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CKB - CodeKataBattle

RASD Requirement Analysis and Specification Document

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1 Introduction

1.1 Purpose

The system has, as main function, to deliver a platform where Students can challenge themselves, alone or in team, writing code to solve exercises assigned by Educators, to improve their software development skills. Students have to follow a test-first approach. The platform is used by Educators to create, manage and close tournaments, each one is composed by battles, while Students have to solve the exercises published for every battle filling them with their own code. Each exercise includes a brief textual description and a software project with build automation scripts that contains a set of test cases that the program must pass, but without the program implementation.

CKB offers also the possibility for each team to know their rank (calculated automatically by the platform) within the context of each battle, and the general rank of that tournament, in addition to a set of badges the Students can achieve, to increase the level of challenge.

1.1.1 Goals

[G1] Educator can manage (create battles and badges, grant permission to other Educators, and close) each tournament he/she creates.

[G2] Educator can manage (deliver exercise, set options, evaluate teams submissions and check rank) each battle he/she creates.

[G3] Student can subscribe to a tournament.

[G4] Student can manage (subscribe and check rank) their participation to a battle.

[G5] Both educators and students can check rank for each tournament.

[G6] Both educators and students can visualize the profile of a Student.

[G7] Both educators and students can see the list of ongoing tournaments.

1.2 Scope

In recent years, it has gained more and more ground the possibility to train and improve writing code skills through platforms, such as CodeKataBattle, that assign to people who want to challenge themselves exercises to fulfill autonomously, in a programming language of choice.

The philosophy behind these platforms is called *codekata*, a method that aims to refine people's software development skills training and solving exercises over and over again, using feedback to get better every time.

CodeKataBattle deals with two main users on its platform:

- Educators
- Students

Each Educator can create a tournament, either creating battles by him/herself or granting to other Educators the permission to create battles within the context of a specific tournament.

Once a new tournament is created, all the Students subscribed to CKB are notified and can decide whether to subscribe to that tournament or not. If a Student decides to subscribe to a tournament, he/she will be notified whenever a new battle is created in the context of that tournament.

An Educator that has the permission to do it can create a new battle, and delivers the exercise associated to it. Moreover, the Educator can set the rules for that specific battle. If a Student subscribes to a specific battle, he/she is asked to build his/her own team, with reference to the limits imposed by the Educator. When the deadline expires, for each team is created a GitHub repository, and each team is asked to modify settings, so that for every push the team does, CKB is notified.

If the platform is triggered, it pulls the latest sources of the team from which it has received the notification and automatically evaluates it. Then, it updates the team rank in the context of the battle.

When the submission deadline expires, there is an intermediate phase, called consolidation stage, in which Educators manually evaluate team projects, if it is required by the battle's settings.

After that, the students participating to that battle are notified by the platform and they can visualize their final rank, as well as their tournament rank, which is updated by CKB whenever a battle ends in the context of that specific tournament.

In every tournament, Students can achieve some Badges, defined by Educators when they create a new tournament.

Every user subscribed to the platform can visualize the list of ongoing tournaments, the corresponding tournament rank and other Student's profile, including the badges achieved.

1.2.1 World Phenomena

[WP1] Students work on the assigned exercise.

[WP2] Students fork the GitHub repository of the code kata and set up an automated workflow that informs the CKB platform as soon as students push a new commit into the main branch of their repository.

1.2.2 Shared Phenomena - controlled by the World

- [SP1] Educator creates a new tournament.
- [SP2] Educator creates a new battle.
- [SP3] Educator grants another Educator the permission to create battles within the context of a specific tournament.
- [SP4] Educator delivers the exercise for a specific battle.
- [SP5] Educator sets the minimum and maximum number of students per group for a specific battle.
- [SP6] Educator sets the registration deadline for a specific battle.
- [SP7] Educator sets the final submission deadline for a specific battle.
- [SP8] Educator eventually sets the possibility of manually evaluating the projects for a specific battle.
- [SP9] Student can subscribe to a tournament.
- [SP10] Student can subscribe to a battle.
- [SP11] Student can form a team for a specific battle.
- [SP12] Both students and educators involved in the battle can see the current rank evolving during the battle.
- [SP13] Educator manually evaluates the projects for a specific battle (consolidation stage).
- [SP14] Both Educators and Students subscribed to CKB can see the list of ongoing tournaments as well as the corresponding tournament rank.
- [SP15] Educator can define a Badge for a specific tournament.
- [SP16] Both Educators and Students can visualize another Student's profile.

1.2.3 Shared Phenomena - controlled by the Machine

- [SP17] CKB sends a notification to all Students subscribed to the platform whenever a new tournament is created.
- [SP18] CKB sends a notification to all Students subscribed to a specific tournament whenever a new battle is created in the context of that specific tournament.
- [SP19] At the end of the consolidation stage, all students participating in the battle are notified when the final battle rank becomes available.
- [SP20] When an educator closes a tournament, as soon as the final tournament rank becomes available, the CKB platform notifies all students subscribed to that tournament.
- [SP21] CKB can assign a Badge to a Student.

1.3 Definitions, Acronyms, Abbreviations

1.3.1 Definitions

- **Programming language:** set of rules that allows string values to be converted into various ways of generating machine code, or, in the case of visual programming languages, graphical elements.
- **Automation scripts:** a specific type of automation script used in software development to automate the process of building, compiling, and packaging software applications.
- **Test-first approach:** is a software development process relying on software requirements being converted to test cases before software is fully developed, and tracking all software development by repeatedly testing the software against all test cases.
- **GitHub:** a platform and cloud-based service for software development and version control, allowing developers to store and manage their code.
- **Badge:** elements in the form of rewards that represent the achievements of individual students.

1.3.2 Acronyms

- **CKB:** CodeKataBattle
- **RASD:** Requirement Analysis and Specification Document
- **UML:** Unified Modelling Language
- **UI:** User Interface
- **OWASP:** Open Web Application Security Project
- **WCAG:** Web Content Accessibility Guidelines

1.3.3 Abbreviations

- $[Gn]$ - the n-th goal of the system
- $[WPn]$ - the n-th world phenomena
- $[SPn]$ - the n-th shared phenomena
- $[UCn]$ - the n-th use case
- $[Rn]$ - the n-th functional requirement

1.4 Revision history

- Version 1.0 (22/12/2023);

1.5 Reference Documents

This document is based on:

- The specification of the RASD and DD assignment of the Software Engineering II course, held by professor Matteo Rossi, Elisabetta Di Nitto and Matteo Camilli at the Politecnico di Milano, A.Y 2023/2024
- Slides of Software Engineering 2 course on WeBeep;
- Official link of Codewars (<https://www.codewars.com/>), a platform similar to CodeKata-Battle
- Other informations that helped the development of the project:
 - In-depth analysis on codekata;
 - In-depth analysis on test-driven development;

1.6 Document Structure

This document is divided in 6 chapters, more in detail:

1. **Introduction:** this chapter describes the reasons for which this project is being developed, highlighting above all the goals aimed to reach. Moreover, it analyses the environment and the shared phenomena between the world and the machine.
2. **Overall description:** it is an initial analysis about the system to be developed, with examples of possible scenarios. In particular it focuses, through diagrams (e.g. class diagrams, state diagrams), on the elements in the system's domain and the interaction between them. This section also includes domain assumptions and the most relevant requirements of the system.
3. **Specific requirements:** this chapter aims to describe all the system's requirements, both functional and non-functional, and eventual constraints. Diagrams are used to integrate requirements with scenarios and generalize them into use cases.
4. **Formal analysis using Alloy:** this chapter describes, with Alloy language, the entire model in a formal way. There is also an overview about what can be verified and some examples of the world obtained running the code.
5. **Effort spent:** this section shows the time spent (in hours) by each member to work on this document.
6. **References:** it contains the references to any documents and to the Software used in this document.

2 Overall Description

2.1 Product perspective

2.1.1 Scenarios

A. Registration

Emanuele is a Computer Science and Engineering student. He wants to showcase and develop his programming skills. He heard about CKB and decides to give it a try. He goes to the CKB website and creates an account providing his personal info, his academic status (student/educator), and setting up a password. After that, he can join tournaments and finally start showing off his abilities while becoming a code master in the process.

B. Tournament creation

Matteo is a Google hiring manager. He is looking for new talented and enthusiastic software engineers. He creates a new tournament specifying the deadline for the subscription and grants his team permission to create new battles. Users who enabled notifications will receive an email notifying them about the creation of this new tournament. Matteo finds a lot of passionate coders and engages with them in a wide variety of battles. He can then pick those who performed brilliantly and can offer them a job at Google.

C. Battle creation

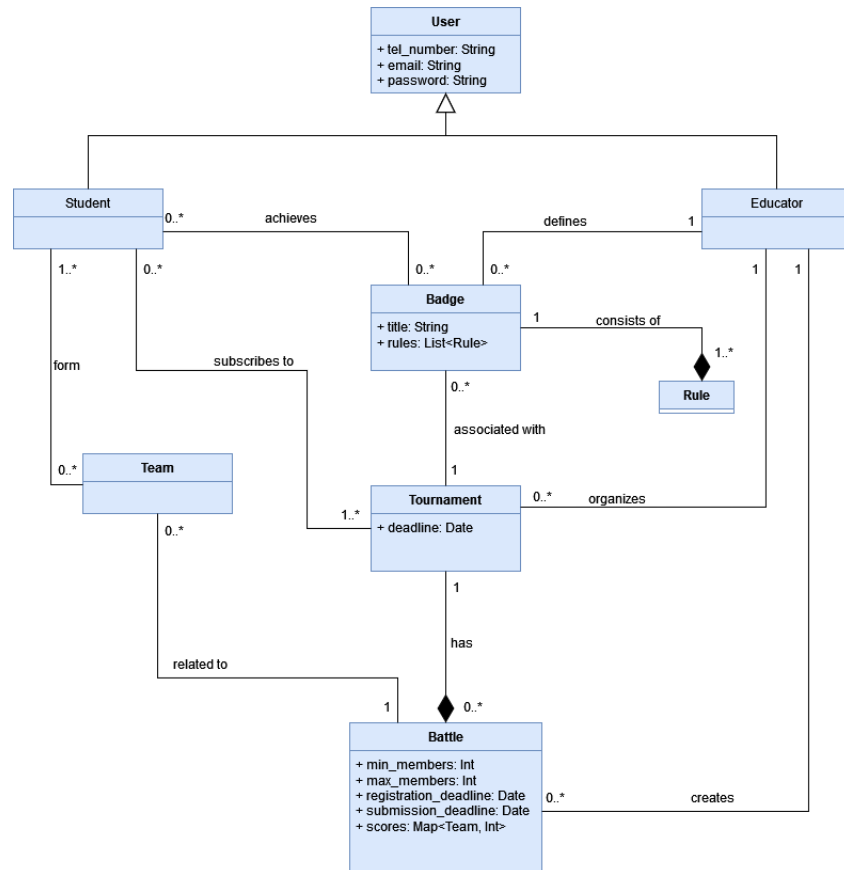
Giuseppe is a recruiter from Google with an 'educator' account in CKB. He has been granted permission to create battles by his superior, Matteo. He publishes the code kata (that includes everything to make the battle work, from the description to test cases and automation scripts) and chooses edits the battle configuration settings such as minimum and maximum number of students per team, submission deadline and more. Students subscribed to this tournament can form teams and start working on the project. After the submission deadline, teams will receive an automatic evaluation. Giuseppe is allowed to review the evaluations if need be, and finally publish the final grades for each team.

D. Badge creation

Matteo wants to add achievements to his tournament to hype up the students. He chooses a few conditions that he finds interesting selects the titles and creates the badges. At the end of the tournament, all the system checks the badges conditions to each user. Ultimately, the badges will be assigned to the students and they will be able to show them in their personal profile.

2.1.2 Class diagram

The presented UML class diagram illustrates a conceptual, high-level model of the software. Due to its nature, it might model entities that won't necessarily be part of the final system under development. At this stage, it lacks references to methods and other low-level details, as these will be elaborated during the subsequent design phase.



The main entities are:

- **User**

A user can be either a student or an educator. Users can perform different actions according to this: educators create tournaments and battles, while students join them.

- **Tournament**

Tournaments are created by educators and students can subscribe to them. They consist of different battles. The creator of the tournament can grant other educators privileges to define battles. Each student has a score consisting of the cumulative sum of scores obtained in all battles. Badges can also be assigned to a specific tournament.

- **Battles**

Battles are created by educators with privileges in the scope of a tournament. Numerous settings are available for customization, such as the minimum and maximum settings for a team, deadlines and more. Students subscribed to a tournament need to form a team for each battle. At the end of the battle, each team is assigned a score between 0 and 100.

- **Badge**

Badges are gamification objects that students can collect and show off in their profile. Educators can create badges and associate them to a specific tournament. Each badge has a set of rules that students need to satisfy in order to achieve it.

2.1.3 State diagrams

The purpose of the following UML state diagrams is to provide additional information about the behaviour of the system. These are the scenarios that we found more interesting.

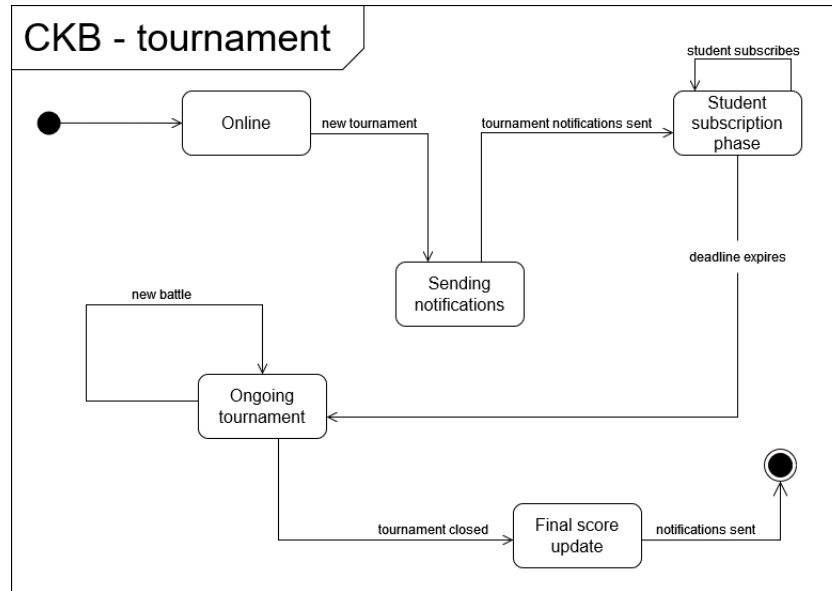


Figure 1: Tournament timeline

This diagram describes what happens inside the system throughout a tournament, from the creation to the conclusion. At first, the system is waiting for new events. When an educator creates a new tournament, the system responds by sending notifications to all students. After that, the system enters a waiting state, allowing students to subscribe to the tournament until the specified deadline. When the tournament is finally open, authorized educators can create new battles. This process is seen more in-depth in the next diagram. After each battle, the system automatically updates the score for each student. New battles can be created until the creator closes the tournament. Students who took part in this tournament are sent a notification about their score, their ranking and eventual badges they may have achieved. At any moment, the creator can grant other educators permission to create battles in the scope of his tournament.

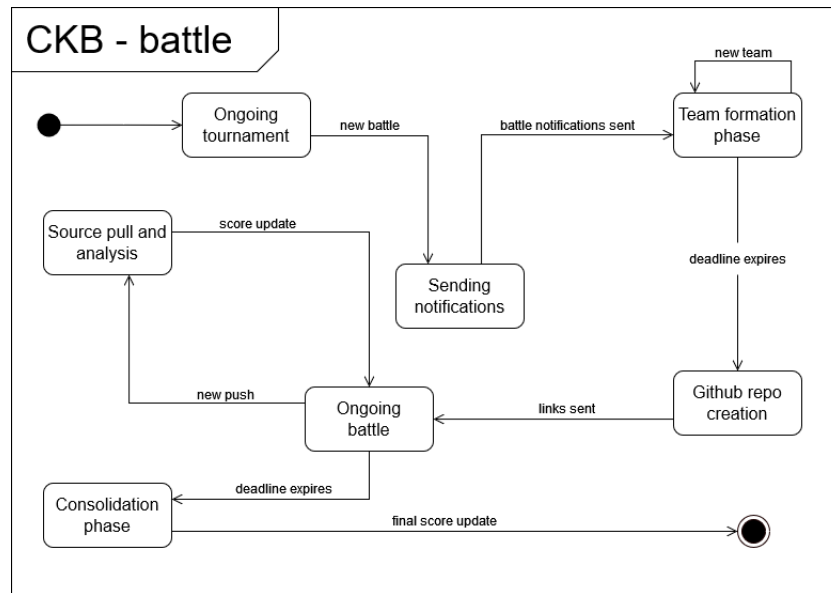


Figure 2: Battle timeline

This diagram describes the steps of a battle. When a new battle is created in the scope of a tournament, the system sends a notification to all students subscribed to that tournament. Students have some time to form teams and after the deadline, a github repository is automatically created. Teams can then start working on the project. The system is notified through API calls every time a team pushes new code. Following each push, the system downloads and evaluates the sources, then publishes the scores up to that point. The specifics of these calls are beyond the scope of this diagram. After the deadline, there is a consolidation phase, where authorized educators can manually adjust the scores if need be. Finally, the battle officially ends and the students are notified.

2.2 Product Functions

2.2.1 User Registration and Authentication

- **User Registration:** Users can create accounts on the CKB platform by providing necessary information such as academic position (educator or student), email address and password. The registration process includes validation and email verification.
- **Authentication:** Once registered, users can log in with their credentials to access the platform. Authentication ensures that only authorized users can use the platform and the available functions are restricted depending on the user.
- **User Account Management:** Registered users have the ability to manage their account settings, update their profile information, and change passwords as needed.

2.2.2 Creating and Managing Tournaments

- **Tournament Creation:** Educators, who act as administrators, can create new tournaments. They provide details about the tournament, including its name, description, duration, and any specific rules.
- **Tournament Management:** Educators can modify and manage existing tournaments. They can update tournament details, add or remove battles, and set deadlines.

for registration and submission. They can add other Educators to administer the tournament, too.

2.2.3 Joining and Forming Teams

- **Joining Battles:** Students can browse and subscribe to available tournaments and join specific battles within those tournaments. They can view information about battles, such as the code kata description and participation rules.
- **Team Formation:** Students can form teams by inviting other students to join them. The system checks that they adhere to the minimum and maximum team size rules set by the educator.

