MINISTRY OF EDUCATION AND TRAINING

FPT UNIVERSITY

Capstone Project Document

Chess Online Learning System

GROUP 04	
Group members	Phạm Hoàng Tuyết Ngân – SE62778 (Leader) Lưu Duy Hòa – SE62529 Đặng Văn Hoàng – SE62687
Supervisor	Nguyễn Huy Hùng
Ext. Supervisor	N/A
Capstone Project code	COLS

- Ho Chi Minh City, ***13th May, 2019*** -

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1 .Capstone Project Register

CAPSTONE PROJECT REGISTER

Class: Duration time: from …. To /…..

(*) Profession: <Software Engineer> Specialty: <ES> ☐ <IS> ☒

(*) Kinds of person make registers: Lecturer ☒ Students ☐

1. Register information for supervisor (if have)

	Full name	Phone	E-Mail	Title
Supervisor 1	Nguyễn Huy Hùng		hungnh@fpt.edu.vn	Mr.

2. Register information for students (if have)

	Full name	Student code	Phone	E-mail	Role in Group
Student 1	Phạm Hoàng Tuyết Ngân	SE62778	0974072150	nganphtse62778@fpt.edu.vn	Leader
Student 2	Lưu Duy Hòa	SE62529	0762629668	hoaldse62529@fpt.edu.vn	Member
Student 3	Đặng Văn Hoàng	SE62687	0902388104	hoangdvse62687@fpt.edu.vn	Member

3. Register content of Capstone Project

(*) 3.1. Capstone Project name:

English: Chess Online Learning System

Vietnamese: Hệ Thống Dạy Đánh Cờ Vua

Abbreviation: COLS

(*) 3.2. Main proposal content (including result and product)

a) Theory and practice (document):

- Student should apply the software development process and the UML 2.0 in modeling the system
- Software artifacts include User Requirement, Software Requirement Specification, Architecture Design, Detail Design, System Implementation and Testing Document, Installation Guide, sources code, and deployable software packages
- Server side technique:
  - Database design, OOA, OOD, OOP, MVC, Java or .Net technology, …
  - Apache Lucene, ElasticSearch
- Client side technique
  - HTML5, CSS, JavaScript, JQuery, Ajax
  - Mobile Platform (iOS, Android)

b) Program:

Build a web site allowing users to learn chess. The following main features need to be implemented:

- Instructor can create/edit/remove chess courses
- Auto bot plays chess with learners
- Bot evaluates levels of learners and suggests appropriate courses
- Learner register and enrol in courses based on user's level
- Support learning chess by articles and practice on the website
- Checking practice results and open new content
- Manage courses and learning process

c) Other products:

- All of management functions of the system must be implemented to support the operating system.

4. Other comment (propose all relative thing if have)

N/A

HCM city, date 26/04/2019 …..

Supervisor (If have)	**On behalf of Registers**
(Sign and full name)	*(Sign and full name)*

2. Report 1

2.1. Project Information

- Project name: **Chess Online Learning System**
- Project Code: **COLS**
- Product Type: **Website application**
- Start Date: **13th May, 2019**
- End Date: **October, 2019**

2.2. Introduction

In this document, we introduce an e-learning portal for people who are willing to learn, improve and entertain the chess. Chess is a strategic board game for 2 players. Chess helps people to relax and improve their thinking. Nowadays, chess is a popular sport in the world. Currently, there are so many ways, which learn chess such as reading books, directly teaching and watching the online course. In a short research from wikihow.com, the most effective learning way is direct teaching or face to face practice, but it also takes too much cost. Meanwhile, learning online from e-portal currently, are the most successful way. However, there are some preventions in learning on the e-portal which could be named like confliction in communicating, boring traditional learning, non-evaluating ranked leaner and non-suggestion road for better playing. At last, reading book is the worst effective learning chess for general people, because it does not interact directly with the learner. Based on our researches and analysis, we proposed an e-learning system to help people to learn chess and improve their level. Especially, the main target is Vietnamese people.

In our system, the player can learn chess by tutorial and practice with exercises, and the instructor can post their course to system. Moreover, the system can be a bridge between chess players and instructors by providing a platform to help their communication.

This document also describes our working process in four months includes our perspective in the system, component designs, and detailed core workflows. We hope the system and our solution will help to resolve the problems from learning chess for the Vietnamese community.

2.3. Current Situation

When starting with chess, generally people are going to search for information and looking for a suitable tutorial for themselves online or offline. In the offline method, both instructors and learners are depended on their time, location and costly for infrastructure. By the way, for the online method, the most factor that brings the pain to leaner that is going to make them avoid choosing a website is language. Not only for a learner who does not know the common language, but also for the learner who knows. The second problem is the tutorials, which is not highly detailed or has bored traditional teaching ways. Therefore, the

tutorial is static while the learner always wants to be challenged. Moreover, it causes frustration inside the learner.

2.4. Problem Definition

From the above current situation, we recognize some disadvantages:

- There is some online interactive courses chess (chess.com/lessons, lichess.org/learn#), but it is fully English, so Vietnamese people are hard to learn.
- Some chess course by Vietnamese is provided, but they do not have any place to practice.
- An instructor, who wants to teach chess must prepare a place with full infrastructure.
- An offline learner must depend on instructor about learning time and location.

2.5. Proposed Solution

Our proposed solution is building a system, which named is Chess Online Learning System (COLS) for Vietnamese people with the following functions:

2.5.1 Feature functions

- Provide interactive chess courses with practice environment by Vietnamese for the learner.
- Provide an environment for the instructor, who wants to share their chess knowledge.
- Provide chess bot, who can play automatically with the learner.
- Collect learner learning history and suggest suitable courses.
- Support Elo rating system to classify the level of learners and courses. A learner can only learn courses which are equal or lower than their level.

2.5.2 Benefits and Trade-offs

- Benefits:
  - An instructor does not need to spend the cost to prepare face to face classes.
  - Flexible in learning time and place.
  - Everything is free.
  - Connecting people who want to learn chess and share chess knowledge without caring about their location.
  - A learner can practice conveniently in our system.
- Trade-offs:
  - The type of lesson or exercise is limited.
  - The course and user activities are checking manually.
  - The instructor benefits are unclear, there is no method to collect money for them, and it will be developed in the next phase.
  - There is only support to play chess with an automated bot, without supporting peer-to-peer playing.

2.6. Functional Requirements

Function requirements of the system are listed below:

- Authentication and Authorization:
  - Authenticate and authorize users to learn or manage system content and user.
- New account registration:
  - A guest can sign up to be a learner or an instructor.
  - A new learner must estimate their chess skill level to start the learning progress. Skill level will be converted to a point for the learner.
  - A new instructor must apply their information to prove competence.
- Manage profile
  - An authorized user can view and edit his/her information.
- View courses
  - A guest or learner can search for any course by course name.
  - A guest or learner can filter courses by category and skill level.
  - A guest or learner can view course details.
- Enrol course
  - A learner can enrol their wanted course if they have enough skill level.
- Learn course
  - A learner can learn any course which he/she have enrolled.
  - A learner can review course he/she has already learned.
  - Learning includes learn chess game, static content and do exercises
  - A learner can manage his/her learning progress.
- Course suggestion
  - A learner can view suggested list which he/she should learn.
- Manage course
  - An instructor can manage his/her courses such as lessons, exercises or feedbacks.
  - An instructor can submit his/her course and wait for review. If a course is rejected, the instructor can restore them else the instructor can unpublish their course to re-build content.
  - An admin can publish or unpublish the course.
- Manage category
  - A course must be classified to some categories, which were given from system.
  - An admin can manage system categories.
- Manage user
  - An admin can control learner or instructor account status.
  - An admin can review new instructor registration.
- Play chess
  - A learner can play chess with a bot.
  - Learners can increase their point by win or draw games.
  - Learners can lose their point if they lose the game.
- Manage the learner skill level
  - An Elo rating system is applied to calculate learner point and evaluate learner chess skill level. Each level will be linked with point range.

- The system can classify learner skill level based on their point.

2.7. Role and Responsibility

No	Full Name	Role	Position	Contact
1	Nguyễn Huy Hùng	Project Manager	Supervisor	hungnh@fpt.edu.vn
2	Phạm Hoàng Tuyết Ngân	Developer	Leader	nganphtse62778@fpt.edu.vn
3	Lưu Duy Hòa	Developer	Member	hoaldse62529@fpt.edu.vn
4	Đặng Văn Hoàng	Developer	Member	hoangdvse62687@fpt.edu.vn
5	Lâm Thanh Tùng	Developer	Member	tungltse61895@fpt.edu.vn

Table 1: Roles and Responsibilities

3. Software Project Model

As the project problem which we mention above, we choose Scrum Model to manage project development with each sprint is 5 working days. This model will help us:
- Scrum team always work together to reach the project goal. Team member working progress is daily updated.
- Minimize risks when changing requirement.
- The working cycle "Learn - Revise – Apply" is done concurrently and continuously, a team member can apply new research and get the result quickly.
- Product coding is focused rather than document to deliver higher product value.
More information: https://www.scrum.org/

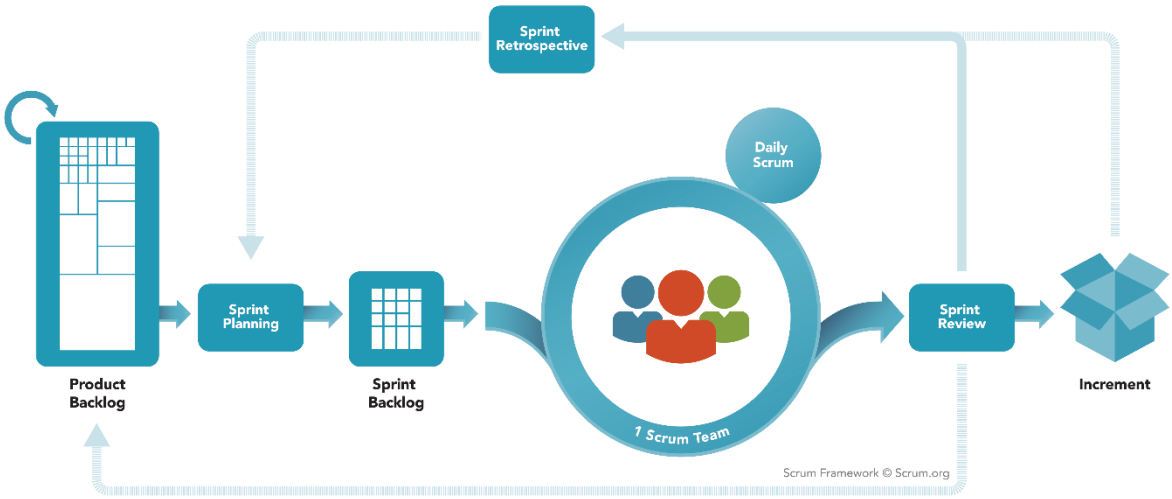


Figure 1: Scrum Model

4. Conceptual Diagram

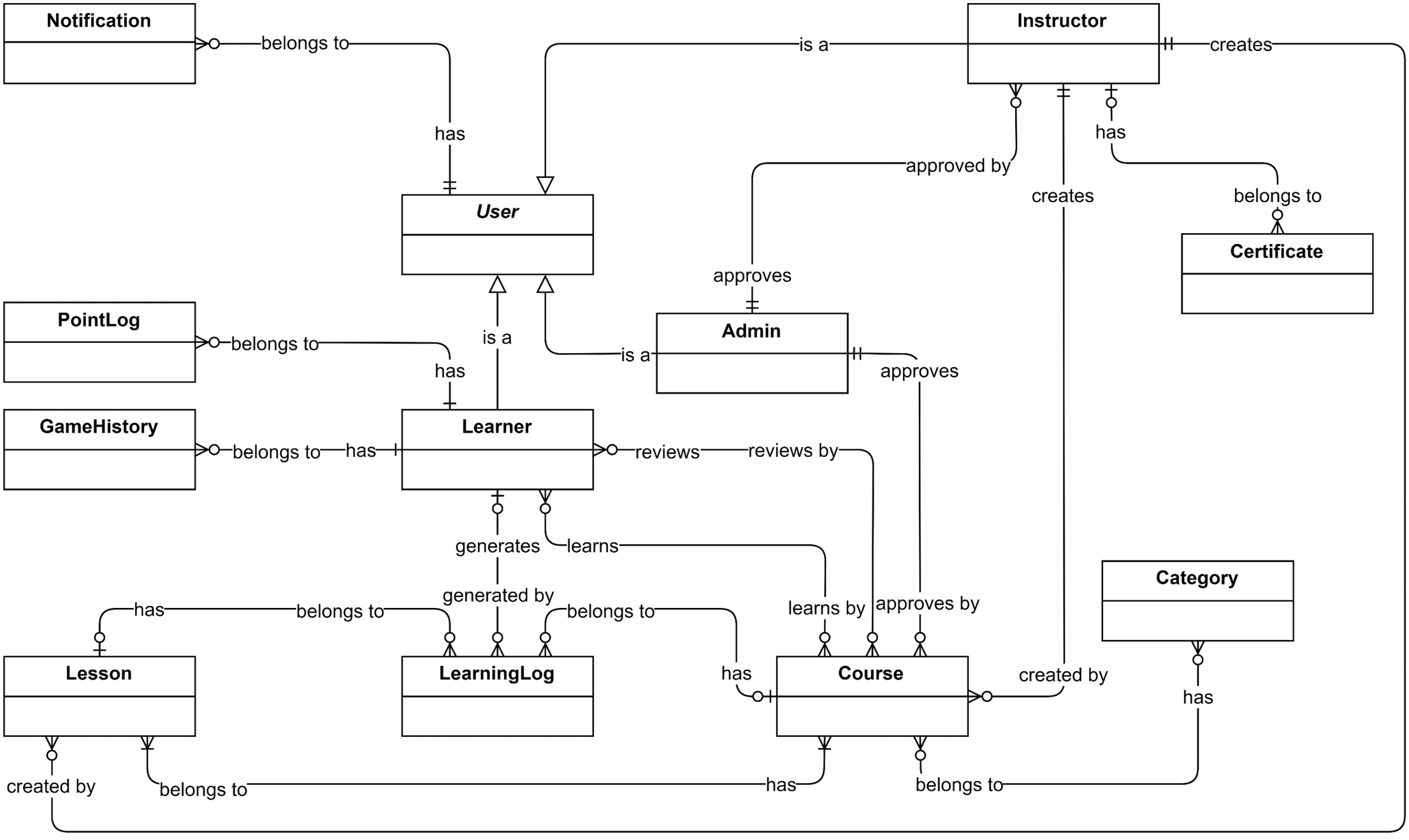


Figure 2: Conceptual diagram

5. Use Case Diagram

5.1. Overview Use Case[1]

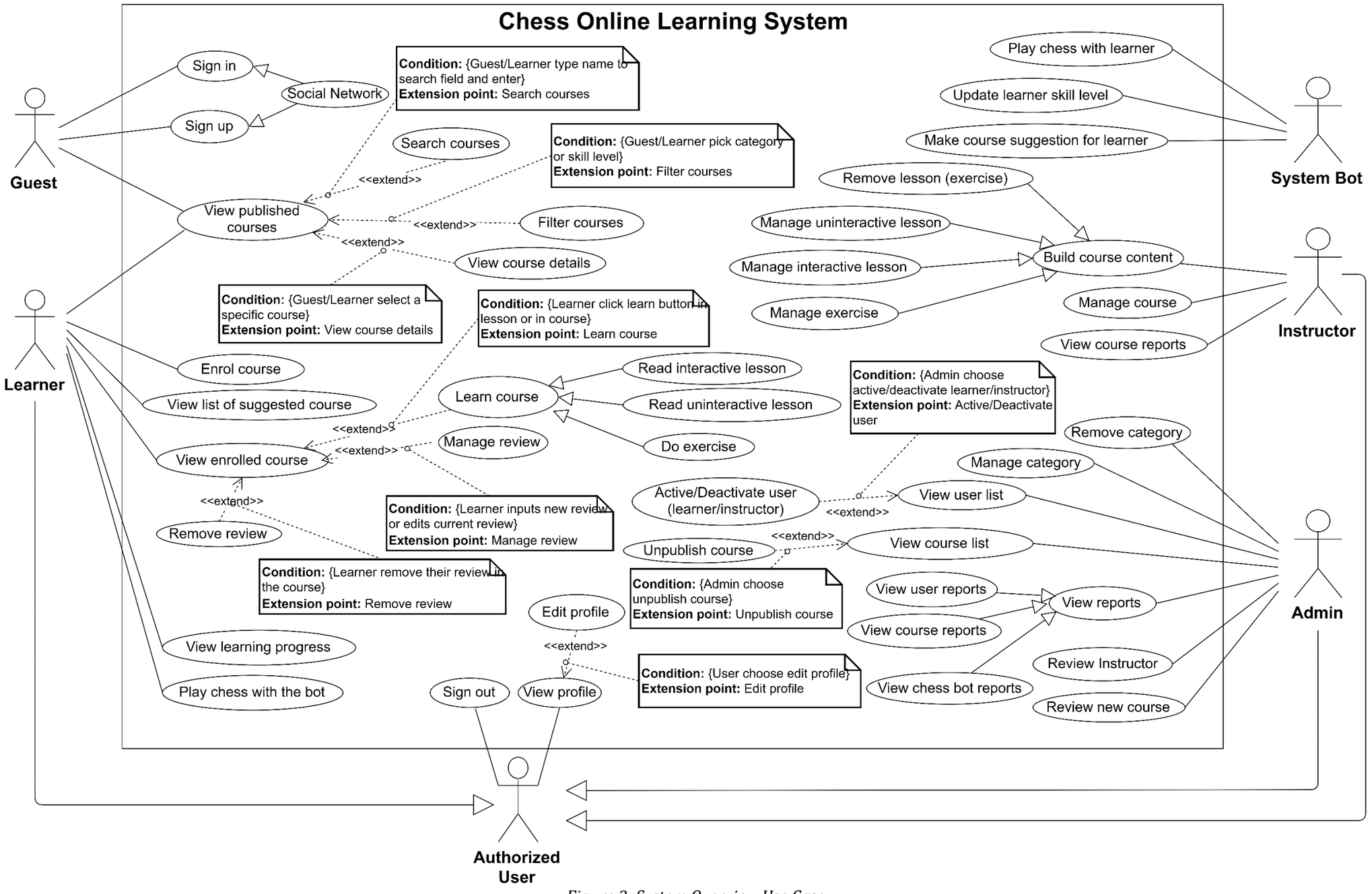


Figure 3: System Overview Use Case

5.2 Use case Specification (Core Flow)

5.2.1 <Learner> Overview Use Case

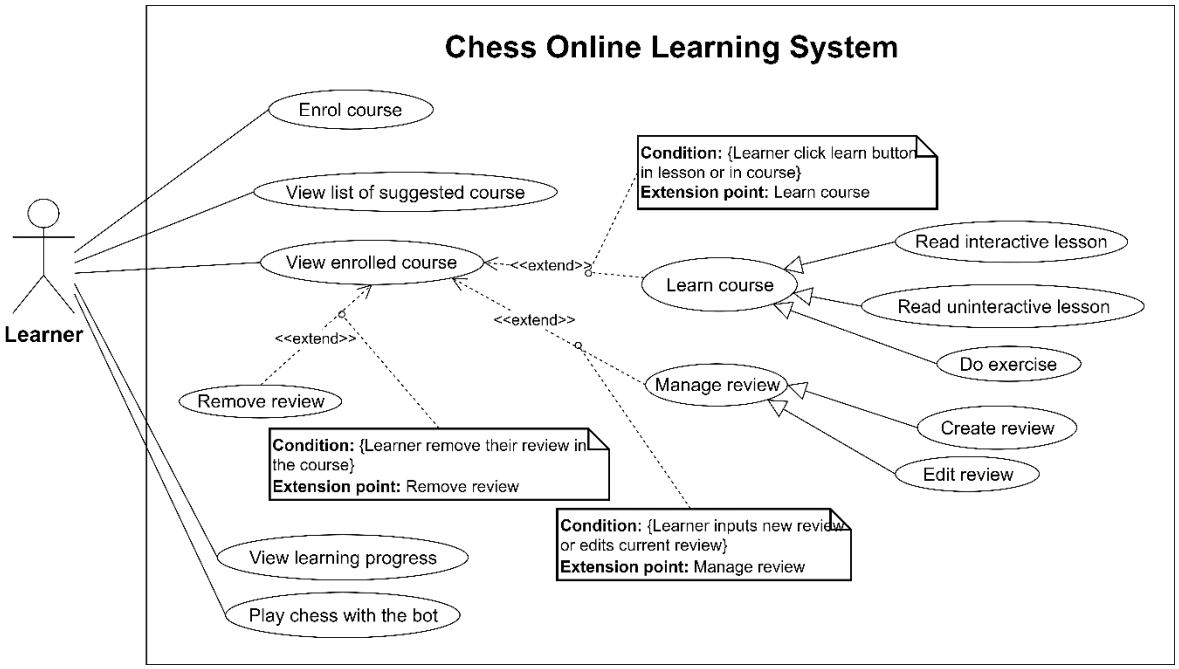


Figure 4: <Learner> Overview Use Case

5.2.1.1 <Learner> Enrol Course

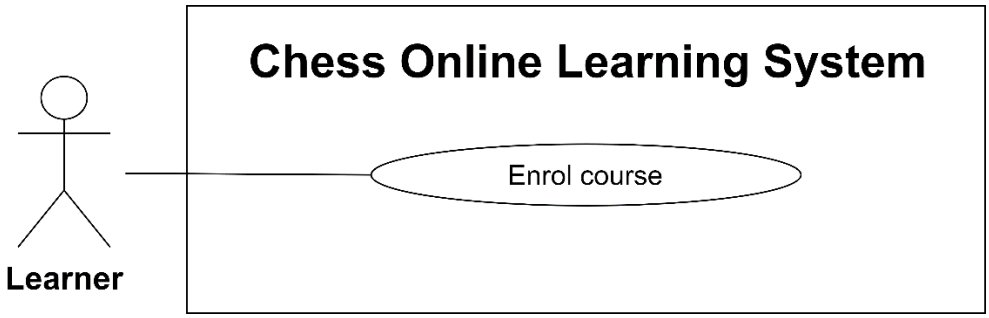


Figure 5: <Learner> Enrol Course

USE CASE – UC_LE.01			
Use Case No.	UC_LE.01	**Use Case Version**	2.0
Use Case Name	Enrol Course		
Author	Lưu Duy Hòa		
Date	20/07/2019	**Priority**	High
Actor: • Learner **Summary:** • This use case allows the learner to enrol system course. **Goal:** • Learner can enrol to learn a specific course under their skill level. **Triggers:**			

- Learner sends the enrol course command.

Preconditions:

- User must sign in into the system with role Learner.

Postconditions:

- Success: System displays enrol course success messages.
- Failed: System shows error messages.

