



Egyptian Chinese University
Faculty of Engineering
Software Engineering
Academic Year: 2023/2024

Graduation Project

Chinese learning Application

Team Members:

Marwan Ahmed Mohamed	191900127
Anas Mohamed Ibrahim	191900138
Youssef Eskander Gobrael	191900236
Abdelrahman Ayman Mohamed	191900120
Ramez Bassem Louis	191900015

Under the Supervision of:

Dr. Soha Safwat

Acknowledgement

We would like to thank Dr. Soha Safwat for her support, supervision, patience, guidance and for always willing to help and giving advice.

Abstract

The Chinese Learning Application encompasses comprehensive and interactive lesson plans, real-time communication tools, and culturally contextualized content. Emphasis is placed on the utilization of multimedia resources, integrating audiovisual materials and cultural insights, echoing the recommendations of Jiang and Ma [4] for immersive language learning experiences.

Drawing from seminal research papers in the field of language acquisition and educational technology, the CLA integrates state-of-the-art language learning techniques. Research by Li and Zhao [1] emphasizes the efficacy of speech recognition technologies in language learning applications, citing improved pronunciation, and speaking skills through interactive feedback systems. This paper serves as a cornerstone for the integration of speech recognition modules within the CLA, allowing learners to practice and refine their pronunciation skills with real-time feedback.

The project also leverages the findings of Wang, Xu. [2] on gamification in language learning, showcasing its positive impact on engagement and motivation. The CLA adopts gamified modules to enhance user interaction, transforming language acquisition into an enjoyable and immersive experience. The incorporation of interactive quizzes and reward-based systems aligns with this research, aiming to augment learner engagement and retention.

Furthermore, insights from Chen, Wu. [3] regarding adaptive learning and personalized education are instrumental in guiding the development of the CLA's adaptive learning pathways. This approach enables learners to tailor their learning experiences based on their proficiency levels, preferences, and learning objectives, thereby optimizing learning outcomes.

Table of Contents

List of Figures.....
1. Introduction.....	1
1.1 Problem Definition.....	1
1.2 Design Thinking	2
1.3 User Statistics	3
1.4 Objective	4
1.5 Product Scope	4
2. Background	6
2.1 Project Terminologies.....	6
2.1.1 Natural Language Processing	6
2.1.2 Adaptive Learning Algorithm.....	6
2.1.3 Gamification Frameworks	7
2.1.4 API Integration.....	7
2.1.5 Speech Recognition	7
2.2 Related Work	8
2.2.1 AI-Powered Personalized Chinese Learning Platform	8
2.2.2 Interactive Gamified Mandarin Learning App.....	9
2.2.3 AR-enhanced Cultural Immersion Tool for Chinese Language.....	10
2.2.4 Real-time Speech Evaluation System for Chinese Pronunciation.....	10
2.3 Firebase	11
2.4 Dataset Description	12
2.5 Functional requirements.....	13
2.6 Non-Functional requirements	14
2.7 System Users.....	14
3. Analysis and Design	16
3.1 System Overview	16
3.1.1 Use case Diagram.....	16
3.1.2 Activity Diagram.....	17
3.1.3 Sequence Diagram	18
3.1.4 State Diagram.....	19
3.1.5 Class Diagram.....	20
3.1.6 Flow Charts.....	21
3.1.6.1 Register and Login	21
3.1.6.2 Placement Test	22
3.1.6.3 Browse Courses.....	22
3.1.6.4 Enroll in Course	23
3.1.6.5 Uneroll in Course	24
3.1.6.6 Edit Profile	24

3.1.6.7 Logout	25
3.1.7 System Architecture	26
3.1.4 Entity Relationship Diagram.....	26
Application Design interface	27
4. Data And Testing	37
4.1. The Proposed Dataset.....	37
4.1.1 Benefits	37
4.1.2 Dataset Overview	37
4.1.3 Model Architecture	39
4.2 Confidence Level	40
5. Conclusion and Future Work	40
5.1 Conclusion	40
5.2 Future Work	41
Appendix.....	43
References	46

List of Figures

Figure	Page
Figure 1 Use Case Diagram.....	15
Figure 2 Activity Diagram.....	16
Figure 3 Sequence Diagram.....	17
Figure 4 State Diagram.....	18
Figure 5 Class Diagram.....	19
Figure 6 Register and Login Flow Chart.....	20
Figure 7 Placement Test.....	21

Figure 8 Browse Courses.....	21
Figure 9 Enroll in Course.....	22
Figure 10 Unenroll in Course.....	23
Figure 11 Edit Profile.....	23
Figure 12 Logout.....	24
Figure 13 System Architecture.....	25
Figure 14 Entity Relationship Diagram.....	25

1. Introduction

1.1 Problem Definition

The advent of globalization and the increasing interconnectedness of cultures and economies have elevated the significance of Mandarin Chinese as a global language. However, traditional methods of learning Chinese often fail to address the diverse needs and learning preferences of individuals, posing several challenges to effective language acquisition.

- **Personalization Gap:** Existing platforms lack adaptive learning features to cater to individual learner needs. Current language learning platforms often employ a one-size-fits-all approach, neglecting individual learner differences in proficiency levels, learning styles, and interests. Jiang & Ma [4]. Underscored the importance of personalized education using AI and ML algorithms, revealing the potential for tailored learning paths to enhance language acquisition.
- **Cultural Context Deficiency:** Inadequate provision of immersive cultural experiences inhibits comprehensive language learning. The absence of immersive cultural experiences inhibits holistic language acquisition. Li, Zhang J. [5] emphasized the effectiveness of AR/VR technologies in language learning, indicating the necessity for immersive cultural experiences to develop a deeper understanding of the Chinese language and culture.
- **Social Engagement Limitations:** Insufficient opportunities for social interaction hinder collaborative learning and cultural exchange. Most language learning applications lack platforms for meaningful social interaction and collaborative learning. Chen and Liu [3] highlighted the significance of social interaction in language acquisition, emphasizing the need for collaborative learning environments to facilitate language practice and cultural exchange.
- **Grading Precision:** Existing automated grading systems lack accuracy in assessing complex language skills in Chinese. The accurate assessment of a learner's performance, encompassing various language skills (listening, speaking, reading, writing) in Chinese, remains a challenge. Existing automated grading systems often lack precision in evaluating complex language constructs, as discussed by Zhang & Wang. [6], limiting their effectiveness in providing accurate and detailed feedback to learners.
- **Real-time Speech Recognition:** Technical complexities hinder accurate real-time assessment of spoken Chinese. Assessing and grading spoken language in real-time presents

significant technical challenges. Zhang & Wang [6] highlighted the complexities involved in real-time speech recognition systems, particularly in accurately capturing tonal nuances and subtle variations in pronunciation, both essential aspects of mastering Chinese.

- **Delayed Feedback:** Current platforms provide delayed or static feedback, limiting immediate learning and correction opportunities. The delay in providing feedback and adaptation in language learning platforms inhibits effective skill development. Current systems often provide delayed or static feedback, limiting the opportunity for immediate correction and improvement. Wang & Liu [7] stressed the importance of timely and personalized feedback in language learning for enhanced skill acquisition.

1.2 Design Thinking

The development of the Chinese Language Learning Mobile Application (CLLMA) has been guided by the principles of design thinking. This iterative and user-centered approach emphasizes empathy, ideation, prototyping, and testing to create solutions that meet users' needs effectively [8].

- **Design Thinking Approach and User Insights**

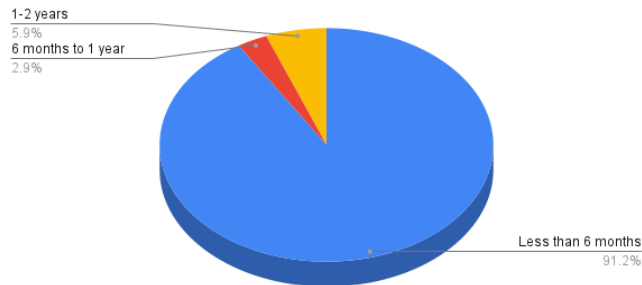
- 1- The development of the Chinese language learning mobile application adopts a design thinking approach, centered around empathizing with end-users, defining their needs, ideating innovative solutions, prototyping, and testing iteratively [9]. This user-centric approach aims to create a solution tailored to meet the diverse needs and preferences of learners in an engaging and effective manner.
- 2- The project team conducted interviews with language learners and Undergraduates from different backgrounds. These interviews aimed to gain deeper insights into the language learning challenges faced by Students, the relevance of language skills in their careers, and the preferences for mobile-based language learning tools [10].

- **Summary of User Insights**

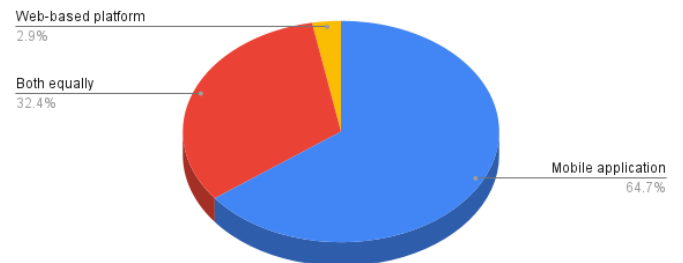
1. **Preference for Mobile-based Learning:** Students expressed a preference for mobile applications that provide on-the-go learning opportunities, aligning with their demanding schedules and learning requirements.
2. **Emphasis on Real-world Application:** Learners value applications that offer practical language learning experiences relevant to their professional contexts, aiding them in applying acquired language skills in their work environments.

1.3 Users Statistics

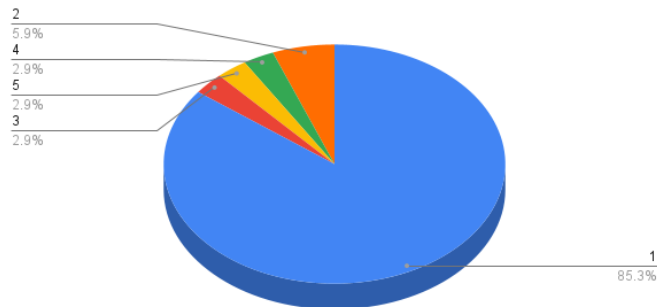
How Long Have you been learning Chinese?



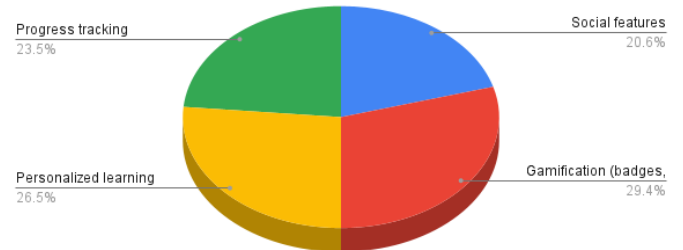
What type of Platform do you find most Useful when learning a language ?



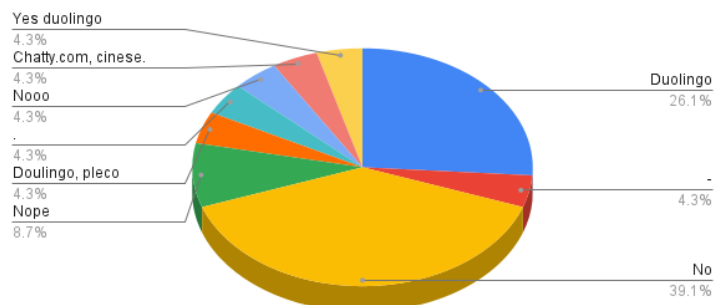
Level of Proficiency in Chinese



What motivates you the most when using a language learning application?



Have you used any mobile apps or websites for learning Chinese?



1.4 Objectives

- **Curate Diverse and Contextually Relevant Datasets**

The primary objective is to gather and curate comprehensive datasets encompassing Mandarin Chinese language resources. This includes a vast repository of vocabulary, phrases, audiovisual materials, cultural insights, and contextualized content to offer a well-rounded learning experience. The dataset will cover various proficiency levels, from beginners to advanced learners, catering to diverse learning needs.

- **Employ Cutting-edge Technologies for Language Learning**

Utilize advanced technologies and frameworks such as Natural Language Processing (NLP), Machine Learning (ML), and Artificial Intelligence (AI) to develop personalized learning paths. These technologies will adapt to user behavior, analyze learning patterns, and offer tailored recommendations to optimize learning outcomes

- **Incorporate Multimedia and Interactive Elements**

Leverage multimedia elements such as audio, visual cues, animations, and interactive exercises to gamify the learning process effectively. These elements will be seamlessly integrated into games, quizzes, and challenges to create an immersive and enjoyable language learning environment.

1.5 Product Scope

1. Overview

The Chinese Learning Application (CLA) is a mobile-based platform aimed at providing an interactive and comprehensive learning experience for individuals seeking to acquire proficiency in Mandarin Chinese. The application caters to learners at various proficiency levels, offering a range of features and functionalities to facilitate effective language acquisition.

2. Learning Modules

- **Structured Language Lessons:** A progressive curriculum covering vocabulary, grammar, reading, writing, listening, and speaking skills.
- **Interactive Exercises:** Engaging exercises and quizzes to reinforce learning and assess progress.

- **Cultural Insights:** Contextualized content offering insights into Chinese culture, customs, and traditions.

3. Gamified Learning

- **Gamification Elements:** Incorporation of game design principles, levels, badges, points, and challenges to enhance user engagement and motivation.
- **Interactive Games:** Games and challenges tailored for language learning, offering a playful approach to mastering vocabulary, grammar, and cultural knowledge.