2.2.4 Code Kata Battles

- **Accessing Projects:** Students participating in a battle can download the respective project. Each project consists of a problem description and an initial codebase with missing functionality.

2.2.5 GitHub Integration

- **GitHub Repository Creation:** For each code kata, the platform creates a corresponding GitHub repository for each team. This repository contains the initial codebase and testing scripts.
- **Updating and Testing Projects:** Students set up GitHub Actions to automate the submission process. With each code commit to their repository, GitHub Actions trigger updates and testing on the platform.

2.2.6 Scoring and Ranking

- **Score Calculation:** The platform calculates scores based on the number of passed test cases, timeliness of submissions, and code quality. The higher the number of passing test cases, the higher the score.
- **Ranking System:** Students can view the real-time ranking of their teams and others in the same battle. Rankings are based on scores achieved during the competition.

2.2.7 Consolidation and Manual Evaluation

- **Consolidation Stage:** After the submission deadline, educators review the code and manually evaluate aspects that cannot be determined automatically, such as code quality and innovation.
- **Final Ranking:** Once the consolidation stage is complete, the final ranking is determined, and students are notified of their positions and scores.

2.2.8 Gamification and Badges

- **Badge Definition:** Educators can create gamification badges with specific titles and rules.
- **Badge Assignment:** The badges are awarded to students based on the rules defined by the educators.

2.2.9 Notification and Communication

- **Notification System:** The platform sends notifications to students about various events, such as new tournament announcements, battle updates, and final tournament rank confirmations.

2.2.10 Profile and Tournament Statistics

- **User Profiles:** Each user has a profile that displays their personal information, tournament participation, and badges earned.
- **Tournament Statistics:** Users can view statistics related to their performance in each tournament, including scores, rankings, and tournament history.

2.3 User characteristics

There are mainly two kinds of users that interact with the system: Educator and Student.

2.3.1 Educator

- **Teaching Level:** Educators can be university professors, instructors, or trainers responsible for organizing and supervising code kata battles.
- **Educational Institution:** They may work in educational institutions and have experience in teaching software development.
- **Platform Experience:** Educators should be familiar with the CodeKataBattle platform to create and manage tournaments, set up battles, and assess student performance.
- **Technical Proficiency:** While not all educators need to be technically proficient, some may have a background in software development and programming.

2.3.2 Student

- **Programming Proficiency:** Students may vary in their level of programming proficiency, ranging from beginners to advanced developers.
- **Educational Level:** Students from various educational backgrounds, such as undergraduate, graduate, or coding boot camp participants, may use the platform.
- **Motivation:** Students may use the platform for different reasons, including academic requirements, self-improvement, or competition.
- **Preferred Programming Languages:** Users may have preferences for specific programming languages and may select code katas accordingly.
- **Team Formation:** Students can either participate individually or form teams based on the requirements of specific battles.
- **Time Availability:** Students have different schedules and availability for participating in code kata battles.

2.4 Assumptions, dependencies and constraints

2.4.1 Regulatory policies

1. *Data Privacy and Protection:*

- **General Data Protection Regulation (GDPR):** The CKB platform will ask for user personal information like name, surname and email address. Email addresses won't be used for commercial purposes. Personal information will be processed in compliance with the GDPR.

2. *Intellectual Property Rights:*

- **Copyright and Licensing:** The platform must respect copyright and licensing regulations when handling code katas, user submissions, and other content. It should encourage users to respect the intellectual property rights of others and provide mechanisms for reporting copyright violations.
- **Plagiarism Prevention:** The platform should have mechanisms in place to detect and prevent plagiarism in code submissions. This includes educating users on proper citation and attribution practices.

2.4.2 Domain Assumptions

The following are the assumptions made for the domain. Such assumptions are properties and/or conditions that the system takes for granted, mostly because they are out of the control of the system itself, and hence need to be verified to assure the correct behavior of CKB.

[D1]: Users have reliable and consistent access to the internet to participate in code kata battles and interact with the platform.

[D2]: Users have access to suitable devices, such as computers or mobile devices, with compatible web browsers.

[D3]: Educators have a basic understanding of the CodeKataBattle platform's features, enabling them to create and manage tournaments and battles effectively. In particular, they have to provide correct tests and rules for projects and badges.

[D4]: User-provided data, including user profiles, code submissions, and scoring information, is assumed to be accurate and valid. Users are supposed to providing truthful information.

[D5]: Users will use the platform responsibly, adhering to ethical guidelines and academic integrity. Students are expected to complete code katas independently or within the rules of team collaboration defined by educators.

[D6]: The platform assumes a high level of system uptime, with minimal downtime, to support user interactions, database storage, and real-time features.

[D7]: Some platform functionalities may rely on external services, such as email verification, communication tools and Github integrations. These external services are assumed to be available and functional.

[D8]: Users are responsible for maintaining the security and privacy of their accounts, including choosing strong passwords and keeping their login credentials confidential.

[D9]: Users are expected to engage in ethical behavior, respecting intellectual property rights, academic integrity, and community guidelines established by the platform.

3 Specific Requirements

3.1 External Interface Requirements

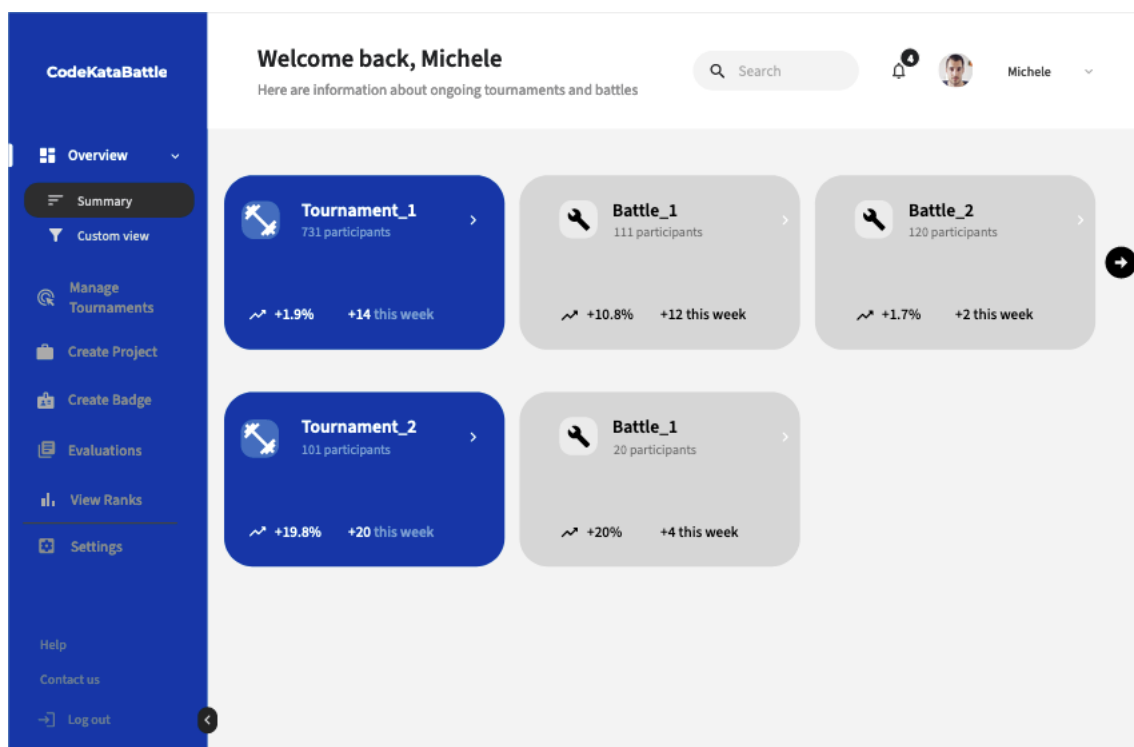
3.1.1 User Interfaces

In this section is presented CKB platform UI. The general view is the same both for educators and students, but there are some small changes between the two views due to additional functions that can be performed by either one or the other.

There are some differences that can be detected. For example, an educator must have the possibility to manually evaluate students' projects, while a student can't, or also an educator has the possibility to create a tournament or a battle within a tournament, while a student can't.

Nevertheless there are also some common functionalities, such as the option to view tournament rank or the list the ongoing tournaments.

More details in the mockup below.



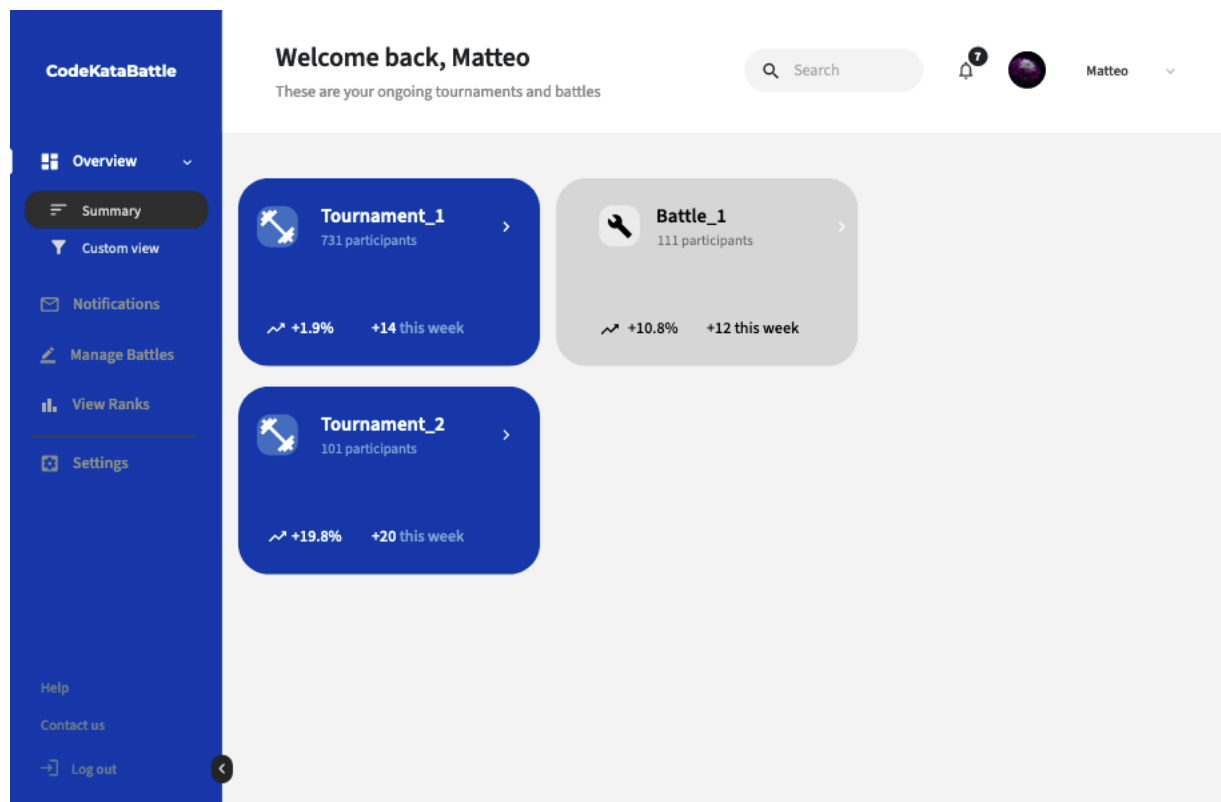
Educator Interface

In the Educator Interface the main page shows the ongoing tournaments, followed by every ongoing battle for that tournament.

The search bar allows educator to search for a nickname and find users associated to it, so that it's possible to visualize their profile.

The main functions an educator can perform are shown on the left column:

- **Manage Tournaments:** allows an educator to create and close a tournament, create (with all the possible settings) and close battles and eventually grant the permission to create battles to another educator.
- **Create Project:** allows an educator to create a new project to assign to students.
- **Create Badge:** allows an educator to create a new badge that could be achieved by the students in a tournament.
- **Evaluations:** allows an educator to manually evaluate students' projects.
- **View Ranks:** view all ongoing tournaments and battles rank.



Student Interface

In the Student Interface the main page shows the ongoing tournaments, followed by the battles to which the student is subscribed.

The search bar allows student to search for a nickname and find users associated to it, so that it's possible to visualize their profile.

The main functions a student can perform are shown on the left column:

- **Notifications:** allows a student to view the notifications the platform sends when a new tournament or a new battle within a tournament the student is subscribed to is created.
- **Manage Battles:** this section allows a student to create teams and contains the link to the GitHub repository for each battles he/she is subscribed to.
- **View Ranks:** view all ongoing tournaments and battles rank.

3.1.2 Hardware Interfaces

Both educators and students that want to use the system are required to have a personal computer and an internet connection available, because CKB is provided via a web page.

3.1.3 Software Interfaces

The system requires the following software interfaces in order to provide its services.

- **GitHub API:** the systems has this API to interact with GitHub to detect every push done by each team during a battle.

3.1.4 Communication Interfaces

The system is based on the communication with users' devices and with GitHub application. For the first one, CKB uses internet connection to send and receive data, while for the second one it uses the GitHub API to communicate with GitHub and pull new code sources pushed by students during a battle.

3.2 Functional Requirements

In this section are specified the system's requirements, divided in three target groups to better classify them.

- **Basic Requirements**

- [R1]: The systems allows educators to sign up.
- [R2]: the system allows students to sign up.
- [R3]: the system allows registered educators to log in.
- [R4]: the system allows registered students to log in.

- **Main Requirements**

- [R5]: the system allows educators to create a new tournament.
- [R6]: the system allows an educator to grant permission to create battles within the context of a specific tournament to another educator.
- [R7]: the system allows educators to create a new battle, if they have the permission to do it.
- [R8]: the system notifies all the students subscribed to the platform when a new tournament is created.
- [R9]: the system allows students to subscribe to a tournament.
- [R10]: the system notifies all the students subscribed to a specific tournament when a new battle in the context of that tournament is created.
- [R11]: the system allows educators that created a battle to upload the code kata.
- [R12]: the system allows educators that created a battle to set minimum and maximum number of students per group.
- [R13]: the system allows educators that created a battle to set a registration deadline.
- [R14]: the system allows educators that created a battle to set a final submission deadline.
- [R15]: the system allows educators that created a battle to set the possibility to manually evaluate projects during the consolidation stage.
- [R16]: the system allows students to create teams for ongoing battles inviting other students.
- [R17]: the system allows students to join a battle.
- [R18]: the system sends to each students that belongs to a team subscribed to a battle the link of the GitHub repository assigned to that team.
- [R19]: the system allows both students and educators to see the current rank evolving during a battle.
- [R20]: the system allows educators to manually evaluate projects during the consolidation stage in the context of a specific battle.
- [R21]: the system notifies all students participating in the battle when the final battle rank becomes available.
- [R22]: the system allows both educators and students to see the list of ongoing tournaments.
- [R23]: the system allows both educators and students to see the rank of each ongoing tournament.
- [R24]: the system allows educators who created a tournament to close it.

[R25]: the system notifies all students involved in a tournament when the final rank of that tournament becomes available.

- **Additional Requirements**

[R26]: the system allows educators that have created a tournament to create badges.

[R27]: the system allows both educator and students to visualize the profile and badges of a student.

3.2.1 Use Cases Diagrams

In this section, we will provide use case diagrams. Then, for each use case, we will provide a detailed description and a sequence diagram.