Main Success Scenario:

Step	Actor Action	System Response
1	Learner navigates to "Đăng ký khóa học" from the course details page.	System shows confirmation popup: • "Xác nhận": button • "Hủy": button
2	Learner click "Xác nhận" button on the confirmation popup. [Alternative 1]	System closes the confirmation popup and shows a message "Đăng kí khóa học thành công". System unlocks lesson list. The "Đăng ký khóa học" button is changed to "Bắt đầu học" button. [Exceptions 1]

Alternative Scenario:

No	Actor Action	System Response
1	Learner clicks on "Hủy" button.	System closes confirmation popup.

Exceptions:

No	Cause	System Response
1	The Learner has not enough required skill level to enrol.	System shows an error message "Bạn chưa đủ điều kiện để đăng kí khóa học này. Xin thử lại các khóa học khác!".

Relationships: N/A

Business Rules:

- System will show the enrol button for learners in the course details page.
- Courses in the system require a skill level to enrol.
- A learner can only enrol courses whose skill level is lower or equal with Learner skill level.

Table 2: Enrol Course specification

5.2.1.2 <Learner> View Enrolled Course

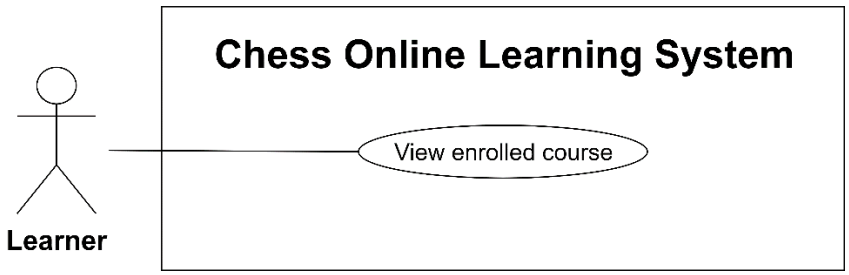


Figure 6: <Learner> View Enrolled Course

USE CASE – UC_LE.02			
Use Case No.	UC_LE.02	**Use Case Version**	2.0
Use Case Name	View Enrolled Course		
Author	Lưu Duy Hòa		
Date	20/07/2019	**Priority**	High

Actor:

- Learner

Summary:

- This use case allows the learner can view an enrolled course.

Goal:

- Learner can view a specific course which they enrolled.

Triggers:

- Learner sends view enrolled course command.

Preconditions:

- User must sign in into the system with role Learner.
- Learner had enrolled in the course.

Postconditions:

- Success: System displays enrolled course page.
- Failed: System shows error messages.

Main Success Scenario:

Step	Actor Action	System Response
1	Learner navigates to a course which they enrolled.	System shows course details page and enables review area, unlock lessons.

Alternative Scenario: *N/A*

Exceptions: N/A

Relationships: N/A

Business Rules:

- Learner can learn course or learn a specific lesson in enrolled courses.
- Learner can review course which is enrolled.

Table 3: View Enrolled Course specification

5.2.1.3 <Learner> Create Review

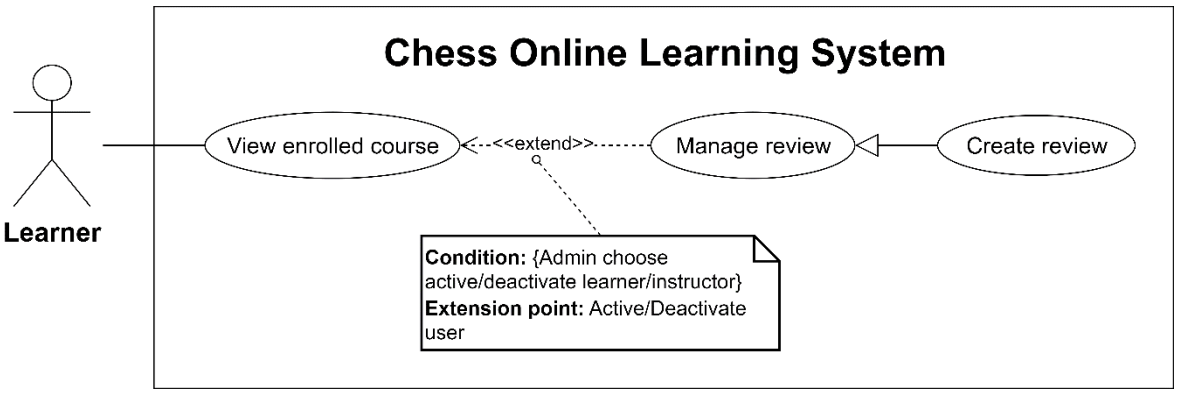


Figure 7: <Learner> Create Review

USE CASE – UC_LE.03			
Use Case No.	UC_LE.03	**Use Case Version**	2.0
Use Case Name	Create Review		
Author	Lưu Duy Hòa		
Date	20/07/2019	**Priority**	Normal

Actor:

- Learner

Summary:

- This use case allows the learner to create a review to course.

Goal:

- User can review a specific course.

Triggers:

- Learner sends the command to review the course.

Preconditions:

- User must sign in into the system with role Learner.
- Learner had enrolled in the course.

Postconditions:

- Success: System add new review for course successfully.
- Failed: System shows error messages.

Main Success Scenario:

Step	Actor Action	System Response
1	On the course details page, learner moves to review area.	System highlights the review area: • Đánh giá của bạn: rating • Bình luận: text field • Đăng: button System required information: • Rating must be chosen
2	Learner clicks “rating” and input text field.	[Exceptions 1]
3	Learner clicks “Đăng” button. [Alternative 1]	System re-calculates course review and displays new review on the top of list.

		[Exception 2]

Alternative Scenario:

Step	Actor Action	System Response
1	Learner removes his action.	There is no review added.

Exceptions:

Step	Cause	System Response
1	Learner does not rate review.	System shows the error message "Điểm đánh giá phải lớn hơn 0".
2	Learner has reviewed on this course before.	System show error message "Đánh giá không thành công. Bạn đã đánh giá khóa học này rồi".

Relationships: UC_LE.02

Business Rules:

- Learner can only review when enrolled course.
- Each learner can only have 1 review in each course.
- Learner review will be shown on the top of Review list.
- Course review is re-calculated.

Table 4: : Create Review specification

5.2.1.4 <Learner> Read Interactive Lesson

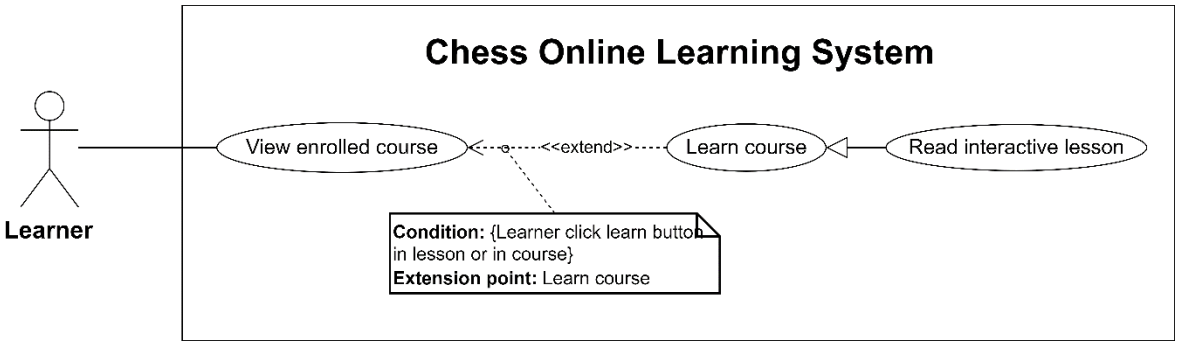


Figure 8: <Learner> Read Interactive Lesson

USE CASE – UC_LE.06			
Use Case No.	UC_LE.06	**Use Case Version**	2.0
Use Case Name	Read Interactive Lesson		
Author	Lưu Duy Hòa		
Date	20/07/2019	**Priority**	High

Actor:

- Learner

Summary:

- This use case allows the learner to read the interactive lesson.

Goal:

- Learner can read an interactive lesson.

Triggers:

- Learner sends the command to read the interactive lesson.

Preconditions:

- User signed in to the system as a learner successfully.
- Learner had enrolled in the course.

Postconditions:

- Success: Learner can read lesson content.
- Failed: System shows error messages.

Main Success Scenario:

Step	Actor Action	System Response
1	Learner clicks on "Bắt đầu học" button. [Alternative 1]	System redirects learner to the next lesson which learner did not learn. If the type is interactive lesson, system shows the lesson content: • Chessboard • Move arrow button group • Move content
2	Learner can click on the move or arrow buttons. [Alternative 2]	System shows the current chess position following the move and may be have a move content.
3	Learner clicks "Bài tiếp" button to continue for the next lesson. [Alternative 3]	System record that learner has finished this lesson and move to the next lesson.

Alternative Scenario:

Step	Actor Action	System Response
1	Learner clicks on a specific lesson.	System redirects to the selected lesson.
2	Learner clicks on the exit button to back to course detail.	System redirects learner to course detail.
3	Learner clicks on "Bài trước" to go to previous lesson.	System shows previous detail lesson. The lesson is not logged to finish.

Exceptions: N/A

Relationships: UC_LE.02

Business Rules:

- Interactive lesson is a lesson which contains a chess-game is analysed. All chess-game moves and position following the move will be loaded and learner learns the lesson by view chess position with a specific move.
- Interactive lesson is recorded to finish when learner request next lesson.
- Course is finished when learner finish all lessons and exercises in the course.

Table 5: Read Interactive Lesson specification

5.2.1.5 <Learner> Read Uninteractive Lesson

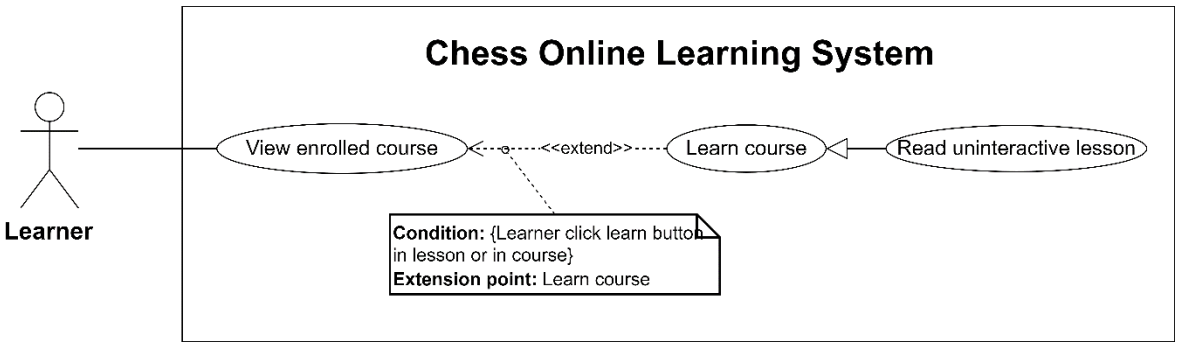


Figure 9: <Learner> Read Uninteractive Lesson

USE CASE – UC_LE.07			
Use Case No.	UC_LE.07	**Use Case Version**	2.0
Use Case Name	Read Uninteractive Lesson		
Author	Đặng Văn Hoàng		
Date	23/03/2013	**Priority**	High

Actor:

- Learner

Summary:

- This use case allows the learner to read the uninteractive lesson.

Goal:

- Learner can read an uninteractive lesson.

Triggers:

- Learner sends the command to read the uninteractive lesson.

Preconditions:

- User must sign in into the system with role Learner.
- Learner had enrolled in the course.

Postconditions:

- Success: Learner can read the uninteractive lesson content.
- Failed: System shows error messages.

Main Success Scenario:

Step	Actor Action	System Response
1	Learner clicks on "Bắt đầu học" button. [Alternative 1]	System redirects learner to the next lesson which learner did not learn.
2	If lesson type is uninteractive, the learner can read lesson content. [Alternative 2]	
3	Learner clicks "Bài tiếp" button to continue for the next lesson. [Alternative 3]	System record that learner has finished this lesson and move to the next lesson.

Alternative Scenario:

Step	Actor Action	System Response
1	Learner clicks on a specific lesson.	System redirects to the selected lesson.
2	Learner clicks on the exit button to back to course detail.	System redirects learner to course detail.
3	Learner clicks "bài trước" to previous lesson.	System shows previous detail lesson. Lesson is not logged to finish.

Exceptions: N/A
Relationships: UC_LE.02
Business Rules:

- Uninteractive lesson content is text and media, which is a post from WYSIWYG Editor.
- Uninteractive is recorded to finish when learner request next lesson.
- Course is finished when the learner finishes all lessons and exercises in the course.

Table 6: Read Uninteractive Lesson specification

5.2.1.6 <Learner> Do Exercise

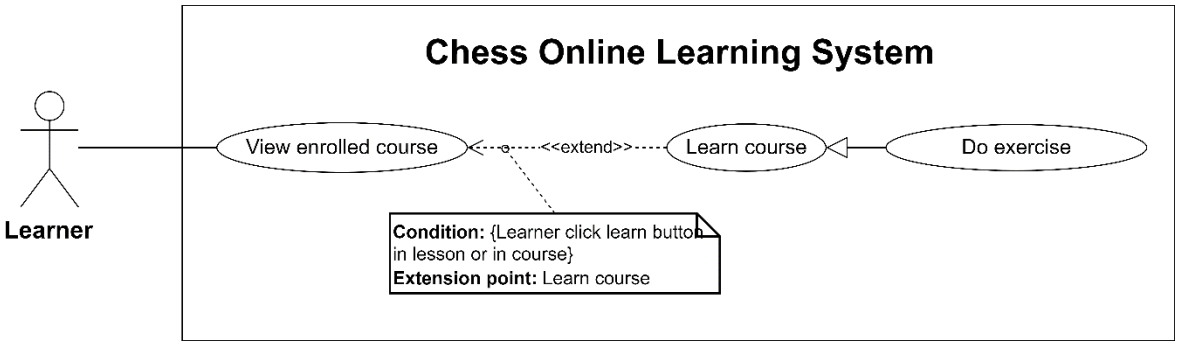


Figure 10: <Learner> Do Exercise

USE CASE – UC_LE.08			
Use Case No.	UC_LE.08	**Use Case Version**	2.0
Use Case Name	Do Exercise		
Author	Phạm Hoàng Tuyết Ngân		
Date	20/07/2019	**Priority**	High

Actor:

- Learner

Summary:

- This use case allows the learner to do exercise.

Goal:

- Learner can do exercise.

Triggers:

- Learner sends the do exercise command.

Preconditions:

- User signed in as a learner successfully.
- Learner had enrolled in the course.

Postconditions:

- Success: Learner can do exercise by performing their chess move.
- Failed: System shows error messages.

Main Success Scenario:

Step	Actor Action	System Response
1	Learner clicks on "Bắt đầu học" button. [Alternative 1]	System redirects learner to the next lesson which learner had not learned.
2	If lesson type is exercise, learner read the question and perform moves to solve the problem. [Alternative 2]	System checks learner move and sends a response for the wrong move or right move (it depends on the exercise content). If learner performs a right move, the system performs a move and change turn to learner again. This action is looped until learner solved the problem and finish the exercise. [Exception 1]
3	Learner clicks on "Bài kế tiếp" button to continue for the next lesson. [Alternative 3]	System record that learner has finished this exercise and move to the next lesson.

Alternative Scenario:

Step	Actor Action	System Response
1	Learner clicks on a specific lesson.	System redirects to the selected lesson.
2	Learner clicks on the exit button to back to course detail.	System redirects learner to course detail.
3	Learner clicks on "Bài trước" button to the previous lesson.	System shows the previous detail lesson. Lesson is not logged to finish.

Exceptions:

Step	Cause	System Response
1	Learner answers wrong.	System resets exercise and does not record this exercise is finished.

Relationships: UC_LE.02

Business Rules:

• Exercise is a lesson which provides a problem for the learner, learner must solve the problem to pass this lesson. • In our system exercise will contain chess position and require learner must perform their chess move. • Exercise is finished when learner solves the problem successfully. • Exercise contains 2 types: Bot answer and Manual answer. In the Bot answer, a learner must solve the problem to checkmate. In the Manual answer, there are 1 to 3 answer and learner only need to solve right 1 answer. • Course is finished when the learner finishes all lessons and exercises in the course.

Table 7: Do Exercise specification

5.2.1.7 <Learner> View List Of Suggested Course

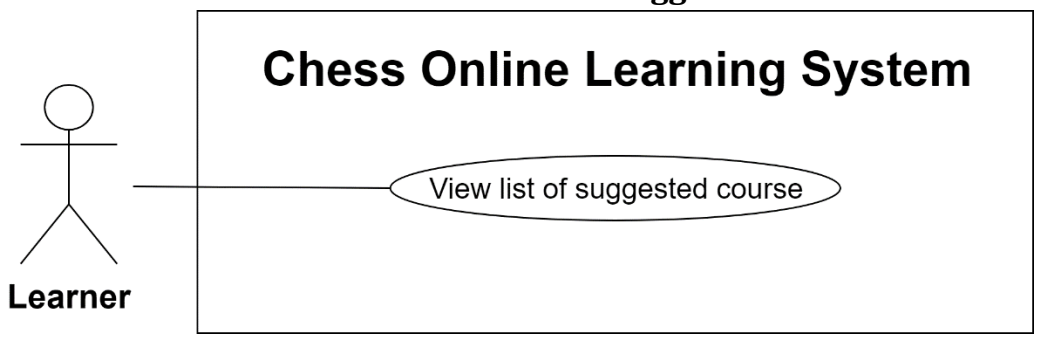


Figure 11: <Learner> View List Of Suggested Course

USE CASE – UC_LE.10			
Use Case No.	UC_LE.10	**Use Case Version**	2.0
Use Case Name	View List Of Suggested Course		
Author	Đặng Văn Hoàng		
Date	09/09/2019	**Priority**	High

Actor:
- Learner

Summary:
- This use case allows the learner to view the course suggested list.

Goal:
- Learner can his suggested courses.

Triggers:
- Learner sends the view course list or view course details command.

Preconditions:
- User signed in to the system as a learner successfully.

Postconditions:
- Success: System displays a suggested course list for the learner.
- Failed: System shows error messages.

Main Success Scenario:

Step	Actor Action	System Response
1	Learner navigates to suggested course list from the course overview page. [Alternative 1]	System calculates appropriate course for the learner from learner history and similar learners and displays to learner. [Exception 1]

Alternative Scenario:

Step	Actor Action	System Response
1	Learner views specific course details.	System displays appropriate courses for the learner based on the current course.

Exceptions:

Step	Cause	System Response
1	Learner has not learned any course.	Suggested list is empty.

Relationships: N/A

Business Rules:

- Learner can view his suggested course list to get an appropriate course.

Table 8: View List Of Suggested Course specification

5.2.1.8 <Learner> Play Chess With The Bot

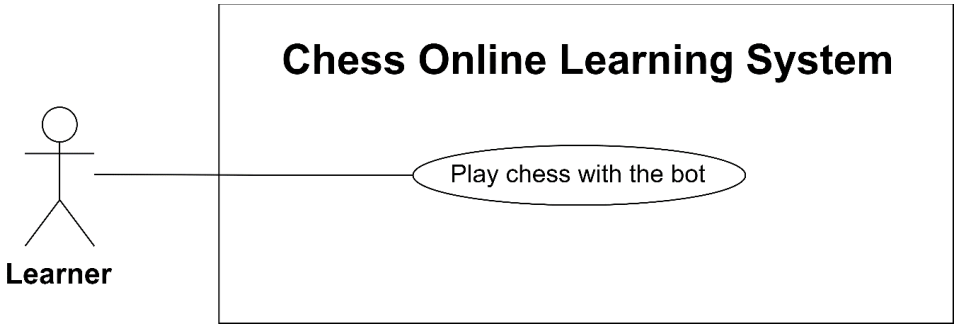


Figure 12: <Learner> Play Chess With The Bot

USE CASE – UC_LE.11			
Use Case No.	UC_LE.11	**Use Case Version**	2.0
Use Case Name	Play Chess With The Bot		
Author	Phạm Hoàng Tuyết Ngân		
Date	20/07/2019	**Priority**	High

Actor:

- Learner

Summary:

- This use case allows the learner to play chess with the bot.

Goal:

- Learner can play chess with the bot.

Triggers:

- Learner sends the playing with bot command.

Preconditions:

- User signed in to the system as a learner successfully.

Postconditions:

- Success: System starts the game and system bot will autoplay with the learner.
- Failed: System shows error messages.

Main Success Scenario:

Step	Actor Action	System Response
1	Learner navigates to playing game page.	System moves to the playing chess page: • Chessboard • Nước đi: move content-box • Chess game description: content-box • Ván đấu mới: button
2	Learner clicks on the new game button.	System shows setting game dialogue: • "Cấp độ": switch button • "Chọn màu quân": button group • "Thời gian đấu": time picker • "Bắt đầu": button • "Đóng": button System required information: • Game Time must larger than 1 minutes. • Game colour will be random if the learner does not choose.
3	Learner settings and clicks "Bắt đầu button. [Alternative 1]	System calculates win, draw and lose point for learner follow the Elo rating system. The game is started. [Exception 1]
4	Learner performs a move in the learner turn. [Alternative 2]	System gets the best move and performs move if the turn is bot. This action loop until the game is drawn or 1 player win. System record each move on the move content-box. When ending the game, system calculates a new point for the learner.

Alternative Scenario:

Step	Actor Action	System Response
1	Learner clicks "Đóng" button on setting game dialogue.	System closes the setting game dialogue. The game does not start.

2	Learner stops playing the game.	System record that learner has given up and lost the game.

Exceptions:

Step	Cause	System Response
1	Game Time less than 1 minutes.	The game cannot be started.

Relationships: N/A

Business Rules:

- Learner can play chess with system bot to get bonus point.
- Learner skill level can be changed after updating points.
- System will record all moves in the game.

