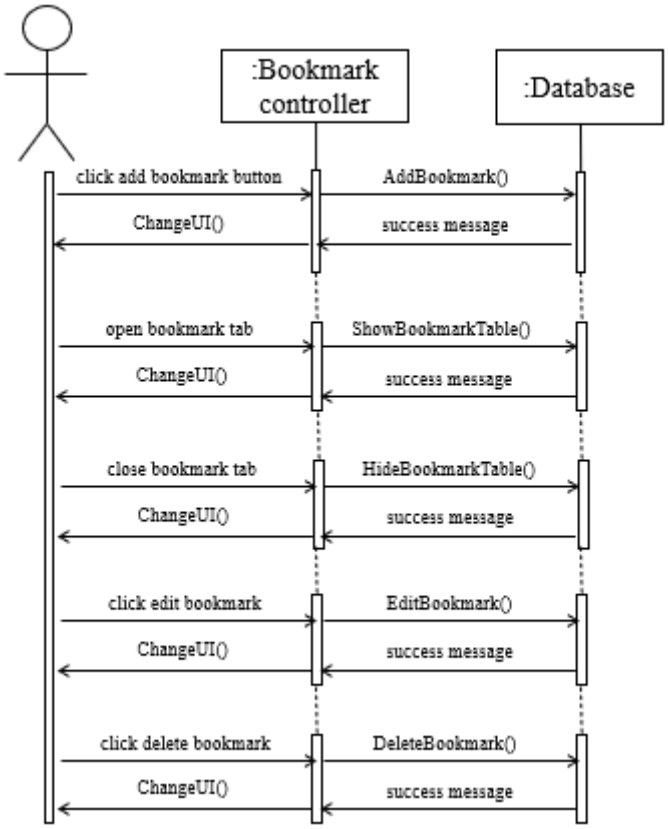
- ShowBookmarkTab()
- HideBookmarkTab()
- ShowInst.BookmarkTab()
- HideInst.BookmarkTab()
- AddBookmark(time)
- EditBookmark(time, string)
- DeleteBookmark()

4.2.2.3. Class Diagram



[Figure 7] Class diagram – Bookmark Controller

4.2.2.4. Sequence Diagram



[Figure 8] Sequence diagram – Bookmark Controller

4.2.3. Lecture Controller

The bookmark flag created during bookmarking allows you to change the lecture directly by adjusting the lecture time and folding it.

4.2.3.1. Attributes

These are the attributes that profile object has.

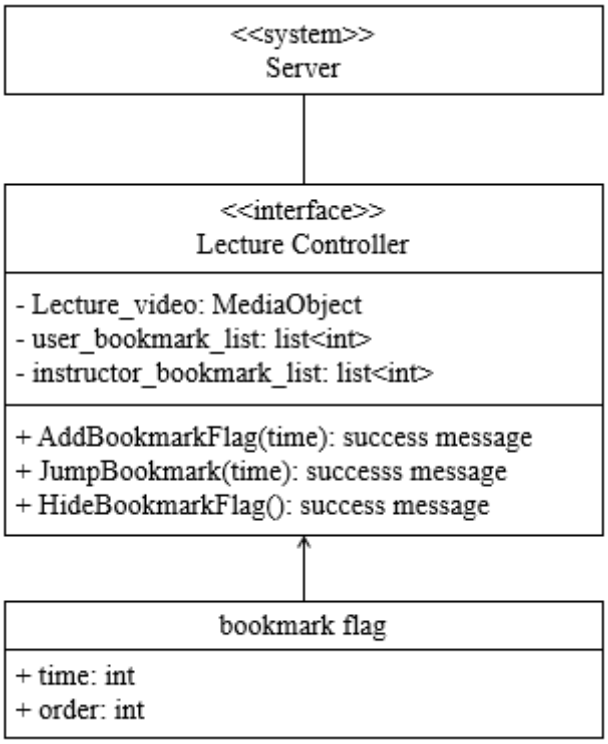
- **user_bookmark_list**: List of bookmark times made by user.
- **instructor_bookmark_list**: List of bookmark times made by instructor of course. If user is intstructor, this list will be empty.
- **Lecture_video**: It contains all the information in the video in the MediaObject object.

4.2.3.2. Methods

These are the methods that profile class has.

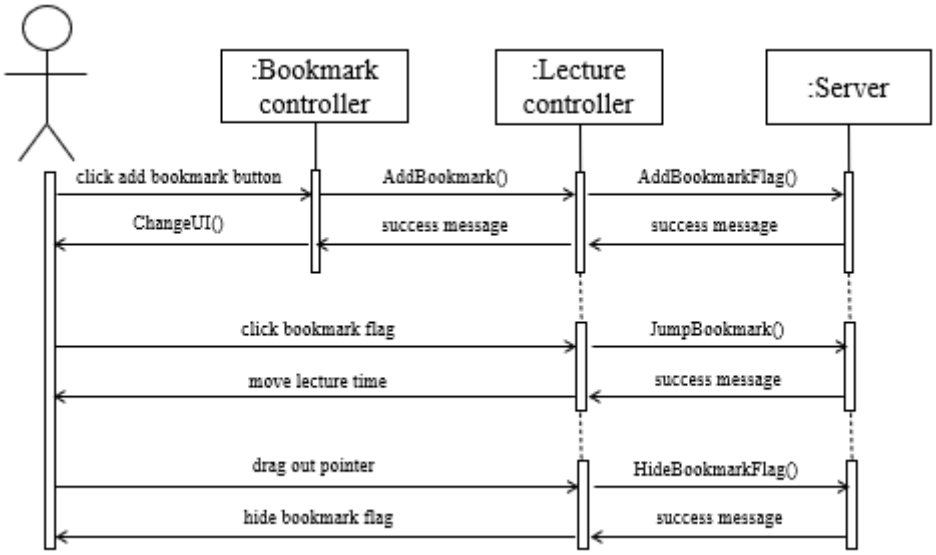
- AddBookmarkFlag(time)
- JumpBookmark(time)
- HideBookmarkFlag()