Note: in the following diagrams, it is the user who initiates the use case

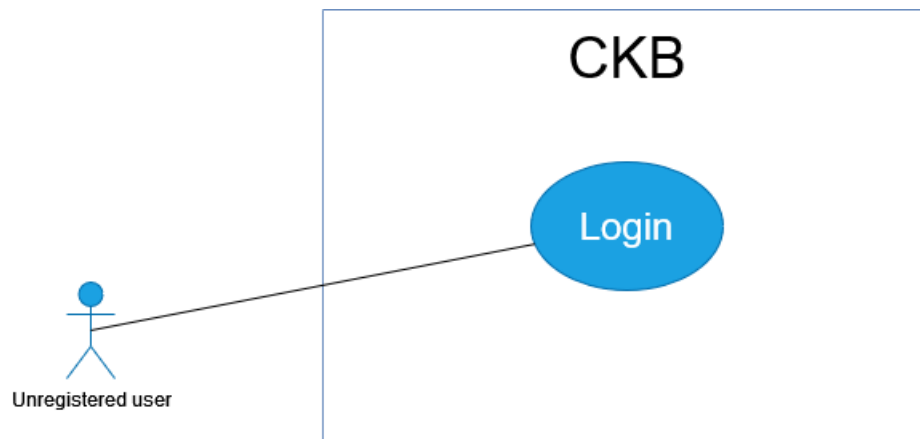


Figure 3: Unregistered user use case diagram

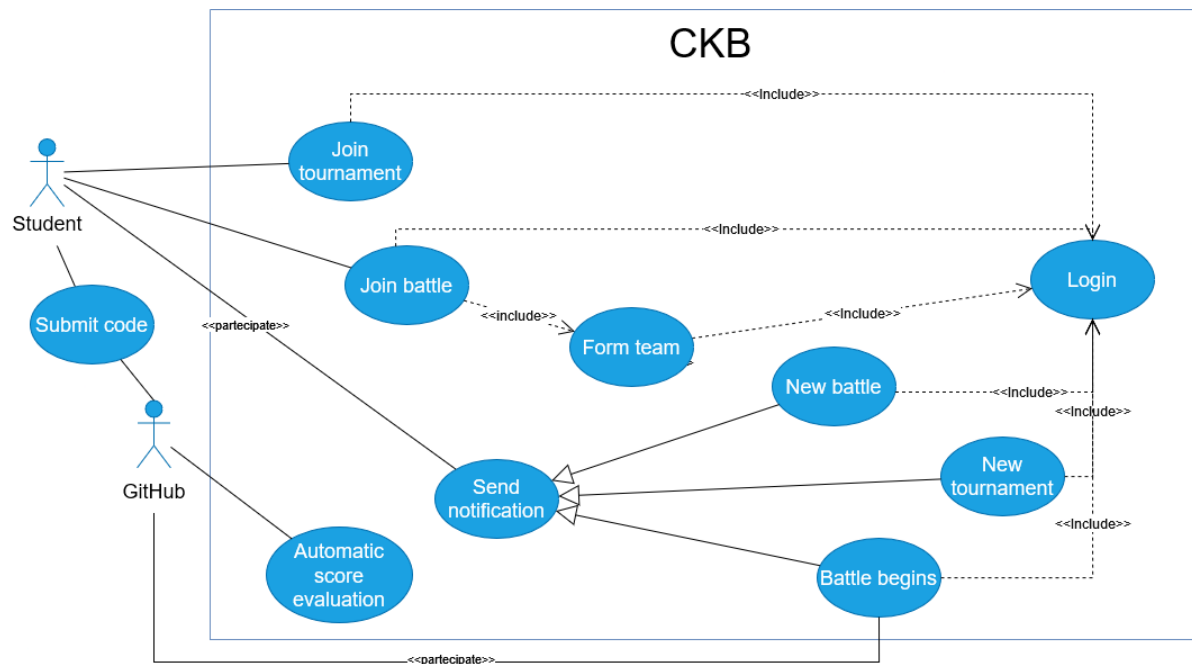


Figure 4: Student use case diagram

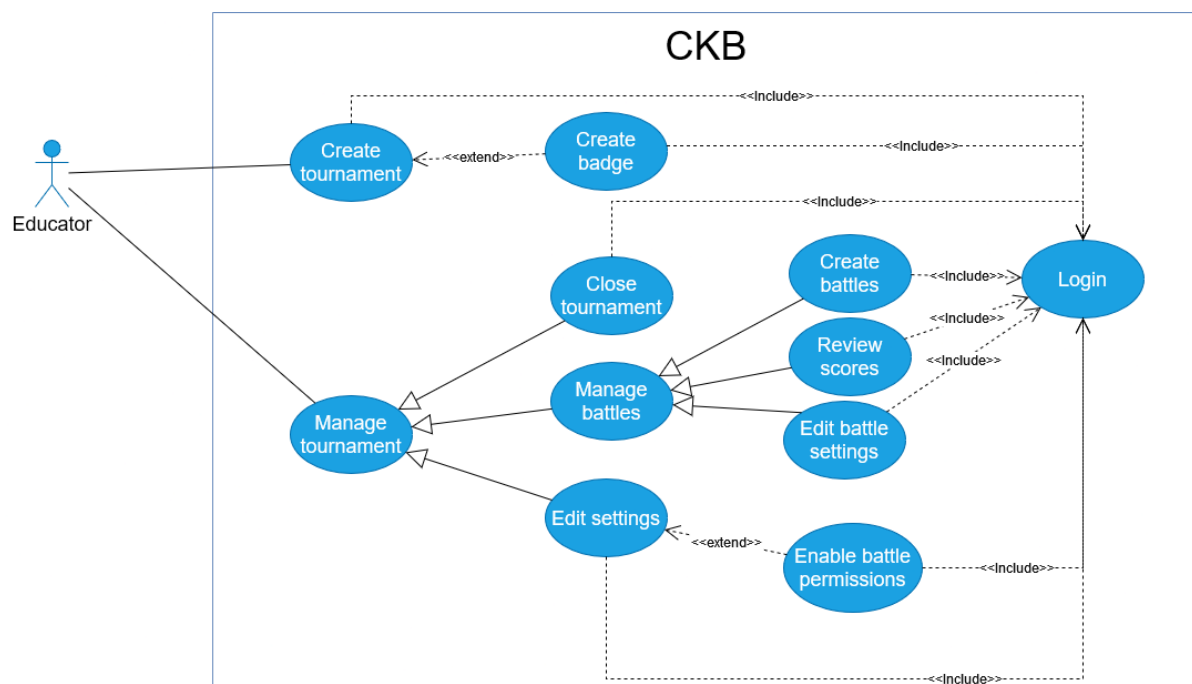


Figure 5: Educator use case diagram

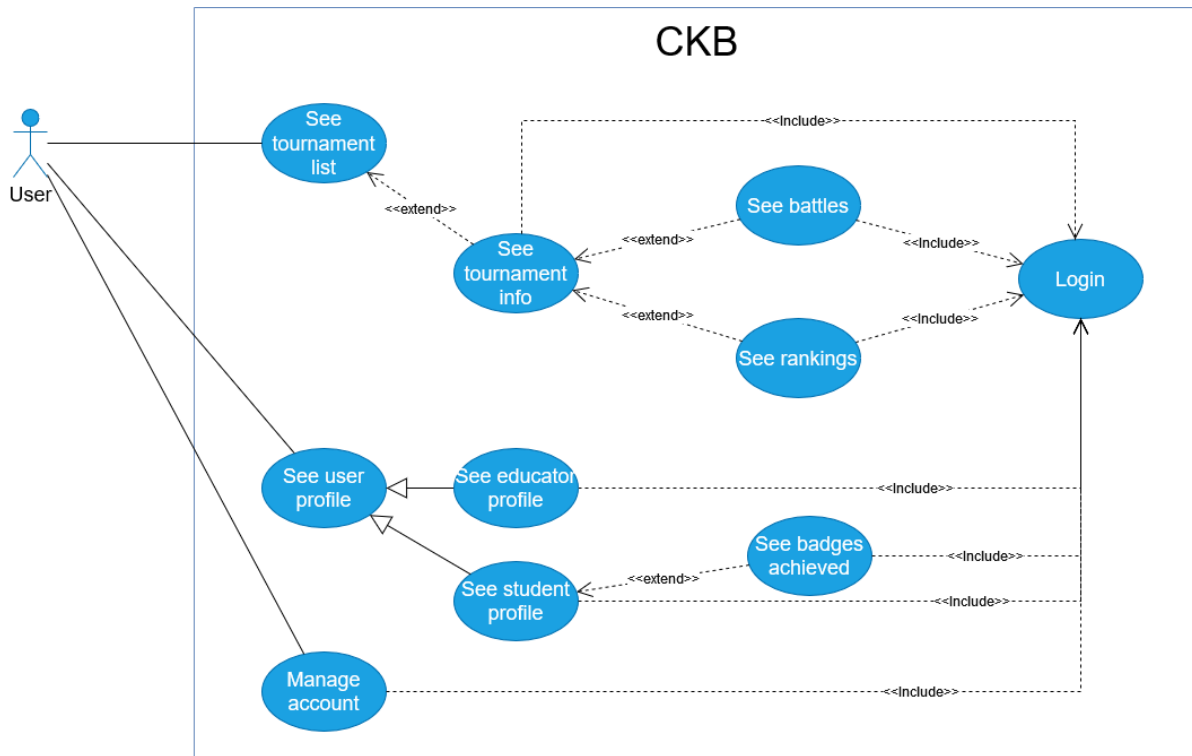


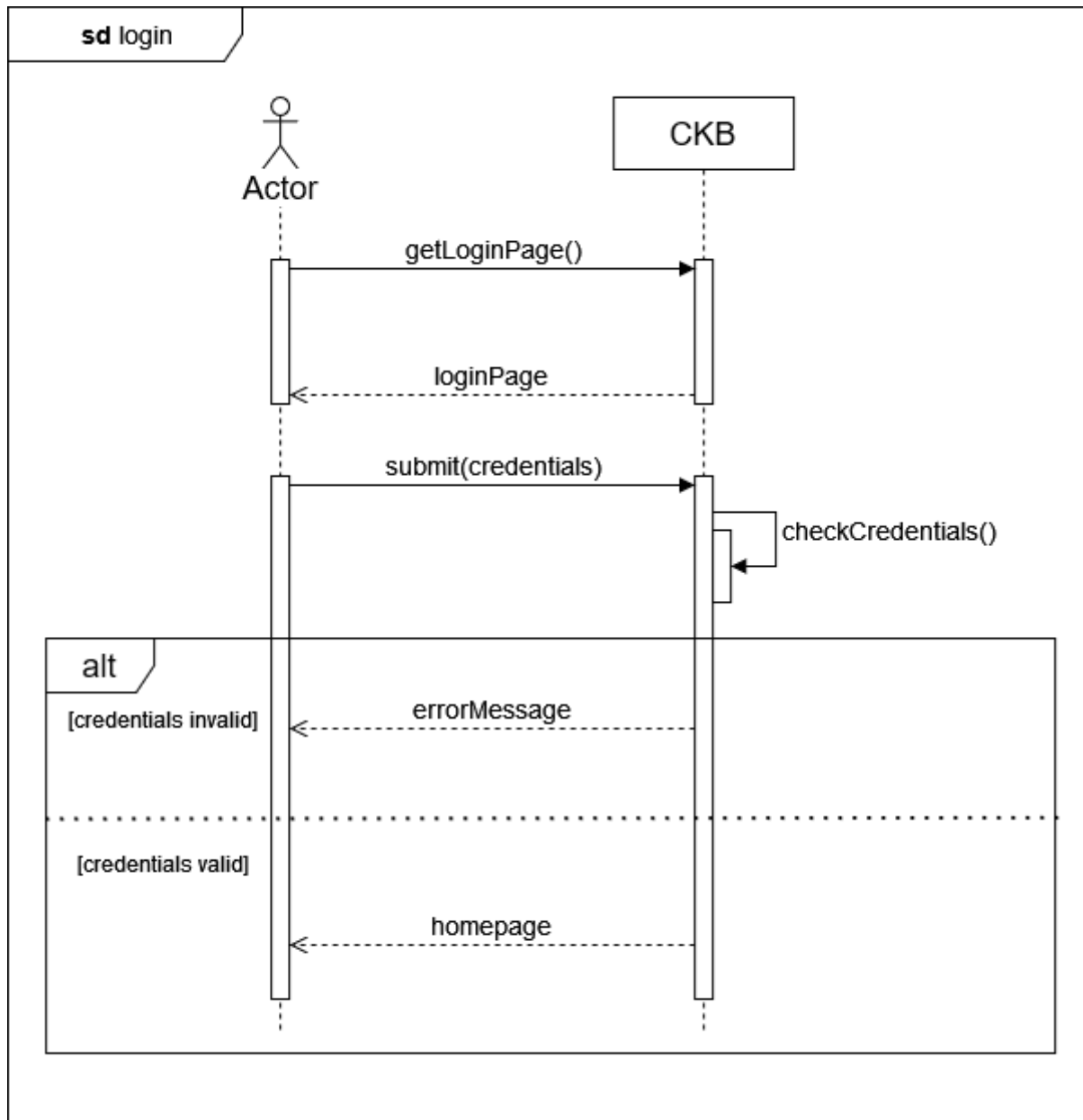
Figure 6: Generic user use case diagram

3.2.2 Use Cases

In the following use cases and sequence diagrams, the system is to be seen as black box interacting with the world.

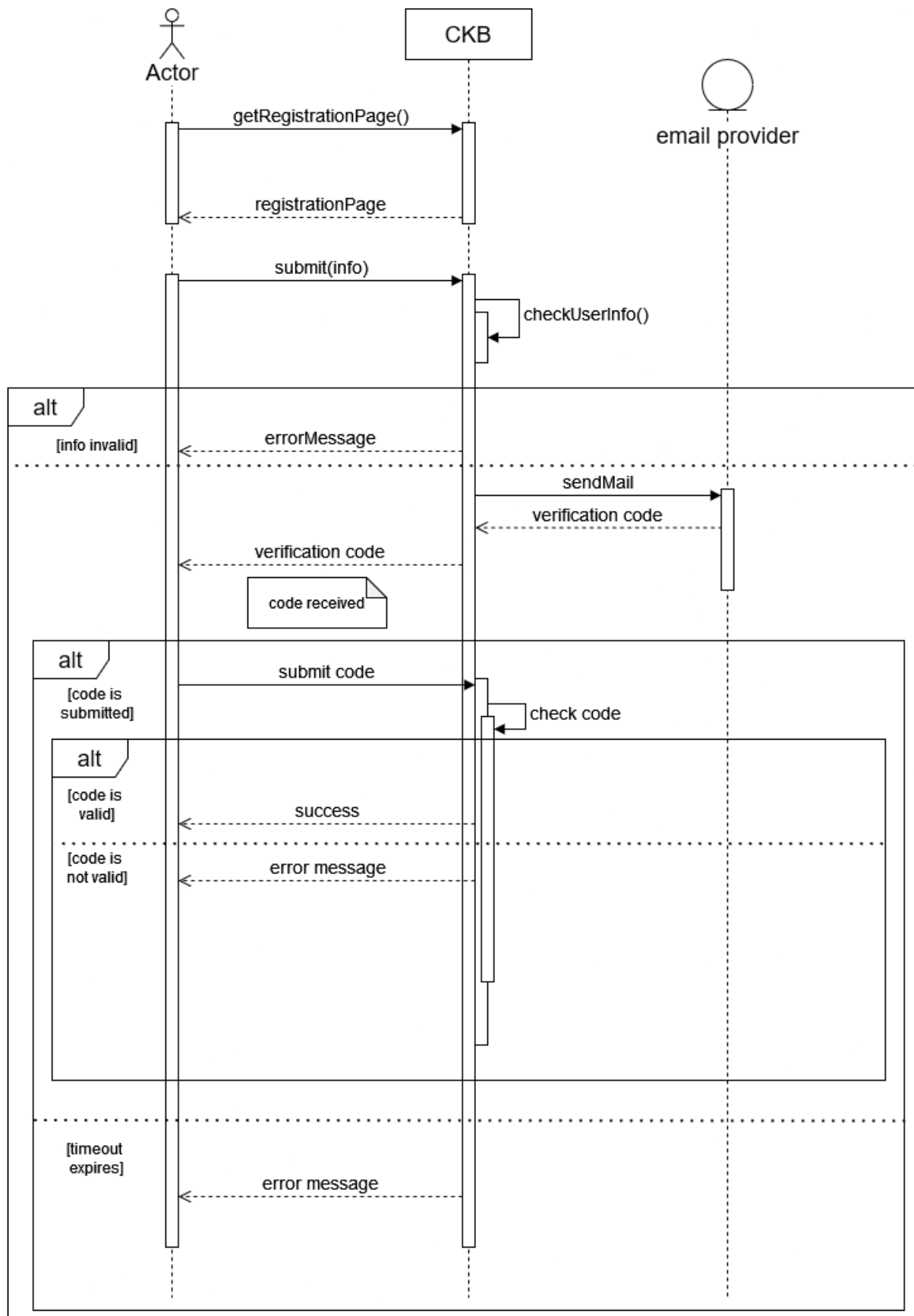
Use case [U1]: Login

Actor(s)	User
Entry Condition	The actor is already registered in the system
Event Flow	<ol style="list-style-type: none">1. User requests the Login Page2. The system shows the Login Page to user3. User inserts credentials and sends them to the system4. The system processes the information and shows a success message redirecting the user to the homepage
Exit Condition	User is logged and the homepage is displayed
Exceptions	<ul style="list-style-type: none">• A wrong username or password is submitted
Notes	In case of exception, a human-readable message will be returned by the system.



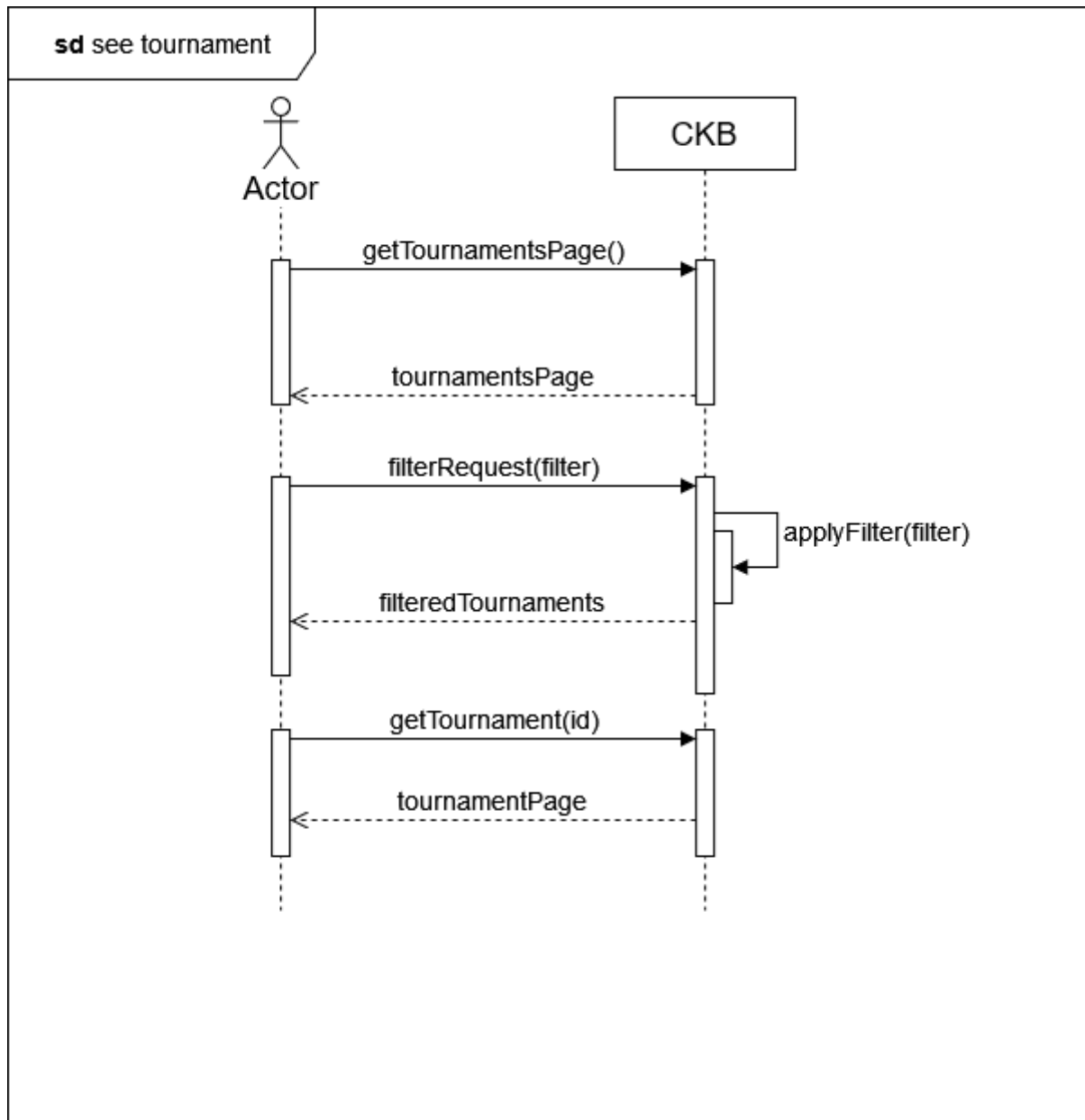
Use case [U2]: User registration

Actor(s)	User, Email provider
Entry Condition	User clicks 'Sign Up' in the homepage
Event Flow	<ol style="list-style-type: none">1. The system sends user the registration form2. User enters email, username password and academic status. Then, submits the data after reading and accepting the Privacy Policy and the Terms of Service3. The system sends an email with a secret verification code to Email provider4. Email provider receives the email and notifies user5. User submits the verification code in the email6. The system processes the provided information and displays a success message
Exit Condition	A new account is created
Exceptions	<ul style="list-style-type: none">• A required registration field is missing when the form is submitted• The username is not available• A wrong verification code is submitted• The timeout for verification expires
Notes	All the exceptions above will notify operator with a human-readable message and the system asks to retry