Table 9: Play Chess With The Bot specification

5.2.2 <System Bot> Overview Use Case

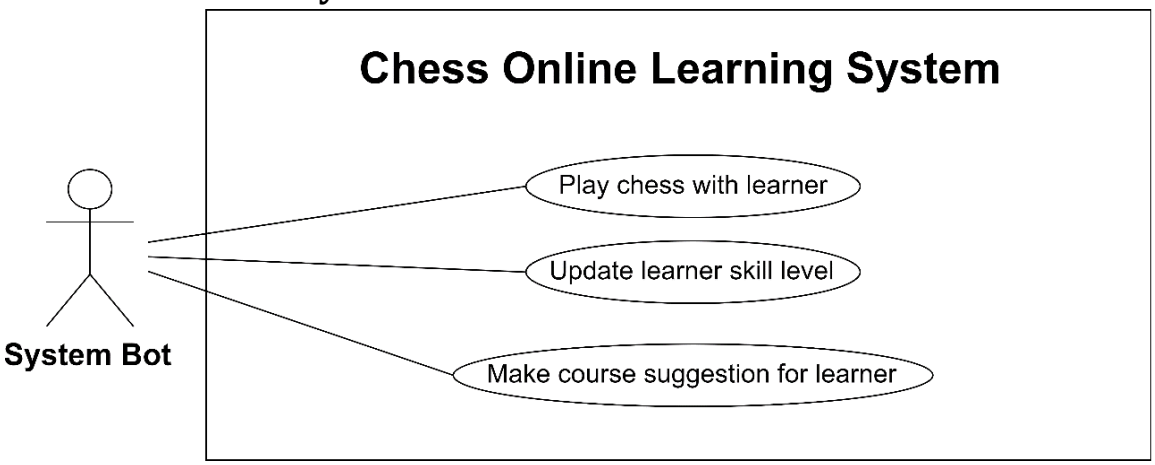


Figure 13: <System Bot> Overview Use Case

5.2.2.1 <System Bot> Play Chess With Learner

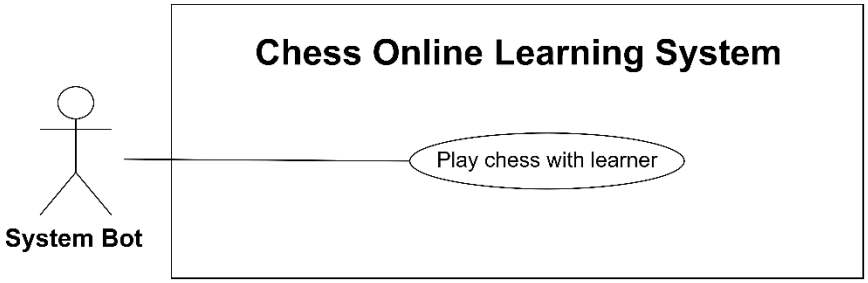


Figure 14: <System Bot> Play Chess With Learner

USE CASE – UC_SB.01			
Use Case No.	UC_SB.01	**Use Case Version**	2.0
Use Case Name	Play Chess With Learner		
Author	Phạm Hoàng Tuyết Ngân		
Date	20/07/2019	**Priority**	High

Actor:

- System Bot

Summary:

- This use case allows the system to autoplay chess with the learner.

Goal:

- System can autoplay chess.

Triggers:

- System sends the perform move commands when the turn is bot turn.

Preconditions: N/A

Postconditions:

- Success: New move is performed automatically.
- Failed: System shows error messages.

Main Success Scenario:

Step	Actor Action	System Response
1	In bot turn, the system will analyse game position and calculate the best move. The new best move will be sent and performed in chessboard.	Move is performed and added to move content-box, turn is changed.

Alternative Scenario: N/A

Exceptions: N/A

Relationships: N/A

Business Rules:

- System can play chess with the learner.
- System bot is triggered if a user sends position, the system will analyse and get the best move.
- This use-case is used for playing chess with learner and response for the learner in exercise.

Table 10: Play Chess With Learner specification

5.2.2.2 <System Bot> Update Learner Skill Level

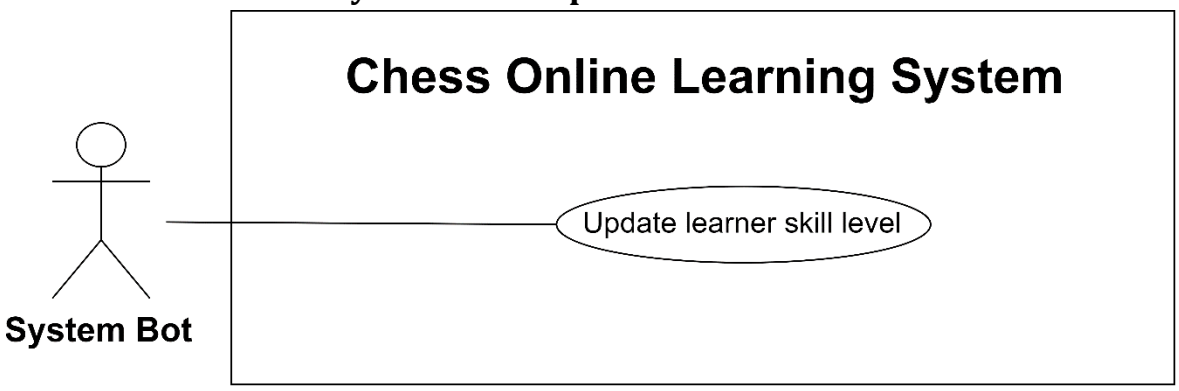


Figure 15: <System Bot> Update Learner Skill Level

USE CASE – UC_SB.02			
Use Case No.	UC_SB.02	**Use Case Version**	2.0
Use Case Name	Update Learner Skill Level		
Author	Phạm Hoàng Tuyết Ngân		
Date	09/09/2019	**Priority**	Normal

Actor:

- System Bot

Summary:

- This use case allows the system to auto-update chess skill level of the learner.

Goal:
- Learner skill level is auto-updated base on their point.

Triggers:
- Learner point is changed to another range of skill level.

Preconditions: N/A

Postconditions:
- Success: Learner skill level is updated.
- Failed: System shows error messages.

Main Success Scenario:

Step	Actor Action	System Response
1	Learner point is increased or decrease after the game is over and point is changed to another range of skill level.	Learner skill level is updated.

Alternative Scenario: N/A

Exceptions: N/A

Relationships: N/A

Business Rules:
- Learner skill level is specified by points.
- Each skill level has a range of point.
- System check learner skill level based on their points.

Table 11: Update Learner Skill Level specification

5.2.2.3 <System Bot> Make Course Suggestion For Learner

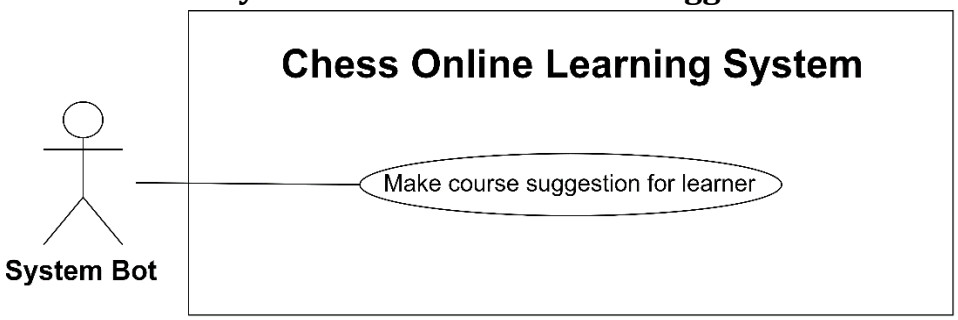


Figure 16: <System Bot> Make Course Suggestion For Learner

USE CASE – UC_SB.03			
Use Case No.	UC_SB.03	**Use Case Version**	2.0
Use Case Name	Make Course Suggestion For Learner		
Author	Phạm Hoàng Tuyết Ngân		
Date	09/09/2019	**Priority**	Normal

Actor:
- System Bot

Summary:
- This use case allows the system to suggest course for learners.

Goal:
- System can suggest appropriate courses for learners.

Triggers:

- Make course suggestion command is sent.

Preconditions: N/A

Postconditions:

- Success: System calculates and synthetic suggestion courses for each learner.
- Failed: System shows error messages.

Main Success Scenario:

Step	Actor Action	System Response
1	System calculates course suggestion for learners periodically.	Suggestion course list for each learner.

Alternative Scenario: N/A

Exceptions: N/A

Relationships: N/A

Business Rules:

- Suggestion courses are based on the learning history of learners.
- System finds new courses which are same with learner courses history list.
- System finds new courses by similar learners.

Table 12: Make Course Suggestion For Learner specification

5.2.3 <Instructor> Overview Use Case

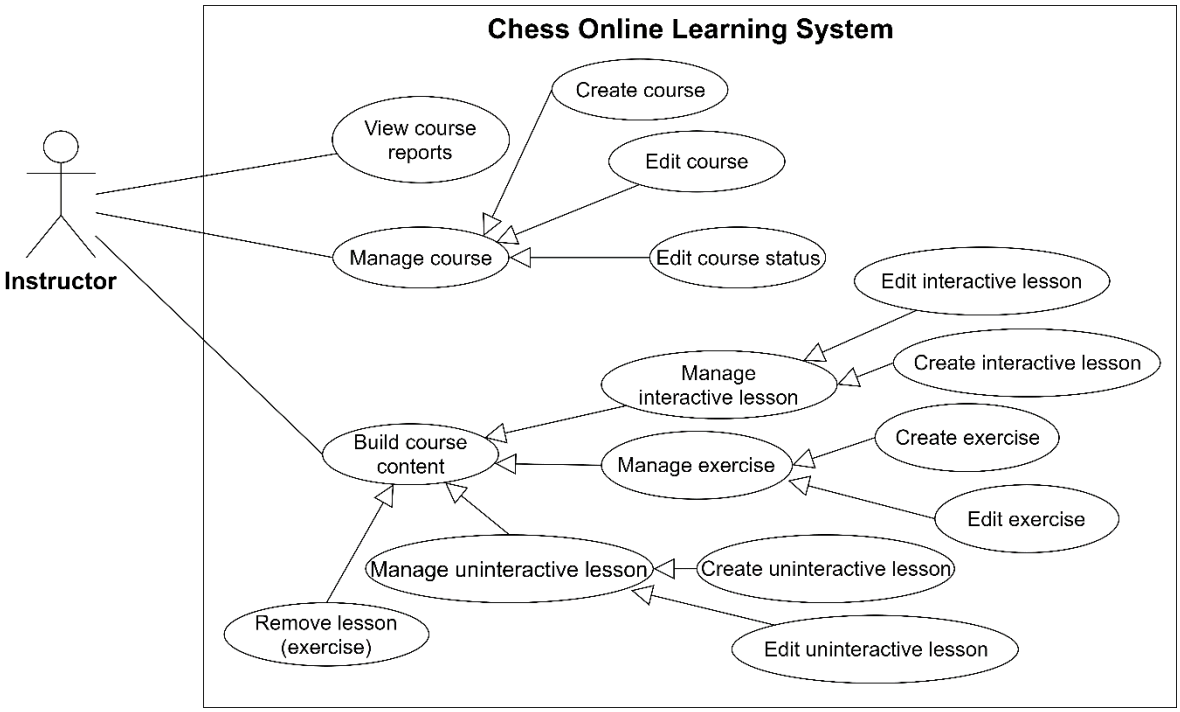


Figure 17: <Instructor> Overview Use Case

5.2.3.1 <Instructor> Create Course

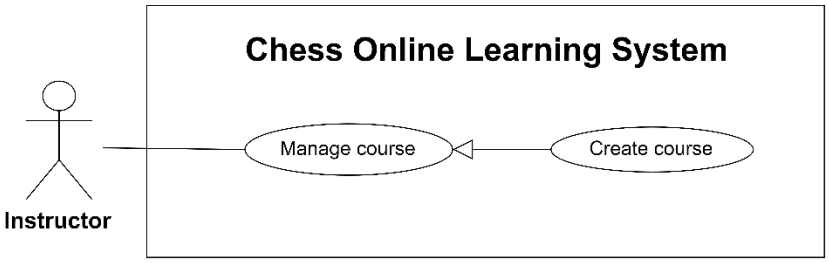


Figure 18: <Instructor> Create Course

USE CASE – UC_IN.01			
Use Case No.	UC_IN.01	**Use Case Version**	2.0
Use Case Name	Create Course		
Author	Phạm Hoàng Tuyết Ngân		
Date	20/07/2019	**Priority**	High

Actor:

- Instructor

Summary:

- This use case allows the instructor to create a course.

Goal:

- New course is created.

Triggers:

- Instructor sends the create course command.

Preconditions:

- User signed in as an instructor successfully.

Postconditions:

- Success: New course is created.
- Failed: System shows error messages.

Main Success Scenario:

Step	Actor Action	System Response
1	Instructor navigates to Create course page.	System goes to create a course page and shows the form: • Tên khóa học: course name text field • Mô tả: course descrption text area • Yêu cầu: skill level selection, default value is "Mới bắt đầu" • Danh mục: category selection • Ảnh khóa học: course image file field, default is system image • Hoàn tất: submit button • Xóa toàn bộ: reset button System required information: • Tên khóa học: min length 6, max length 255 • Mô tả: min length 6
2	Instructor inputs information.	[Exception 1]

3	Instructor clicks on "Hoàn tất" button. [Alternative 1]	System shows the message "Tạo khóa học thành công" and create course. System redirects to course details page with empty content.

Alternative Scenario:

Step	Actor Action	System Response
1	The instructor click "Xóa toàn bộ" button.	The create course form is reset.

Exceptions:

Step	Cause	System Response
1	Instructor inputs invalid information.	System shows error message match with fields: • Empty name: "Tên khóa học không được bỏ trống" • Name is less than 6 characters: "Tên khóa học không được ít hơn 6 kí tự" • Name is more than 225 characters: "Tên khóa học không được nhiều hơn 255 kí tự" • Empty description: "Mô tả khóa học không được bỏ trống" • Description is less than 6 characters: "Mô tả khóa học không được ít hơn 6 kí tự" • Wrong image format: "Hình ảnh không đúng định dạng"

Relationships: N/A

Business Rules:

- Instructor can create courses.
- A new course is added in the database with status is Drafting and empty learning content.

Table 13: Create Course specification

5.2.3.2 <Instructor> Edit Course Status

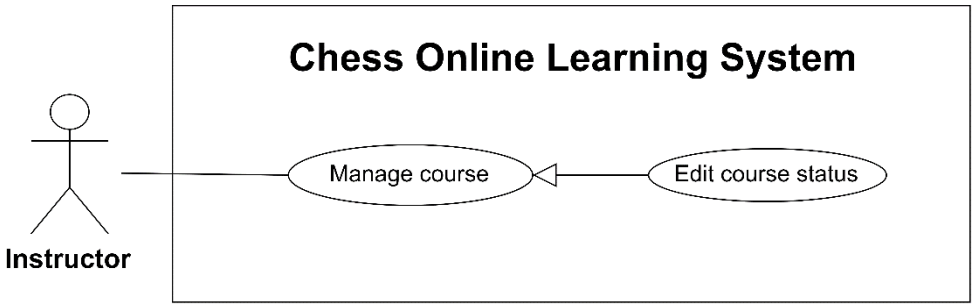


Figure 19: <Instructor> Edit Course Status

USE CASE – UC_IN.03			
Use Case No.	UC_IN.03	**Use Case Version**	2.0
Use Case Name	Edit Course Status		
Author	Phạm Hoàng Tuyết Ngân		
Date	20/07/2019	**Priority**	High

Actor:

- Instructor

Summary:

- This use case allows instructors to change the status of their courses.

Goal:

- Instructors can change their course status.

Triggers:

- Instructor sends the edit course status command.

Preconditions:

- User signed in as an instructor successfully.
- The instructor must have at least 1 course.

Postconditions:

- Success: Course status is changed.
- Failed: System shows error messages.

Main Success Scenario:

Step	Actor Action	System Response
1	Instructor clicks on "Setting" button in a specific course.	System displays actions for instructor: • Submit course: for drafting course • Unpublish course: for published course • Restore course: for rejected course • Resist course: for waiting course
2	Instructor request to change course status.	System displays confirm dialogue with confirming message.
3	Instuctor clicks on "Xác nhận". [Alternative 1]	Course status is changed and the system occurs to users.

Alternative Scenario:

Step	Actor Action	System Response
1	Instructor clicks on "Đóng" button.	System closes the dialogue without changing.

Exceptions: N/A
Relationships: N/A
Business Rules:

- Instructor can unpublish their Published courses.
- Instructor can submit their Drafting courses if lesson list is not empty.
- Instructor can restore their Rejected courses.
- Instructor can resist their Waiting courses.

• After action successfully, the course status is transformed. • System will send a notification to admin and enrolled learners if the course is unpublished. • System will send a notification to admin if the course is submitted.

Table 14: Edit Course Status specification

5.2.3.3 <Instructor> Create Interactive Lesson

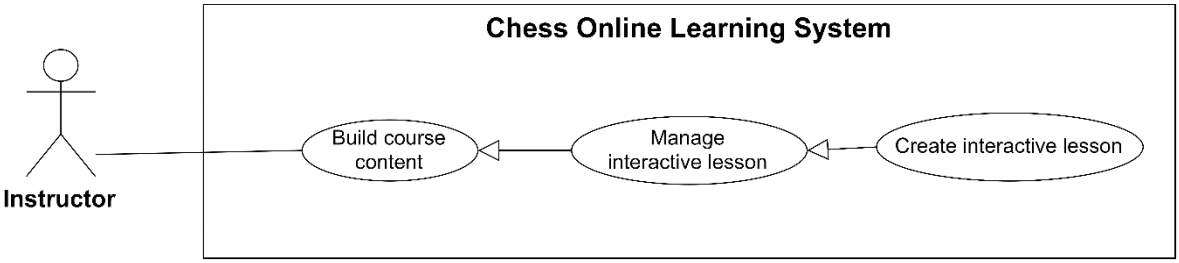


Figure 20: <Instructor> Create Interactive Lesson

USE CASE – UC_IN.05			
Use Case No.	UC_IN.05	**Use Case Version**	2.0
Use Case Name	Create Interactive Lesson		
Author	Phạm Hoàng Tuyết Ngân		
Date	20/07/2019	**Priority**	High

Actor:
- Instructor

Summary:
- This use case allows the instructor to create an interactive lesson.

Goal:
- New interactive lesson is created successfully.

Triggers:
- Instructor sends the create interactive lesson command.

Preconditions:
- User signed in as an instructor successfully.
- Instructor must have at least 1 course.

Postconditions:
- Success: New lesson is created to course.
- Failed: System shows error messages.

Main Success Scenario:

Step	Actor Action	System Response
1	Instructor requests to create an interactive lesson.	System displays a screen to add interactive lessons: • Tên bài học: text field • Mô tả: text area • Nội dung: text area • Nước đi: move content-box • Xóa toàn bộ: button • Chessboard • FEN Editing board button

		• Xem trước: button (disable, enable when information is validated) • Trở về: button (disable, enable when user the is in preview mode) • Close button System required information: • Tên bài học: min length 6, max length 255 • Mô tả: min length 6 • The move list is not empty
2	Instructor input lesson name and description.	[Exception 1]
3	Instructor creates lesson content by performing move on the chessboard. [Alternative 1]	Move is auto-added in move content box.
4	Instructor can add content for each move in "Nội dung" field.	Content is added for the move.
5	Instructor clicks "Xem trước" button [Alternative 2] [Alternative 3]	System displays lesson content as live mode: • Lưu: button • Trở về: button
6	Instructor clicks "Lưu" button. [Alternative 2]	System displays a message "Tạo trận đấu thành công" and create new interactive lesson.

Alternative Scenario:

Step	Actor Action	System Response
1a	Instructor clicks FEN editing board button.	System shows form "Tạo thế cờ" • Chessboard • Lưu thế cờ: button • Đóng: button.
1b	Instructor drags chess pieces to the chessboard and clicks the save button.	System shows a new chess position on the chessboard and all existing moves is removed.
2	Instructor clicks the close button.	System closes create lesson form and return to previous page.
3	Instructor clicks the remove all button.	System removes all the information were set up.

Exceptions:

Step	Cause	System Response
1	Instructor inputs invalid information in the text fields.	System shows error message match with fields: • Empty name: "Tên bài học không được bỏ trống"

		• Name is less than 6 characters: "Tên bài học không được ít hơn 6 kí tự" • Name is more than 225 characters: "Tên bài học không được nhiều hơn 255 kí tự" • Empty description: "Mô tả bài học không được bỏ trống" • Description is less than 6 characters: "Mô tả bài học không được ít hơn 6 kí tự"

Relationships: N/A
Business Rules:
- Instructor creates a new interactive lesson to build course content.
- Interaction lesson consists of many different chess moves and moves analyse, the instructor can freely set the chessboard.
- A course can have many interactive lessons.

Table 15: Create Interactive Lesson specification

5.2.3.4 <Instructor> Create Uninteractive Lesson

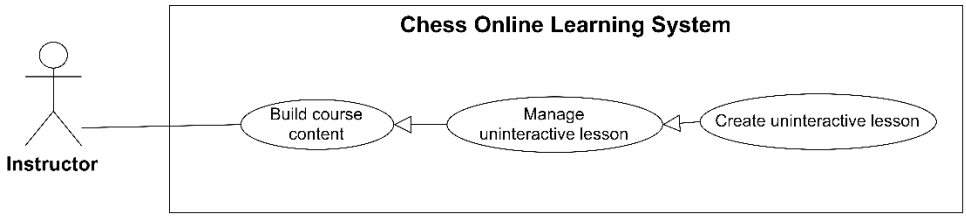


Figure 21: <Instructor> Create Uninteractive Lesson

USE CASE – UC_IN.07			
Use Case No.	UC_IN.07	**Use Case Version**	2.0
Use Case Name	Create Uninteractive Lesson		
Author	Đặng Văn Hoàng		
Date	20/07/2019	**Priority**	High

Actor:
- Instructor

Summary:
- This use case allows the instructor to create an uninteractive lesson.

Goal:
- Instructor can create an uinteractive lesson for the course.

Triggers:
- Instructor sends the create uninteractive lesson commands.

Preconditions:
- User signed in as an instructor successfully.
- The instructor must have at least 1 course.

Postconditions:
- Success: An uninteractive lesson is added to the course.
- Failed: System shows error messages.

Main Success Scenario:

Step	Actor Action	System Response
1	Instructor navigates to creates an unteractive lesson	System displays a form to create the uninteractive lesson: • Tên bài học: text field • Mô tả: text area • Nội dung bài học: WYSIWG Editor • Thêm: button • Close button System required information: • Tên bài học: min length 6, max length 255 • Mô tả: min length 6 • Nội dung: min length 6
2	Instructor inputs information.	[Exception 1]
3	Instructor clicks on "Thêm" button. [Alternative 1]	System create uninteractive lessons and displays message "Tạo bài đọc học thành công".

Alternative Scenario:

Step	Actor Action	System Response
1	Instructor clicks on the close icon.	System closes the form without changing.

Exceptions:

Step	Cause	System Response
1	Instructor inputs invalid information or not fill in WYSIWYG Editor.	System shows error message match with fields: • Empty name: "Tên bài học không được bỏ trống" • Name is less than 6 characters: "Tên bài học không được ít hơn 6 kí tự" • Name is more than 225 characters: "Tên bài học không được nhiều hơn 255 kí tự" • Empty description: "Mô tả bài học không được bỏ trống" • Description is less than 6 characters: "Mô tả bài học không được ít hơn 6 kí tự" • Empty content: "Nội dung bài học không được bỏ trống" • Content is less than 6 characters: "Nội dung bài học không được ít hơn 6 kí tự"

Relationships: N/A
Business Rules:

- Instructor can create uninteractive lessons to build course content.
- Uninteractive lesson is a theoretical learning format including images, videos, document files.
- A course can have many uninteractive lessons.