4.2.3.3. Class Diagram



[Figure 9] Class diagram – Lecture Controller

4.2.3.4. Sequence Diagram



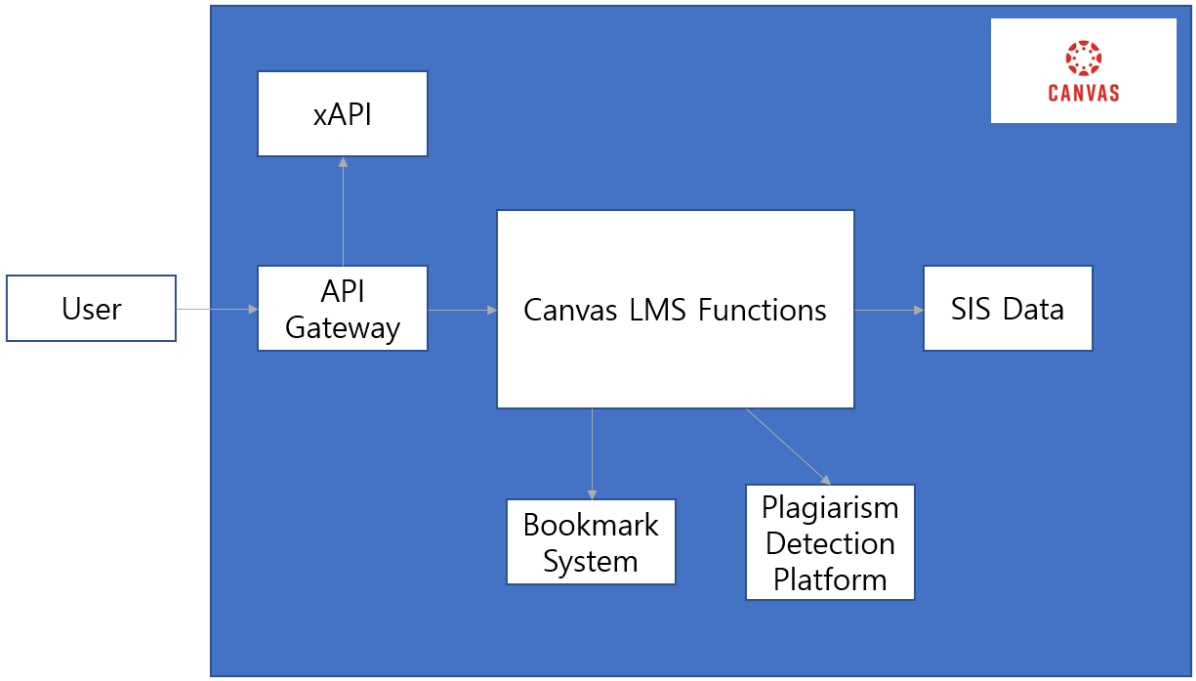
[Figure 10] Sequence diagram – Lecture Controller

5. System Architecture – Backend

5.1. Objectives

This chapter describes the structure of the back-end system including DB and API.

5.2. Overall Architecture



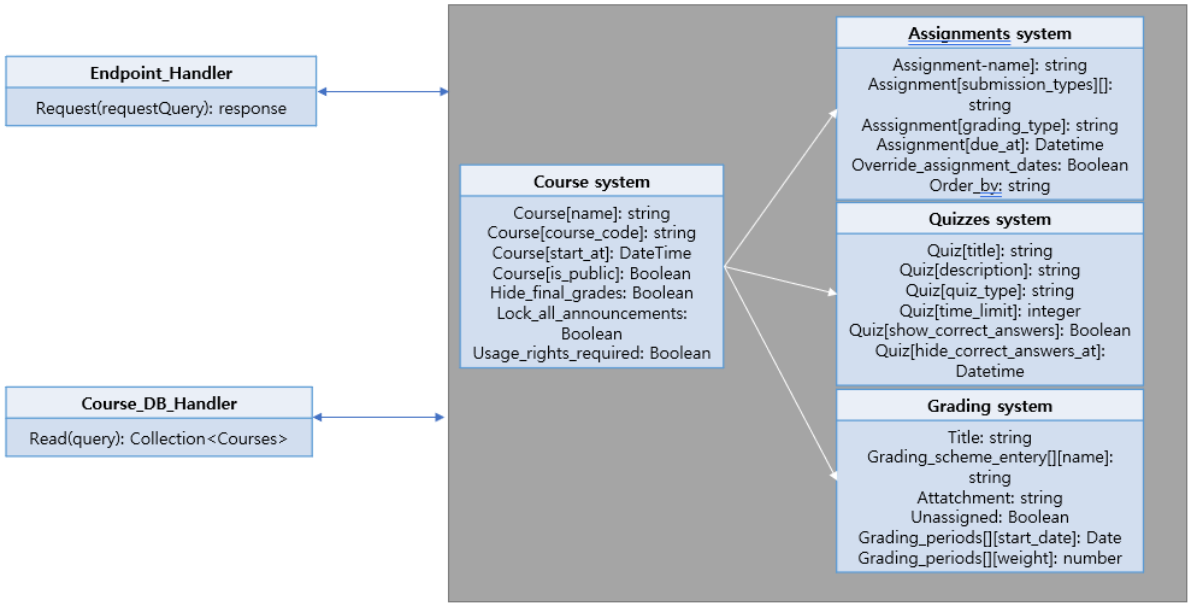
[Figure 11] Overall architecture

This is the overall architecture of canvas and our bookmark function. The API gateway receives the request from the user. There are xAPIs and functions in Canvas LMS such as Accounts, Assignments, Discussions, and quizzes. Bookmark function will be one of the functions in Canvas LMS and SIS(Student Information Services) data will be stored in the database. Plagiarism detection platform provides a standard way for LTI2 tool providers to seamlessly integrate plagiarism detection tools with Canvas.