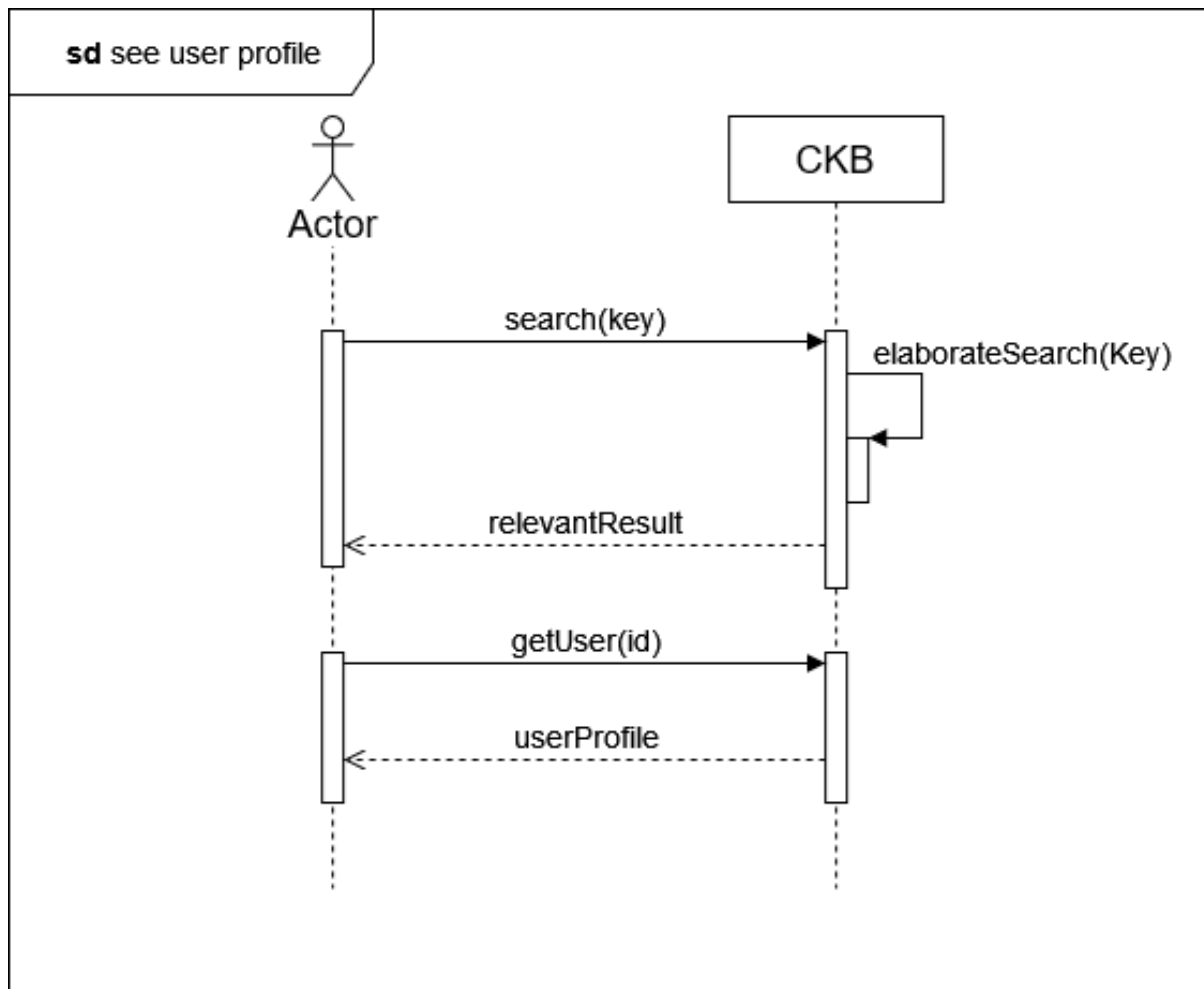
Use case [U3]: See tournament

Actor(s)	User
Entry Condition	Registered user
Event Flow	<ol style="list-style-type: none">1. User requests to see the tournaments section2. The system shows the tournaments section3. User applies a filter (ongoing, finished, programming language)4. The system shows the tournaments satisfying the filters5. User selects desired tournament
Exit Condition	The system shows the tournament page
Exceptions	None
Notes	The tournament page displays all the information about that tournament, including rankings, battles and badges



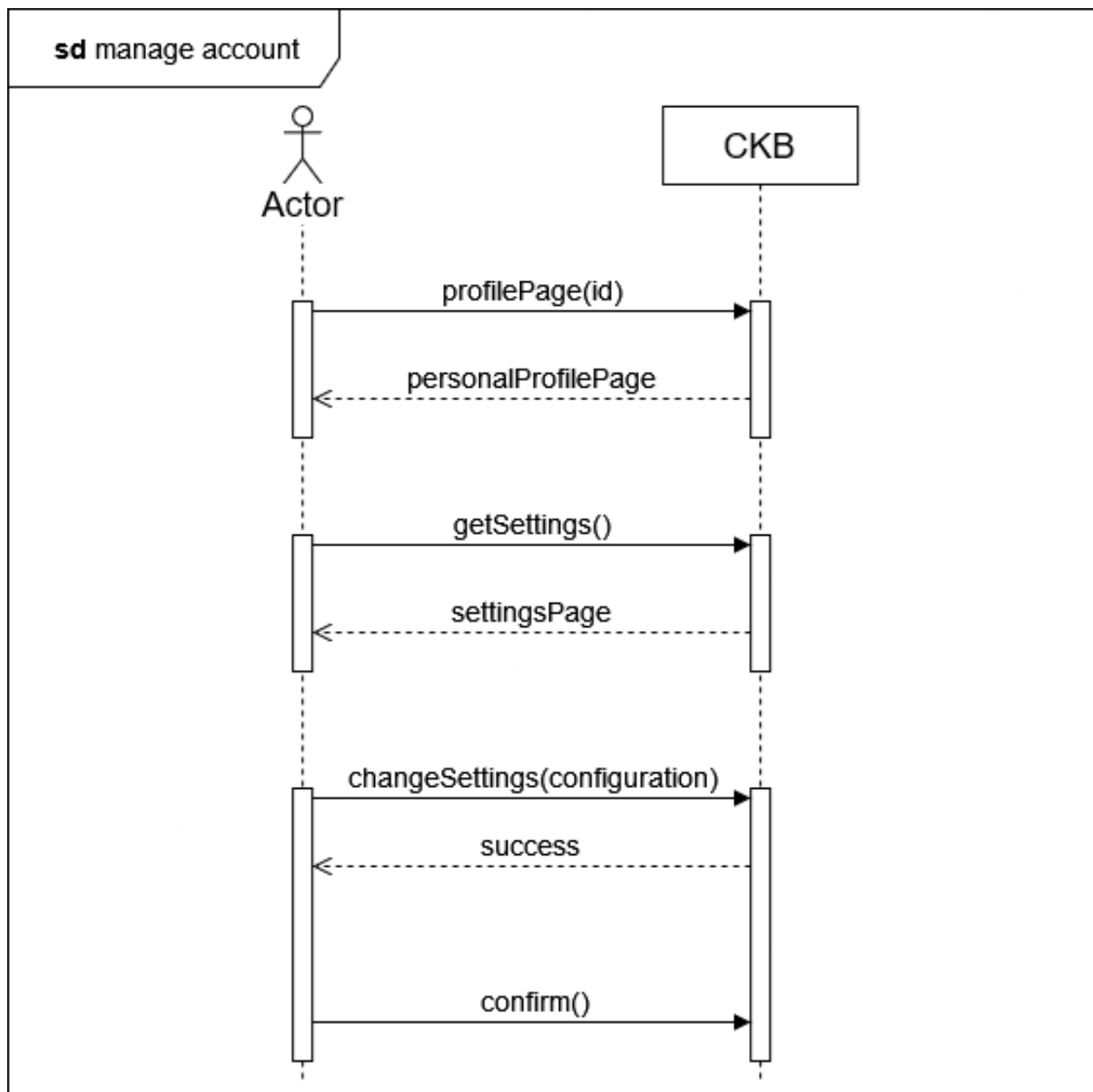
Use case [U4]: See user profile

Actor(s)	User
Entry Condition	Registered user
Event Flow	<ol style="list-style-type: none"> 1. User searches a profile by name 2. The system shows relevant results 3. User selects the desired profile
Exit Condition	The system shows the profile page
Exceptions	None
Notes	The profile page displays all the information about a profile, including badges if profile is a student's



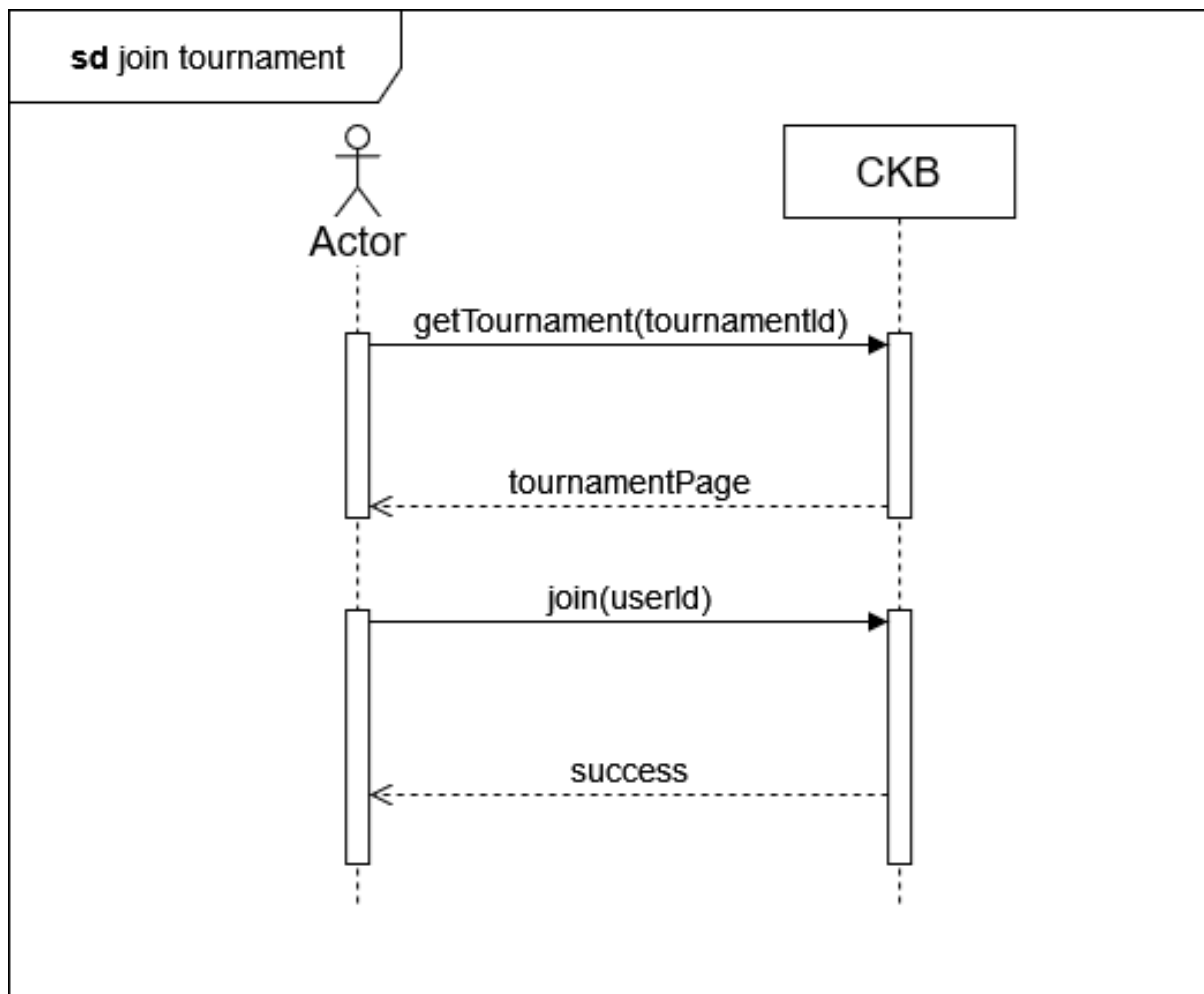
Use case [U5]: Manage account

Actor(s)	User
Entry Condition	Registered user
Event Flow	<ol style="list-style-type: none">1. User navigates to personal profile2. The system shows the personal profile page3. User selects 'change settings'4. The system shows the personal settings page5. User edits the personal settings to his liking, then clicks confirm
Exit Condition	The system saves the configurations
Exceptions	<ul style="list-style-type: none">• None
Notes	



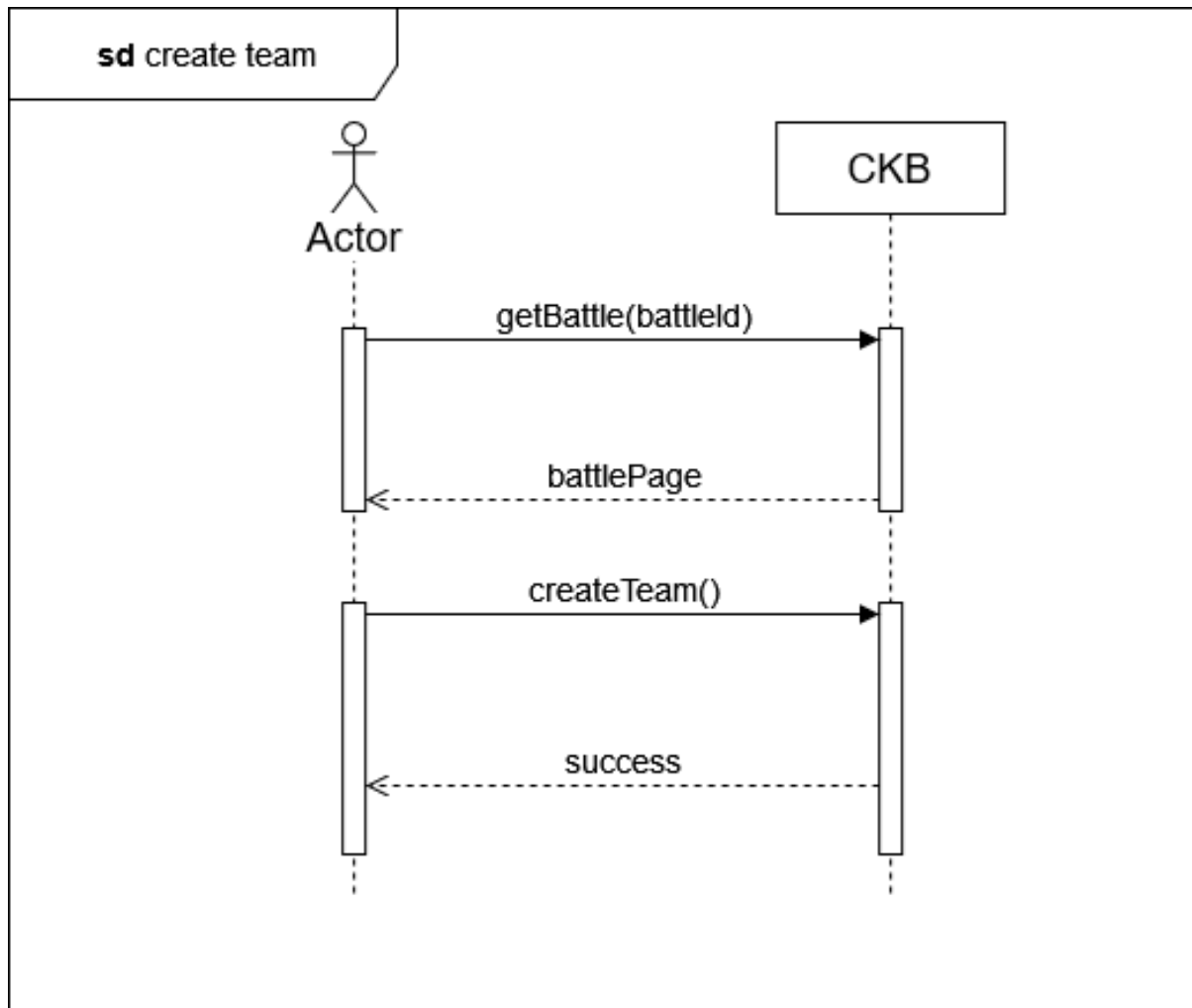
Use case [U6]: Join tournament

Actor(s)	User
Entry Condition	User logged in to the platform as student, tournament still in subscription phase
Event Flow	<ol style="list-style-type: none"> 1. User requests the tournament page 2. The system displays the tournament page 3. User clicks the 'join' button
Exit Condition	User join the tournament
Exceptions	<ul style="list-style-type: none"> • None
Notes	