Table 16: Create Uniteractive Lesson specification

5.2.3.5 <Instructor> Create Exercise

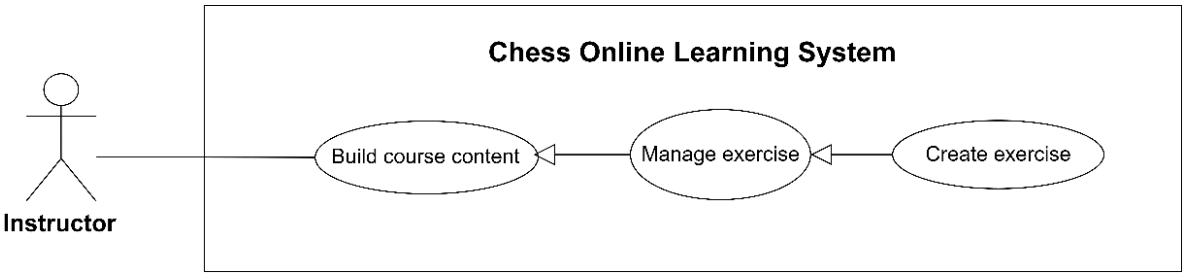


Figure 22: <Instructor> Create Exercise

USE CASE – UC_IN.09			
Use Case No.	UC_IN.09	**Use Case Version**	2.0
Use Case Name	Create Exercise		
Author	Phạm Hoàng Tuyết Ngân		
Date	20/07/2019	**Priority**	High

Actor:
- Instructor

Summary:
- This use case allows the instructor to create an exercise.

Goal:
- Instructor can create a new exercise.

Triggers:
- Instructor sends the create exercise command.

Preconditions:
- User signed in as an instructor successfully.
- The instructor must have at least 1 course.

Postconditions:
- Success: An exercise is added to the course.
- Failed: System shows error messages.

Main Success Scenario:

Step	Actor Action	System Response

1	Instructor navigates to create a new exercise.	System displays a form to create an exercise:
		• Tên bài tập: text field
		• Câu hỏi: text field
		• Mô tả: text area
		• Three of the answer:
		  ▪ Nước đi: move content-box
		  ▪ Thực hiện đúng: text field
		  ▪ Thực hiện sai: text field
		• Xóa toàn bộ: button

		• Chessboard • FEN Editing board button • Xem trước: button (disable/enable when information is valid) • Trở về: button (disable/enable when the user is in preview mode) • Close button • Dùng chế độ đánh tự động: checkbox System required information: • Tên bài tập: min length 6, max length 255 • Câu hỏi: min length 6 • Mô tả: min length 6 • Answer List is not empty or enable chess bot mode
2	Instructor inputs exercise name, question and description.	[Exception 1]
3	Instructor adds lesson content by performing a move. [Alternative 1] [Alternative 2]	Move is auto-added to move content-box.
4	Instructor can fill "Thực hiện đúng" and "Thực hiện sai" content for each move.	System saves the right response and wrong response for the move.
5	Instructor clicks "Xem trước" button. [Alternative 3] [Alternative 4]	System shows the new exercise in live mode: • Lưu: button • Trở về: button.
6	Instructor clicks "Lưu" button. [Alternative 3]	System creates a new exercise and shows a message "Thêm bài tập thành công".

Alternative Scenario:

Step	Actor Action	System Response
1a	Instructor clicks FEN editing board button.	System shows form "Tạo thế cờ" • Chessboard • Lưu thế cờ: button Đóng: button.
1b	Instructor drags chess pieces to the chessboard and clicks the save button.	System shows a new chess position on the chessboard and all existing moves is removed.
2	Instructor chooses bot answer.	Move answer form is disabled and the answer is noted in a bot answer.
3	Instructor clicks on the close button.	System closes the for without changing.
4	Instructor clicks on the remove all button.	System removes all the instructor information which were set up.

Exceptions:

Step	Cause	System Response
1	Instructor inputs invalid information in the text fields.	System shows error message match with fields: • Empty name: "Tên bài tập không được bỏ trống" • Name is less than 6 characters: "Tên bài tập không được ít hơn 6 kí tự" • Name is more than 225 characters: "Tên bài tập không được nhiều hơn 255 kí tự" • Empty question: "Câu hỏi không được bỏ trống" • Question is less than 6 characters: "Câu hỏi bài học không được ít hơn 6 kí tự" • Empty is description: "Mô tả bài tập không được bỏ trống" • Description is less than 6 characters: "Mô tả bài tập không được ít hơn 6 kí tự"

Relationships: N/A

Business Rules:

- Instructor can create exercises to build course content.
- A course can have many exercises.
- Exercise is a lesson, which provides a chess puzzle and learner must perform the right move to solve the problem.
- Exercise contains 2 types of answer: using Bot answer and Manual answer.
- There are as much as possible 3 answers in Manual answer.
- Manual answer support right response and wrong response for each move.

Table 17: <Instructor> Create Exercise specification

5.2.4 <Admin> Overview Use Case

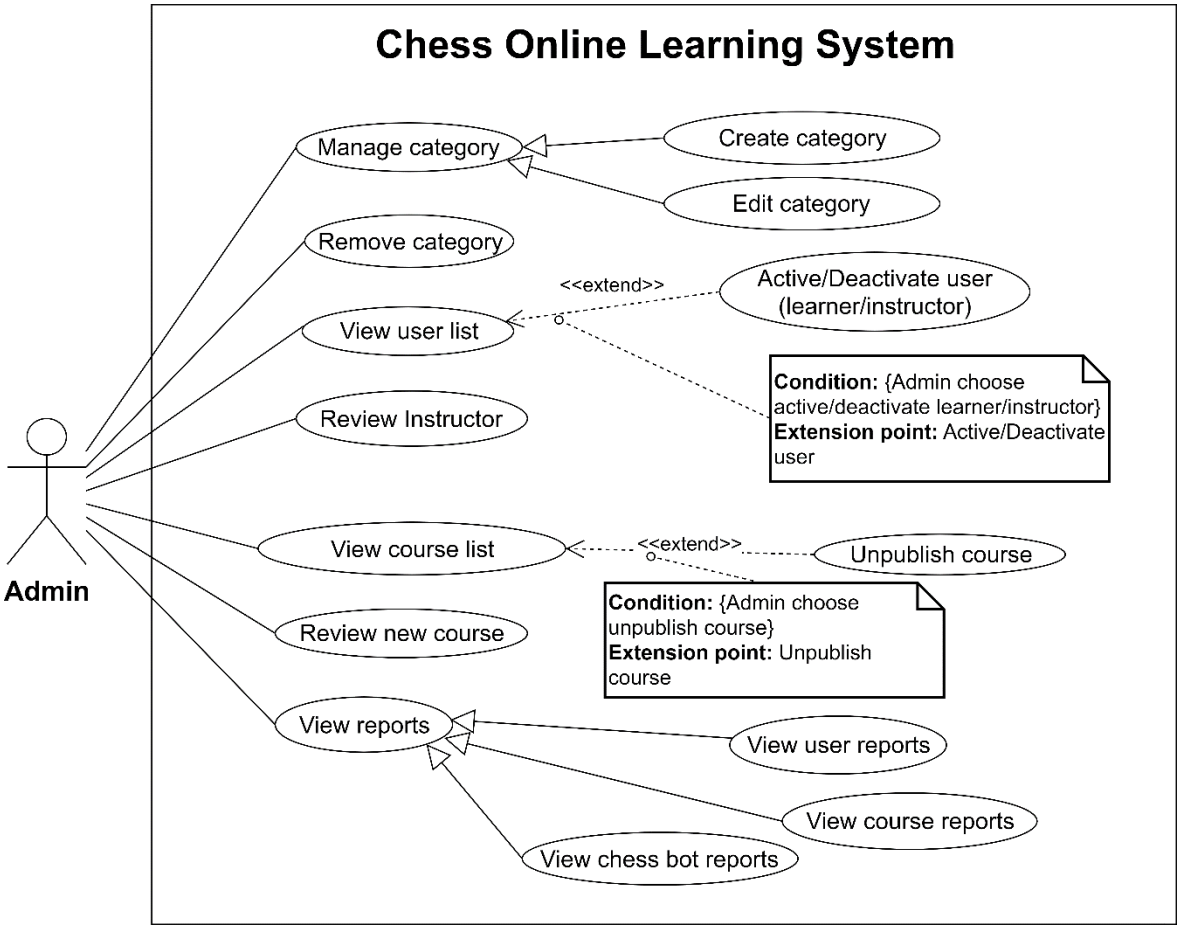


Figure 23: <Admin> Overview Use Case

5.2.4.1 <Admin> Create Category

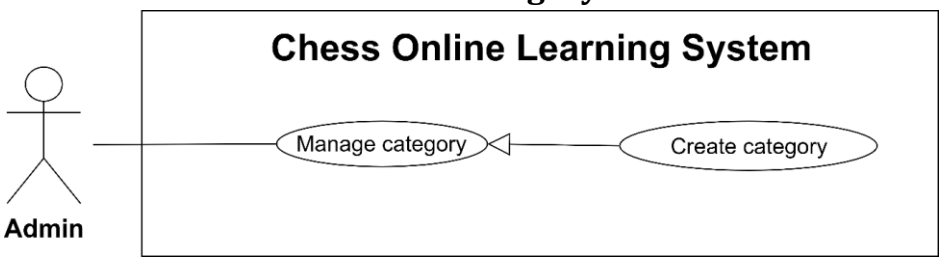


Figure 24: <Admin> Create Category

USE CASE – UC_AD.01			
Use Case No.	UC_AD.01	**Use Case Version**	2.0
Use Case Name	Create Category		
Author	Đặng Văn Hoàng		
Date	20/7/2019	**Priority**	Normal
Actor: • Admin **Summary:** • This use case allows the admin to create a category. **Goal:** • A new category is added to system.			

Triggers:

- Admin sends the create category command.

Preconditions:

- User signed in as an admin successfully.

Postconditions:

- Success: A category is added to the system successfully.
- Failed: System shows error messages.

Main Success Scenario:

Step	Actor Action	System Response
1	Admin requests to create a new category.	System shows create category form: • Danh mục: text field • Đồng ý: button • Hủy: button System required information: • Danh mục: min length 6, max length 255
2	Admin inputs text field.	[Exception 1]
3	Admin clicks on "Đồng ý" button [Alternative 1]	System shows the message "Tạo danh mục thành công" and a new category is added.

Alternative Scenario:

No	Actor Action	System Response
1	Admin clicks on "Hủy" button	System returns to the category management page without changing.

Exceptions:

No	Cause	System Response
1	Admin inputs invalid information.	System shows error message match with fields: • Empty name: "Tên danh mục không được bỏ trống" • Name is less than 6 characters: "Tên danh mục không được ít hơn 6 kí tự" • Name is more than 225 characters: "Tên danh mục không được nhiều hơn 225 kí tự"

Relationships: N/A

Business Rules:

- System category can be created by admins.

Table 18: Create Category specification

5.2.4.2 <Admin> Review New Course

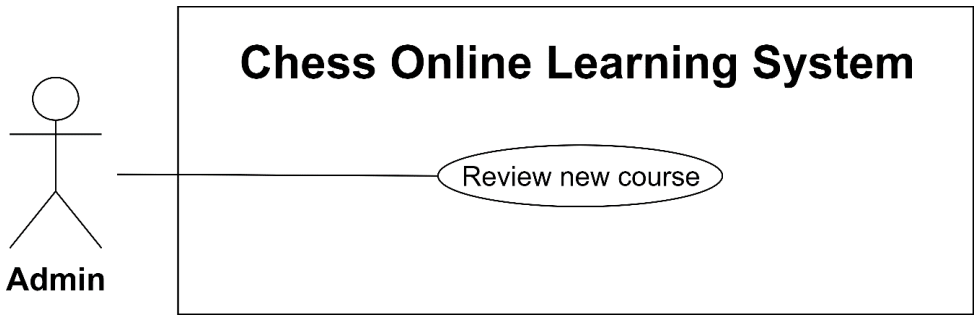


Figure 25: <Admin> Review New Course

USE CASE – UC_AD.07			
Use Case No.	UC_AD.07	**Use Case Version**	2.0
Use Case Name	Review New Course		
Author	Đặng Văn Hoàng		
Date	20/7/2019	**Priority**	Normal

Actor:

- Admin

Summary:

- This use case allows admin review new course. See details of the course: course information and course content.

Goal:

- A course is reviewed before publishing.

Triggers:

- Admin sends the review new course command.

Preconditions:

- User signed in as an admin successfully.

Postconditions:

- Success: A new course is published or rejected.
- Failed: System shows error messages.

Main Success Scenario:

Step	Actor Action	System Response
1	Admin navigates to waiting course.	System displays the course details: • Course information: name, description, skill level required, categories. • Course content: the number of lessons, lesson list. • Setting button
2	Admin clicks on the setting button [Alternative 1]	System show dialog "Thay đổi trạng thái khóa học": • Đồng ý: button • Từ chối: button • Đóng: button
3	Admin click on "Đồng ý" button [Alternative 1] [Alternative 2]	System displays a message "Khóa học đã được công khai" and change status course.

Alternative Scenario:

No	Actor Action	System Response
1	Admin clicks on "Đóng" button	System closes dialog without changing in course.
2a	Admin clicks on "Từ chối" button	System displays dialog to enter rejected reason, after Admin confirm reason.
2b	Admin input rejected reson.	Course status is transformed to "Rejected" and system displays a message "Khóa học đã bị từ chối công khai".

Exceptions: N/A
Relationships: N/A
Business Rules:

- When the admin review is completed, the system sends a notifications and confirm email to the instructors.

Table 19: Review New Course specification

5.2.4.3 <Admin> Review Instructor

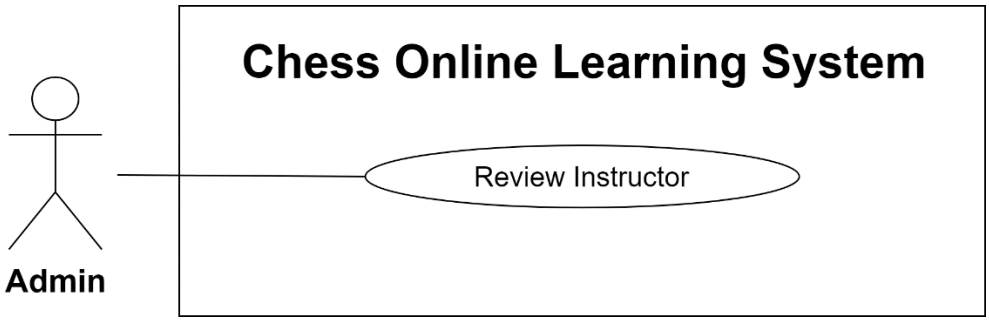


Figure 26: <Admin> Review Instructor

USE CASE – UC_AD.10			
Use Case No.	UC_AD.10	**Use Case Version**	2.0
Use Case Name	Review Instructor		
Author	Đặng Văn Hoàng		
Date	20/7/2019	**Priority**	Normal

Actor:

- Admin

Summary:

- This use case allows admin view the list of registered users to become instructors, view personal information of new instructor and approve or reject them.

Goal:

- Limit instructor for system.

Triggers:

- Admin sends the instructor review command.

Preconditions:

- User signed in as an Admin successfully.
- New instructor apply to system.

Post conditions:

- Success: A new instructor is approved or rejected.
- Fail: System shows error messages.

Main Success Scenario:

Step	Actor Action	System Response

1	Admin navigates to view new instructor.	System shows new instructor information to the form and review buttons:
		• Information fom:
		  ○ Full Name
		  ○ Email
		  ○ Achivement
		  ○ Certificate
		• Đồng ý: button
		• Từ chối: button

2	Admin clicks "Đồng ý" button [Alternative 1]	System shows a message "Người hướng dẫn mới đã được chấp nhận" and changes status of instructor.

Alternative Scenario:

No	Actor Action	System Response
1a	Admin click on "Từ chối" button	System shows rejected reason dialogue.
1b	Admin inputs rejected reason and confirm with the system.	System removes user and sends rejected email to them.

Exceptions: N/A
Relationships: N/A
Business Rules:

- Admin can review all register.
- When admin accepts, the user account can access the instructor's page. An accept notification is sent to the instructor.
- When admin rejects, the instructor is removed in the database and they can apply again.

Table 20: Review Instructor specification

6. System Architecture Design[2]

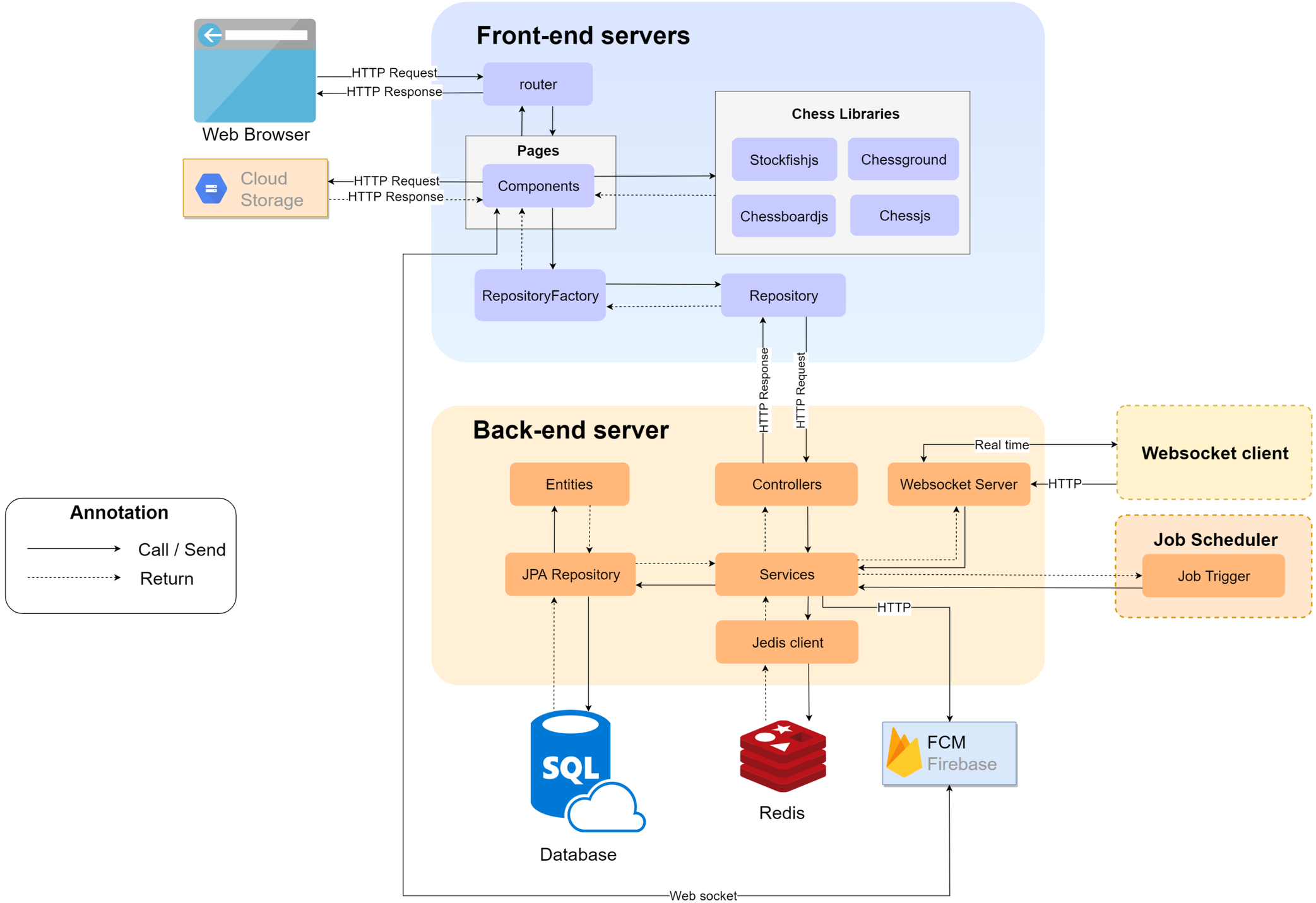


Figure 27: System architecture overview

This system is developed base on multi-tiers architecture with Database, Back-end server for process business logic and 2 front-end servers (for learning-app and admin-app) to process presentation.

a. Data tier

In Data tier, we use Relational Database Management System - MySQL to store system data.

b. Business Logic tier

In Business Logic tier, we use Spring Boot to develop RESTful APIs with MVC pattern.

In this system, the chess engine performs in the presentation tier, then we using websocket to synchronize game states between server and client.

We also use Redis, an in-memory data structure for caching data.

In order to schedule automatic tasks such as giving course suggestions to learners. We use Quartz Job 2.0 to schedule the task to run repeatedly. Besides, it is also used to trigger the timeout of the chess game by the cron expression.

c. Presentation tier

For Front-end applications, we use VueJS framework and Repository-pattern to manage data. We also apply chess libraries to solve our problems, which be related to user interaction, include:

- **Stockfishjs:** Stockfish is an opensource chess engine, which supports to analyse chess move and Stockfishjs is a pure JavaScript implementation of Stockfish. We can use UCI (Universal Chess Interface) to communicate with the chess engine. The chess engine performs as a worker thread, they receive UCI command by `postMessage()` method and perform tasks to get a result, and return the result by `onmessage()` method. We apply stockfishjs to build chess bot, which can autoplay with learner and support learner in exercises.
- **Chessjs:** Chessjs is a chess library which use to generate chess move and validate the client move. We use this library to validate user move and manage current status of chess game, such as turn colour, pieces position.
- **Chessboardjs and Chessground:** There 2 library also support to render Graphic User Interface (GUI), 2 libraries which be discussed above only support data in console, then we must use this libraries to display chessboard for the user. They can perform move and display pieces position from Chessjs and Stockfishjs by using FEN String, which will be discussed below.

d. Cloud Services

In this system, we use cloud services, which are Cloud Storage and Firebase Cloud Messaging (FCM). We use Cloud Storage of Google Cloud Platform to store images which are uploaded by the client and store the URL in Database. The FCM is used to push real-time notifications easily and conveniently.