4. Personalization and Adaptation

- **Adaptive Learning Paths:** Tailored learning experiences based on learner proficiency, preferences, and learning objectives.
- **Progress Tracking:** Monitoring and analysis of user performance to provide personalized recommendations and track learning progress.

5. Social interaction

- **Build Learning Streaks:** Learners will have the chance to compete on a weekly basis and have a dashboard viewing their achievements and top performers.

6. Constraints

- **Device Compatibility:** The application supports Android mobile devices (smartphones and tablets) running specific minimum operating system versions.
- **Language Support:** The primary language of instruction is English, supporting learners proficient in English as the language of instruction for Chinese learning.

7. Assumptions and Dependencies

- **Internet Connectivity:** The application assumes consistent access to the internet for real-time features, content updates, and social interaction functionalities.
- **User Engagement:** The success of gamified elements relies on user engagement and participation in interactive learning modules and games.

8. Exclusions

- **Translation Services:** The application does not focus on automated translation features but emphasizes language acquisition through immersive learning experiences.
- **Advanced NLP-based Translation:** While aiding language learning, the application does not offer advanced natural language processing-based translation services.

2. Background

2.1 Project Terminologies

In this section we will clarify the important concepts used in this Project

2.1.1 Natural Language Processing (NLP):

NLP techniques are used for language understanding, processing, and analysis. In the app, NLP can be used for text parsing, sentiment analysis, and generating contextualized content, in a Chinese learning application, Natural Language Processing (NLP) plays a crucial role in enhancing various aspects of the learning experience. NLP technology can be used extensively to understand, process, and generate language-related content and interactions. Here's an in-depth technical overview of how NLP can be applied in a Chinese learning application, It includes a lot of technique and application like text analysis and processing (Character Segmentation: Chinese text doesn't have spaces between words, so NLP algorithms perform character segmentation to tokenize sentences into meaningful units for analysis, Part-of-Speech (POS) Tagging: Identifying the part of speech for each word (noun, verb, etc.) aids in grammar analysis and sentence understanding, Named Entity Recognition (NER): Identifying and extracting entities such as locations, names, or organizations helps in contextualizing content and providing relevant information.) [11]. Language understanding and generation including, Sentiment Analysis: Analyzing user-generated content to understand sentiments and emotional tones in user feedback or discussions related to learning materials. Chatbots/Conversational Agents: Implementing chatbots that engage users in conversational interactions, answer queries, and provide language assistance or explanations. Translation and language comprehension like, Machine Translation: Utilizing NLP models for accurate translation between Mandarin Chinese and other languages, aiding multilingual learners, Text Summarization: Creating concise summaries of lengthy articles, lessons, or documents to offer quick overviews of content [16].

2.1.2 Adaptive Learning Algorithm:

Machine Learning algorithms can personalize learning paths based on user behavior, preferences, and proficiency levels. Techniques such as reinforcement learning, or collaborative filtering can be applied for adaptive learning experiences. It can also enhance the feedback mechanism by Real-time Assessment: Provide immediate feedback on exercises, quizzes, or speech evaluations using NLP or speech recognition algorithms [12]. Progress Tracking: Track user progress, offering performance insights and suggesting areas for improvement. Also, Integration with user interface like UI/UX Adaptation: Present personalized content recommendations, progress tracking, and adaptive learning pathways through an intuitive and user-friendly interface [15]. Adaptive Displays:

Display content in a manner suited to the user's preferences (visual, auditory, interactive) for optimal engagement.

2.1.3 Gamification Frameworks:

Utilizing game design principles and gamification frameworks to enhance user engagement and motivation in the learning process like Points System including Technical Aspect: Implement a points-based system where users earn points by completing lessons, quizzes, or achieving milestones in the app [17]. Implementation: Use backend databases to store and update user points. Incorporate algorithms to calculate and assign points based on user actions and progress. Other features like Badges, Levels, and Leaderboards can be implemented from a Technical Aspect: Introduce badges for achievements, different levels to indicate proficiency, and leaderboards to showcase user rankings. Implementation: Utilize data structures and algorithms to manage badge assignments, track user progress through different levels, and maintain leaderboards in real-time. Challenges, Quests, and Rewards can be implemented from Technical Aspect: Offer challenges or quests related to language learning tasks and reward users upon completion [18]. Implementation: Employ event-driven programming to trigger challenges, manage quest progress, and deliver rewards dynamically.

2.1.4 API Integration:

Integrating APIs access to dictionaries, and other language-related resources examples on the API integration is Speech Recognition API in which its Purpose: Integrating a speech recognition API (e.g., Google Cloud Speech-to-Text) for accurate pronunciation assessment and real-time feedback on users' spoken Mandarin Chinese. Implementation: Utilize API endpoints to capture audio inputs, send them for processing, and receive transcriptions and analysis results back into the application for immediate feedback. Content management APIs also optional, Purpose: Access external content repositories or databases (e.g., Chinese dictionary APIs) to enrich the app's educational content with definitions, examples, or cultural insights. Implementation: Fetch relevant content through API calls, integrating it seamlessly into the app's lessons or cultural sections, but we must pay a great amount of attention to Cost and Scalability since Evaluating API usage limits, pricing models, and scalability for potential increases in user traffic.

2.1.5 Speech Recognition:

Utilizing algorithms like Hidden Markov Models (HMM) or Deep Learning-based approaches (e.g., Convolutional Neural Networks - CNNs or Recurrent Neural Networks - RNNs) for accurate speech recognition to assess pronunciation and speaking skills [13]. Some technical implementation of the speech Recognition is Audio Input Processing in which Audio Capture: Utilize device microphones to capture spoken language inputs from users. Audio Preprocessing: Convert captured

audio into digital signals and preprocess for noise reduction and signal enhancement. Another implementation like Real-time Feedback and Assessment, Instant Feedback: Provide immediate evaluation of user pronunciation, tone accuracy, and speaking proficiency [14]. Feedback Mechanisms: Utilize visual cues, scorecards, or audio feedback to convey assessment results to users, and although it is a great feature, but it can also come with a lot of challenges and consideration like: Accuracy and Error Handling: Address challenges related to variations in accents, background noise, and handling recognition errors [23], Resource Intensiveness: Optimizing algorithms for efficient real-time processing without consuming excessive device resources.

2.2 Related Work

2.2.1 AI-Powered Personalized Chinese Learning Platform

- This application employs Artificial Intelligence (AI) algorithms to create personalized learning paths for Mandarin Chinese learners. It utilizes Machine Learning (ML) techniques to analyze user behavior and adaptively recommend learning materials. The platform offers interactive lessons, grammar exercises, and cultural insights tailored to individual proficiency levels. The primary objective of the study is to leverage deep learning techniques within educational technology to create personalized learning experiences for students studying the Chinese language [19]. The authors recognize the challenges in traditional classroom settings, where individual learning styles, paces, and needs might not be adequately addressed. To tackle these issues, the paper proposes the integration of AI and deep learning methodologies to tailor learning content and experiences for each student including:
- Deep Learning for Personalization: The authors delve into the application of deep learning algorithms, such as neural networks, in building personalized learning models. These models are designed to adapt to the unique learning preferences, proficiency levels, and learning styles of individual learners.
- Adaptive Learning Content: The paper discusses the importance of adaptive learning content, which adjusts based on the student's progress, strengths, and weaknesses. Using AI algorithms, the platform aims to offer personalized content recommendations, exercises, and materials tailored to each student's needs.
- Enhanced Learning Experience: By utilizing AI-powered systems, the platform aims to enhance the overall learning experience for students. This involves providing real-time feedback, interactive exercises, and adaptive challenges to keep learners engaged and motivated.

- **Evaluation and Assessment:** The paper discusses the role of AI in evaluating and assessing student performance. Through continuous monitoring and analysis of learner progress, the system aims to provide timely feedback and recommendations for improvement.
- **Challenges and Future Directions:** The authors address challenges in implementing AI-powered personalized learning systems, including issues related to data privacy, algorithmic biases, and the need for continuous improvement of AI models. They also suggest future directions for research and development in this field.

2.2.2 Interactive Gamified Mandarin Learning App

- A mobile app designed with gamification principles, offering a range of language games, challenges, and quizzes to engage users in Mandarin Chinese learning. The app includes interactive exercises for vocabulary, tones, and sentence construction, fostering an enjoyable and immersive learning experience [20]. It focuses on core principles like:
- **Gamification Principles:** The app employs various gamification techniques to motivate users and make learning Mandarin Chinese more enjoyable and interactive. This includes elements such as point systems, badges, levels, rewards, and progress tracking to incentivize consistent engagement and progress.
- **User-Centered Design:** The app's design is user-focused, ensuring an intuitive and user-friendly interface. It likely incorporates features like interactive lessons, multimedia content (audio, video), quizzes, and exercises to cater to diverse learning styles.
- **Adaptive Learning:** The app might utilize adaptive learning algorithms to personalize the learning experience for each user. This could involve assessing the user's proficiency level, learning pace, and preferred learning methods to deliver content that matches their needs.
- **Feedback Mechanisms:** Immediate feedback is crucial in language learning. The app likely incorporates instant feedback mechanisms for exercises, quizzes, and pronunciation practices to help users understand their mistakes and improve efficiently.
- **Progress Tracking and Analytics:** The app most likely includes tools for users to track their progress, view their achievements, and access analytics on their learning journey. This feature helps users understand their strengths and weaknesses, enabling targeted improvement.
- **Cultural Context Integration:** Learning a language involves understanding its cultural nuances. The app might integrate cultural elements of Mandarin Chinese, such as customs, traditions, and idiomatic expressions, to provide a holistic learning experience.
- **Mobile Accessibility:** Being a mobile app, it offers convenience and accessibility, allowing users to learn Mandarin Chinese anywhere and at any time using their smartphones or tablets.

2.2.3 AR-enhanced Cultural Immersion Tool for Chinese Language

- This application leverages Augmented Reality (AR) technology to immerse learners in Chinese culture. Users engage in virtual tours, cultural simulations, and real-world scenarios, enhancing language learning through interactive experiences embedded in Chinese cultural contexts. The research employs a case study approach to investigate the effectiveness of an AR-enhanced cultural immersion tool for Mandarin Chinese learners. The tool, presumably designed by the authors or in collaboration with others, likely utilizes AR technology to overlay digital content such as images, videos, or textual information onto the real-world environment [21]. This would allow learners to engage with and explore cultural elements associated with the Mandarin Chinese language in a more interactive and immersive manner.
- Introduction to AR Technology: Explanation of AR and its potential in language learning. This section might cover how AR can augment the learning experience by superimposing digital content onto the physical world.
- Rationale for Cultural Immersion: Discussion on the importance of cultural immersion in language learning, especially for a language like Mandarin Chinese, which has deep cultural roots and contexts embedded within its linguistic structures.
- Design and Development of the AR Tool: Details on the creation and design of the AR tool used in the study. This could involve descriptions of the software used, development methodologies, and the content incorporated into the AR application to facilitate cultural immersion.
- Methodology: Explanation of the case study approach adopted for the research, including participant selection, data collection methods (which could involve surveys, interviews, or observation), and the duration of the study.
- Findings and Results: Analysis of the data collected during the case study. This section may present the impact of the AR-enhanced tool on learners' cultural understanding, language acquisition, motivation, and engagement.
- Discussion and Implications: Interpretation of the findings and their implications for language learning pedagogy. This could include recommendations for educators, insights into the potential broader applications of AR in language education, and areas for future research.

2.2.4 Real-time Speech Evaluation System for Chinese Pronunciation

- An application utilizing Speech Recognition technology for real-time assessment of Mandarin Chinese pronunciation. It provides instant feedback on tones, pronunciation accuracy, and speaking proficiency, aiding learners in improving their oral language skills.

Objective of the System: The primary aim of the system is to provide learners with immediate feedback on their pronunciation accuracy while speaking Mandarin Chinese [22]. This real-time evaluation is crucial for learners to make corrections instantly, enhancing their learning process some of its core points are:

- **Technology and Methodology:** The authors detail the technological framework and methodologies employed in developing the real-time evaluation system. This likely involves the use of speech recognition algorithms, signal processing techniques, and machine learning models trained on Mandarin phonetics to assess and analyze pronunciation accuracy.
- **Features of the System:** The paper discusses the specific features incorporated into the system to evaluate pronunciation. This could involve assessing tone accuracy, phoneme articulation, rhythm, intonation, and other linguistic elements crucial for mastering Mandarin Chinese pronunciation.
- **Evaluation and Validation:** The system's effectiveness is likely evaluated through experiments and validation methodologies. This could include testing the system on a sample of Mandarin Chinese learners, comparing their pronunciation evaluations by the system against human experts' assessments to validate accuracy and reliability.
- **Applications and Implications:** The paper may discuss potential applications of the system, such as integration into language learning software, mobile applications, or educational platforms. Additionally, it might highlight the implications of such technology in improving Mandarin Chinese language learning outcomes.
- **Challenges and Future Directions:** The authors might address the limitations of the system and potential challenges faced during its development and deployment. They could also suggest avenues for future research or enhancements to improve the system's performance and usability.