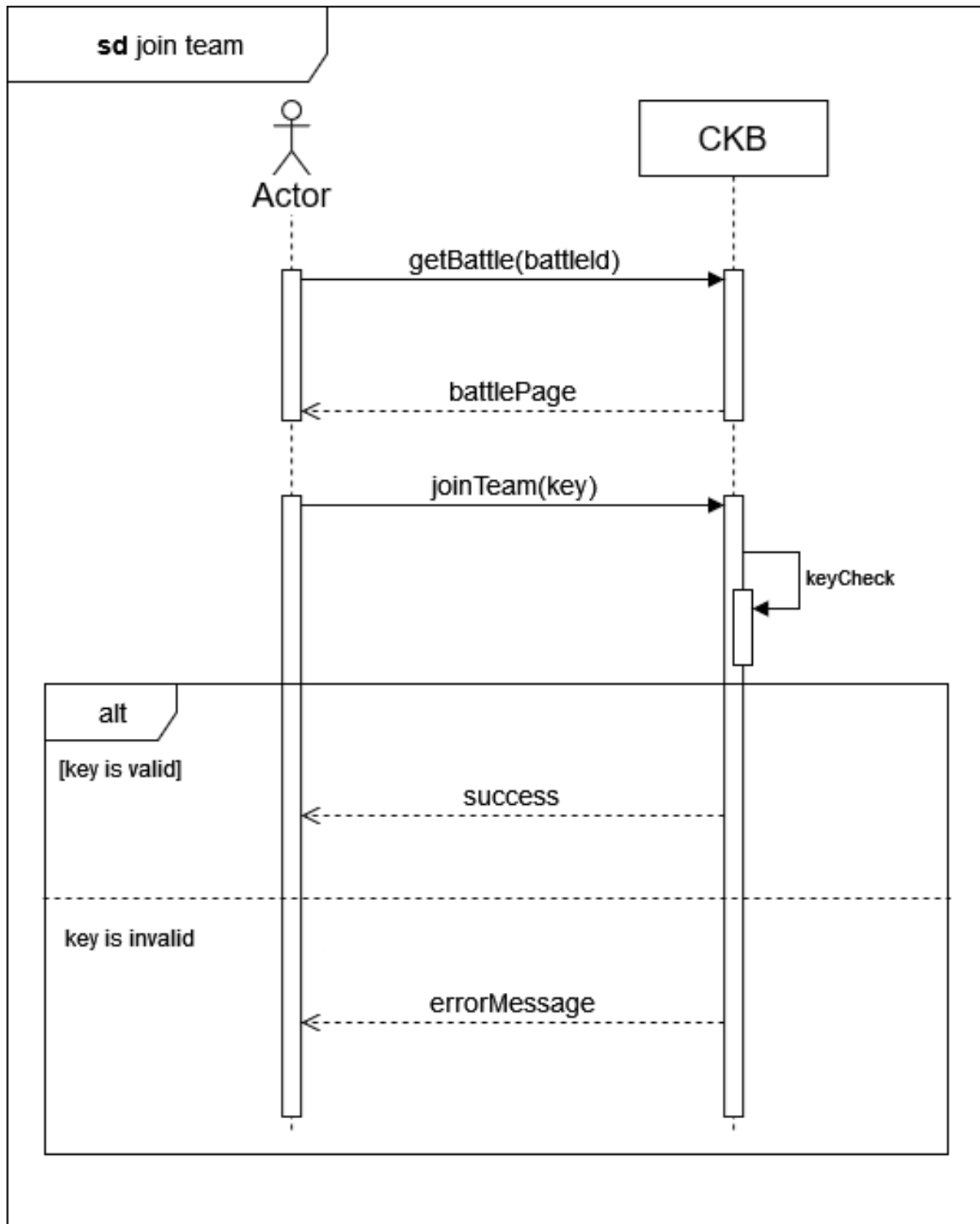
Use case [U7.1]: Create team

Actor(s)	User
Entry Condition	User logged in to the platform as Student, user subscribed to a tournament, the battle is related to that tournament and still in team formation phase, user is not yet part of a team
Event Flow	<ol style="list-style-type: none"> 1. User navigates to the battle page 2. The system displays the battle page 3. User clicks the create team button
Exit Condition	New team is created
Exceptions	<ul style="list-style-type: none"> • None
Notes	None



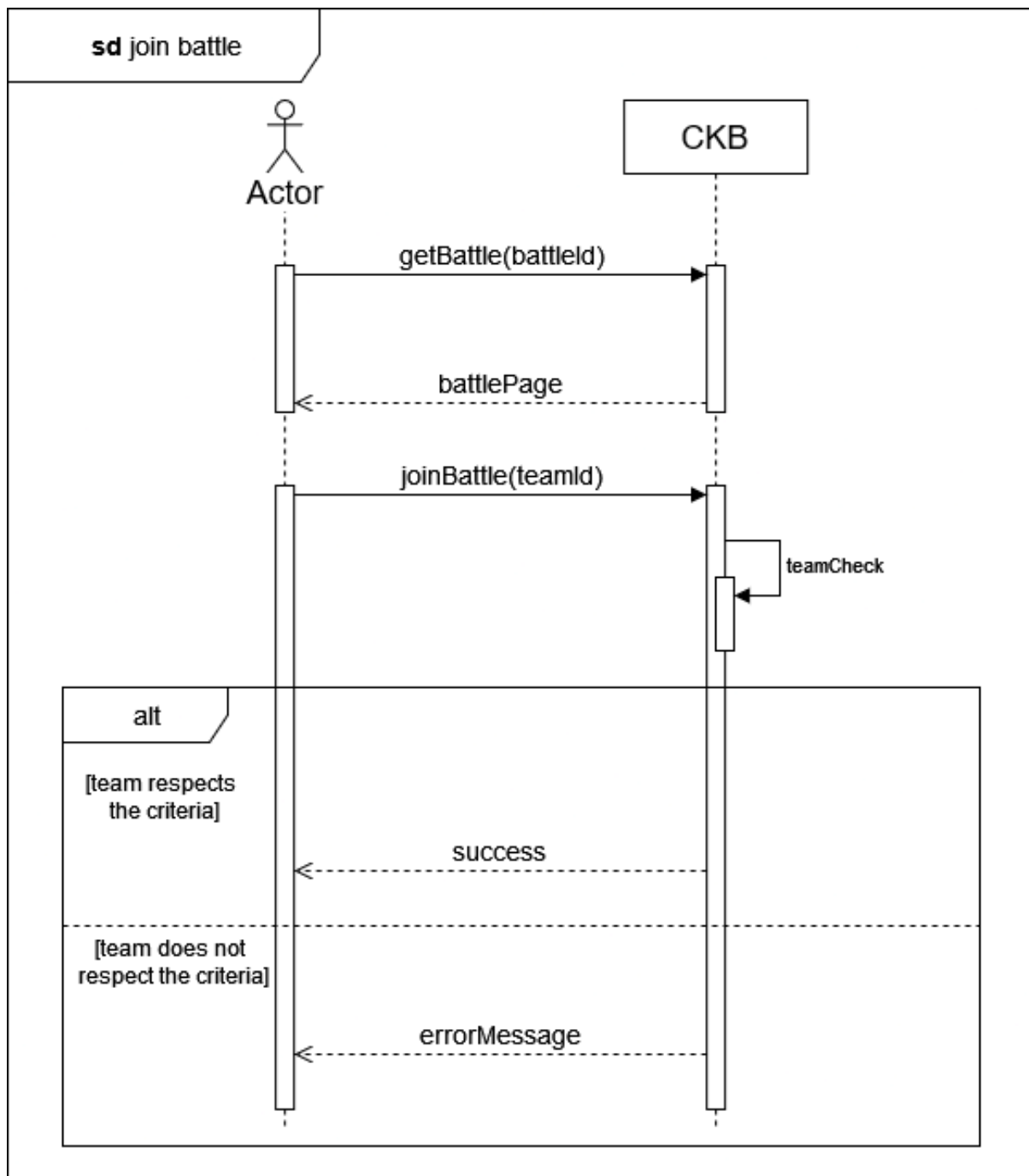
Use case [U7.2]: Join team

Actor(s)	User
Entry Condition	User logged in to the platform as Student, user subscribed to a tournament, the battle is related to that tournament and still in team formation phase, user is not yet part of a team
Event Flow	<ol style="list-style-type: none">1. User navigates to the battle page2. The system displays the battle page3. User enters the team code
Exit Condition	User joins team
Exceptions	<ul style="list-style-type: none">• Team code invalid
Notes	<ul style="list-style-type: none">• The system displays an error message



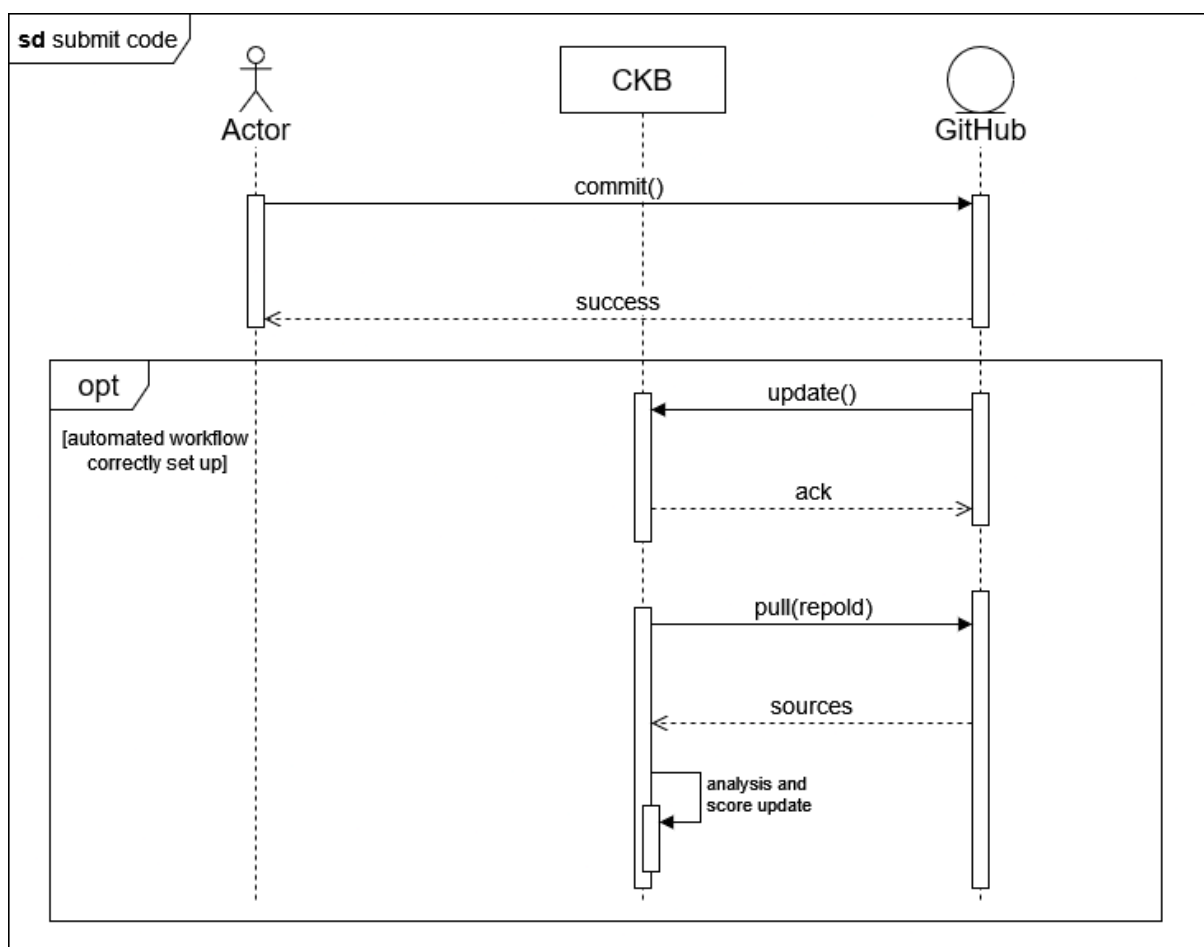
Use case [U7.3]: Join battle

Actor(s)	User
Entry Condition	User logged in to the platform as Student, User subscribed to a tournament, the battle is related to that tournament and still in team formation phase, User is the creator of a team
Event Flow	<ol style="list-style-type: none">1. User navigates to the battle page2. The system displays the battle page3. User clicks join battle
Exit Condition	The team user created joins the battle
Exceptions	<ul style="list-style-type: none">• The team does not respect the minimum/maximum number of members per team criteria
Notes	<ul style="list-style-type: none">• The system displays an error message and asks to respect the criteria and try again



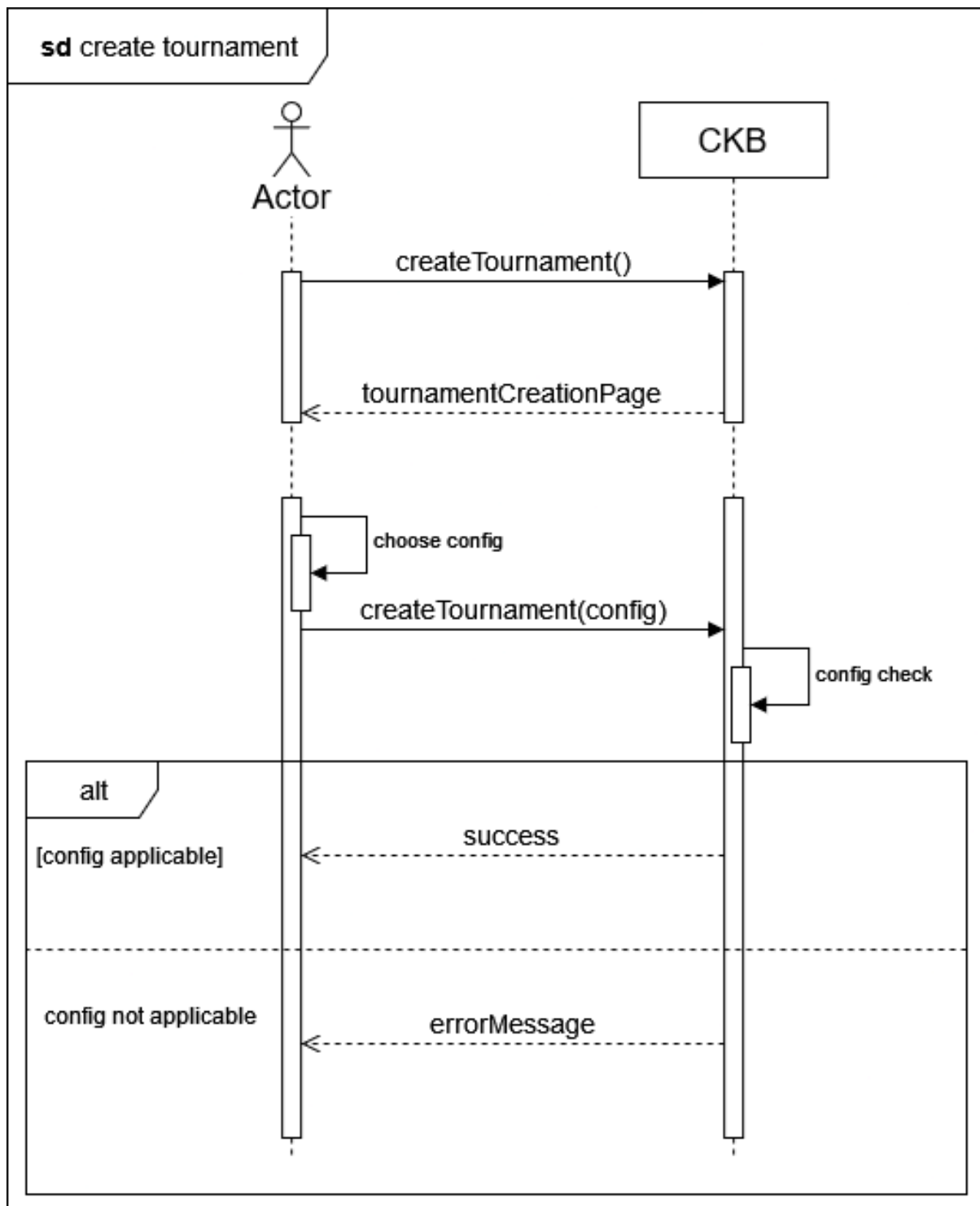
Use case [U8]: Submit code

Actor(s)	User, GitHub
Entry Condition	User logged in to the platform as student, user joined a battle, battle is ongoing
Event Flow	<ol style="list-style-type: none"> 1. User commits code to main branch on GitHub 2. GitHub notifies the System through an API call 3. The system pulls the recent sources from GitHub and evaluates them
Exit Condition	The system shows the updated scores
Exceptions	<ul style="list-style-type: none"> • Student did not set up a proper automated workflow
Notes	In case of exception, the system will not respond to the new push since It will not be notified



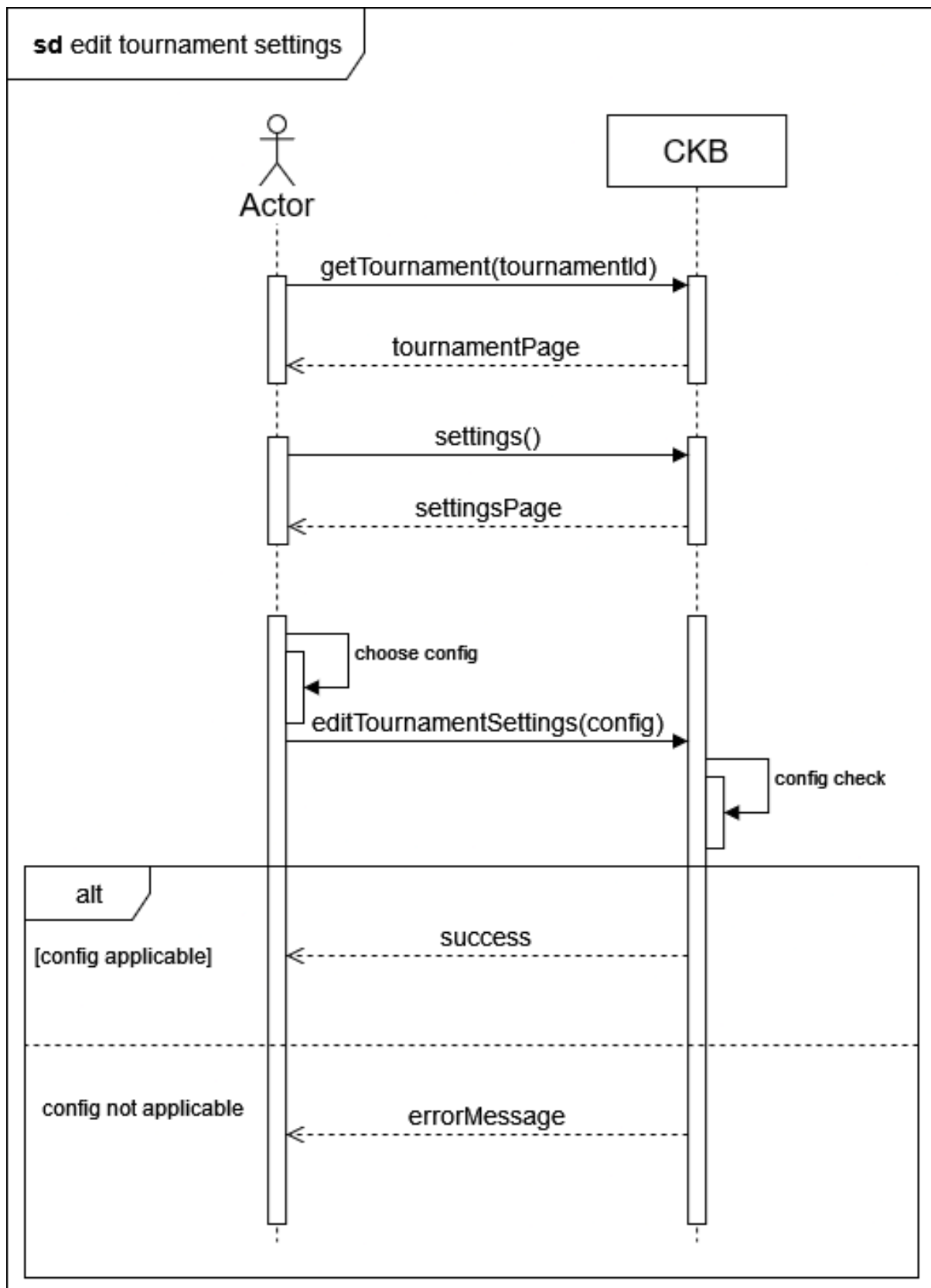
Use case [U9]: Create tournament

Actor(s)	User
Entry Condition	User logged in to the platform as Educator
Event Flow	<ol style="list-style-type: none">1. User clicks the create tournament button2. The system shows the create tournament page3. User chooses his desired settings for that tournament, (including name, deadlines, badges, educators allowed to create battles, ...), then submits
Exit Condition	New tournament is created
Exceptions	<ul style="list-style-type: none">• One or more of the settings is not applicable
Notes	<ul style="list-style-type: none">• Exception: the system displays a message showing the issue and asking to address it before trying again <p>User can choose his desired settings here, but he will be able to edit some of them even after tournament creation</p>