7. Component Diagram[1]

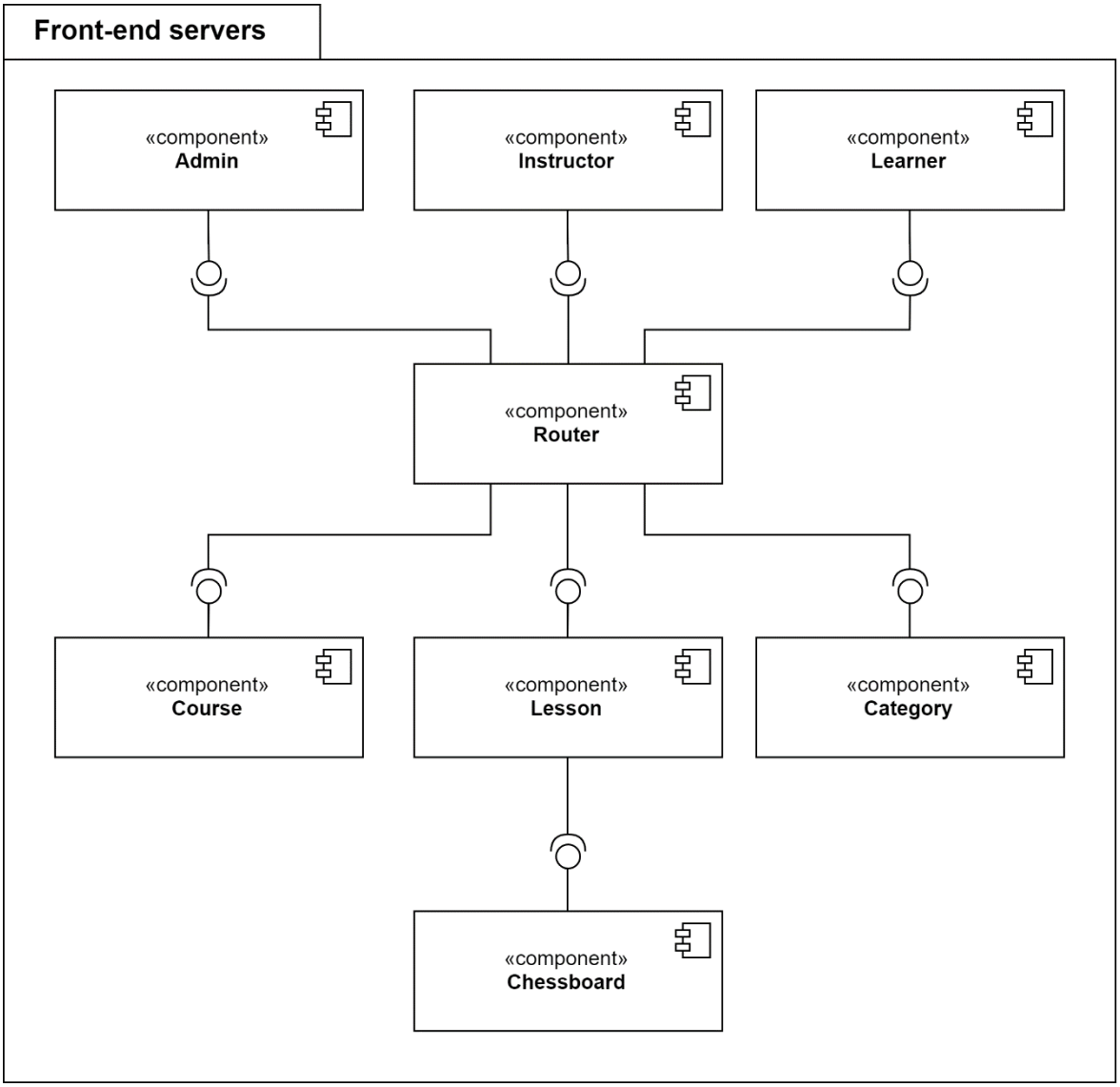


Figure 28: Front-end Servers Component diagram

COMPONENT DICTIONARY: DESCRIBES COMPONENTS	
Router	Handle HTTP request, response
Course Component	Handle activity about Course
Lesson Component	Handle activity about Lesson
Chessboard Component	Handle activity about Chessboard
Category Component	Handle activity about Category
Admin Component	Handle activity of Admin
Instructor Component	Handle activity of Instructor
Learner Component	Handle activity of Learner

Table 21: Front-end Servers Component Dictionary

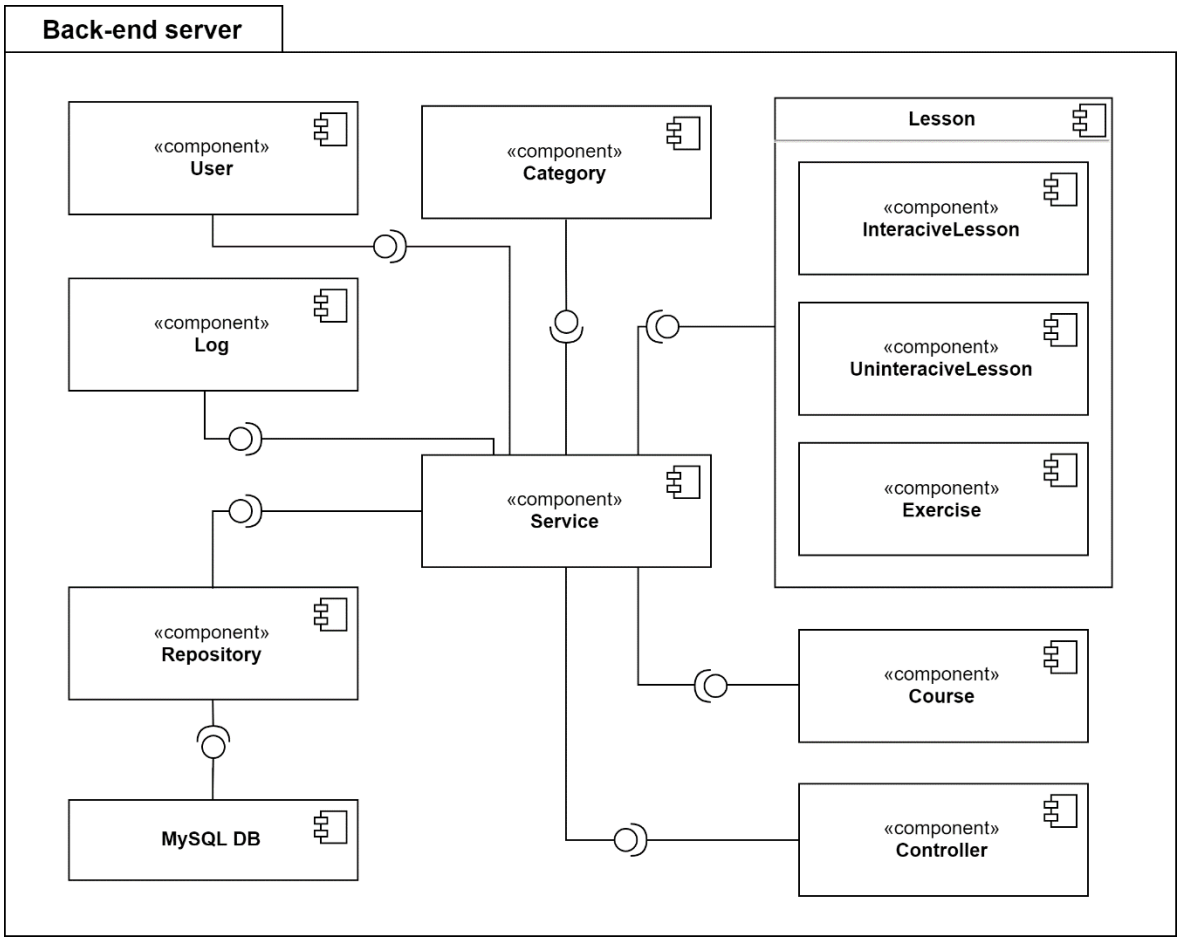


Figure 29: Back-end Server Component diagram

COMPONENT DICTIONARY: DESCRIBES COMPONENTS	
Constroller	Handle HTTP request, response
Service Component	Process data
Repository Component	Access data from database
MySQL DB	Database component
Category Component	Handle activity about Category
User Component	Handle activity of User
Log Component	Handle log about system activity
Course Component	Handle activity about Course
Lesson Component	Handle activity about Lesson
Interactive Lesson Component	Handle activity about Lesson (type Interactive)
Uninteractive Lesson Component	Handle activity about Lesson (type Uninteractive)
Exercise Component	Handle activity about Exercise

Table 22: Back-end Servers Component Dictionary

8. Class Diagram[1]

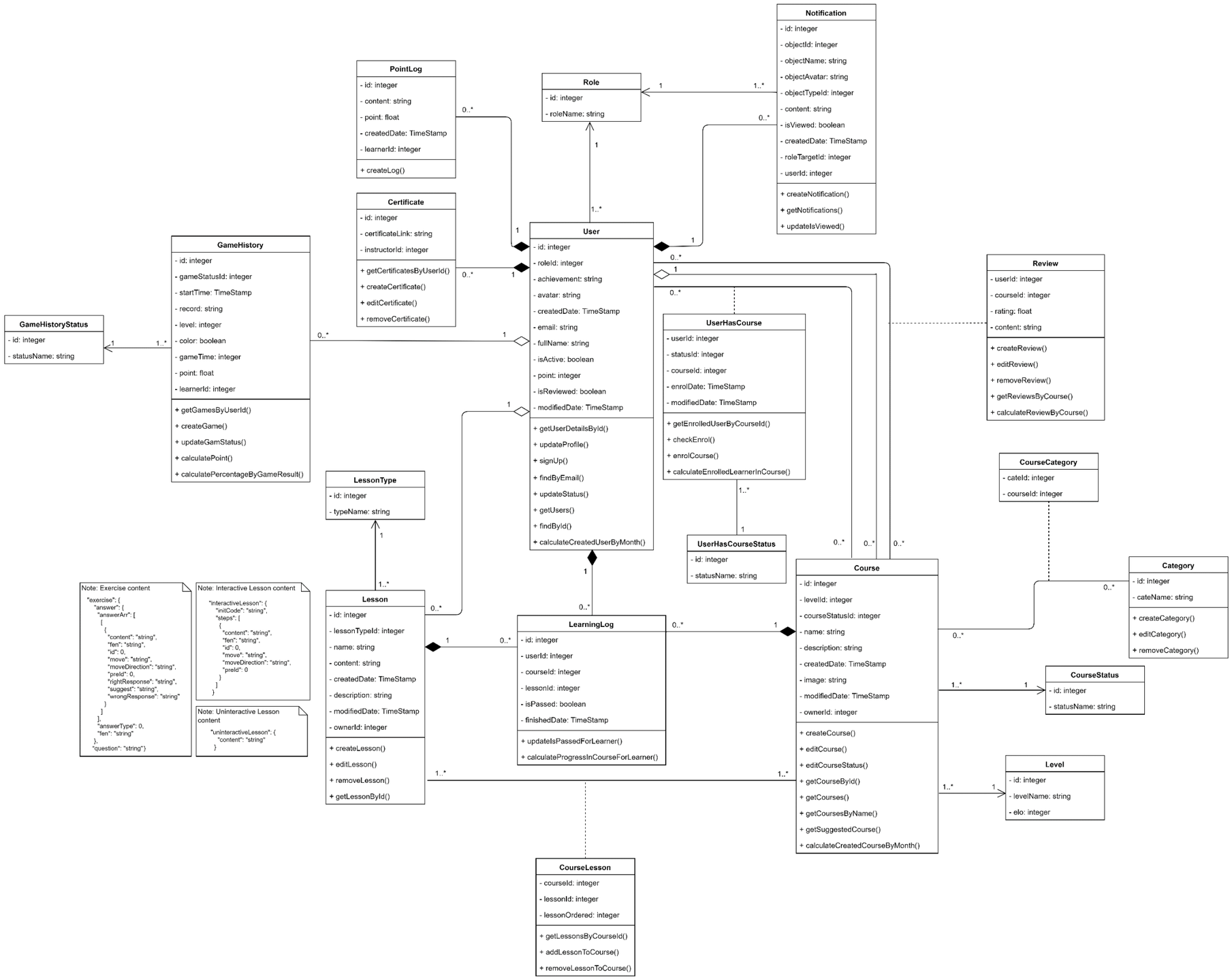


Figure 30: Class Diagram

CLASS DICTIONARY: DESCRIBE CLASS		
Class Name	**Mapping column with Conceptual diagram**	**Description**
User	User	Contains the user information
Role	N/A	Not exist in Conceptual diagram but need this class to contain role name for user
Notification	Notification	Contains the notification for user
Certificate	Certificate	Contains the certificate information for instructor
PointLog	N/A	Not exist in Conceptual diagram but need this class to log point transaction for learner
GameHistory	GameHistory	Contain the game history information for learner
GameHistoryStatus	N/A	Not exist in Conceptual diagram but need this class to contain the status name of game history
Course	Course	Contains the course information
CourseStatus	N/A	Not exist in Conceptual diagram but need this class to contain status name of course
CourseLesson	N/A	Not exist in Conceptual diagram but need this class to contain the course which lesson belongs to
Review	Review	Contains the review for each course by learner
UserHasCourse	N/A	Not exist in Conceptual diagram but need this class to contain status for each course of learner
UserHasCourseStatus	N/A	Not exist in Conceptual diagram but need this class to contain status name for each course of learner
Category	Category	Contains the category information
CourseCategory	N/A	Not exist in Conceptual diagram but need this class to contain the relationship between courses and categories
Lesson	Lesson	Contains the lesson information

LessonType	N/A	Not exist in Conceptual diagram but need this class to contain the type name for each lesson
LearningLog	LearningLog	Contain learning logs of learners

Table 23: Class Dictionary

9. Entity Relationship Diagram[3]

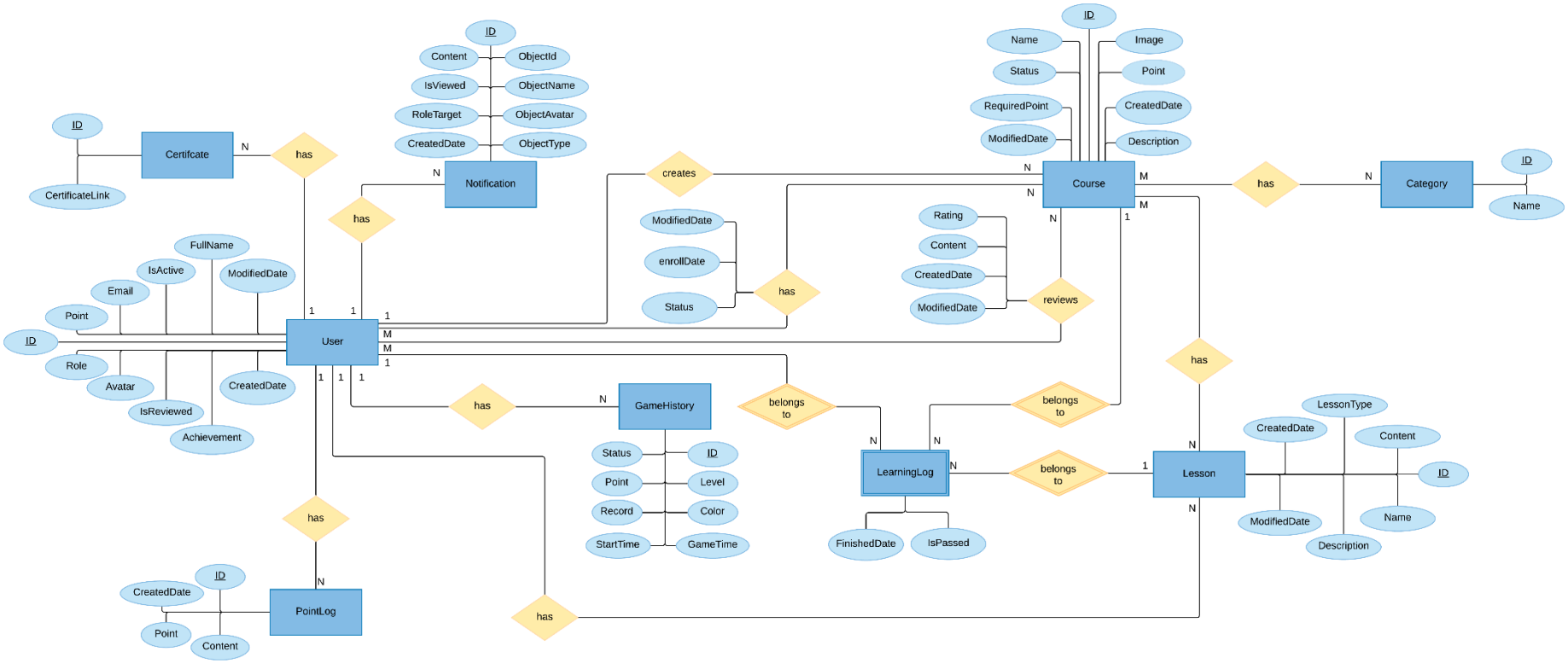


Figure 31: Entity relationship diagram (ERD)

Entity Data Dictionary: describe content of all entities	
Entity name	**Description**
User	Contains the user's information
Certificate	Contains certificates's link for Instructor
Notification	Contains User's notification
PointLog	Contains log about point transaction of Learner.
GameHistory	Contains the game history's information.
Course	Contains the course's information
Category	Contains the category's information
Lesson	Contains the lesson's information
LearningLog	Contains learning log for Learner