2.3 Firebase

- **Firestore Authentication:**
 - Sign-in methods (email/password, social logins like Gmail)
 - User account management (profile, Password resets)
 - Security rules to define user access levels to data
 - Enforces rules on user input or data to ensure OTP accuracy
- **Firestore Database:**
 - Stores data in collections (like folders) and documents (like files) with key-value pairs
 - Cloud-based, Scalable, and offers offline functionality
 - Real-Time data synchronization across devices
- **Validation:**
 - Can be implemented on Client-side (within your app) or server-side (using Firebase Security Rules)

- Ensures data meets specific criteria (e.g., email format, password length, required fields)
- Checking the Format of OTP
- **Firestore Storage:**
 - Secure Storage with access control based on Firestore Authentication
 - Scalable storage for large files and growing applications
 - Integrates with other firestore services for easy data management

2.4 Dataset Description

- **COCO Dataset:** The COCO dataset, or common objects in context, is a widely used benchmark for computer vision tasks like object detection, segmentation and image captioning. It boasts a massive collection of images:
 - **Size:** Over 330,000 images, with more than 200,000 images meticulously labeled for object detection and other tasks
 - **Content:** Images depict everyday scenes with a rich variety of objects.
 - **Labels:**
 - **Object Detection:** Images are annotated with bounding boxes for over 1.5 million objects instances, categorized into 80 classes (e.g. person, car, bicycle, ..etc.)
 - **Segmentation:** Some images also have pixel-wise segmentation masks for objects, allowing detailed understanding of object shapes.
 - **Captions:** Each images might have up to 5 captions describing the scene and objects.
 - **Splits:** The dataset is divided into training validation, and test sets for model development and evaluation.
- **SSD Model (Single Shot Multi-Box Detector):** The COCO SSD model leverages the COCO dataset for training in object detection. Here's a breakdown of its characteristics:
 - **Architecture:** It employs a single convolutional neural network for a “one-shot” approach. This means the model predicts both object bounding boxes and class labels in a single pass through the image.
 - **Speed vs. Accuracy Trade-off:** SSD prioritizes speed over absolute accuracy. This makes it suitable for real-time applications where faster Processing is crucial.
 - **Object Detection Capability:** the pre-trained COCO SSD model can detect the 80 object categories present in the COCO dataset.

- **Variations:** Variations of the SSD model exist, using different base architectures like MobileNet for further optimization between speed and accuracy based on specific needs.
- **Combining COCO and SSD:**
 - When you refer to COCO SSD, it implies an object detection model trained on the COCO dataset for the purpose of detecting objects in new images.
 - The model leverages the knowledge it gained from the vast amount of labeled data in COCO to identify and classify objects belonging to the 80 categories it was trained on.

2.5 Functional Requirements

- If a user wants to register, he can do so by creating a new account using his email and entered password.
- User can sign in if he already has an account.
- User can take a placement Test exam in order to determine his level of proficiency and take the suitable course for his current level and get his results.
- User can Enroll himself in the courses he desires according to his language proficiency level.
- User can Unenroll himself in the courses he doesn't want to be part of it according to his language proficiency level.
- User can switch between light and dark mode of the application.
- User can rely on the chatbot for help during any inconvenience he might face with the application.
- User will have the opportunity to receive feedback on his performance.
- User will have the option to download a lesson to practice whether online or offline for better learning process.
- User will have recommendations to access cultural insights, tip and tricks when communicating in Chinese.
- The User will be able to bookmark his favorite courses or notes for future references.
- User can browse the upcoming course or even courses he wants to get enrolled or unenrolled from in his current level.
- User can edit and change his Avatar.
- User can edit and change his current username.
- User can reset his password.

2.6 Non-Functional Requirements

- **Performance (Responsiveness):** The application must respond promptly to user interactions, ensuring minimal latency during lesson loading, quiz submissions, or content navigation. High responsiveness ensures an engaging and seamless user experience.
- **Usability (Intuitive User Interface):** The app should feature an intuitive and user-friendly interface, ensuring ease of navigation, clear instructions, and straightforward access to learning modules. A visually appealing and user-centric design fosters user engagement and enhances usability.
- **Reliability (Stability and Availability):** The app should maintain a high level of stability, minimizing downtime and ensuring availability. Reliable access to learning resources, quizzes, and cultural insights is essential for consistent learning experiences.
- **Security and Privacy (Data Protection):** Ensure robust data encryption and security measures to safeguard user information, learning progress, and personal data. Compliance with data protection regulations ensures user trust and confidentiality.
- **Scalability:** Design the app with a scalable architecture to accommodate growing user bases and increased usage without compromising performance. Scalability allows for seamless addition of new features and content.
- **Compatibility and Interoperability:** Ensure compatibility with various Android versions and screen sizes to provide a consistent user experience across different phones and tablets. Interoperability with other systems or APIs facilitates seamless integration with external resources.
- **Multilingual Support:** Provide multilingual support beyond Mandarin Chinese to cater to users from diverse linguistic backgrounds. Localization enables a wider user base.

2.7 System Users

- **Learners/Students:** They are our primary users seeking to learn Mandarin Chinese, including beginners, intermediate learners, and advanced students, their role is to Engage with lessons, quizzes, cultural insights, games, and interactive exercises to improve language skills.
- **Language Instructors/Tutors:** They are responsible for creating new content, answering questions, and enhancing the learning journey of the learners.

- **Developers/Technical Support:** They will Maintain and support the technical aspects of the application, including updates, bug fixes, and enhancements and resolve technical issues, implement new features, and maintain app performance.
- **Administrators/Moderators:** Manage and administer the application, oversee content, user accounts, and overall functionality, Curate content, ensure platform integrity, manage user accounts, and address technical issues.

3. Analysis and Design

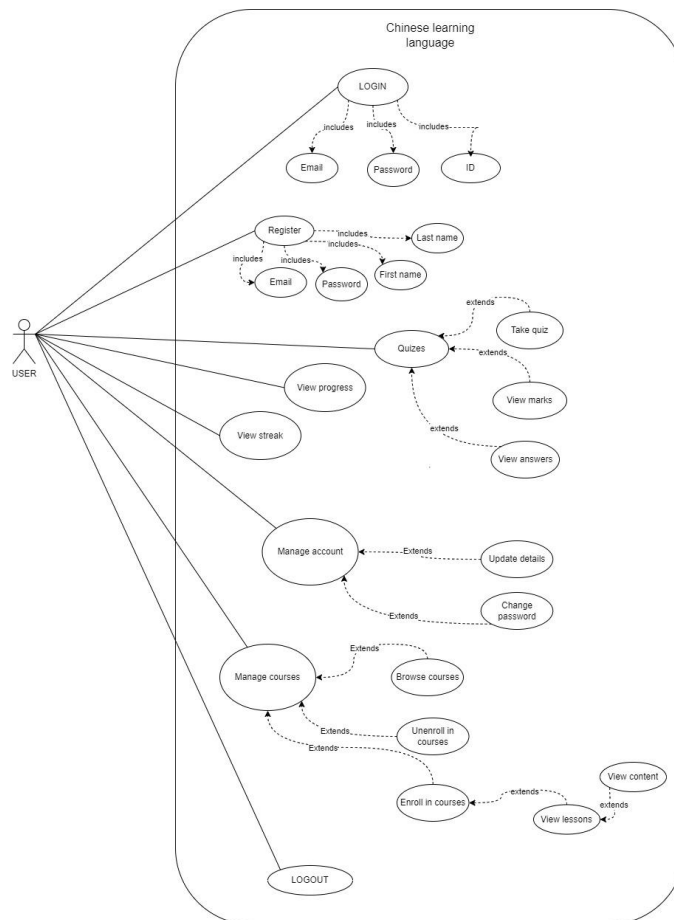
3.1 System Overview

In this section we will discuss a high-level description of the system through – diagrams.

3.1.1 Use Case Diagram

The following figure represents the actions that the user can directly perform on the system namely:

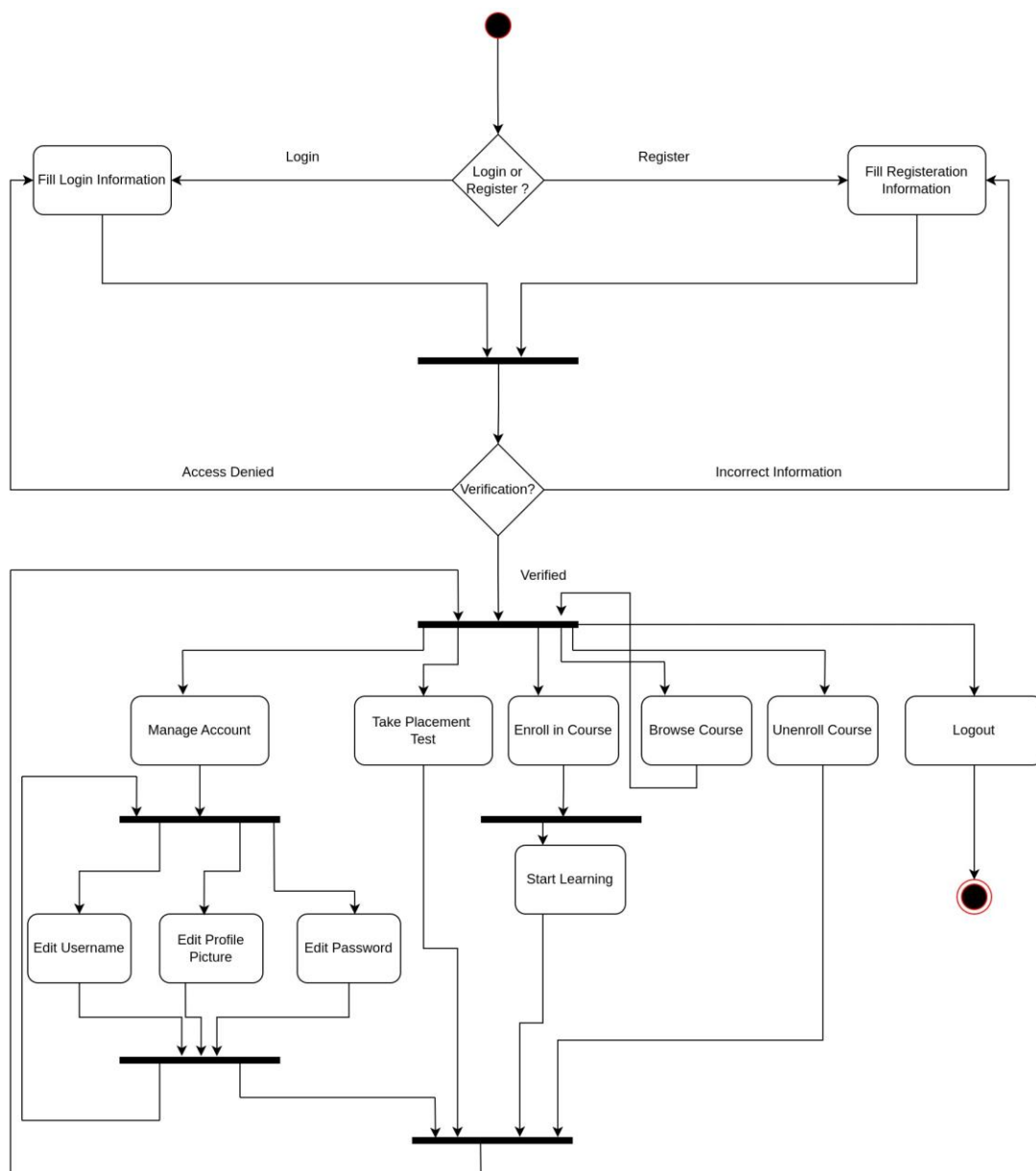
- Registering if he has no account.
- Logging in if he already has an account.
- Viewing his current Progress.
- Taking Quizzes and Test placement exams.
- Managing his own account and profile (username, passwords, avatar).
- Viewing his learning streak since the beginning of his learning journey.
- Managing his own Courses whether browsing his courses or other courses, enrolling in a new course, unenrolling from a specific course according to his level of proficiency.
- Logging out of his account.



3.1.2 Activity Diagram

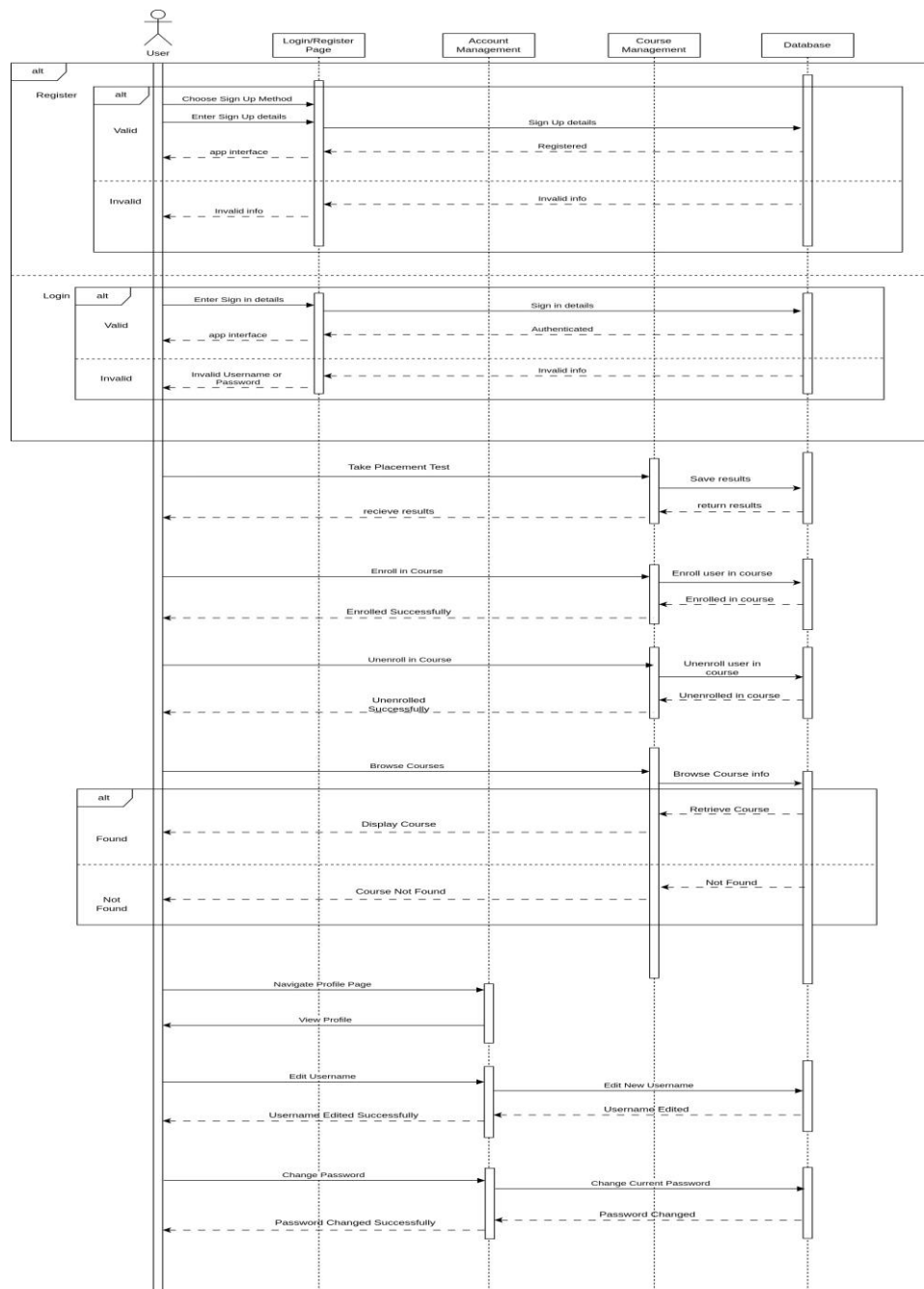
The Following figure represents the flow of activities that the user can do:

- It shows the flow of Login and Register activities, user can choose whether to login if he has account or register to create new account to access the home page. User will not be able to access the home page without verifying.
- After Logging in User can Take a placement test, enroll/unenroll in course, browse a desired course, manage his own account regarding various aspects like username and password, or he can logout.