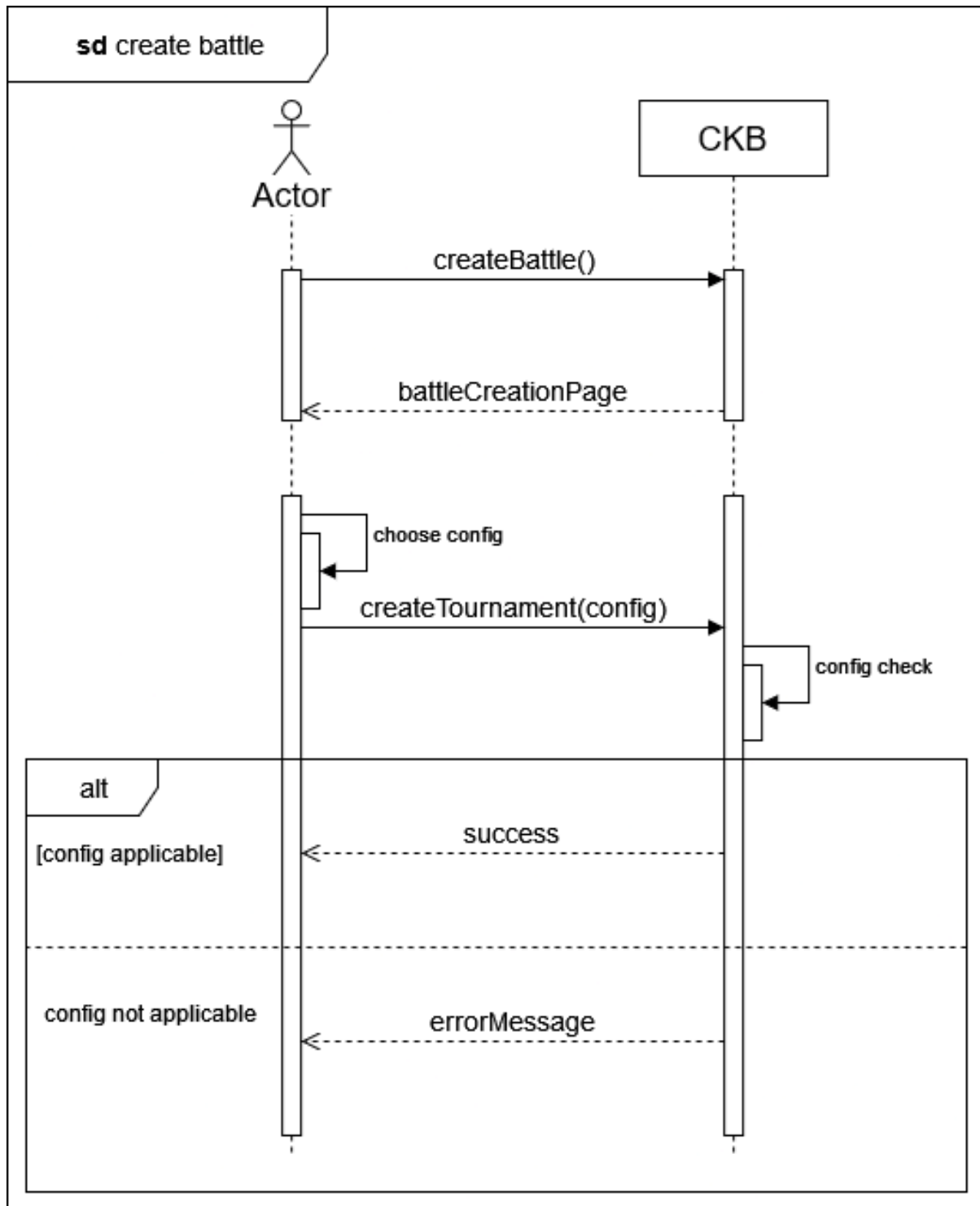
Use case [U10]: Edit tournament settings

Actor(s)	User
Entry Condition	User logged in to the platform as educator, the tournament is not closed, user is the owner of the tournament
Event Flow	<ol style="list-style-type: none">1. User navigates to the tournament page2. The system shows the tournament page3. User goes to the settings section4. The system shows the settings page5. User chooses his desired settings, then submits
Exit Condition	Tournament settings are updated
Exceptions	<ul style="list-style-type: none">• One or more of the settings is not applicable
Notes	<ul style="list-style-type: none">• Exception: the system displays a message showing the issue and asking to address It before trying again



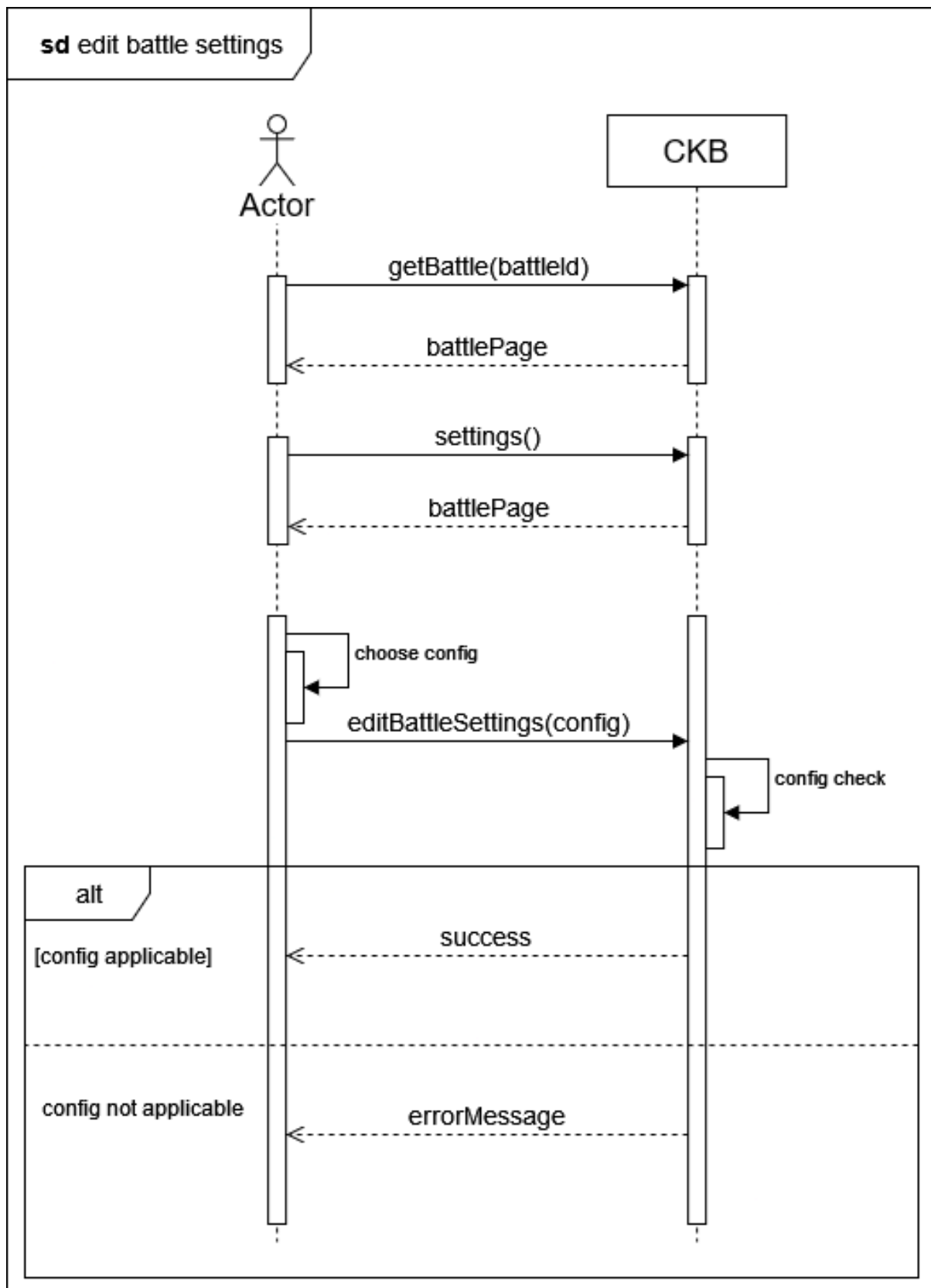
Use case [U11.1]: Create battle

Actor(s)	User
Entry Condition	User logged in to the platform as educator, tournament is ongoing, user has been granted permission to create battles (or is the tournament creator itself)
Event Flow	<ol style="list-style-type: none"> 1. User navigates to the tournament page 2. The system displays the tournament page 3. User clicks the create new battle button 4. The system shows the battle creation page 5. User chooses his desired settings (like uploading code kata, setting minimum and maximum number of students per team, deadlines, ...) and submits
Exit Condition	New battle is created within the context of that tournament
Exceptions	<ul style="list-style-type: none"> • One or more of the settings is not applicable
Notes	<ul style="list-style-type: none"> • Exception: the system displays a message showing the issue and asking to address It before trying again <p>User can choose his desired settings here, but he will be able to edit some of them even after battle creation</p>



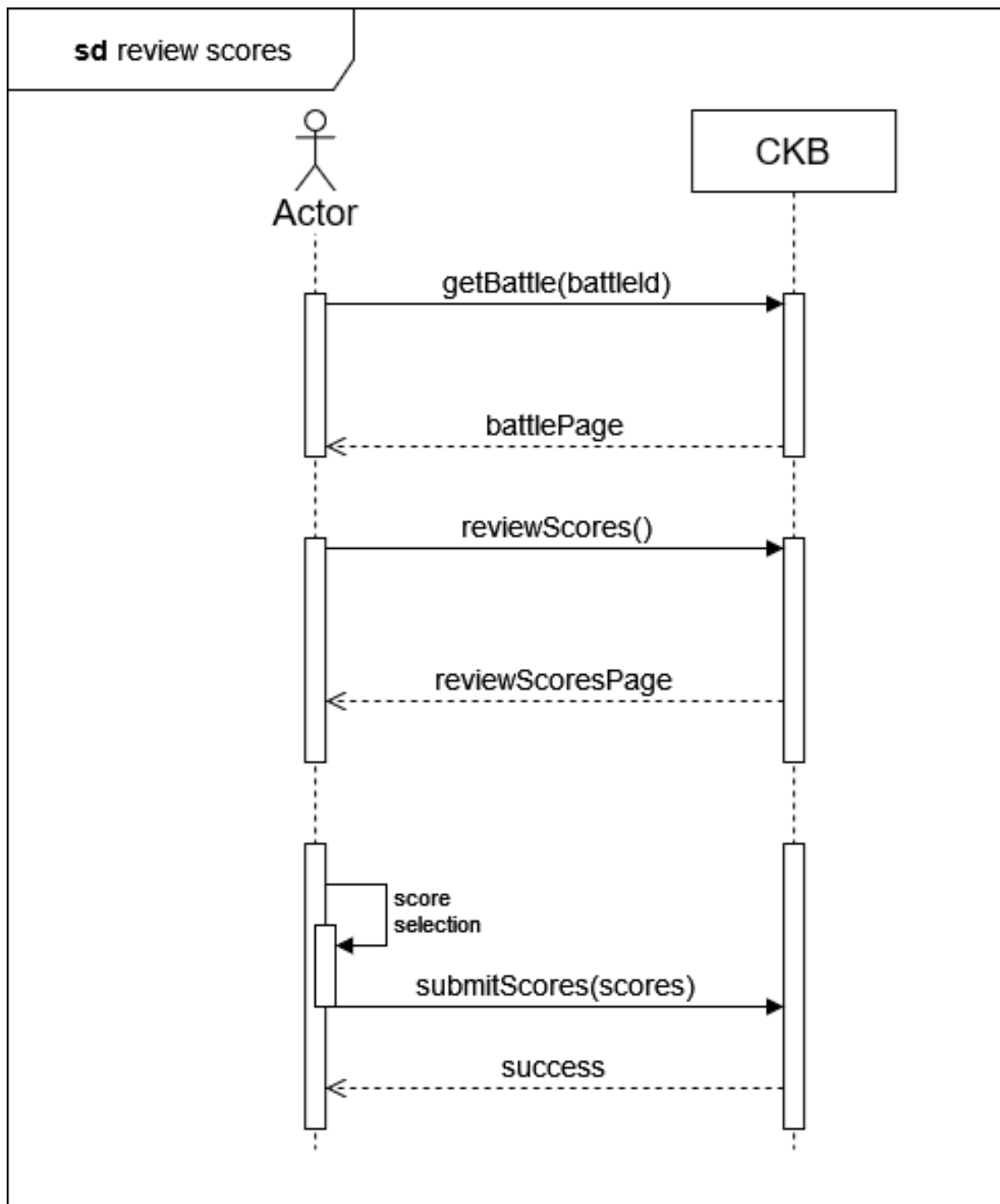
Use case [U11.2]: Edit battle settings

Actor(s)	User
Entry Condition	User logged in to the platform as educator, battle is ongoing, user has been granted permission to create battles (or is the tournament creator itself)
Event Flow	<ol style="list-style-type: none">1. User navigates to the battle page2. User clicks the edit settings button3. The system shows the settings section4. User chooses his desired settings and submits
Exit Condition	Battle configurations are updated
Exceptions	<ul style="list-style-type: none">• One or more of the settings is not applicable
Notes	<ul style="list-style-type: none">• Exception: the system displays a message showing the issue and asking to address It before trying again



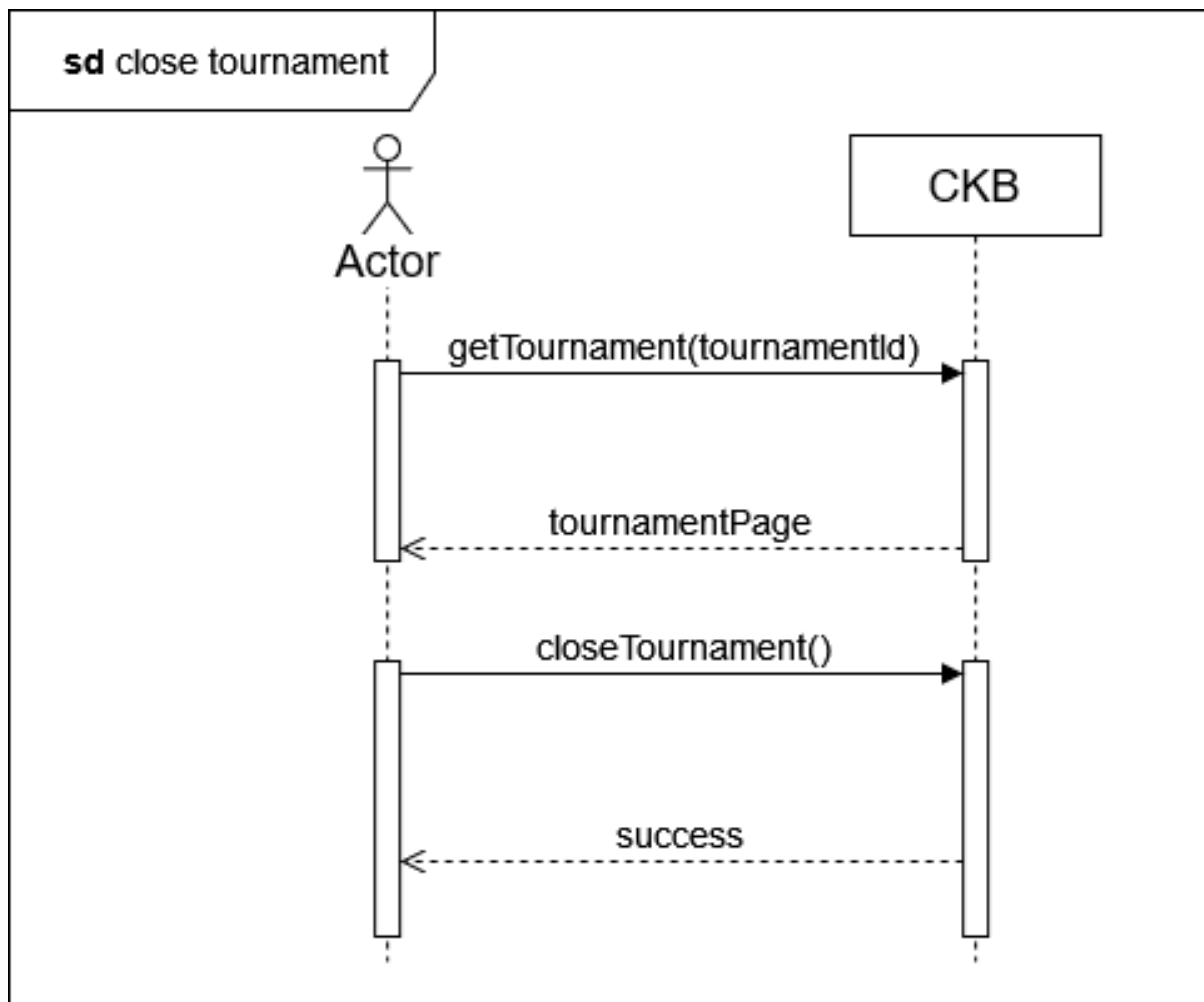
Use case [U11.3]: Review scores

Actor(s)	User
Entry Condition	User logged in to the platform as educator, battle is in consolidation phase, user has been granted permission to create battles (or is the tournament creator itself)
Event Flow	<ol style="list-style-type: none">1. User navigates to the battle page2. User clicks the review scores button3. The system shows the review scores section4. User performs manual evaluation, then submits
Exit Condition	Battle scores are updated
Exceptions	<ul style="list-style-type: none">• None
Notes	