Table 24: Entity data dictionary

10. Interactive Diagram[1]

10.1 Learner

10.1.1 Enrol Course

Summary: this diagram shows the process to enrol a course

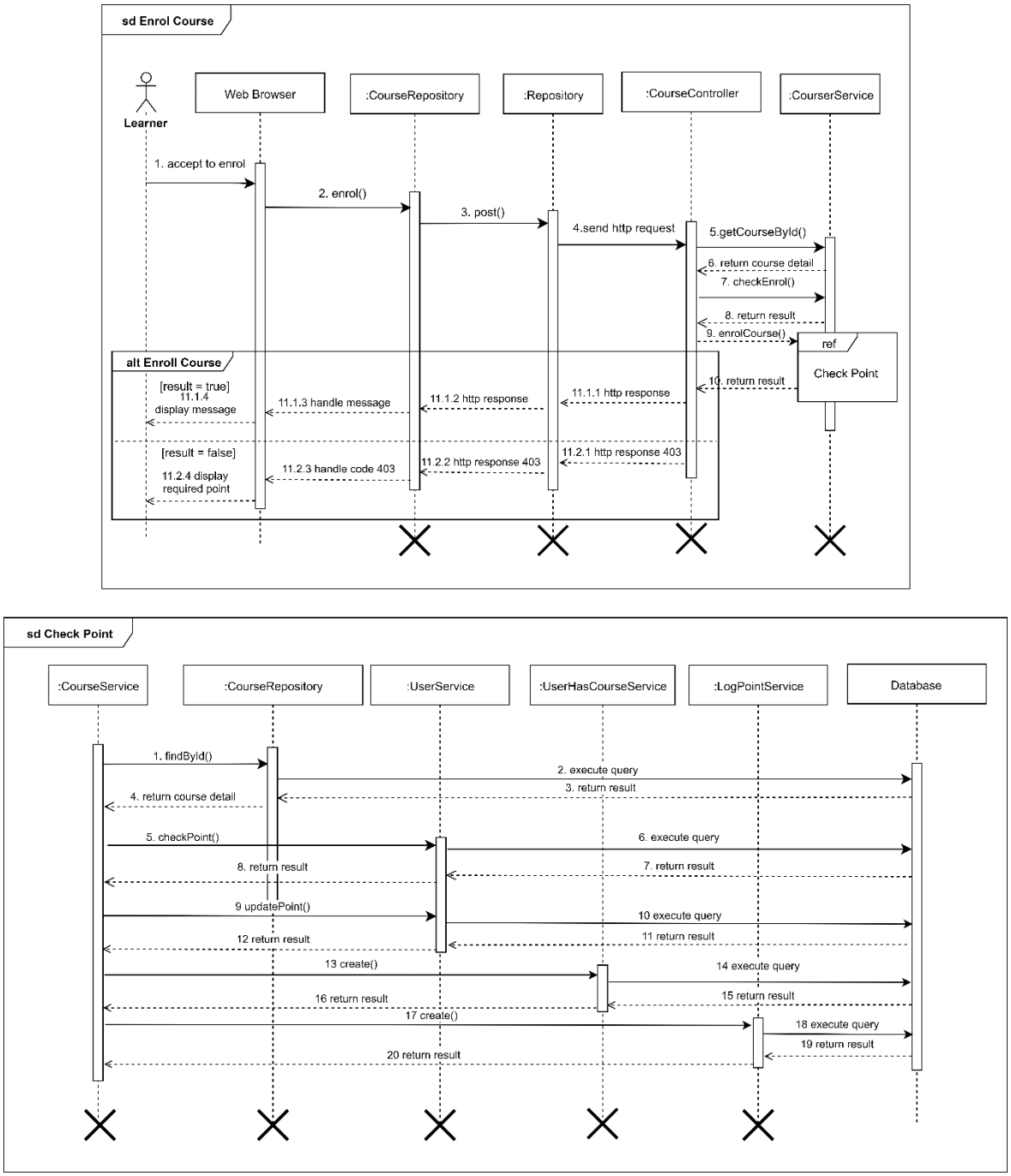


Figure 32: Sequence Diagram - <Learner> Enrol Course

10.1.2 Create Review

Summary: this diagram shows process of create a review

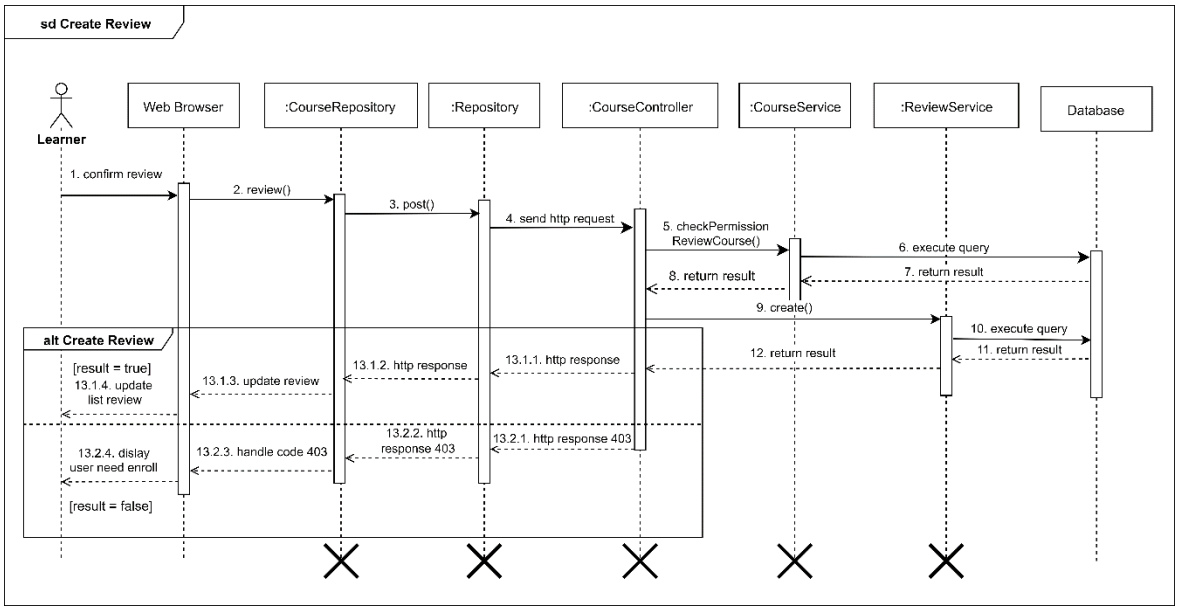


Figure 33: Sequence Diagram - <Learner> Create Review

10.1.3 View List Of Suggested Course

Summary: this diagram shows process of view list of suggested course

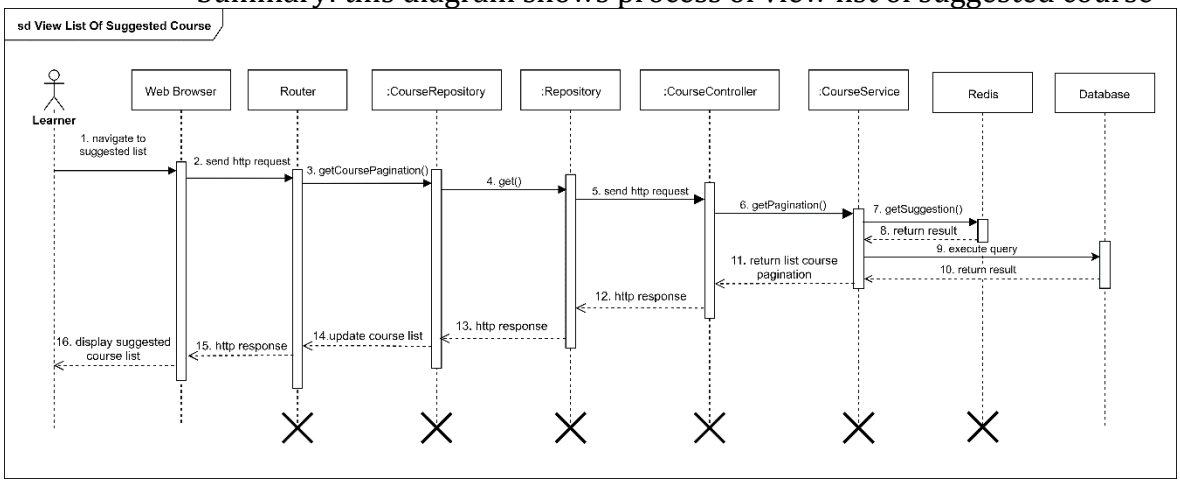


Figure 34: Sequence Diagram - <Learner> View List Of Suggested Course

10.2 Instructor

10.2.1 Create Course

Summary: this diagram shows process of create a course

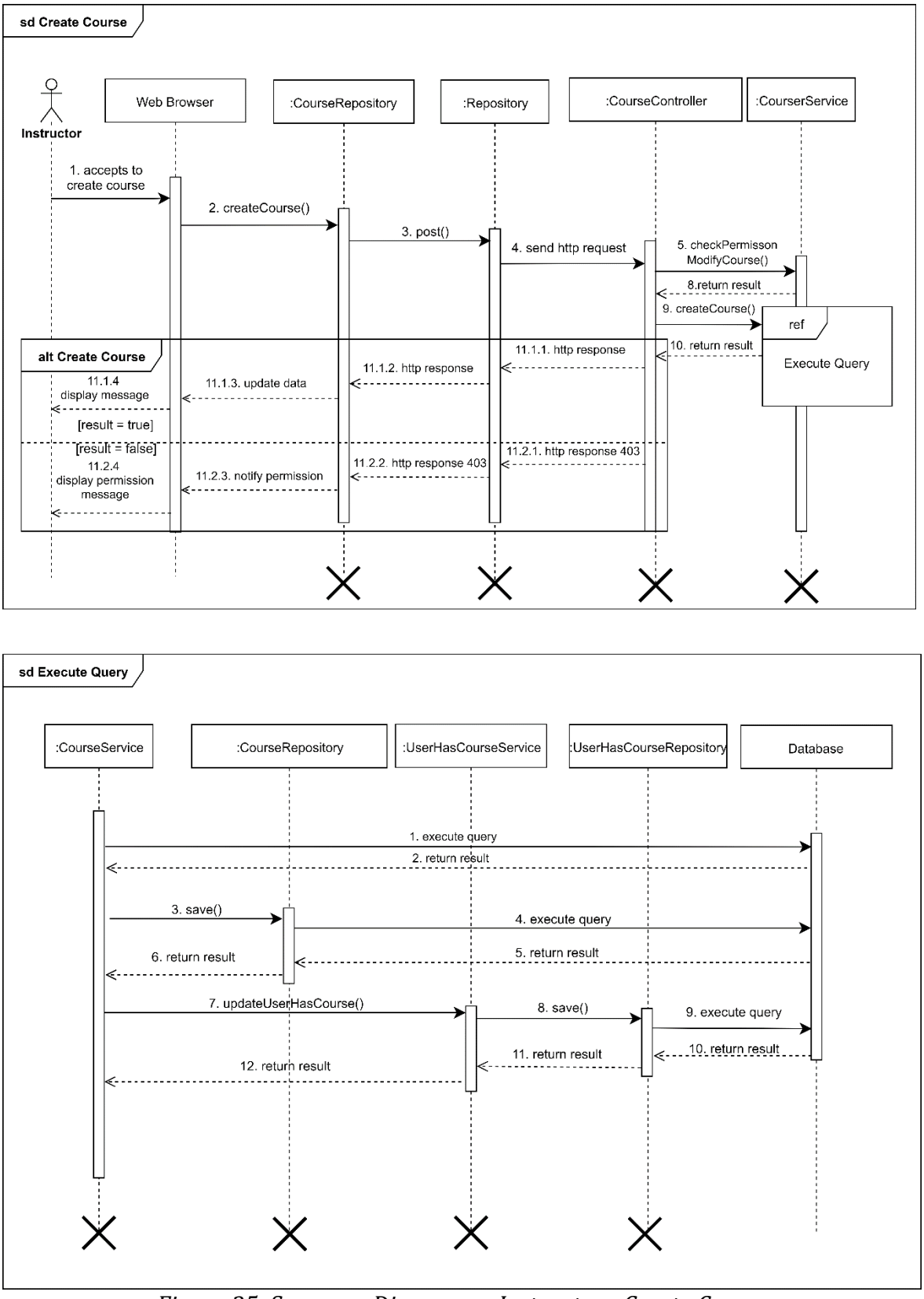
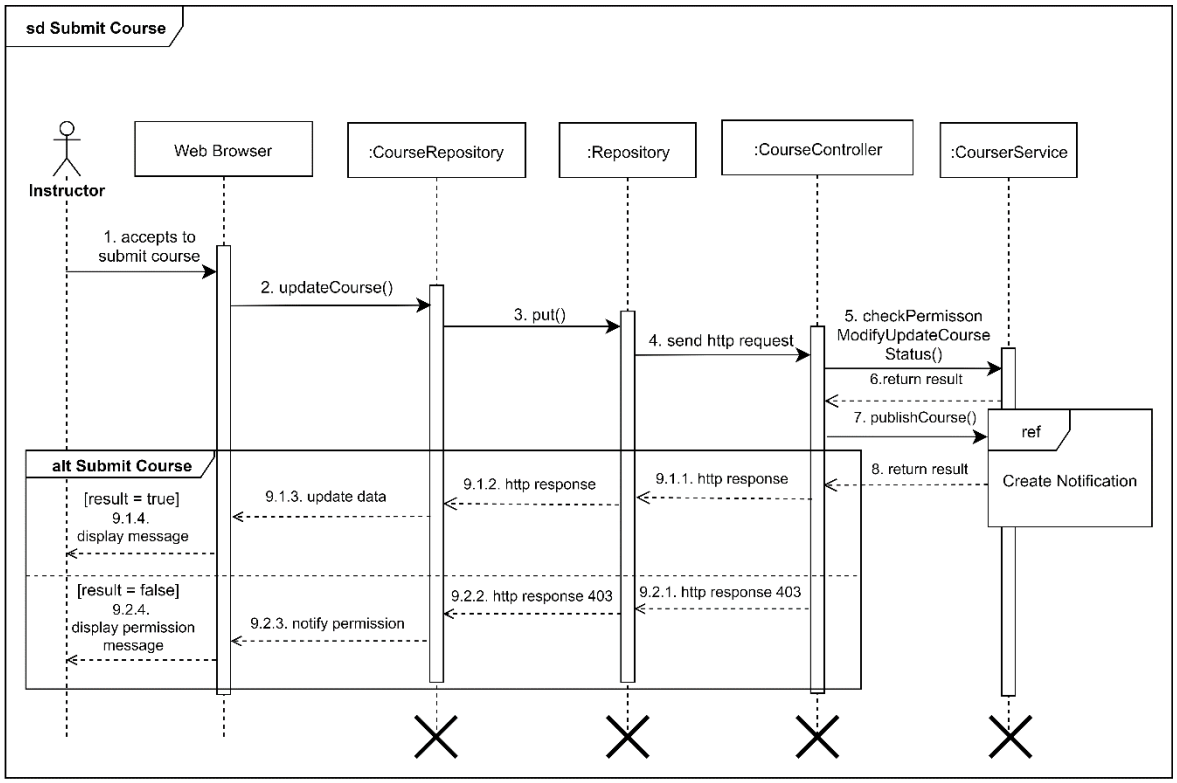


Figure 35: Sequence Diagram - <Instructor> Create Course

10.2.2 Submit Course

Summary: this diagram shows process of submit course



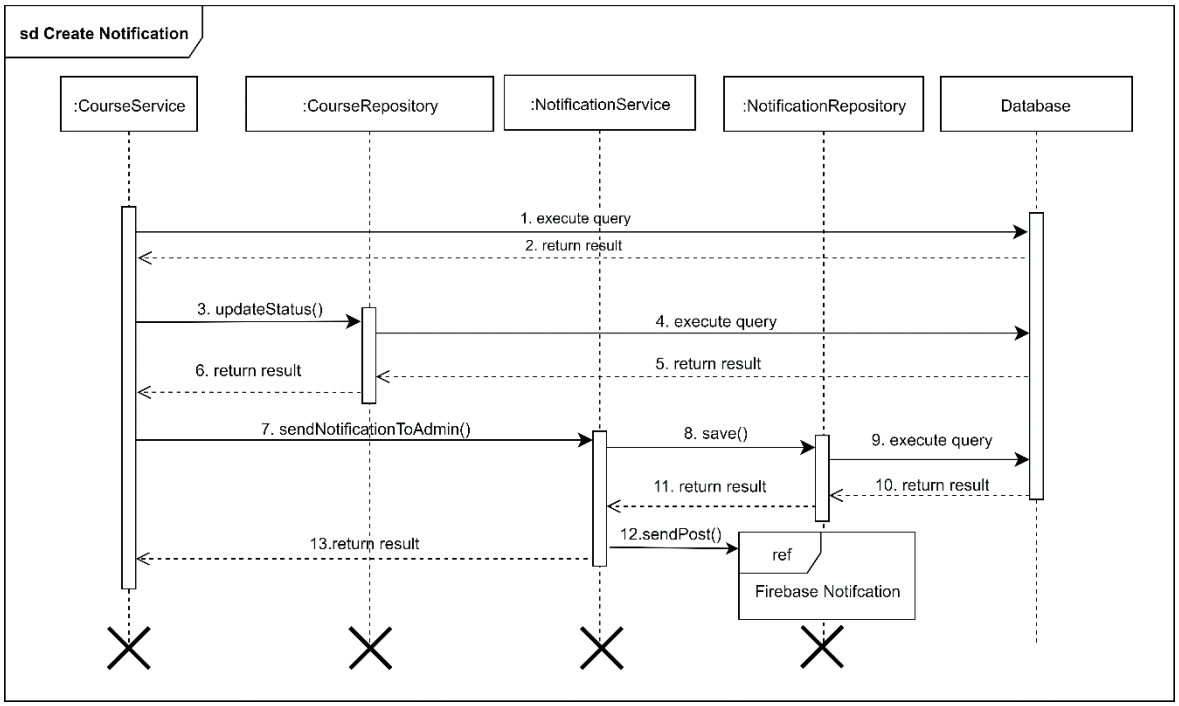
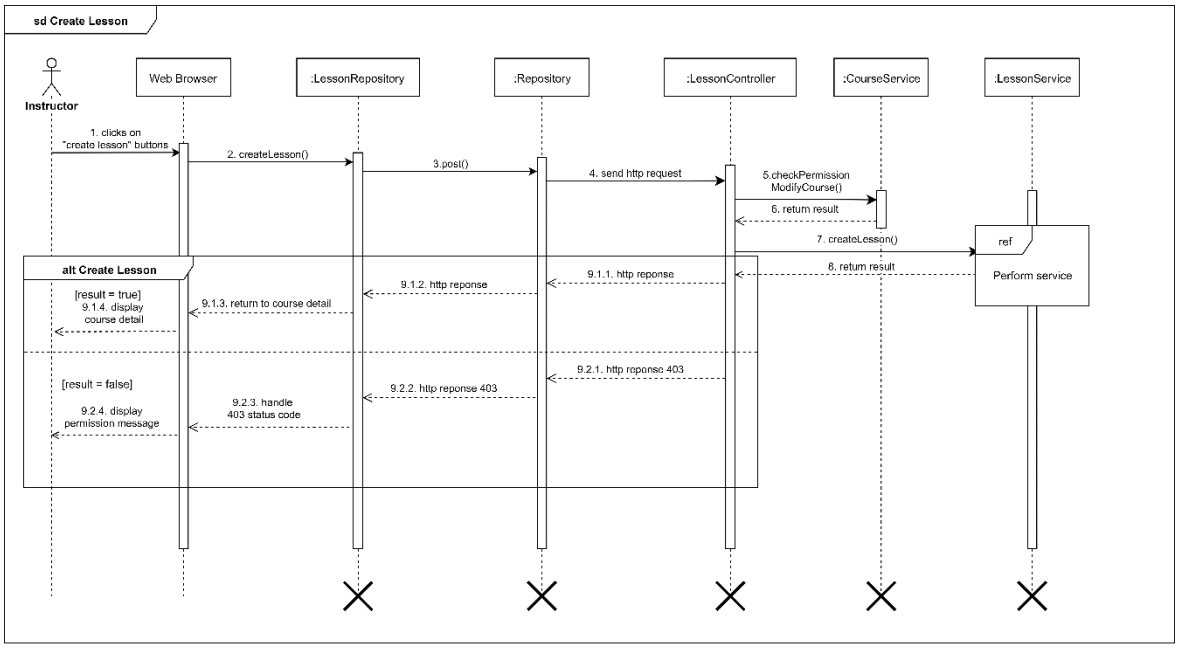


Figure 36: Sequence Diagram - <Instructor> Submit Course

10.2.3 Create Lesson

Summary: this diagram shows process of creating lesson or exercise



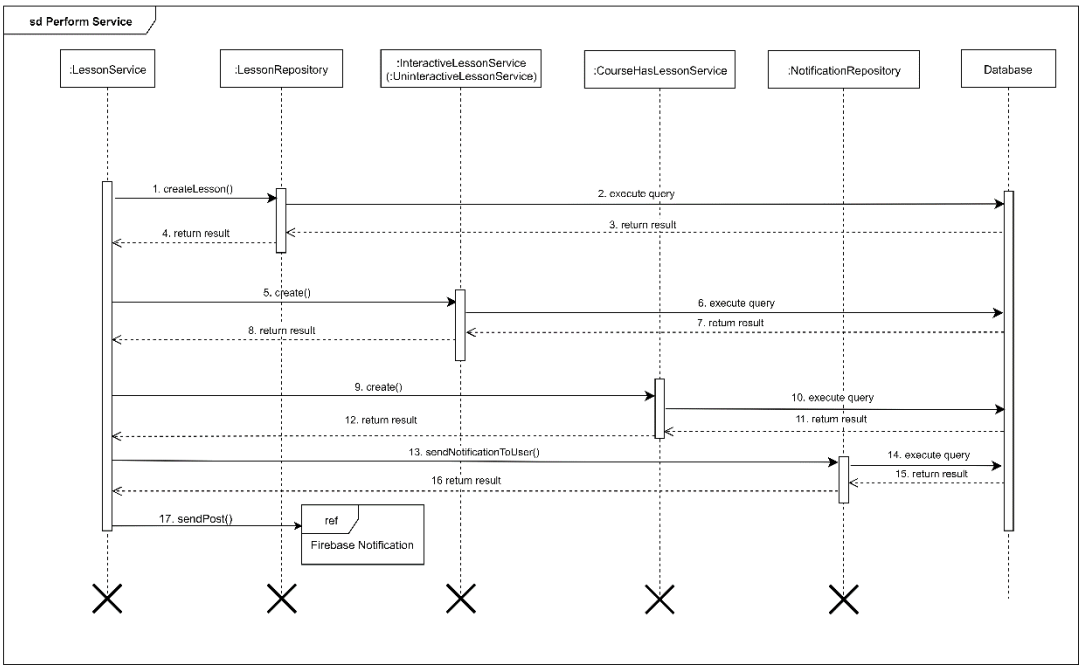


Figure 37: Sequence Diagram - <Instructor> Create Lesson

10.2.4 Edit Lesson

Summary: this diagram shows process of editing lesson or exersise

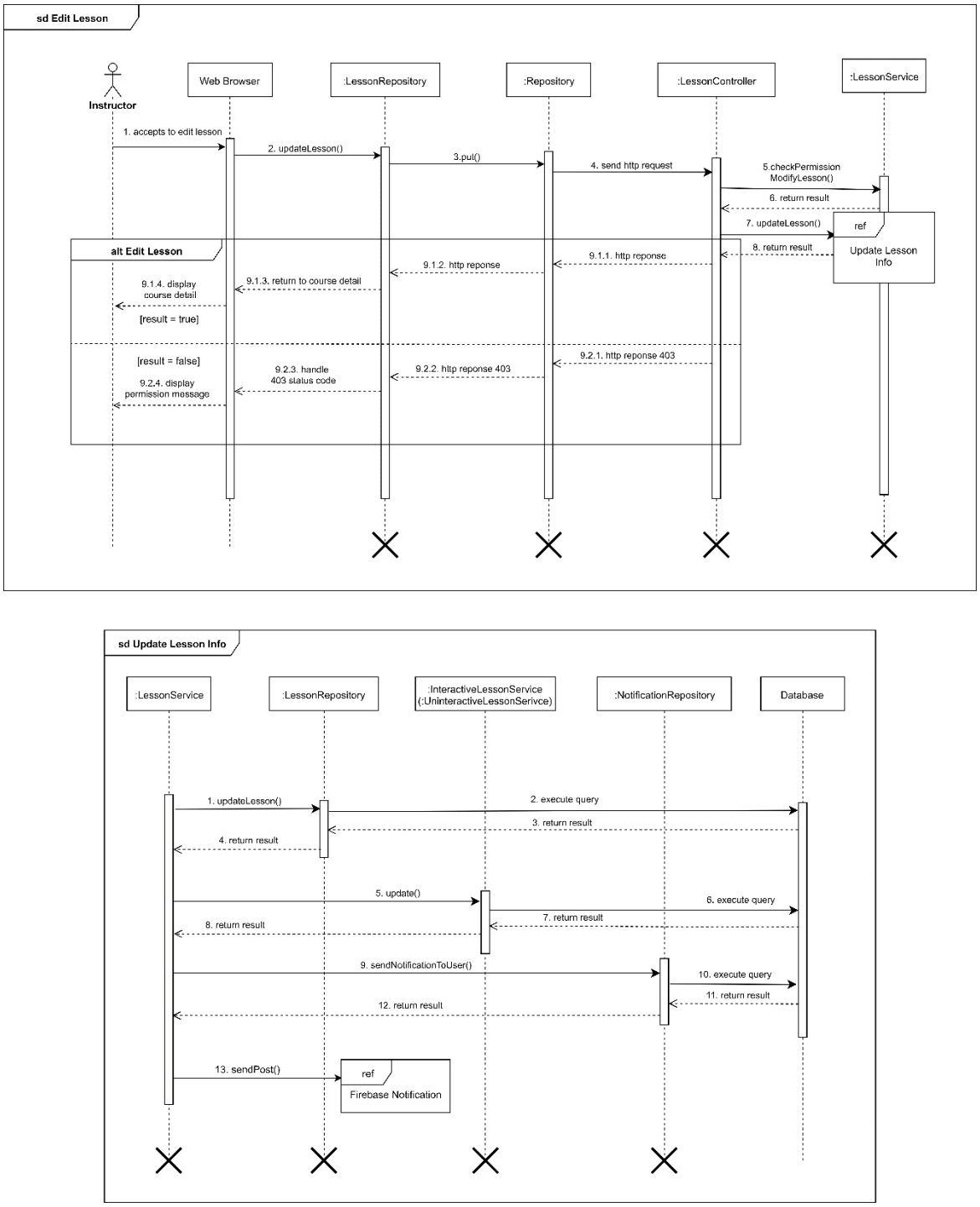
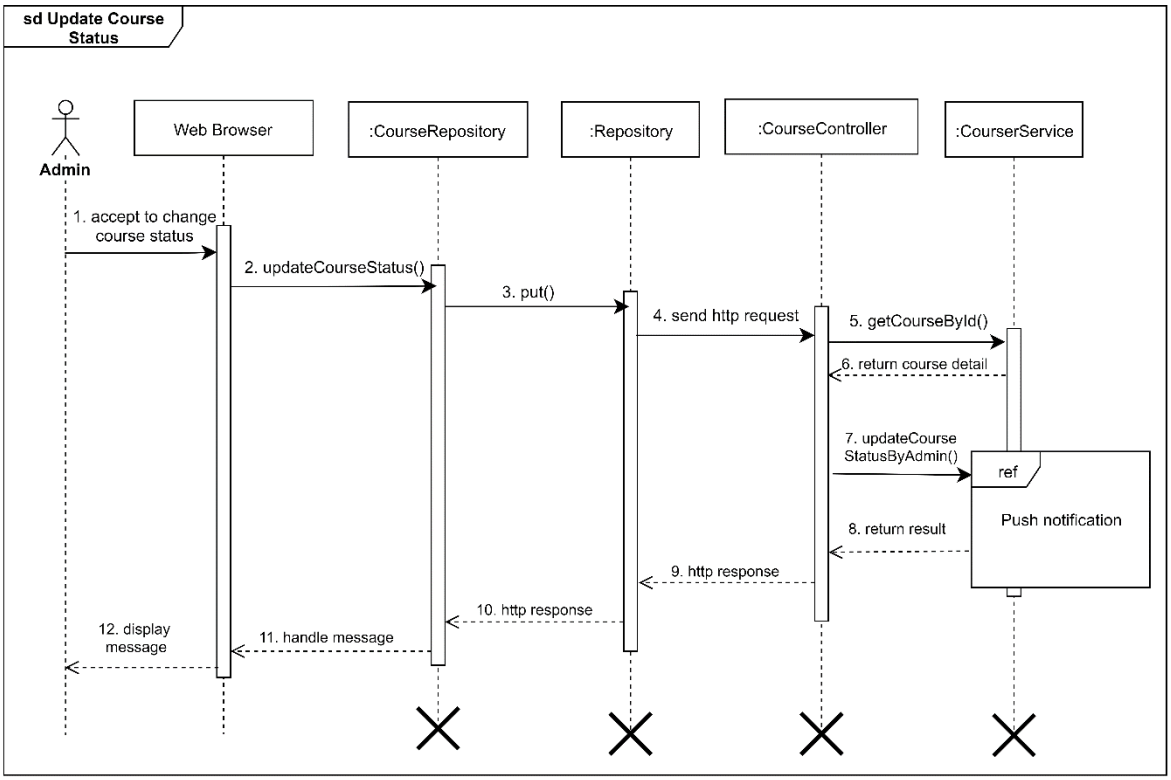


Figure 38: Sequence Diagram - <Instructor> Edit Lesson

10.3 Admin (Update Course Status)

Summary: this diagram shows process of update course status. This process is used for approve, reject or unpublish course.