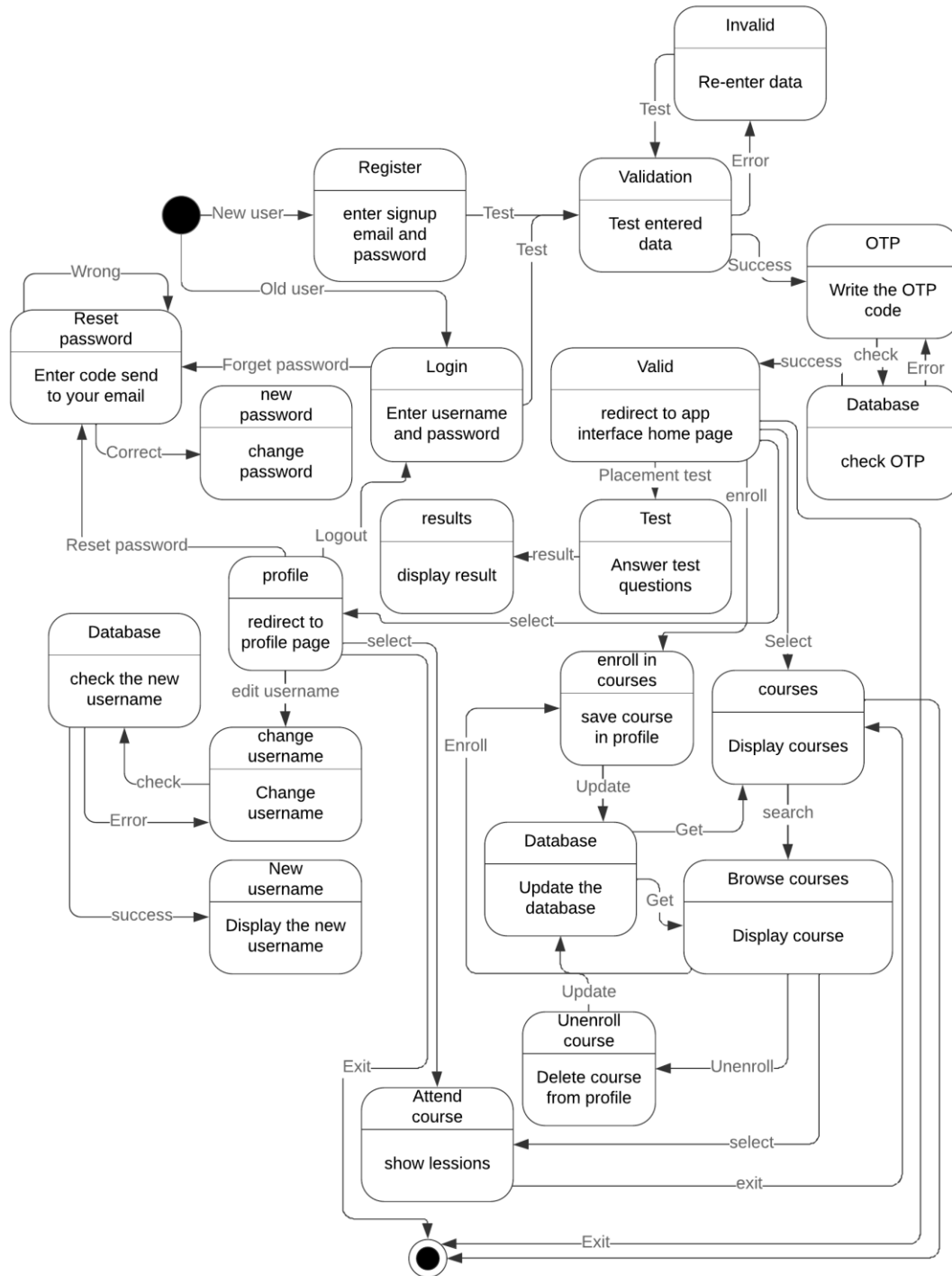
3.1.3 Sequence Diagram

The diagram describes the sequence of actions that a user can make starting by logging in if he already has an account. After providing his username and password, the system will check with the database if they are valid or not. On the other hand, if he is a new user, he can also register, and the system will add his account to the database if it is valid. Once the user logged in successfully, he can take a placement test to level his own proficiency in the language and then start his learning journey whether by enrolling in the recommended course or by browsing a specific course according to his level of knowledge, also if he is an old user and has taken a course before and want to unenroll from it he has the complete freedom to do so. Also, he could navigate to his profile for personal preferences if he wanted to change his username or password for security concerns. He can accomplish this task easily.



3.1.4 State Diagram

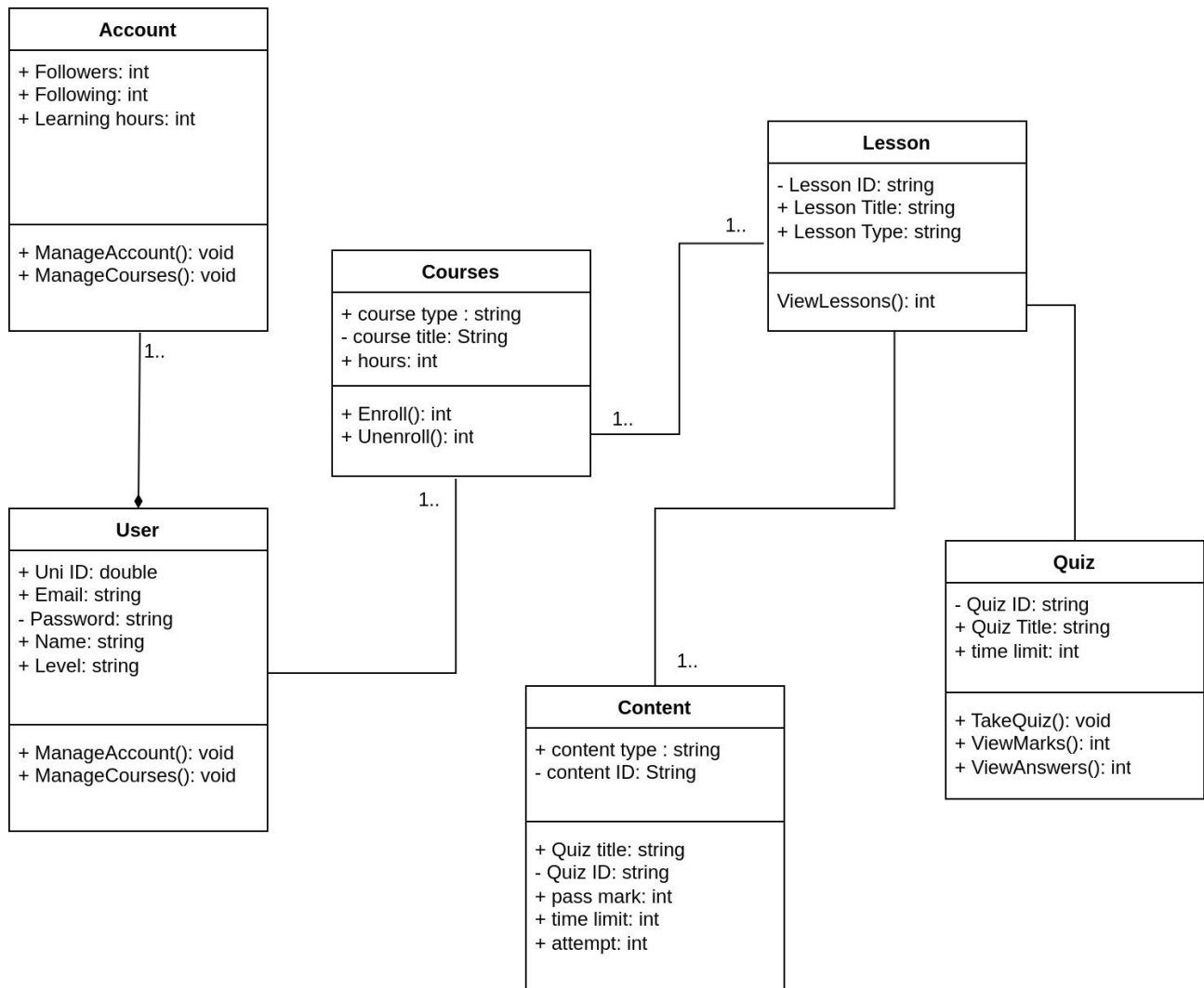
This Diagram shows the response of all the classes in the system to the user actions.



3.1.5 Class Diagram

The following figures represents the functions and attributes of the four main classes that the system use:

- User
- Account
- Courses
- Lesson
- Content
- Quiz



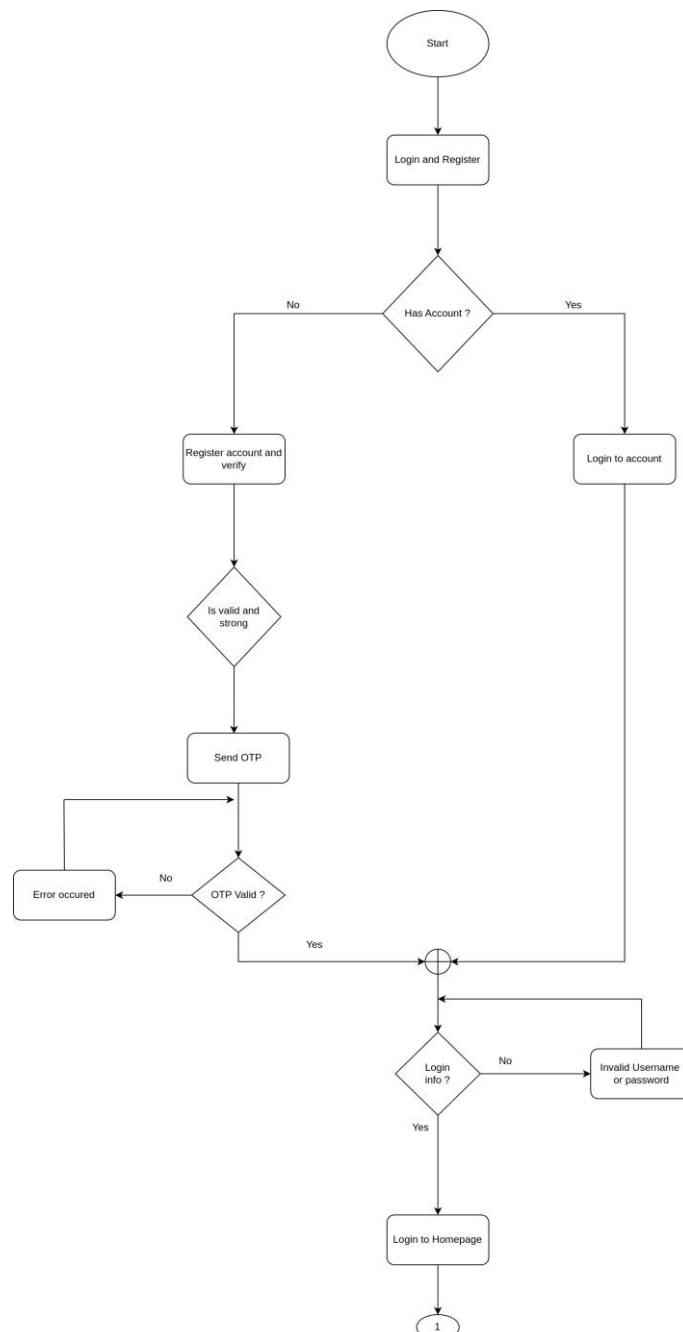
3.1.6 Flow Chart

Each one of the following flow charts represents a function in our system in detail.