Use case [U12]: Close tournament

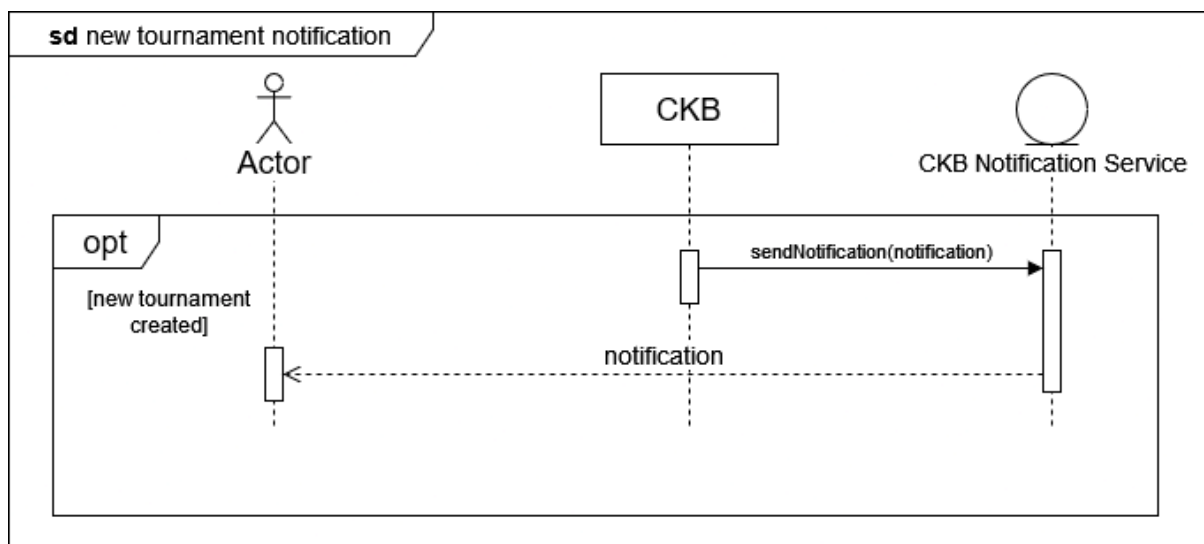
Actor(s)	User
Entry Condition	User logged in to the platform as educator, tournament is ongoing, user is tournament creator
Event Flow	<ol style="list-style-type: none"> 1. User navigates to the tournament page 2. The system shows the tournament page 3. User clicks close tournament button
Exit Condition	Tournament is closed
Exceptions	<ul style="list-style-type: none"> • None
Notes	



In the next use cases, CKB notification service is represented, even though It's part of the system itself, in order for the diagrams to be more comprehensible.

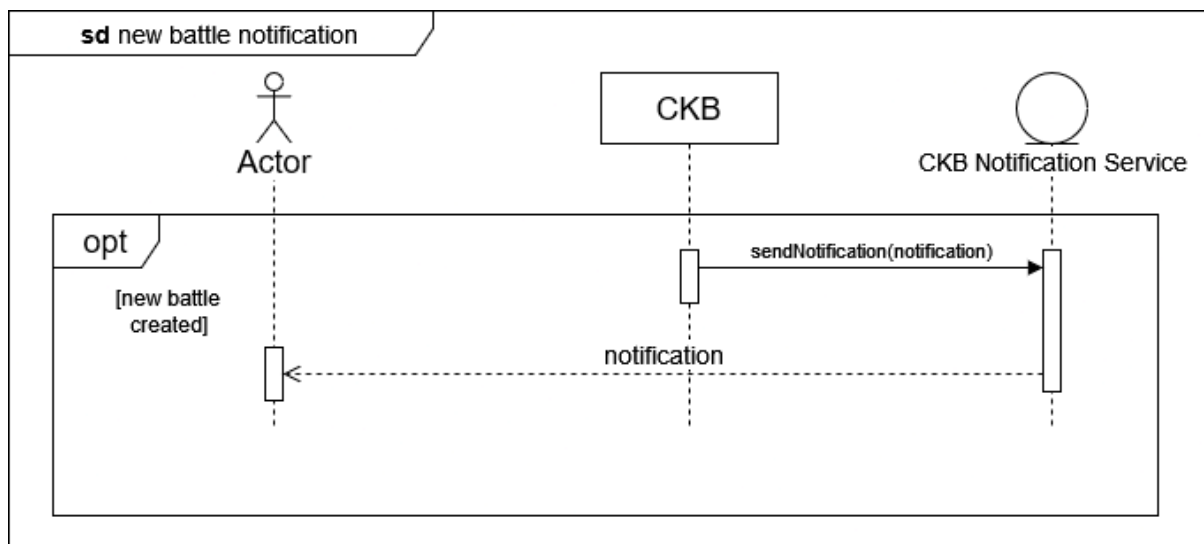
Use case [U13.1]: New tournament notification

Actor(s)	User, CKB Notification Service
Entry Condition	User logged in to the platform as student
Event Flow	<ol style="list-style-type: none"> 1. New tournament is created in the platform 2. The system calls the CKB Notification Service 3. CKB Notification Service sends the notification
Exit Condition	User is notified
Exceptions	<ul style="list-style-type: none"> • None
Notes	



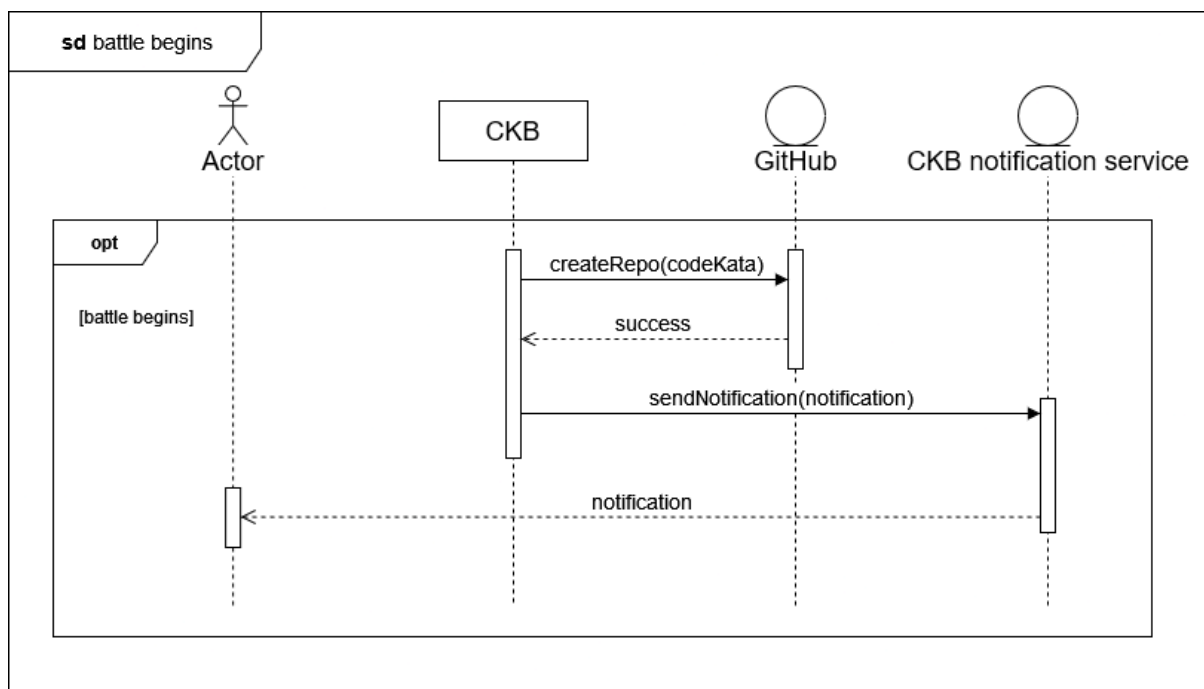
Use case [U13.2]: New battle notification

Actor(s)	User, CKB Notification Service
Entry Condition	User logged in to the platform as student, User subscribed to a tournament
Event Flow	<ol style="list-style-type: none"> 1. New battle is created in the context of a tournament user is subscribed to 2. The system calls the CKB Notification Service 3. CKB Notification Service sends the notification
Exit Condition	User is notified
Exceptions	<ul style="list-style-type: none"> • None
Notes	



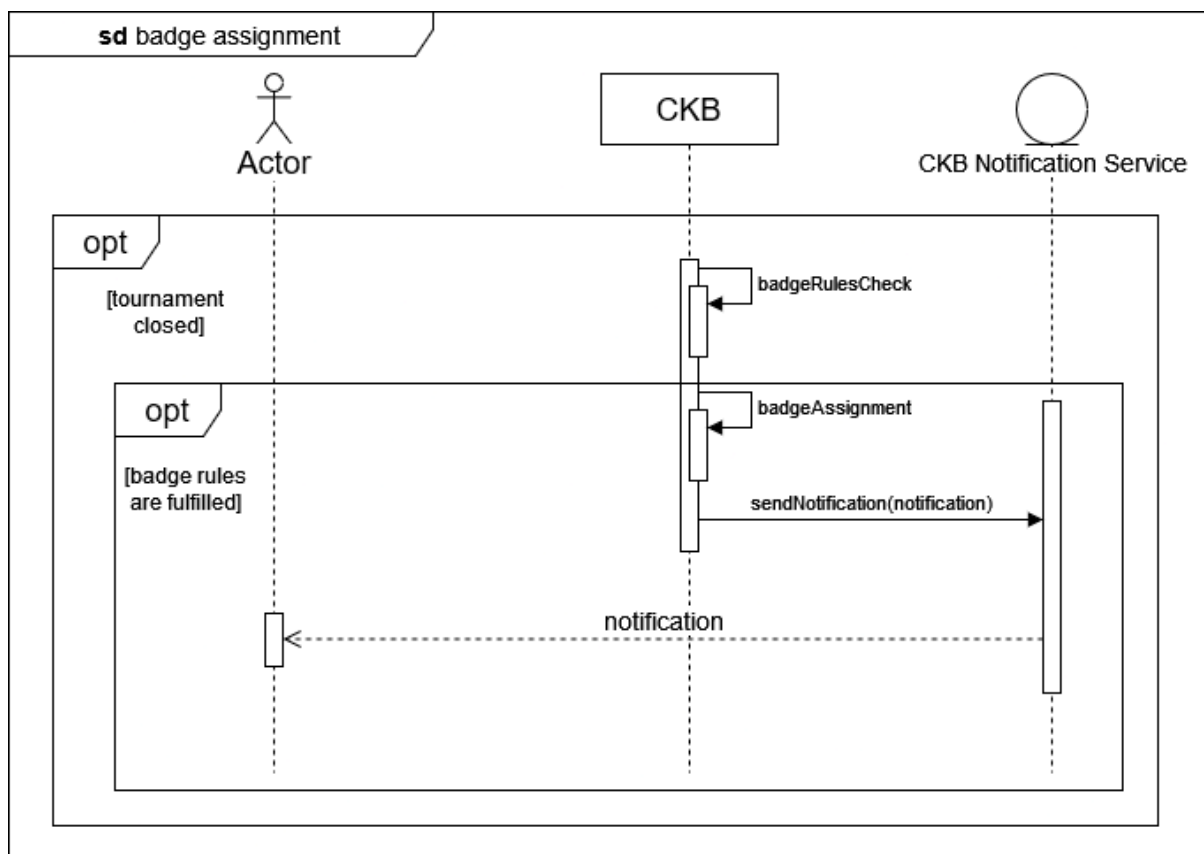
Use case [U13.3]: Battle begins notification

Actor(s)	User, CKB Notification Service, GitHub
Entry Condition	User logged in to the platform as student, User subscribed to a tournament, user joined a battle
Event Flow	<ol style="list-style-type: none"> 1. Battle team formation deadline expires, battle begins 2. The system creates a new GitHub repository containing the codekata 3. GitHub successfully creates the repository 4. The system calls the CKB Notification Service 5. CKB Notification Service sends the notification
Exit Condition	User receives the notification and the link to the github repository
Exceptions	<ul style="list-style-type: none"> • None
Notes	



Use case [U14]: Badges assignment

Actor(s)	User, CKB Notification Service
Entry Condition	User subscribed to a tournament, tournament has a badge associated
Event Flow	<ol style="list-style-type: none"> 1. Tournament is closed 2. The system checks the badge rules fulfillment for all students subscribed to that tournament 3. User is assigned a badge 4. The system calls the CKB Notification Service 5. CKB Notification Service sends the notification
Exit Condition	User receives the notification of the badge assigned
Exceptions	<ul style="list-style-type: none"> • User does not fulfill the rules associated to the badge
Notes	<ul style="list-style-type: none"> • Exception: User is not assigned the badge, thus does not receive the notification <p>This operation is performed for every badge associated with the tournament that is closed</p>



3.2.3 Requirements Mapping

<p>[G1] Educator can manage (create battles and badges, grant permission to other Educators, and close) each tournament he/she creates.</p>	<p>[R1]: The systems allows educators to sign up. [R3]: the system allows registered educators to log in. [R5]: the system allows educators to create a new tournament. [R6]: the system allows an educator to grant permission to create battles within the context of a specific tournament to another educator. [R7]: the system allows educators to create a new battle, if they have the permission to do it. [R24]: the system allows educators who created a tournament to close it. [R26]: the system allows educators that have created a tournament to create badges.</p> <p>[D1]: Users have reliable and consistent access to the internet to participate in code kata battles and interact with the platform. [D2]: Users have access to suitable devices, such as computers or mobile devices, with compatible web browsers. [D3]: Educators have a basic understanding of the CodeKataBattle platform's features, enabling them to create and manage tournaments and battles effectively. In particular, they have to provide correct tests and rules for projects and badges. [D5]: User-provided data, including user profiles, code submissions, and scoring information, is assumed to be accurate and valid. Users are supposed to providing truthful information. [D7]: The platform assumes a high level of system uptime, with minimal downtime, to support user interactions, database storage, and real-time features. [D9]: Users are responsible for maintaining the security and privacy of their accounts, including choosing strong passwords and keeping their login credentials confidential.</p>
<p>[G2] Educator can manage (deliver exercise, set options, evaluate teams submissions and check rank) each battle he/she creates.</p>	<p>[R1]: The systems allows educators to sign up. [R3]: the system allows registered educators to log in. [R11]: the system allows educators that created a battle to upload the code kata. [R12]: the system allows educators that created a battle to set minimum and maximum number of students per group. [R13]: the system allows educators that created a battle to set a registration deadline. [R14]: the system allows educators that created a battle to set a final submission deadline. [R15]: the system allows educators that created a battle to set the possibility to manually evaluate projects during the consolidation stage. [R19]: the system allows both students and educators to see the current rank evolving during a battle. [R20]: the system allows educators to manually evaluate projects during the consolidation stage in the context of a specific battle.</p> <p>[D1]: Users have reliable and consistent access to the internet to participate in code kata battles and interact with the platform. [D2]: Users have access to suitable devices, such as computers or mobile devices, with compatible web browsers. [D3]: Educators have a basic understanding of the CodeKataBattle platform's features, enabling them to create and manage tournaments and battles effectively. In particular, they have to provide correct tests and rules for projects and badges. [D5]: User-provided data, including user profiles, code submissions, and scoring information, is assumed to be accurate and valid. Users are supposed to providing truthful information. [D7]: The platform assumes a high level of system uptime, with minimal downtime, to support user interactions, database storage, and real-time features. [D9]: Users are responsible for maintaining the security and privacy of their accounts, including choosing strong passwords and keeping their login credentials confidential.</p>

[G3] Student can subscribe to a tournament.	
<p>[R2]: the system allows students to sign up.</p> <p>[R4]: the system allows registered students to log in.</p> <p>[R8]: the system notifies all the students subscribed to the platform when a new tournament is created.</p> <p>[R9]: the system allows students to subscribe to a tournament.</p>	<p>[D1]: Users have reliable and consistent access to the internet to participate in code kata battles and interact with the platform.</p> <p>[D2]: Users have access to suitable devices, such as computers or mobile devices, with compatible web browsers.</p> <p>[D5]: User-provided data, including user profiles, code submissions, and scoring information, is assumed to be accurate and valid. Users are supposed to providing truthful information.</p> <p>[D7]: The platform assumes a high level of system uptime, with minimal downtime, to support user interactions, database storage, and real-time features.</p> <p>[D9]: Users are responsible for maintaining the security and privacy of their accounts, including choosing strong passwords and keeping their login credentials confidential.</p>
[G4] Student can manage (subscribe and check rank) their participation to a battle.	
<p>[R2]: the system allows students to sign up.</p> <p>[R4]: the system allows registered students to log in.</p> <p>[R10]: the system notifies all the students subscribed to a specific tournament when a new battle in the context of that tournament is created.</p> <p>[R16]: the system allows students to create teams for ongoing battles inviting other students.</p> <p>[R17]: the system allows students to join a battle.</p> <p>[R18]: the system sends to each students that belongs to a team subscribed to a battle the link of the GitHub repository assigned to that team.</p> <p>[R19]: the system allows both students and educators to see the current rank evolving during a battle.</p> <p>[R21]: the system notifies all students participating in the battle when the final battle rank becomes available.</p>	<p>[D1]: Users have reliable and consistent access to the internet to participate in code kata battles and interact with the platform.</p> <p>[D2]: Users have access to suitable devices, such as computers or mobile devices, with compatible web browsers.</p> <p>[D4]: Students know how to configure Github Actions for let the system aware of the push on the main branch.</p> <p>[D5]: User-provided data, including user profiles, code submissions, and scoring information, is assumed to be accurate and valid. Users are supposed to providing truthful information.</p> <p>[D6]: Users will use the platform responsibly, adhering to ethical guidelines and academic integrity. Students are expected to complete code katas independently or within the rules of team collaboration defined by educators.</p> <p>[D7]: The platform assumes a high level of system uptime, with minimal downtime, to support user interactions, database storage, and real-time features.</p> <p>[D8]: Some platform functionalities may rely on external services, such as email verification, communication tools and Github integrations.</p> <p>[D9]: Users are responsible for maintaining the security and privacy of their accounts, including choosing strong passwords and keeping their login credentials confidential.</p> <p>[D10]: Users are expected to engage in ethical behavior, respecting intellectual property rights, academic integrity, and community guidelines established by the platform.</p>