5.3. Subcomponents

5.3.1. Canvas LMS Functions

5.3.1.1. Canvas LMS Functions – Course System



[Figure 12] Class diagram – Course system

5.3.1.1.1. Endpoint Hander

Canvas LMS Functions – Course System

5.3.1.1.2. Course DB Handler

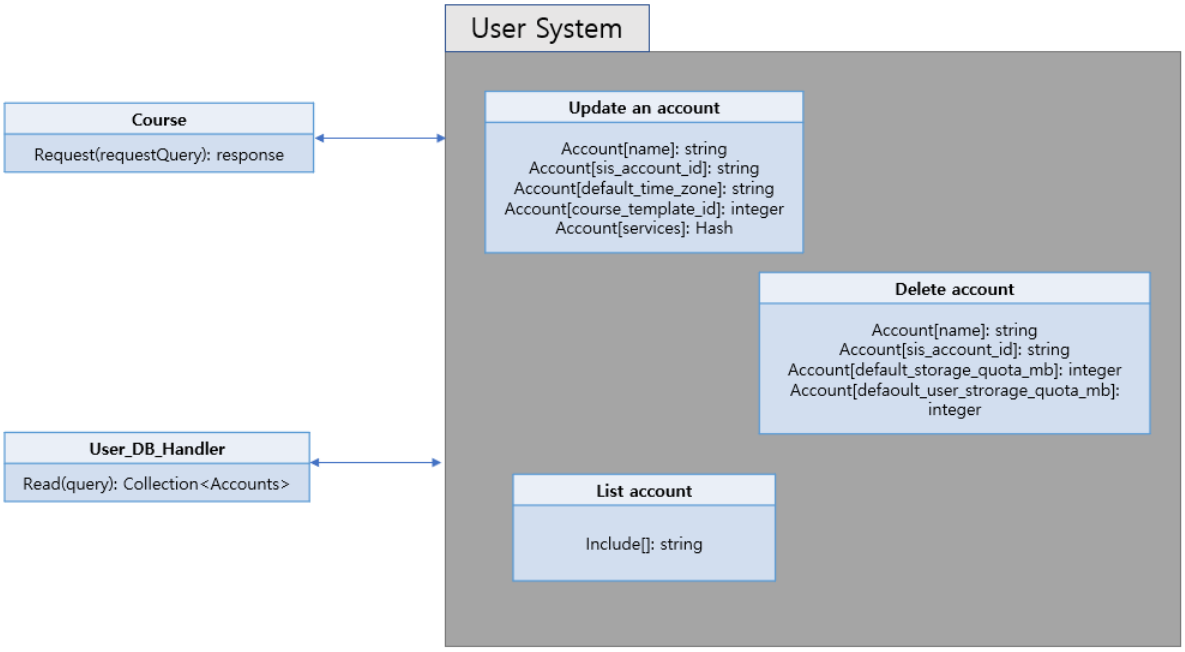
Interface to communicate with DB with course information. The information about each course is stored and it retrieves the course information to show it to the user.

5.3.1.1.3. Course System

System for accessing course information. Users can list, create, delete, and update a course. There will be additional systems for assignments, quizzes and grading.

5.3.1.2. Canvas LMS Functions – User System

API gateway. Distribute requests form the user to the appropriate controller or API



[Figure 13] Class diagram – User system

5.3.1.2.1. User DB Hander

Interface to communicate DB with user information. The information about user accounts is stored and gets the user information to show it to them.

5.3.1.2.2. User System

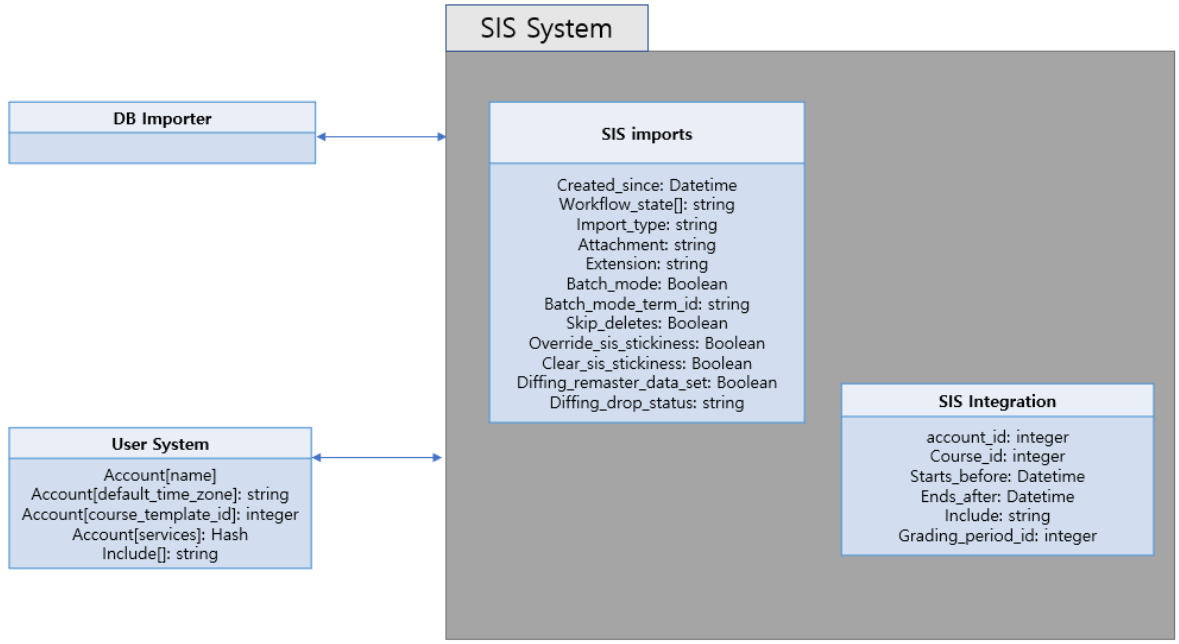
User can make a new account, update them and delete their account.

5.3.2. xAPI

xAPI(Experience API) is a data and interface standard that lets software applications capture and share data on human performance. There are functions such as training progress data from a simulation, chatting with a mentor, and watching a video.

5.3.3. SIS Data

LMS database gets data from DB Importer scripts and sends it to SIS Importer Scripts. Then this information turns into Roster files and is sent to Canvas LMS.