3.1.6.1 Register and Login

The following figures show the steps of register and login functionalities:

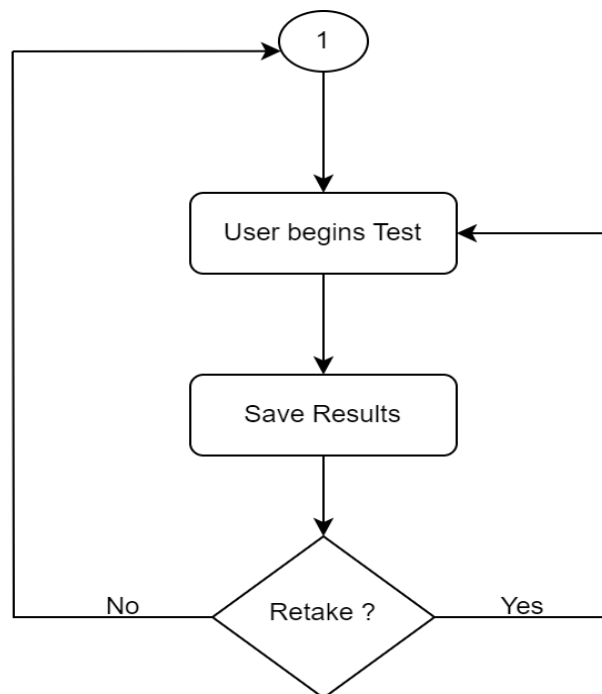
- The user either register to create new account or login by his account.
- User can login by entering username and password.
- The system will let the user access the home page if the information is valid.



3.1.6.2 Placement Test

The following figure shows the steps for Taking the placement test:

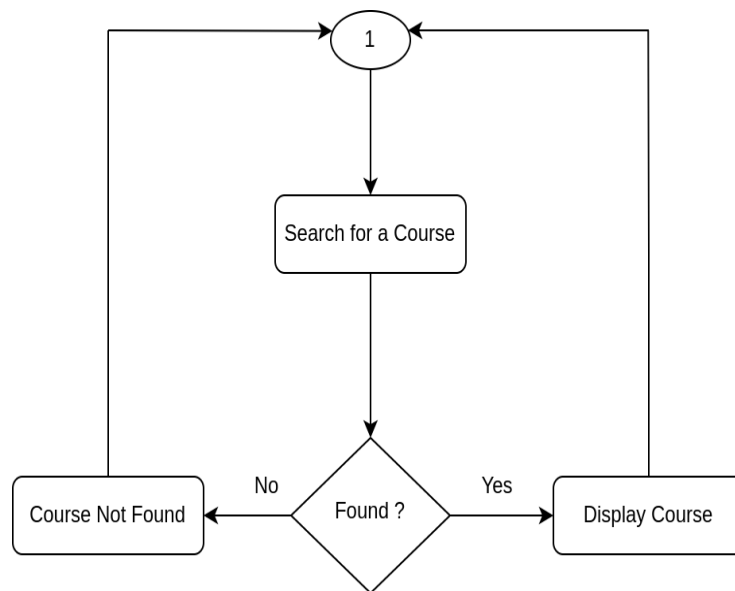
When the user has successfully logged in and prompted to the homepage, he has the option to undertake a placement test to determine his level of proficiency in the language rather than starting from a very beginning level.



3.1.6.3 Browse Courses

The following figure shows the steps of browsing a course:

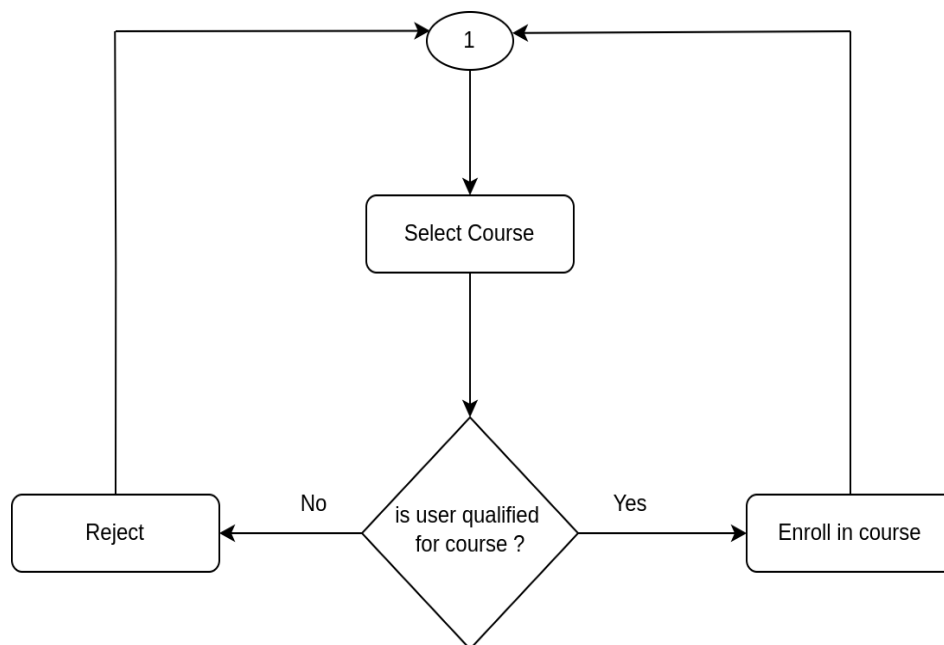
- The User enters the course name.
- The system checks whether it is available or not.



3.1.6.4 Enroll in Course

The Following figure shows the process of enrolling in a course:

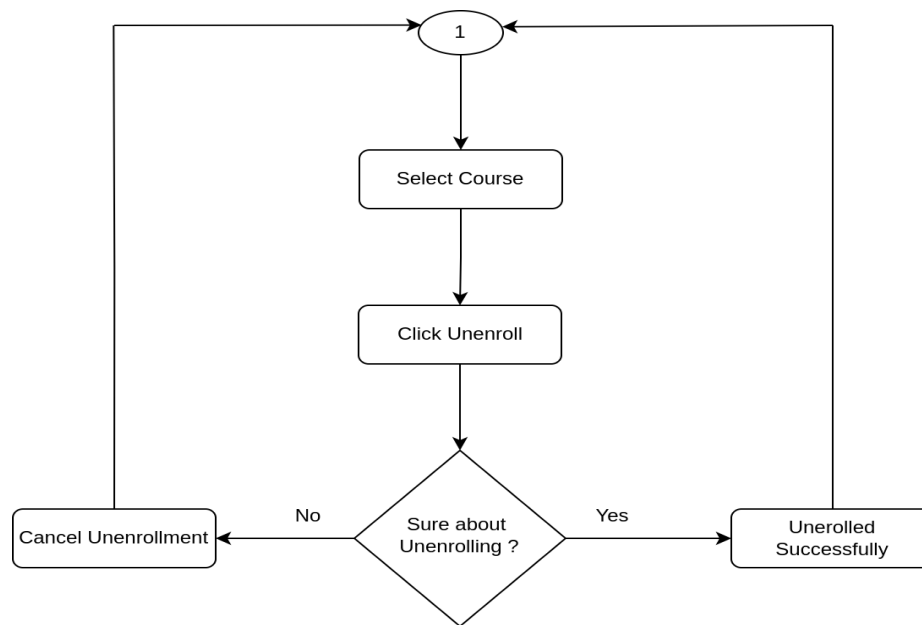
- Selecting the desired course, you want to enroll in.
- The System checks your level of proficiency to confirm this enrollment.
- Otherwise, the system will reject due to incompatibility with your level.



3.1.6.5 Unenroll in Course

The Following figure shows the process of unenrolling in a course:

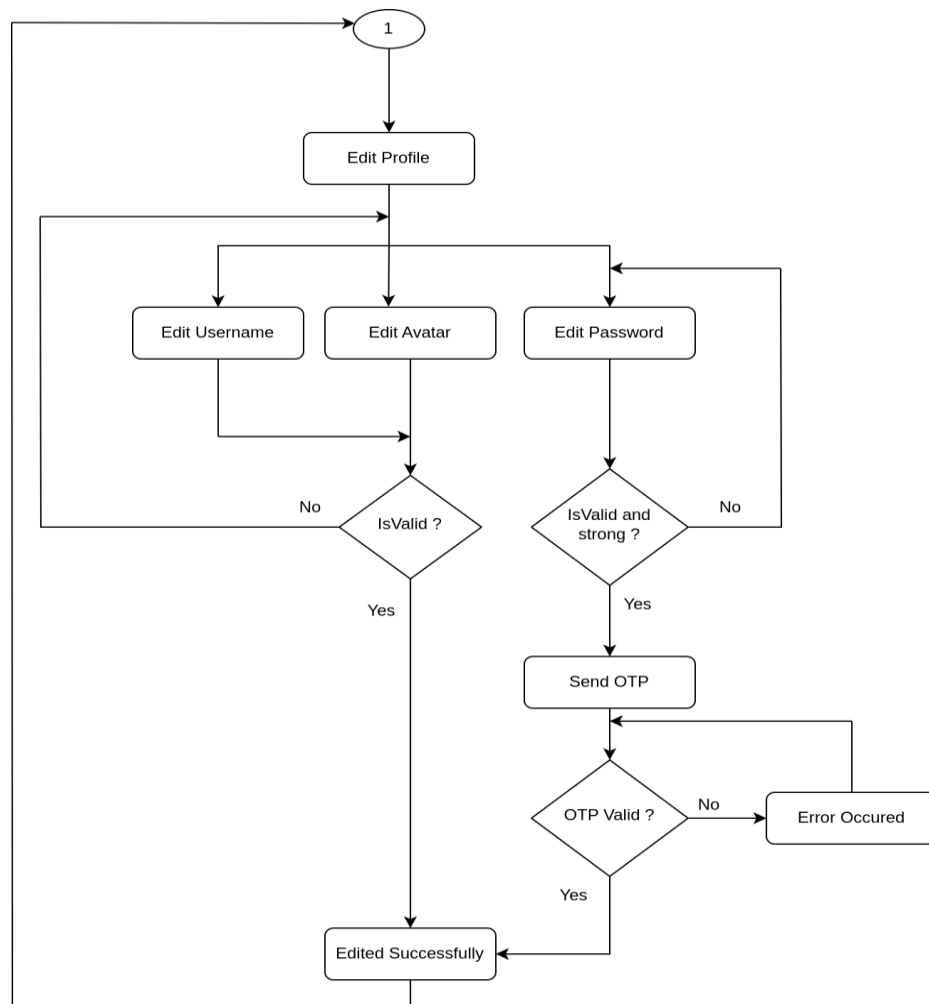
- Selecting the desired course, you want to unenroll from.
- The System prompts you with a check statement if you still want to confirm your unenrollment.
- Otherwise, the System will cancel your request.



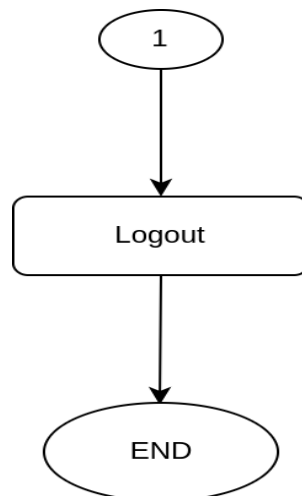
3.1.6.6 Edit Profile

The figure shows the workflow of edit profile functions:

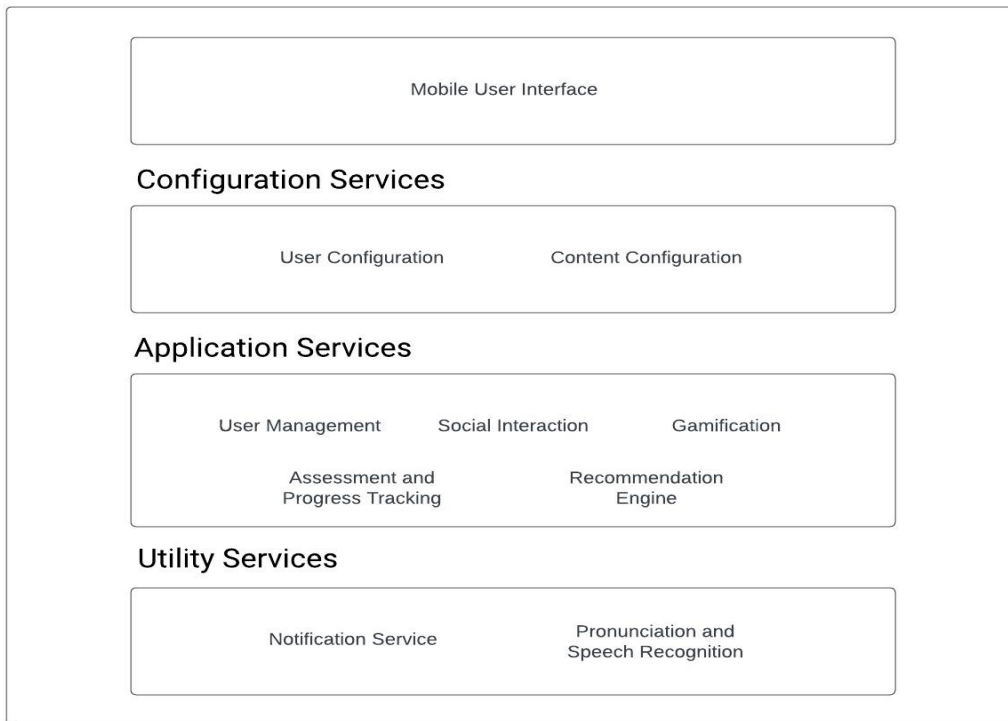
- When the user chooses to edit his profile, he can edit his password, Avatar, or password.
- We took special care of the password from a security perspective and added “OTP” to enhance this aspect.
- If the password is valid but the OTP is incorrect the user can’t change the password.