[G5] Both educators and students can check rank for each tournament.	
<p>[R1]: The systems allows educators to sign up.</p> <p>[R2]: the system allows students to sign up.</p> <p>[R3]: the system allows registered educators to log in.</p> <p>[R4]: the system allows registered students to log in.</p> <p>[R23]: the system allows both educators and students to see the rank of each ongoing tournament.</p> <p>[R25]: the system notifies all students involved in a tournament when the final rank of that tournament becomes available.</p>	<p>[D1]: Users have reliable and consistent access to the internet to participate in code kata battles and interact with the platform.</p> <p>[D2]: Users have access to suitable devices, such as computers or mobile devices, with compatible web browsers.</p> <p>[D5]: User-provided data, including user profiles, code submissions, and scoring information, is assumed to be accurate and valid. Users are supposed to providing truthful information.</p> <p>[D7]: The platform assumes a high level of system uptime, with minimal downtime, to support user interactions, database storage, and real-time features.</p> <p>[D9]: Users are responsible for maintaining the security and privacy of their accounts, including choosing strong passwords and keeping their login credentials confidential.</p>

[G6] Both educators and students can visualize the profile of a Student.	
<p>[R1]: The systems allows educators to sign up.</p> <p>[R2]: the system allows students to sign up.</p> <p>[R3]: the system allows registered educators to log in.</p> <p>[R4]: the system allows registered students to log in.</p> <p>[R27]: the system allows both educator and students to visualize the profile and badges of a student.</p>	<p>[D1]: Users have reliable and consistent access to the internet to participate in code kata battles and interact with the platform.</p> <p>[D2]: Users have access to suitable devices, such as computers or mobile devices, with compatible web browsers.</p> <p>[D5]: User-provided data, including user profiles, code submissions, and scoring information, is assumed to be accurate and valid. Users are supposed to providing truthful information.</p> <p>[D7]: The platform assumes a high level of system uptime, with minimal downtime, to support user interactions, database storage, and real-time features.</p> <p>[D9]: Users are responsible for maintaining the security and privacy of their accounts, including choosing strong passwords and keeping their login credentials confidential.</p>

[G7] Both educators and students can see the list of ongoing tournaments.	
<p>[R1]: The systems allows educators to sign up.</p> <p>[R2]: the system allows students to sign up.</p> <p>[R3]: the system allows registered educators to log in.</p> <p>[R4]: the system allows registered students to log in.</p> <p>[R22]: the system allows both educators and students to see the list of ongoing tournaments.</p>	<p>[D1]: Users have reliable and consistent access to the internet to participate in code kata battles and interact with the platform.</p> <p>[D2]: Users have access to suitable devices, such as computers or mobile devices, with compatible web browsers.</p> <p>[D5]: User-provided data, including user profiles, code submissions, and scoring information, is assumed to be accurate and valid. Users are supposed to providing truthful information.</p> <p>[D7]: The platform assumes a high level of system uptime, with minimal downtime, to support user interactions, database storage, and real-time features.</p> <p>[D9]: Users are responsible for maintaining the security and privacy of their accounts, including choosing strong passwords and keeping their login credentials confidential.</p>

3.3 Performance Requirements

To work properly the system must guarantee low response time in some aspects such as the time spent to calculate and update the battle score of each team after a pull of the latest sources by the platform.

Another aspect that must be prioritized is the deadline management to avoid some users perform actions out of the maximum time established, such as subscription to a battle or push new code on GitHub. Moreover, the system has to send as soon as possible the notifications that have to be sent to students.

However there could be problems out of the system that can affect the performances, for example problems with users' devices or their internet connection.

3.4 Design Constraints

3.4.1 Standards compliance

In the development of CKB several standards and compliance considerations are addressed. The wireless network communication adheres to the IEEE 802.11 standard, ensuring a reliable and secure connection for users participating in coding challenges. Additionally, strict adherence to data protection standards is paramount, with the implementation of privacy laws and regulations governing the handling of personal information.

To facilitate collaboration and version control in the development process, the system integrates the Git protocol for communication with GitHub, following established best practices for code repository management.

Given the competitive coding nature of the platform, it is imperative to align with OWASP guidelines for web application security. This encompasses robust measures to prevent common vulnerabilities, secure coding practices, and continuous monitoring to ensure the highest standards of security in the challenges and user interactions.

Furthermore, considering the dynamic nature of the platform and its coding challenges, accessibility standards (such as WCAG) are implemented to guarantee an inclusive experience for users. Additionally, performance standards are upheld to ensure the website's responsiveness and optimal user experience across various devices and network conditions.

3.4.2 Hardware limitations

There are very few hardware requirements to use the platform. Users shall have an internet connection (Wi-Fi) and a modern device.

3.4.3 Any other constraint

There are no limitations about users, everyone can sign in to CKB and try its functionalities. To facilitate interactions with users the application page should be intuitive, simple to interact with and aesthetically pleasing.

3.5 Software System Attributes

3.5.1 Reliability

CKB should exhibit consistent and predictable performance, minimizing the occurrence of failures or disruptions, and ensuring its ability to deliver intended functionality over time. According to this, the system is distributed and its data are replicated in order to guarantee continuous interactions with it.

3.5.2 Availability

There is no constraint about the time during the day the system can be accessed, so it has to be online as much time as possible. In particular CKB must guarantee availability of 99.9% so that users are affected by offline periods as less as possible.

3.5.3 Security

The system holds critical user data, underscoring the paramount importance of security considerations. Safeguarding the central database is imperative, necessitating the implementation of comprehensive measures to thwart both external and internal threats. Encryption must be applied to stored passwords, ensuring they remain secure; furthermore, any password recovery process must avoid transmitting sensitive information in plain text.

For online communication, CKB should employ robust encryption protocols to mitigate the risks of traffic interception and spoofing, thereby thwarting deceptive attacks and upholding privacy and data integrity.

3.5.4 Maintainability

The system's maintainability is a top priority, necessitating the implementation of effective design patterns and adherence to high standards. It is imperative to ensure thorough documentation, steering clear of hard-coding practices. Additionally, a comprehensive testing routine should be established.

3.5.5 Portability

The application is developed for each operating system among the most popular ones, such as MacOS, Windows or Linux. The only requirement about the OS is that it supports a browser to access the web page of the platform.

4 Alloy

In the following are stated all the signatures defined for the Alloy modelization.

```
-- Alloy model for CodeKataBattle platform

// SIGNATURES

-- Time is used to represent a couple <date,time>
sig Time {
  value: one Int,      -- Value of the <data, time> couple
}

-- Signature representing a user in the system
abstract sig User {
  userId: one Int,      -- Unique identifier for a user
  username: lone String, -- User's username
  email: one String,    -- User's email address
  password: one String, -- User's password
}
sig Educator extends User {}
sig Student extends User {
  badges: some Badge    -- Student's badges
}

-- Signature representing a code kata for programming exercises
sig CodeKata {
  kataId: one Int,      -- Unique identifier for a code kata
  description: lone String, -- Description of the programming exercise
  programmingLanguage: lone String, -- Programming language for the exercise
}

-- Signature representing a tournament organized by an educator
sig Tournament {
  tournamentId: one Int, -- Unique identifier for a tournament
  educators: some Educator, -- Educator organizing the tournament and Educators managing the
    ↪ tournament
  battles: set Battle,    -- Set of battles within the tournament
  badges: some Badge      -- Some badges that could be associated with the tournament
}

-- Signature representing a battle within a tournament
sig Battle {
  battleId: one Int,      -- Unique identifier for a battle
  codeKata: one CodeKata, -- Code kata for the battle
  tournament: one Tournament, -- Tournament associated to the battle
  teams: set Team,        -- Set of teams participating in the battle
  maxTeamSize: one Int,   -- Max Number of Students allowed in a team
  minTeamSize: one Int,   -- Min Number of Students allowed in a team
  registrationDeadline: one Time, -- Deadline for team registration
  submissionDeadline: one Time -- Deadline for code submission
}

-- Signature representing a team participating in a battle
sig Team {
  teamId: one Int,      -- Unique identifier for a team
  members: set Student, -- Set of users in the team
  submissions: set Submission -- Set of submissions of the team
}

-- Signature representing a code submission by a team
sig Submission {
  submissionId: one Int, -- Unique identifier for a submission
  team: one Team,        -- Team that submitted the code
  code: lone String,     -- Code submitted by the team
  timestamp: one Time    -- Timestamp of the submission
}

sig Badge {
  badgeId: one Int, -- Unique identifier for a badge
  description: one String -- Description of the badge
}
```

```

// FACTS

-- Fact specifying time constraint
fact TimeConstraints{
  all t: Time |
    t.value > 0
  and
  (all disj t1, t2: Time |
    t1.value ≠ t2.value)
}

-- Fact specifying constraints on user attributes
fact UserConstraints {
  (all u: User |
    u.userId > 0 and
    u.email ≠ none and
    u.password ≠ none)
  (all disj u1, u2: User |
    u1.email ≠ u2.email and
    u1.username ≠ u2.username and
    u1.userId ≠ u2.userId)
  (all s: Student |
    #s.badges ≥ 0)
}

-- Fact specifying constraints on code kata attributes
fact CodeKataConstraints {
  (all ck: CodeKata |
    ck.kataId > 0 and
    ck.description ≠ none and
    ck.programmingLanguage ≠ none)
  and
  (all disj ck1, ck2: CodeKata |
    ck1.kataId ≠ ck2.kataId)
}

-- Fact specifying constraints on tournament attributes
fact TournamentConstraints {
  (all t: Tournament |
    t.tournamentId > 0 and
    t.educators ≠ none and
    #t.battles ≥ 0)
  and
  (all disj t1, t2: Tournament |
    t1.tournamentId ≠ t2.tournamentId)
}

-- Fact specifying constraints on battle attributes
fact BattleConstraints {
  all b: Battle |
    b.battleId > 0 and
    b.codeKata ≠ none and
    b.teams ≠ none and
    b.registrationDeadline ≠ none and
    b.submissionDeadline ≠ none
  and
  (all disj b1, b2: Battle |
    b1.battleId ≠ b2.battleId)
}

-- Fact specifying constraints on team attributes
fact TeamConstraints {
  all t: Team |
    t.teamId > 0 and
    t.members ≠ none and
    t in Battle.teams
  and
  (all disj t1, t2: Team |
    t1.teamId ≠ t2.teamId)
}

-- Fact specifying constraints on submission attributes
fact SubmissionConstraints {
  (all s: Submission |
    s.submissionId > 0 and
    s.team ≠ none and
    s.code ≠ none and
    s.timestamp ≠ none and
    (all t: Team |
      s in t.submissions iff s.team = t))
  (all disj s1, s2: Submission |
    s1.submissionId ≠ s2.submissionId
    and
    (s1.team = s2.team implies s1.timestamp ≠ s2.timestamp))
}

```

```

-- Fact specifying constraints on submission attributes
fact BadgeConstraints {
  all b: Badge |
    b.badgeId > 0 and
    b.description ≠ none
  and
  (all disj b1, b2: Badge |
    b1.badgeId ≠ b2.badgeId)
}

-- Fact specifying the constraint of the team size in a battle
fact TeamInBattleConstraints {
  all b: Battle |
    all t: b.teams |
      #t.members ≤ b.maxTeamSize and
      #t.members ≥ b.minTeamSize
}

-- Fact specifying the constraint of the size of teams
fact SizeOfTeamsConstraints {
  all b: Battle |
    b.minTeamSize ≥ 1 and
    b.maxTeamSize ≥ 1
}

-- Fact specifying the membership of the student to a single team in the scope of a battle
fact MembershipOfStudentConstraints {
  (all b: Battle |
    all disj t1, t2: b.teams |
      all s: t1.members |
        s not in t2.members)
}

-- Fact specifying the time constraint between registration and submission deadlines
fact RegistrationSubmissionConstraints {
  (all b: Battle |
    b.registrationDeadline.value < b.submissionDeadline.value)
}

// ASSERTIONS

-- Assertion: All users have unique user IDs
assert UniqueUserIDs {
  all u1, u2: User | u1 ≠ u2 implies u1.userId ≠ u2.userId
}

-- Assertion: All code katas have unique IDs
assert UniqueKataIDs {
  all ck1, ck2: CodeKata | ck1 ≠ ck2 implies ck1.kataId ≠ ck2.kataId
}

-- Assertion: All tournaments have unique IDs
assert UniqueTournamentIDs {
  all t1, t2: Tournament | t1 ≠ t2 implies t1.tournamentId ≠ t2.tournamentId
}

-- Assertion: All battles have unique IDs
assert UniqueBattleIDs {
  all b1, b2: Battle | b1 ≠ b2 implies b1.battleId ≠ b2.battleId
}

-- Assertion: All teams have unique IDs
assert UniqueTeamIDs {
  all t1, t2: Team | t1 ≠ t2 implies t1.teamId ≠ t2.teamId
}

-- Assertion: All submissions have unique IDs
assert UniqueSubmissionIDs {
  all s1, s2: Submission | s1 ≠ s2 implies s1.submissionId ≠ s2.submissionId
}

-- Assertion: All team members are distinct
assert DistinctTeamMembers {
  all t: Team | no disj u1, u2: t.members | u1 ≠ u2
}

-- Assertion: CodeKata associated with a battle must be unique
assert UniqueCodeKataPerBattle {
  all b: Battle | all disj ck1, ck2: b.codeKata | ck1 ≠ ck2
}

```

```
-- Assertion: Submission timestamp is within the battle deadlines
assert SubmissionWithinDeadlines {
  all b: Battle, s: Submission | s in b.teams.submissions implies
    b.registrationDeadline.value ≤ s.timestamp.value and
    s.timestamp.value ≤ b.submissionDeadline.value
}

-- Assertion: Each team in a battle has a distinct set of members
assert DistinctTeamMembersInBattle {
  all b: Battle | all t1, t2: b.teams | t1 ≠ t2 implies no t1.members & t2.members
}

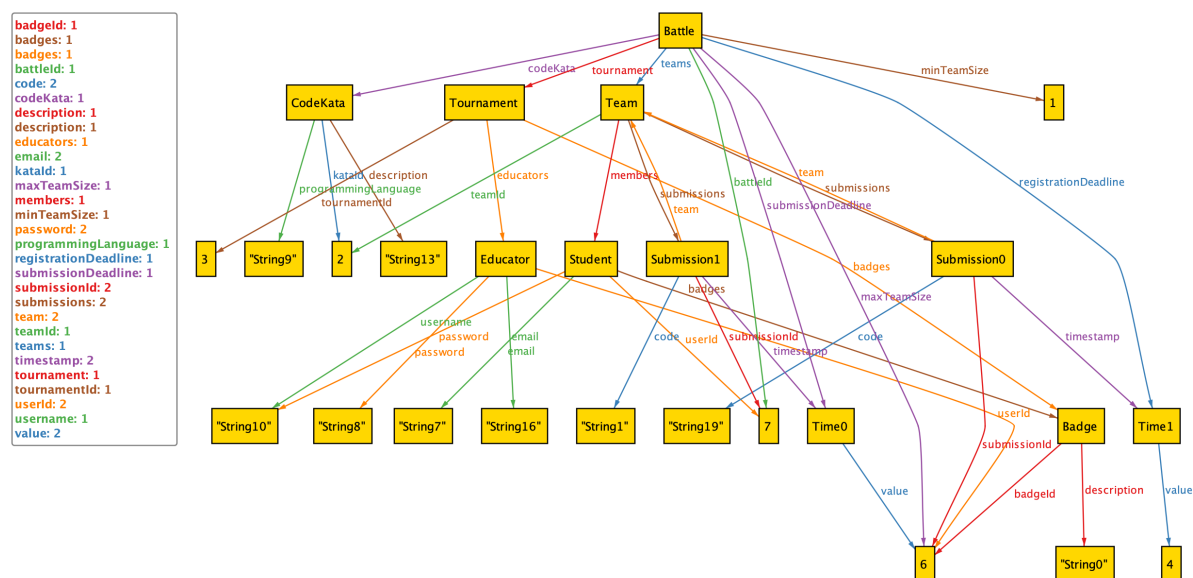
-- Assertion: All battles within a tournament have distinct IDs
assert UniqueBattlesPerTournament {
  all t: Tournament | all disj b1, b2: t.battles | b1 ≠ b2
}

// PREDICATES

-- Predicate representing the action of a user registering for a battle
pred RegisterForBattle[student: Student, battle: Battle] {
  student in battle.teams.members
}

-- Predicate representing the evaluation of a code submission in a battle
pred EvaluateSubmission[battle: Battle, submission: Submission] {
  submission in battle.teams.submissions
}

run show{} for 3 but exactly 20 String
```



Alloy Model

5 Effort Spent

Emanuele Pocelli

Chapter	Effort (in hours)
1	2
2	10
3	16
4	2

Fabrizio Sordetti

Chapter	Effort (in hours)
1	4
2	8
3	5
4	13

Andrea Varesi

Chapter	Effort (in hours)
1	9
2	5
3	12
4	4

6 References

- Diagrams made with: draw.io
- Mockups made with: moqups.com
- Alloy models made with: Alloy Analyzer 6.1.0
- Alloy models runned and checked with: Alloy Analyzer 6.1.0