[Figure 14] Class diagram – SIS System

5.3.3.1. SIS imports

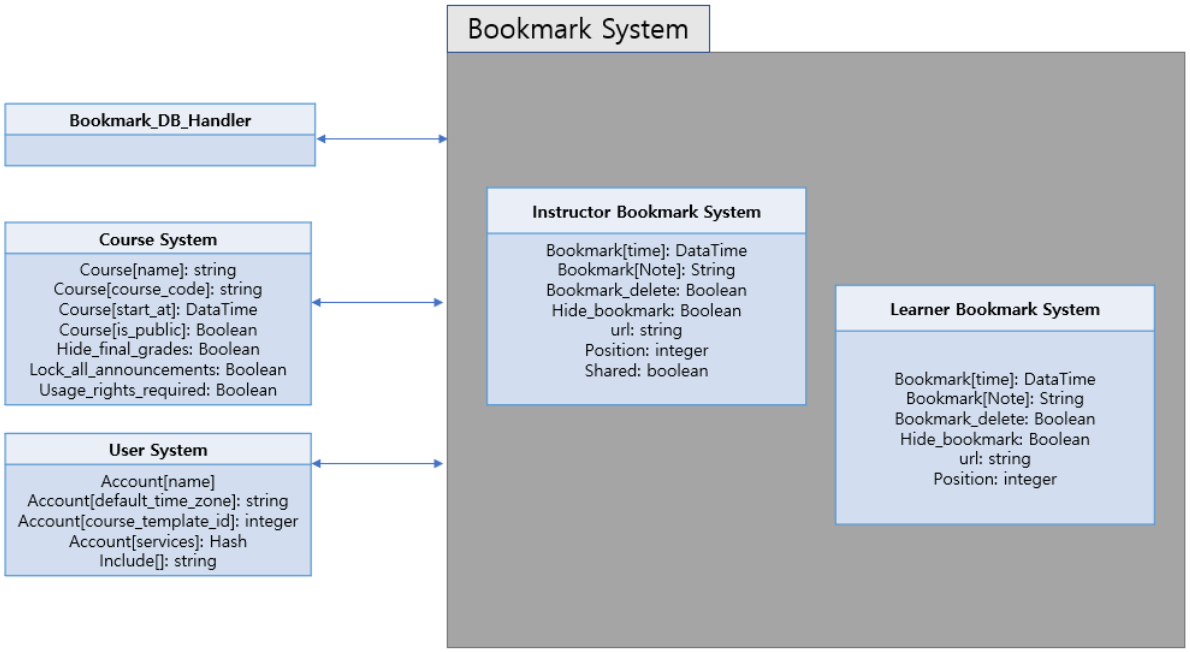
Imports data from Student Information Systems. Gets SIS import list, the current importing SIS import, import SIS data, and abort SIS imports.

5.3.3.2. SIS Integration

Includes helpers for integration with SIS Systems. It retrieves assignments enabled for grade export to SIS and disables assignments currently enabled for grad export to SIS.

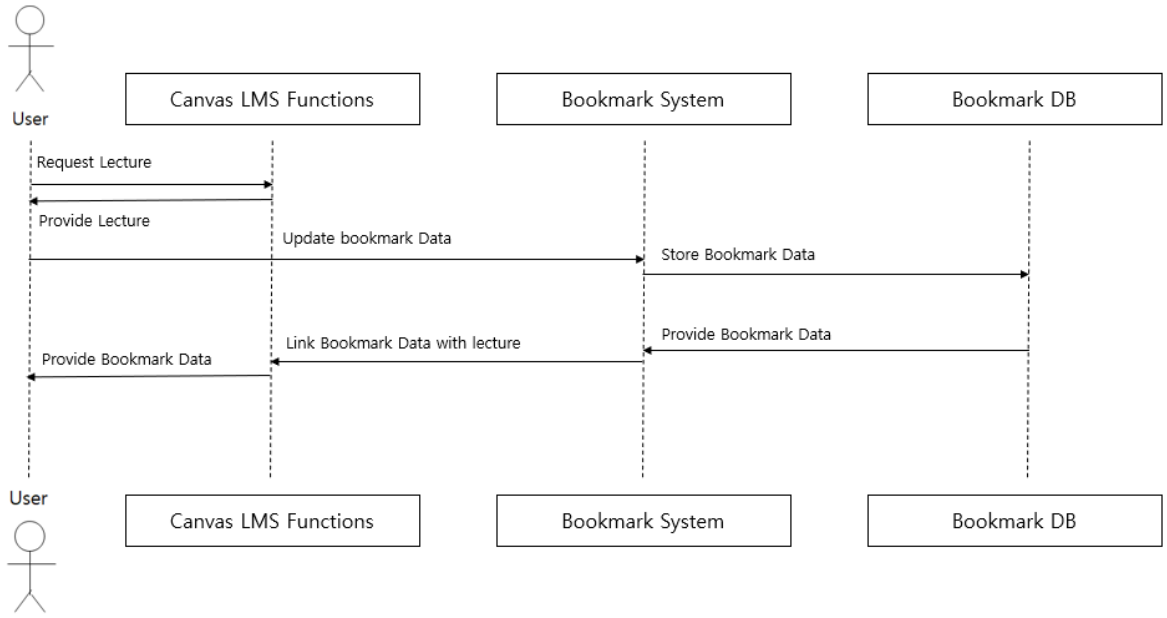
5.3.4. Bookmark System

5.3.4.1. Class Diagram



[Figure 15] Class diagram – Bookmark System

5.3.4.2. Sequence Diagram



[Figure 16] Sequence diagram – Bookmark System

6. Protocol Design

6.1. Objectives

In this chapter, we describe what structures are used for protocol design which are used for interactions between subsystems, especially between web or app applications (front-end) and the server (back-end) of the canvas-lms bookmark System. The chapter also describes how each interface is defined.