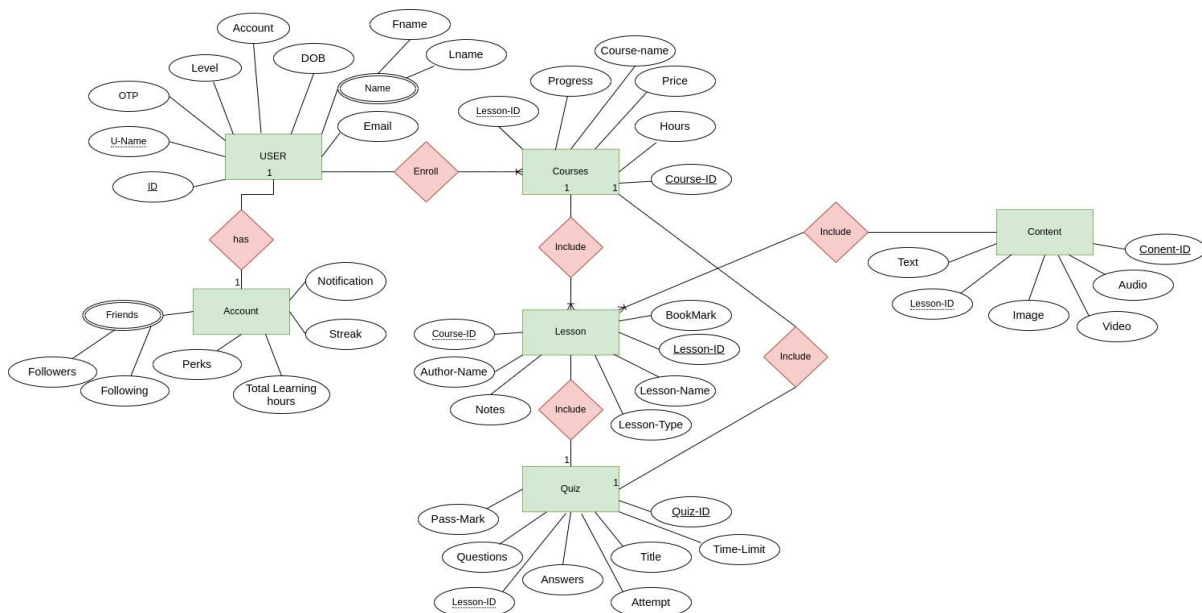
3.1.6.7 Logout



3.1.7 System Architecture



3.1.8 Entity Relationship Diagram



Application Design Interface



Application Start

9:30

←

Get Started

start learning!!

● ● ●

First name Last name

Username

Day Month Year


Gender ▼

Signup

Already have account? **Log In**

OR

Sign in using



9:30

WELCOME BACK!

Username

Password


[forget password?](#)

LOGIN

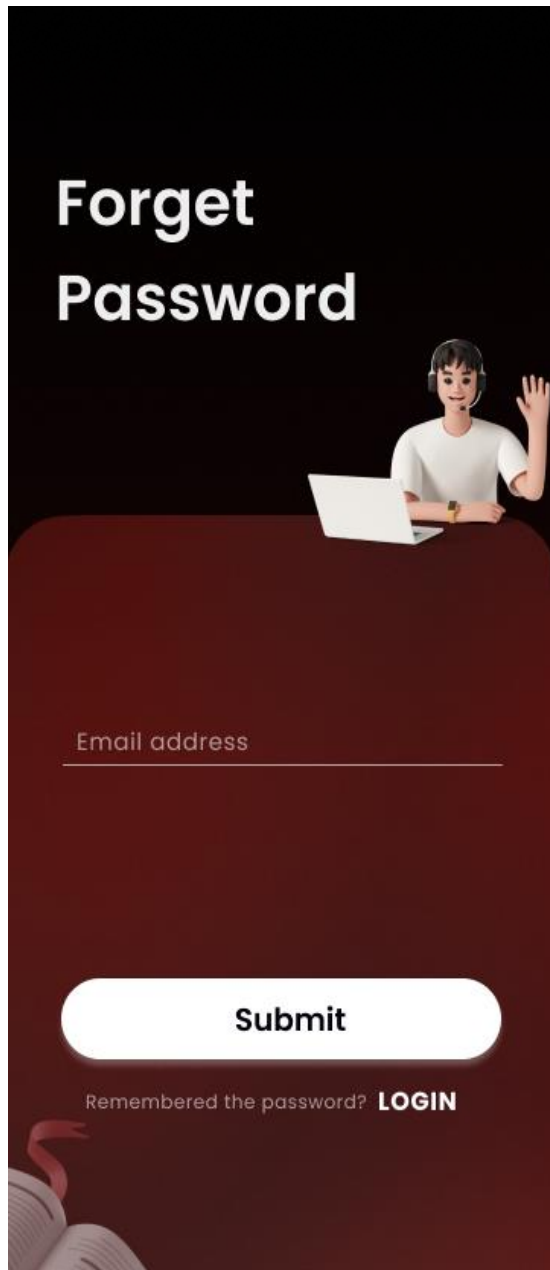
Don't have account? **SIGNUP**

OR


Sign in using



Application Start




Forgot Password

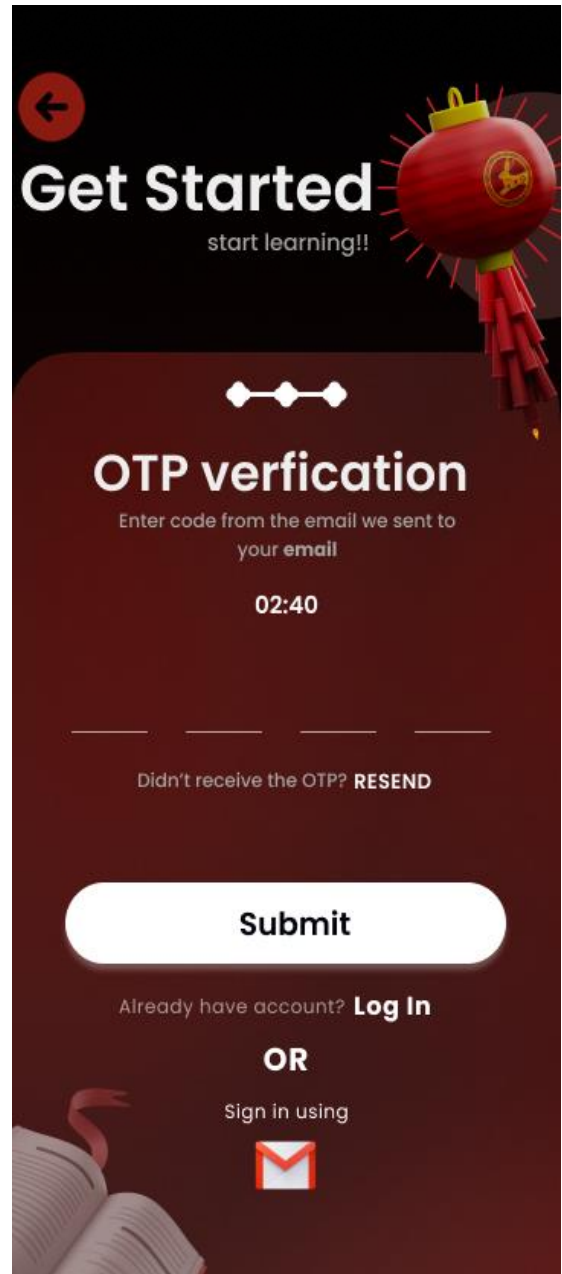




Email address


Submit

Remembered the password? **LOGIN**





 **Get Started**
start learning!! 



OTP verification
Enter code from the email we sent to your email


02:40


Didn't receive the OTP? **RESEND**

Submit


Already have account? **Log In**

OR

Sign in using 



Passwords

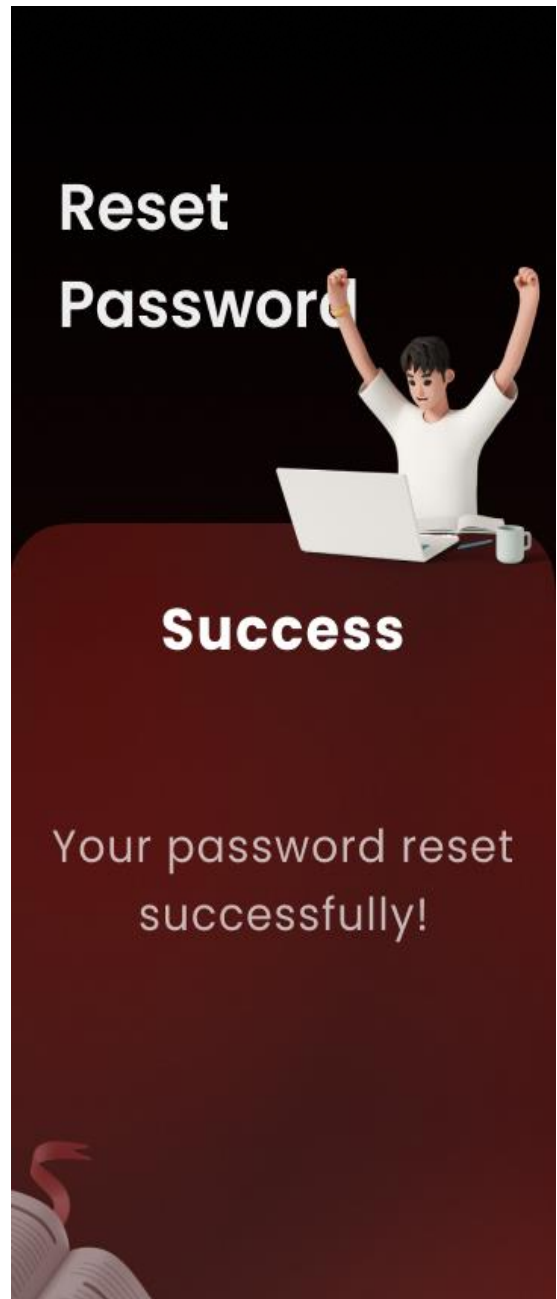



Reset Password

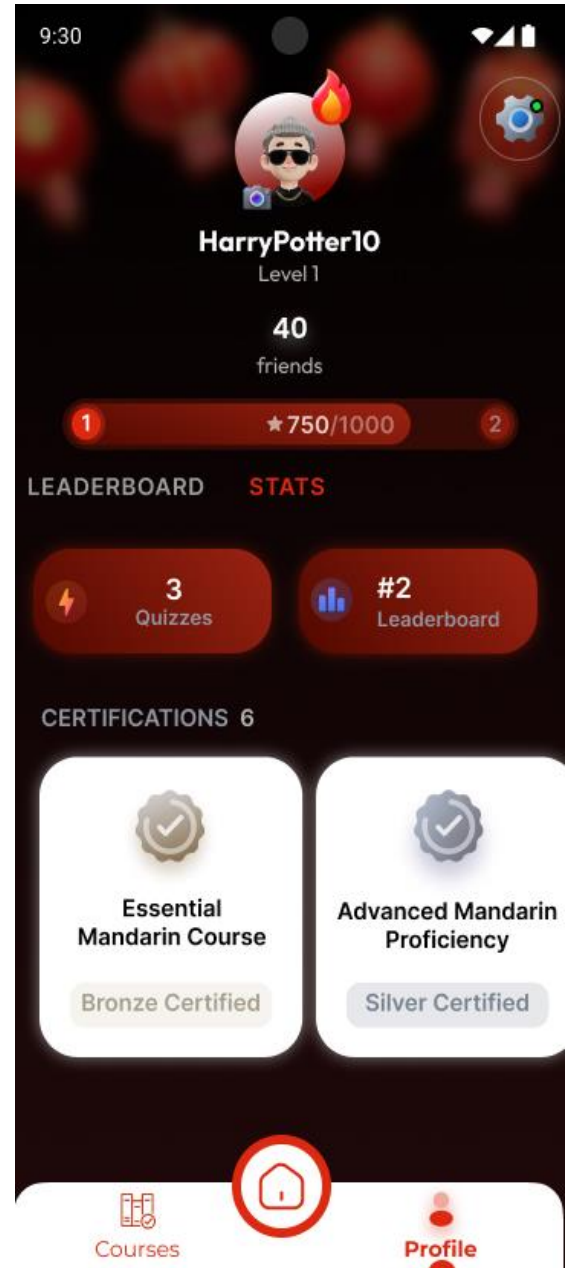
New Password

Confirm Password

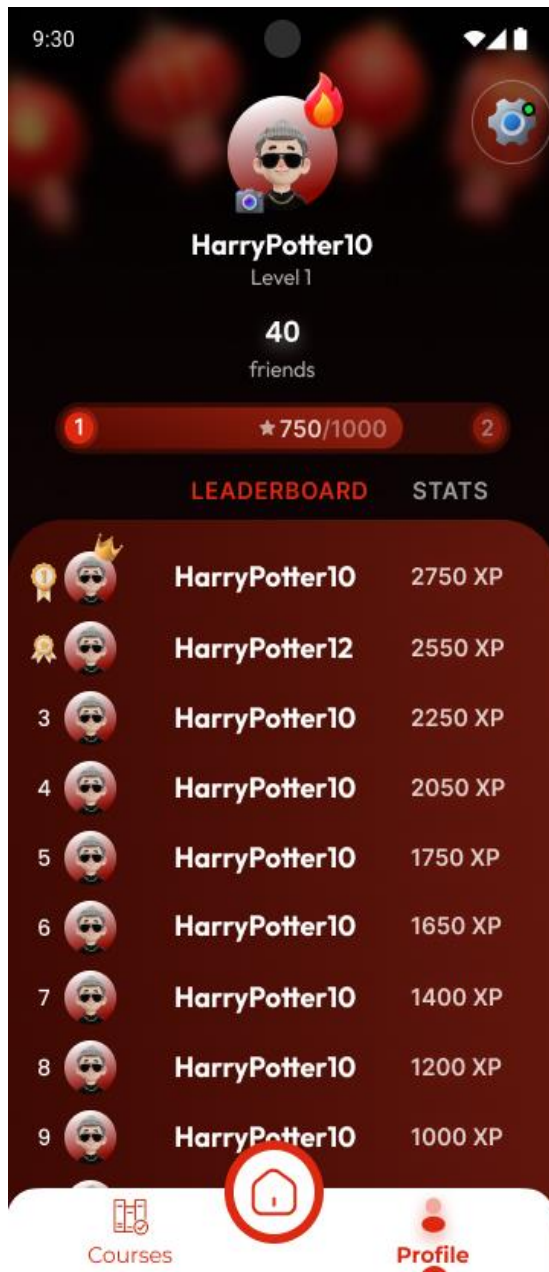
Submit



Homepage



Options



Exercises

 Course details



Chinese HSK 1

Enroll Now

Welcome to our Chinese HSK 1 course, designed to introduce you to the basics of Mandarin Chinese! Whether you're a complete beginner or looking to brush up on your language skills, this course is perfect for learners at the foundational level....