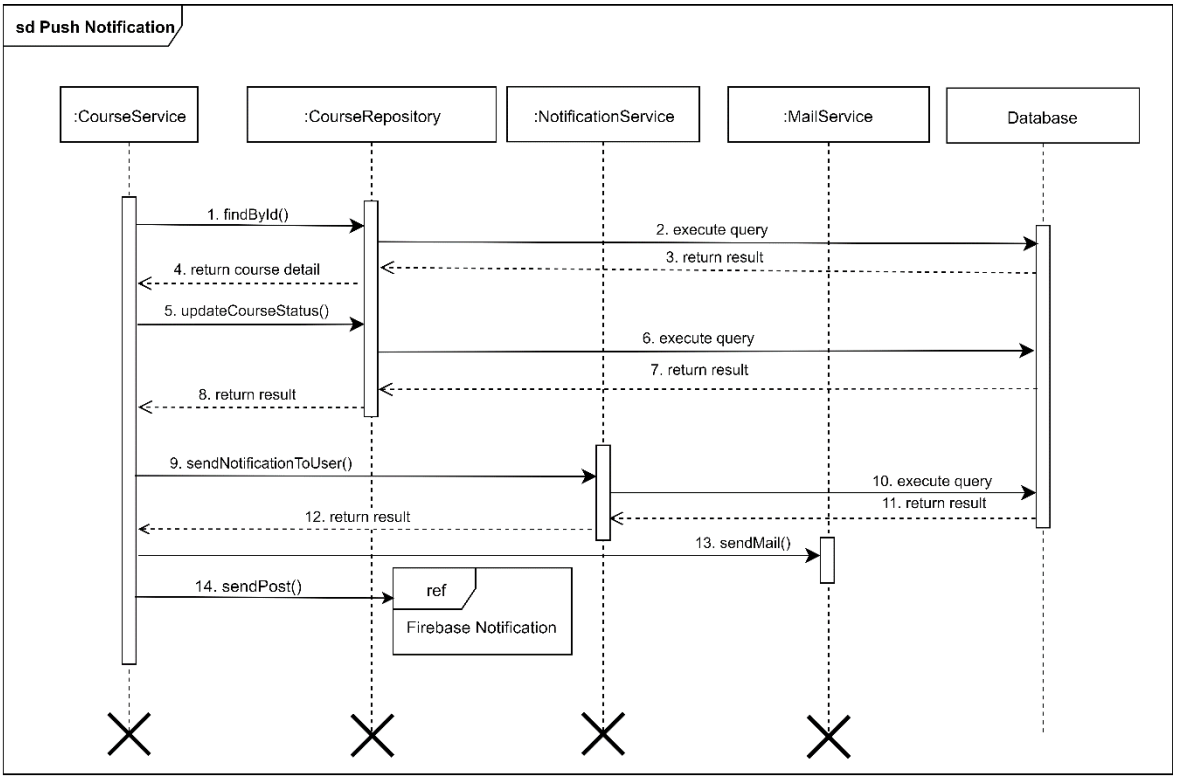


Figure 39: Sequence Diagram - <Admin> Update Course Status

10.4 System Bot (Play Chess With Learner)

Summary: this diagram shows process of play chess with learner.

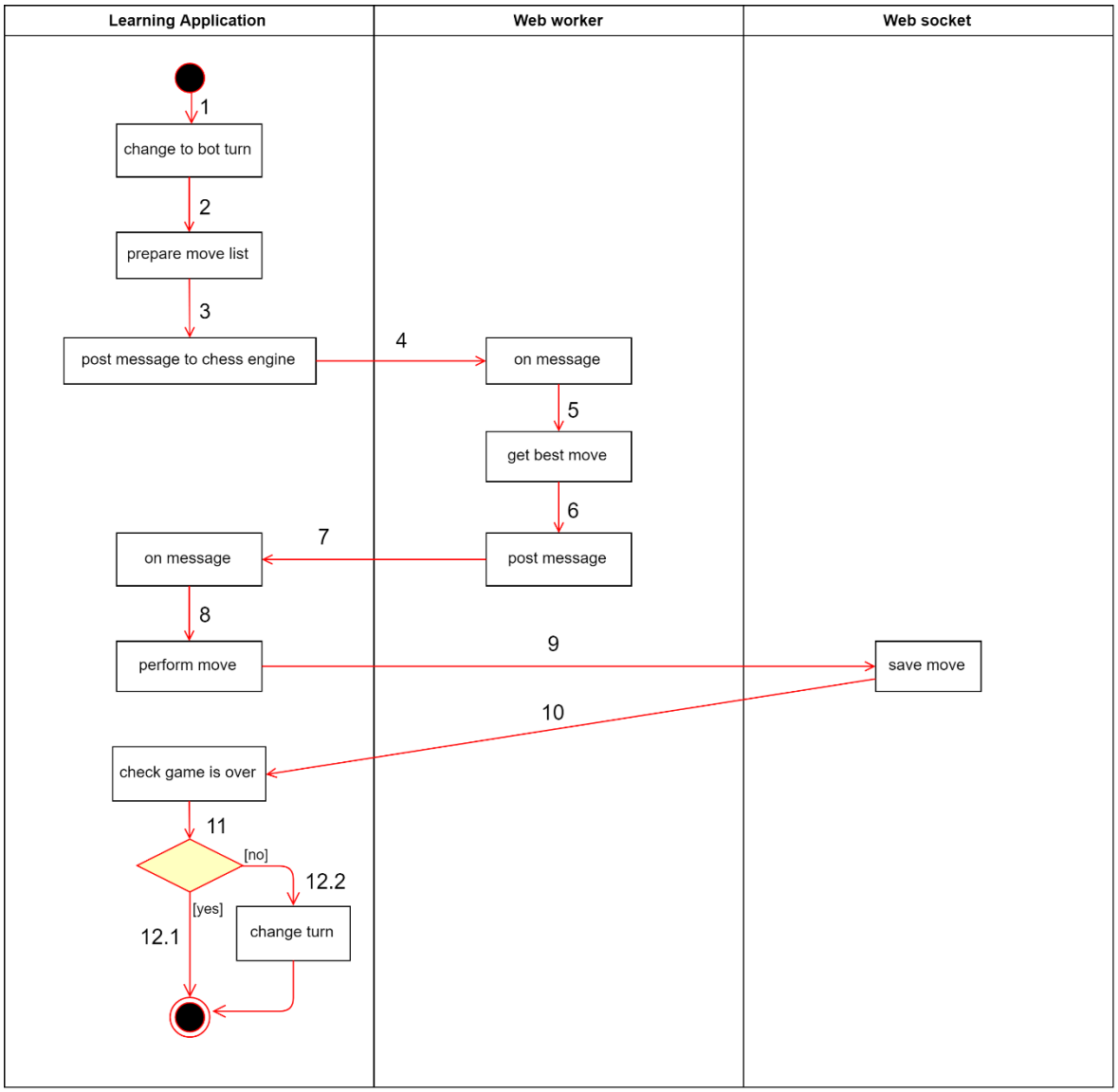


Figure 40: Activity Diagram - <Admin> Play Chess With Learner

11. Database Relationship Diagram

11.1 Physical Diagram

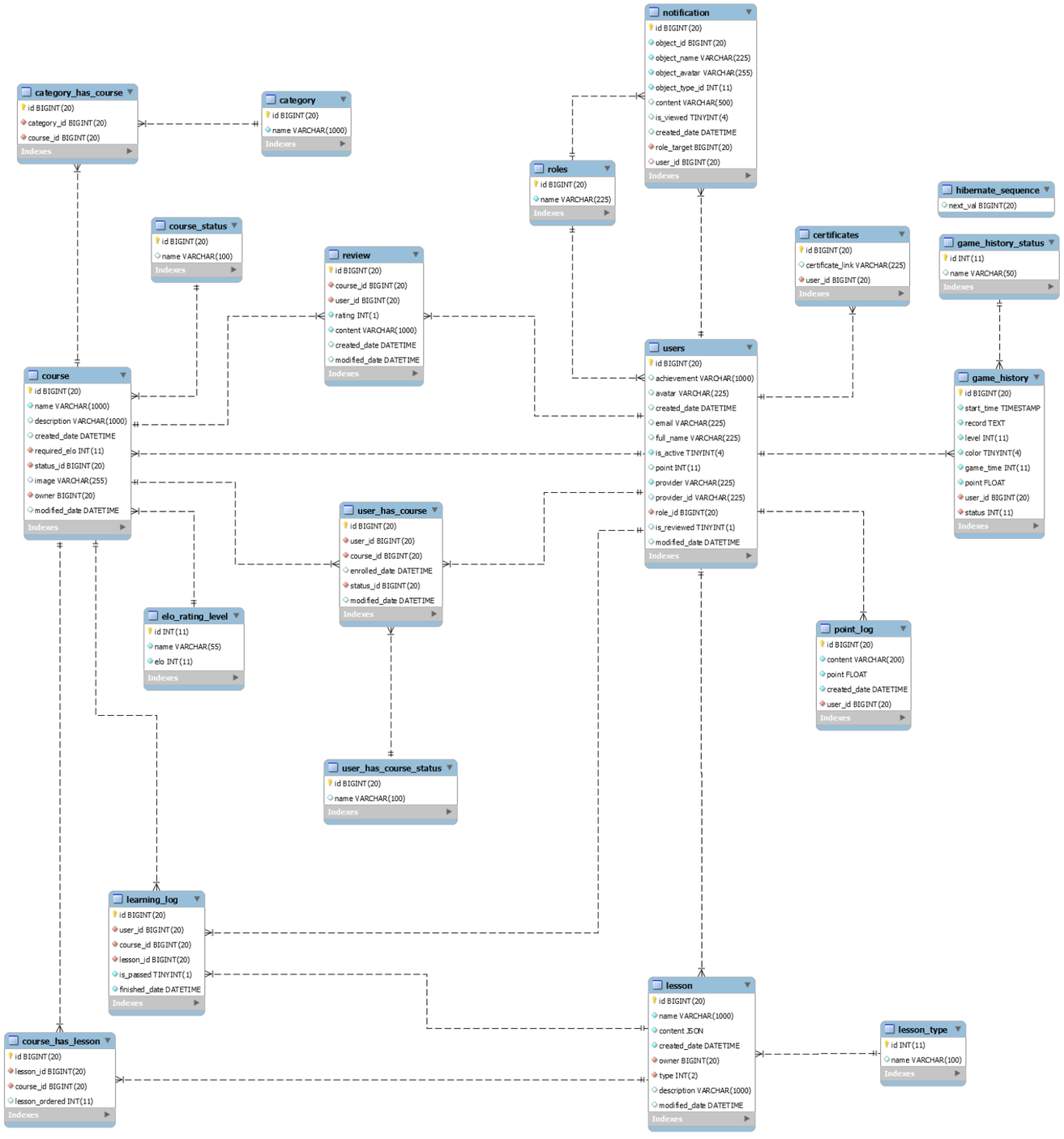


Figure 41: Physical diagram

11.2 Data dictionary

DATA DICTIONARY: DESCRIBE CONTENT OF ALL TABLES	
Table name	**Description**
users	Contains the user information
roles	Contains the user role name
point_log	Contains the log of user point transactions
notification	Contains the notification for each user
certificates	Contains the certificates for instructor
game_history	Contains the game history for learner
game_history_status	Contains the status name of game
review	Contains the course review information
course	Contains the course information
course_status	Contains the status name for a course
elo_rating_level	Contains the level name based on elo rating
category	Contains the category information
category_has_course	Contains the relationship between category and course
user_has_course	Contains the relationship between course and user
user_has_course_status	Contains the status name of course for user
lesson	Contains the lesson information
lesson_type	Contains the lesson type name
course_has_lesson	Contains the relationship between course and lesson
learning_log	Contains the learning progress information of a learner
hibernate_sequence	Table of Hibernate for tracking auto-increment ID

Table 25: Data Table Dictionary

Table Name	Attributes	Description	Domain	Null
user	id	Unique identifier of a user	BIGINT(20)	NO
	achievement	Instructor's achievement	VARCHAR(1000)	YES
	avatar	User's avatar URL	VARCHAR(225)	YES
	created_date	Created time of a user	DATETIME	YES
	email	User's email	VARCHAR(225)	YES
	full_name	User's full name	VARCHAR(225)	YES
	is_active	Current user's status	TINYINT(4)	NO
	point	Learner's point	FLOAT	YES
	provider	User's social network provider name	VARCHAR(225)	NO
	provider_id	User's social network provider identifier	VARCHAR(225)	YES

	role_id	Identifier of the user's role	BIGINT(20)	NO
	is_reviewed	Tracking instructor is reviewed or not	TINYINT(1)	NO
	modified_date	User information updated time	DATETIME	YES
roles	id	Unique identifier of a role	BIGINT(20)	NO
	name	Name of role	VARCHAR(225)	NO
point_log	id	Unique identifier of a point's log	BIGINT(20)	NO
	content	Point transaction's reason	VARCHAR(200)	NO
	point	Number of points	FLOAT	NO
	created_date	Log's time	DATETIME	NO
	user_id	Point owner's identifier	BIGINT(20)	NO
notification	id	Unique identifier of the notification	BIGINT(20)	NO
	object_id	Source object identifier	BIGINT(20)	NO
	object_name	Source object name	VARCHAR(225)	NO
	object_avatar	Source object avatar	VARCHAR(225)	NO
	object_type_id	Source object type identifier	INT(11)	NO
	content	Notification content	VARCHAR(500)	YES
	is_viewed	Tracking notification is viewed or not	TINYINT(4)	YES
	created_date	Notification time	DATETIME	YES
	role_target	Target role identifier	BIGINT(20)	NO
	user_id	Target user identifier	BIGINT(20)	NO
certificates	id	Unique indentifier of a certificate	BIGINT(20)	NO
	certificate_link	Instructor certificate image URL	VARCHAR(225)	YES
	user_id	Instructor's identifier	BIGINT(20)	NO
game_history	id	Unique identifier of a game history	BIGINT(20)	NO
	start_time	Game's start time	TIMESTAMP	NO
	record	Game's PGN	TEXT	NO
	color	Learner's colour	TINYINT(4)	NO
	game_time	Playing time for each player	INT(11)	NO
	point	Bonus point when ending game	FLOAT	NO
	user_id	Learner's identifier	BIGINT(20)	NO
	status	Game's status	INT(11)	NO

game_history_status	id	Unique identifier of a game status	INT(11)	NO
	name	Game status name	VARCHAR(50)	YES
review	id	Unique identifier of a review	BIGINT(20)	NO
	course_id	Course's identifier which contains the review	BIGINT(20)	NO
	user_id	Reviewer's identifier	BIGINT(20)	NO
	rating	Review's rating point	INT(1)	NO
	content	Review's content	VARCHAR(1000)	NO
	created_date	Review's time	DATETIME	YES
	modified_date	Review's updated time	DATETIME	YES
course	id	Unique identifier of a course	BIGINT(20)	NO
	name	Course's name	VARCHAR(1000)	NO
	description	Course's description	VARCHAR(1000)	YES
	created_date	Course's created time	DATETIME	YES
	required_elo	Course's required level identifier	INT(11)	NO
	status_id	Current course's status identifier	BIGINT(20)	NO
	image	Course's cover image URL	VARCHAR(255)	YES
	owner	Course's owner identifier	BIGINT(20)	NO
	modified_date	Course's updated time	DATETIME	YES
course_status	id	Unique identifier of a course's status	BIGINT(20)	NO
	name	Course's status name	VARCHAR(100)	YES
category	id	Unique identifier of a category	BIGINT(20)	NO
	name	Category's name	VARCHAR(1000)	NO
category_has_course	id	Unique identifier of a relationship between course and category	BIGINT(20)	NO
	category_id	Category identifier	BIGINT(20)	NO
	course_id	Course identifier	BIGINT(20)	NO
elo_rating_level	id	Unique identifier of a level	INT(11)	NO
	name	Level's name	VARCHAR(55)	NO
	elo	Level's required Elo	INT(11)	NO
user_has_course	id	Unique identifier of a relationship between user and course	BIGINT(20)	NO

	user_id	User identifier	BIGINT(20)	NO
	course_id	Course identifier	BIGINT(20)	NO
	enrolled_date	Enrol's time	DATETIME	YES
	status_id	Status identifier between course and user	BIGINT(20)	NO
	modified_date	Relationship's status updated time	DATETIME	YES
user_has_ course_status	id	Unique identifier of a status name for the relationship between user and course	BIGINT(20)	NO
	name	Status's name	VARCHAR(100)	YES
lesson	id	Unique identifier of a lesson	BIGINT(20)	NO
	name	Lesson's name	VARCHAR(1000)	NO
	content	Lesson's content	JSON	NO
	created_date	Lesson's created time	DATETIME	NO
	owner	Lesson's owner identifier	BIGINT(20)	NO
	type	Lesson's type identifier	INT(2)	NO
	description	Lesson's description	VARCHAR(1000)	YES
	modified_date	Lesson's updated time	DATETIME	YES
lesson_type	id	Unique identifier of a lesson type	INT(11)	NO
	name	Lesson type's name	VARCHAR(100)	YES
course_has_ lesson	id	Unique identifier of a relationship between course and lesson	BIGINT(20)	NO
	lesson_id	Lesson identifier	BIGINT(20)	NO
	course_id	Course identifier	BIGINT(20)	NO
	lesson_ordered	Lesson ordered in course	INT(11)	YES
learning_log	id	Unique identifier of a learning log	BIGINT(20)	NO
	user_id	Learner identifier	BIGINT(20)	NO
	course_id	Course identifier	BIGINT(20)	NO
	lesson_id	Lesson identifier	BIGINT(20)	NO
	is_passed	Tracking lesson is passed by the learner	TINYINT(1)	NO
	finished_date	Lesson finished time	DATETIME	NO

hibernate_ sequence	next_val	Next value of auto-increment key	BIGINT(20)	YES

Table 26: Data Table Description

12. Algorithms

12.1 Convert chess move list from database to display list

12.1.1 Definition

In our interactive lesson or exercise, the content is a chess game with existing move list, we need to display all chess move for the learner, and learner can click on each move to view the analysis of that chess puzzle. Moreover, chess game maybe contains more than 1 move for certain chess puzzle. Our system approves that 1 puzzle, a learner can view 2 moves, game move and another move from analyst, and we limit this action in 2 times, it means, in another move, we only have 1 another move again or the move depth is 3.

12.1.2 Define problem

From above requirement, we used an array to display chess move for the learner, each object in array is a turn include: turn index, depth of move turn, if depth is 1, object will contain white move and black move and chess move information, such as: move direction, FEN string,… is store in every move, if the depth is 2, the object will contain an array of depth 2 move, and it is same with depth is 3. Then we use linked list to store chess move with JSON format in the database, and we need to convert move linked list to displayed list. For example:

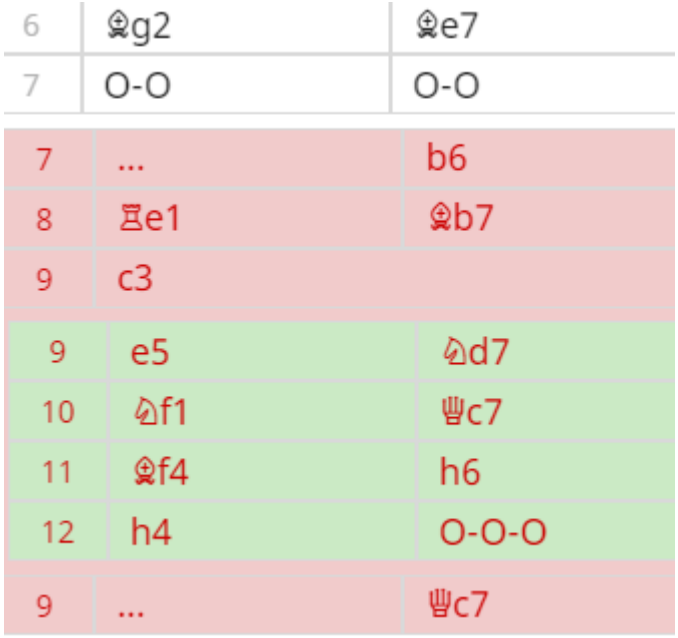


Figure 42: Target Move List

```
{
"id": 13,
"move": "O-O",
"content": "",
"moveDirection": "e1g1",
"fen": "r1bqk2r/pp2bppp/2n1pn2/2pp4/4P3/3P1NP1/PPPN1PBP/R1BQ1RK1 b kq - 4 7",
"preId": 12
},
{
"id": 14,
"move": "O-O",
"content": "",
"moveDirection": "e8g8",
"fen": "r1bq1rk1/pp2bppp/2n1pn2/2pp4/4P3/3P1NP1/PPPN1PBP/R1BQ1RK1 w - - 5 8",
"preId": 13
},
```


Figure 43: Sample move list from database

Move list dictionary	
Key	Description
id	Move Identifier
move	Chess Move in SAN, use for display move to the learner
content	Description for puzzle follow with a move
moveDirection	Move direction include source square, target square and maybe it contains promotion piece name. Chess programming needs to move directly to generate a new position.
fen	FEN String to present for current a chess position
preId	Previous move identifier

Table 27: Move list dictionary

12.1.3 Solution

To display chess move history in array list to the client. We need to take 3 steps:

- We will implement an array list to simple linked list by adding 1 attribute is the next step to each element.
- After we have a simple linked list, we will use Depth First Search (DFS) Algorithm.
- We will save this tree in array again but with our format for rendering

Firstly, we need to implement a simple linked list because we need to know what is the next steps of any step.