6.2. OAuth2

6.2.1. Log-in

- Request

[Table 1] Table of Log-in request

Attribute	Detail	
Protocol	OAuth	
Request Parameters	client_id	The client id for your registered application.
	response_type	The type of OAuth2 response requested. The only currently supported value is code.
	redirect_uri	The URL where the user will be redirected after authorization

- Response

[Table 2] Table of Log-in response

Attribute	Detail	
Success Code	200 OK	
Failure Code	HTTP error code = 400	
Success Response Body	Access Token	Token for access
	Message	Success message

Attribute	Detail	
Failure Response Body	Message	Fail Message

6.3. User

6.3.1. Get User Profile

- Request

[Table 3] Table of get user profile request

Attribute	Detail	
Method	GET	
URI	/api/v1/users/:user_id/profile	
Request Body	X	X
Header	Authorization	jwt token

- Response

[Table 4] Table of get user profile response

Attribute	Detail	
Success Code	200 OK	
Failure Code	HTTP error code = 400	
Success Response Body	User Profile	User Profile Objects
Failure Response Body	Message	Fail Message

6.3.2. Store User Data

6.3.2.1. Description

Store arbitrary user data as JSON. Arbitrary JSON data can be stored for a User. A typical scenario would be an external site/service that registers users in Canvas and wants to capture additional info about them.

6.3.2.2. Request and Response

- Request

[Table 5] Table of store user data request

Attribute	Detail	
Method	POST	
URI	/api/v1/users/:user_id/custom_data	
Request Body	User Custom Data	Data Object
Header	Authorization	jwt token

- Response

[Table 6] Table of store user data response

Attribute	Detail	
Success Code	200 OK	
Failure Code	HTTP error code = 400	
Success Response Body	User Custom Data	Data Object
Failure Response Body	Message	Fail Message

6.4. File

6.4.1. Upload Lecture

- Request

[Table 7] Table of upload lecture request

Attribute	Detail	
Method	POST	
URI	/api/v1/courses/:course_id/files	
Request Body	File	lecture file

Attribute	Detail	
Header	Authorization	jwt token

- Response

[Table 8] Table of upload lecture response

Attribute	Detail	
Success Code	200 OK	
Failure Code	HTTP error code = 400	
Success Response Body	File	lecture file
Failure Response Body	Message	Fail Message

6.4.2. Upload Assignment

- Request

[Table 9] Table of upload lecture request

Attribute	Detail	
Method	POST	
URI	/api/v1/courses/:course_id/assignments/:assignment_id/submissions/self/files	
Request Body	File	Assignment file
Header	Authorization	jwt token

- Response

[Table 10] Table of upload lecture response

Attribute	Detail	
Success Code	200 OK	
Failure Code	HTTP error code = 400	
Success Response Body	File	Assignment file

Attribute	Detail	
Failure Response Body	Message	Fail Message

6.5. Bookmark

6.5.1. Open User Bookmark

- Request

[Table 11] Table of Open User Bookmark request

Attribute	Detail	
Method	GET	
URI	/api/v1/bookmarks/:lecture_id/:user_id	
Request Body	X	X
Header	Authorization	jwt token

- Response

[Table 12] Table of Open User Bookmark response

Attribute	Detail	
Success Code	200 OK	
Failure Code	HTTP error code = 400	
Success Response Body	List<Bookmark>	User Bookmark List
Failure Response Body	Message	Fail Message

6.5.2. Open Instructor Bookmark

- Request

[Table 13] Table of Open Instructor Bookmark request

Attribute	Detail	
Method	GET	
URI	/api/v1/bookmarks/:lecture_id/:instructor_id	
Request Body	X	X
Header	Authorization	jwt token

- Response

[Table 14] Table of Open Instructor Bookmark response

Attribute	Detail	
Success Code	200 OK	
Failure Code	HTTP error code = 400	
Success Response Body	List<Bookmark>	Instructor Bookmark List
Failure Response Body	Message	Fail Message

6.5.3. Create User Bookmark

- Request

[Table 15] Table of Create User Bookmark request

Attribute	Detail	
Method	POST	
URI	/api/v1/bookmarks/:lecture_id/:user_id	
Request Body	Bookmark_time	Bookmark Attribute
	Bookmark_note	Bookmark Attribute
Header	Authorization	jwt token

- Response

[Table 16] Table of Create User Bookmark response

Attribute	Detail	
Success Code	200 OK	
Failure Code	HTTP error code = 400	
Success Response Body	Bookmark	Created User Bookmark Object
Failure Response Body	Message	Fail Message

6.5.4. Create Instructor's Bookmark

- Request

[Table 17] Table of Create Instructor's Bookmark request

Attribute	Detail	
Method	POST	
URI	/api/v1/bookmarks/:lecture_id/:instructor_id	
Request Body	Bookmark_time	Bookmark Attribute
	Bookmark_note	Bookmark Attribute
Header	Authorization	jwt token

- Response

[Table 18] Table of Create Instructor's Bookmark response

Attribute	Detail	
Success Code	200 OK	
Failure Code	HTTP error code = 400	
Success Response Body	Bookmark	Created Instructor Bookmark Object
Failure Response Body	Message	Fail Message

6.5.5. Edit Bookmark

- Request

[Table 19] Table of Edit Bookmark request

Attribute	Detail	
Method	PUT	
URI	/api/v1/bookmarks/:bookmark_id	
Request Body	Bookmark_time	Bookmark Attribute
	Bookmark_note	Bookmark Attribute
Header	Authorization	jwt token

- Response

[Table 20] Table of Edit Bookmark response

Attribute	Detail	
Success Code	200 OK	
Failure Code	HTTP error code = 400	
Success Response Body	Bookmark	Edited Instructor Bookmark Object
Failure Response Body	Message	Fail Message

6.5.6. Delete Bookmark

- Request

[Table 21] Table of Delete Bookmark request

Attribute	Detail	
Method	PUT	
URI	/api/v1/bookmarks/:bookmark_id	
Request Body	X	
Header	Authorization	jwt token

- Response

[Table 22] Table of Delete Bookmark response

Attribute	Detail	
Success Code	200 OK	
Failure Code	HTTP error code = 400	
Success Response Body	Messege	Success Messege
Failure Response Body	Message	Fail Message