About this course

150 Words, 300 Example Sentences, with Audio


450 audio


90 ratings


3.9k enrolled

After completion badge


Beginner Chinese
HSK 1
Bronze Certified



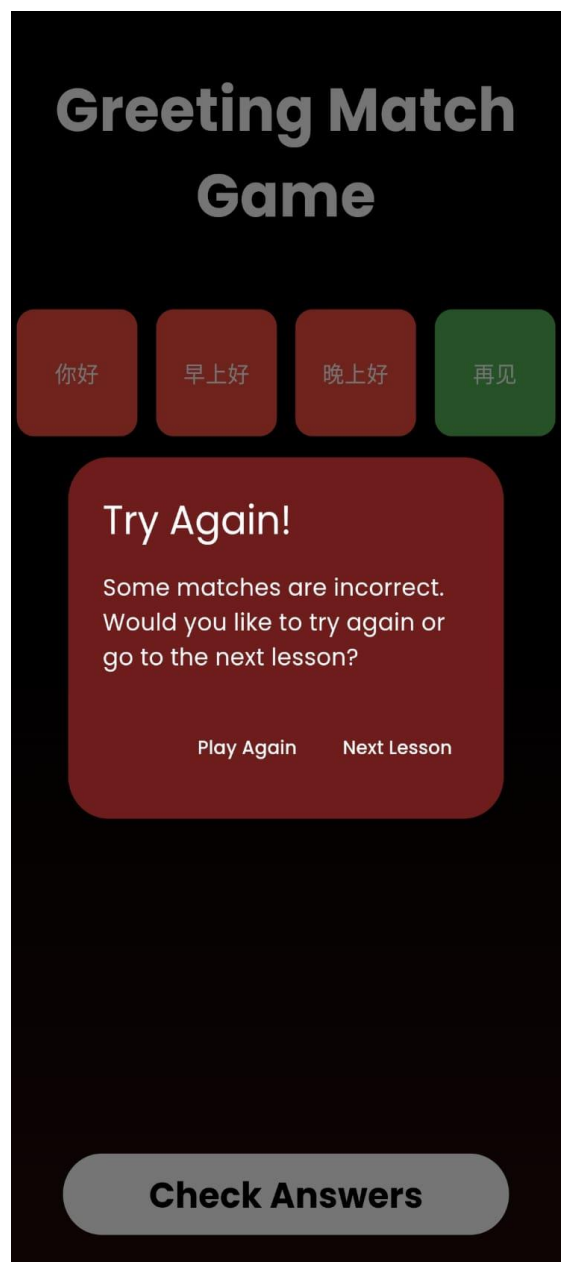
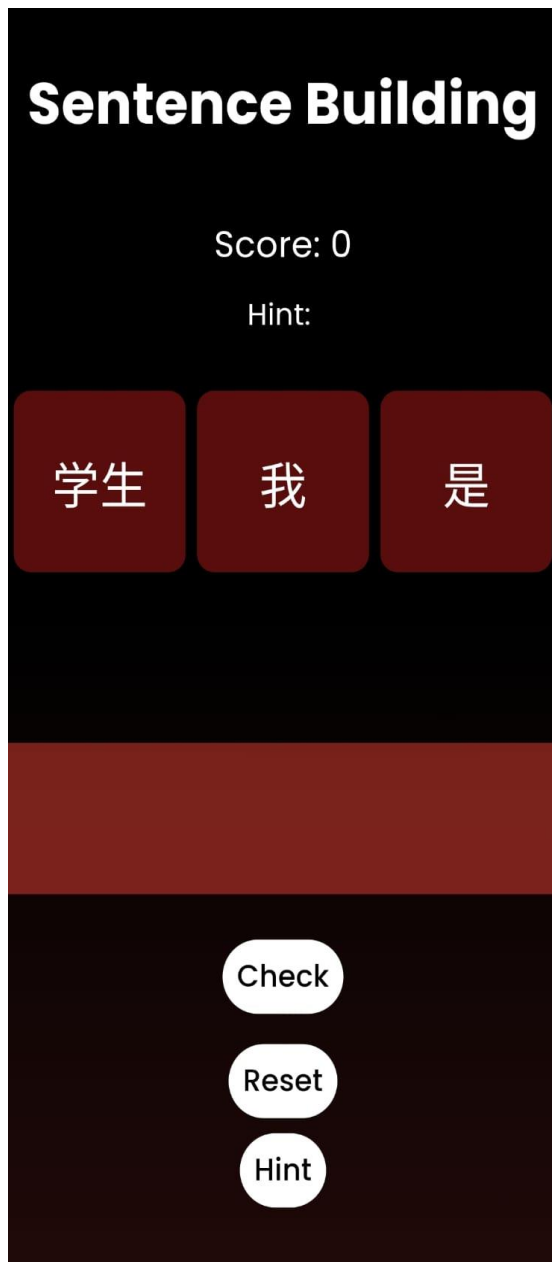


Welcome to Chinese Tones

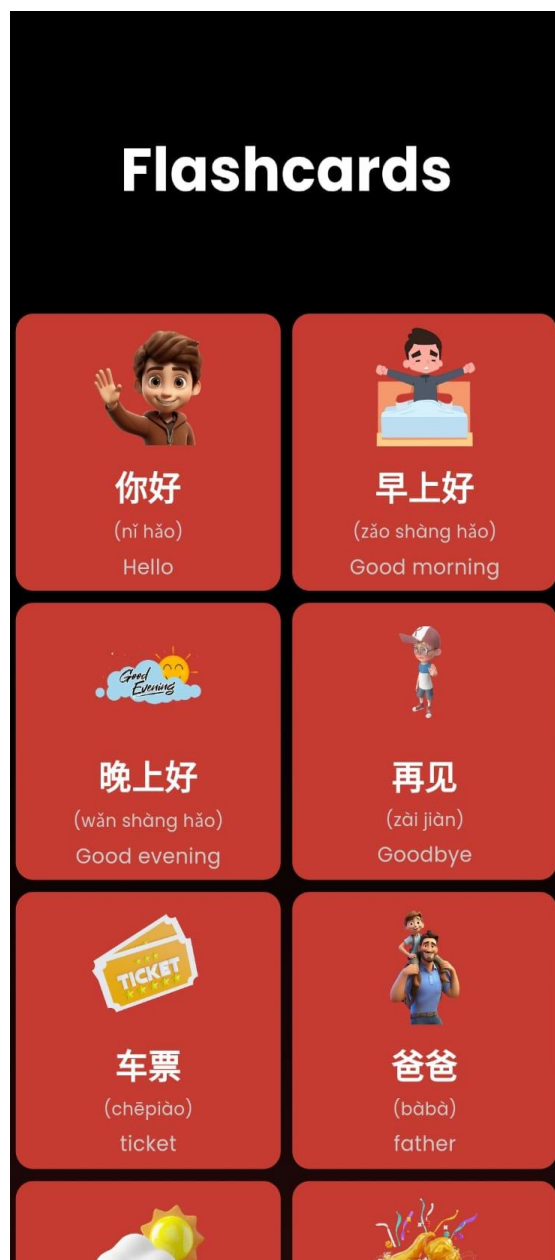
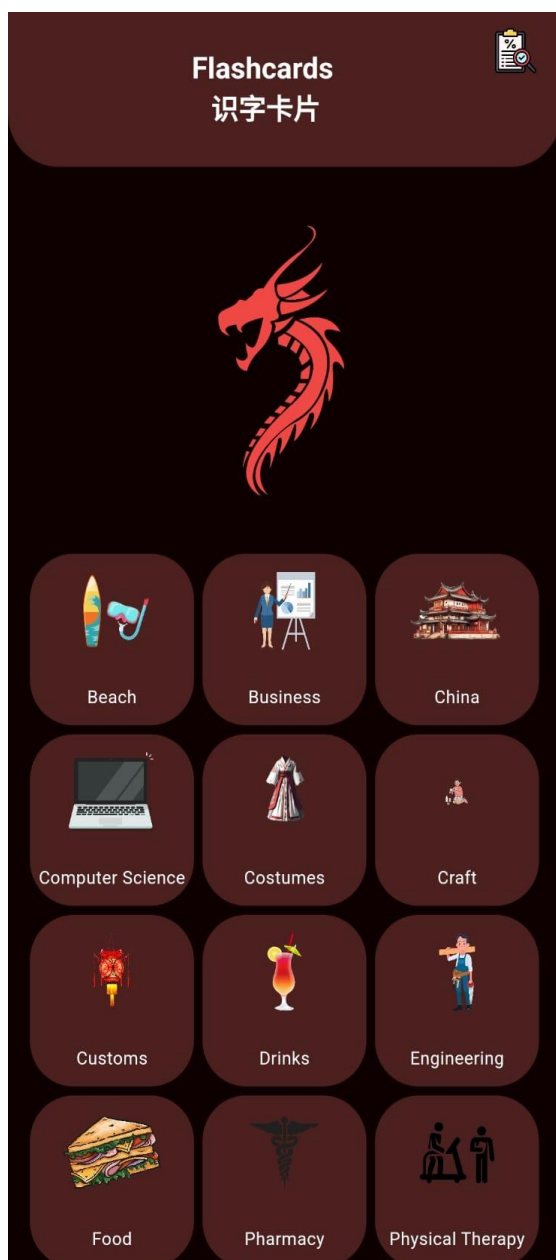
In this lesson, you will learn about the different tones in the Chinese language.

Skip  →

Tasks



Flashcards



Dialogues and Speaking



4. Analysis and Design

4.1 The Proposed Dataset

COCO (Common Objects in Context) is a widely used dataset containing over 330,000 images, with more than 200,000 labeled for object detection, segmentation, and captioning tasks. It encompasses 1.5 million object instances across 80 categories, including everyday objects like people, vehicles, and furniture.

4.1.1 Benefits

The COCO-SSD dataset provides a robust foundation for training object detection models. While not directly related to the Mandarin language itself, this model can be leveraged for future functionalities within CLA, such as: Recognizing objects within educational images used in lessons (e.g., identifying objects in cultural scenes), Developing features for visually impaired users where the application describes objects within the learning materials.

4.1.2 Dataset Overview

#	Word
1	Person
2	Bicycle
3	Car
4	Motorcycle
5	Airplane
6	Bus
7	Train
8	Truck
9	Boat
10	Traffic light
11	Fire hydrant
12	Stop sign
13	Parking meter
14	Bench
15	Bird
16	Cat
17	Dog
18	Horse
19	Sheep
20	Cow
21	Elephant
22	Bear
23	Zebra
24	Giraffe
25	Backpack

26	Umbrella
27	Handbag
28	Tie
29	Suitcase
30	Frisbee
31	Skis
32	Snowboard
33	Sports ball
34	Kite
35	Baseball bat
36	Baseball glove
37	Skateboard
38	Surfboard
39	Tennis racket
40	Bottle
41	Wine glass
42	Cup
43	Fork
44	Knife
45	Spoon
46	Bowl
47	Banana
48	Apple
49	Sandwich
50	Orange
51	Broccoli
52	Carrot
53	Hot dog
54	Pizza
55	Donut
56	Cake
57	Chair
58	Couch
59	Potted plant
60	Bed
61	Dining table
62	Toilet
63	Tv
64	Laptop
65	Mouse
66	Remote
67	Keyboard
68	Cell phone

4.2 Confidence Level

```
▼ Array(3) i
  ► 0: {bbox: Array(4), class: 'cell phone', score: 0.8645135164260864}
  ► 1: {bbox: Array(4), class: 'person', score: 0.7989416122436523}
  ► 2: {bbox: Array(4), class: 'car', score: 0.7637920379638672}
```

```
► 0: {bbox: Array(4), class: 'frisbee', score: 0.9023279547691345}
► 1: {bbox: Array(4), class: 'person', score: 0.5593554973602295}
```

```
► 0: {bbox: Array(4), class: 'person', score: 0.8409362435340881}
► 1: {bbox: Array(4), class: 'chair', score: 0.5507715344429016}
```

```
► 1: {bbox: Array(4), class: 'book', score: 0.6903945803642273}
► 2: {bbox: Array(4), class: 'scissors', score: 0.5886860489845276}
```

```
► 0: {bbox: Array(4), class: 'toothbrush', score: 0.6521158814430237}
length: 1
```

```
► 0: {bbox: Array(4), class: 'clock', score: 0.8150805830955505}
```

5. Conclusion and Future work

5.1 Conclusion

In conclusion, The Chinese Learning Application (CLA) stands as a testament to the power of technology in revolutionizing language acquisition. Designed specifically for Mandarin Chinese learners, CLA goes beyond traditional methods by offering a comprehensive, interactive, and user-centric learning experience. CLA meticulously crafts a progressive learning path, ensuring a solid foundation in essential language skills. Structured lessons encompass vocabulary development, grammar mastery, reading comprehension, writing practice, listening comprehension, and spoken communication skills. Learners can confidently embark on their Mandarin learning journey, knowing they are guided by a well-defined curriculum.