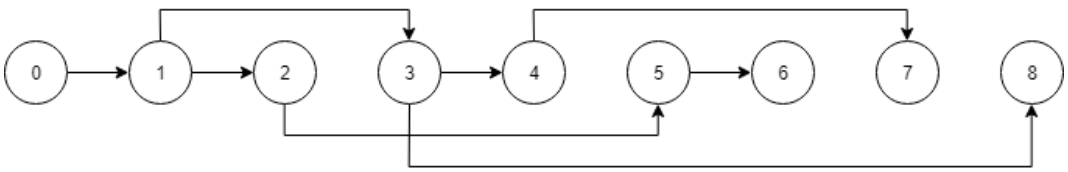


Figure 44: Example simple linked list

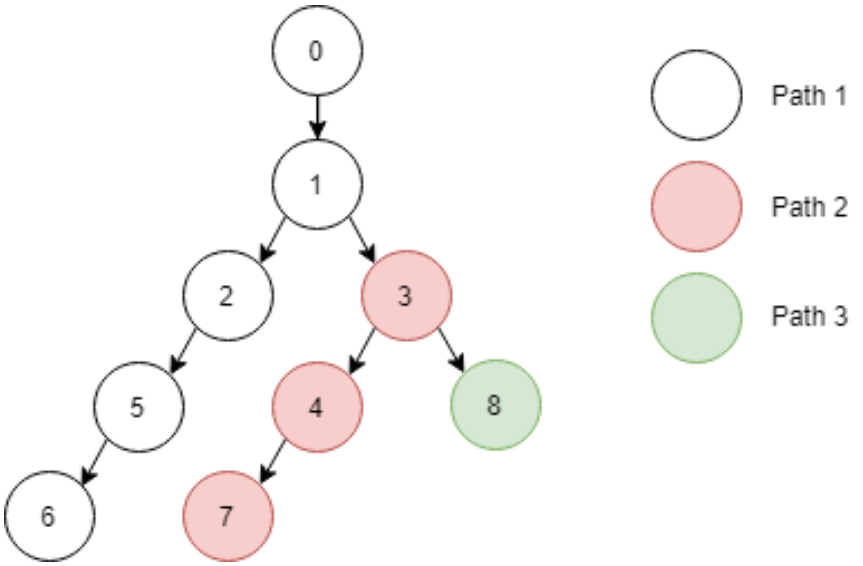


Figure 45: Example tree

With this tree, we have to find each path of the tree by using Recursion to implement Depth First Search (DFS) Algorithm. Of course, Breath First Search (BFS) is not suitable in this case.

Finally, while using DFS, we will save each node to element in the array with our format for rendering like this:

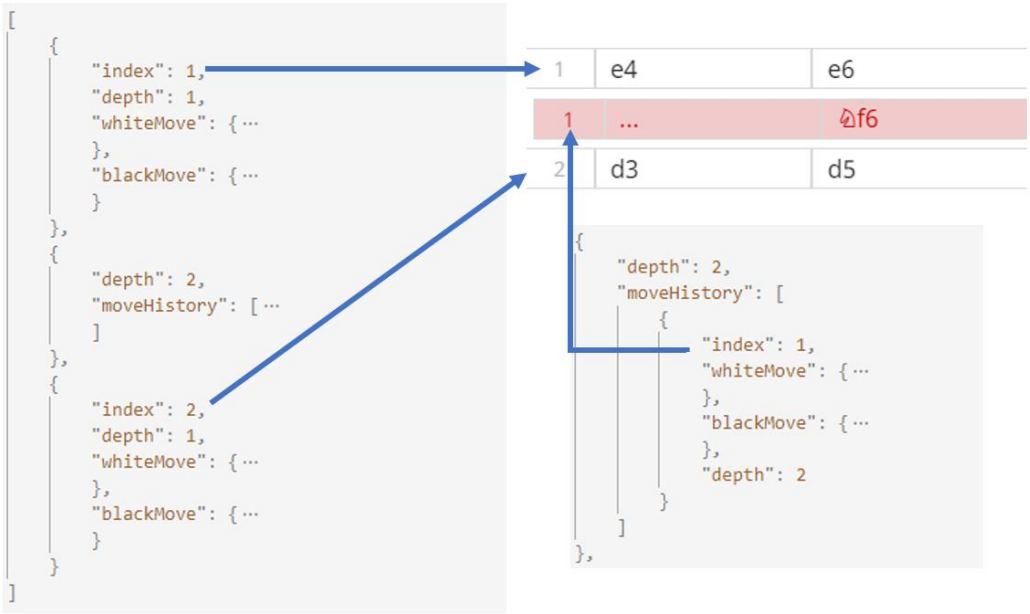


Figure 46: Move list result

12.1.4 Complexity

The complexity of this algorithm is: O(N)

12.2 Building chess bot

12.2.1 Definition

In COLS, we must build a chess bot, which can autoplay chess with the learner to improve their skills. We also use this bot to play with the learner in exercises.

12.2.2 Define problem

In a chess game, when a move is performed, there will have more possible game have existed. The number of game will be increased after more moves. Then we cannot use exhausted method to get the best move, it will take the memory very much.
When human play chess, they also calculate move with some of the material properties, such as:

- Controlling centre squares are better than controlling unoccupied squares.
- Double pawns are not good, they cannot defend each other.

Nowadays, there are more chess programming, they combine the chess material properties and computed methods to analyse chess move in computer. In COLS, we also use existing chess engine to get the best move for a specific chess position, which is called Stockfishjs.

12.2.3 Solution

In building play chess feature, we use stockfishjs chess engine to calculate the best move, Chessjs to handle the game and validates the player move. We also use Chessground library to show Chessboard for the learner.
There are some concepts in chess programming, then we will discuss an overview of them.
Chessboard: A chessboard will have 64 squares represents an 8x8 grid. In chess programming, they call file for each board column and rank for each board row. It means a chessboard contains 8 ranks: 1-8 and 8 columns: a-h. We also use rank and file to record a square, such as a1, b3, e6,…, it is called Algebraic notation (AN).

8	a8	b8	c8	d8	e8	f8	g8	h8
7	a7	b7	c7	d7	e7	f7	g7	h7
6	a6	b6	c6	d6	e6	f6	g6	h6
5	a5	b5	c5	d5	e5	f5	g5	h5
4	a4	b4	c4	d4	e4	f4	g4	h4
3	a3	b3	c3	d3	e3	f3	g3	h3
2	a2	b2	c2	d2	e2	f2	g2	h2
1	a1	b1	c1	d1	e1	f1	g1	h1
	a	b	c	d	e	f	g	h

Figure 47: A chessboard with square in AN

FEN String: A FEN string is used to mark current position in a chess game, which will contain 6 parts – pieces position, move turn, castle tracking, en passant target, half move clock to handle 50 moves rule, and full move number.

- The first part in FEN String will use to represent chess pieces position by their name: **K**ing, **Q**ueen, **R**ook, **B**ishop, K**N**ight and **P**awn. The black pieces will be noted by lowercase (kqrbnp) and uppercase for white pieces. They will note chess pieces from rank 8 to rank 1 for each rank, and ranks will be joined at "/". If a square which contains pieces, it will be noted by pieces name and empty square will be noted by number. When a rank has adjacent empty squares, the number will be incremental until a piece square, for example:

Figure 48: Sample rank in FEN String

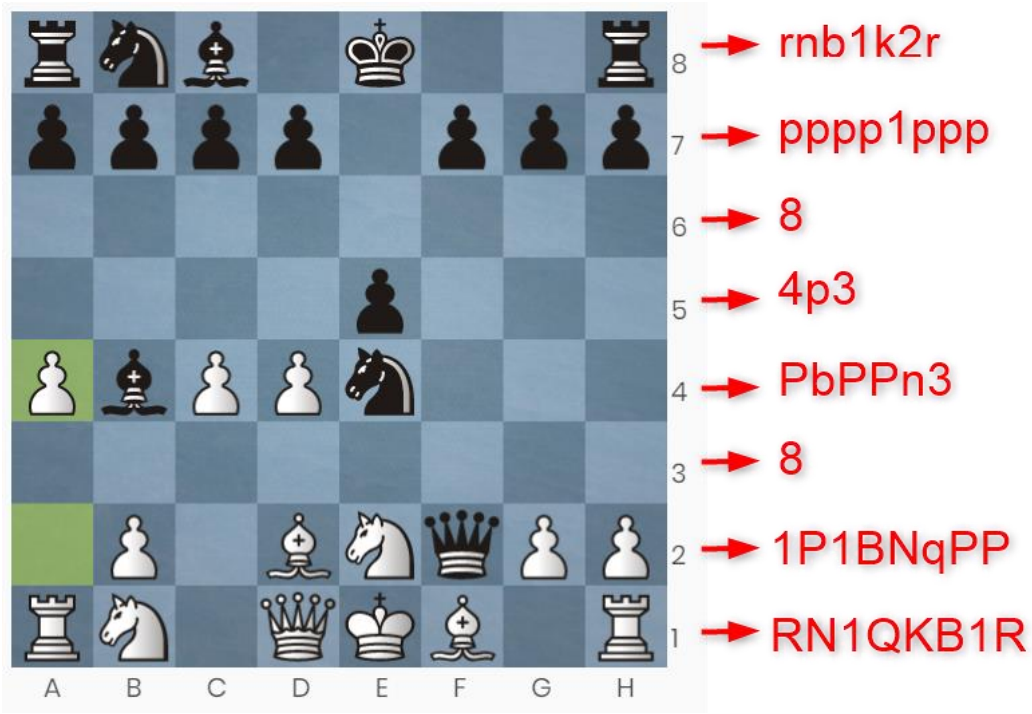


Figure 49: Sample Position in FEN String

(The above chess position will be noted:
rnb1k2r/pppp1ppp/8/4p3/PbPPn3/8/1P1BNqPP/RN1QKB1R)

- The second part in FEN String will represent for move turn: "w" for the white turn in next move and "b" for the black turn.
- The third part is castling tracking, each character is the wing which player can use castling move: K (White King), Q (White Queen), k (Black King), q (Black Queen).

- The fourth part will display an en passant target square if a player performs a two squares move or "-" for other moves. It means an en passant target move will be a move in rank 3 or 6.
- The fifth part is the total of half move since the last capture or pawn advance. It will be returned to 0 after a capture or pawn advance move and it is used to check 50 moves rule.
- The last part is the number of a full move in-game. It is count after a black's move.

FEN String is important data, which can represent all states in the current game. In our chess bot, we use all above chess libraries follow this flow:

- When the game is started, the all chess libraries: chessjs, chessground, stockfishjs will have initial FEN String:
  rnbqkbnr/pppppppp/8/8/8/8/PPPPPPPP/RNBQKBNR w KQkq - 0 1
- For player turn:
  - When a move is performed in the chessboard, Chessground will generate a move, which contains source square and target square (and promotion pieces for promotion move in lowercase), for example e2e4 or f7f8q (f7 to f8, promote to Queen).
  - The move will be sent to chessjs and chessjs will generate new FEN String by it. Chessground will render a new position from new FEN String. User can see new game position.
- For bot turn, we use UCI command to communicate with Stockfishjs to get the best move, the UCI command:
  position startpos moves [string of moves from start game]
  If the string of moves is empty, the engine will calculate from start game, else it will calculate game from the game position in the last move of string. The result will be the best move with move direction (source square, target square and maybe promotion piece name). We also use this command, it will use FEN String for analyzing in custom position:
  position fen <fen string> moves [string of moves from start game]
- With the above UCI command, we need to add move after each half move.
- We also use chessjs to generate new FEN String and re-render new position.
- All the above step will repeat until the game is over. Chessjs lib will check FEN String to evaluate game is playing or over. After half move, chessjs also check possible moves and we will use possible moves to validate player move, if the move is not included, the player needs to perform again.

For building different bot level, we call different engine-level by this command:
setoption name Skill Level value <skill_level>

12.2.4 Flow chart

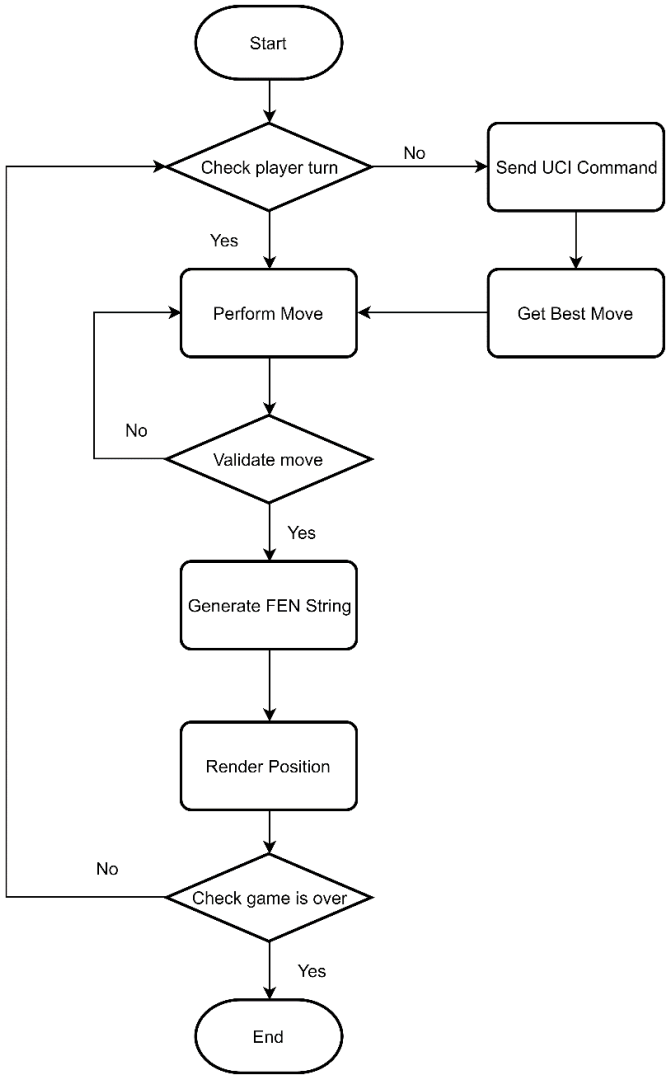


Figure 50: Building Chess Bot Flow chart

12.3 Building Elo rating system

12.3.1 Definition

In COLS, we must evaluate the learner's level by playing chess with the bot. Therefore, we need a standard rating system, which approved by FIDE (Fédération internationale des échecs).

12.3.2 Define problem

In COLS, the learner will start with specially point based on their chosen level. Whenever learner complete playing chess with the bot, the system will update point of learner depend on a final result chess game.

Each level of stockfishjs chess bot will have a specially Elo point and learner point will be calculated following the Elo rating system.

12.3.3 Solution

In the learner's rankings, we use the International Chess Association (FIDE) rankings[15] as the standard and readjust it to match the ranking of the system. Each rank will correspond to an Elo range:

- Beginner (0 ~ 1000 Elo points)
- Minor (1000 ~ 1200 Elo points)
- Intermediate (1200 ~ 1400 Elo points)
- Major (1400 ~ 1600 Elo points)
- Master(> 1600 Elo points)

When users create an account will allow them to choose their current level. Then the system will fill in the corresponding points for them.

In classifying each level of the bot in the Elo system. We use the CCRL 4040 calculation to help evaluate the bot's Elo level when learners play:

Rank	Name	Elo	+	-	games	score	oppo.	draws
1	Stockfish 10 x64 1T20	3495	102	102	400	99%	2804	2%
2	Stockfish 10 x64 1T19	2855	32	32	400	45%	2965	26%
3	Stockfish 10 x64 1T18	2825	32	32	400	41%	2972	27%
4	Stockfish 10 x64 1T17	2793	32	32	400	36%	2980	27%
5	Stockfish 10 x64 1T16	2745	23	23	800	50%	2788	24%
6	Stockfish 10 x64 1T15	2677	30	30	400	60%	2602	26%
7	Stockfish 10 x64 1T14	2652	30	30	400	56%	2608	26%
8	Stockfish 10 x64 1T13	2552	31	31	400	39%	2633	21%
9	Stockfish 10 x64 1T12	2458	24	24	800	50%	2444	14%
10	Stockfish 10 x64 1T11	2370	33	33	400	65%	2253	14%
11	Stockfish 10 x64 1T10	2269	32	32	400	49%	2279	12%
12	Stockfish 10 x64 1T09	2181	33	33	400	36%	2301	13%
13	Stockfish 10 x64 1T08	2105	25	25	800	49%	2108	8%
14	Stockfish 10 x64 1T07	2050	35	35	400	66%	1910	7%
15	Stockfish 10 x64 1T06	1950	34	34	400	51%	1935	5%
16	Stockfish 10 x64 1T05	1862	34	34	400	39%	1957	4%
17	Stockfish 10 x64 1T04	1722	29	29	800	52%	1683	3%
18	Stockfish 10 x64 1T03	1589	37	37	400	68%	1408	2%
19	Stockfish 10 x64 1T02	1427	36	36	400	48%	1449	2%
20	Stockfish 10 x64 1T01	1302	38	38	400	32%	1480	1%
21	Stockfish 10 x64 1T00	1181	42	42	400	19%	1510	0%

The realistic part of the ellipse after the learner completes the game of chess with the bot. It includes the probability of making ellipse commands between learners and bots and finding K-factors.
Probability of ellipse between learner and bot In which learners are A and bots are B:

$$E_A = \frac{1}{1 + 10^{(R_B - R_A)/400}}$$

$$E_B = \frac{1}{1 + 10^{(R_A - R_B)/400}}$$

E_A: expected score of A

E_B: expected score of B

R_A: rating of A (current elo point)

R_B: rating of B (current elo point)

Note that:

$$\boldsymbol{E_A + E_B = 1}$$

$$R'_A = R_A + K(S_A - E_A)$$

R'_A: new rating of A

S_A: actually scored (1 for win , 0 for lose and drawn for 0.5)

K: k-factors

FIDE used the following ranges for K[15]:

- K = 40 for a player new to the rating list until he has completed events with at least 30 games.
- K = 20 as long as a player's rating remains under 2400.
- K = 10 once a player's published rating has reached 2400 and remains at that level subsequently, even if the rating drops below 2400.

12.4 Finding Similar User

12.4.1 Definition

In order to make a recommendation for learners based on existing data, we use Collaborative filtering technique by memory-based. Firstly, we need to find similar users with the current user.

12.4.2 Define problem

The existing data is a rating of learners for their courses. We would calculate similarity based on the interest of learners with courses.

12.4.3 Solution

We apply cosin similarity to calculate similar between 2 users:

$$similarity(A,B) = \frac{\sum_{i=1}^{n} A_i B_i}{\sqrt{\sum_{i=1}^{n} {A_i}^2}\sqrt{\sum_{i=1}^{n} {B_i}^2}}$$

A_i: Rating in course i of user A

B_i: Rating in course i of user B

Result range: [0,1] with 1 is the most similar

12.4.4 Example

There are ratings of 4 users for course 1 to 5:

Course	User A	User B	User C	User D
1	4.0	5.0	4.5	5.0
2	5.0	null	4.0	4.5
3	4.0	4.0	null	5.0
4	3.0	3.5	4.0	null
5	null	3.0	3.0	4.5

Similarity between User A and other User:

$$similarity(A,B) = \frac{4*5+4*4+3*3.5}{\sqrt{4^2+5^2+4^2+3^2}\sqrt{5^2+4^2+3.5^2+3^2}} = 0.78006$$

$$similarity(A,C) = \frac{4*4.5+5*4+3*4}{\sqrt{4^2+5^2+4^2+3^2}\sqrt{4.5^2+4^2+4^2+3^2}} = 0.7864$$

$$similarity(A,D) = \frac{4*5+5*4.5+4*5}{\sqrt{4^2+5^2+4^2+3^2}\sqrt{5^2+4.5^2+5^2+4.5^2}} = 0.80869$$

12.4.5 Complexity

The Complexity is: O(n)

12.5 Course Rating Prediction (User-based filtering)

12.5.1 Definition

From the above result, we perform next step is predicting ratings for courses which user has not been learned based on similar users.

12.5.2 Define problem

Each user has different courses, but if they have large similarity, we can predict the rating for courses which they have not been learned.

12.5.3 Solution

Calculating the weighted average based on rating and similarity of top n user:

$$R = \frac{(\sum_{u=1}^{n} R_u S_u)}{\sum_{u=1}^{n} S_u}$$

R: Predicted rating of course

R_u: Rating in course of user u

S_u: Similarity between current user with user u

12.5.4 Example

Course	User A	User B	User C	User D
1	4.0	5.0	4.5	5.0
2	5.0	null	4.0	4.5
3	4.0	4.0	null	5.0
4	3.0	3.5	4.0	null
5	null	3.0	3.0	4.5

We will use above data and assump that User B, C, D is top 3 similar user of A. The similar between A and them are sim(A,B) = 0.78, sim(A,C) = 0.7864 and sim(A,D) = 0.809.

The predicted rating of A for course 5 is:

$$R = \frac{3*0.78+3*0.7864+4.5*0.809}{0.78+0.7864+0.809} = 3.51$$

12.5.5 Complexity

The Complexity is: O(n)

12.6 Item-based filtering

12.6.1 Definition

In COLS, we also calculate similar between system courses and user enrolled courses.

12.6.2 Define problem

When the user views a specific course, the system will find similar courses with current course to suggest for the user. The suggested course must be the same with learner skill level.

12.6.3 Solution

We also using cosin similarity with special parameter to calculate similar course. Courses in the system will have similar attributes:

Attribute	Course A (current course)	Course B
Same instructor	1	x
Same category	1	y
Course rating	r_A	r_B

x: value is 0 if course B has different instructor and 1 if course B has same instructor

y = $\frac{number\ of\ same\ categories\ between\ course\ A\ and\ course\ B}{number\ of\ categories\ in\ course\ A}$

r_A: Average rating of course A

r_B: Average rating of course B

$$similarity(A,B) = \frac{x + y + r_A * r_B}{\sqrt{{r_A}^2 + 2}\sqrt{x^2 + y^2 + {r_B}^2}}$$

Result range: [0,1] with 1 is the most similar

12.6.4 Example

Attribute	Course A (current course)	Course B	Course C
Same instructor	1	0	1
Same category	1	0.5	0.33
Course rating	4	4.5	4

Similarity between Course A and other courses:

$$similarity(A,B) = \frac{0.5 + 4.5 * 4}{\sqrt{4^2 + 2}\sqrt{0.5^2 + 4.5^2}} = 0.46$$

$$similarity(A,C) = \frac{1 + 0.33 + 4 * 4}{\sqrt{4^2 + 2}\sqrt{1 + 0.33^2 + 4^2}} = 0.98$$

Course C is almost identical to A than the other course because the similarity is larger.

12.6.5 Complexity

The Complexity is: O(n)

13. Future plan

Current system also has problems and it will be developed in the future:

- Detect cheating in game to improve point reliability.
- Support chess playing peer to peer to extend practice opportunity for learner.
- Develop money collecting features for instructor.
- Automatively administrator working.
- Develop course suggestion feature based on learner profile.

14. Appendix

1. **The Unified Modeling Language** *[Online]* Available: https://www.omg.org/spec/UML/2.0/About-UML/ Accessed on: Sept. 2019.

2. **Multitier Architecture** *[Online]* Available: https://www.ibm.com/support/knowledgecenter/en/SSAW57_8.5.5/com.ibm.websphere.nd.multiplatform.doc/ae/covr_3-tier.html Accessed on: Sept. 2019.
3. Chen, P.P., "The Entity-Relationship Model: Toward a Unified View of Data". *ACM Trans. on Database Systems*.

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