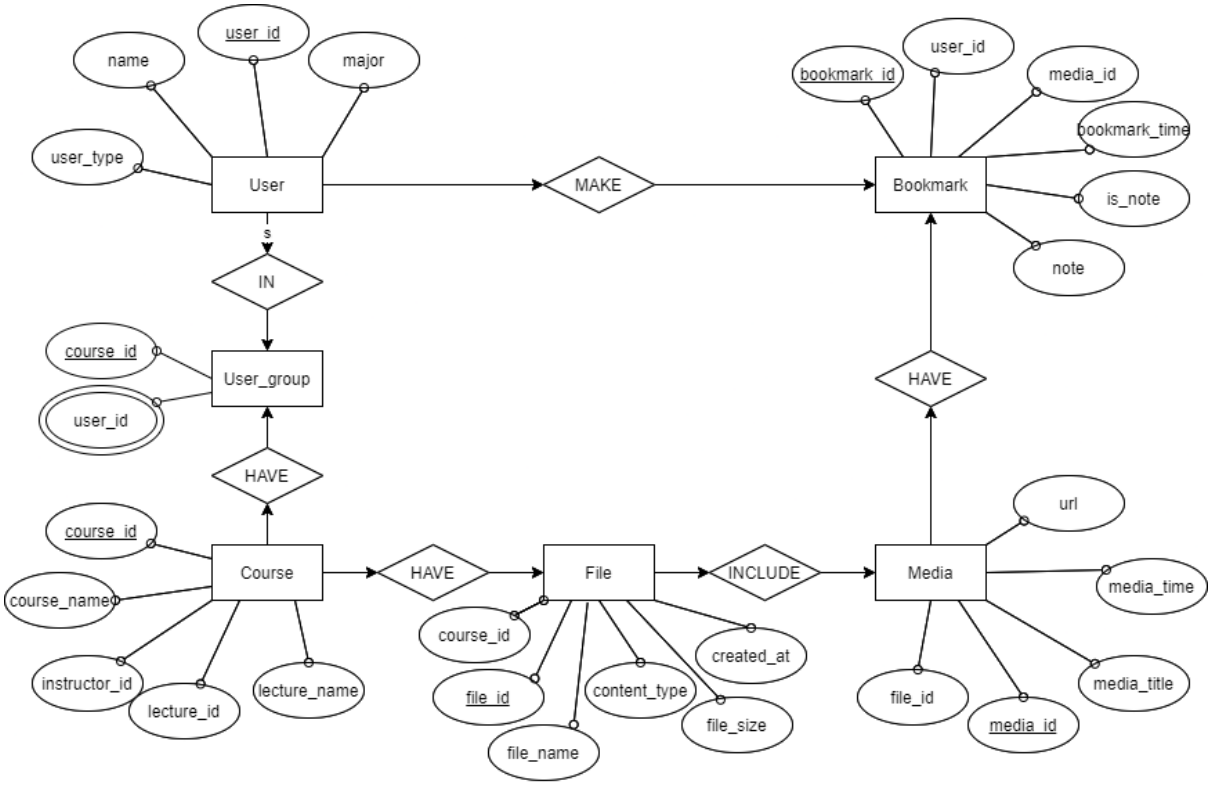
7. Database Design

7.1. Objectives

This section describes the system data structures and how these are to be represented in a database. It first identifies entities and their relationship through ER-diagram (Entity Relationship diagram). Then, it generates Relational Schema and SQL DDL (Data Description Language) specification.

7.2. ER Diagram

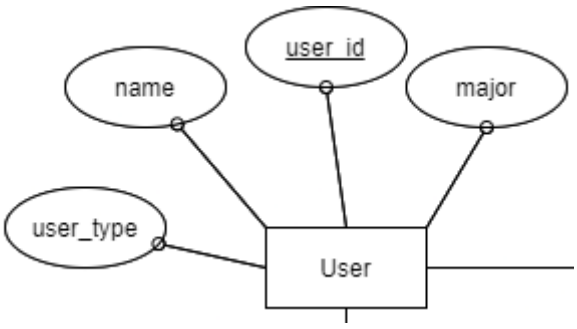
The system consists of four entities; User, Course, File, Media, Bookmark. ER-diagrams express each entity as a rectangular and their relationship as a rhombus. When an entity has multiple relationships with other entities, tridents (three line) are used to indicate it. When an entity has just one relationship with another entity, the cross (two line) is used to indicate it. The attribute of an entity is expressed as an ellipse. The unique attribute which uniquely identifies an entity is underlined. If an entity has a number of same attributes, that attribute is expressed as an ellipse with a double border line.



[Figure 17] ER-diagram

7.2.1. Entities

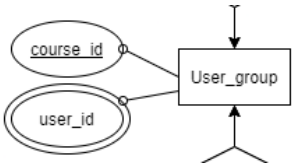
7.2.1.1. User



[Figure 18] ER diagram, Entity, User

User entity represents the user of the i-Campus lecture sub-system. It consists of the user's information which include user_id, name, major, user_type, and user_id attribute as the primary key. It can make multiple bookmarks and belong to multiple user_groups.

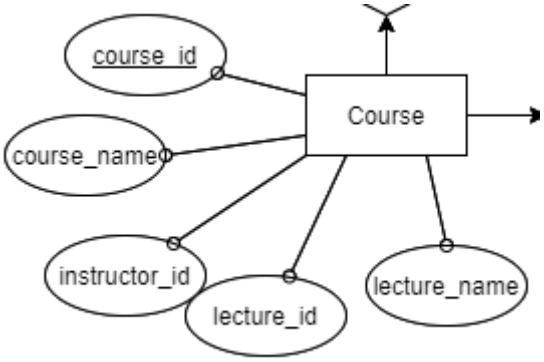
7.2.1.2. User Group



[Figure 19] ER diagram, Entity, Search History

The user_group entity represents the group of users who watch the corresponding lecture. It consists of course_id and user_id. The course_id attribute is the primary key and user_id is a multi-value attribute.

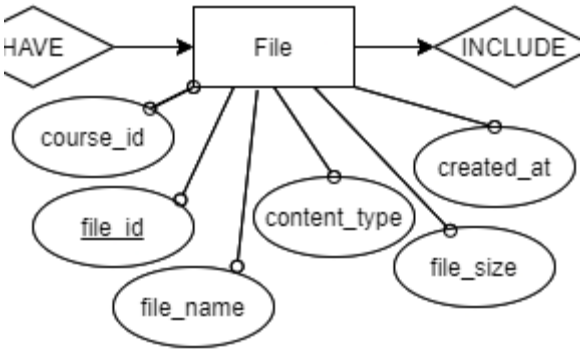
7.2.1.3. Course



[Figure 20] ER diagram, Entity, Cart

Course entity represents the lecture of the i-Campus lecture sub-system. It consists of the information of the lecture where course_id, course_name, instructor_id, lecture_id, lecture_name and course_id attribute is the primary key. It can have multiple files and one user_group.