Learning a language can be a challenging but rewarding endeavor. CLA acknowledges this by incorporating interactive exercises and quizzes into its framework. These engaging activities not only solidify understanding of newly introduced concepts but also act as a fun and effective way to assess progress. Furthermore, CLA leverages the power of gamification by introducing elements of play. Points, badges, and levels create a sense of accomplishment and motivate users to continue

their learning journey. This playful approach not only fosters engagement but also makes language acquisition more enjoyable.

Language learning extends beyond memorizing vocabulary and grammar rules. CLA recognizes the importance of cultural context and provides users with access to insightful content. This curated content delves into various aspects of Chinese culture, customs, and traditions. By understanding the cultural nuances woven into the language, learners gain a deeper appreciation for Mandarin Chinese and its rich heritage.

CLA empowers learners by tailoring the learning experience to their individual needs. Adaptive learning paths analyze learner proficiency, preferences, and learning objectives. This allows the application to recommend courses and activities that cater to each user's specific requirements.

Additionally, progress-tracking functionalities allow users to monitor their performance, celebrate achievements, and identify areas for improvement. This personalized approach fosters a sense of ownership and empowers learners to take control of their Mandarin learning journey.

The Chinese Learning Application (CLA) is a groundbreaking platform designed to empower individuals seeking to acquire proficiency in Mandarin Chinese. Its innovative features, emphasis on user engagement, and focus on cultural context make CLA a valuable tool for learners at all levels. CLA has the potential to revolutionize the way people learn Mandarin Chinese, making the journey engaging, personalized, and ultimately, successful.

5.2 Future Work

The Chinese Learning Application (CLA) has a bright future with exciting possibilities for further development. Here are some key areas we'll focus on:

- **Enhanced Machine Learning Model:** We plan to refine the current ML model trained on the COCO-SSD dataset to detect a wider range of labels. This will allow for more nuanced feedback and personalized learning experiences. Additionally, we can explore the integration of other advanced models to further improve accuracy and provide features like sentiment analysis in conversations.
- **Enriched Course Materials and Gamification:** While offering high-quality learning modules, we aim to continuously add and upgrade course materials. This includes exploring optional advanced pricing quizzes for users seeking deeper challenges. Furthermore, we plan to develop a more sophisticated gamification system with dynamic rewards and engaging activities, motivating users to stay engaged and progress through the courses.
- **Collaborations and Learning Paths:** We recognize the value of human interaction. We plan to collaborate with qualified Chinese tutors to offer personalized learning guidance and support. Additionally, we aim to refine the adaptive learning algorithm to create more structured learning paths based on individual user needs and goals. This will ensure a more efficient and effective learning journey.
- **Cultural Exchange and Real-time Interaction:** CLA can be a bridge between cultures. We plan to construct video and text-based cultural exchange channels where users can interact with native speakers and immerse themselves in Chinese culture. Implementing a real-time translator would further empower users to confidently navigate conversations during travel or online interactions.
- **Accredited Learning and Global Expansion:** We are pursuing official authorization from established Chinese language centers in Egypt to offer accredited certificates and badges for completed courses. This will add significant value to the learning experience and enhance user

recognition of their achievements. Additionally, we plan to scale the application to integrate with other universities and learning institutions, expanding our reach and fostering a global learning community.

- **Robust Security and Scalability:** As CLA grows, robust security measures are crucial. We will continue to implement cutting-edge security protocols to protect user data and ensure complete peace of mind. Finally, scaling our application to ingest data from other universities and languages will require a robust and scalable architecture. By prioritizing scalability, we ensure CLA can accommodate a growing user base and future expansion plans.

Appendix

```
const labelMap = {  
  person: "人 (rén)",  
  bicycle: "自行车 (zìxíngchē)",  
  car: "汽车 (qìchē)",  
  motorcycle: "摩托车 (mótuōchē)",  
  airplane: "飞机 (fēijī)",  
  bus: "公共汽车 (gōnggòng qìchē)",  
  train: "火车 (huǒchē)",  
  truck: "卡车 (kǎchē)",  
  boat: "船 (chuán)",  
  "traffic light": "交通灯 (jiāotōng dēng)",  
  "fire hydrant": "消防栓 (xiāofáng shuān)",  
  "stop sign": "停车标志 (tíngchē biāozhì)",  
  "parking meter": "停车计时器 (tíngchē jìshíqì)",  
  bench: "长凳 (chángdèng)",  
  bird: "鸟 (niǎo)",  
  cat: "猫 (māo)",  
  dog: "狗 (gǒu)",  
  horse: "马 (mǎ)",  
  sheep: "羊 (yáng)",  
  cow: "牛 (niú)",  
  elephant: "大象 (dàxiàng)",  
  bear: "熊 (xióng)",  
  zebra: "斑马 (bānmǎ)",  
  giraffe: "长颈鹿 (chángjǐnglù)",  
  backpack: "背包 (bēibāo)",  
  umbrella: "雨伞 (yǔsǎn)",  
  handbag: "手提包 (shǒutí bāo)",  
  tie: "领带 (lǐngdài)",
```

```
suitcase: "手提箱 (shǒutí xiāng)",  
frisbee: "飞盘 (fēipán)",  
skis: "滑雪板 (huáxuě bǎn)",  
snowboard: "滑雪板 (huáxuě bǎn)",  
"sports ball": "运动球 (yùndòng qiú)",  
kite: "风筝 (fēngzhēng)",  
"baseball bat": "棒球棒 (bàngqiú bàng)",  
"baseball glove": "棒球手套 (bàngqiú shǒutào)",  
skateboard: "滑板 (huábǎn)",  
surfboard: "冲浪板 (chōnglàng bǎn)",  
"tennis racket": "网球拍 (wǎngqiú pāi)",  
bottle: "瓶子 (píngzi)",  
"wine glass": "酒杯 (jiǔbēi)",  
cup: "杯子 (bēizi)",  
fork: "叉子 (chāzi)",  
knife: "刀 (dāo)",  
spoon: "勺子 (sháozi)",  
bowl: "碗 (wǎn)",  
banana: "香蕉 (xiāngjiāo)",  
apple: "苹果 (píngguǒ)",  
sandwich: "三明治 (sānmíngzhì)",  
orange: "橙子 (chéngzi)",  
broccoli: "西兰花 (xīlánhuā)",  
carrot: "胡萝卜 (húluóbo)",  
"hot dog": "热狗 (règǒu)",  
pizza: "比萨 (bǐsà)",  
donut: "甜甜圈 (tiántián quān)",
```

```

donut: "甜甜圈 (tiántián quān)",
cake: "蛋糕 (dàngāo)",
chair: "椅子 (yǐzi)",
couch: "沙发 (shāfā)",
"potted plant": "盆栽 (pénzāi)",
bed: "床 (chuáng)",
"dining table": "餐桌 (cānzhuō)",
toilet: "厕所 (cèsuǒ)",
tv: "电视 (diànshì)",
laptop: "笔记本电脑 (bǐjìběn diànnǎo)",
mouse: "鼠标 (shǔbiāo)",
remote: "遥控器 (yáokòngqì)",
keyboard: "键盘 (jiànpán)",
"cell phone": "手机 (shǒujī)",
microwave: "微波炉 (wēibōlú)",
oven: "烤箱 (kǎoxiāng)",
toaster: "烤面包机 (kǎo miànbāo jī)",
sink: "水槽 (shuǐcáo)",
refrigerator: "冰箱 (bīngxiāng)",
book: "书 (shū)",
clock: "时钟 (shízhōng)",
vase: "花瓶 (huāpíng)",
scissors: "剪刀 (jiǎndāo)",
"teddy bear": "泰迪熊 (tàidíxióng)",
"hair drier": "吹风机 (chuīfēngjī)",
toothbrush: "牙刷 (yáshuā)",

```

```

const colorMap = {};

export const drawRect = (detections, ctx) => {
  detections.forEach((predictions) => {
    // Get predictions results
    const [x, y, width, height] = predictions["bbox"];
    const text = predictions["class"];

    const chineseText = labelMap[text];

    if (!colorMap[text]) {
      colorMap[text] = getRandomColor();
    }
    // Set styling
    const color = colorMap[text];
    ctx.strokeStyle = color;
    ctx.lineWidth = 3;
    ctx.font = "18px Arial";
    ctx.fillStyle = color;

    // Draw rectangles and text
    ctx.beginPath();
    ctx.rect(x, y, width, height);
    ctx.stroke();
  });
}

```

```
// Draw text background
const textMetrics = ctx.measureText(chineseText);
const textWidth = textMetrics.width;
const textHeight = parseInt(ctx.font, 10); // Get text height from font size
ctx.fillRect(x, y - textHeight - 5, textWidth + 10, textHeight + 10);

// Draw text
ctx.fillStyle = "black"; // Set text color to black
ctx.fillText(chineseText, x + 3, y - 5);
});
};

function getRandomColor() {
  const letters = "0123456789ABCDEF";
  let color = "#";
  for (let i = 0; i < 6; i++) {
    color += letters[Math.floor(Math.random() * 16)];
  }
  return color;
}
```

References

- [1] Li, J., & Zhao, X. (2018). The Application of Speech Recognition Technology in English Teaching. *International Journal of Emerging Technologies in Learning (iJET)*, 13(2), 126-138.
- [2] Wang, Y., Xu, J., & Zhang, L. (2019). *The Application of Gamification in English Learning. *Journal of Physics: Conference Series*, 1234(1), 012345.
- [3] Chen, H., Wu, H., & Liu, Y. (2020). Adaptive Learning in Intelligent Educational Systems. *IEEE Transactions on Learning Technologies*, 13(3), 572-585.
- [4] Jiang, X., & Ma, Z. (2017). The Importance of Multimodal Learning in Language Acquisition. *Proceedings of the 12th International Conference on Mobile Learning Applications and Technologies*.
- [5] Li, H., Sun, C., & Zhang, J. (2019). Personalized Language Learning Based on AI and Big Data. *IEEE Transactions on Learning Technologies*, 12(4), 567-580.
- [6] Zhang, L., Chen, Y., & Wang, Q. (2021). Augmented Reality and Virtual Reality in Language Learning: A Comprehensive Review. *International Journal of Computer-Assisted Language Learning and Teaching*, 11(3), 45-63.
- [7] Wang, X., & Liu, Y. (2020). Enhancing Collaborative Learning in Language Acquisition through Social Interaction. *Educational Technology & Society*, 23(1), 214-227.
- [8] Brown, T. (2008). Design Thinking. *Harvard Business Review*.
- [9] Kelley, D., & Kelley, T. (2013). *Creative Confidence: Unleashing the Creative Potential Within Us All*. Crown Business.
- [10] Plattner, H., Meinel, C., & Leifer, L. (Eds.). (2011). *Design Thinking: Understand – Improve – Apply*. Springer.
- [11] "Natural Language Processing with Python" by Steven Bird, Ewan Klein, and Edward Loper.
- [12] "Neural Machine Translation by Jointly Learning to Align and Translate" by Dzmitry Bahdanau, Kyunghyun Cho, and Yoshua Bengio.
- [13] "Deep Speech: Scaling up end-to-end speech recognition" by A. Hannun, et al.

[14] "Tacotron: Towards End-to-End Speech Synthesis" by Y. Wang, R. Skerry-Ryan, and D. Stanton.

[15] "A Survey of Adaptive Learning in Intelligent Tutoring Systems" by G. K. W. Wong and R. M. Looi.

[16] "Machine Learning for Language Learning and Processing" by L. R. King and S. C. Haque.

[17] "Gamification in Education: A Systematic Mapping Study" by J. Deterding, et al.

[18] "Applying Game Design Principles to Educational Software" by J. Van Eck.

[19] Liu, Y., & Xu, S. (2020). Personalized Learning Systems Based on Deep Learning for Chinese Language Education. *Journal of Educational Technology & Society*, 23(2), 112-125.

[20] Zhang, L., & Li, J. (2019). Design and Development of a Gamified Mobile App for Mandarin Chinese Learning. *Proceedings of the International Conference on Computer-Assisted Language Learning*.

[21] Wang, Q., & Chen, H. (2018). Augmented Reality for Cultural Immersion in Language Learning: A Case Study of Mandarin Chinese. *International Journal of Computer-Assisted Language Learning and Teaching*, 8(3), 45-58.

[22] Li, X., & Wu, Y. (2017). Real-time Speech Evaluation System for Mandarin Chinese Learners. *IEEE Transactions on Learning Technologies*, 10(4), 567-580.

[23] Yu, M. Kang, Y. Chen, J. Wu and X. Zhao, "Acoustic Modeling Based on Deep Learning for Low-Resource Speech Recognition: An Overview," in *IEEE Access*, vol. 8, pp. 163829-163843, 2020.