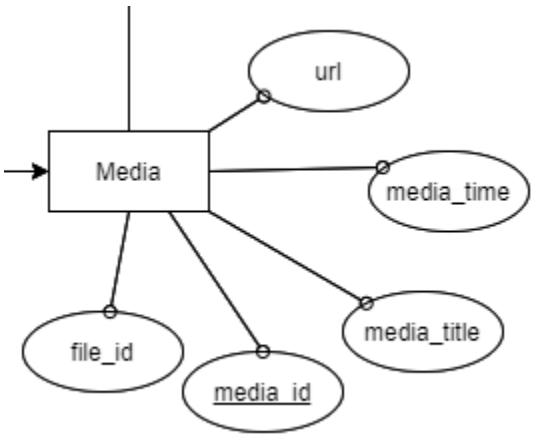
7.2.1.4. File



[Figure 21] ER diagram, Entity, Laptop

File entity represents the files including the lectures uploaded by the instructor. It consists of file_id, course_id, tile_name, content_type, file_size, created_at, and file_id which is the primary key. It can belong to one course.

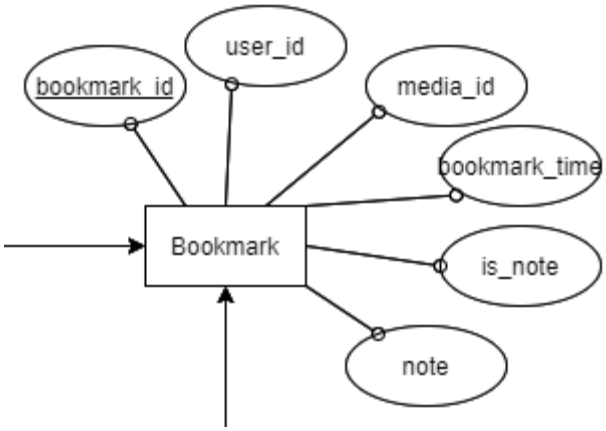
7.2.1.5. Media



[Figure 22] ER diagram, Entity, Laptop

Media entity represents the lecture video uploaded by the instructor. It consists of file_id, url, media_id, media_title, media_time, and media_id attribute, which is primary key. It can have multiple bookmarks.

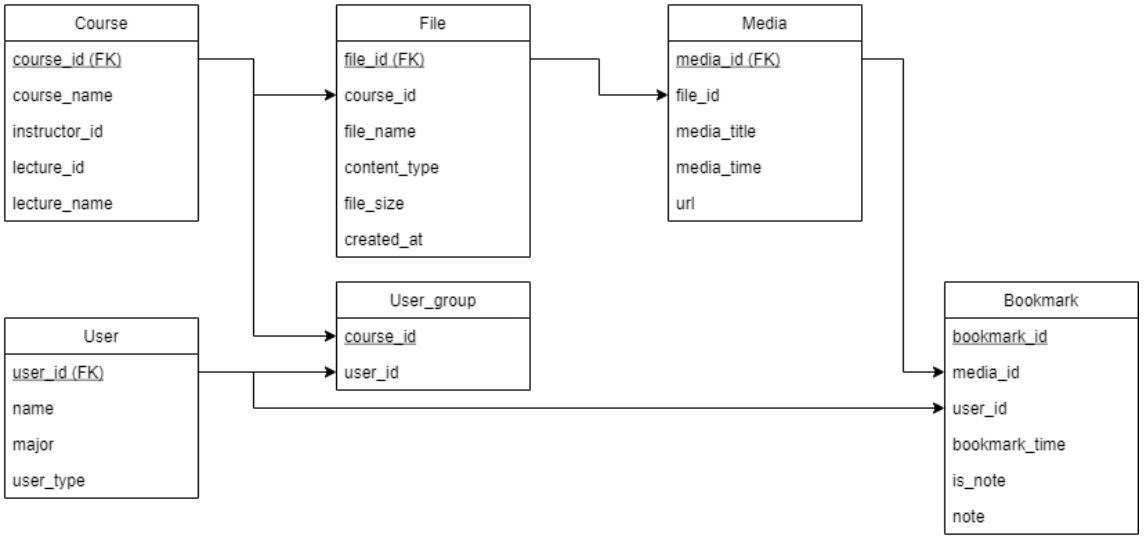
7.2.1.6. Bookmark



[Figure 23] ER diagram, Entity, Laptop

Bookmark entity represents bookmarks in a lecture video. It consists of bookmark_id, user_id, media_id, bookmark_time, is_note, note, and bookmark_id is the primary key. The user_id represents the foreign key of the user entity representing the bookmark author, and the media_id represents the foreign key of the media representing the lecture to which the bookmark belongs. The bookmark_time refers to the time when the bookmark jumps in the media or indicates the position. is_note represents whether the bookmark has a note element. Note means the contents of the memo written on the bookmark.

7.3. Relational Schema



[Figure 24] Relational Schema

7.4. SQL DDL

7.4.1. User

```
CREATE TABLE User
(
   user_id INT NOT NULL,
   name CHAR(10) NOT NULL,
   major CHAR(30) NOT NULL,
   user_type CHAR(20) NOT NULL,
   PRIMARY KEY (user_id)
   FOREIGN KEY (user_id) REFERENCES
User_group(user_id),
   FOREIGN KEY (user_id) REFERENCES
Bookmark(user_id),
);
```

7.4.2. User_group

```
CREATE TABLE User_group
(
  course_id INT NOT NULL,
  user_id INT NOT NULL,
  PRIMARY KEY (user_id)
);
```

7.4.3. Course

```
CREATE TABLE Course
(
  course_id INT NOT NULL,
  course_name CHAR(20) NOT NULL,
  instructor_id INT NOT NULL,
  lecture_id INT NOT NULL,
  lecture_name CHAR(20) NOT NULL,
  PRIMARY KEY (course_id)
  FOREIGN KEY (course_id) REFERENCES File(course_id),
  FOREIGN KEY (course_id) REFERENCES User_group(course_id)
);
```

7.4.4. File

```
CREATE TABLE File
(
  file_id INT NOT NULL,
  course_id INT NOT NULL,
  file_name CHAR(20) NOT NULL,
  content_type CHAR(20) NOT NULL,
  file_size INT NOT NULL,
  created_at INT NOT NULL,
  PRIMARY KEY (file_id).
  FOREIGN KEY (file_id) REFERENCES
Media(file_id)
);
```

7.4.5. Media

```
CREATE TABLE Media
(
  media_id INT NOT NULL,
  file_id INT NOT NULL,
  media_title CHAR(20) NOT NULL,
  media_time INT NOT NULL,
  url CHAR(20) NOT NULL,
  PRIMARY KEY (media_id),
  FOREIGN KEY (media_id) REFERENCES Bookm
ark(media_id)
);
```

7.4.6. Bookmark

```
CREATE TABLE Bookmark
(
  bookmark_id INT NOT NULL,
  media_id INT NOT NULL,
  user_id INT NOT NULL,
  bookmar_time INT NOT NULL,
  is_note BOOLEAN NOT NULL,
  note CHAR(20) NOT NULL,
  PRIMARY KEY (link_to_vendor, laptop_model),
  FOREIGN KEY (laptop_model) REFERENCES Lap
top(laptop_model)
);
```

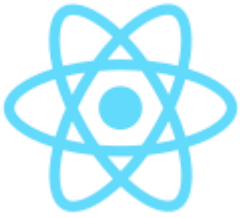
8. Development Plan

8.1. Objectives

This chapter illustrates the technologies and environment for the development of the application.

8.2. Frontend Environment

8.2.1. React



[Figure 25] React logo

It is a raster graphics editor developed and published by Adobe Inc. for Windows and macOS. This program would provide aesthetical layout and icons for improved user experience during our project.

8.2.2. jQuery

[Figure 26] jQuery logo

jQuery is an open source-based JavaScript library designed to simplify client-side manipulation of HTML. It has been a long time since it was developed, and especially because of the framework that employed virtual DOMs such as React and Vue.js, it is not as popular as before, but is more useful when producing static and light web pages.

8.2.3. Webpack

[Figure 27] Webpack logo

Webpack is an open-source JavaScript module bundler. It converts front-end assets such as JS, HTML, CSS, and images. It is used for fast loading speed and high performance of web applications.

8.3. Backend Environment

8.3.1. RubyMine

[Figure 28] RubyMine logo

RubyMine is a full-featured IDE that provides essential tools for Ruby and Ruby on Rails development out of the box. It offers smart code completion and analysis, easy code navigation, safe automated refactorings, an interactive debugger, JavaScript & HTML/CSS, automatic deployment, Git workflow support, and many other tools all integrated together in a highly customizable, productive, user-friendly environment.

8.3.2. Redis

[Figure 29] Redis logo

Redis is an open source (BSD licensed), in-memory data structure store, used as a database, cache, and message broker. Redis provides data structures such as strings, hashes, lists, sets, sorted sets with range queries, bitmaps, hyperloglogs, geospatial indexes, and streams. Redis has built-in replication, Lua scripting, LRU eviction, transactions, and different levels of on-

disk persistence, and provides high availability via Redis Sentinel and automatic partitioning with Redis Cluster.

8.3.3. Github

[Figure 30] Github logo

GitHub is a provider of Internet hosting for software development and version control using Git. It offers the distributed version control and source code management (SCM) functionality of Git, plus its own features. It provides access control and several collaboration features such as bug tracking, feature requests, task management, continuous integration and wikis for every project.

8.4. Constraints

The system is designed and implemented based on this document. Basically, the following matters shall be followed and other matters shall be governed by the developer in a way that does not deviate from the ethics of software engineering:

- When bookmarks are created or deleted, they shall be applied within 3 seconds.
- Reduce page load speed difference from existing to less than 1 second after bookmark function is added.
- It provides enough space to store bookmark data for all learners for at least one year.
- Made by considering system development costs, maintenance costs, and scalability.
- Optimize source code to reduce system efficiency and operating time.
- Specify the modifications accurately so that they do not violate the Canvas LMS license.

- Make all versions supported by Canvas LMS compatible.
- All developments are open source based and should be made available on all devices that are not subject to operating system restrictions in Canvas LMS.

8.5. Assumptions and Dependencies

All systems in this document are designed and implemented as internal features of the Canvas LMS system. Therefore, the system's constraints are the same as those of Canvas LMS and its mobile application Learning-X. For PC versions, it is assumed to be available on search engines such as Safari (MacOS 11.0 or later), Google Chrome, and Firefox. Other search engines may have login or video viewing problems. For mobile devices, the system should work on the Learning X application operating basics of iPhone iOS 13.0 or later, iPad OS 13.0 or later, and Android version 5.0 or later. Other devices may have application usage problems.

9. Supporting Information

9.1. Software Design Specification

This software design specification was written in accordance with the IEEE Recommendation (IEEE Recommended Practice for Software Design Description, IEEE-Std-1016).

9.2. Document History

[Table 23] Document History

Date	Version	Description	Writer
2021/05/10	0.1	Style and overview	Jisun Lee
2021/05/12	1.0	Addition of 1	Krogross Ryan
2021/05/13	1.1	Addtion of 2, 3	Dongjun Lee
2021/05/14	1.2	Addition of 7	Jisun Lee
2021/05/14	1.3	Addition of 6	Seongwoo Kim
2021/05/14	1.4	Addition of 4	Deokjae Kang
2021/05/14	1.5	Addition of 5	Chihyun Lee
2021/05/15	1.6	Addition of 8.2	Deokjae Kang

Date	Version	Description	Writer
2021/05/15	1.7	Addition of 8.3	Seongwoo Kim
2021/05/16	1.8	Addition of 8.4, 8.5	Dongjun Lee
2021/05/16	1.9	Fix grammar error	Krogross Ryan